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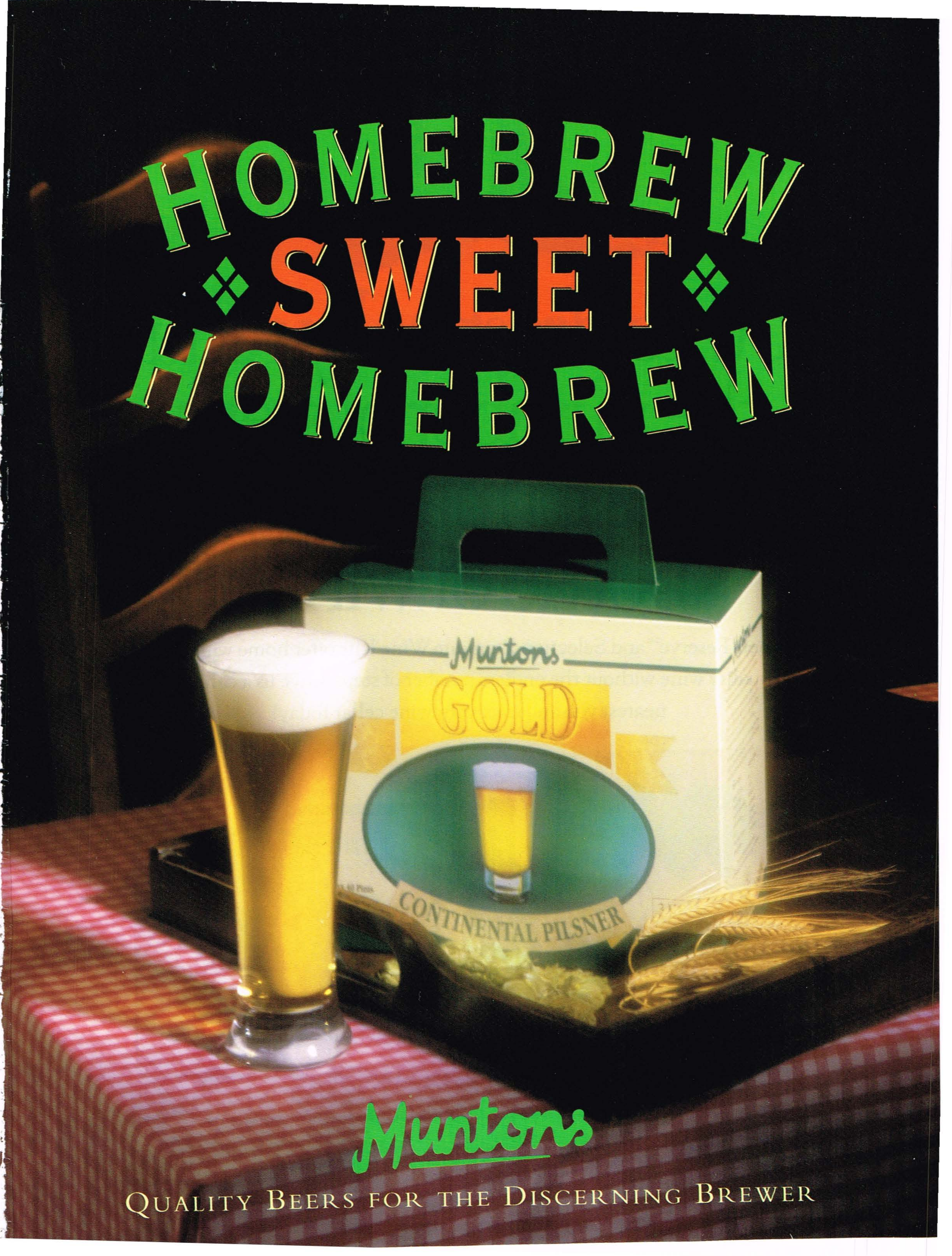
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To promote public awareness and appreciation of the quality and variety of beer through education, research and the collection and dissemination of information; to serve as a forum for the technological and cross-cultural aspects of the art of brewing; and to encourage responsible use of beer as an alcohol-containing beverage.

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Zymurgy \ zī'mər jē \ *n: the art and science of fermentation, as in brewing.*

THE GREAT GRAIN ISSUE

GRAIN: THE HEART OF BEER

PRINCIPLE AND PRACTICE

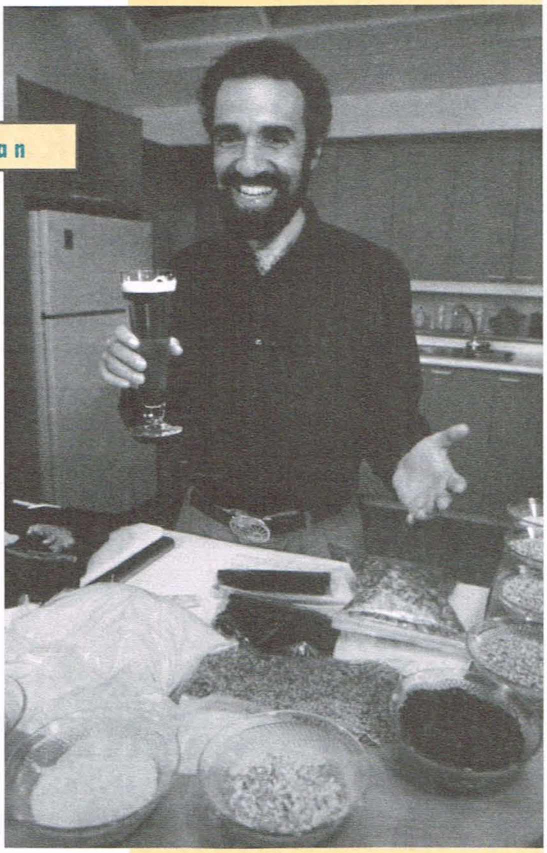
GEAR AND SYSTEMS

SPECIAL ISSUE COLUMNS

COVER BY MICHAEL LICHTER PHOTOGRAPHY

Ten Years Later and a New Approach

By Charlie Papazian



Each spring fields of grain emerge from the prairies where I live in Colorado. By July the green turns gold. Wheat, oats, barley — their long stems curved low with anticipation of harvest.

Have you ever walked through a field of grain? Its simplicity continues to fascinate me despite all I know of what we turn those kernels into. The ripened seeds seem so simple, yet fascinating. Their simplicity invites action and evokes art. The sun is beating down. It is the dog days of July and I'm thirsty. I imagine the way people felt upon first examination of these neat little "packages" of food.

It's the same feeling I have as a brewer — thirst and the simplicity of a handful of grain invites one to do something. There they are. Grain in hand and beer on the mind. What a fantastic connection of interwoven thoughts; art and science transpire between the initial spark to the final indulgence.

We know so much more now about the qualities of grains, how to process them and how they influence the character of our extracts, worts and beers. Our scientific knowledge serves as a powerful tool, a tool we didn't have centuries ago, yet centuries ago great beers were made. We know that by way of a communion with the spirit of beer, don't we? Why else would there be so many songs and traditions borne of the barleycorn. This is all encouraging for the novice, the beginner — the first-time brewer. It reassures me there is a lot of latitude and simplicity in procedures that can still be successfully used in modern homebrewing.

The mash-extract and all-grain brewers appreciate the magic of grain brewing. All those grains and so little time. Have a homebrew and prepare yourself to know more. Stop learning about beer? Impossible.

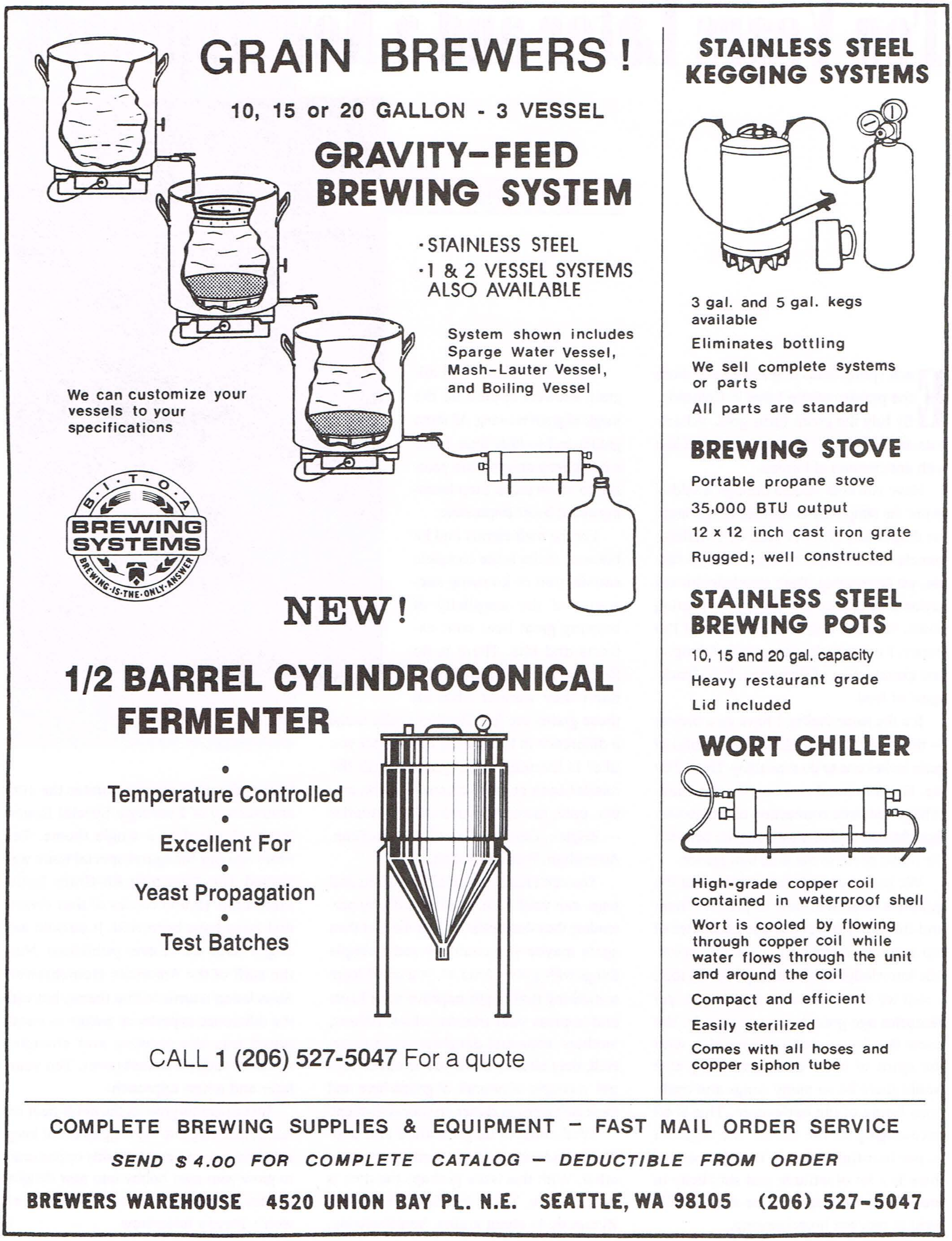
For the malt extract and kit brewers, theirs is the complete satisfaction of knowing success and the simplicity of brewing great beer with extracts and kits. There is no denying their priorities. But don't they wonder what all those grains are for? Do they really make a difference in the quality of the beer you like? Is learning about grains worth the hassle? Look at those colors — black, amber, pale, roast, red; and all the varieties — Belgian, German, Canadian, American, Australian, French, British.

You can't really ignore all those bins and bags, can you? Sure, you can walk by pretending they don't exist in your life. But then again maybe you could try some simple things with grains. After all, you could learn something that might improve your beers and impress your friends, wives, fathers, mothers, sons and daughters even more. Hell, they already think you're out of control, a couple of pounds of grains here and there isn't going to clutter up your enjoyment.

Well, most of us get started and doodle around with grains at some time or another. With this issue perhaps the time is right for you. This 1995 Special Issue of ***Zymurgy*** is about grains, homebrewing, beer and you. It commemorates the 10th anniversary of ***Zymurgy*** Special Issues: issues devoted to a single theme. Ten years ago our inaugural special issue was named The ***Zymurgy*** All-Grain Issue. More than 10,000 copies of that classic first issue have been sold. It outsold any single issue we've ever published. Now the staff of the American Homebrewers Association returns to that theme, but with the difference experience makes — a staff tuned into the growing and changing needs of today's homebrewer. Ten years later and a new approach.

Just as grains grow in the fields near my home, maturing into the delights of our imaginations, you too can take this opportunity to grow your own hobby into new delights of your imagination. Have fun. Relax. Don't worry. Have a homebrew.

ASSOCIATION OF BREWERS FILE PHOTO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By Dena Nishek

Editor's Note

Grain on the Brain

I approach the keyboard with some trepidation because I know many of you are extract brewers. Period. I hear things like, "You've got too many all-grain recipes," and, "I don't give a hoot about all those calculations and international bitterness whatevers." So how do I feel about presenting to you "The Great Grain Issue"? *Excited.*

With terms defined, procedures explained and processes illustrated, the whole grain issue is demystified, simplified, made as tangible and tempting as a handful of aromatic Munich malt or a spoonful of sweet malt extract. You'll turn the pages and swear you could smell fresh-roasted grain. Maybe you're wondering if we are trying to convert extract brewers to all grain. Nope. Keep brewing the way you do — you make good beer. Whether you get to beer via malt extract or grain, it is the process, the homebrew and your satisfaction that are important. But if we succeed in this presentation you'll feel comfortable with grain. You'll consider grain a realistic option. You may enhance your next extract wort with specialty grain. Or you'll decide to try one of the techniques described here to brew your next batch.

This Special Issue is a collection of articles from 22 homebrewers. They are award-winning brewers, consistent brewers and brewers who enjoy their hobby and want to share their knowledge or techniques so others might feel the same satisfaction. The articles are divided into three sections. "Grain: The Heart of Beer" is your reference section. It features a comprehensive list of available grain, a glossary of terms and a few other articles that set the scene for the rest of the issue. "Principle and Practice" is the why and how-to section and encompasses the majority of articles. To understand why a certain temperature rest is included in a mash schedule for example, it helps to know what is happening at various temperatures. With that information, you are ready to proceed to the practical applications where processes from steeping grain to decoction are detailed in step-by-step fashion. Finally, in "Gear and Systems" you'll get a look at how some homebrewers brew, what equipment is available and how to get by on your existing gear.

The methods explained in this issue are by no means the only way to get from grain to glass, but they are meant to get you started, to get you interested, to get you thinking about the great grain issue.

PHOTO BY GALEN NATHANSON

THE GRAIN: HEART OF BEER

Malt: A Spectrum of Colors and Flavors

By Neil C. Gudmestad

& Raymond J. Taylor

As homebrewers, many of us enjoy the brewing process as much as sampling the finished product. Mixing and matching malts, hops and techniques with beer styles is not only challenging but fun. For many of us, making the switch to grain brewing meant expanding the versatility of beermaking. While it is true that brewing with raw product is less expensive than producing a beer from extract, we find that the real advantage is that it has increased our enjoyment of homebrewing.

The purpose of this article is to provide a basic reference on the variety of malts available to homebrewers today. We do not intend to provide a definitive work on malt usage, but rather an introduction to malts for anyone wanting to pursue grain brewing.

Base Malts

PALE MALT

Compared to just 10 years ago (see ***Zymurgy*** Special Issue 1985 Vol. 8, No. 4), the variety of pale malts available to homebrewers today is a smorgasbord. Maltsters in both the United States and Europe (Table 1) have made their products available to homebrewers through an expanded network of homebrew suppliers. Homebrewing as we know it definitely took a giant leap forward when the Belgian, British and German malts finally invaded our shores in quantity and variety. Homebrewers have numerous pale malts from which to choose and, while they may appear similar, their subtle differences will lend a uniqueness to each beer in which they are used.

Pale barley malt is the basis for nearly every beer. It provides most of the enzymatic (diastatic) power to convert complex starches into fermentable sugars. In short, pale malts are the workhorses of the mash. Since pale malts usually compose greater than 50 percent of the total grain bill, they also provide the bulk of the fermentable sugars available in the wort for yeast fermentation. These malts are dried completely before they are kilned at relatively low temperatures to preserve enzyme capability and to minimize color development. Pale malts from America and Europe are readily available to homebrewers (Table 2).

U.S. and Canadian pale malt comes in either two-row or six-row varieties. Briefly, American six-row malt has less starch but greater husk weight than two-row malt. This means that for any given weight, more extract will be obtained from two-row than six-row. However, to many homebrewers, these differences are negligible. In cases where homebrewing equipment provides a shallow grain bed (less than six inches), six-row malt may actually provide higher extraction rates than two-row malt. It should be noted however, that six-row malt contains a

higher proportion of proteinaceous substances. This is important because the higher protein content can result in greater break material (hot and cold). This increased protein can also result in increased problems with haze in the finished beer. Six-row malt may also be slightly less expensive than two-row malt, depending on the supplier.

Six-row malts are generally regarded as possessing greater enzymatic power than two-row malts, although many brewers believe two-row malts lend a more mellow flavor to the beer. Six-row can be useful in brewing beers with a high proportion of adjuncts that lack enzymes, or wheat malt that lacks husk. The use of six-row malt can help the homebrewer achieve conversion of starch to sugar. Beyond this, color differences between six-row and two-row malts are slight.

Continental pale malts, primarily from Germany and Belgium, are also widely available to homebrewers. British pale malts are in ample supply, too. Although generally more expensive than domestic pale malts, there are benefits in their use for homebrewers who desire to make beer styles using authentic ingredients.

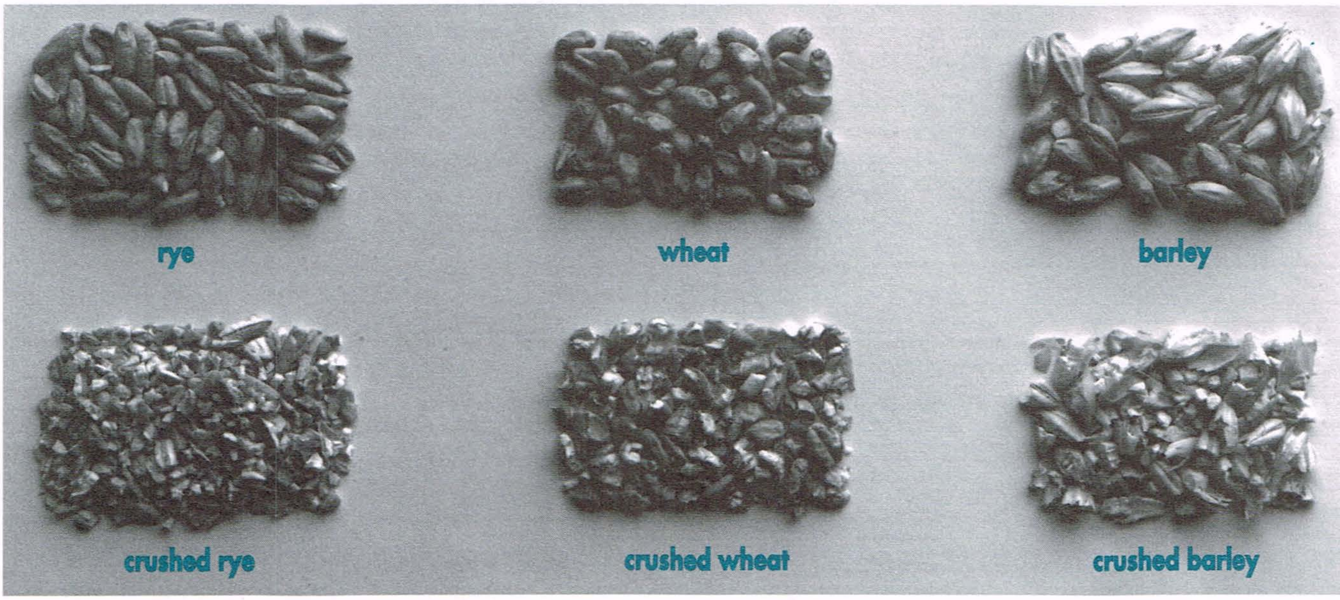
Because of differences in the malting procedures of European and American maltsters, pale malts from Europe generally have less diastatic power compared to those from the United States. These differences are not generally great enough to cause significant problems for the homebrewer. We believe British and continental pale malts provide a more complex malt palate and rounder flavors than their domestic counterparts when used to make beers that lack a significant proportion of specialty malt. This makes them worth the extra cost, especially when trying to duplicate your favorite English bitter, German Oktoberfest or Bohemian Pilsener.

OTHER MALTED GRAINS

Although most homebrewers are familiar with malted barley, other grains can make significant contributions to the malt profile of a beer. The most common of these is wheat malt, which is essential in making American and German wheat beers and Kölsch. Also, the addition of 3 to 5 percent wheat malt in many other all-malt beers can aid in improving head retention without imparting any significant changes in flavor.

The amount of extractable sugar obtained from wheat malt is somewhat higher than can be achieved by using barley malt alone. Wheat malt flavor is different from barley malt, usually lighter, although this can vary with the mash procedure used. The color derived from wheat malt is quite light, typically in the same range as pale barley malt, with the exception of soft white wheat malt (see Table 2). Diastatic enzyme power is higher than that of barley malt.

Unfortunately for the homebrewing community, German dark wheat malt, wonderful in a Dunkelweizen, and roasted wheat malt, which have been available in the past, are becoming more difficult to find. Apparently demand was insufficient for most



homebrew suppliers to keep these in stock. We suggest you contact your local microbrewery or brewpub for information if you would like to experiment with these malts.

Rye malt imparts a very distinctive flavor to the final product. If you like the taste of rye bread, you are sure to enjoy the flavor of a beer in which a substantial proportion of the grain bill includes rye malt. Additions as low as 5 percent of the total grist can lend a nutty, rye finish to a beer, depending on the style. We recommend starting out with small quantities of rye malt to determine if you do indeed appreciate the flavor. More intense yet is roasted rye, which is very dark and a more acrid variant of rye malt. This malt, however, also is becoming difficult to find.

Rye malt, like wheat malt, is huskless. The barley that makes up the remainder of a grain bill including rye or wheat should be properly crushed with husks intact to reduce the chances of a stuck runoff during sparging. The extract obtained from rye malt is considerably less than that obtained from the malts previously discussed. The color of rye malt is slightly darker than barley or wheat malt.

Specialty Malts

Now that we know something about pale malt, we are ready to begin discussing the types of malts that add character to the beer we are trying to brew. For us, this is where the fun really begins! We enjoy seeking bold new brews through experimentation, testing and tasting. Creativity makes the homebrewing world go 'round and specialty grains are what get that big beer ball turning. Most of these malts are produced in similar ways to the malts described above except they are kilned at slightly higher temperatures once they are completely dry or have very low moisture content. The result is a malt with darker color, sweeter flavors and slightly fewer fermentables that still retains some diastatic capability. Examples of this type of malt are Vienna, Munich, amber, brown, biscuit, aromatic, mild and victory, to name a few. Still others are kilned over open fires (German smoked malt) or peat (Scottish peat malt) to give a special "smoked" flavor characteristic of certain beers.

Specialty malts can be particularly enjoyable for the homebrewer to use. Each imparts characteristic flavors ranging from lightly toasted to a biscuity, malty sweetness. Some, such as aromatic, greatly enhance the malt aroma of a beer even when used in small quantities. The color they contribute is red to amber depending on the quantity used and other malts in the grist.

Most of the malts listed here can be used in either small or quite significant quantities. For example, using 10 percent Munich malt will lend a malty sweetness and slight toasty flavor to a number of beer styles such as German alts, California common beers or any beer style you fancy (including your own). It is important to remember that the enzymatic power of darker (unroasted)

TABLE 1. Malt Companies

Products from the following maltsters have been or are available in the United States:

ARGENTINA
Malteria Pampa S. A. – Buenos Aires

BELGIUM
DeWolf-Cosyns Maltings – Aalst

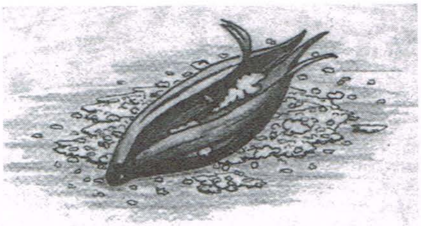
CANADA
Canada Malting Co. – Toronto, Ontario
Gambrinus Malting Co. – Armstrong, British Columbia
Prairie Malt Ltd. – Biggar, Saskatchewan
United Canada Malt – Petersborough, Ontario

GERMANY
Bamberg Malzerei – Bamberg
Brauerei Ayinger – Munich
Durst Malz – Bruchsal
Ireks Arkedy – Kulmbach
Weyermann Malzerei – Bamberg

GREAT BRITAIN
Archer Daniels – Midland
Crisp Maltings of Great Ryeburg
Edme – Manningtree, Essex
Hugh Baird & Sons – Witham, Essex
Munton & Fison PLC – Stowmarket, Suffolk
Pauls Malt Ltd. – Newmarket, Suffolk

SCOTLAND
Beeston Malt Co. – Arbroath
Brewing Products (U.K.) – Kirkliston
Telfords – Kirkliston

UNITED STATES
ADM Malting Co. – Decatur, Ill.
Briess Malting Co. – Chilton, Wis.
Chilton Malting Co. – Chilton, Wis.
DVC Ultramalt – Manitowoc, Wis.
Froedtert Malt Co. – Milwaukee, Wis.
Great Western Malting Co. – Vancouver, Wash.
Ladish Malting Co. – Milwaukee, Wis.
Minnesota Malting Co. – Cannon Falls, Minn.
Premier Malt Products – Grosse Point, Mich.
Rahr Malting Co. – Minneapolis, Wis.
Schreier Malting Co. – Sheboygan, Wis.
Sunrise Milling – Johnson Creek, Wis.



Properly crushed malt

Over-crushed malt

malts, such as Munich and Aromatic, is quite low and therefore you should be careful not to overshoot your mash temperatures in brews made up mostly of these malts.

Amber and brown malts were used in British beers such as porters during the 18th and 19th centuries. Their use tapered off after 1817 when black malt became available, and are now something of a rarity. Try using them to make a British brown or mild ale as well. Our own experience with these malts is that, if used in high proportion, the beer can take on harsh notes in the finish which are difficult to resolve, even with extended aging. The lesson with specialty malts such as these is simple: The use of small to moderate quantities (less than 10 percent) will greatly enhance the flavor characteristics and malt complexity of your beer. We suggest they be used judiciously until you are certain the flavor imparted to the beer is to your liking. This is especially true in the case of smoked malts. The key to the use of any specialty malt is controlled experimentation, keeping detailed notes on the flavors imparted by the malt and using only one at a time so you can define the flavor you obtain with each malt.

Caramelized Malts

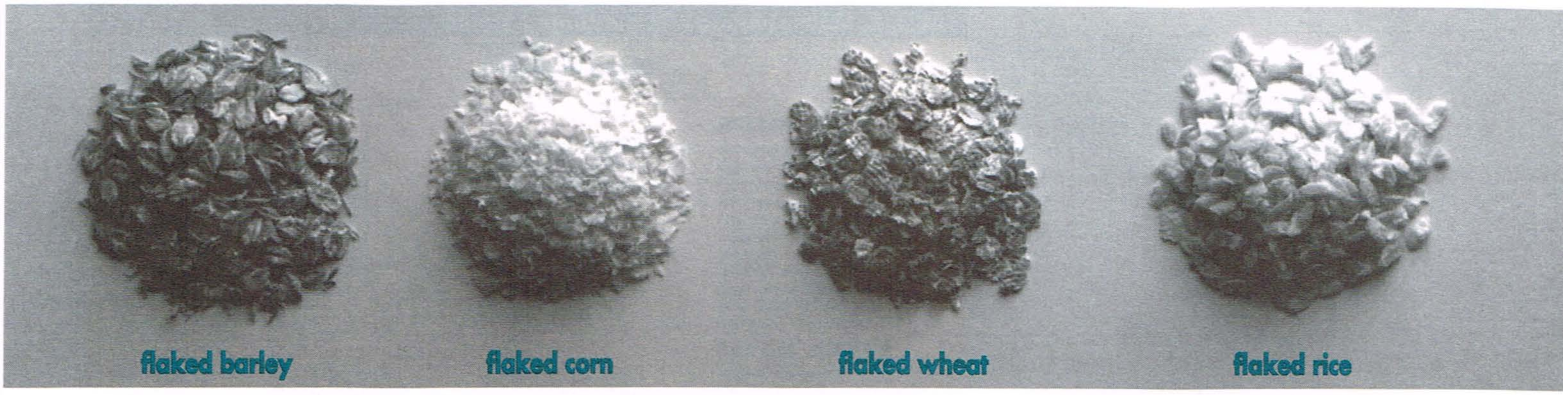
Crystal and caramel malts are fully modified during malting procedures and are kilned at relatively high temperatures when

TABLE 2. Malts Available in the United States

	EXTRACT (SG per pound per gallon)	COLOR (in °Lovibond per pound per gallon)	DIASTATIC POWER (relative rating based on common ° Lintner values)
PALE MALTS			
American two-row	1.035-1.037 (1.037)	1.4-2.0 (1.8)	very high
American six-row	1.031-1.035 (1.035)	1.5-2.1 (1.8)	very high
Belgian two-row	1.036-1.037 (1.037)	1.8-3.8 (3.0)	moderate
British two-row	— (1.038)	2.0-3.5 (2.5)	low
Canadian two-row	1.034-1.037 (1.036)	1.8-2.4 (2.1)	very high
British Pilsener	— (1.036)	1.0-2.5 (1.8)	moderate
German Pilsener	1.035-1.038 (1.038)	1.0-2.0 (1.6)	high
Belgian Pilsener	1.035-1.037 (1.037)	1.4-1.8 (1.8)	high
British Lager (two-row)	1.035-1.038 (1.038)	1.4-1.8 (1.4)	moderate
Lager malt (two-row)	— (1.035)	— (1.7)	high
Lager malt (six-row)	— (1.031)	— (1.7)	high
OTHER MALTS			
American wheat	1.038-1.039 (1.038)	1.7-2.1 (2.0)	very high
American soft white wheat	1.039-1.040 (1.040)	2.5-3.5 (2.8)	very high
Belgian wheat	1.038-1.039 (1.038)	1.6-2.0 (1.8)	moderate
German wheat	1.038-1.039 (1.039)	1.0-2.0 (1.8)	moderate
German dark wheat	1.038-1.039 (1.039)	7.0-9.0 (8.0)	moderate
American rye	1.029-1.030 (1.030)	2.0-4.7 (3.5)	moderate
SPECIALTY MALTS			
LIGHT			
Sauer (acid)	— (1.035)*	1.0-2.0 (1.5)	high*
American Vienna	1.030-1.035 (1.035)	3.0-4.0 (4.0)	very high
German Vienna	1.030-1.037 (1.037)	2.0-4.0 (3.0)	moderate
British mild	1.033-1.037 (1.037)	3.0-4.2 (4.0)	moderate
German smoked (Bamberg)	— (1.037)	6.0-12.0 (9.0)	moderate*
British peated	— (1.038)*	1.6-6.0 (5.0)	low*
Scottish peated	— (1.038)*	— (5.0)	low*
DARK			
American victory	1.029-1.034 (1.034)	7.0-30.0 (25.0)	nil
British brown	— (1.032)	38.0-70.0 (70.0)	nil
Belgian biscuit	1.030-1.035 (1.035)	22.5-27.0 (24.0)	very low
Belgian aromatic	1.030-1.036 (1.036)	15.5-26.0 (25.0)	low
British amber	— (1.032)	30.0-35.0 (35.0)	nil
Canadian honey	1.030-1.035 (1.030)	18.0-25.0 (18.0)	low
American two-row (toasted)	— (1.033)	— (30.0)	low*
American special roast	— (1.033)*	— (40.0)	low*
Melanoidin	— (1.033)*	30.0-40.0 (35.0)	low*
Belgian Munich	1.032-1.038 (1.038)	5.0-10.0 (7.8)	moderate
German Munich	1.030-1.037 (1.037)	5.0-8.0 (8.0)	moderate
American Munich (light)	1.033-1.034 (1.033)	8.0-12.0 (10.0)	moderate
American Munich (dark)	1.032-1.033 (1.033)	18.0-22.0 (20.0)	moderate
Canadian Munich (light)	— (1.034)*	— (15.0)	moderate*
Canadian Munich (dark)	— (1.034)*	— (30.0)	moderate*
British Munich	1.036-1.037 (1.037)	4.0-8.0 (6.0)	low
CARAMELIZED MALTS			
Dextrin malt (CaraPils)	1.030-1.033 (1.033)	1.5-3.0 (1.8)	nil
Belgian caramel Pils	1.030-1.034 (1.034)	4.0-8.0 (7.9)	nil
British CaraMalt	— (1.035)*	10.0-13.0 (12.0)	nil
American crystal 10 °L	1.024-1.035 (1.035)	— (10.0)	nil
American crystal 20 °L	1.024-1.035 (1.035)	— (20.0)	nil
American crystal 30 °L	1.024-1.035 (1.035)	— (30.0)	nil
American crystal 40 °L	1.024-1.034 (1.034)	— (40.0)	nil
American crystal 60 °L	1.024-1.034 (1.034)	— (60.0)	nil
American crystal 80 °L	1.024-1.034 (1.034)	— (80.0)	nil
American crystal 90 °L	1.024-1.033 (1.033)	— (90.0)	nil
American crystal 120 °L	1.024-1.033 (1.033)	— (120.0)	nil
British Light Carastan	— (1.035)*	12.0-19.0 (15.0)	nil
British Carastan	— (1.035)*	30.0-39.0 (34.0)	nil
British crystal 50-60 °L	— (1.034)	50.0-60.0 (55.0)	nil
British crystal 70-80 °L	— (1.034)	70.0-80.0 (75.0)	nil
British crystal 95-115 °L	— (1.033)	95.0-115.0 (105.0)	nil
British crystal 135-165 °L	— (1.033)	135.0-165.0 (150.0)	nil
German Carahell	— (1.034)*	10.0-15.0 (12.0)	nil
German light caramel	1.035-1.037 (1.037)	2.2-2.8 (2.5)	nil
German dark caramel	1.035-1.037 (1.037)	50.0-80.0 (65.0)	nil
German wheat caramel	1.036-1.038 (1.038)	50.0-60.0 (55.0)	nil
Belgian CaraVienne	1.030-1.034 (1.034)	15.0-30.0 (22.0)	nil
Belgian CaraMunich	1.032-1.033 (1.033)	53.0-80.0 (75.0)	nil
Belgian Special "B"	1.029-1.030 (1.030)	75.0-250.0 (220.0)	nil
ROASTED MALTS			
American chocolate	1.023-1.029 (1.029)	325.0-400.0 (350.0)	nil
Belgian chocolate	1.029-1.030 (1.030)	375.0-500.0 (500.0)	nil
British chocolate	1.029-1.034 (1.034)	350.0-600.0 (475.0)	nil
German Carafa	— (1.030)*	— (400.0)*	nil
German Carafa special	— (1.030)*	500.0-750.0 (600.0)	nil
American black patent	1.023-1.029 (1.028)	475.0-530.0 (500.0)	nil
British black patent	1.023-1.030 (1.027)	500.0-750.0 (525.0)	nil
Belgian black	1.028-1.030 (1.030)	500.0-675.0 (600.0)	nil
UNMALTED			
American roasted barley	1.024-1.029 (1.028)	450.0-510.0 (450.0)	nil
American black barley	1.023-1.028 (1.027)	500.0-550.0 (530.0)	nil
Belgian roasted barley	1.029-1.030 (1.030)	450.0-650.0 (575.0)	nil
British roasted barley	— (1.029)*	500.0-600.0 (575.0)	nil
German roasted wheat	1.028-1.030 (1.030)	550.0-750.0 (650.0)	nil
Roasted rye	1.028-1.029 (1.029)	400.0-650.0 (500.0)	nil
German Carafa chocolate	— (1.030)*	— (525.0)*	nil

The information presented here was compiled from a wide variety of sources including Charlie Papazian's *The Home Brewer's Companion* (Avon, 1994), numerous homebrewing catalogs and technical data from maltsters' fact sheets. Ranges are given followed by the most commonly published value for the malt type. Note: This value will not necessarily represent the median value for the ranges obtained from all the sources. *Indicates authors' estimate based on available information on related malts

ILLUSTRATIONS BY GREGORY J. NOONAN, *BREWING LAGER BEER* (BREWERS PUBLICATIONS, 1986)



still moist. The result is a "stewing," rather than a roasting or toasting, in which the starches convert to sugars and then caramelize. These malts come in a wide range of colors from light to very dark amber. They provide a sweet maltiness to a beer and contribute considerable mouthfeel and body to the final product even when used in 5 to 15 percent concentrations. Because the starches are already converted, these malts need not be mashed and many extract brewers steep crystal malts to add color and body to their beers. These malts also have no enzyme activity because of the kilning process. The wide color range of crystal and caramel malts makes them quite versatile and they can be used in a variety of beer styles with great success.

Belgian CaraVienne and CaraMunich are unique caramelized malts. While generally similar to domestic, British and German crystal and caramel malts, the Belgian varieties produce a very subtle toasted flavor with some residual caramel sweetness that can enhance a beer such as bock or Oktoberfest, but work well in a wide variety of beer styles. CaraMunich is a darker and more robust version of CaraVienne. Both contribute a soft, smooth finish. Belgian Special "B" is an extremely dark caramel malt that imparts a distinctive but intense toasted (almost toffeelike) malt flavor. It should be used in very small quantities (two to four ounces per five-gallon batch) until you are sure you like its flavor contributions. This malt could be used in almost any beer style but it would seem most at home in a toasty, roasty Scottish ale.

Dextrin and CaraPils® malts are produced much like crystal malts except that kilning temperatures are considerably lower, which minimizes color development. When used in small quantities, say 5 to 10 percent, these malts greatly enhance body, mouthfeel and head retention while changing the color of the beer very little. Dextrin malts are commonly used in light-colored lagers where pale malt alone, or the use of adjuncts (discussed below), may be insufficient to achieve a desired malt characteristic.

Finally, British carastan malts offer a unique experience for homebrewers. Although not widely available to homebrewers, they are used quite extensively by microbreweries and brewpubs, which is where we have obtained them. Apparently they were developed as a "crystal" malt for use in lagers where mouthfeel and body were desired without residual sweetness. In this regard, carastans are similar to dextrin malt although, in our experience, the former do provide for some additional sweetness not obtained from dextrin or CaraPils. Belgian caramel Pils also fits into this category but is much lighter in color than any available carastan malt.

Roasted Malts and Grains

Malts and grains in this category are generally used in small quantities, so the potential extract yield is not particularly important to the homebrewer. Roasted malts and grains are produced by kilning at very high temperatures that carbonize the starch and sugars. Examples are chocolate malt, black patent (also called roasted malt or black malt), black barley and roasted barley. The latter two differ in that the grain is not malted prior to kilning.

These malts impart a very dark color to beer and an intense nutty (in the case of chocolate malt) or anything from a chocolatelike to a burnt charcoallike flavor. They are used to some degree in most porters and stouts. Chocolate and black malt can also be used to add color and malt complexity to a number of other beer styles when used in very small quantities. Roasted barley is used almost exclusively in dry and sweet stouts. All of these highly carbonized malts and grains have no diastatic power and need not be mashed in order to take advantage of color and flavor enhancement of beer. When used with caution (one to two ounces per five gallons), these dark roasted malts can provide a hint of brownish-red color as well as an enhanced background flavor to the overall malt profile of a pale beer.

A particularly nice variant of these malts is German Carafa chocolate malt. Although not widely available, it is certainly worth seeking out. It is darker than other domestic and imported chocolate malts, but slightly lighter than black malt and black barley. This malt gives a luscious but intense chocolate finish even when as little as four ounces in a five-gallon batch is used. We use it often in our favorite beer style — porter!

Several obscure extremely specialized malts such as white malt (very pale at 1 °L for lightening Pilseners, etc.), melanoidin malt (high in melanoidin content for fullness and flavor stability) and Sauer malt (an acidified German malt for pH adjustment and intensifying fermentation). Brumalt is a German green malt good for intensifying color, flavor and aroma (see Narziss, ***Zymurgy*** Winter 1993, Vol. 16, No. 5). These malts have been marketed in this country at one time or another. However, most of them

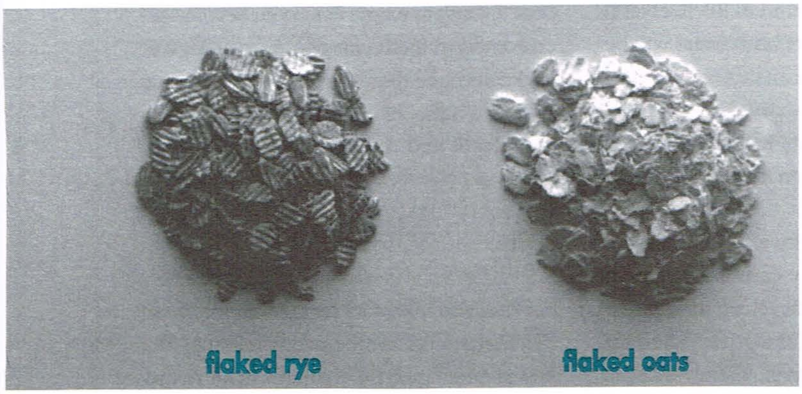


TABLE 3. Additional Fermentable Grain Adjuncts

Grain Adjunct	Extract (SG per pound per gallon)	Color (in °Lovibond)
flaked corn	1.039-1.040 (1.040)	0.5-0.8 (0.5)
flaked oats	1.025-1.033 (1.033)	2.0-2.5 (2.2)
flaked rice	1.038-1.040 (1.040)	0.5-1.0 (0.5)
flaked rye	1.033-1.036 (1.036)	1.5-3.0 (2.8)
flaked wheat	1.020-1.036 (1.034)	1.5-2.5 (2.0)
flaked barley	1.025-1.032 (1.032)	1.5-2.5 (2.2)

The above unmalted grains can be incorporated into the mash to enhance mouthfeel, head retention and/or flavor. The same grains can be used in their raw (unflaked) form with similar results, but must be gelatinized first.

have been discontinued because of lack of demand. If you do happen to run across any of them in your malt-hunting expeditions they may be worth a test batch or two. Gambrinus Malting Co. of Canada, recently began exporting to the United States their version of Brumalt called "honey malt" because of its intense, sweet honeylike aroma and flavor. Based on our limited experience we believe honey malt probably could find a home in many different styles of beer, light or dark. It would be particularly useful where more malt aroma and/or a subtle malty sweet flavor is desired.

Grain Adjuncts

There is really nothing sacred about using malted barley, wheat and the other malts already discussed. Fermentable sugars can be derived from other sources of starch and can contribute desirable characteristics to beer. Examples of adjuncts that are routinely used in the production of beer include flaked barley, flaked corn, flaked wheat, flaked rice, flaked rye and rolled oats, all of which are unmalted (Table 3). When using unmalted, unprocessed grains, the starches in them should be gelatinized prior to use for best results. Depending on the grain, gelatinization involves heating that renders the starch vulnerable to enzyme degradation into simple sugars (see page 14). Since gelatinization occurs during the rolling process, flaked adjuncts can be incorporated directly into the mash. If all of this appears too daunting a task, refined corn starch, available at any supermarket, can be added without any processing prior to use. A number of the adjuncts listed here will result in a beer with lighter body than if it were brewed with all barley malt. This is particularly desirable when brewing a number of American lagers, cream ales and the like.

Flaked rye imparts a distinct sharp flavor. Flaked barley not only contributes to foam stability (head retention) but can improve mouthfeel. Rolled oats also will improve mouthfeel but impart a slight oiliness to the beer. Both flaked barley and rolled oats can be used to improve the quality of any classic stout recipe already in your repertoire.

Homebrewers not experienced in the use of adjuncts should be aware of some potential problems that can result from their use. For example, because these unmalted grains generally lack enzyme power, it is sometimes advisable to use a domestic two-row or six-row malt in conjunction with them. The extra enzyme capability of these pale malts is generally sufficient to convert the starch available in the flaked grains with little noticeable delay. Flaked grains also can lead to slow runoffs during the sparging process. Therefore, many brewers prefer to use six-row pale malt with its high husk-to-endosperm ratio. It also is advisable to use 20 percent or less adjunct in the grain bill. Some adjuncts, such as flaked barley, can lead to chill haze problems, which is why they are more commonly used in darker beer styles where this is less a concern.

Non-traditional Grains

Although this topic is really beyond the scope of this article we believe it is important to mention that grains from a wide variety of other crop species could be, and have been, used as adjuncts in beer. Those that have definite brewing potential range from the common (buckwheat, millet, sorghum, triticale and wild rice) to the exotic (adlay, amaranth, dinkel, fundi, kamut, kasha, quinoa, spelt and tef). These can be gelatinized and used as is, or the ambitious homebrewer might attempt to malt them. This area is wide open and ripe for experimentation. We take the time to mention these non-standard fermentables because we have personal experience with amaranth and kasha, both of which contribute a subtle nuttiness to the overall malt flavor profile. Amaranth has the highest protein content per unit of weight of any basic grain in the world and this attribute contributes to the formation of a rich, creamy head. Even with the high protein content, our amaranth beer was remarkably free of protein haze. Amaranth and kasha have worked very well for us in British mild and brown ales. Additional information on alternative fermentable grains can be found in ***Zymurgy*** 1994 Special Issue (Vol. 17, No. 4). As a note of caution, stick to grains that are known to be edible. Grains (seeds) of many plants are not eaten because they contain toxic substances. Exercise caution when breaking new ground.

Recipe Guidelines

Now that you have some familiarity with the available malts and grains that can be used by the homebrewer, it's time to give some thought to how you should use them. It is difficult to argue with the adage, "Keep it simple, stupid!" especially because so many fine beers contain only one, two or three malts. However, we believe one of the simple pleasures of homebrewing is to combine malts in small quantities to experience the diverse flavors and other characteristics imparted to the finished product.

An easy way to demonstrate the differences in malt quality achieved by using a variety of malts is by producing a simple pale ale. In a five-gallon batch, try making a pale ale using eight pounds of pale malt with one pound of 40 °L crystal malt. Next time, while using the same mashing procedures, hopping schedule and yeast strain, make a similar pale ale but change the color of the crystal. Rather than using one pound of 40 °L, use one-half pound while blending in one-quarter pound of 20 °L and one-quarter pound of 80 °L crystal malt. While the color of both beers will be copper, you will find considerable differences in malt complexity and residual sweetness flavors. This little experiment may well start you off on an exploration of the mysteries of malt.

When using specialty and a number of caramelized and highly carbonized malts, we have a rule of thumb: Keep them at 15 percent or less of the total grist. When we experiment with a new malt, it rarely exceeds 5 percent of the total grain bill. That way if the flavors are intense they usually will not overwhelm the malt profile and make the beer difficult to enjoy. Once you become accustomed to the flavor of a particular malt and determine that you like it, try blending small quantities of different malts to increase malt depth and complexity.

ON THE GELATINIZATION PROCESS ...

In the strictest sense, gelatinization is simply the release of starch into suspension by rupturing starch storage granules. A certain degree of gelatinization occurs whenever malted or unmalted grains are exposed to temperatures over 140 degrees F (60 degrees C). Gelatinization is therefore important because starches not liberated during the malting process are made available for enzymatic conversion during the mash, but the process is most important when incorporating unmalted grains or seeds in your brews.

Unmalted grains contain large quantities of starch that will be used as a source of energy by the developing sprout. This starch is basically in an "unmashable" form because it is tied up in cellular storage structures. In addition to activating the enzymes important for mashing, the malting process also liberates much of this stored starch. Soaking unmalted grain in hot water extracts this starch by helping break the hard seed coat, disrupting cell walls within the seed itself and eventually causing the starch storage particles to burst. The freed starch forms a thick colloidal suspension. At this point the starch can be used by the enzymes of the mash.

ON GELATINIZING ADJUNCTS ...

Flaked (rolled) adjuncts are produced from unmalted grains by softening them with steam then passing them through pressure rollers. The heat associated with both of these processes almost completely gelatinizes the starches, so flaked materials can be added directly to the mash without further preparation.

Not so with unprocessed unmalted grains — they must first be gelatinized. Unfortunately, complete details on how to accomplish this at home are not readily available. The amount of time required for gelatinization varies depending on the grain adjunct used. Details are sparse because many of these adjuncts have had only limited use, and procedures for gelatinizing them are unknown.

To gelatinize an unmalted adjunct for the first time, mix it with water at a rate of two gallons (7.57 L) of water per pound (0.45 kg) of grain. Bring to a boil, reduce heat and simmer the grain suspension for a minimum of 15 minutes (30- to 60-minute boils may be necessary for some grains). Use plenty of water, and additional water may be added at any time because, as gelatinization proceeds and the grain breaks down, the slurry will become very thick, pasty and sticky. Heat the mixture carefully because the potential for burning it is high. Gelatinization is complete when the suspension becomes uniform in texture and the adjunct grain is indistinguishable. The slurry will have the consistency of Cream of Wheat.

The gelatinized adjunct then may be added directly to the mash, but since it has not been modified by malting, include a protein rest in the mash schedule prior to raising the mash to saccharification temperatures. Allow the gelatinized suspension to cool to close to protein-rest temperature before mixing it into the grains. A final recommendation: Take good notes (especially details about quantities of water and boil times).

Summary

There are times when the abundance of available malts can be overwhelming. The key to making sense of all this is for homebrewers to take advantage of the situation and use the available malts to improve their beer. The extensive selection of malts lends great versatility and flexibility in the production of quality homebrew. These malts may be best used by homebrewers who choose to brew their own style of beer while refusing to be trapped by conventional recognized styles. For these brewers, this period in homebrewing is particularly exciting.

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By Gregory J. Noonan

Making Sense of a Malt Analysis

If you are interested in knowing the nitty gritty about your grains, at some point you'll face a malt analysis. If you've never seen one before, it can look like a jumble of letters and numbers. In an excerpt from his revised work New Brewing Lager Beer *(Brewers Publications, to be published in 1996), Greg Noonan prepares you for some advanced homebrewing applications — reading a malt analysis. If this is more than you ever wanted to know, relax and skip this article.-Ed.*

Every lot of malt that emerges from a maltsters' kiln is analyzed. A lot analysis is available for any malt you purchase. In addition to this, maltsters also publish a "typical" analysis so brewers can evaluate malt before purchase. A typical analysis should not be accepted as a substitute for an actual lot analysis.

Any grain analysis is only useful if you can read it. There are more than 30 parameters that may be encountered in malt analyses, and 15 to 20 may appear in any given analysis. Although each provides very useful information, there are nine basic values every grain brewer should understand: moisture content, color, fine grind extract, fine-coarse difference, diastatic power, protein (total nitrogen), soluble nitrogen ratio, mealiness and size. Only the first three may be given for specialty/colored malts, although the brewer really needs to know the protein content, mealiness and size of colored malts to know how they will perform.

Moisture content, shown as a percentage, is abbreviated MC. Lot analyses are given on a "dry basis," which means they are adjusted to give values as if the malt were oven-dried to 0 percent moisture content. This makes comparisons between lots easier, but gives a false impression of the extract yield a brewer can expect. The higher the MC, the less extract the malt will give per pound. The lower the moisture content of any malt, the less deterioration of quality, flavor and aroma will have occurred during storage. Malt with greater than 6 percent MC indicates shoddy malting. British ale malts usually have the lowest MC, as low as 1.5 percent, and any good malt should be below 5 percent MC.

Color is expressed in Standard Reference Method (SRM) units or degrees Lovibond. For batch-to-batch beer consistency, the grain bill should be adjusted to reflect the color of the lot of malt on hand. This is especially true when dark malts are used.

American maltsters quote color in SRM units using the American Society of Brewing Chemists (ASBC) scale. Where European Brewing Convention (EBC) units are given, the formula ASBC = (°EBC + 1.2) ÷ 2.65 gives reasonable conversions through the entire color range. The color for English malts often is given as Institute of Brewing (IOB) color, at about 80 percent of EBC color. ASBC = [(IOB ÷ 0.80) + 1.2] ÷ 2.65. European maltsters will gradually adopt the new EBC standards, requiring American brewers to use a new conversion formula that Ray Daniels has calculated to be SRM = EBC ÷ 3.94.

Extract, dry basis fine grind (DBFG) expresses the maximum possible extract yield. Dry basis means 0 percent moisture content, and Fine grind is obtained from a standard Buhler-Miag laboratory mill set at 0.2 millimeters (referred to as "2 Miag"). A standard laboratory mash is employed. British maltsters generally quote Hot Water Extract (HWE) at 2 Miag, in liter-degrees per kilogram (L°/kg), expressing how many liters of wort at 1.001 specific gravity each kilogram of the malt can yield.

The hot water extract can be simply converted to percent extract, ASBC dry basis fine grind, by dividing it by 386: (300 ÷ 386 = 77.7%). Any base malt that gives less than 300 L°/kg is unacceptable. A good base malt gives 305 to 315 L°/kg at 2 Miag. Hot water extract is sometimes given as 7 Miag, in which case it should be 300 to 310 L°/kg.

DBFG and HWE at 2 Miag indicate the quality of the barley and the proficiency of its malting. The higher the DBFG extract the better the malt. Any base malt that does not give at least 78 percent DBFG extract is substandard.

Fine grind-coarse grind difference, abbreviated as FG-CG, is a measure of malt modification. Samples of the malt are crushed at 2 and 7 Miag and mashed. The difference in extract yield between the two mashes is given as FG-CG. Steely undermodified malt gives a greater fine grind-coarse grind difference than well-modified mealy malt. Malts destined for infusion mashing should show an FG-CG difference of 1 to 1.5 percent. An FG-CG of up to 2.2 percent is acceptable if a decoction or step mashing is used.

Dry basis fine grind, moisture content and fine grind-coarse grind difference are used to predict extract yield, as the gravity that each pound of the malt will give to five gallons of wort, by the formula: gravity = [DBFG – (FG-CG)] ÷ [(1.00 + MC) x Brewhouse Efficiency x 9.23]. For example: DBFG = 81.5%, FG-CG = 1.5%, MC = 4%, Brewhouse Efficiency = 85%; so ([(0.815 – 0.015) ÷ (1.00 + 0.04)] x 0.85) x 9.23 = 6.04 gravity, or S.G. 1.006.

Brewhouse efficiency ranges between 80 and 95 percent, and depends on equipment and techniques. Where it is not known, use 85 percent to plan a brew and adjust it in future brews to reflect the gravity that you actually yield.

Diastatic power (DP, expressed in degrees Lintner or 0.025 maltose equivalent), expresses the combined alpha- and beta-amylase strength of the malt. Use it with FG-CG and mealiness/vitreosity (below) as a measure of how well a malt will respond to mashing. The di-

Malt Analysis, Dry-Basis, Comparative Analysis of Acceptable Ranges	TRADITIONAL TWO-ROW LAGER	EUROPEAN TWO-ROW LAGER	AMERICAN TWO-ROW BREWERS	AMERICAN SIX-ROW LAGER	BRITISH TWO-ROW BEST PALE
MOISTURE CONTENT, %	3.5–4.5	3.5–4.5	3.5–4.5	3.5–4.5	1.5–3.5
COLOR, SRM (°L, ASBC)	1.2–1.6	1.4–1.8	1.4–2.0	1.4–2.0	2.0–2.7
COLOR, °EBC	2.0–3.0	2.5–3.5	2.5–4.0	2.5–4.0	4.0–6.0
EXTRACT, DBFG	80.0–82.0	80.0–82.0	79.0–81.5	78.0–79.5	80.5–82.5
EXTRACT, DBCG	78.0–80.5	78.0–80.5	77.0–80.5	76.0–78.1	79.0–81.5
FG-CG, DIFFERENCE	1.5–2.2	1.5–2.0	1.0–2.0	1.4–2.0	1.0–1.5
HWE (L°/KG @20° C), 0.2M	309–316	309–316	305–315	301–307	311–318
CWE	16–18	18–20	18–21	18–21	18–22
HARTONG 45°, %	30–34	32–38	36–42	38–42	36–42
A AMYLASE, DU	44–48	40–48	40–45	35–45	25–35
DP, °LINTNER	70–100	75–110	100–150	125–160	50–70
DP, °WK	200–325	220–350	375–450	400–500	150–220
CONVERSION, MIN	10–15	10–15	5–10	5–10	10
PROTEIN, %	9.0–11.0	9.0–11.0	11.5–12.5	12.0–13.5	9.0–10.0
SOLUBLE PROTEIN, %	3.0–4.2	3.5–4.6	4.2–5.3	4.8–5.8	3.5–3.8
TN, %	1.4–1.75	1.4–1.75	1.8–2.0	1.9–2.2	1.4–1.55
TSN, %	0.48–0.67	0.50–0.75	0.65–0.85	0.7–0.93	0.5–0.6
SNR, (S/T, SN/TN, %)	33–38	36–42	36–42	40–45	38–42
MEALY, %	92–97	95–97	95–97	92–97	97–99
HALF-GLASSY, %	2–8	2–4	2–4	2–8	1–3
GLASSY, %	0–1	0–1	0–1	0–1	0
FRIABILITY, %	80–85	80–90	80–90	75–85	85–95
ON 7/64" SCRN-PLUMP %	75–85	75–85	60–70	45–55	80–85
ON 6/64" SCREEN %	10–20	10–20	20–30	35–45	10–20
ON 5/64 SCRN %<2.2	0–3	0–3	7–13	10–20	0–2
THRU 5/64 SCRN-THIN %	0–2	0–2	0–2	0–2.5	0
WORT pH	5.8–5.9	5.7–5.9	5.7–5.9	5.7–5.9	5.5–5.8
VISCOSITY, cP	165–1.75	1.55–1.65	1.52–1.62	1.60–1.70	1.45–1.55
ODOR OF MASH	AROMATIC	ARO	ARO	ARO	ARO
SPEED OF FILTRATION	NORM-SLOW	NRM-RAPD	NORMAL	NRM-SLOW	NRM-RAPD
DEGREE OF CLARITY	CLR-SL HZ	CLEAR	CLEAR	SL HAZY	CLEAR

astatic power may be as low as 35 to 40 for a well-converted, low-protein ale malt suitable only for infusion mashing without adjuncts. The diastatic power is generally about 100 for European lager malt, 125 for American lager/brewers malt, and as high as 160 for six-row brewers malt. Diastatic power decreases as malt color increases, so dark malts have no diastatic power.

British Institute of Brewing diastatic power units give values similar to SRM units. Convert EBC Windish-Kolbach (WK) units to ASBC units with the formula °ASBC = (°WK + 16) ÷ 3.5.

Protein, expressed as a percent, indicates the protein/nitrogen content of the malt. Where total nitrogen (TN) percent is given it can be converted to percent protein by multiplying the TN by 6.25.

Protein content should always be below 12 percent unless a very large percentage of adjuncts is being used; 9 to 10 percent is typical for European lager and British ale malts. High-protein malt not only has more nitrogen than low-protein malt, but a greater percentage of its proteins are complex and troublesome to the brewer.

SNR, which means soluble nitrogen ratio, (also referred to as S/T, or soluble-total, SN/TN, soluble nitrogen/total nitrogen ratio), is a measure of the soluble nitrogen (or protein) expressed as a percentage of the total nitrogen (or protein). It is an important indicator of malt modification. The higher the soluble nitrogen ratio, the more highly modified the malt sample is. Malts to be infusion mashed ideally have an SNR of 38 to 42. For traditional lager malts, 30 to 33 percent indicates undermodification and 37 to 40 percent indicates overmodification. Malt is rejected on the basis of the SNR if it approaches 50 percent for infusion mashing and 40 percent for decoction or multitemperature mashing. At 50 percent SNR, any beer brewed from the malt will lack body and fullness. European Brewing Convention analyses give the percent soluble nitrogen in the Kolbach Index; a Kolbach Index unit of 40 equals 40 percent (0.40) SNR.

Mealiness is expressed as a percent. Malt is classified as being mealy, half-glassy/glassy ends and glassy (steely or vitreous). The better and more extensive the malting, the higher the percentage of mealy kernels. Glassy malt does not crush well and is not readily hydrolyzed. Malt to be infusion mashed must be at least 95 percent mealy, and for any other mash program should be 90 percent mealy. Where mealiness is expressed as mealy/half-glassy/glassy, for base malts to be infusion mashed the ratio should be 95 percent/4 percent/1 percent or better, and 90 percent/9 percent/1 percent or better for decoction and step mashing.

Friability is a similar measurement. Any malt should be at least 80 percent friable, and for infusion mashing should be 85 percent friable.

Where vitreosity is given instead, sample kernels of the malt have been evaluated and assigned values; 1 for kernels that have a glassy endosperm, 0.5 for half-glassy, 0.25 indicating glassy ends and 0 for completely modified (mealy) kernels. The average result is given. The range is 0 to 1.0, and a vitreosity of 0 to 0.25 is preferred.

Size is most clearly expressed as screen separations, but is just as commonly given as plump/thin. European malts often list only the percentage that can be sieved through 2.2 millimeter openings (thins). Generally the plumper the kernels, the better the yield; however, the uniformity of malt size is just as important.

To this end, some analyses list homogeneity instead of sizes. Any lot of malt that will crush reasonably well must have kernels that are at least 90 percent adjacent sizes regardless of the plumpness. Brewers generally demand malt that is of 95 percent or greater homogenous.

Malt also is rejected for more than 1 percent thin, or more than 2 percent smaller than 2.2 millimeters, because these factors indicate unmodified kernels.

No malt can be fairly judged by any single factor. Each parameter should be weighed against all the others to determine how much of any malt will need to be used, and how it should be used.

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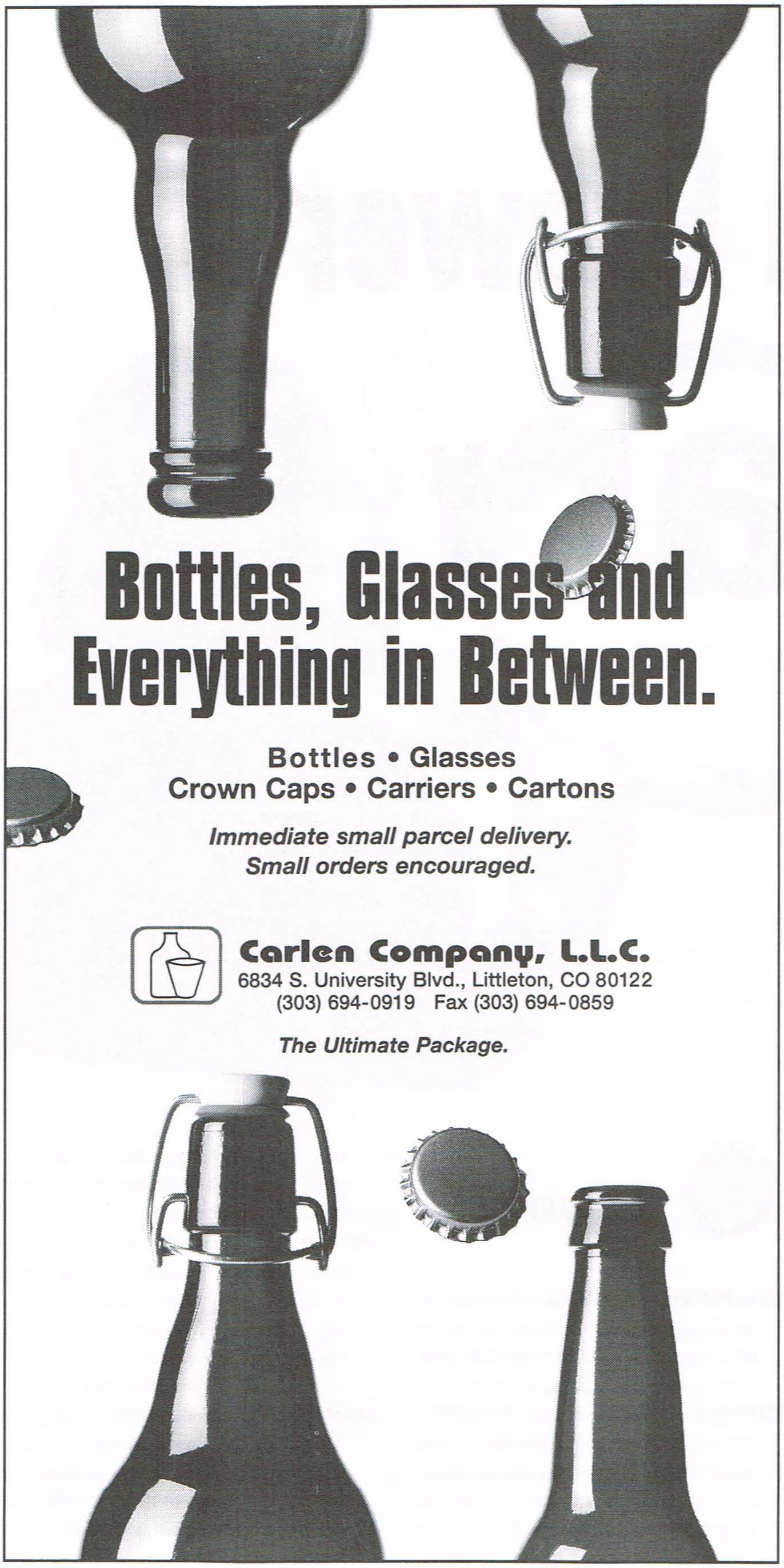
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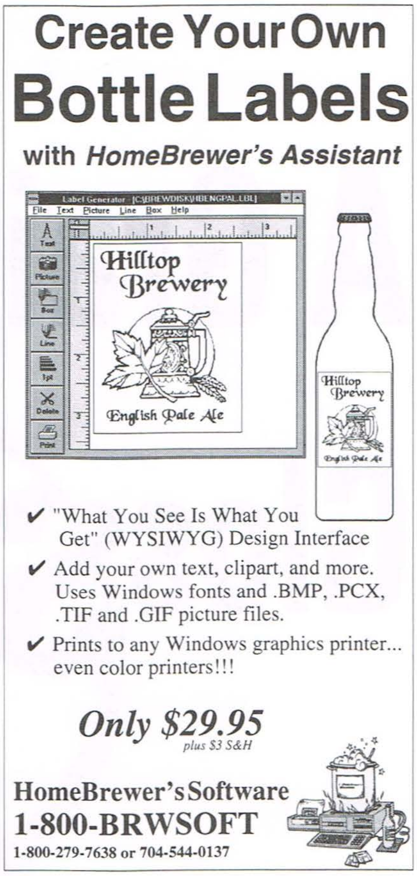
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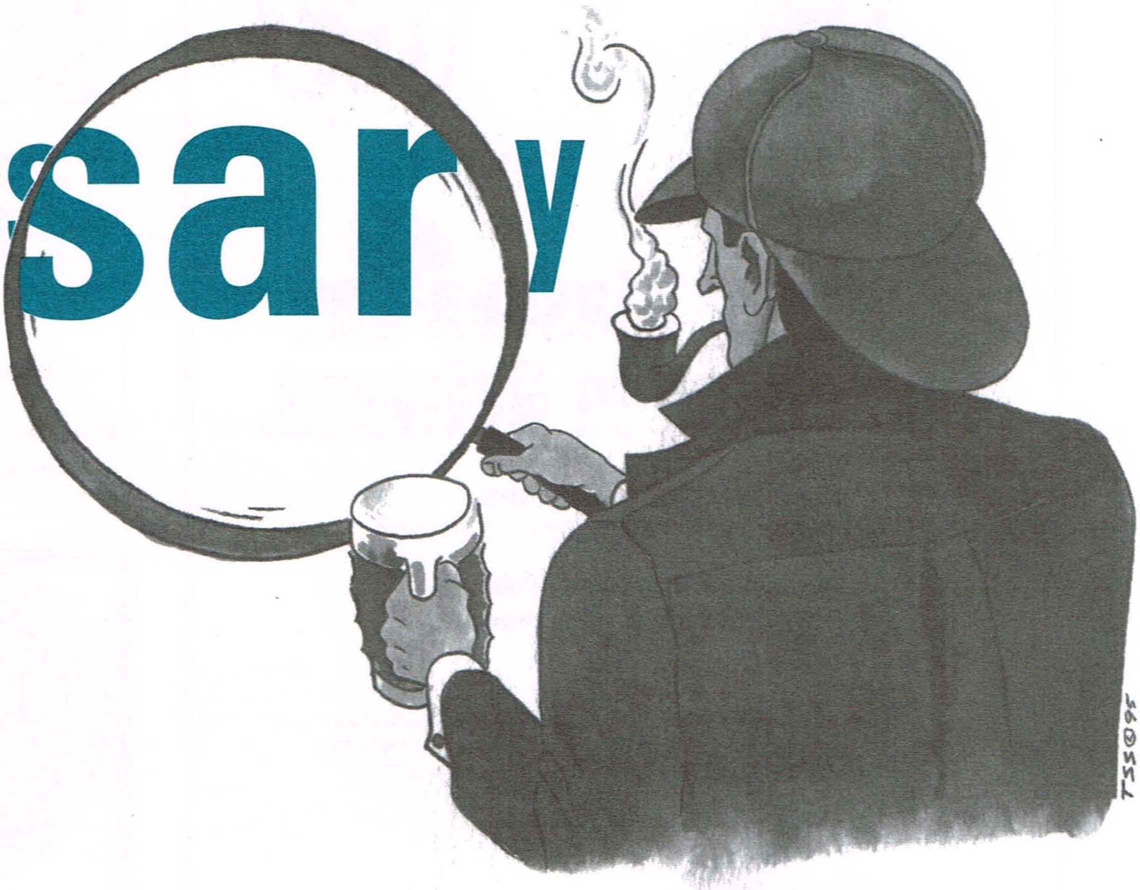
A Grain Brewer's Glossary



Producing delicious all-grain beer does not require an advanced chemistry degree, but the terms associated with the craft can be daunting. What follows is a glossary of commonly used terms and phrases. They are limited to the pre-kettle portion of the process, because this is where all-grain brewing differs from brewing with malt extract. Although not exhaustive, the list provides an overview of terms associated with the production of all-grain wort for brewing. I've also included a few obscure words to supplement the reader's catalog of beer trivia.

Equipment

False bottom — A perforated plate or screen set between one-eighth and two inches above the bottom of the lauter tun to separate grain from the mash liquor during sparging.

Flour mill — This type of grain mill employs one rotating and one fixed plate to grind grain, which is forced between the plates by a rotating screw auger. The degree of grinding can be adjusted from a fine flour to a coarse grist by adjusting the distance between the plates. These mills grind rather than crush, and do not leave husks entirely intact.

Grain bag — Bags with an open weave made from cloth or synthetic fabrics used to contain grains during mashing, sparging or steeping. The open weave allows liquid to penetrate to the grain, and acts as a colander to strain the grain.

Grain mill — A device used to crush grain into small pieces and to separate the grain from the husk. Grain mills use hammers and rotating plates or rollers to pulverize the interior of the grain while leaving the husk largely intact.

ILLUSTRATIONS BY TIM SPOSATO

Hydrometer — A hydrometer measures the specific gravity of a solution by displacement.

Lauter tun — A vessel used to separate spent grains, or draff, from the sweet mash liquor. This vessel is typically insulated and fitted with a false bottom to strain the mash and a spigot to control the flow of mash liquor.

Mash tun — A vessel used to hold the grain and water mixture during the mashing process. Mash tuns come in a variety of styles to accommodate various mashing methods. A kettle periodically heated to maintain the desired mash temperature is the simplest design. Insulated plastic or metal containers also can be used as mash tuns. These containers can be fitted with false bottoms and plumbing to allow for use as combination mash/lauter tuns.

pH meter — An instrument with a digital display that measures, calculates and displays the pH of a solution. This device must be calibrated with a solution of known pH. A properly calibrated pH meter is more accurate than pH paper because visual comparison of color is not required.

pH paper — Chemically treated strips used to measure the pH of a solution. The strips change color in response to the acidity or alkalinity of a solution. The degree of color on the strip is compared to a standard scale to determine the level of acidity or alkalinity.

Roller mill — Roller grain mills contain one or more rotating rollers to crush the grain while leaving the husk largely intact. The motion of the rollers draws grain into the crushing mechanism. This system works much like an old-fashioned laundry wringer.

Scale — A device used for measuring specific quantities of a substance by weight. A grain scale should be graduated in one-eighth- to one-quarter-pound increments. A scale used for measuring hops and water treatments should have gram graduations.

Sparger — A device used to deliver an evenly dispersed spray of water over the grain bed in the lauter tun. This device can be a perforated pipe, a sprinkler head attached to a piece of tubing, a watering can diffuser or a manufactured sparging unit. It is used to wash the soluble sugars from the grain bed. A fine spray is employed to make sure the grain bed is not disturbed during sparging.

Thermometer — A device used to measure temperature. A thermometer is indispensable for monitoring and maintaining mash temperatures. Thermometers are characterized by their displays and are available in liquid scale, analog dial and digital versions.

Grain and Malt

Acrospire — The growing embryo of the barley plant. The acrospire is the shoot of a barley plant that grows during the germination stage of the malting process.

Adjuncts — Fermentable materials derived from sources other than barley or wheat malt. The most commonly used adjuncts include rice, corn, unmalted wheat, unmalted barley and dextrose. Although these are the principal brewing adjuncts, any source of starch or sugar can be used in the brewing process. Other adjuncts include oats, potatoes, rye, sorghum, triticale, millet, maple syrup, honey and fruit. Adjuncts typically lack the enzymes required to convert starches to sugars needed for fermentation. For this reason, most adjuncts must be mashed along with enzyme-rich malted barley. Before mashing, however, these adjuncts must be gelatinized.

Astringency — A mouth-drying characteristic of beer taste mostly caused by tannins, oxidized tannins (phenols) and various aldehydes (in stale beer).

Barley — A member of the grass family that grows in several varieties. The seeds grow in two or six rows, called heads, along the central stem of the plant. The number of seed rows is determined by the number of fertile flowers produced by the specific variety.

Conversion — The enzymatic transformation of starches into various fermentable and unfermentable sugars that occurs during the mashing process.

Couch — A heap of steeped barley that is cast on the malting floor for germination.

Diastatic power — A measurement in degrees Lintner of the starch conversion enzymes present in a malt sample.

Endosperm — The nutrient portion of a seed. The endosperm is composed of starchy matter that serves as the first source of nutrients for a growing plant. In barley, the endosperm is also the source of starch for mashing. The endosperm of barley is very hard and is described as "steely" in its original, or unmodified, state.

Farinator — A hand-operated device used to slice barley kernels in the middle to allow the maltster to determine the degree of malt modification.

Flaked — Grains that have been moistened and pressed or rolled into flakes. Flaked grains are gelatinized during the flaking process, and can be added directly to the mash without pre-cooking.

Flour — Finely ground grain meal. The intentional use of flour is rare in large-scale brewing. Flour is used to a limited extent in the production of some Belgian specialty beers.

Gelatinization — A process during which a grain's starch molecules burst and break apart during heating.

Germ — The embryo of a cereal grain.

Germination — The beginnings of seed growth. Germination is characterized by acrospire and rootlet growth. During germination, the starchy endosperm is used by the plant embryo for nutrients.

Grain bill — The list of grains and their amounts used for a particular recipe.

Grist — The entire quantity of grain used in the mash.

Grits — Processed grain that has undergone husk removal, bran removal, germ removal and fine milling. Grits are ungelatinized.

Highly modified malt — Highly modified malt contains few complex proteins, many free amino acids and has a large amount of soluble starch available for conversion. Highly modified malt typically exhibits an acrospire growth between three-quarters and full length of the barley kernel. This type of malt provides several advantages to the brewer. First, the presence of free amino acids aids yeast growth in the final wort. The absence of complex proteins also reduces the likelihood of haze problems in the finished product. Because of this, there is no need for a protein rest, which simplifies the mashing schedule and allows the use of a single-step infusion mash. Highly modified malt, however, gives a lower yield to the maltster because the malted barley kernel loses more of its weight to the growth of the acrospire than less modified malt.

Husk — The protective outer layer surrounding a seed. Barley is a husked grain, while wheat has no husk. The barley husk is important to the mashing process because it helps form the filter bed through which sugars are washed during sparging. For this reason, special care should be taken during grain crushing not to shred or pulverize the husks.

Lovibond — A standard scale for the measurement of grain, wort and beer color. A particular sample is characterized with a Lovibond rating by comparing it to a standard liquid reference sample. Malt is assigned a Lovibond rating by producing a sample wort from a single-malt grist and comparing the result to the standard color reference samples.

Malt — Processed barley that has been steeped in water, germinated on malting floors or in germination boxes or drums and later dried in kilns to convert insoluble starch in barley to the soluble substances and sugars in malt.

Modification — The breakdown of proteins and starch during germination. As the acrospire grows, the protein matrix of the endosperm is broken down by the enzymes formed during germination. Modification begins at the bottom of the barley kernel and proceeds toward the top as the acrospire grows. As the grain is modified, the hard steely endosperm becomes friable or mealy.

Rootlet — The small, immature root structures that appear during germination. These structures are removed during the processing of malt.

Six-row barley — A variety commonly used in North American brewing that produces seeds growing in six distinct rows called heads along the central plant stem. Although six-row barley typically provides a higher yield per acre than two-row varieties, the husk and germ of the seed account for a higher percentage of the grain's overall weight. Because of this composition, six-row malt yields less extract by weight than two-row varieties.

Six-row varieties generally have a greater enzyme potential than two-row varieties. For this reason six-row barley allows a more generous use of adjuncts in the mash. Another potential benefit is provided by the larger proportion of husk in six-row barley. This husk material makes a good filter bed, thus aiding the sparging and lautering process. Although potentially beneficial, the larger proportion of husks in the mash also presents the possibility of a higher rate of tannin extraction during sparging. This type of barley also has a high protein content that can present problems with clarity and stability in the finished product.

Specialty malt — Barley malt can be further divided into varieties based on its method of production. The degree of roasting during the kilning process determines the color and flavor characteristics of the finished malt. Malt characteristics range from pale to black, and each style has a particular flavor from mild to roasty. Specialty malts do not need to be mashed and include crystal, chocolate and black patent.

SRM — Standard Reference Method. A method of measuring color intensity roughly equal to Lovibond degrees, used by the ASBC (American Society of Brewing Chemists). This reference number is referred to as an SRM degree. This system has largely replaced the older Lovibond color rating system in the brewing industry. The Europeans use a unit called "EBC (European Brewery Convention) degree." To convert between the two use these formulas:

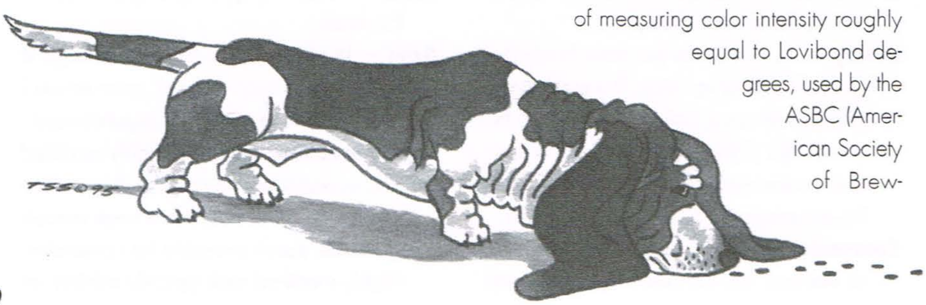
1 °EBC = 2.65 °SRM − 1.2

1 °SRM = 0.375 °EBC + 0.46

Two-row barley — A variety that forms two seed rows in the grain head. This type is characterized by its plump kernel and high potential yield. Two-row barley has a lower enzyme potential than six-row varieties. This type also has a lower husk ratio. A consequence of its low husk ratio is the potential for a smoother, mellower beer because the likelihood of tannin extraction is reduced with two-row barley. This is the preferred barley for European brewing.

Undermodified malt — Undermodified malt has fewer free amino acids and many complex proteins. This type of malt requires an additional step in the mashing process to break down the proteins in the grain. Undermodified malt also has the potential to cause the appearance of a protein chill haze in the finished beer. By producing an undermodified malt, the maltster increases the malt yield per pound of barley because less of the original kernel is lost to acrospire growth. Virtually no modern malts are undermodified.

Wort — The prefermentation solution of sugars, proteins, amino acids, etc., produced by mashing and lautering.



Procedures

Crush — A procedure used to break grain into small pieces while maintaining the integrity of the barley husk.

Decoction — Literally, to extract by boiling. This method of mashing takes the mash through a series of controlled temperature stages by removing a portion of the grist from the mash (including a small amount of liquid), bringing this mixture to a boil and returning it to the mash. Each successive step, or decoction, is used to raise the temperature of the main mash. This type of mash typically employs two or three decoction steps that correspond to temperature rests employed by other mashing methods. Decoction mashing typically achieves an extremely high rate of extraction and increased amount of malt character.

Decoction mashing is a historical method of achieving starch conversion, and is generally thought to predate the existence of the thermometer. It is usually associated with the use of undermodified malt.

Double Mashing — a procedure in which two separate mashes are mashed-in simultaneously. The first is all malt and is comprised of about 90 percent of the recipe's total malt and is raised to 122 degrees F (50 degrees C). The second mash consists of the remainder of the recipe's malt and all of the adjuncts. This mash is brought up to 158 degrees F (70 degrees C) and held for about 15 minutes to allow alpha amylase action to occur. The adjunct mash is then boiled for 20 minutes and added to the main mash so the resulting temperature is 158 degrees F (70 degrees C). Double mashing ensures the adjunct starch is completely converted.

Doughing-in — The gradual addition of water to crushed malt to create a uniformly moistened grain and water solution. Doughing-in is used to prevent the formation of dry spots in the mash.

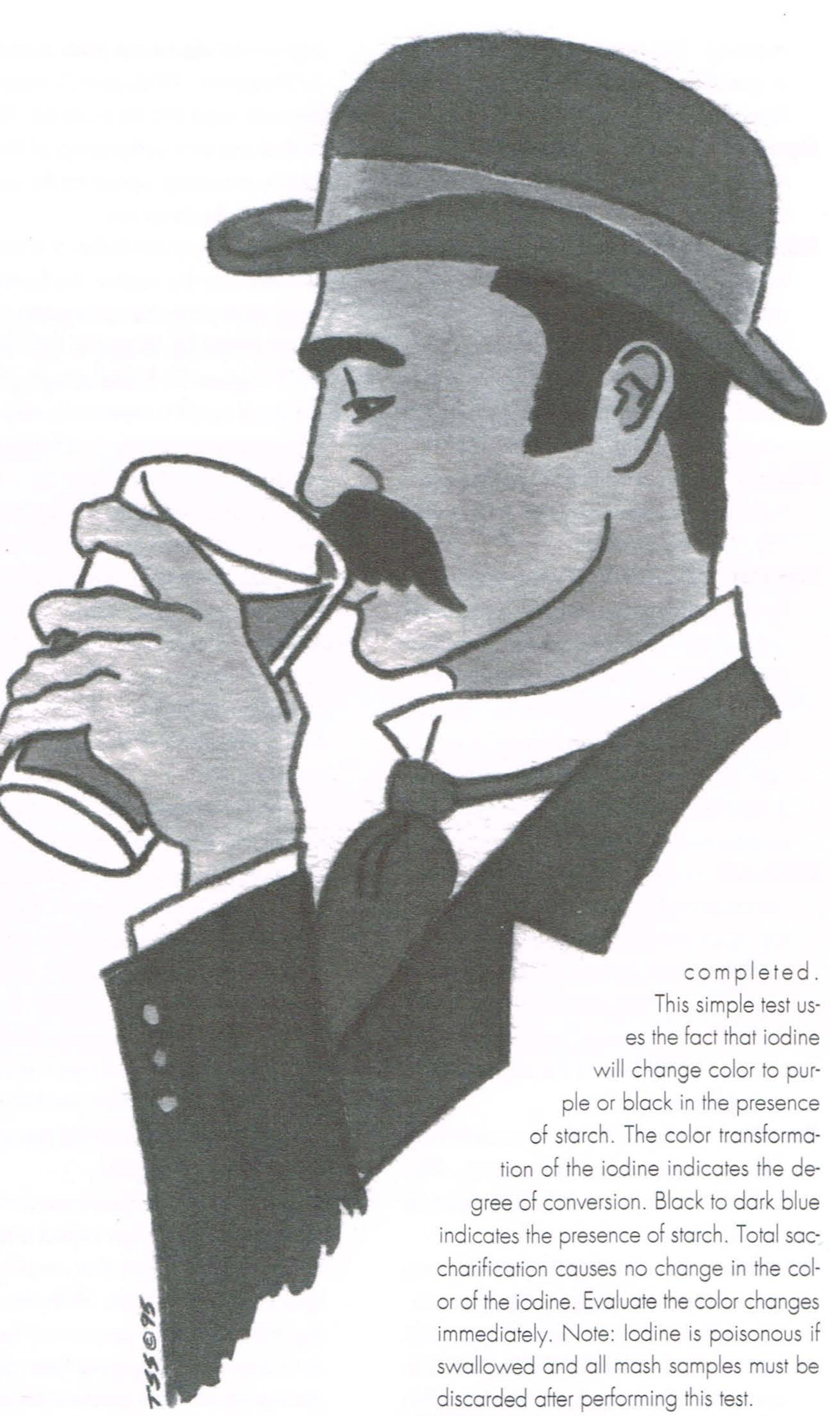
Draff — The solid material, spent grains, remaining in the lauter tun after sparging.

Extract — The sugar solution derived from malt and adjuncts during mashing.

Extract efficiency — The yield of fermentable sugar from the mash. This can be measured directly as degrees of specific gravity per gallon of wort (per pound of grist), or as an absolute percentage of dry grain weight which is extracted into a standard mash.

Grain bed — The grain bed is formed by the collection of solid particles and grain husks on top of the false bottom of the lauter tun. Once established, the grain bed allows for the separation of the clear sweet wort from the spent grains during sparging. The typical grain bed ranges from 12 to 18 inches deep.

Grind — A term often used synonymously with "crush." Grinding, however, is the act of using friction to turn things into small pieces — crushing is using a heavy mass to break something up.



Kilning — The process of drying germinated barley that terminates the germination process. The degree of kilning determines the final characteristics of the malt being produced. The lowest temperature and duration kilnings provide a light straw-colored malt. Higher temperatures and longer kilning produce specialty malts like chocolate or black patent.

Iodine test — A procedure used to determine whether starch conversion has been completed. This simple test uses the fact that iodine will change color to purple or black in the presence of starch. The color transformation of the iodine indicates the degree of conversion. Black to dark blue indicates the presence of starch. Total saccharification causes no change in the color of the iodine. Evaluate the color changes immediately. Note: Iodine is poisonous if swallowed and all mash samples must be discarded after performing this test.

Infusion mash — A single-step, single-temperature method employed to mash highly modified malt. During an infusion mash, the temperature of the mash is maintained between 150 and 158 degrees F (66 and 70 degrees C) for one-half to one hour to achieve starch conversion. This single-step mashing procedure employs only the saccharification rest.

Lauter — The process of separating spent grains from the sweet wort produced by mashing. This process is carried out in a specialized straining vessel called a lauter tun.

Liquor — The name given in the brewing industry to water used for mashing and brewing.

Malting — The process of converting barley into malt. The process is divided into three stages: (1) steeping the barley in water until a designated moisture content has been reached; (2) germinating the wet barley under controlled conditions; (3) kilning the germinated barley (green malt) to dry it.

Mash-in — The combination of crushed grain with water in the mash tun to form a solution. (See doughing-in).

Mashing — The process by which starches are converted into sugar is extracted from crushed grain. Mashing involves combining crushed grain and water, and the maintenance of various temperatures for prescribed periods of time. The various temperature stages or rests are used to activate the desired enzymes that ultimately convert the grain constituents into sugars and amino acids.

Mash out — The final stage of decoction and step mashing. During the mash out, the mash temperature is raised to 168 degrees F (76 degrees C) and allowed to rest for five minutes. This procedure is used to terminate enzymatic activity and to improve the flow of the sugar solution during lautering.

Runoff — The liquid that is separated from the spent grains during lautering. Also called runnings, wort, sweet wort or sweet liquor.

Set mash — The cessation of runoff flow not caused by a blockage in the lauter tun. Set mashes can be caused by grain that was too finely crushed, inadequate husk content or by a compacted filter bed. This condition can only be corrected by stirring the mash to allow percolation of the liquid through the filter bed. Stirring will require a rest period because it will allow grist to pass through the filter bed. These suspended particles must be allowed to settle out of solution. After all particulate has settled, the runnings should be recirculated to re-establish the grain bed.

Setting the grain bed — A procedure used to avoid compacting the grain bed. In this procedure the lauter tun is filled to one-eighth-inch above the false bottom with 175-degree-F (79-degree-C) water. Then the mash is put into the lauter tun. This procedure prevents compacting of the grain bed by providing support for the grains as they enter the lauter tun.

Sparge — The even distribution of a fine spray of water over the mash in the lauter tun to wash sugars from the spent grain. Sparge water should be heated to 170 degrees F (77 degrees C). Before sparging begins, the initial runoff is repeatedly returned to the lauter tun until the runoff clears. The sparge water is then introduced in a fine spray at about the same rate as the runoff. The lauter tun must not be allowed to run dry because this will compact the filter bed and can cause a set mash.

Steeping — The soaking of grains in water. This process is used prior to germination in the malting process. Steeping barley provides the moisture required for seed growth.

The term steeping also refers to the practice of crushing and immersing specialty grains in the brewing kettle prior to producing wort with malt extract. This procedure allows the characteristics of the specialty malts to be imparted to an extract brew. Grains are typically introduced to the brewing water in a grain bag while the water temperature is raised to boiling. Grains are removed from the brew kettle before boiling to prevent the extraction of tannin from barley husks.

Step infusion — A temperature-controlled mash procedure often called a temperature program mash that employs multiple temperature rests. With this mashing method, the temperature of the mash is changed by applying heat or introducing hot water to produce the desired temperature increase. Typically, this method of mashing employs a protein rest and a saccharification rest.

Strike temperature — The temperature of the mash water before its addition to grains. This temperature must be higher than the desired rest temperature because the temperature will be reduced when the grain and water are combined. The water temperature can be calculated from tables provided in most brewing manuals.

Reactions and Chemicals

Acid rest — A stage of the mashing process that allows the enzyme phytase to convert phytic acid to phosphoric acid to acidify the mash. During this rest, the mash is held at 95 degrees F (35 degrees C).

Alpha-amylase — An enzyme that breaks down long glucose chains (starch) into smaller molecules by splitting the chains from the center. Because alpha amylase works at random on these chains, it produces glucose, maltose, maltotriose, maltotetraose and long dextrin chains. Until these long chains are broken into one-, two-, or three-molecule-long glucose chains, they are not fermentable. This process is called liquefaction or dextrinization.

Beta-amylase — An enzyme that breaks down long glucose chains into smaller chains by attacking the chains from the ends. Beta-amylase breaks down these long chains by chopping off maltose molecules from the end. This process is called saccharification because it produces fermentable sugars.

Carmelization — The heat-induced browning of sugars, different from the Maillard reactions in malt kiling.

Diastase — The collective term used to refer to all enzymes involved in the conversion of starch to sugar during mashing.

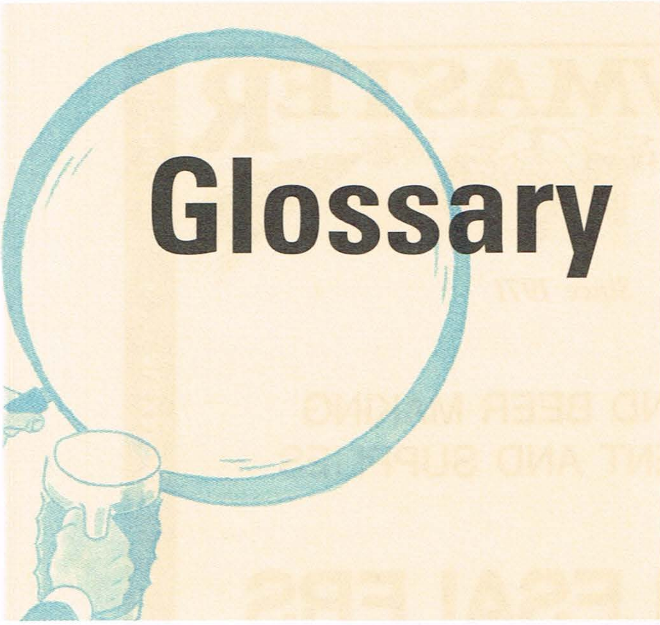
Enzymes — Complex protein-based catalysts that induce reactions between substances without being changed by the reaction.

Epsom salts — Magnesium sulfate. Used to increase the magnesium content of water and make the water hard.

Gypsum — Calcium sulfate. Used as a water additive to correct water chemistry, change mash pH or duplicate the water of a particular region. In mashing, gypsum is a source of the calcium ion and helps acidify the mash and inhibit the deactivation of alpha-amylase by high temperatures.

Hard water — Water hardness is measured by the presence of magnesium and calcium ions present in the supply. Water hardness is measured as the sum of temporary and permanent hardness of the supply. Temporary hardness is determined by the concentration of carbonate and bicarbonate. The hardness that carbonate and bicarbonate ions contribute is temporary because carbonate and bicarbonate are precipitated when water is boiled. Permanent hardness is determined by the amount of calcium and magnesium ions present in the water.

Ions — Ions are unstable atoms or groups of atoms that have either a positive or negative charge because of the loss or gain of an electron. Negatively charged ions have an extra electron and are called anions. Positively charged ions are termed cations.



Glossary

Lipids — Fatty substances that compose about 3 percent of malt.

Maillard reactions — A complex series of chemical reactions beginning with the reaction of carbohydrates and amino acids, which occur during the processing of many foods and result in the production of dark pigments, called melanoidins, and many different flavors.

Oxidation — The chemical reaction that combines oxygen with other reactants (beer, food). In brewing and beer storage oxidation produces off-flavors.

Peptides — A class of proteins consisting of between two and 30 amino acid molecules bound by peptide links. Peptides enhance the viscosity, or fullness, of beer.

Peptidase — This proteolytic enzyme works to break large and medium-sized protein molecules into amino acids. It is more thermolabile than protease so it is denatured quickly at higher temperatures.

pH — A numerical measurement of acidity or alkalinity determined by the presence of hydrogen ions. The pH scale ranges in values from one to 14, with seven being neutral. A pH of lower than seven indicates acidity, or the presence of more hydrogen ions. The lower the pH number, the higher the concentration of hydrogen ions, and the stronger the acidity of the solution. Numbers above seven represent alkalinity, with 14 representing the strongest alkali solution. Wort should have a pH between 5.0 and 5.5, and finished beer should have a pH between 4.0 and 4.5.

Phosphates — These molecules are the source of phytic acid created during malting and during decoction mashes. They contribute to the acidulation of the mash.

Phytase — An enzyme that reduces the mash pH by creating phytic acid from the phytin of the malt. This aids saccharification, wort clarification and fermentation.

Polyphenols — Polyphenols are derived from the husk and are acidic precursors of tannins. These molecules can give beer an astringent taste. Polyphenol extraction can be reduced by keeping the pH of the mash between 5.0 and 5.5. Polyphenols form complexes with proteins and are the cause of chill haze.

Precursor — A substance from which another substance is derived in chemical reactions.

Protein — Complex chains of amino acids. Proteins provide essential yeast nutrients and contribute to the body and head retention of beer. During mashing, large proteins are converted to amino acids and smaller, soluble proteins.

Protein rest — A stage of the mashing process during which complex proteins are decomposed by proteolytic enzymes to progressively less complex fractions. The stability of finished beer is largely established during the protein rest. Nutrients required for proper fermentation also are developed during this process. The proteolytic enzymes become active at temperatures from 113 to 140 degrees F (45 to 60 degrees C). The protein rest should be employed for a period of 20 to 30 minutes when using undermodified malts.

Proteinase — This proteolytic enzyme works to break large protein molecules down into medium-sized proteins. It is less thermolabile than peptidase so it works at higher temperatures where peptidase is soon denatured.

Saccharification rest — A stage of the mashing process during which complex glucose chains are broken down into fermentable sugars. Saccharification is accomplished by alpha-amylase and beta-amylase acting in concert to reduce complex glucose chains. Alpha-amylase is most active at temperatures between 131 and 158 degrees F (55 and 70 degrees C). Beta-amylase is most active at temperatures between 113 and 149 degrees F (45 and 65 degrees C). This stage of mashing requires a temperature range between 145 and 158 degrees F (63 and 70 degrees C). Higher mash temperatures produce more full-bodied worts because beta-amylase becomes deactivated sooner at higher temperatures. Lower mash temperatures yield more fermentable sugars. Rest durations vary with temperature. At higher temperatures, a 20- to 40-minute rest will accomplish conversion. At lower temperatures, a rest of 45 to 120 minutes is required.

Salt — Any of numerous compounds produced by the reaction of an acid with an alkali. Term applied to brewing water minerals.

Slaked lime — Calcium hydroxide. Used to precipitate bicarbonate from water.

Soft water — Water softness is measured by the absence of bicarbonate, magnesium and calcium ions in the supply.

Tannins — Complex polyphenol polymers. Tannins react with proteins and contribute to haze formation.

Sugars

Amylopectin, Amylose — Native starches that are soluble in water. Amylose is reduced to dextrins and various sugars by diastatic enzymes during mashing.

Carbohydrates — Complex organic compounds that form the majority of the barley malt. Carbohydrates include insoluble cellulose, soluble hemicellulose, starch and sugars.

Cellulose — An insoluble carbohydrate that composes the husk of barley.

Dextrins — Unfermentable carbohydrates that contribute to full body in beer.

Disaccharides — Double sugars formed by the combination of two monosaccharides.

Fructose — A highly fermentable monosaccharide that occurs naturally in malt and fruit. Fructose also can be derived from cane or beet sugar.

Glucose — The most common monosaccharide. It is a highly fermentable sugar identical in composition to dextrose (corn sugar).

Lactose — An unfermentable disaccharide derived from milk.

Maltose — Maltose is a fermentable disaccharide that occurs naturally in malt.

Maltotetraose — An unfermentable polysaccharide or dextrin derived during mashing.

Maltotriose — A slowly fermentable trisaccharide.

Monosaccharides — Single molecule carbohydrates. Glucose is the most common monosaccharide.

Oligosaccharides — Polysaccharides composed of four or more molecules. These sugars are not fermentable by *Saccharomyces* yeast and include maltotetraose. These are intermediate fractions that occur during the reduction of starch during mashing.

Polysaccharides — Carbohydrate compounds formed by the union of two or more monosaccharides. Of these, the trisaccharides are most important to brewing.

Sucrose — A fermentable sugar (disaccharide) that occurs naturally in malt. Sucrose is commercially available as common table sugar.

Trisaccharides — Sugars formed from the combination of three monosaccharides.

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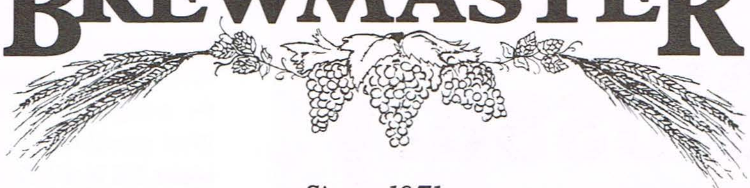

Home Grain Roasting

Home roasted grains add an interesting toasted malty flavor and aroma to your homebrew that otherwise would be unachievable. They also add depth to the color of your beer. Roasting your grain further broadens your malt options and enables you to duplicate otherwise unavailable malts.

All types of grains can be warmed quickly and roasted in your oven to bring out various flavors and colors. The technical explanation for these changes is due to Maillard (pronounced *may-yard*) reactions in which all sorts of foods undergo a browning and flavor change because of exposure to heat and reduction of moisture. Try experimenting by toasting your grain until you find a pleasing aroma and taste. Just think about the differences between lightly or darkly toasted bread and you will begin to understand the difference that time spent in the oven makes.

The aromatic components formed in kilning and roasting malt form at different temperatures. This is why similarly colored malts roasted for different lengths of time and temperature will have different flavor profiles. Moisture content also affects roasting flavor. Astute brewers experiment with various blends of specialty and dark malts to develop an added range and depth of flavors in similarly colored beers. For example, you can achieve a copper-toned pale ale by brewing with pale malt (3 to 5 °L) and some crystal malt or with lager malt (2 °L) with some black patent (500 °L), but the former will be tastier and truer to style.

Homebrewers now have access to a wide variety of grains for creating every style of beer recognized by the AHA and then some. The use of domestic and imported grains, along with specialized yeast cultures and water adjustments, enable homebrewers to travel around the world with their beer creations in the comfort of their homebrewery. With historical research and a bit of experimenting we can now add another dimension to our beer adventures. We can recreate and brew long-forgotten historic recipes for beer.

The Durden Park Beer Circle is an intriguing group of enthusiastic British homebrewers who have dedicated themselves to researching and recreating long-forgotten historical beers. Their collection of recipes requires home roasting of malt to recreate obsolete 18th and 19th century amber and brown specialty malts that have no modern commercial equivalent. These old-style grains were roasted in large ovens or kilns that were heated with fierce hardwood fires that added a slight smokiness to the grain. The skilled maltsters were able to impart the flavors of toasted dark grains while avoiding burned black malt and charcoal.

The cylindrical drum roaster incorporating water sprays that could instantly quench the roasting grain was invented by D. Wheeler in 1817, allowing the production of amber, brown, chocolate, black patent and roast barley. A very popular beer of the time was porter, also known as entire. Apparently an enterprising pub owner developed porter, a beer with the flavor of a blended beer called three threads. Brown malt was a key ingredient in the porter of that time. Many beers ranging from interesting to superb can be made from the research and old formulations described by the Durden Park Beer Circle. The grain bill for many of their recipes includes modern malts roasted to approximate the flavor and color of old-style malt.

My method of home roasting grain is to line a clean baking pan or cookie sheet with aluminum foil and put an inch-deep layer of grain in the pan. The pan should easily accommodate one to two pounds of grain. Toast the grain in a preheated 350-degree-F (177-degree-C) oven and carefully monitor the smell, taste and color changes. Stir the grain occasionally to avoid uneven toasting or scorching. Most of these flavorful aromatics quickly dissipate so it is best to roast your grains the day you plan to brew and allow them to cool completely before crushing. Lightly roasting malt for five to 10 minutes at 350 degrees F (177 degrees C) brings out an aromatic, malty flavor of the grain. This gives the beer a slightly caramelly, rich flavor somewhat like using a light crystal malt but with more complexity. A light roasting will not deactivate enzymes or change the color of the grains.

A medium roasting of malt for 20 to 40 minutes at 350 degrees F (177 degrees C) will produce an amber colored malt. Amber malt has a strong toasted flavor that gives the beer a biscuity and freshly roasted nut character that is similar to the imported Belgian specialty grains biscuit and dark Munich malt. The amber malt will no longer have active enzymes and will start to contribute a reddish copper color to the beer.

A long roasting of malt for 50 to 70 minutes at 350 degrees F (177 degrees C) will produce a form of brown malt. Brown malt is the main flavoring ingredient in historic porters and stouts, and has a strong roasted flavor that is similar to chocolate malt but with a different character. The brown malt has a smooth rich roasted flavor that

ILLUSTRATIONS BY PETER CUNIS

isn't quite as strong and pronounced as chocolate and black patent malts. Chocolate and black patent malts add much more dark coloring and can seem more acrid compared to homemade brown malt.

I have found that a light 10-minute toast enhances the fresh malty grain flavors of specialty grains along with the brewing malt. Try lightly roasting crystal or Munich malt for some flavor enhancing characteristics. The effects of these flavors are very concentrated, so usually one pound or so is a good starting point for adding some complexity to your beer flavor profile. Here are a few recipes to get you roasting.

Original 1750 Porter

Although porters in 1750 would have contained a mixture of amber and pale brown malt, modern brown malt lacks enzymes for full conversion of large quantities. This modern formulation meets descriptions of historic porter, i.e., black, strong, bitter and nutritious.

Ingredients for 3 1/2 gal (13.25 L)

- 10 lb British pale malt (4.5 kg)
- 1 1/2 lb brown malt (British malt roasted 60 min. at 350 degrees F or 177 degrees C) (0.68 kg)
- 1 1/2 lb British crystal malt (0.68 kg)
- 1/4 lb chocolate malt (0.11 kg)
- 1/2 lb black patent malt (0.23 kg)
- 2 1/2 oz Kent Goldings hops, 5% alpha acid (71 g) (60 min.)
- 2 oz Kent Goldings hops, 5% alpha acid (51 g) (30 min.)
- 2 oz Fuggles hops, 4% alpha acid (51 g) (15 min.)
- 1 oz Goldings hops, 5% alpha acid (28 g) (1 min.)
- Wyeast Irish ale No. 1084 or English ale yeast
- 1/2 cup dry malt extract (118 ml) to prime

- Original specific gravity: 1.090
- Final specific gravity: 1.030 to 1.032

Mature for six months to one year to develop proper conditioning.

Dorchester Ale 1800

The original recipe used only amber and brown malts that would not mash satisfactorily today. The grain bill has been chosen to reproduce the character required in a form that is easier to process. This is a dark brown barleywine. Mature for one year to develop proper character and balance.

Ingredients for 3 1/2 gal (13.25 L)

- 3 lb British pale malt (1.36 kg)
- 6 lb British crystal malt (2.72 kg)
- 3 lb brown malt (British malt roasted 60 min. at 350 degrees F or 177 degrees C) (1.36 kg)
- 2 lb EDME D.M.S. (Diastatic Malt Syrup) (0.91 kg)
- 1 oz Northern Brewer hops,

7.5% alpha acid (28 g) (60 min.)
1 oz Fuggles hops,
4% alpha acid (28 g) (60 min.)
2 oz Goldings hops,
5% alpha acid (57 g) (30 min.)
2 oz Goldings hops,
5% alpha acid (57 g) (15 min.)
1 oz Goldings hops,
5% alpha acid (28 g) (1 min.)
Wyeast Irish ale No. 1084
or English ale yeast
1/2 cup dry malt extract (118 ml)
(to prime)

- Original specific gravity: 1.100
- Final specific gravity: 1.038 to 1.040

Add D.M.S. to infusion mash to convert any residual starch.

Toasty Cream Ale

Ingredients for 5 1/2 gal (20.82 L)
6 lb Klages malt (2.7 kg)
1 lb toasted Klages malt
(10 min. at 350 degrees F or
177 degrees C) (0.45 kg)
2 lb wheat malt (0.9 kg)
1/2 lb dry rice extract (0.23 kg)
1/2 oz Cascade hops,
5.8% alpha acid (14 g) (60 min.)
1/2 oz Liberty hops,
5.5% alpha acid (14 g) (30 min.)
1/4 oz Cascade hops,
5.8% alpha acid (7 g) (1 min.)
Wyeast American ale No. 1056

- Original specific gravity: 1.042
- Final specific gravity: 1.006 to 1.008

California Common Ale

Ingredients for 5 gal (18.9 L)
8 lb Alexander's light malt extract
(3.63 kg)
1/2 lb U.S. crystal malt (0.23 kg)
1 lb toasted Klages malt
(10 min. at 350 degrees F or 177
degrees C) (0.45 kg)
1 1/2 oz Northern Brewer hops,
7.5% alpha acid (43 g) (60 min.)
1/2 oz Cascade hops,
5.8% alpha acid (14 g) (30 min.)
1/2 oz Cascade hops (14 g) (1 min.)
1/2 oz Cascade hops (14 g)
(dry hop in secondary for 1 week)
Wyeast California lager yeast No. 2112

- Original specific gravity: 1.048
- Final specific gravity: 1.010 to 1.012

Steep grains in 3 quarts (2.84 L) 150- to 152-degree-F (66- to 67-degree-C) water for 30 minutes. Rinse grains with warm water and add runoff to malt extract.

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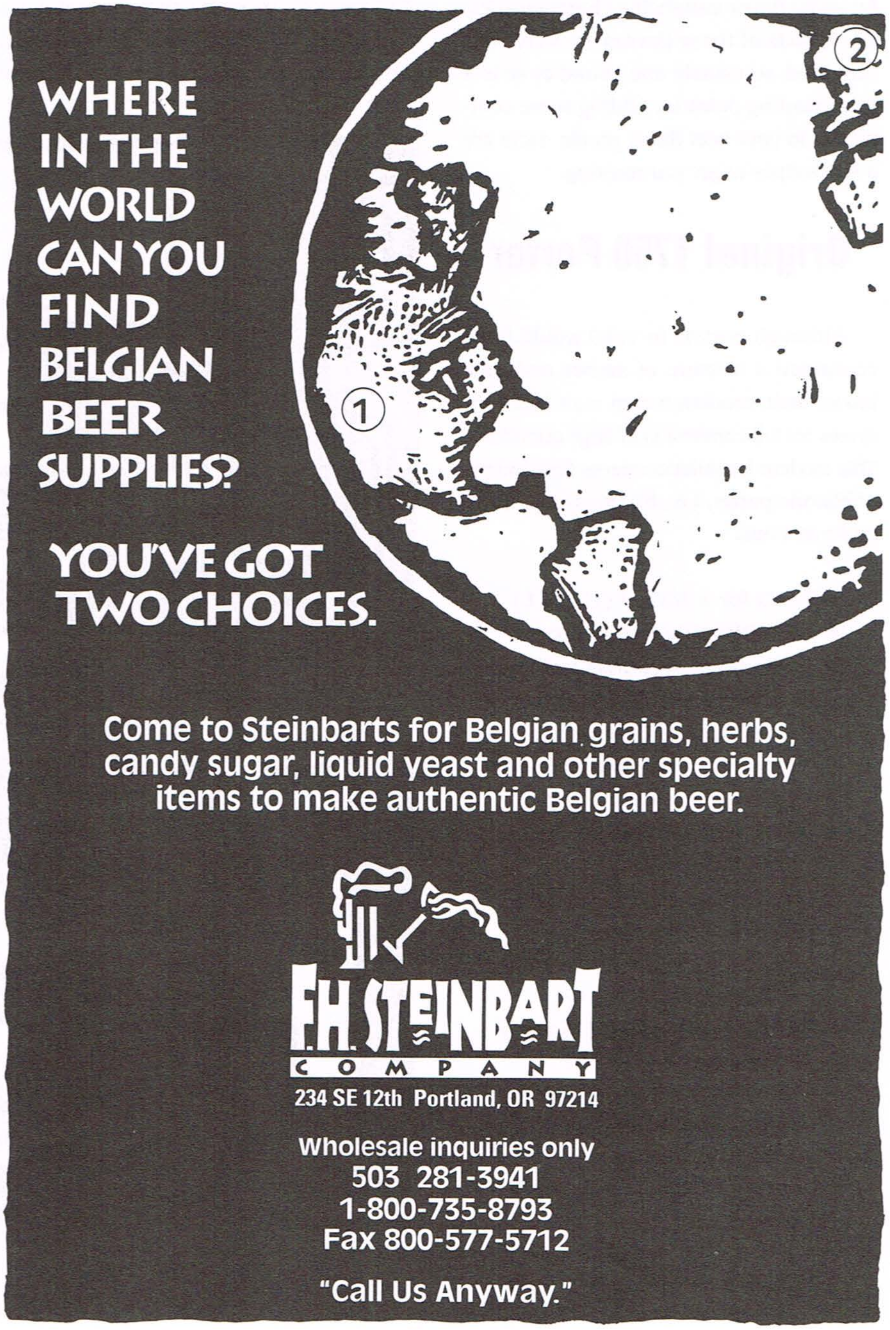

PRINCIPLE AND PRACTICE

WHY Water MATTERS

By Ginger Wotring

You've found the perfect recipe. You have the latest thing in mash tuns. You've found the best-quality grains, kilned to perfection for your recipe. You accurately weigh out the grains, crush them, put them in your mash tun, add water and wait for the magic to happen. What? You say your yield was lower than expected? There are harsh flavors in the beer? Unfortunately, the best grain in the world still needs a hospitable environment for a successful mash. The missing element here is water. It's so commonplace we often forget it may require careful attention.

What Is Water, Anyway?

We tend to think of water as nothing but empty space. Yes, it's wetter than air, but essentially empty. This is far from the truth. In its pure form water is the familiar H_2O, but in reality it exists as a solution of hydroxide ions (OH^-) and hydronium ions (H_3O^+, often written as H^+) in dynamic equilibrium with water. Water is a universal solvent; it dissolves almost everything it touches, given enough time. The water we collect from the earth's surface or underground reservoirs is a dilute solution of whatever this water has come in contact with: mostly minerals, gases and organic matter. The identity and concentrations of these solutes can make a dramatic difference in mash efficiency and beer flavor.

Do I Need Water Treatments?

There is no need for the beginning all-grain brewer to do any complicated water adjustments. However, there are three simple things that even the first-time grain brewer should consider: dechlorinate the mash and sparge water; check the mash pH and if necessary, adjust so it is in the 5.0 to 5.5 range; and acidify the sparge water to pH 5.7 with phosphoric or lactic acid. If you've already been making all-grain beers successfully without water adjustments and are completely happy with the results, you needn't worry about your water. Conveniently, the grain itself will often lower the mash pH to roughly the right range. This can make getting started in mashing a little easier. It is also possible that you have been blessed with the perfect water supply for the styles you like to brew. Sadly, most of us are not blessed this way, and we need to make certain adjustments to our brewing water to maximize extract efficiency and/or achieve the desired flavor profile.

Evaluating Water

How do you tell if your tap water could be used to make an all-grain beer? If the water is potable it is probably suitable for mashing. It may, however, require some simple adjustments, especially if you are trying to duplicate certain styles. Do a taste test on your water first. Does it have distinctive odors or flavors? Can you identify characteristics of sulfur, metals or chlorine? If so, you may need to treat it, or use water from another source. Next, call your water supplier. Ask the water quality lab for the average value of ion concentrations. Ask if there are wide variations throughout the year and why this might occur. Do the high or low points correspond to rainfall or to a particular season? Ask them what chlorination procedure and other treatments they use. It may help to explain that you are not a nervous customer or an investigative reporter, but that you make your own beer and need this information to optimize the process. Write down the answers because you'll want to refer to this information.

If you have well water, it is a good idea to have it analyzed before you brew with it. You'll want the same information about ion concentrations, but chlorination shouldn't be a concern. Many people who live in hard water areas use water softeners to improve the cleaning performance of soaps and detergents. This process replaces calcium, magnesium, iron and lead with sodium, which doesn't make the water any easier to brew with, it merely replaces one problem with another. If your water supply is truly terrible (very hard; high in sulfur, nitrate, iron, lead or mercury) it is possible to add salts to deionized or distilled water for brewing, but this extreme is rarely necessary. You can use pure water without any salt additions, which will save time and trouble, but might sacrifice flavor qualities or hinder yeast growth. If your water is too hard for the beer style you want to make, it may be more practical to dilute it with deionized or distilled water. Salt additions may not be needed if you dilute appropriately. Use your water analysis as a guide in dilution. If the ion concentrations would be reasonable if they were cut in half, then add one part distilled water to one part tap water. Be careful about water you buy at the store. It may not be as pure as you think. If you use bottled water regularly, it may be a good idea to get an analysis from the bottling company.

Chlorination

Water treatment plants generally bring chlorine levels to around 2 or 3 parts per million (ppm). This is high enough to prevent most microbial growth, but low enough to not be terribly offensive. (Most people can detect chlorine aromas or taste at around 0.1 ppm and find more than 50 ppm objectionable.) For all brewing, even with extract, it is best to remove as much chlorine as possible. Once in solution, chlorine may be present as chloride ions or hypochlorous acid (HOCl). Chlorine will react with other compounds in the wort to form chlorophenols, which are usually perceived as strange plasticlike or medicinal odors. If the chlorine in your water exists as free chlorine, you may boil the water to drive the chlorine off in the steam. Alternatively, you may let it sit in an uncovered container for 24 hours (be careful that insects, pets or children don't interfere with your dechlorinization!), or you may run the water through a carbon filter.

Unfortunately for brewers, most water treatment plants now use a process called chloramination in which ammonia and chlorine are added to the water to produce monochloramines and dichloramines (NH_2Cl and $NHCl_2$). Chloramines are longer lasting than chlorine (Cl_2) and thus ensure disinfection throughout the entire water supply system. Chloramines may react with components in your beer to produce unusual plastic or medicinal odors and flavors. If your water is chloraminated, you will need a carbon filter to remove the chlorine compounds; boiling or sitting for 24 hours will

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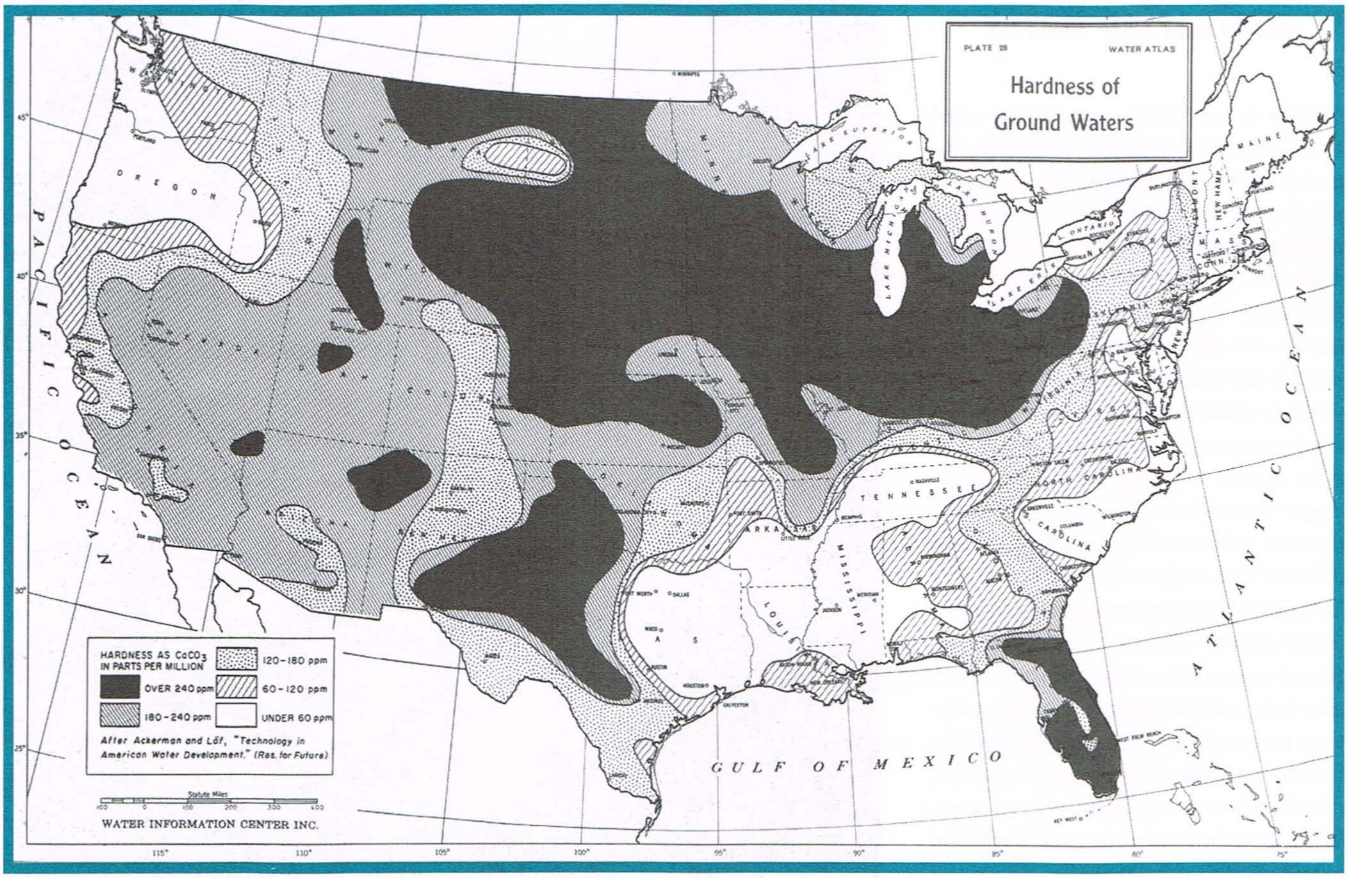


not work well. Chloramines are more stable in solution than chlorine, and will not evaporate with time or boiling. Carbon filters range from devices that screw onto your kitchen faucet to whole-house models. Some have filters that are treated with silver to help prevent growth of bacteria in the filter. Be sure to change the filter as often as the manufacturer recommends, and only run cold water through it. You may have to run water through this type of filter rather slowly to get the best results.

Hardness and Alkalinity

Hardness is a measure of the cations (positively charged ions) dissolved in the water. These are usually calcium and magnesium. The anion (negatively charged ions) associated with these cations determines if the hardness is permanent or temporary. If the anion is a bicarbonate, the hardness is temporary and can be removed. Boil the water and allow it to cool. A white solid called calcium carbonate ($CaCO_3$), H_2O and carbon dioxide (CO_2) will form. The CO_2 will be driven off in the steam, and its removal will encourage this reaction to continue until either the bicarbonate or the calcium is consumed. After boiling and settling, siphon the water off the white precipitate.

If the predominant anion in your water is sulfate, the hardness is permanent and cannot be removed by boiling. If the calcium level is less than 100 ppm and the magnesium level is less than 30 ppm, you need not take any further action. If calcium and/or magnesium levels are high, you may want to consider diluting your water with deionized or distilled water, especially for pale styles of beer.

Alkalinity is a measure of the buffering capacity of the dissolved anions, especially bicarbonate. Water with a high buffering capacity or alkalinity tends to have a pH that is very stable, even when acids or bases are added to it. Alkalinity measurements tell you how much calcium carbonate would have to be added to pure water to produce an equivalent buffering effect. In a complex solution like water, there is an equilibrium between carbonic acid and carbonates.

$$H_2CO_3 \rightleftharpoons NaHCO_3 \rightleftharpoons Na_2CO_3$$

The measured pH of the water is dependent on the balance of alkalinity and the free acid concentration. When alkalinity is high, this equilibrium is driven toward the right and pH is raised. Thus, water that is high in alkalinity tends to have a high pH, but water with high pH is not necessarily high in alkalinity.

Water pH

pH is a measurement of the total acidity or the hydronium ion concentration in water, expressed as the negative logarithm ($pH = -\log [H^+]$). This scale runs from 0 to 14, with 0 the most acidic and 14 the most basic or alkaline. Because it is a negative log function, each one-unit increase in pH actually means that the H^+ concentration decreases by a factor of 10. For example, a pH 4 solution is 10 times more acidic than a pH 5 solution and 100 times more acidic than a pH 6 solution. Acid solutions tend to taste sour, while alkaline solutions may taste bitter or astringent. However, it is not for

MAP COURTESY OF *WATER ATLAS OF THE UNITED STATES* BY JAMES J. GERAGHTY, DAVID W. MILLER, FRITS VAN DER LEEDEN AND FRED L. TROISE, WATER INFORMATION CENTER INC., NEW YORK, 1973.

taste reasons that pH is important in the mash. It's because mash enzymes work fastest in certain pH ranges, and because pH will influence how husk tannins are dissolved in the mash water. Ions other than OH^- and H_3O^+ affect pH by reacting with the OH^- and H_3O^+ present. For example, Ca^{++} may react with malt proteins to form calcium-protein complexes and free H^+ from the malt protein, effectively increasing the H^+ concentration and decreasing the pH.

Each mash reaction that breaks down protein, peptide or starch is sped (catalyzed) by an enzyme specific for that reaction. Enzymes bind to reactant molecules and make the formation of products more energetically favorable. These reactions will often occur without the catalyst, but they proceed so slowly that essentially no product is formed in a reasonable period of time. The catalysis enzymes are proteins themselves, long chains of amino acids linked together with charged side chains, like phosphates, sulfates or amides. Instead of existing as long chains, however, they fold and bend, allowing negatively charged regions to be close to positively charged regions and to keep all charged regions away from the uncharged regions. This gives the molecule a particular shape, and this shape or conformation is critical in allowing the appropriate interactions with reactant molecules, and the formation and release of products. The H^+ environment can influence the amount of charges carried on proteins, and thus change the way it folds. Enzymes usually work best in a particular conformation of bends and folds, so the pH of their surroundings is vitally important to effectiveness.

Husk tannins are acidic molecules. Acids dissolve best in slightly alkaline solutions and less readily in acidic solutions. Therefore, by adjusting mash and sparge water to an acid pH, extraction of tannins is inhibited. To optimize enzyme activity and reduce extraction of husk tannins, a pH of 5.2 to 5.4 is generally recommended.

Important Ions in Brewing

❶ **Calcium (Ca^{++})** — Fifty to 150 ppm is considered optimal for mashing. Calcium speeds the activity of many enzymatic reactions, probably by encouraging the most active conformation of the protein. Calcium also lowers the pH of the mash by reacting with complex phosphates in malt and freeing H^+. Calcium is also said to aid protein coagulation (hot and cold break formation) probably by binding to proteins and forming complexes heavy enough to precipitate out of solution. Calcium can be supplied in a number of forms: gypsum ($CaSO_4 \bullet 2H_2O$), calcium carbonate or chalk ($CaCO_3$), or calcium chloride ($CaCl_2 \bullet 2H_2O$); sometimes available as $CaCl_2$. Unlike other calcium salts, chalk will raise pH, not lower it. Use the anion to choose which compound to use for increasing calcium. You can't add just calcium, you have to add a salt. If you have water that is high in sulfate, or you are making a Dortmund, you probably don't want to add gypsum. The chloride or carbonate form would be better. But for a pale ale, or water with low sulfate, gypsum would be fine.

❷ **Magnesium (Mg^{++})** — Magnesium is similar to calcium in that it has lost two electrons and has essentially the same activities. Ten to 20 ppm are recommended as a yeast nutrient, but more than 30 ppm may give a sour-bitter taste. Some Flanders browns are brewed with water relatively high in magnesium.

❸ **Sodium (Na^+)** — Sodium has no effect on mash reactions, but because it has a taste of its own it can change the overall impression of a beer. At a level of 70 to 150 ppm, it will accentuate sweetness, especially if chloride is also present. Above 200 ppm, a salty flavor may be distinguished. Do not use iodized table salt. Iodine is toxic to yeast. Kosher salt is a readily available non-iodized form of sodium chloride.

❹ **Carbonate (CO_3^{--})** — Carbonate is an important ion in mash water. It will counteract the effects of calcium by reacting with it to form a precipitate. Carbonate neutralizes acidity, slows enzyme activity and increases the extraction of color and tannins. Ideally, carbonate should be less than 50 ppm for pale beers. If you are using only pale malts or infusion mashing, high carbonate may hinder gelatinization of starch and impede yeast flocculation.

❺ **Bicarbonate (HCO_3^-)** — Bicarbonate has basically the same effects as carbonate, but has twice the buffering capacity. It can be removed by boiling if there is sufficient calcium in the water.

$$Ca^{++} + 2\,HCO_3^- \rightleftharpoons CaCO_3\,(ppt) + H_2O + CO_2\,(evaporates)$$

Calcium carbonate forms, but does not dissolve well in water so it becomes a solid deposited on the bottom of the kettle. CO_2 forms and is a gas so it evaporates. Water, in a liquid state, remains as such unless it is boiled away (evaporated).

Note that it takes a single calcium ion to remove two bicarbonate ions, and remember that you want to have 50 to 100 ppm calcium remaining in your water for mash enzyme activity.

❻ **Chloride (Cl^-)** — Chloride has no direct effect on mash reactions, but concentrations greater than 250 ppm may enhance sweetness, especially in the presence of sodium. High concentrations are said to hamper yeast flocculation.

❼ **Sulfate (SO_4^{--})** — Sulfate is another anion that makes only stylistic contributions to beer. It accentuates hop bitterness and dryness, but at concentrations greater than 400 ppm this may be unpleasantly astringent.

Water Treatments for Brewers

In addition to boiling and filtration, homebrewers can use a number of acids and salts to alter their water. These are used to either adjust pH to optimize the mash or to mimic the water of some other geographical location to reproduce a particular style of beer. Take into consideration what the ion levels are in your water and what they are in the places where traditional beer styles originated (see Table 1). Note that you cannot add ions to a solution; you must add a compound that is composed of a cation and an anion and sometimes associated water molecules. Make sure the partner ion is not something that is already present in your water at a high concentration. Some published recipes call for salt additions appro-

TABLE 1. Model Brewing Waters

BREWING CENTER	ION CONCENTRATION (PPM)					
	Ca^{++}	Mg^{++}	Na^{+}	CO_3^{--}	SO_4^{--}	Cl^{-}
Pilsen (Plzeň)	7	2	2	14	5	5
Munich	76	18	2	152	10	2
Vienna	200	60	8	120	125	12
Dortmund	225	40	60	180	120	60
London	52	16	99	156	77	?
Dublin	118	4	12	319	54	19
Burton	268	62	54	200	638	36

(Reprinted from *Zymurgy* Winter 1991 Vol. 14, No. 5)

priate for the water used by the author of the recipe, but your water could be different. It is much safer to use your water analysis along with a brewing water table to determine what salt additions you may need. Measure these salts carefully. Measuring spoons are not recommended because of variation. Use a gram scale if possible.

Acids

pH may be adjusted directly by adding acid. Phosphoric and lactic acids are most commonly used. Phosphoric acid is essentially flavorless and adds phosphates that are present in malt anyway. Lactic acid has a clean, nondescript flavor and lactate ions cause no problems in the mash. In theory, sulfuric and hydrochloric acids could be used, but most brewers don't want to routinely add excessive chloride or sulfate ions to their mashes because of the potential flavor effects.

Handle strong acid solutions with care. It is safest to make a working solution that is fairly dilute, both to prevent overshooting the target pH and to minimize accidents. Partially fill a container with the desired amount of water and add a small amount of your concentrated acid to this. Adding water to a container of strong acid may result in dangerous splashing. Add this dilute solution to your brewing water, stir well and measure the pH.

Small hand-held pH meters are available at reasonable prices, but good-quality pH paper may be used successfully. When taking pH readings during the mash, remember that at warm temperatures the measured pH will be lower than the actual pH. Let a small amount of your mash liquid cool in a spoon for a few seconds before you take a reading. Dip your pH meter into this or put a drop on the paper. If you are using paper, wait until the color stops changing before you compare with the color guide supplied with the paper. If you have a pH meter with automatic temperature compensation features, you might be tempted to dip the electrode directly into the mash for readings, but there is the risk of breaking the glass bulb at the end of the electrode. This would contaminate your mash with not only bits of glass,

TABLE 2. Salts for Water Adjustment

COMMON NAME	CHEMICAL NAME	CHEMICAL FORMULA	EFFECTS ON MASH	BEER STYLES	COMMENTS	1 GRAM PER GALLON ADDS
gypsum	calcium sulfate	$CaSO_4 \cdot 2H_2O$	lowers pH ↑Ca^{++}	English pale ales, bitters	emphasizes hoppiness	55 Ca^{++} 132 SO_4^{--}
chalk	calcium carbonate	$CaCO_3$	raises pH ↑Ca+2 ↑CO_3^{--}	stout, porter Dortmund, Munich styles	only soluble at acidic pH (like the mash)	105 Ca^{++} 158 CO_3^{--}
calcium chloride	calcium chloride	$CaCl_2 \cdot 2H_2O$	lowers pH ↑Ca^{++}	Dortmund	adds Ca^{++} without adding SO_3 or CO_3	71 Ca^{++} 126 Cl^{-}
Epsom salts	magnesium sulfate	$MgSO_4 \cdot 7H_2O$	↑Mg^{++} ↑SO_4^{--}	certain Flanders browns, English pale ales, bitters	emphasizes hoppiness	26 Mg^{++} 103 SO_4^{--}
non-iodized salt	sodium chloride	NaCl	↑Na^{+} ↑Cl^{-}	Dortmund, Burton pale ales	round, full flavor	103 Na^{+} 160 Cl^{-}

WARNINGS: Do not use iodized table salt.
Always use food-grade chemicals. Road salt and dessicants are often calcium chloride, but in these forms it can contain arsenic, lead and other chemicals.

TABLE 4. Your Water Work Sheet

ION	LOCAL WATER SUPPLY	BEER STYLE ORIGIN WATER SUPPLY	DIFFERENCE	MINERAL ADDITION	RESULTING WATER
Calcium (Ca^{++})					
Magnesium (Mg^{++})					
Sodium (Na^{+})					
Sulfate (SO_4^{--})					
Chloride (Cl^{-})					
Carbonate (CO_3^{--})					

ION	PPM IN MY LOCAL WATER SUPPLY	PPM IN WATER SUPPLY OF BEER STYLE ORIGIN (Burton, for this example)	DIFFERENCE (above or below target ppm)
Calcium (Ca^{++})	20	268	248
Magnesium (Mg^{++})	12	62	50
Sodium (Na^{+})	15-55	54	39
Sulfate (SO_4^{--})	100	638	538
Chloride (Cl^{-})	20	36	16
Carbonate (CO^{--})	15-120	200	185

TABLE 3. St. Louis, Mo. vs. Burton Water

but also potassium chloride and either mercuric chloride or silver chloride, depending on the type of electrode. Withdrawing a small sample for pH measurement is the safest option.

The mash may also be acidified via an acid rest at 95 degrees F (35 degrees C). The naturally occurring malt enzyme phytase degrades phytin (a malt component) and releases free H^+ in the process. This approach will add two to three hours to the mash time, but it may appeal to purists who don't wish to add chemicals to the mash. Lactic acid producing bacteria of the species *Lactobacillus* are naturally present on malt and will sour a mash left overnight.

Making Perfect Water

The water the city of St. Louis supplies to my kitchen has 20 ppm calcium, 12 ppm magnesium, 15 to 55 ppm sodium, 100 ppm sulfate, 20 ppm chloride and carbonate varies from 15 to 120 ppm (depending on rainfall and river stage). The pH is around 9.5, and the hardness is mostly temporary. To make a classic English pale ale, I want to compare my water to the water in Burton, where this style originated (Table 3). The primary differences between St. Louis water and Burton water are in the calcium, sulfate and carbonate concentrations.

I could add gypsum ($CaSO_4 \bullet 2H_2O$) to lower pH, increase calcium and increase sulfate for hop character. The characteristics of these ions are compatible with the pale ale style. (If I were brewing a bock instead, I wouldn't want to add all that sulfate to my water because the bock beer style has a very subdued hop character. I could use calcium chloride and avoid stylistic problems.) From my calculations, I could add about 250 ppm calcium, 50 ppm magnesium, 40 ppm sodium, 540 ppm sulfate, 15 ppm chloride and 185 ppm carbonate to my water. The ppm of each ion in a gram of salt can be obtained from Table 2 but the calculation is as follows: $CaSO_4 \bullet 2H_2O$ has a formula weight (see glossary) of 172. Calcium is 40/172 of this, or 23 percent. Sulfate is 96/172, or 56 percent. This means that one gram $CaSO_4 \bullet 2H_2O$ added to one liter of water will increase calcium by 230 ppm and sulfate by 560 ppm. To put this in the unit of volume used by most of us, 55 ppm calcium and 132 ppm sulfate are added when one gram $CaSO_4 \bullet 2H_2O$ is added to one gallon of water. Addition of 3 grams gypsum per gallon, 2 grams magnesium sulfate per gallon, 1 gram calcium carbonate per gallon and perhaps one-quarter gram sodium chloride per gallon, would put my water in the right range for a pale ale. After doing this, I would check the pH of my mash and adjust it with phosphoric acid to 5.4 if necessary. You don't need to get each ion concentration to match exactly. Because we can only add salts, this may be impossible. I try to correct differences of more than 50 percent. After a few times, you'll know how much of what salt you'll need for your favorite beer styles without going through the entire process, but a work sheet may make it easier the first few times (Table 4).

By using what you have learned about your water supply, what you know about different beer styles and some simple chemistry, it is easy to recreate traditional beer styles from almost anywhere. It takes a few calculations and some careful measuring, but the results are worth it!

Water Glossary

Anion — a negatively charged ion; an element or compound that has gained electrons.

Buffer — a solution that resists pH changes even upon addition of acid or base.

Cation — (cat-eye-un) a positively charged ion; an element or compound that has lost electrons.

Deionized water — water that has had ions removed by a series of ion-exchange columns; may contain non-charged contaminants.

Distilled water — water that has been purified by heating until the water vaporizes; large molecules like salts will remain behind while organic molecules either vaporize earlier than water or have a higher boiling point and stay behind.

Equilibrium — a state in which opposing processes are occurring at equal rates, resulting in no net change. For example, $OH^- + H_3O^+ \rightleftharpoons H_2O$. At neutral pH this reaction breaks down and forms water molecules at equivalent rates; the ions come together to form H_2O just as often as the water separates into OH^- and H_3O^+ ions.

Formula weight — the sum of the atomic weights of each atom in a compound; the number of grams in one mole.

Precipitate (ppt) — a solid compound formed by the reaction of compounds in a solution.

ppm — parts per million; a measure of concentration; equivalent to milligrams per liter (mg/L) or 0.0001 percent.

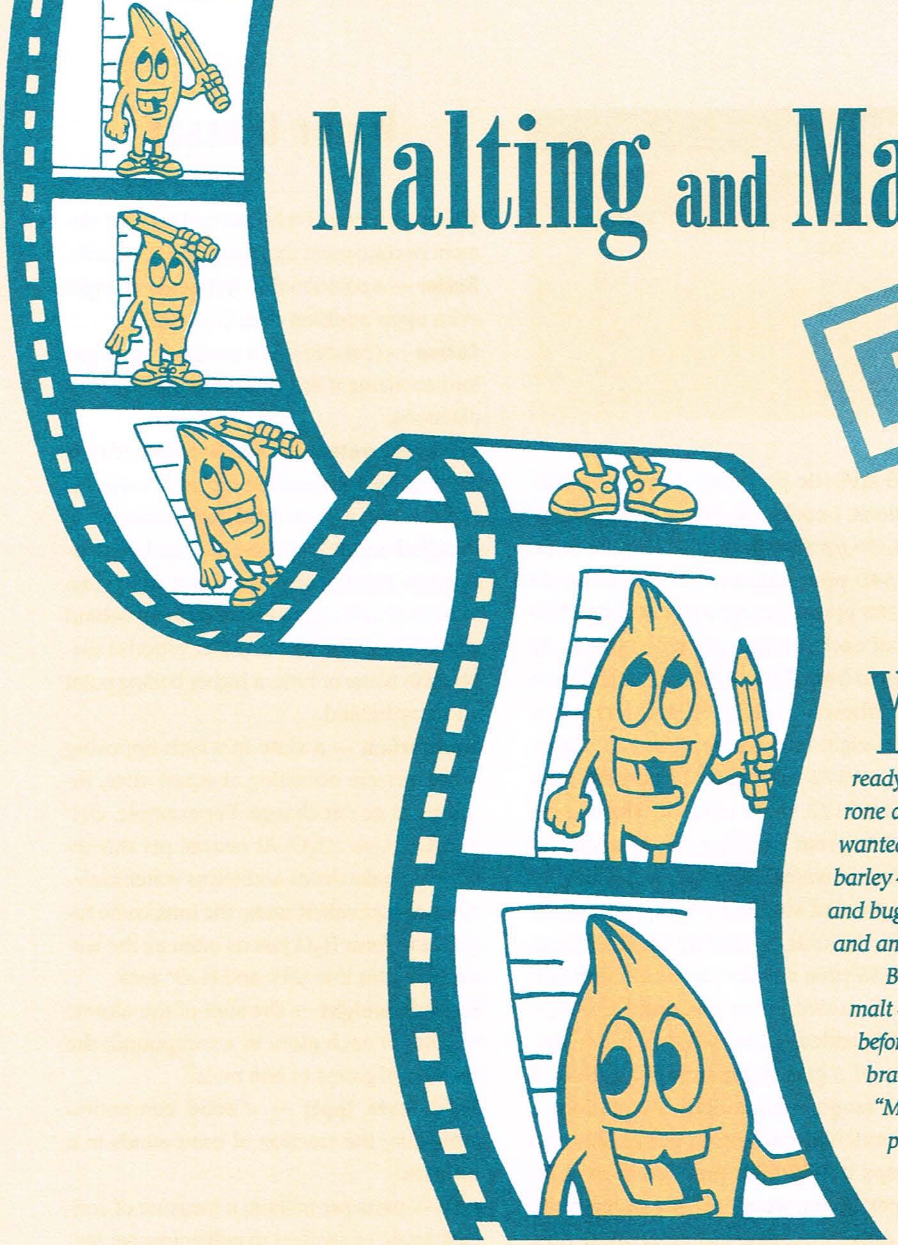
Reverse osmosis — a filtration method that uses pressure to push water and other very small molecules through a membrane with fine pores. Larger molecules are excluded. A good method for removing inorganic contaminants (metals, chloride, nitrates), but because it usually is used in conjunction with a carbon filter it also removes organics. A reverse osmosis system is rather expensive and generates a large volume of waste water.

Solution — homogenous mixture of compounds.

Solute — the component of a solution whose physical state changes, or the component that is present in smaller quantity.

Solvent — the component of a solution whose physical state does not change, or the component that is present in greater quantity.

Malting and Mashing: Rated G



In the Beginning

Young Bart Barleycorn ponders the meaning of malt. The word alone is enough to frighten young Barleycorn. Even though he was plump and golden and about ready for harvest, the word sent a shiver through his aleurone all the way to his testa! "Malt" was not something Bart wanted to be. You see, Bart came from a proud family of seed barley — a family that had survived drought and floods, mold and bugs. To end up as malt would be a disgrace to his heritage and an abandonment of future generations of Barleycorn.

Bart knew that only the very best barley could become malt — and often did — but he would fight spike and awn before it happened to him. His cousin Benny laughed at Bart's bravado. "You'll never know what hit you," said Benny. "Malting is the same as sprouting. But just when your sprout pops out and goes looking for sunlight, they shovel you into a hot kiln. Your rootlets wither, your sprout dies and you wind up drier than harvest straw."

The thought of being in a kiln worried Bart so much it wrinkled his ventral crease. He engaged in several days of serious thinking — the kind that might have been called "navel gazing" if he'd had a navel. He quizzed Benny on the subject. Like most geeks, Benny wasn't much help on the metaphysics, but he did have some answers about what would happen to Bart if he were malted.

"You see," Benny began, "all that starch you are carrying around inside you is kind of a universal food. Your acrospire isn't the only growing thing that needs starch. When barley is malted, humans can use your starch in many ways."

At this, Bart brightened slightly. "So there is a purpose to this malting madness?"

"Of course," said Benny. He explained that humans use the starch from barley, along with the proteins and some other minor components, to make a drink called beer.

"Beer?" inquired Bart.

"Yes, it's supposed to be great stuff," said Benny. "When made properly, your vital reserves provide all the nutrients and much of the flavor. Humans love the stuff."

ILLUSTRATION BY KEN TRUHAN

By Ray Daniels

Down to Business

Malt, and therefore barley, is indeed the central component of beer. Beyond water, most of the chemistry of beer begins with barley. It contributes not only sugar but also body and head, a significant portion of the flavor and a good portion of the color.

But raw barley is fairly unsuitable for brewing. Once harvested, the barley must be malted before it can be used in beer. During malting it is allowed to germinate and then quickly dried. This process begins the breakdown of complex molecules inside the barley kernel and develops the enzyme system needed by brewers for beermaking.

The harvested barley kernel is a seed. It contains an embryonic barley plant and large reserves of starch and protein. An outer husk and membrane protects everything inside from damage.

Before malting, the kernel itself is as hard as rock. Unlike most living things, the kernels contain little water, just 12 percent by weight. The reserves of starch and protein are formed into long chains and tightly packed structures suitable for storage.

Starch and Sugar

About 60 to 65 percent of the barley kernel by weight consists of starch, which is long sequences of sugars all linked together. Some starch structures are straight and unbranched, like a length of chain pulled taut. These are called amylose. Others, called amylopectin, are highly branched, looking like a bush that has been stripped of its leaves.

Both types of starch are made up of linked glucose sugars. Glucose is a six-sided ring with the structure shown in Figure 1. Glucose is represented as an 'S' throughout the article for simplicity.

In the long, straight starch structures, sugars are joined end-to-end without variation. In this case, each sugar is linked to just two other sugars: one in front and one in back. These amylose molecules usually include about 1,000 sugars, or glucose molecules, and account for about 25 percent of the total starch found in a barley kernel.

In the bushy type of starch, branches are formed by links between the corner of one sugar and the end of another. At these branch points, the central sugar of each branch will be directly linked to three other sugars instead of two (see Figure 1). Each molecule of amylopectin includes about 10,000 glucose molecules.

Inside barley both types of starch are found together, tightly packed into starch granules. The granules, encased in a matrix of protein and gum, make up the majority of the huge endosperm inside all barley kernels.

In nature, the starch is broken down into sugars and used as food for growing roots and shoots. Fortunately for brewers, yeast also can use these sugars as food.

Sugars can be used as food when they stand alone or when two or three are linked together. Simple, six-sided sugar rings are called "monosaccharides." "Mono" means one and "saccharide" is just another word for sugar.

Yeast also can use sugars as food when they are linked into short chains of two or three sugars. Since "di" means two and "tri" means three, these bigger sugars are known as disaccharides and trisaccharides.

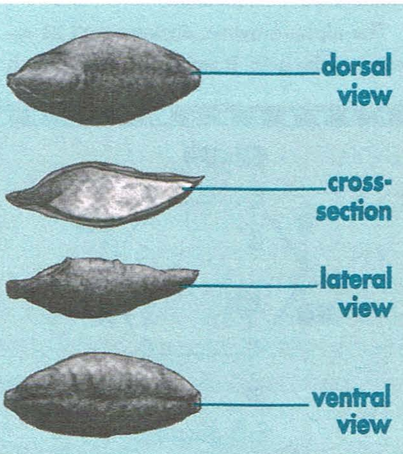
One particular disaccharide is known as "maltose." This is the primary sugar produced by the breakdown of barley starch, both naturally and during the brewing process.

Chains of four or more sugars cannot be fermented by yeast and are known as dextrins. Dextrins range in length from four sugars to about 500 sugars.

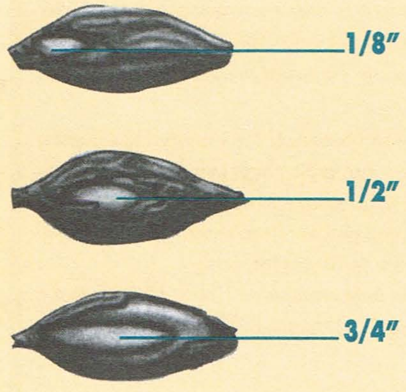
Because neither barley nor yeast can use starch as a food source without further processing, the whole goal of malting and mashing is to break down the starch into sugars.

Malting

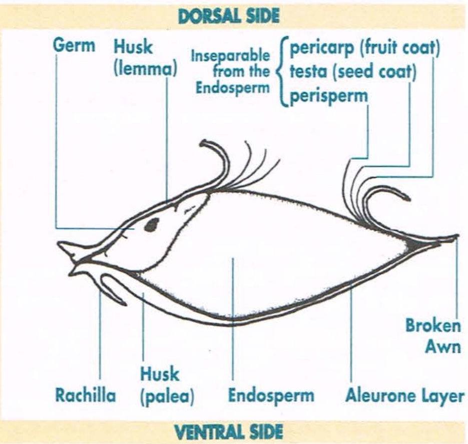
Malting sets the stage for the breakdown of starch that will occur during mashing. During malting the protein and gum matrix around the starch granules is broken down. This increases the water permeability of the



DEHUSKED BARLEY KERNEL



MALTED BARLEY, ACROSPIRE GROWTH



BARLEY CORN

BARLEY ILLUSTRATIONS BY GREGORY J. NOONAN, *BREWING LAGER BEER* (BREWERS PUBLICATIONS, 1986)

Proteins and Enzymes

Like carbohydrates, proteins are polymers, or long chains of a basic building block. In the case of proteins, the building blocks are known as amino acids. Amino acids may occur singly, in short chains known as peptides, or in longer chains as proteins.

A special class of proteins is called enzymes. Where nonenzyme proteins tend to have storage and structural roles, enzymes make things happen. Enzymes are catalysts, and as such they promote chemical reactions without changing their own structure or character. Enzymes are generally given names that end with "ase."

Enzymes play a critical role in malting and mashing. Those called amylases are responsible for the breakdown of starch into sugars. Others break down different complex molecules, including proteins, into simpler products. Still others synthesize new compounds from various precursors.

The complex protein of the raw barley kernel includes some enzymes, but others are developed during malting. The critical mashing enzyme known as alpha-amylase is an example of an enzyme that is absent in raw barley but is formed during malting.

Each enzyme catalyzes just one very specific chemical reaction. Also, enzymes generally achieve optimal performance under specific conditions of temperature and pH. When subjected to nonoptimal conditions, their performance deteriorates, but it will improve again when optimal conditions are restored.

Under extreme conditions of heat or pH, enzymes can permanently lose their catalytic activity. When this occurs the enzyme is said to be denatured. In malts that have been subjected to high-temperature kilning such as chocolate or crystal, most of the mash enzymes have been denatured. Munich malt is kilned at an intermediate temperature that denatures some of the amylases, but still leaves adequate enzymes for mashing.

In addition to the amylases discussed in the accompanying article, two other groups of enzymes are important to brewing: proteases and beta-glucanase.

Proteases digest proteins by breaking down the bonds between amino acids. This is the mechanism by which reserves present in the barley as storage proteins are liberated. Both peptides and amino acids result from the breakdown of these proteins and play an important part in beer chemistry. Among other things, they contribute to yeast metabolism and head retention.

The proteases include more than 40 different enzymes that act in different ways on protein. Some cleave a single amino acid from one end, while others liberate long chains of amino acids from the larger protein.

Many of the proteases survive in malt and will be active in the mash at temperatures near 122 degrees F (50 degrees C). A mash rest at this temperature can produce modest increases in the levels of free amino nitrogen that is an essential yeast nutrient. This rest can also improve head retention through production of additional medium-sized proteins.

Beta-glucanase acts on gumlike materials in the malt to help improve lautering and beer clarity. A carbohydrate, beta-glucan is made up entirely of simple sugar molecules, just like starch. The critical difference between the two comes in the structure of the bonds between the individual sugar units.

The gumlike character of beta-glucan can increase viscosity of the wort during lautering and lead to slow runoffs. This will be especially true when grains high in beta-glucans, such as rye and oats, are used. Also, beta-glucans tend to be soluble in hot wort but insoluble in cold beer and thus may contribute to chill haze. If these problems are encountered (or anticipated) steps can be taken to increase beta-glucanase activity in the mash.

Beta-glucanase is reported to work best at mash temperatures of 104 to 122 degrees F (40 to 50 degrees C). The midpoint of 113 degrees F (45 degrees C) is often recommended for optimal beta-glucanase activity.

endosperm and makes the starch accessible to enzyme activity. During mashing, the starch granules will be attacked and broken down into sugars.

The other critical process that occurs during malting is development (and preservation) of the enzyme system needed for brewing. Some of the enzymes needed for brewing are not present in raw barley and only develop during germination. Also, kilning determines the type and level of enzymes that will be present in the finished malt.

The process of malting requires a week to 10 days to complete. First the embryonic plant inside the barley seed must be awakened by the proper combination of temperature and moisture. Then the kernel is allowed to grow for a few days before it is kilned.

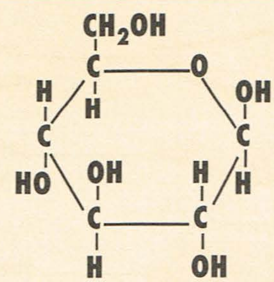
The drying that occurs in the kiln stops the growth process without completely destroying the enzymes inside the kernel. The finished malt, containing only about 4 percent moisture, enters a new dormant stage. Here, the work of the maltster ends and that of the brewer begins.

Mashing

Amylases, the enzymes that break starch into sugar, are preserved during the dormancy of malt. The two amylases, designated beta and alpha, work together to break starch down into simple sugars when reactivated during mashing.

Beta-amylase works only from the end of the starch chain and "bites off" two sugars at a time. The disaccharide that it produces is maltose, the most common sugar available from barley malt.

The alpha-amylase enzyme isn't as selective as the beta. It can break apart starch



ß-D-glucose

FIGURE 1. Sugar and Starch

chains at almost any point. As a result, it usually breaks long chains 100 to 500 sugars in length off the starch molecule. The work of alpha-amylase speeds breakdown of starch by splitting a single starch molecule into many shorter chains that can all be attacked by beta-amylase.

When these two enzymes act on straight-chain starch (amylose), they can completely reduce the starch to fermentable sugar. This means it is possible for every bit of this type of starch to be broken down into units no more than two or three sugars long. As a result of this breakdown, all of the sugars would be fermentable by yeast.

With amylopectin, the bushy type of starch, the two amylases have some problems. The branch points in the starch structure are places where the alpha- and beta-amylase can't break up the starch chain.

Remember that the branch points were different from all other locations in a starch chain. Unlike normal sugars that are connected only to one other sugar at each end, the central sugar at the branch point is connected to three other sugars — one at each end and one at one corner.

As a result, the amylases can't break up the four sugars that make up the branch point in the bushy kind of starch. In fact, it usually gets so crowded around those branch points that the amylases can't work very close by either. As a result, each unbroken branch point may consist of eight or even more connected sugars.

As mentioned earlier, groups of four or more sugars are known as dextrins and cannot be fermented by yeast. While straight-chain dextrins of any length are just called "dextrins," those that include a branch point are called "limit dextrins."

TABLE 1. Enzyme Specifics

ENZYME	TEMPERATURE RANGE	PH RANGE	COMMENTS
Alpha-amylase	131 to 158° F (55 to 70° C)	5.0 to 7.0	Calcium ions needed for stability.
Beta-amylase	113 to 149° F (45 to 65° C)	4.0 to 6.0	Rapidly inactivated above 149° F (65° C).

Note: These enzymes cannot act on starch until it has been gelatinized with water. For barley, maize and wheat, gelatinization occurs at temperatures at or above 140°F (60°C).

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S-S-S-S-S
    \
     S-S-S
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limit dextrin

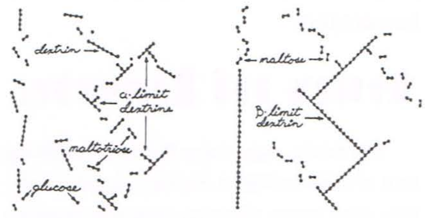
Amylopectin branch points occur about once every 20 to 25 sugars. Thus, even if the amylases break down everything they can, about a quarter of all the sugars in amylopectin will be tied up in limit dextrins after the mashing process.

Native barley, by the way, possesses an enzyme called limit dextrinase that breaks up these branches during natural seed growth. The heat of kilning destroys this enzyme so it is not naturally available to brewers. Brewers who want to break down limit dextrins during the production of light and dry beers often use another enzyme (derived from molds) called glucoamylase.

Fortunately, the most important brewing enzymes are not destroyed by kilning and the amylases work well on malted barley at temperatures of 140 to 158 degrees F (60 to 70 degrees C) typically found in a mash.

Mash Control

When we make beer, we like having some dextrins. The fermentable sugars are



Alpha-amylase **Beta-amylase**

turned into alcohol and carbon dioxide during fermentation. But the dextrins that remain in the finished beer provide body, mouthfeel and carbohydrates. In fact, dextrins are sufficiently important that brewers will manipulate the brewing process to increase the amount of dextrins in their beer. This is done by varying the conditions of the mash to favor alpha-amylase.

You know already that the two amylases are a little different from each other. Alpha works almost anywhere to make long chains of sugars and beta works only at the end of a chain to make the bite-sized pieces called maltose. It turns out that the two amylases work best at different temperatures and pH as well (see Table 1).

Generally, alpha-amylase works best at higher mash temperatures; beta at lower mash temperatures. Since alpha amylase generally makes long sugar chains or dextrins, conditions that favor this enzyme will generally produce greater mouthfeel and less fermentability. Thus brewers who want a beer with more mouthfeel and less alcohol will conduct the mash at a higher temperature. Lower temperature mashes give less mouthfeel and more alcohol.

From a practical perspective, the critical dividing line between fermentability and mouthfeel begins at 149 degrees F

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S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S
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Amylose

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                  S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S
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S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S
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   S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S-S
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Amylopectin

(Glucose = S)

(65 degrees C). Above the temperature, beta-amylase is quickly inactivated and alph-amylase plays an increasingly dominant role in starch breakdown. Thus mashes conducted at or below 149 degrees F (65 degrees C) will be highly fermentable. As mash temperatures rise between 150 and 158 degrees F (66 and 70 degrees C) the role of beta-amylase decreases and the resulting worts become progressively more dextrinous and less fermentable.

Review and Remember

To review, sugars are the basic building unit of carbohydrates. In their simple forms, they may occur alone as monosaccharides or in short chains called disaccharides or trisaccharides. All of these sugars can be fermented by yeast.

Four or more sugars linked together form unfermentable units called dextrins. If a dextrin includes a branch point where one central sugar is linked to three other sugars, this is called a limit dextrin.

When strung together in very long chains or bushlike structures, sugars form starch molecules. In the form of starch known as amylose, the sugars are linked end-to-end. The amylopectin type of starch takes on a bushy form because of branch points that give rise to many side chains.

It's not easy to remember all of this information about mash enzymes. To help keep it straight, here is a little memory device that may be useful.

Alpha, as in alpha-amylase, begins with the letter A. The important things you want to remember about alpha-amylase also start with A; namely, that it breaks down starch almost Anywhere to make long chains and that it works best at mash temperatures Above those that are best for beta amylase. That's alpha, anywhere, above.

Beta, as in beta-amylase, starts with B. Beta amylase Bites off two sugars at a time and works at temperatures Below those of the other amylase. Beta, bite, below.

Having this theoretical knowledge of the brewing process at your fingertips can be useful while formulating a beer and even during brewing. Then of course, you can also use it to impress your friends at cocktail parties! Good luck and good brewing.

Amylase Rap

Alpha is an amylase; beta is too
Lots inside a barleycorn;
what does it do?
Shoop. Ba-boop. Ba-boo-bop, ba-boop.

Breakin' up the starch chain,
fast as they can
Funky little sugars, part of the plan.
Shoop. Sha-boop. Baa-baa-ba-boop.

Alpha goes a-hunting,
looking for a fight
Beta hits the end and
busts off a bite.
Shoop. Ba-boop. Ba-boo-bop, ba-boop.

Two bad enzymes chompin' on a tree
But da branch so tough,
they let them be!
Shoop. Sha-boop. Baa-baa-ba-boop.

— Ray Daniels

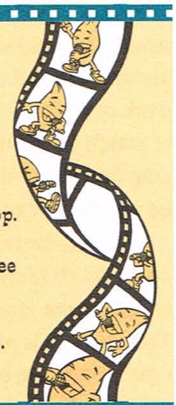
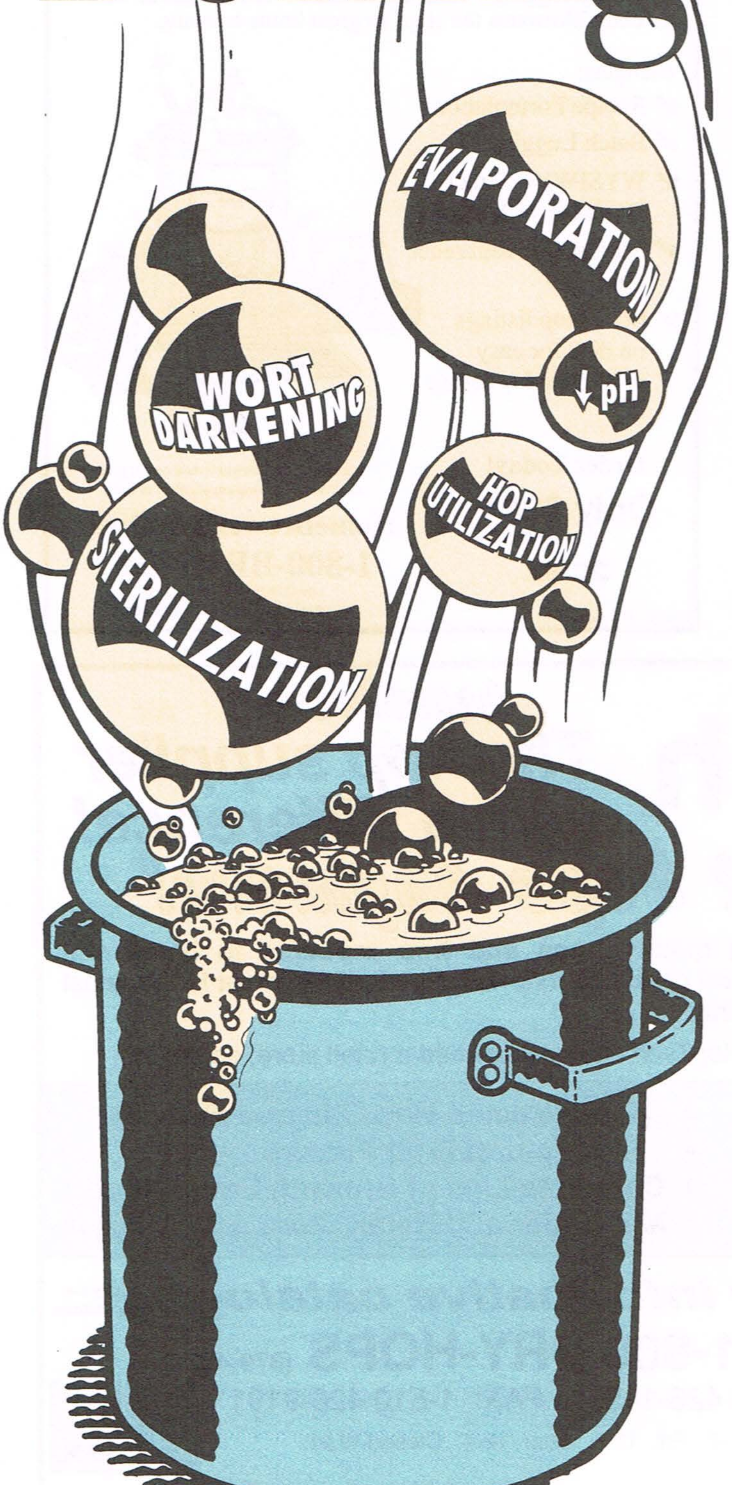


ILLUSTRATION BY KEN TRUHAN

Boiling— An Ebullient



Boiling the extract of grain has been a part of the brewing process for centuries. The necessity for wort boiling has been observed through generations of brewers, and today we recognize that it is essential and understand defined goals of the boil. This article is a brief description of these goals and serves more as an introduction to the concepts involved in boiling than it does a thorough explanation of the chemistry involved. Several good texts explore in greater detail the current understanding of the wort boil for those interested (see References).

Most brewers would recognize the following list as a full outline of the goals of wort boiling: sterilization, protein coagulation and tannin removal, termination of enzymic activity, lowering of pH, hop utilization, volatilization of undesirable compounds, color development, evaporation/concentration and addition of kettle adjuncts.

ILLUSTRATION BY JEFF KANDYBA

By Tom Flores

Affair

Sterilization kills bacteria, mold and yeast in relatively short order.

Protein coagulation occurs because heat disrupts the molecular structure of proteins. If the order in a protein structure is disrupted to the point where the protein unfolds, the damage may become irreversible through agglomeration and rapid cooling. Once agglomeration (clustering of particles) ensues, coagulation and precipitation pull the protein out of solution (we know it as trub). Tannin from the malt, and to a lesser extent the hops, can associate itself with the protein (hot and cold break) and be driven out of solution along with the protein. This is important in reducing nonbiological haze in the finished beer.

Because enzymes are proteins, anything that disrupts the order of protein structure will affect enzyme activity. As the wort is heated above 176 degrees F (80 degrees C), virtually all enzymic activity ceases and this effect becomes permanent as the enzymes are denatured (effectively destroyed) during boiling.

The calcium ion (Ca^{++}) coordinates with ionizable groups that release protons (H^+) upon complexing with Ca^{++}. These groups include the phosphates, oxalate and phytate. As protons are liberated, the wort pH drops. This process occurs mainly in the mash, but continues in the boil. The wort pH has an effect on the amount of trub formation, as does the concentration of calcium itself. Trub is largely protein, so as protein solubility decreases as the pH is lowered, trub formation increases. Calcium can form electrostatic bridges between charged protein molecules so they will come together in close association and be rendered less soluble than if calcium were not present. This situation is actually more complex if you consider the reverse effect from carbonate.

The lupulin glands of hops contain the essential oils (responsible for aroma), and the alpha and beta acids. The heat and mechanical vigor of boiling combine to extract the constituents of the lupulin glands. Physical involvement with trub particles can remove the important hop structures and thereby reduce hop utilization. This is one way pH can affect hop utilization — through the amount of trub formed. Once the constituents of the lupulin glands are extracted, the essential oils are driven off and the alpha acids change into their soluble isomers. There are a number of compounds in the essential oils that flash off almost as soon as they are extracted, but there are others that are retained in solution longer. If late hopping is employed, the character will be different from the dry-hopping character because of the absence of the extremely volatile essential oils.

By boiling at atmospheric pressure, it is relatively easy to drive off undesirable volatile compounds from the wort. These include dimethyl sulfide (canned corn or parsnip aroma) and certain hop constituents that can lend a grassy aroma when extracted at boiling. And, of course, water is volatilized (evaporated) in great quantity during boiling. Dimethyl sulfide (DMS) is produced at high temperatures from a soluble precursor (S-methyl methionine), which dissolves from the malt during the mash, so it is important to chill the wort as soon as possible after the boil to prevent additional DMS formation when there is a much lower rate of volatilization.

Reducing sugars, available in quite high concentrations in worts, can combine with amino acids, also available in wort, to form color and flavor compounds. This process of color development is called "non-enzymatic browning" or "Maillard browning" (after the early 20th century French chemist). The reactions that make up Maillard browning are numerous, but the progress of all the browning events is initially dependent on the rate at which the sugar rings can open up into their reducing form. Browning is thus dependent on the heat content of the system. Also, if there is a high temperature gradient between the wort and the heating source, there will be caramelization and maybe even charring. Depending on the preferences of the homebrewer, this may or may not be desirable. The main point here is that the longer the boil, the darker and less nutritive it becomes as the amino acids are used up in the non-enzymatic browning reactions.

Professional brewers have a rule of thumb for evaporation that states the rate should be no lower than 6 percent of the initial wort volume and preferably near 8 percent. Some traditional brewers want an evaporation rate of as much as 10 percent. The most obvious effect of this evaporation is concentration of the wort. Less obvious though, is the correlation that evaporation rate has with all the processes mentioned above. It is to ensure a complete and effective boil, in terms of the previous processes, that brewers consider the primary variable of evaporation rate so important. Without adequate volatilization of undesired aroma compounds, the finished beer will be unacceptable; without sterilization, there will be obvious problems in the finished beer; without sufficient trub formation, there may be haze development in the finished beer, as well as too much non-yeast materials in recovered yeast (for repitching) and so on.

If you want to experiment with kettle adjuncts (honey, corn syrup, molasses), the boil is a convenient place to add these ingredients because the heat will help them dissolve, and the absence of mash solids makes it easier to stir and dissolve them. The boil will sterilize and possibly clarify somewhat the mixture of wort and adjunct.

Other Bubbling Issues

Boilovers have always been a safety issue for brewers. To achieve a rolling boil safely, it is best to leave the lid off. This also is an advantage for allowing sufficient evaporation of volatile compounds.

Noting the time of the boil is very important for reproducibility. It does not really matter if you call time zero the time at which the boil breaks or when the first hops are added, as long as the total boil time and the times of hop additions are faithfully reproduced for a given recipe. The length of the boil will depend on the preferences of the individual brewer, but it is possible to boil for too long. Not too many boils last more than two hours, and the more common maximum is 90 minutes.

The major differences between boiling a normal gravity wort or a high-gravity wort (to be diluted in the fermenter) are hop utilization and color development. The high-gravity wort diluted in the fermenter may be a bit darker than the wort boiled at normal gravity. For an easy way to increase production without buying new equipment, it is hard to beat high-gravity brewing. Keep in mind that hop utilization decreases as wort gravity increases [see Jackie Rager's article in ***Zymurgy*** Hops and Beer Special Issue 1990 (Vol. 13, No. 4) for formulas to calculate utilization].

Foaming and boilover are often noticed when hops are added. This is because the hop particles serve as thousands of nucleation sites where bubbles can form. If you observe the bottom of the pot when bringing water to a boil for spaghetti you see many little bubbles on the metal, but only a few that are detached from the wall or bottom. This is because small imperfections in the metal's surface cause the bubbles to form. When the bubbles get big enough, they break away from the imperfection and a new bubble forms soon after. The same process occurs on the quite irregular surface of the hop particles (flowers or pellets). So when you add the hops to the boiling wort, sudden development of many small bubbles results in foaming. For another example of this mechanism, sprinkle salt into a carbonated beverage and watch the foam form (but don't do this to a good beer!).

Conclusion

To ensure an adequate boil, the process must be vigorous (rolling) to achieve an acceptable evaporation rate. The heat source must not cause localized hot spots in the boil, unless caramelization and charring are desired. Finally, cooling should be done as quickly as possible to retain a desirable flavor profile and to minimize the time elapsed before yeast is pitched.

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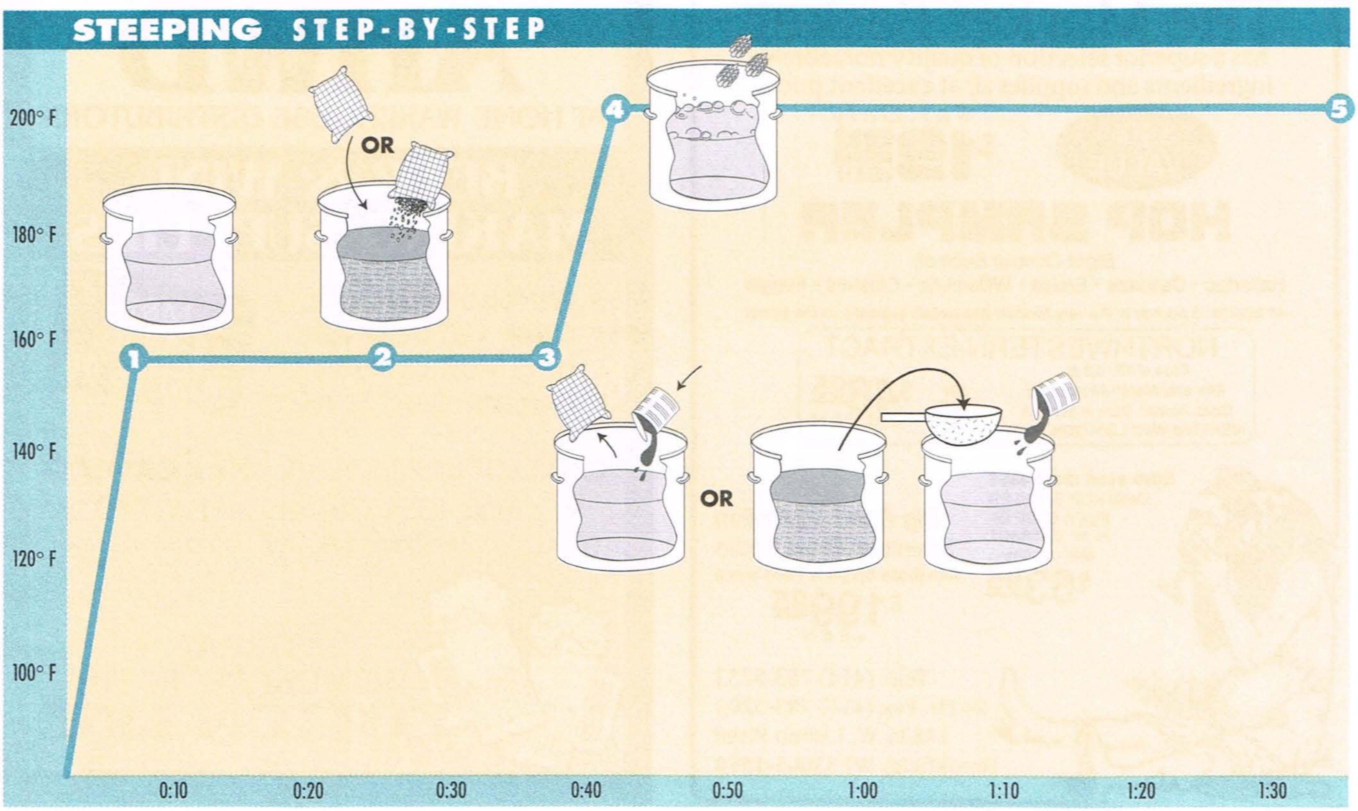
Steeping: THE EASY STEP

This issue is all about grain and how we use it to make beer. One of the simplest ways to incorporate grain into your very next batch is by steeping some specialty grains. This process only requires a thermometer and a way to remove the grains from the resulting extract.

Steeping specialty malts will enable you to control more carefully the character of your beer. With specialty malts, you'll be contributing color, sweetness, body and aroma to your brew. Just like when you spice up a can of soup or jar of pasta sauce, the small effort makes a definite difference.

The kinds of malts you should consider adding include black or black patent, chocolate, crystal, caramel malts or roasted barley. These malts don't require mashing, so their contributions can be made to your wort via the steeping process.

Adding the steeping step to your brewing procedure involves soaking the grains in 155-degree-F (68-degree-C) water for about 30 minutes. You have two alternatives: adding the grain to the water loose or containing the grain in a grain bag. If you choose to add them loose, you'll have to consider how to get them back out. A screened kitchen strainer, a colander with fine holes, a bucket with holes drilled in the bottom or a nylon or cloth bag could serve this purpose. Once loose grain is captured, you can sparge, or rinse, the grain with additional water to get the most extract from your effort.



ILLUSTRATIONS BY VICKI HOPEWELL

By Shawn Bosch

Steeping the grain in a bag in the brewing water means the bag can be removed easily, rinsed and discarded with no extra mess. For a quick brew, it is hard to beat as far as convenience and time are concerned.

Straining Options

Kitchen strainer: The strainer must be large enough to hold at least a half pound of grain. At best it will hold almost four pounds. Most kitchen strainers are made of stainless-steel, aluminum or plastic. Stainless is most durable, plastic the most difficult to clean. Strainers generally require two people for ease of operation; one to hold the strainer and one to pour the extract and grains through.

STEEPING

1. Bring water temperature to 155°F.
2. Add grain bag and steep 30 minutes.

   OR

   Add loose grain and steep 30 minutes.
3. Remove and discard grain bag, add malt extract syrup.

   OR

   Pour "grain tea" through strainer to remove grain and add malt extract syrup.
4. Raise temperature to boiling and add hops.
5. Boil 60 minutes.

Colander: Colanders are available in a wide variety of capacities and materials. Once again stainless steel is the most durable, but aluminum, copper and plastic are also popular. The determining factor in using a colander is the size of its perforated holes. If the holes are too large grain will pass into the boiling kettle, which you don't want. Lining the inside of the colander with cheesecloth is an easy way to adapt a standard piece of kitchen apparatus to your brewing needs. Find a colander that can rest securely in your brewing pot and you won't need an extra pair of hands.

Drilled bucket: A very practical and inexpensive strainer that can lead to great versatility is a drilled bucket. Any food-grade plastic bucket drilled with hundreds of one-eighth-inch holes in its bottom becomes a large-capacity strainer. The bucket's large opening makes it easy to clean. If the strainer is placed inside another bucket one person will be able to handle the operation. Otherwise, one person will need to hold the bucket above the boiler while another pours the grain and water through.

Straining bag: These large bags function similarly to the drilled bucket. They have a large capacity and are relatively inexpensive. They work best when placed inside a bucket with the mouth of the bag folded over the lip of the bucket (securing the bag to bucket with clothespins can prevent the bag from sagging into the bucket as you pour). This setup allows one person to separate the extract from the grain.

Grain also can be tied into the bag and the whole thing put directly into the boiling pot, steeping it like a big tea bag. If the bag is made of nylon, don't let it rest on the bottom of a pot on an hot burner. The heat can melt the bag and release the grain.

To clean the bag after use, remove the spent grain, rinse it well and send it through the washing machine; a true convenience!

Disposable cheesecloth steeping bag: Also known as muslin hop bags, these cheesecloth bags are the easiest, quickest way to steep grain. Each bag usually can contain up to one pound of grain. Simply tie the grain in the bag, steep, remove the bag and dispose of the grain properly. For first-time grain users, this is an excellent way to experiment without investing much money. Steeping and straining are performed in one vessel and as long as the bag isn't dropped on the floor, cleanup is a snap.

The Process

For a five-gallon batch of beer, put 1 1/2 gallons (5.68 L) of water in your boiling pot. If you've chosen to use a grain bag, tie the crushed grains in the bag and add it to the water. If you decided to add the grain loose, pour it directly into the water. Slowly raise the temperature of the water to about 155 degrees F (68 degrees C), being careful not to allow the mixture to boil. Boiling the grain will leach tannins and astringency from the grain husks. Maintain this temperature for about 30 minutes, then remove the grain bag, discard it, add your malt extract and proceed with your boil. If you steeped loose grains, carefully pour the extract through the strainer and collect it in a brewing pot. If you want to maximize your extraction, pour an additional 1/2 gallon of 170-degree-F (77-degree-C) water over the grain in your strainer to rinse them thoroughly.

Here are some of my favorite extract specialty grain recipes.

Never-Let-Me-Down Porter

Ingredients for 5 gal (19 L)

- 1/2 lb chocolate malt (0.23 kg)
- 1/2 lb medium or dark crystal malt (0.23 kg)
- 6 1/2 lb unhopped amber malt extract (3 kg)
- 1 1/2 oz Northern Brewer hops, 7.5% alpha acid (43 g) (60 min.)
- 1/2 oz Northern Brewer hops, 7.5% alpha acid (14 g) (20 min.)
- 1 oz Northern Brewer hops, 7.5% alpha acid (28 g) (5 min.)
- English ale yeast (Wyeast No. 1968 is my favorite)
- 3/4 cups dextrose (177 mL) (to prime)

- Original specific gravity: 1.044
- Final specific gravity: 1.012

Georgia Stream Common Beer

Ingredients for 5 gal (19 L)

- 1/2 lb Belgian biscuit malt (0.23 kg)
- 1/2 lb medium crystal malt (0.23 kg)
- 2 oz Belgian Special "B" malt (57 g)
- 3 1/2 lb Munton and Fison Premium kit (1.59 kg)
- 3 lbs light dry malt extract (1.36 kg)
- 1/2 oz Northern Brewer hops, 7.5% alpha acid (14 g) (45 min.)
- 1/2 oz Cascade hops, 7.5% alpha acid (14 g) (30 min.)
- 1/2 oz Northern Brewer hops, 7.5% alpha acid (14 g) (15 min.)
- Wyeast California lager No. 2112
- 3/4 cup dextrose (177mL) (to prime)

- Original specific gravity: 1.045
- Final specific gravity: 1.014

This is a great full-flavored beer. It is hopped aggressively and tends to mature well in the bottle.

Double Dipper (BELGIAN DOUBLE)

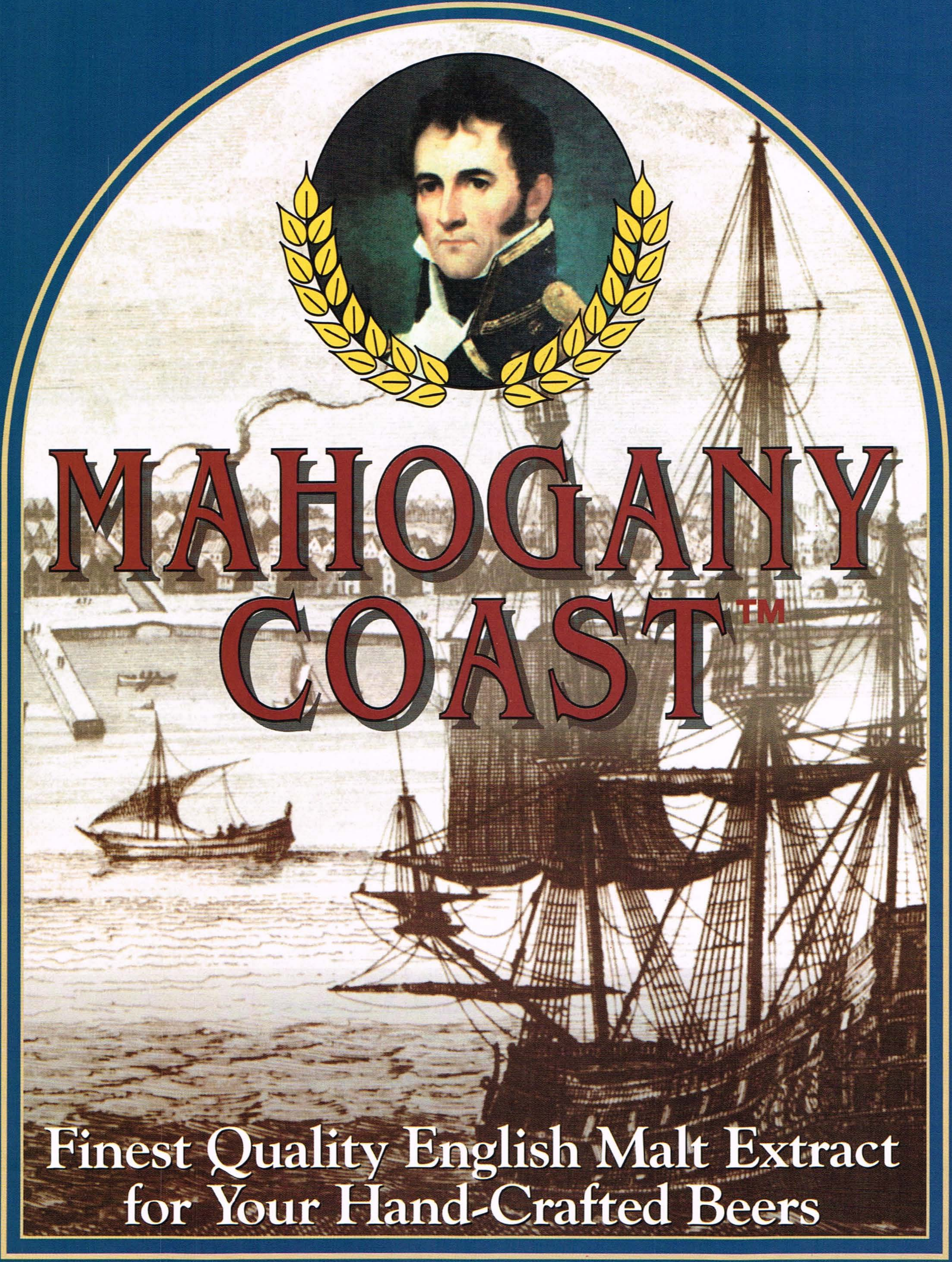
Ingredients for 5 gal (19 L)

- 1/2 lb Belgian Special "B" malt (0.23 kg)
- 1 lb light crystal malt (0.45 kg)
- 1/2 lb Belgian aromatic malt (0.23 kg)
- 8 lbs light dry extract (3.63 kg)
- 2 oz Mt. Hood hops, 4.5% alpha acid (57 g) (45 min.)
- 1 oz Saaz hops, 3% alpha acid (28 g) (5 min.)
- Wyeast Belgian ale No. 1214
- 3/4 cup dextrose (177 mL) (to prime)

- Original specific gravity: 1.068
- Final specific gravity: 1.018

This is a satisfying beer to brew. Loaded with flavor from the darker grain and esters only a real Belgian brewing yeast strain can produce. Let it age.

Remember, what goes into your beer is what goes into your glass. Pick and choose your ingredients intelligently. Whether you stay with extracts and specialty grains or move on to mashing, using fresh grain will make a difference in your homebrew.



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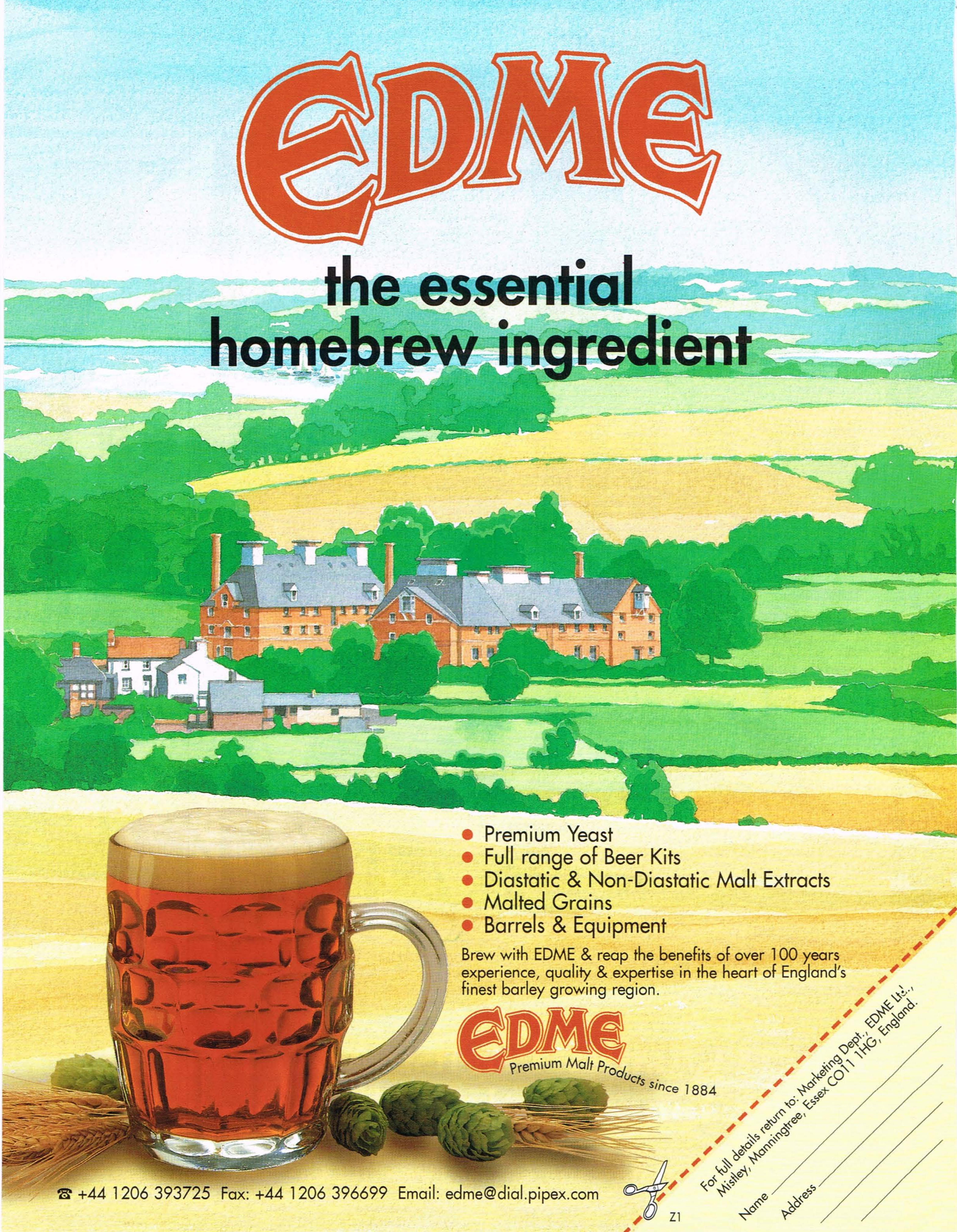
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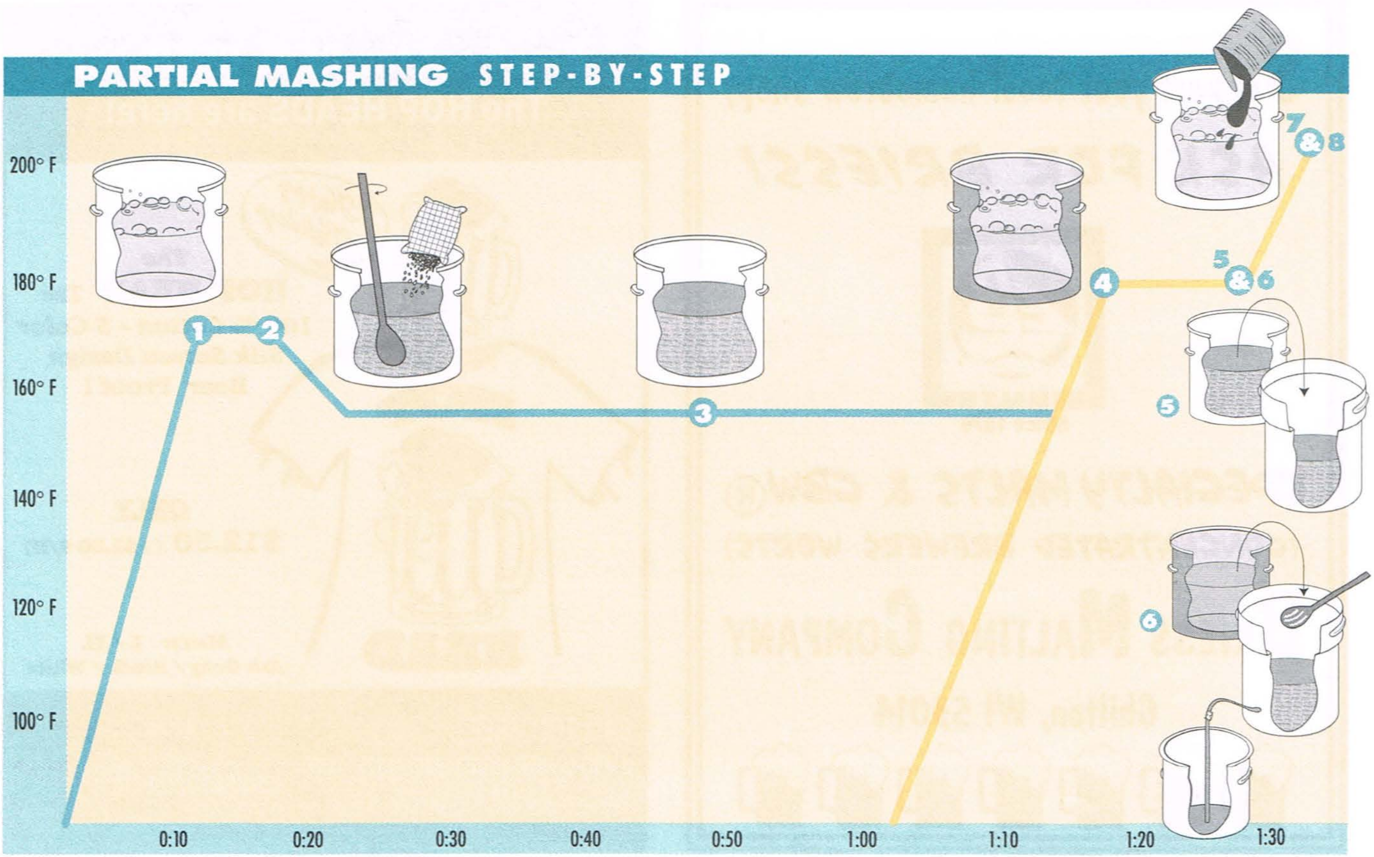
PARTLY INTERESTED? TRY Partial

When I first thought about all-grain brewing I was both intimidated and intrigued. After all, there were new procedures and terms I didn't understand, not to mention the equipment I'd need. If you are thinking this too, let me shed some light on your predicament.

The introduction of grains into the brewing process allows you to fine-tune your beer. You will find there are a great deal of options you never had before you started brewing with grains.

Partial mashes are a good way to learn the mechanics of mashing without the equipment needs or intimidation of an all-grain mash. In essence, what you are doing is a very small all-grain batch (say three pounds of grain) then adding malt extract to the resulting wort for a final batch size of five gallons (19 L). Because you're only using two to four pounds (0.9 to 1.8 kg) of grain for a five-gallon batch, you don't really need any fancy equipment. I added only one new piece of equipment for my first partial mash. I mashed in my original 20-quart (18.9-L) stainless-steel brew kettle and converted two 18-quart (17-L) food-grade plastic buckets into a lauter tun. Drill small, one-eighth-inch holes in the bottom of one bucket and mount a drain (spigot) about one inch from the bottom of the other. This lauter tun allows you to separate the husks (which you discard, compost or mulch) from the liquid (the wort you will boil with malt extract).



ILLUSTRATIONS BY VICKI HOPEWELL

By Jeff Niggemeyer

Mashing

Now that your equipment is gathered, it's time to get started. First, decide what type of beer you want to brew. I really enjoy a good Oktoberfest, so that's the recipe I've chosen. The first recipe does not require mashing, just steeping some specialty grains. Consider it a warm-up batch, or compare the results of the extract recipe to the partial mash and taste the difference.

Oktoberfest
(EXTRACT RECIPE)

Ingredients for 5 gal (19 L)

1 lb 20 °L crystal malt (0.45 kg)
1/2 lb 80 °L crystal malt (0.23 kg)
4 lb pale malt extract (1.8 kg)
4 lb Alexander's pale malt extract (1.8 kg)
1 1/4 oz Liberty hops, 3.5% alpha acid (35 g) (60 min.)
1/2 oz Liberty hops, 3.5% alpha acid (14 g) (30 min.)
1/4 oz Liberty hops, 3.5% alpha acid (7 g) (5 min.)
1/4 tsp Irish moss (1.2 mL) (15 min.)
Wyeast Bavarian lager yeast No. 2206

- Original specific gravity: 1.056
- Final specific gravity: 1.012
- Primary fermentation: 45 to 50 degrees F (7 to 10 degrees C)
- Secondary fermentation: 30 to 35 degrees F (-1 to 2 degrees C)
- Lager for two to six weeks

One easy way to steep the crystal malt and extract its color and flavor contributions is to put the crushed malt in a cheesecloth or nylon grain bag and put the bag into your pot of brewing water. Slowly heat this water and just before it boils, lift the grain bag out of the water, allow it to drain for a few minutes then discard it. Next, add the malt extract and proceed with your boil.

PARTIAL MASHING

1. Heat 12 quarts water to 170°F and stabilize temperature.
2. Add grains and stir.
3. Maintain 155°F for 60 minutes.
4. Heat sparge water to 180°F in another kettle.
5. Transfer mash to lauter tun.
6. Sparge.
7. Add malt extract.
8. Boil wort.

Oktoberfest
(SINGLE-STEP INFUSION RECIPE)

Ingredients for 5 gal (19 L)

2 lb two-row Pilsener malt (0.91 kg)
3 lb Munich malt (1.3 kg)
4 lb Alexanders pale malt extract (1.8 kg)
1 1/4 oz Liberty hops, 3.5% alpha acid (35 g) (60 min.)
1/2 oz Liberty hops, 3.5% alpha acid (14 g) (45 min.)
1/4 oz Liberty hops, 3.5% alpha acid (7 g) (5 min.)
1/4 tsp Irish moss (1.2 mL) (15 min.)
Wyeast Bavarian lager yeast No. 2206

- Original specific gravity: 1.056
- Final specific gravity: 1.012
- Primary fermentation: 45 to 50 degrees F (7 to 10 degrees C)
- Secondary fermentation: 30 to 35 degrees F (-1 to 2 degrees C)
- Lager for two to six weeks

For the partial mash, collect one quart of water for every pound of grain (5 pounds of grain equal 5 quarts of water or 1 1/4 gallon) and heat it to 169 degrees F (76 degrees C). I used my boiling kettle for that purpose. Let the kettle sit for a minute or two and make sure the temperature is stable. (You will need a thermometer that reads temperatures from freezing to boiling.) Next, pour the grain into the water and stir until the grains are evenly wet. You should now have an porridgelike mixture in your kettle (mash tun). Cover your kettle to trap the heat. (I wrapped a bath towel around the kettle to act as insulation. You could put your mash kettle in a warm oven with the heat turned off to maintain the temperature.)

Let your mash stand about five minutes, then check the temperature. You want the temperature to stabilize between 150 and 158 degrees F (66 and 70 degrees C). If the temperature is too low then apply heat or add boiling water to attain the temperature you want. If the temperature is too high add a little cold water or let the mash stand uncovered until the desired temperature is reached. As long as you're close to the temperature range you'll be fine.

Once the temperature of your mash has reached 150 to 158 degrees F (66 to 70 degrees C), let it sit for 60 minutes. Starch conversion is typically achieved after 60 minutes.

At this point your infusion partial mash is finished and it's time to start the lauter process to remove the sweet wort from the grain. Move the mash to the lauter-tun by scooping the wet grain out of the kettle with a large spoon and gently laying it in the lauter tun. For the last bit of grain, it is OK to just pour it out of the kettle. Let the mash stand in the lauter tun for about 10 minutes to establish a filter bed.

Heat five quarts of water to 175 degrees F (79 degrees C) for sparging. Depending on your available pots, you could have this water ready, or you'll have to use your mashing pot. It's OK to let your mash sit in the lauter tun while you are heating sparge water, just wrap a blanket around the lautering bucket to retain heat.

To drain wort from the lauter tun to the kettle for boiling, attach a three-eighths-inch rubber hose to the spigot on the lauter-tun. Avoid splashing the wort while it's hot because this introduces oxygen that could result in off-flavors in the finished beer.

Slowly open the spigot of the lauter tun and start draining the wort into a cup (drain slowly). When the cup is about half full, stop the flow and pour the wort back into the grain bed slowly. Do this for about five to 10 minutes until the liquid clears. This recirculation process establishes a good filter bed so you don't boil any husk particles in your wort. Once a filter bed is set, allow the wort to drain into your kettle and begin pouring hot sparge water over the top of the grains. Pour the water onto a slotted spoon or through a strainer to disperse the water over the grain without disturbing the grain bed. Sparge until you have collected about two gallons of wort.

Now add your malt extract to the wort you have collected and continue brewing the same as you have before. The only difference is that you are starting with wort in your kettle instead of water. This means you will need less malt extract because you already have sugars.

Using partial mashes is an easy way to experiment with grains and ease into all-grain brewing. There are other systems and mashing methods, but the important thing is to find a way of brewing with which you are comfortable.

Testing for Conversion How do you know when to stop mashing? Can you tell when the starch has been converted to sugar? If you want to be sure, you can do a simple test using tincture of iodine, which is available at any pharmacy. Since starch has a powerful color reaction with iodine solution, combining a tablespoon of mash liquid and a drop of iodine can tell you if all of the starches in your mash have been converted to sugars and dextrins or not.

Remove a tablespoon of mash liquid from the mash tun. Put the spoonful of liquid on a cool white plate then add a drop of iodine to the puddle and observe. If you notice the color change to black or purple, starch is present and you should continue mashing. Stir the mash, restore the mash temperature and hold for 30 minutes more. If there is no change in color, then saccharification has been achieved and you can sparge and lauter.

NOTE: Iodine is poisonous. Discard the test sample and clean all equipment that came in contact with the iodine.

SINGLE-STEP Infusion TECHNIQUES

I began all-grain brewing as many of us have, by timidly doing a few partial mashes, using perhaps one or two pounds of grains wrapped in cheesecloth. At some point I decided I was ready for the next step. I had read a couple of books so I had an idea how to do a five-gallon infusion mash. I gathered a few bits of extra equipment to add to my faithful starter kit, and figured out what I was going to do.

First, you need to decide what style of beer you want to make. An ideal first brew is a pale ale, so I'll use my IPA recipe as an example. If you follow the example described here, you'll have the wort in the primary fermenter in about seven hours. OK, this is longer than an extract brew, but in the end you'll be darn proud of it!

To begin, your brewpot should contain about 12 quarts (11.36 L) of preboiled water, or one quart of water per pound of grain. Heat the water to 170 degrees F (77 degrees C). Remove pot from the stove top and add the premeasured or weighed crushed grains (recipe follows), then stir, stir, stir. It's important to moisten all of the grain to attain an even mash consistency. You need to maintain a constant temperature for about an hour, so you can wrap insulation around your brewpot, put the pot in a warm oven or build an insulated box for the mash. Stick a thermometer into the middle of the mash, allow the temperature to equilibrate and record the temperature. It should be close to 155 degrees F (68 degrees C); if not, add some hot or cold preboiled wa-

INFUSION MASHING

1. **Heat 12 qts. water to 170°F and stabilize temperature.**
2. **Add grains and stir.**
3. **Maintain 155°F for 60 minutes.**
4. **Heat sparge water to 180°F in another kettle.**
5. **Transfer mash to lauter tun.**
6. **Sparge.**
7. **Boil wort.**

PRINCIPLE AND PRACTICE

By John R. Griffiths

ter to adjust. You can extract a tablespoon of liquid at this stage and check the pH with pH papers or a meter, or you can not worry. The pH should be between 5.0 and 5.5. Once the temperature is stabilized, put the lid on the brewpot and relax for about 60 minutes.

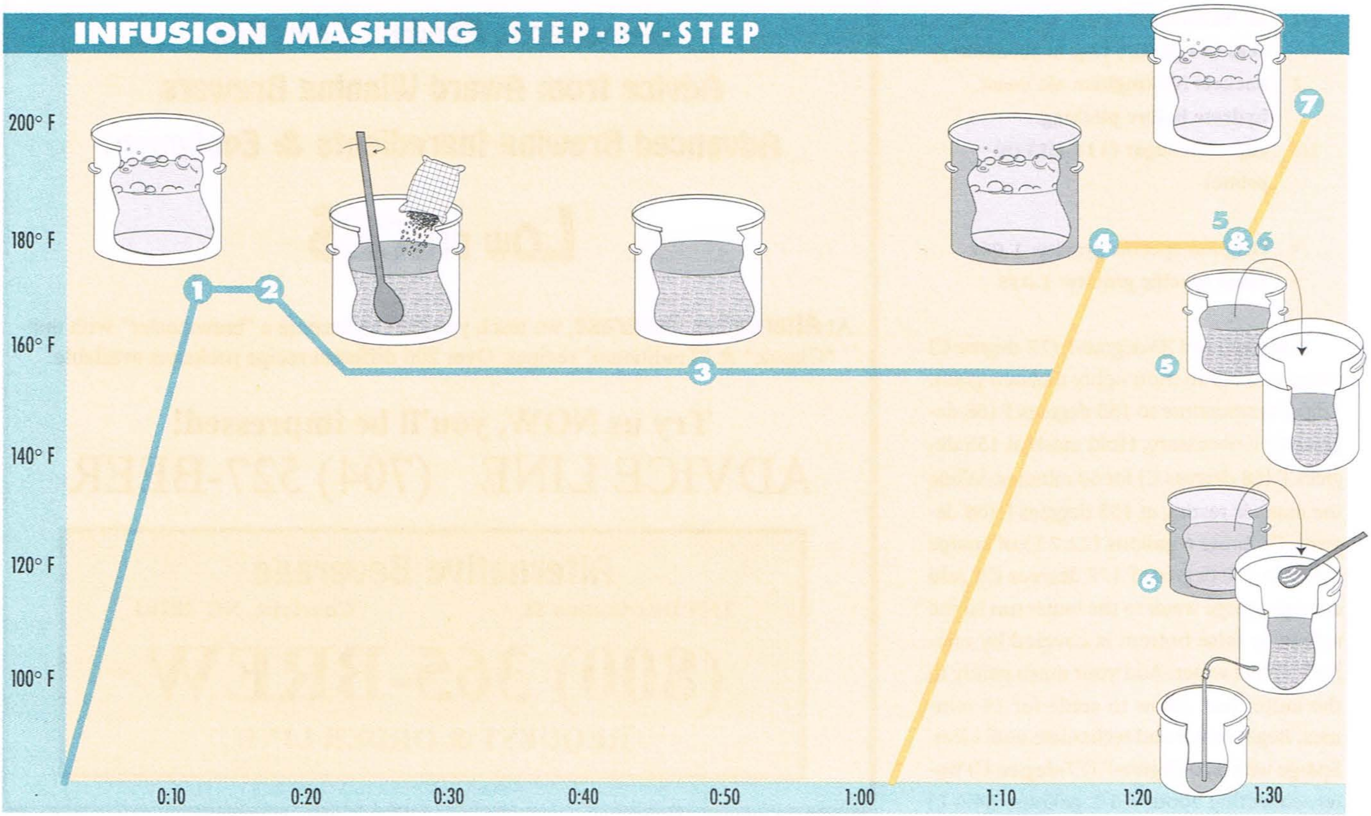
During the 60 minute mash, prepare the sparge water. Bring about six gallons of water or about one-half gallon per pound of grain mashed, to about 180 degrees F (67 degrees C). Monitor the mash temperature, and if it drops below about 152 degrees F (67 degrees C) add a little boiling water and stir gently until mixed then check the temperature again. A few degrees off will not be catastrophic, but aim for the recommended temperatures.

Next, assemble your lauter tun. Pour sparge water into the lauter tun so the perforated inside bottom (false bottom) is covered with about half an inch of water. Then transfer the mash to the lauter tun gently. Remove the insulation from the brewpot and wrap it around the lauter tun.

After 15 minutes, during which time the grain bed has settled and you have cleaned out your brewpot, begin the runoff. I use a couple of two-quart pans and affix a length of plastic tubing from the spigot to below the pan rim to prevent splashing as I drain wort into the saucepan. Open the spigot slowly and let the flow begin. At first the wort will be quite cloudy. Put the second pan under the spigot and pour the first full pan back over the grain (you can use your upturned stirring spoon to distribute the liquid evenly). Repeat this procedure until the runoff is clear (this could take 10 or more pans). What you are doing is establishing the grain bed. Replace the pan with your rinsed-out brewpot and continue the runoff. Use a long enough plastic tube so the runnings don't splash into the kettle. By now your sparge water should be about 170 degrees F (77 degrees C). Begin pouring sparge water over the grains, keeping the liquid level a little above the grains (again, use your upturned spoon to distribute the water evenly). Sparge until you have collected about 6 1/2 gallons of wort in your brewpot. Put the brewpot back on the stove and you are ready to boil the wort.

The rest of the procedure is similar to an extract brew, except you have a larger volume of wort. Bring the wort to a boil — this takes up to an hour on my stove. If the length of the boil in your recipe is 90 minutes, begin timing once the wort is boiling. Add hops according to the hopping schedule during the boil. When the boil is complete, cool the wort to about 65 degrees F (18 degrees C). Transfer the cooled wort to a fermenter, taking a sample to measure original gravity and leaving the last residue in the brewpot. Pour the wort directly into the fermenter or rack through a piece of tubing. Keep the end of the racking cane above the bottom of the brewpot to avoid clogging it with hop particles. You should have 5 1/2 gallons in the fermenter. Stir or shake the fermenter to oxygenate the wort and then pitch the yeast.

After fermentation is complete (you can tell either by taking a hydrometer reading or by evaluating the airlock activity), rack to a secondary. Record the date and gravity and allow it to sit for a few days. Residual solids will settle out in the secondary, and you'll



ILLUSTRATIONS BY VICKI HOPEWELL

HOW MUCH
Water?

TO MASH,
add one quart of water per pound of grain.

TO SPARGE,
heat one-half gallon water per pound of grain.

be ready to bottle your first all-grain brew. Rack into your sanitized primary fermenter or bottling bucket, record the final gravity, prime with wort or corn sugar dissolved in boiling water then bottle. For this IPA, wait a few weeks, then taste and enjoy!

India Pale Ale

Ingredients for 5 gal (19 L)

- 10 lb pale ale malt (4.5 kg)
- 1 lb 20 °L crystal malt (0.45 kg)
- 1 oz Chinook hops, 12.8% alpha acid (28 g) (75 min.)
- 2 oz Irish Northdown hops, 9.4% alpha acid (57 g) (30 min.)
- 1 oz Kent Golding hops, 5.5% alpha acid (28 g) (dry hop in secondary)
- 1/2 oz Hallertauer hops, 4.1% alpha acid (14 g) (dry hop in secondary)
- 2 packets Nottingham ale yeast, hydrate before pitching
- 1/2 cup corn sugar (118 mL) (to prime)

- Original specific gravity: 1.062
- Final specific gravity: 1.018

Add grain to 170-degree-F (77-degree-C) water and stir to thoroughly moisten grain. Adjust temperature to 155 degrees F (68 degrees C) if necessary. Hold mash at 155 degrees F (68 degrees C) for 60 minutes. While the mash is resting at 155 degrees F (68 degrees C), bring 6 gallons (22.7 L) of sparge water to 170 degrees F (77 degrees C). Add enough sparge water to the lauter tun so the screen or false bottom is covered by one-half inch of water. Add your mash gently to the lauter tun. Allow to settle for 15 minutes. Begin runoff and recirculate until clear. Sparge with 170-degree-F (77-degree-C) water, collecting about 6 1/2 gallons (24.6 L) of wort in your brewpot. Heat the wort to boiling and continue as you normally would brew adding hops at the indicated times. Chill wort and pitch hydrated yeast into aerated wort and ferment.

The Next Steps

Once you've done an all-grain brew, you will probably be hooked. Many styles of beer including stout, porter, English bitter and Scotch ale lend themselves to the infusion mashing technique. Don't be afraid to experiment.

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Decoction for Beginners

So you're considering making the jump to all-grain brewing, or maybe you've already started. Perhaps you've never heard of decoction and you're just reading this paragraph to find out what the title is about. Or you've heard terrible things about how it's difficult and long and doesn't really make any difference in how your beer turns out.

I'm here to change that.

Decoction mashing is an alternative to multiple temperature infusion mashing. It involves removing a portion of your mash, boiling it and returning it to the main (or rest) mash to raise the temperature to the next step. That's all there is to it.

Why use decoction? Infusion mashing involves either limiting your mashing creativity (single temperature mashing) or making trade-offs — like buying a second large pot in which to heat the entire mash, or starting with a very thick mash so you can add lots of boiling water to make each temperature step. Decoction gets by on less hardware and can add a distinctive color and flavor to your beers that you just can't get from caramel, black or chocolate malts.

Decoction is the time-tested, traditional technique for making most German- and Czech-style beers: Pilsener, export, altbier, weizen, Kölsch, Munich helles and dunkel, rauchbier, Oktoberfest, Märzen, bock and doppelbock. These beers, whether their hop balance is light or forceful, all have a significant malt character that is not necessarily sweet and that provides a firm body.

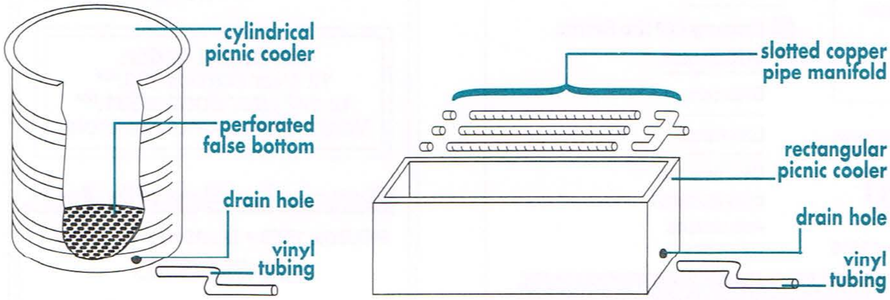


FIGURE 1 Sample Lauter Tuns

I'm going to show you how to make a great yet simple Pilsener beer. If you don't have a refrigerator to properly lager it, you can ferment with a neutral ale yeast and call it a Kölsch-style beer.

Ingredients for your mash

8 1/2	lb Pilsener malt (3.9 kg)
2 3/4	gal water (10.4 L)

A Word About Water

If your water is hard you may need to adjust it. You can tell if your water is pretty hard because soap rinses off your hands very quickly, and it doesn't seem to leave a lingering slippery feel. If you find lots of soap "curds" after your bath, you have very hard water. The easiest way to adjust water is to buy distilled water at the market and add it to tap water. If your water is really hard, you might use other techniques (see the article by Ginger Wotring on page 32 or *The Complete Handbook of Home Brewing*, by Dave Miller, Storey Communications, 1988).

Equipment

You'll need a lauter tun of some sort. Although the bucket in a bucket style is expedient, it loses heat quickly. It can be insulated with a blanket or sleeping bag pad. A better solution is probably a picnic cooler with its built-in insulation and either a copper pipe

ILLUSTRATIONS BY VICKI HOPEWELL

By Darryl Richman

manifold drain or a traditional screen false bottom (see Figure 1 for examples). These designs have been described in ***Zymurgy*** (see Gadgets and Equipment Special Issue 1992, Vol. 15, No. 4 for example).

You also will need, in addition to the eight-gallon (30-L) brewing pot that any form of all-grain brewing requires, a two-gallon (7.5-L) pot and a measuring cup, at least the quart size (0.95 L) but I find a half-gallon (1.9-L) measuring cup even better. Finally, a wire mesh strainer makes things easier.

SINGLE DECOCTION

1. **In your eight-gallon brewing pot heat 2 3/4 gallons (10.4 L) of water to 155 degrees F (68 degrees C) and transfer it to your lauter tun.**

2. **Slowly add crushed grain, stirring gently as you go so it all goes into solution and there are no lumps. The temperature should come to rest at about 140 degrees F (60 degrees C). If the temperature is too high, you can add cold water to adjust; if too low, add boiling water. Let the mash sit for 15 minutes.**

3. **Using a strainer, scoop out 1 1/2 gallons (5.68 L) of mash (the decoction). Use a measuring cup to get the volume right. The idea here is to get a thick, but not dry, portion of the mash. You should see some liquid near the top in each measure, but each scoop should be mostly malt solids. Transfer the mash to the two-gallon pot.**

4. **Turn on the stove and raise the temperature of the decoction slowly to a boil. The temperature change should be no more than 2 degrees F (1 degree C) per minute, so it should take about one-half hour or even a bit longer to get to a boil. Stir occasionally but don't leave it alone. The brewing gods have decreed that the brewer who ignores a decoction shall spend much elbow grease cleaning the pot.**

5. **When it reaches a boil, continue to stir occasionally. Add up to one quart (0.95 L) of water, a little at a time, during the boil to keep it from drying out and burning. Boil for 20 minutes.**

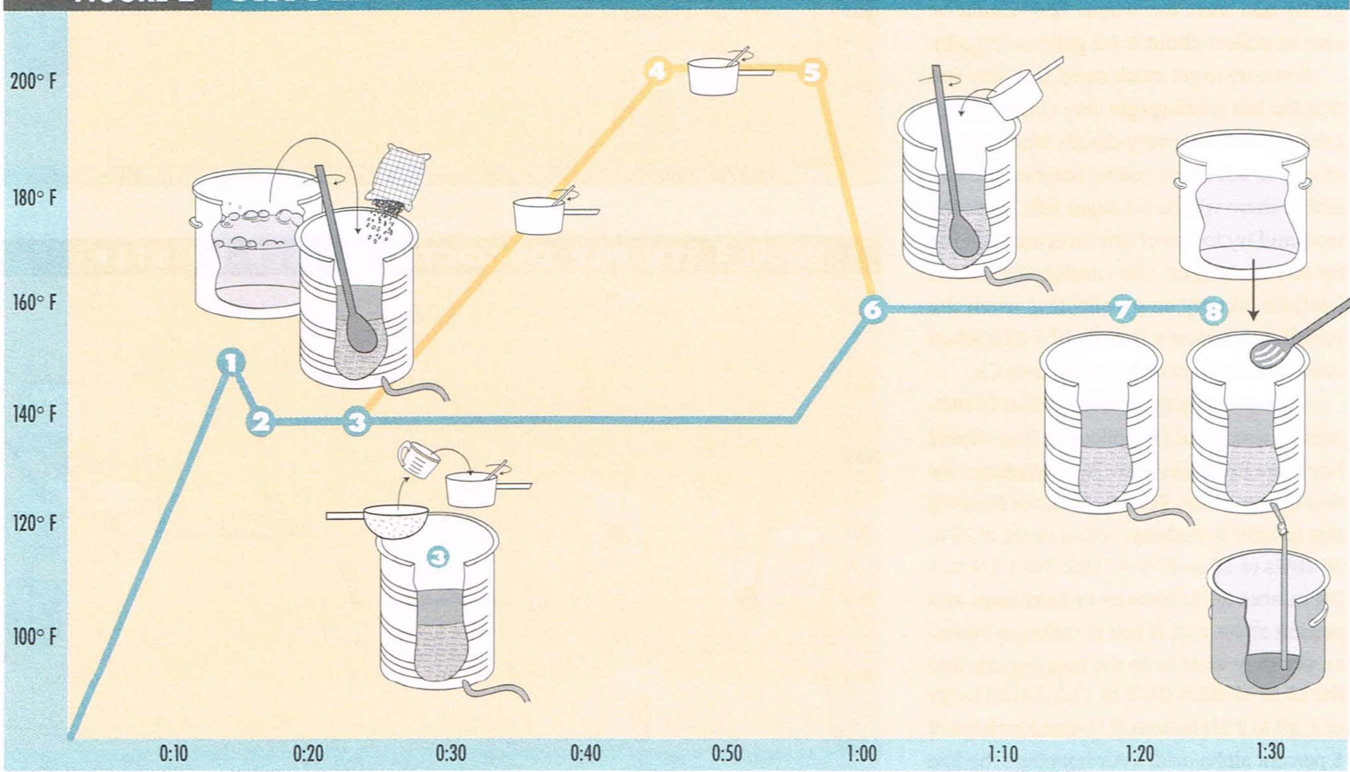
6. **Add one gallon (3.79 L) of the decoction mash back to the main mash which has been maintained at 140 degrees F (60 degrees C) in the lauter tun. Stir gently to distribute the mash evenly and take a temperature reading. Continue adding the boiled mash back until the resting mash reaches 160 degrees F (71 degrees C). If there's any boiled mash left over, let it cool to 160 degrees F before adding it.**

7. **Let the mash rest for another 20 minutes or until an iodine test shows no blue-black color in the mash liquid. (Never allow any of the iodine to get back into your mash.)**

8. **Time to lauter!**

Figure 2 shows these steps in schematic form. You can see that the temperature of the decoction is measured on the yellow line that

FIGURE 2 SINGLE DECOCTION STEP-BY-STEP



splits from the blue-green line and goes up to 212 degrees F (100 degrees C), while the rest mash chugs along at 140 degrees F (60 degrees C). Because the main mash must rest for nearly an hour, the insulating properties of your lauter tun are very important.

In these eight easy steps and about an hour and a half you have performed your first single decoction mash. The rest is the same as with an infusion mash.

Lauter the mash by recirculating the wort from the outflow at the bottom of the tun back to the top until it runs clear and there are no solids floating in the wort. Try to return the liquid gently, without splashing. While you are doing that, heat 2 1/2 gallons (9.46 L) of water to 175 degrees F (80 degrees C). Rinse out your decoction pot and transfer two gallons (7.6 L) of the heated water to it. Turn on the heat to maintain the temperature and slowly add the remaining half gallon (1.9 L) to your lauter tun, without splashing or stirring up the grain.

Drain the sweet wort from the bottom of the lauter tun slowly; a quart per minute or so is a good rate. Add this to your brewing pot. After the first gallon is collected, begin heating your brewing pot and start to bring it to a boil.

Whenever the liquid level in the lauter tun threatens to meet the top of the grain, gently add more hot water. You should be able to collect about 5 1/2 gallons (20.8 L).

If you try to get much more, you may find that the last runnings get very cloudy. Don't take any solids or very cloudy wort. Another way to tell when you've reached the end is that there will be no sugar left. Taste the wort and try to detect any sweetness on the tip of your tongue. (Be careful, the wort is hot!) Or, simply stop collecting when the runoff falls below a gravity of 1.010 when cooled to 60 degrees F (15 degrees C).

Once you've got your wort, boil for 70 minutes — watch out for boilovers! You should buy some European hops, like Hallertauer, for that classic flavor. For a Kölsch, the hopping rate usually is moderate with a range of 25 to 35 IBUs (6.25 to 8.75 AAUs). Try 1 1/4 to 1 3/4 ounces of Hallertauer or Saaz hops at 5 percent alpha acid. If you're making a Pilsener, you may want to up the hopping rate into the 35 to 45 IBUs (8.75 to 11.5 AAUs) range or 1 3/4 to 2 1/4 ounces of Hallertauer hops at 5 percent alpha acid. Your hopping schedule should be in three phases: 10 minutes after the boil starts for boiling hops, 40 minutes after for flavor hops and 70 minutes after for aromatic hops. After boiling and cooling, ferment with a neutral ale yeast for the Kölsch or lager yeast for a Pilsener. In both styles, a patient lagering (at least three weeks) below 40 degrees F (5 degrees C) will reward you with a beer with a distinct, mellow, malty aroma and flavor, in spite of the hopping level.

But Why?

Now, what does this decoction do for your beer? The decoction process is often lauded for squeezing out the last drop of extract from undermodified malts. While this probably is true, most homebrewers find it unnecessary to be so miserly with inexpensive malts. The difference is cited at only a few percentage points, and when a brewer is transitioning from malt extracts the cost of an additional pound of malt is hardly noticed.

The reasons to go to decoction mashing are the same reasons to go to all-grain brewing in the first place. It provides more control over the process and is a more authentic recreation of the traditional techniques used by brewers around the world. Homebrewers who are interested in not only the results but also the process of brewing will find this an interesting and rewarding alternative.

Decoction mashing was developed without the use of any modern technology. If brewers could measure volumes and detect when a liquid is at body temperature

FIGURE 3 DOUBLE DECOCTION STEP-BY-STEP

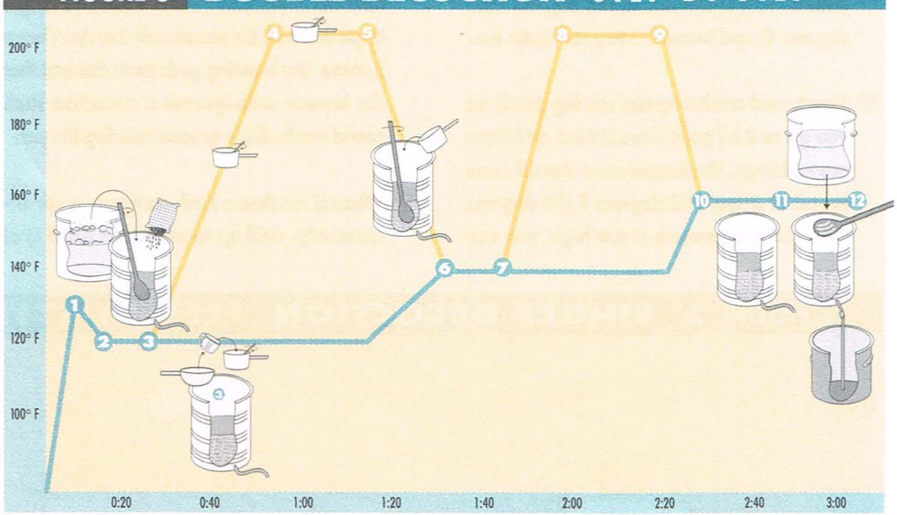
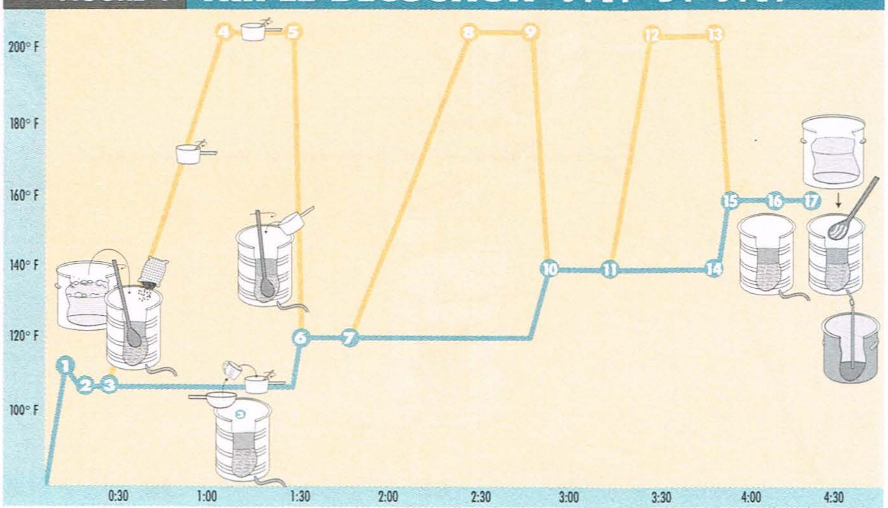


FIGURE 4 TRIPLE DECOCTION STEP-BY-STEP



or is boiling, then repeated extractions, boilings and returns will "magically" cause the mash to convert.

When brewing was a food preparation technique practiced in every farmhouse across Europe, it had to be this simple. Today you can visit Europe and find open air museums where old buildings have been saved, and see in old farmhouses the 10- to 15-gallon cook pot that is inevitably mounted behind the fireplace and was used to brew beer in this way.

But decoction has a modern use as well. Investigation into cooking of all kinds has discovered that a lot of the great aromas and flavors we so love — roasted meat, crusty bread, baked potatoes — all result from a general process called the Maillard reactions. This same process occurs during the boiling of the mash in a decoction.

The Maillard reactions create brown-colored pigments called melanoidins. Decoction darkens beer color somewhat without the addition of harsh black malts or sweet caramel malts. While you would be hard pressed to achieve stout blackness with just decoction, many shades of amber can be achieved by using Pilsener, Vienna and Munich malts.

And the flavor! Those same melanoidins (and other byproducts of the reaction) produce heavenly malty aromas. If you can lose yourself in the aroma of a great doppelbock, you will want to know that this is how it got there! The process definitely produces a distinct range of malt flavors that can't be duplicated without resulting in a sweet beer. With an extended triple decoction mash, even some raisiny or dark fruit flavors can be achieved.

Speaking of flavors, extract-and-grain brewers are always warned not to allow their grain to boil because this will leach out the tannins in the husks and produce a very astringent beer. Why isn't this a problem with decoctions?

Actually, it can be. The pH of your decoction must be below 5.5, or you will extract significant amounts of tannin. The pH of the mash is controlled by the water you use and the malts you choose. Darker malts are more acidic (lower pH numbers). Carbonate waters are more basic (higher pH numbers). It's a very good idea to get some pH papers and test your mash during the first 15 minutes while it's resting.

My First Decoction Pilsener

Ingredients for 5 gal (18.9 L)

- **8 1/2 lb Pilsener malt (3.9 kg)**
- **3/4 oz Hallertauer hops, 5% alpha acid (21 g) (60 min.)**
- **1/2 oz Hallertauer hops, 5% alpha acid (14 g) (30 min.)**
- **3/4 oz Hallertauer hops, 5% alpha acid (21 g) (end of boil)**
- **lager yeast**

- **Original specific gravity: 1.048**
- **Final specific gravity: 1.011 to 1.013**

If the pH isn't low enough, you can add some calcium chloride (crush it if it isn't a powder and dissolve it in some warm water before adding). You can add some gypsum (stir it into warm water first), or you can add some crushed chocolate or black patent malt. All of these will help to lower the pH but they affect the flavor of the beer, too. I've listed them in increasing order of flavor change.

But extract brewers are told never to boil their grains because the specialty grains are being used in small quantities and, because they are added to a large volume of water, their acidity is diluted and the pH will be too high. The specialty grains might be diluted at a rate of one pound per two gallons of water. With a decoction mash, the dilution will be no more than one pound per 1 1/2 quarts of water.

Once you have mastered the single decoction mash, you can build on the maltiness and color by doing two or even three decoctions. Most European dark beers are made with a double decoction. Figure 3 shows the step program for such a beer. For really malty beers like bocks and doppelbocks a triple decoction is the way to go. That is shown in Figure 4. Note the temperature schedules for double and triple decoctions differ from the single decoction.

While most brewers seem to fall into the rut of infusion-based British and American amber-colored ales, there's another whole world to explore using decoction. Once you try it, you'll see that, like all-grain brewing itself, it's harder to describe than do and the results are really fabulous. Prosit!

By Dan Leithauser

Mashing and Saving Time

Everyone knows that in homebrewing it takes more time to mash than to use an extract to make wort. You should consider mashing, however, because the time spent may well be worth it. Mashing gives you more control over the final flavor of your brew. Mashing allows you total control over the grains, the amount of body or mouthfeel and gives a better understanding of how beer is made.

I'm going to describe some easy shortcuts that allow you time to do other things while you are making beer. This brewer spends most of the brew "day" sleeping, reading the newspaper, listening to music and cleaning equipment (hey, it's not all fun and games). The brew day starts at 7 a.m. and usually ends at 10 a.m. — three hours. A brief summary of my brewing operation follows.

The night before:

1. **Draw water for sparge, store in 10-gallon stainless-steel pot.**
2. **Draw water for mash and heat to specified temperature.**
3. **Start mash. Go to bed.**

The next morning:

4. **Boil water for sparge, read newspaper or something while waiting for water to heat.**
5. **Sparge and collect wort, continue reading newspaper.**
6. **Boil wort, wash out lauter tun, listen to music.**
7. **Cool wort, transfer to primary fermenter, pitch yeast, wash equipment.**
Drink a beer, relax.

There are two areas where significant time can be saved in the brewing process: mashing and sparging. Overnight mashing saves time because you are sleeping during the process. Adding most of the sparge water to your lauter tun at the beginning of the sparge and using a valve or pinch clamp to control the rate of runoff allows attention-free operation of this part of brewing.

Overnight mashing was presented in Dave Line's *The Big Book of Brewing* (Argus Books, 1985). The two major advantages to an overnight mash are assurance of adequate saccharification (provided you have good temperature control) and the time saved by sleeping while mashing. Overnight mashing is only for infusion mashing. Mashes with multiple temperature changes require more time and attention.

For the overnight mashing method, I generally use 1 1/3 quarts (1.2 L) of water per pound (0.45 kg) of grain used. So if you use about eight to 10 pounds (3.63 to 4.54 kg) of grain for a 5-gallon (18.9-L) batch, you can heat up 2 1/2 to 3 gallons (9.5 to 11.4 L) of water to between 165 and 170 degrees F (74 and 77 degrees C). When mixed with grain in the preheated mash tun, the final temperature will be 152 to 155 degrees F (67 to 68 degrees C). If your mash tun is a picnic cooler, simply seal it and leave in the kitchen at room temperature. If you are using a kettle or buckets, you have to insulate the mash tun to preserve heat, or place a kettle in a preheated oven.

Sparging is a time-consuming activity, but there is no need to pay attention to it. Find something else to do.

Heat about 5 1/2 to 6 gallons (20.82 to 22.71 L) of water to between 165 and 170 degrees F (74 and 77 degrees C). This water can be heated while you set up your grain bed in the lauter tun.

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COURTESY TONY STONE IMAGES ©1995
PHOTO IMAGING BY VICKI HOPEWELL

Transfer (dump or scoop) the grain-liquid slurry from the mash tun to the lauter tun. Use small amounts of heated sparge water to rinse the remaining grain out of the mash tun.

It is a good idea to set up a filter bed in the lauter tun to minimize sediment and cloudiness in your final brew. This is accomplished by draining the liquid in the lauter tun into a container and pouring this liquid back in the top of your grain bed. An ideal container is a half-gallon (1.9-L) plastic pitcher. If you use a 5-gallon (18.93-L) Zapap lauter tun you can use a plastic colander to help evenly distribute the hot liquid over the top of the soaked grain. When the runnings from the lauter tun become free of particles the filter bed is set. This usually takes about four to six drainings.

At this point you can drain off about one-half to one gallon (1.9 to 3.8 L) of liquid into your boiling pot. Then add about half of the hot sparge water and set the control valve or pinch clamp so the runnings drain at about 20 ounces (0.6 L) per minute. With a good control valve or pinch clamp you can control the rate of movement through the lauter tun with no attention at all to the process.

Ready to try overnight all-grain brew? Here's what to do before bed (the night before brewing):

1. **Heat 2 1/2 to 3 gallons (9.5 to 11 L) water to between 165 and 170 degrees F (74 and 77 degrees C). Preheat mash tun (I use an insulated cooler) by adding about one-half gallon (1.9 L) of boiling water to the mash tun while the mash water is heating. Seal the mash tun and let it sit. Remove this water just prior to adding the mash water. Add the heated mash water to the mash tun, stir in the grain, check and record the temperature. Seal mash tun, store at room temperature with towels, blankets or newspapers on top for added insulation. Draw five gallons (19 L) of water to heat for sparging the next day. Go to bed.**

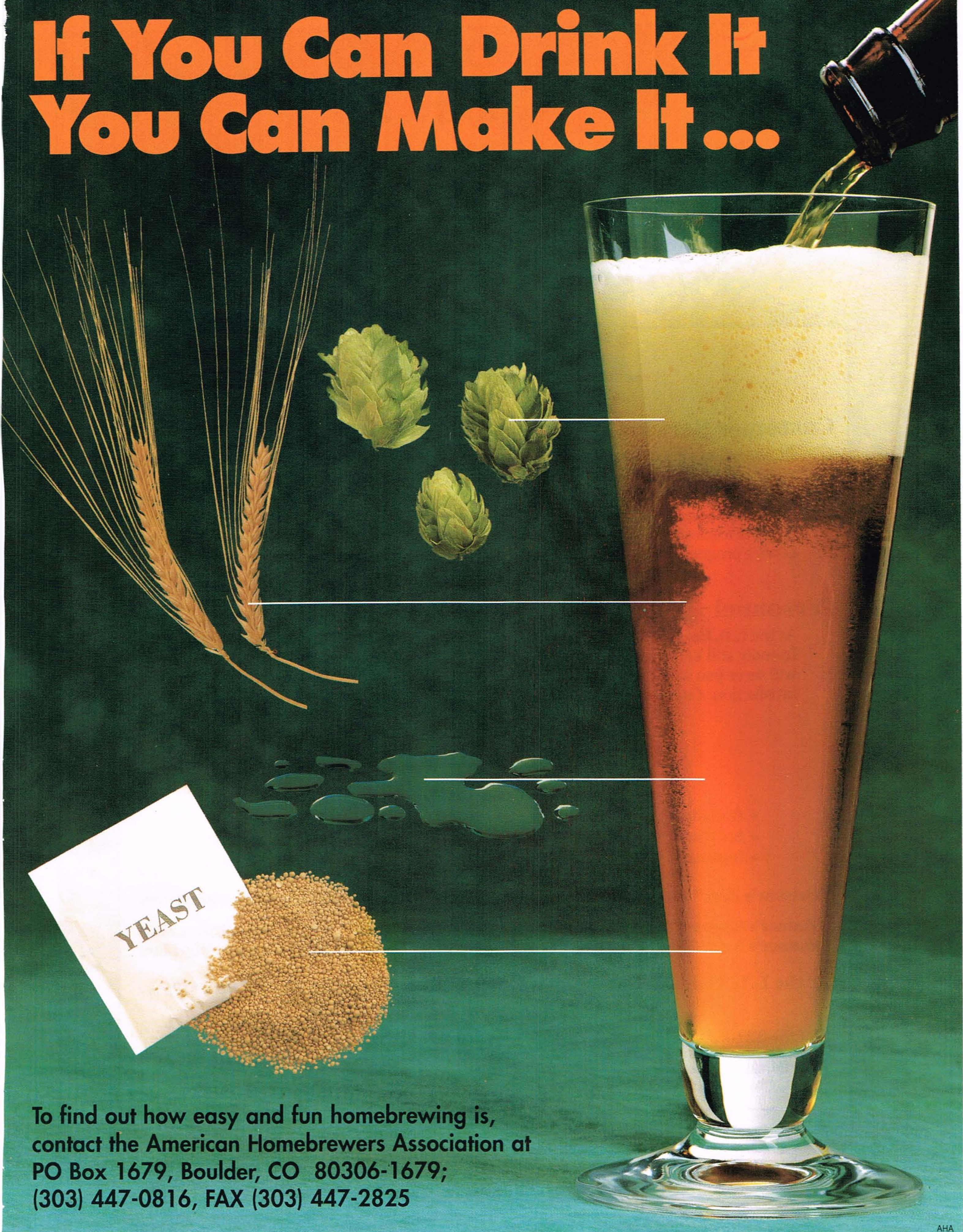
2. **After a good night's rest, heat sparge water (the five gallons or 19 L drawn the night before) to between 166 and 170 degrees F (74 and 77 degrees C). It takes two minutes to assemble the Zapap lauter tun. Read the Sunday news, water the plants, enjoy a cup of coffee or whatever while the water heats.**

3. **Transfer mash to the lauter tun. Set up a filter bed by recirculating the wort through the grain. Add about half the hot sparge water to the lauter tun and adjust the flow rate.**

4. **Change the compact disc and relax while the lauter tun does the work. After about 20 minutes add another 1 1/2 to 2 gallons (5.7 to 7.6 L) of the sparge water. Try to keep the grain bed covered with water until the very end. Sparging should take 45 to 60 minutes to maximize extract potential.**

Once the sparging is complete, boil the wort. If you find something else to do during the boil, keep one eye on the kettle otherwise cleaning up a boilover could consume most of your saved time. Cool wort to pitching temperature, transfer wort to primary fermenter and aerate. Pitch yeast and enjoy watching nature work.

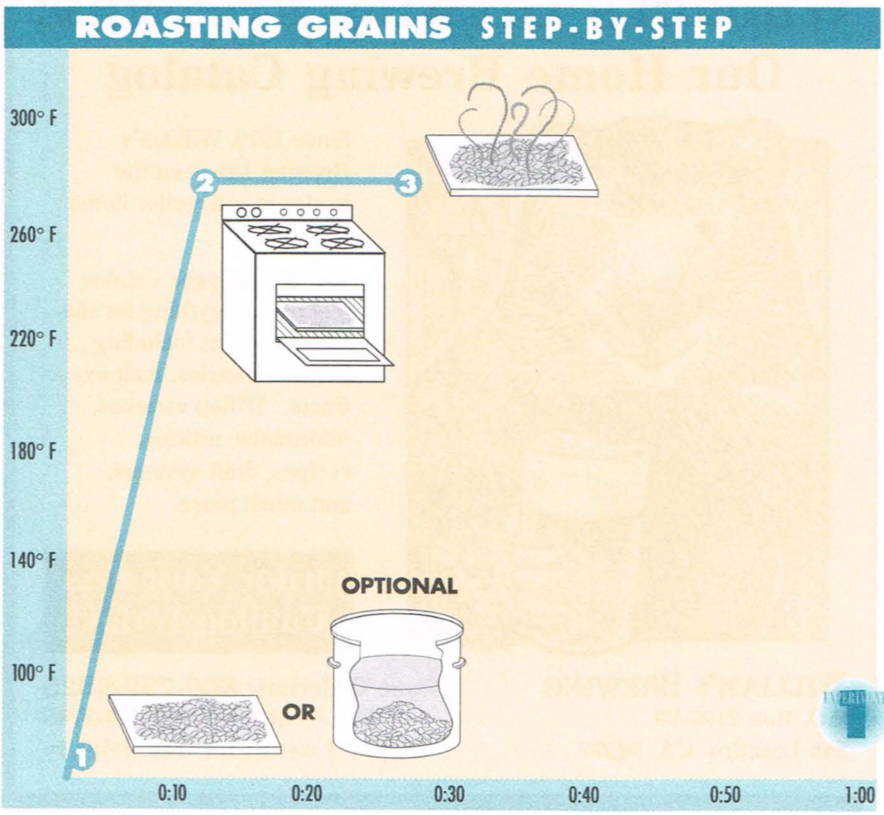
Although mashing takes more time, it can be just as easy as using an extract. These suggestions may provide fodder for your own time-saving ideas. Be sure to write everything down in your brewing journal so you can employ your new ideas in your next brew session.


If You Can Drink It You Can Make It...
YEAST
To find out how easy and fun homebrewing is, contact the American Homebrewers Association at PO Box 1679, Boulder, CO 80306-1679; (303) 447-0816, FAX (303) 447-2825
AHA

Fun Flavor Experiments

Among the many variables facing homebrewers is the choice of mashing method. In many cases, such as the production of pale ale, a simple single-temperature infusion procedure is perfectly sufficient to produce an excellent beer. With other beer styles, however, it can be argued that there are advantages to using multistep infusion, double mashing (see Glossary on page 20) or decoction mashing methods. The latter method, which involves removing a portion of the mash and heating it to boiling before returning it to the main mash, has traditionally been employed with undermodified or low-enzyme malt. Because most modern malt is sufficiently modified, decoction mashing often is viewed as unnecessary for achieving a good yield. It is safe to say that most homebrewers avoid decoction procedures because they view them as too time-consuming. On the other hand, some brewers have come to realize that decoction mashing is essential for producing the deep, complex maltiness appropriate for Munich dunkels, bocks and several other styles, and is well worth the effort. To understand this point of view, I would like to ask the reader to put on his or her lab coat (don't forget your pocket protector) and conduct a few brewing experiments.

These experiments should illuminate some aspects not only of brewing but also an important branch of food chemistry in general. The distinctive flavors and aromas of many foods, including coffee, cocoa, bread and malt, arise from complex blends of a very large number of components in proper balance, no one of which alone would even suggest the familiar flavor or aroma. In each of these foods, the complex flavor-aroma profile is the result of a series of chemical reactions that take place during processing. For example, "green" coffee and cocoa beans are transformed into roasted coffee and cocoa. Malted barley is kilned under a variety of conditions to produce a wide spectrum of malts from pale to black. And, in my home state of Vermont, the unmistakable flavor and aroma of one of our most important food products, maple syrup, are produced by boiling the sweet but mostly tasteless sap from the sugar maple. Scientific study of these flavor-developing chemical reactions began with the work of Louis-Camille Maillard who, in 1912, observed that by heating concentrated solutions of glucose and amino acids one could cause a gradual darkening of the mixture and produce aromas somewhat like those of freshly baked bread or, with other amino acids, like those of roasted meat. Eventually these



ILLUSTRATIONS BY VICKI HOPEWELL

PRINCIPLE AND PRACTICE

By Paul D. Hale, Ph.D.

with Malt

aroma and flavor-developing reactions became known as Maillard reactions.

The kilning of malted barley illustrates how Maillard reactions can result in an incredible variety of flavors and aromas from only a few primary components. By varying the temperature, moisture content and length of kilning, the maltster can produce a range of malts with completely different characteristics. Lager malts typically are dried slowly at temperatures up to 150 degrees F (66 degrees C) before being roasted at 180 degrees F (82 degrees C), producing a very pale and delicately flavored malt. Vienna malt, roasted at 210 to 230 degrees F (99 to 110 degrees C), has a unique toasty character that is an integral component of Märzen and Oktoberfest beers. Munich malt, one of the essential ingredients of Munich dunkel, derives its rich maltiness and nutty character, as well as its darker color, from slightly longer kilning at temperatures up to 240 degrees F (116 degrees C). Crystal and caramel malts are not dried until after they are "stewed" and have undergone saccharification (conversion of the grain's starch to fermentable sugars) at 150 to 170 degrees F (66 to 77 degrees C). The malts are then roasted at about 250 degrees F (121 degrees C). With the starch largely converted, the kilning of these malts sets off Maillard reactions that involve simpler sugars instead of more complex carbohydrates, producing a flavor and aroma profile very different from those characteristic of other malts. In addition, the high moisture content enhances the formation of caramel flavors, produced via the reaction of sugar molecules with one another. Chocolate malt, black malt and roasted barley are roasted at high temperatures (greater than 400 degrees F or 204 degrees C) and provide very dark reddish hues and sharp, dry, roasty aromas and flavors.

HOME-KILNED MALT

EXPERIMENT 1

Many of the flavor compounds resulting from the Maillard reactions of the kilning process are small heterocyclic molecules (ring-shaped molecules containing nitrogen, oxygen and/or sulfur, in addition to carbon) with extremely low taste thresholds which means you can taste even a very small amount of the substance. These tastes and aromas are often described as breadlike, biscuity, burnt, coffeelike, doughlike, grainy, malty, nutty, roasty or toasty. The yellow, red and brown pigments resulting from the complex series of Maillard reactions that take place during kilning are called melanoidins. These are nitrogenous polymers and copolymers that have the added benefit of improving foam stability in beer, probably through interactions with proteins that assist in forming the bubble microstructure, thus providing enhanced head retention.

Homebrewers can produce many of these flavors, aromas and colors by simply toasting pale malt in the oven. It is easy to give a nice toasty malt character to a Pilsener or helles by adding a pound or so of lightly toasted lager malt to an extract or all-grain recipe. And because the Maillard reaction products vary with time, temperature and moisture content, it is possible to produce a broad range of flavors, aromas and colors. For the first few attempts at home toasting, I recommend you follow some time and temperature guidelines laid out several years ago by Randy Mosher:

ROASTING GRAINS

1. **Preheat oven to 300°F. Spread uncrushed malt on cookie sheet 1/2-inch deep.**

   OPTIONAL

   Soak then drain grain before roasting.

2. **Toast for 10 to 15 minutes.**
3. **Taste and smell results.**

EXPERIMENT 1

DESIRED MALT TYPE	DESIRED COLOR (°L)	TOASTING TIME (MINUTES)	TEMPERATURE °F/C*
Pale	6	10	300/149
Gold	15	20	300/149
Amber	24	20	350/177
Deep Amber	38	30	350/177
Copper	50	20	400/204

* Use an oven thermometer for more reliable temperature readings. (Table adapted from Randy Mosher, "The Flavorful World of Malt," *Beer and Brewing, Vol. 10*, Brewers Publications, 1990.)

Spread one-half to one pound of uncrushed pale malt (2 to 3 °L) on a cookie sheet to about one-half inch in depth. After you place the malt in the oven, taste it every now and then and give it a gentle stir for even toasting. In general, short toasting times at lower temperatures bring out grainy, toasty and biscuity flavors and aromas, while higher temperatures and longer toasting times produce a distinct nutty character. To experiment further, try moistening the malt prior to toasting; Mosher recommends soaking the grain for an hour. Keep in mind that the moistened grain will require more time in the oven. As the moistened grain is heated, its starch will be partially converted into sugars that can undergo caramelization, producing a flavor and aroma profile that is quite different from that obtained by toasting dry malt. Freshly roasted grains can be somewhat harsh. It is best to allow grain to mellow for a couple of weeks before using.

The following Munich helles recipe takes full advantage of the toasty flavor and aroma resulting from the Maillard reactions of the above home-kilning process. This beer, even when prepared using the extract recipe, has a pleasant grainy, biscuity maltiness delicately balanced by the restrained hopping rate.

Green Mountain Light
(CLASSIC MUNICH HELLES)

Ingredients for 5 gal (18.9 L) (extract/grain)

- 1 lb home-toasted pale malt (0.45 kg)
- 4 lb Alexander's pale malt extract syrup (1.81 kg)
- 2 1/2 lb Laaglander light dry malt extract (1.13 kg)
- 1 1/4 oz Hallertauer hop pellets (6 HBU) (35 g) (60 min.)
- 1 tbsp Irish moss (14.8 mL) (20 min.) Wyeast 2206 lager yeast (or equivalent) in active 1-pint starter (0.47 L)

Toast the uncrushed pale malt in the oven at 300 degrees F (149 degrees C) for 10 to 15 minutes. Crush the toasted malt and steep in 3 gallons (11.4 L) of 150-degree-F (66-degree-C) water for 15 minutes. After straining out the grains, add the malt extract and 3 gallons (11.36 L) of water. Bring the sweet wort to boiling, and after 15 minutes add the bittering hops. Continue boiling for 60 minutes. One tablespoon of Irish moss may be added 20 to 30 minutes prior to the end of the boil. After cooling (to below 50 degrees F or 10 degrees C if possible), pitch the yeast. Ferment and bottle as you would any lager-style beer.

Ingredients for 5 gal (18.9 L) (all-grain)

- 1 lb home-toasted pale malt (0.45 kg)
- 8 lb Irek's Pilsener malt (3.63 kg)
- 1 1/4 oz Hallertauer hop pellets (6 HBU) (35 g) Wyeast 2206 lager yeast (or equivalent) in active 1-pint starter (0.5 L)
- Original specific gravity: 1.050
- Final specific gravity: 1.010

Toast the uncrushed pale malt in the oven at 300 degrees F (149 degrees C) for 10 to 15 minutes. Crush the toasted and Pilsener malts and mix them into 2 1/4 gallons (8.5 L) of 136 to 138 degrees F (58 to 59 degrees C) water, which should provide a mash temperature of about 122 to 124 degrees F (50 to 51 degrees C). After a 30-minute rest, raise the mash to saccharification temperature (152 degrees F or 67 degree C) for 60 minutes. After mashing out at 168 degrees F (76 degrees C) for five minutes, transfer the goods to the lauter tun and sparge with 170 degrees F (77 degrees C) water to obtain about 6 1/2 gallons of sweet wort. Proceed with the wort boil as described above.

CARMELIZING WORT

1. **As you are raising the temperature of the unhopped wort to boiling, remove 1 quart.**
2. **Boil 1 quart wort until thick and syrupy (about 15 minutes). Stir constantly to prevent scorching.**
3. **Return the dark, thickened wort to main kettle and proceed with boil.**

EXPERIMENT 2

CARAMELIZING WORT

EXPERIMENT 2

When concentrated sugar solutions are heated in the absence of amino acids, melanoidins and other Maillard flavor and aroma products are not produced. Instead, the sugars undergo a series of reactions leading to caramel formation. The typical caramel flavor results from the combination of several sugar degradation and dehydration products, such as diacetyl (hence the butterscotch note), acetic and formic acids, and several other more complex molecules. When a large amount of water is present, darkening and flavor development are caused primarily by caramelization even when amino acids are available, but at low water levels (and especially at a pH greater than 6) the Maillard reactions predominate. During wort boiling both processes occur but there is relatively less flavor and aroma production via the Maillard reactions than one would obtain during a decoction mash procedure. Because caramelization requires very high temperatures, it occurs mostly at the kettle/wort interface.

Several beer styles benefit from wort caramelization. In strong Scotch ales, caramel notes are essential, while an English ESB or brown ale can derive some added complexity from the presence of caramel. Greg Noonan and Glen Walter of the Vermont Pub and Brewery obtain this wonderful characteristic in their award-winning Scotch "Wee Heavy" by caramelizing a small amount of sweet wort in the kettle prior to the main boil. We homebrewers can achieve similar results by boiling a small amount of unhopped wort (for a five-gallon batch, one quart is sufficient) in a saucepan. Because high temperatures are necessary, it is important to constantly stir the wort to prevent scorching. Within 15 minutes or so the wort will thicken to a syrupy consistency and the desired caramel flavors and aromas will be very apparent. Add this syrup to your kettle which you have been bringing to a boil and proceed with the main wort boil.

DECOCTION VS. INFUSION MASHING

EXPERIMENT 3

Toasting grain in the oven and caramelizing sweet wort on the stove top are simple ways to learn about some of the important malt-based flavor and aroma compounds that contribute to the remarkable complexity of beer. Another straightforward, although somewhat more time-consuming, experiment is to compare decoction mashing with infusion or step mashing procedures using an otherwise identical recipe. I have tried this with the following Munich dunkel recipe and have found that a single decoction is sufficient to produce the nutty, malty character of this classic style.

Green Mountain Dark
(CLASSIC MUNICH DUNKEL)

Ingredients for 5 gal (18.9 L)

- 5 lb Pilsener malt (2.27 kg)
- 5 lb Munich malt (2.27 kg)
- 1 lb German dark crystal malt (0.45 kg)
- 1 lb German light crystal malt (0.45 kg)
- 4 oz chocolate malt (113 g)
- 1 oz Hallertauer hop pellets (4.5 HBU) (28 g) (60 min.)
- 1 oz Tettnanger hop pellets (4.5 HBU) (28 g) (60 min.)
- 1 tbsp Irish moss (14.8 mL) (20 min.) Wyeast 2206 (or equivalent) in active 1 pint-starter (0.47 L)
- Original specific gravity: 1.055
- Final specific gravity: 1.012

Decoction Mashing Procedure: Mix the crushed grains into 2 3/4 gallons (10.4 L) of 136- to 138-degree-F (58- to 59-degree-C) water, which should provide a mash temperature of about 122 to 124 degrees F (50 to 51 degrees C). After resting at this temperature for 20 minutes, remove about 40 percent of the mash (the thickest part) with a strainer or slotted spoon and place it in a separate kettle for the decoction step. It is important to take the thickest part of the mash and only a little liquid for the decoction because most of the malt's enzymes are dissolved in the mash liquid. Thus, by removing only the thickest portion, a sufficient quantity of enzymes is left behind in the main mash. Slowly heat this thick mash to 158 degrees F (70 degrees C) and hold at that temperature for 15 to 20 minutes for saccharification. Stirring constantly to prevent scorching, gradually increase the temperature to achieve boiling. Continue boiling for 30 minutes. At this stage, you will notice the unique aromas resulting from Maillard reactions and caramelization processes, and a corresponding darkening of the mash.

Next, over the course of about 10 minutes, slowly add the decoction back to the main mash, aiming for a mash temperature of 150 to 152 degrees F (66 to 67 degrees C). Adjust the main mash temperature if necessary by heating or adding boiling water. Hold at this temperature until saccharification is complete (about 30 minutes). (For decoction step-by-step see page 63.)

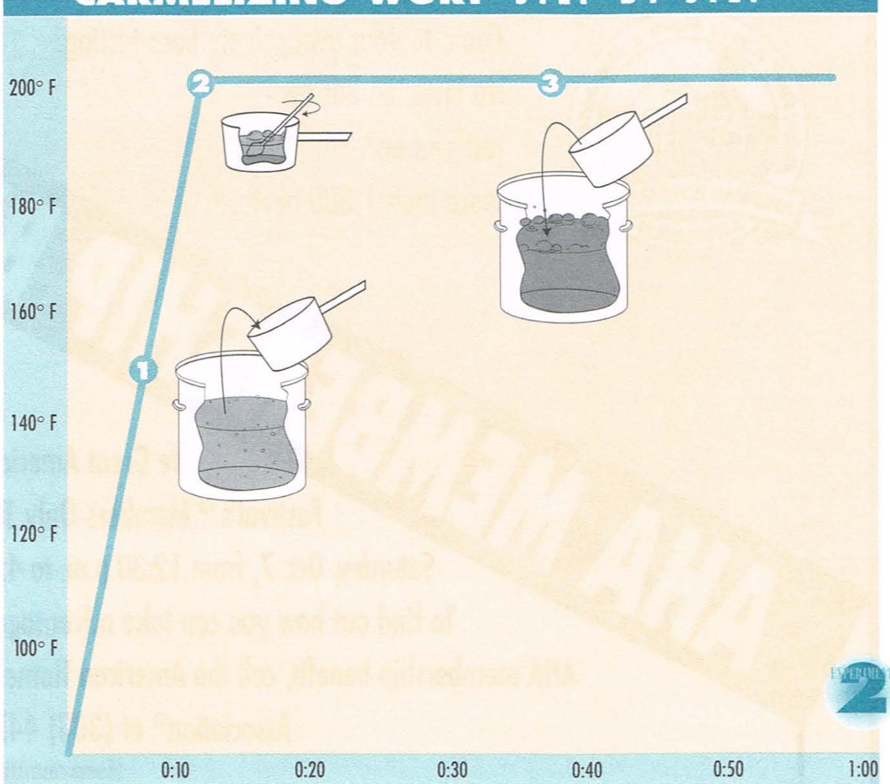
Infusion Mashing Procedure: Dough-in the grains as described above to achieve a mash temperature of about 122 to 124 degrees F (50 to 51 degrees C). After a 30-minute rest, increase the temperature to saccharification temperature (152 degrees F or 67 degrees C) for 60 minutes.

After the mashing procedure has been completed, transfer the goods to the lauter tun and sparge with 170-degree-F (77-degree-C) water to obtain about 6 1/2 gallons (24.6 L) of sweet wort. Bring the wort to boiling, and after 15 minutes add the bittering hops. Continue boiling for at least 60 minutes. One tablespoon of Irish moss may be added 20 to 30 minutes prior to the end of the boil. After cooling to below 50 degrees F (10 degrees C), if possible, pitch the yeast. Ferment and bottle as you would any lager-style beer.

Using this recipe I have found that, because the malts are well-modified, decoction mashing does not result in a substantially improved yield compared to an infusion procedure. However, it does provide a degree of maltiness and complexity not achievable through infusion mashing. The Munich dunkel produced by the decoction process has a wonderfully aromatic, nutty, malty character that in my opinion provides the difference between a good homebrew and an authentic world-class beer. It certainly is worthwhile for the all-grain homebrewer to give decoction mashing a try, especially for beer styles requiring bold malt flavors and aromas.

During the various stages of brewing, Maillard reactions and caramelization processes contribute a truly remarkable number of flavor, aroma and color compounds to beer. Pilsener and Munich helles styles benefit from the subtle toastiness imparted to the malt during the kilning process, Scotch ales acquire their unmistakable butterscotch character through caramelization of wort sugars, and bocks and Munich dunkels obtain their elegant maltiness from the traditional decoction mashing procedure. By understanding how these flavors and aromas are produced, and using some straightforward procedures such as home toasting the malt, caramelizing small portions of wort or decoction mashing, homebrewers can impart enhanced complexity and depth of color to their brews.

CARMELIZING WORT STEP-BY-STEP



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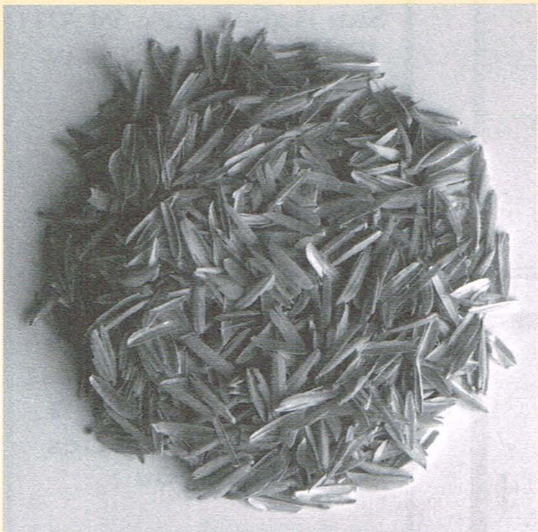
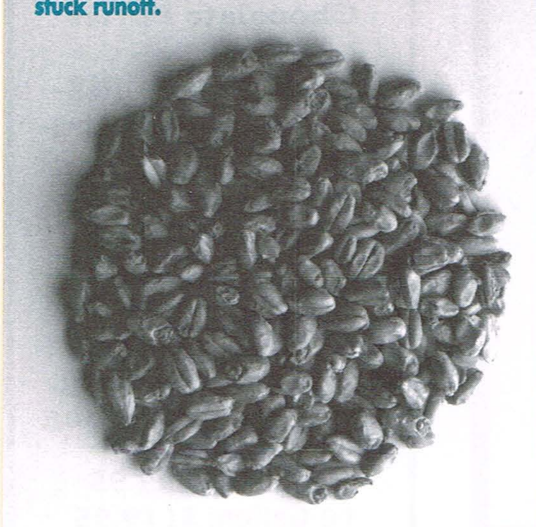
Rice Hulls



Rice hulls (above) provide or enhance inadequate filter beds enabling brewers to use more huskless grain like wheat (below) without risking a stuck runoff.



Rice hulls can add great flexibility to your brewing and save you from agonizing over a set mash. Using rice hulls during mashing can help eliminate set mashes and enable you to include as much huskless grain in your grist as you wish.

But first things first. Unless you are using a recirculating infusion mash system (RIMS) where you circulate wort during the mash, the terms "stuck mash" or set mash are misnomers. Your mash isn't stuck, your runoff is. However, because the problems addressed and the solutions proffered in this article apply to both the mash using a RIMS and the runoff phase of conventional procedures, I will continue to use the term "set mash" to refer to both of these situations. Before we examine mashing with rice hulls, we need to visualize what occurs mechanically during mashing and sparging and why set mashes occur.

In conventional mashing procedures, whether decoction, infusion or multi-temperature infusion, the grain is fully immersed in hot water that is not circulated. When using a RIMS, the grain is fully immersed in circulating hot water during the mash. Regardless of the equipment and procedure, the grain will absorb water and expand. Gravity also will cause considerable compacting of the grain filter bed. Meanwhile, enzymes have worked their magic and converted grain starches into sweet fermentable sugars, leaving us with lots of very sticky grain and some concentrated sugar water we call wort.

Our next objective is to separate as much of the sweet wort from the grain as possible. To accomplish this we rinse or sparge the grain with more hot water. For this to happen we must be able to get liquid to drain through the grain bed, through some filter at the bottom of the grain bed, out the drain valve and tubing and into a boiling kettle.

There are only three types of set mashes or stuck runoffs: a grain bed that will not allow water to drain through it, a clog of some portion of the mechanical drainage-circulation equipment or a vacuum in the drainage-circulation system. A set mash can be caused by a number of reasons, one being too-finely-crushed grain which results in husk fragments that are too small to form an adequate filter bed or fine particles that can clog drainage equipment. ***Zymurgy*** Fall 1994 (Vol. 17, No. 3) has two articles with detailed information on proper grain crushing and how to achieve it.

PHOTO BY ZACHARY EPPS

By Roger Jones

to the Rescue

Why Rice Hulls?

Barley, the mainstay of beer production, comes out of the field with the husk still encasing the grain, or berry, inside. This retention of the husk is what makes beer brewing possible because, when ground, the husk separates from the grain. When we put the ground grain and husks in water we get a mixture that is porous enough to allow liquid to drain through.

On the other hand, wheat loses its husk in the field. Therefore, using conventional methods, we are not able to mash using a 100 percent wheat grain bill. Prior to mashing with rice hulls it was said that wheat should never constitute more than 70 percent of the grain bill, the remainder being malted barley to provide enough husk for an adequate filter bed.

Fortunately there is another common grain from which we can borrow husks for use in brewing. When rice is cut in the field, the husk (rice farmers and processors call them hulls) doesn't separate from the grain. This separation occurs at the mill where rice is dried and the hull separated from the grain. Rice hulls are then packaged and sold.

Rice hulls are light golden in color and very hard. A tea made from rice hulls proves their negligible flavor contribution. In my experience no tannins are extracted from the hulls during mashing. They are about the size of a barley husk, but since you don't crush them, the rice hulls in your grist are larger than the barley husks.

How Do Rice Hulls Work?

The problem we are addressing is a missing or inadequate filter bed. Adding rice hulls to a mash supplements an inadequate filter bed or supplies one. Commercial brewers and a few homebrewers increase the ability of their grain bed to drain liquid by rotating a paddle below the surface of their grain bed. This technique, however, still does not enable them to brew exclusively with huskless grains. Mechanical mixing of the mash is certainly a proven technology, but the investment in money and expertise may be beyond many homebrewers. With rice hulls we improve the porosity of our filter bed inexpensively and in a manner that does not require special brewing skills or expose us to the possibility of oxidation by aerating hot wort.

Additionally, an inch-deep layer of rice hulls placed directly over the filter or false bottom in your lauter tun can assist in preventing a set mash caused by a clogged screen or drainage tubing. Carlos Kelley, a good friend and award-winning brewer from Fort Worth, Texas, recently brewed a 10-gallon batch of beer using 15 pounds of pale malt and seven pounds of flaked wheat.

When wet, flaked wheat looks like industrial-strength Wheaties in milk. Carlos thought the barley would give him an adequate filter bed to allow drainage, but from his previous experience with flaked wheat he knew the screen at the bottom of his lauter tun would clog. He placed a one-inch layer of rice hulls directly over his screen before putting his mash in the lauter tun. He reports that his runoff cleared immediately and his screen didn't clog.

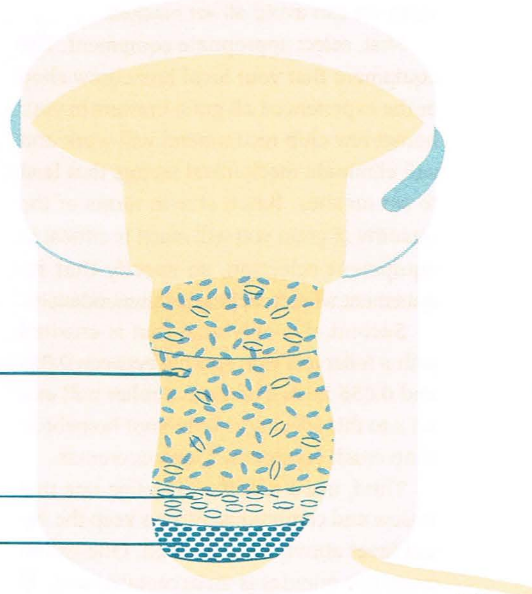


ILLUSTRATION BY STEPHANIE JOHNSON

A Substitute Filter Bed

My first experience with adding rice hulls to mash was a result of my desire to brew a 100 percent wheat beer. Being familiar with rice hulls, I believed they would supply the missing filter bed in malted wheat mashes.

To brew 100 percent wheat beers I add one pound of cleaned and dried rice hulls for every 10 pounds of malted wheat. Plan to experiment with your equipment and the amount of rice hulls, but I suggest adding a pound of rice hulls for every 10 pounds of huskless grain used in your recipe.

Rice hulls actually are quite dusty and need to be cleaned before use. Put the hulls in a nylon grain steeping bag, take it outside and shake vigorously to remove dust. Then, leaving the hulls in the bag, rinse thoroughly with water.

I recommend cleaning and air-drying your rice hulls as soon as you get them. Using wet rice hulls can throw off hot water addition calculations. If you use cleaned and dried rice hulls and add their weight to the weight of your grain, your calculations for raising the temperature with hot water will be accurate.

Thoroughly mix rice hulls with your dry ground grain. Add a handful of cleaned rice hulls to a pound of grain, mix and repeat until you have added one pound of rice hulls for every 10 pounds of grain. Dry, non-compacted rice hulls weigh one pound per gallon.

Eliminating Set Mashes

By using three simple precautionary measures we can avoid all set mashes.

First, select appropriate equipment. The equipment that your local homebrew shop or the experienced all-grain brewers in your homebrew club recommend will work and will eliminate mechanical factors that lead to set mashes. Batch size in terms of the quantity of grain you will mash is critical in equipment selection, so specify that requirement when soliciting recommendations.

Second, use only malt that is crushed with a roller mill with spacing between 0.050 and 0.055 inch. Purchase a roller mill and set it to this spacing or have your homebrew shop crush your grain. Don't overcrush.

Third. use a runoff and sparge rate that is slow and continuous. Always keep the liquid level above the grain bed. One gallon every five minutes is an acceptable rate.

RECIPE FLEXIBILITY

If we homebrewers have a void in our ingenuity, it probably is in recipe formulation. When deciding what we will brew for our next batch, most of us start by selecting a style. Then we tweak some proven recipe but take great pains to ensure the final product remains within AHA guidelines. Guidelines are a must for meaningful homebrew competitions, but we shouldn't let them suffocate our creativity. Here are a few recipes to get your creative juices brewing.

100% WHEAT BEER

Ingredients for 5 gal (19 L)

- 9 lb malted wheat (4 kg)
- 3/4 oz Hallertauer Hersbrucker hop pellets, 4% alpha acid (21 g) (40 min.)
- 1 lb rice hulls (0.45 kg)
- 2 cups Wyeast No. 2206 Bavarian lager yeast starter (473 mL)

- Original specific gravity: 1.043
- Final specific gravity: 1.011

Mix rice hulls with dry crushed wheat before adding mash water. Use a 45-minute protein rest at 122 degrees F (50 degrees C). Raise mash temperature to 155 degrees F (68 degrees C). Expect very pale gold wort after sparging. Boil for 75 minutes then cool wort and pitch yeast. The finished beer is a crisp, 100 percent wheat lager.

AMERICAN-STYLE DUNKELWEIZEN

Ingredients for 10 gal (37.8 L)

- 6 lb Munich malt (2.7 kg)
- 1 lb chocolate malt (0.45 kg)
- 2 lb Pilsener malt (0.91 kg)
- 4 lb Belgian biscuit malt (1.81 kg)
- 4 lb 30 °L crystal malt (1.81 kg)
- 14 lb malted wheat (6.4 kg)
- 2 1/2 lb rice hulls (1.13 kg)
- 2 oz Tettnanger hops, 4.5% alpha acid (57 g) (60 min.)
- 1 oz Hallertauer Tradition hops, 6.8% alpha acid (28 g) (30 min.)
- Wyeast No. 1056 American ale yeast starter

- Original specific gravity: 1.078
- Final specific gravity: 1.020

Mix rice hulls with dry crushed wheat before adding mash water. Employ a 45-minute protein rest at 122 degrees F (50 degrees C). Raise mash temperature to 155 degrees F (68 degrees C). Place a one-half-inch layer of rice hulls on the false bottom or screen of the lauter tun prior to adding the mash. Boil wort for 90 minutes, cool wort then pitch yeast.

OPTIONS FOR RICE HULL ACQUISITION

MORRISON HOME BREW SUPPLY
1811 N. Elm
Denton, TX 76201
(817) 383-4399

RICELAND FOODS
PO Box 927
Stuttgart, AR 72160
(501) 673-5314

They prefer to sell rice hulls in 50-pound bags, but they may fill orders for smaller quantities.

ASK YOUR local homebrew supply shop. Check local livestock supply companies because rice hulls are used as bedding for poultry and horses.

Put Your Grain to Work

Formulating your own homebrew recipe is one of the many rewarding aspects that draws adventurous beer aficionados to homebrewing. The list of variables is immense. The sensory, chemical and biological effects of those variables are complicated. In this article we will delve into the morass of recipe formulation, highlighting the fundamentals and directing the reader to references that can explain each variable in depth. Our goal is to put the homebrewer on a successful path toward actually producing the beer about which they have been daydreaming. With a little effort, your beer will not be a "shot in the dark" generic ale, but a "right on the bull's-eye" beer you'll be proud to share.

Setting the Target

The first step of recipe formulation is for the brewer to decide what beer he or she wants to brew. I call this simple decision "setting the target." It's also known as brewing to style. Start with a specific style of homebrew or a commercial favorite you want to emulate. The AHA style guidelines, published yearly in ***Zymurgy***, and books by Fred Eckhardt and Michael (the Beerhunter) Jackson (see references) are excellent sources. From these glean the three most important quantitative parameters of the target beer: the original gravity (OG), color and bitterness level (measured in IBU or HBU). Other information is necessary but secondary, such as the malt-hop profile, fermentation style, body, aroma characteristics, alcohol content and preferred water chemistry.

Knowing Your Brewing System

The second step is the most difficult for brewers. I refer to this step as knowing and understanding your brewing system. I have yet to see two homebrewers who do everything the same. Equipment and techniques are only limited by our imagination. Simple to sophisticated systems all can make great homebrew, but still yield a different beer from the same recipe. To understand your system requires detailed notes, thought,

ILLUSTRATION BY BOB STAAKE

some experience and some level of consistency in techniques and equipment. You should understand your water supply and incorporate data on batch size, mash constraints and efficiency, anticipated bitterness level for your favorite hop addition schedule, fermentation temperature control and yeast-handling techniques.

Ingredient Selection

In the third step we begin selecting the types of ingredients for the recipe. Reading about the target style and/or tasting the commercial target beer should give the homebrewer a good mental picture of the goal. If you're starting your recipe from scratch, begin with one or two from *Zymurgy* "Winners Circle." Look for one that seems to be closest to your type of brewing system. Don't worry where it placed in competition because you are going to change it anyway. Remember, this will be your recipe when it's finished. Consider your preferences for mash and fermentation techniques and the availability of ingredients.

The key step in using published recipes is to adapt them to your system. Never follow them blindly. Read the recipes to see what the brewer used for the important beer parameters of original gravity and color, then the ingredient characteristics. Almost all grain beers, from light lager to stout, are based on the lightest colored malts, pale ale or lager barley malt, Vienna/Munich malts for some continental styles and wheat malt. These make up the bulk of the recipe. Most recipes use some crystal malts for flavor, color and head retention. These range in your choice of color from pale dextrin malt all the way to brown. The roasted grains (chocolate malt, black malt and roasted unmalted barley) give beers dark colors and roasted, somewhat bitter flavors. Use them sparingly to adjust color, and modestly to get the dark roasted flavors. From the published recipe you'll see the types of grains used and note the relative percentages.

For hops, note the varieties and amounts used, especially for the late hopping for flavor and aroma. Hop quantities in recipes can be misleading because you have no way of knowing how much bitterness actually ended up in that beer. It depends on the brewer's techniques, condition of the hops and the alpha-acid rating of the hops used. However, getting the bitterness level correct in your beer is critical. Overhopped beers can be harsh and undrinkable, while underhopping produces a sickly sweet or bland beverage that fails to refresh the palate.

Tom's California Common

Ingredients for 10 gal (37.8 L)

15	lb Munich malt (6.8 kg)
1 1/2	lb crystal malt (0.7 kg)
2	lb dextrin malt (0.9 kg)
3 4/5	oz Northern Brewer hops, 7% alpha acid (107 g) (60 min.)
2	oz Northern Brewer hops, 7% alpha acid (57 g) (10 min.) lager yeast

"I try to visualize the beer. If I have brewed it before I have a good idea what it will be like. If not, I try to [simplify] the visualization to parameters such as color, bitterness and gravity. I use a middle color of malt first: start with a Munich and add chocolate malt for color and pale malt for gravity. I calculate the hops based on IBU. Each hop is calculated separately even if it will only be in the boil for five or 10 minutes. It takes me about one hour to formulate the recipe. The most important aspect of recipe formulation is **the big idea**, the concept of the beer you are about to make. You need a short description of what you want to accomplish. Every decision you make affects the beer."

Randy Mosher, author of *The Brewer's Companion* (Alephenalia Press, 1994), is a frequent contributor to *Zymurgy* and has been a homebrewer for 11 years.

"I approach recipe formulation by starting with the style. I look to the *New Joy* and go from there. I may add a Northwest twist to things and use regional hops and barley. Half the time I try to make beer according to style and the other half of the time it's whatever sounds good. **Ingredients** are the most important aspect of recipe formulation — the amount and type of hops, specialty grains and the yeast profile are all very important aspects. If I'm sticking to style my recipes usually take about five minutes to formulate, if I am creating my own it is a process of days. I always try to brew something I can drink two cases of."

Gary Arkoff has written a review for *Zymurgy* and has been homebrewing for two years.

I consider yeast selection to be a secondary parameter. My advice here is to use liquid yeast and a healthy active starter — the more yeast the better. If you are brewing a lager style, the yeast should be a lager strain fermented cold, below ale temperatures. If you plan to use dry yeast, stick to ale styles. See *Zymurgy* Summer 1994 (Vol. 17, No. 2) for a table of available yeast strains and some suggested uses.

Hitting the Target

The fourth step is where the recipe is tailored to hit that target beer. It's time to whip out those pencils, calculators, computers, whatever is your choice to crunch a few numbers. If you need more help consult previous articles by Jim Hilton and Ray Daniels (see references). Various computer spread-sheet programs do the calculations for you, as do some simple slide-rule-type calculators. If you're computer-inclined, it's also fun to develop your own recipe spread sheet. However, all you really need is a pencil, logbook and some reference data. This is an iterative process, selecting quantities and types of malts and hops and running through the numbers to see if the results are in the ballpark.

Let's pick California common beer for a sample target. From the AHA style guidelines the original gravity range is 1.040 to 1.055, bitterness is 35 to 45 IBU and color 8 to 17 SRM. The description is: "Light amber to copper. Medium body. Toasted or caramellike maltiness in aroma and flavor. Medium to high hop bitterness. Hop flavor medium to high. Aroma medium. Fruitiness and esters low. Lager yeast, fermented warm, but aged cold." That's a mouthful.

Calculate the original gravity first. My batch size is 10 gallons (37.8 L) and from experience I can expect a mash efficiency of 80 percent of the maximum theoretical yield. To calculate the mash efficiency on a previous batch, take the actual specific gravity points (SG points) achieved divided by the maximum possible contribution from each malt (where y1 x m1 equals yield of malt multiplied by pounds of malt used) in the recipe (see Equation 1) where malt yield is given in SG points per pound per gallon and the batch volume is in gallons. If you haven't figured your mash efficiency (m.e.) yet, try a lower value like 75 percent to start. For this recipe, aim for the high end of original gravity, at 1.055, or 55 specific gravity points. Pale lager malt has a maximum yield of 36.5 specific gravity points per pound per gallon, so my total grain bill will have at least 19 pounds of malt (see Equation 2). This gives an estimate of the total malt requirement, which will consist of primarily pale malt and some specialty malts. A first approximation on determining the amount for each specialty malt is to look at other recipes from ***Zymurgy*** "Winners Circle" to see what types and proportions of specialty malts are used. Find the ratio of each specialty malt to the total malt used, and then multiply that ratio times the 19 pounds estimated for this recipe to get the amount needed here. Study brewing literature to learn the projected effects of each specialty malt on aroma, flavor and body.

Equations to Help You Hit Your Target

Equation 1

$$\text{efficiency} = \frac{\left[\dfrac{\text{(SG points)}}{(y_1 \times m_1) + (y_2 \times m_2) + \ldots + (y_n \times m_n)}\right]}{\text{batch volume in gal.}}$$

Equation 2

$$\text{minimum lb malt} = \frac{\text{(recipe SG points)} \times \text{(batch gallons)}}{[\text{(max yield)} \times \text{(m.e.)}]} = \frac{(55) \times (10)}{(36.5) \times (0.8)} = 18.8 \text{ or about 19 lb}$$

Equation 3

$$\text{OG est.} = \frac{(\text{lb pale} \times \text{y pale}) + (\text{lb Munich} \times \text{y Munich}) + (\text{lb crystal} \times \text{y crystal}) + (\text{lb dextrin} \times \text{y dextrin})] \times (\text{m.e.})}{\text{batch volume in gal.}}$$

$$= \frac{[(15) \times (36.5) + (1) \times (35) + (2) \times (32.5) + (1) \times (32.5)] \times (0.8)}{(10)} = 54.4$$

Equation 4

$$\text{color est.} = \frac{[(\text{lb pale} \times \text{c pale}) + (\text{lb dextrin} \times \text{c dextrin}) + (\text{lb Munich} \times \text{c Munich}) + (\text{lb crystal} \times \text{c crystal})]}{\text{batch volume in gal.}}$$

$$= \frac{[(15 \times 1.8) + (1 \times 8) + (1 \times 10) + (2 \times 60)]}{10} = 16.5 \text{ HCU}$$

Equation 5

$$\text{bittering hop oz} = \frac{[(\text{batch gal.}) \times (\text{goal IBU})]}{[(\text{util }\%) \times (\alpha\text{ a }\%) \times (0.749)]} = \frac{(10) \times (40)}{(20 \times 7 \times 0.749)} = 3.8 \text{ oz}$$

To get the toasted and caramel flavors include one pound of Munich malt and two pounds of crystal malt. To increase the body add one pound of dextrin malt. That leaves about 15 pounds of pale malt on which to base the recipe. Randy Mosher's book (see references) is an excellent resource for supplying the data needed for these calculations. From there find the maximum yield values for Munich, crystal and dextrin malts as 35, 32.5 and 32.5 respectively. Then to estimate the original gravity multiply the total contribution of the malts (yield or "y" times pounds of malt used) by the mash efficiency (m.e.) and divide by the batch size in gallons (see Equation 3).

This is close enough to the target, or you can tweak the pale malt a little to hit 55. Don't forget to measure and record your actual original gravity during brewing and use this to estimate your mash efficiency for future batches.

Next, figure the color, which really has to be done in conjunction with the original gravity calculation because the color is determined primarily by the grain bill. Each malt also has a color rating in degrees Lovibond which we use to establish relative colors of various recipes. These Lovibond ratings should be available when you purchase the malt, or see the article by Neil Gudmestad and Raymond Taylor on page 8. By multiplying each malt quantity by its color rat-

"Ideally I think of recipe formulation ahead of time. I usually use previous recipes that I have developed over the years and I decide how to change them. My award-winning pale ale is from a recipe that has evolved over time. In the beginning, the recipe produced a bitter pale ale. Now the beer could use more bitterness. I do research if I am brewing a beer style new to me. I define what I want the beer to look and taste like. *The Essentials of Beer Style* by Fred Eckhardt (Fred Eckhardt Associates, 1989) is helpful in this part of my research. I can usually hit the right specific gravity and bitterness, but color is still a mystery. The most important aspect of recipe formulation is achieving the right **balance** for the style. I brew to satisfy personal taste, but I also try to brew within style guidelines. If you succeed you formulate a beer that pleases your personal tastes and fits the style descriptors."

Dave Shaffer, a homebrewer for six years, earned a gold and two bronze medals in the AHA 1995 National Homebrew Competition.

ing (c), we can come up with a composite color estimate for the batch in homebrew color units (HCU). This can be correlated roughly to the SRM values given in the AHA profile. The actual SRM rating is determined from a laboratory measurement. From reading Mosher, an HCU rating of 16 should be in the ballpark when correlated to a range of 8 to 17 SRM, for light amber to copper. Let's assume that pale malt is 1.8 °L, dextrin 8 °L, Munich 10 °L and crystal 60 °L (see Equation 4). This is close enough to the target, or you can tweak the crystal malt a little to hit 16.

Next, compute the bitterness. For simplicity, I have chosen a single hop type, Northern Brewer, which is what Anchor Brewing Co. uses, at 7 percent alpha acid according to the package. In other recipes this has been popular in the California common style. For a single bittering hop addition boiled 60 minutes we might expect a hop alpha acid utilization of 20 percent, using whole hops in a full wort boil at sea level and ignoring wort specific gravity effects. To achieve the 40 IBU the style calls for, we need to boil 3.8 ounces of hops (see Equation 5).

Unfortunately, homebrewers can't easily measure IBU, so rely heavily on your taste buds when reevaluating for subsequent batches. Use a good scale and measure the bittering hops as accurately as possible. For the flavor and aroma hops we also will use Northern Brewer, with two ounces added at 10 minutes before the end of boil for flavor and four ounces at knockout for aroma. From my experience, this should produce a medium hop flavor and aroma, but experimentation is needed to determine the appropriate effects for your homebrew system. There is a lot of room for variability in late hopping, while great care must be taken with the bittering hops. Read ***Zymurgy*** Special Issue 1990 (Vol. 13, No. 4) and *Using Hops* by Mark Garetz (Hop Tech, 1994) for detailed information on hop selection and calculations, and for a definition of the magic conversion factor needed to make the units used in the equation balance properly.

The California lager yeast strain is a good choice for fermentation, but any lager strain will suffice. Ferment at low ale temperatures to limit production of esters, then lager cold. While this example recipe has been kept simple, there's no reason to hold back on creativity when you design your own. One advantage of a complicated recipe with lots of different malts and hop varieties is the resulting complexity in the flavors imparted to the finished beer. It makes for fun and interesting consumption.

"I have a Zen approach to recipe formulation. I plan a year's brewing in the summer around major competitions. I know for a year what I will be brewing. In that time period I read as much as I can about the style. I used to copy and modify recipes as part of the learning process. Now I use original source material, learn the characteristics of the beer and sit down and write the recipe to match those characteristics. I may go back to the recipe after a few weeks and tinker with it and make minor adjustments as I go along. I get to the point where I can taste the beer in my mind. In September, October and November I brew my bocks, old ales, specialty and spice beers. I keep meticulous records of what I do and I track when my beers will be peaking. I try to gear my beers to peak during AHA National Competition. Probably one-third to one-half of my beers are sent to competitions. I make modifications and improve recipes based on judge comments from competitions. The most important aspect of recipe formulation is thoroughly understanding the **style** and letting it sink into your brain."

Ross Hastings, a brewer for seven years, has won 24 awards in the last year including a silver and two bronze medals in the AHA 1995 National Competition.

Converting Recipes

As you work on designing your own homebrew recipes, you may want to know how to convert some all-grain recipes to extract or your favorite extract recipes to all-grain. Here are some guidelines to help.

If you want to use dried extract in a recipe that calls for syrup, you can convert pounds of syrup (S) to dried (D) using the following formula:

$$S \times 0.85 = D$$

and it follows that to convert from dried to syrup:

$$\frac{D}{0.85} = S$$

If you would like to try an extract version of an all-grain recipe, what you need to know is that the amount of extract (E) is 75 to 80 percent of the amount of grain (G) needed.

$$G \times 0.80 = E$$

As far as what extracts to substitute for grains, this is easy. Generally there are two classes of grains used by brewers, base grains and specialty grains. The different kinds of base grains include two-row, six-row, light malt, pale malt and Klages malt. You can substitute light malt extract for any of these in the amounts you determine using the above formula.

Specialty grains are basically everything else — you may run across references to Munich, dextrin, chocolate, crystal, black patent malts and roasted barley. Most specialty malts can be added in the same manner and quantities for both all-grain and extract brewing, by steeping them. There are two exceptions — Munich malt and dextrin malt cannot be used in extract brewing because they must be mashed. You can, however, approximate the effect of Munich malt by substituting an equal amount of crystal malt. Dextrin malt can be replaced by adding additional light malt to your recipe.

If you are brewing a dark or amber style beer, you can choose to forego the specialty grains and substitute dark or amber extract for all the grains in the recipe. However, if you use light pale malt extract as your base and steep specialty grains such as crystal or chocolate malts, you will have more control over your end result. Check for the availability of specialty malt extracts that enable you to include specialty grains in your extract brew without steeping whole grains.

There is a wide variety of extracts on the market today, so it will take some experimenting to determine which are your favorite brands and how they work in your conversion recipes. Keep good records, and enjoy the process as much as the result.

Excerpts from "Malts: The Great Debate" by Monica Favre and Tracy Loysen, Zymurgy Summer 1990 (Vol. 13, No. 2).

"I tend to do a lot of experimentation. If I am looking to see what a new type of hop will do to a beer I quickly formulate a standard recipe and change only the hops. If I am making a more exotic beer it is more complicated. It takes time for me to decide what beer I will brew. Once I've picked a beer, it's a matter of five to 10 minutes to put the recipe to paper. The most important aspect of recipe formulation is the major **characteristics** for the style you are brewing. My recipe formulation is a compilation of experience synthesized over time. I have a spreadsheet on the computer that allows me to make calculations based on style. Aspects such as bittering units, water treatment, yield from malt and gravity are all included. It just takes a few minutes to come up with the final recipe."

Terry Foster is the author of the *Pale Ale* and *Porter* (Brewers Publications, 1990 and 1992). He has been homebrewing for 35 years.

Taste Testing

Your creation is finally brewed and packaged. In the fifth step evaluate the results. Just how close did that homebrew come to the target? It's very instructive and enjoyable to try to match a commercial beer and then compare your creation to the commercial example. It's a tough job, but it helps to do this several times over the shelf life of your beer, because homebrew changes significantly with age. Of course, you have to save some for these evaluations. For this recipe compare your brew to Anchor Steam®. Compare aromas: hops, malt, yeasty or fruity smells. If hop aroma is deficient in yours, you know to boost the late hopping next time. Compare color and adjust your crystal or roasted malts accordingly. Compare flavor, especially malty or caramel characteristics, hop bitterness, flavor and body. On the first try it's unlikely that your homebrew will be a ringer for the target beer, but you certainly can get closer on subsequent efforts. One of the most satisfying experiences I've had in homebrewing is zeroing in on a target beer then realizing that, while it wasn't quite a bull's-eye, I actually preferred my homebrew to the target micro or import beer. At that point it's time to stop the comparisons and enjoy!

It's hard to be completely objective about one's specially crafted work, so I recommend sharing the evaluation with friends, especially knowledgeable homebrew club members. They'll provide you with even more suggestions for the next batch. You'll also get feedback on how your beer stacks up to a style when you enter homebrew competitions. Believe me, those judges can be nitpicky when it comes to style, but their evaluations are based on a lot of study and experience.

The Next Brew

The final step is planning your next brew. Whether you try to perfect the same style again or try something completely different, apply what you learned from the previous batch. Many authors recommend the scientific approach of changing only one variable at a time and learning its effect. It works, but it's boring. I prefer the more pragmatic engineering approach, also called the shotgun method. I take everything I learned from the previous evaluation and change as many variables as I think might help, then go for it. With this approach I can "home in" on a target very quickly. Who has time for 20 trials just to nail one bull's-eye? There is too much beer out there to be brewed. To apply this shotgun technique, I recommend reading as much brewing literature as possible to understand the projected effects of each variable. Learn from other brewers' experience and knowledge. Don't forget to account for major changes in your brewing procedures, because homebrewers are constantly striving to perfect their equipment and techniques.

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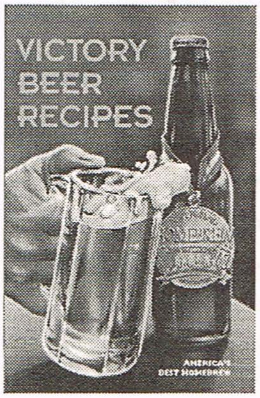

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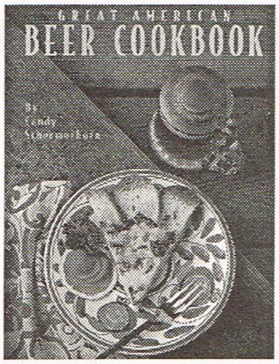

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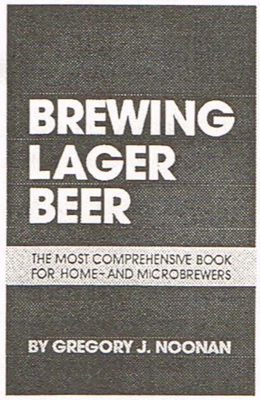

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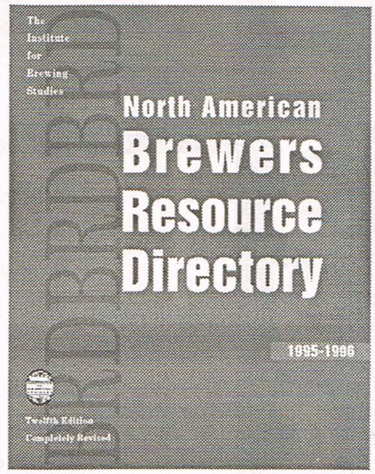

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GEAR AND SYSTEMS

All-Grain on a

By Mark Moylan

The reasons I told folks I waited so long to begin all-grain brewing sounded honest enough. What if I made the investment and added the extra time to my brewing sessions and wasn't happy with the results? What if I jammed all that new gear into my storeroom and didn't make better beer? And what if all-grain brewing turned out to be a personal fiasco and each sip stung my already delicate ego?

So many what ifs. But I was fibbing. The real reason I held off was because I was broke. I had started a new career and at the same time my wife had decided not to go back to work after the birth of our baby boy, Brendan. Though money was tight, I was still spoiling for an all-grain brewing session. Lack of funds never stopped me from having fun in the homebrew arena before and I sure wasn't going to let it stop me now. I was a homebrewer, dammit, and homebrewers are a resourceful bunch. If I made the decision to go all-grain, ready cash or no ready cash, it would happen.

I made the decision to make it happen and I'm glad I'm did. My all-grain setup is low cost, reliable and beautifully Rube Goldbergesque. Every piece has been searched out, haggled over, cobbled, cursed and cajoled. I just bottled my 11th all-grain batch and the beer is very good. And I went all-grain for about a hundred bucks.

The biggest investment is a brewpot large enough to hold more than 5 1/2 or six gallons (20.8 or 22.7 L) of boiling wort. Shiny stainless-steel pots are expensive so I opted for a 33-quart (30.3-L) canning kettle I saw in a ***Zymurgy*** ad from a homebrew shop for $29. The metal could be heavier and it probably will wear out, but it fit my tight budget. Plus, it matches my old 4 1/2 gallon brewpot that became my mash tun for stove top step infusions, and I was always taught that economy should never be at the cost of fashion. Vanity, thy name is homebrewer.

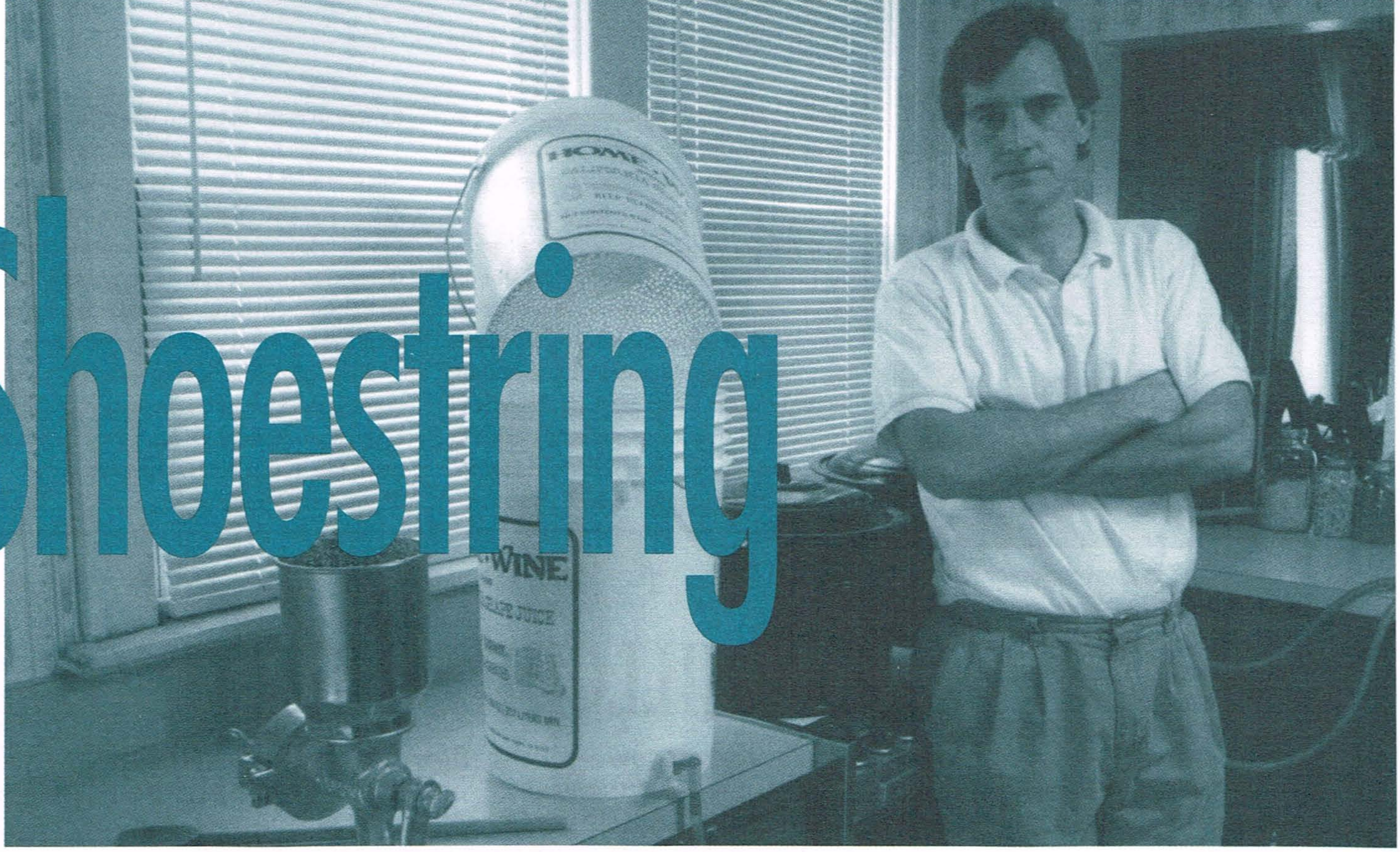
A mill to crush grain is the next biggest expense. It can be avoided altogether if you order your grain precrushed through the mail or crush it when you buy it at your local homebrew supply store. I bought a Corona grain mill through a catalog from a homebrew shop in the Midwest to keep shipping costs low on such a heavy piece of equipment. I paid $35 less UPS charges. I have since seen this mill listed for as little as $26 and as much as $42.

I went with the Corona because I wanted to grind my grain fresh for each batch and buying 50-pound bags is very cost effective. You can figure about 1 1/2 pounds of grain equals one pound of malt extract. U.S. two-

TOP 10 Ways To Keep Costs Down

1. **Don't be in a hurry. Good bargains, like good homebrew, cannot be rushed.**
2. **Use two pots to boil wort. You don't have to buy a big one. Just be sure to divide the hops correctly between the two pots, and watch carefully to avoid boilovers.**
3. **Borrow everything. This is good for a few batches, but don't forget to return stuff.**
4. **A nylon grain bag available from most homebrew shops turns one plastic pail — your bottling bucket? — into a lauter tun.**

Shoestring



Mark Moylan's all-grain setup is reliable and cost about $100.

row is about 50 to 60 cents a pound, so I'm paying about 90 cents per pound versus $3 for a basic ingredient. Homebrewers have been using these weighty iron Coronas for at least a decade and they produce a pretty good grist if tended to properly. How well does it work for me? A lot better than "fair to middling," as the old miller's phrase goes.

Before I started buying stuff I had put together a lauter tun for partial mash recipes. The lauter tun lets me rinse the converted sugars from the mashed grains and these runnings become the wort. The design is pure Papazian: two six-gallon plastic buckets, a plastic spigot and three feet of tubing. My neighbor makes wine and tossed out three plastic buckets his grape juice came in. One is my bottling bucket and the other two became a very workable lauter tun. (Most restaurants have five-gallon plastic buckets for the asking or for a shared bottle of homebrew. Avoid pickle buckets because they will always smell of pickles.)

Inspired by the Zapap lauter tun system described by Charlie Papazian in *The New Complete Joy of Home Brewing* (Avon, 1991), I drilled a ton of holes (about one-eighth inch in diameter) in the bottom of one and attached a plastic spigot I bought at the local homebrew shop to the other. The two buckets fit together in a beautiful industrial-strength straining outfit that holds up to 15 pounds of grain. Luckily, this intricate piece of all-grain brewing equipment is the easiest one to put together. Elegant it is not, but boy, it works.

I got the pot, ground the grain, mashed, sparged and boiled, now who's going to help me chill the wort? A major hardware chain to the rescue. Fifty-feet of three-eighths-inch copper tubing, hose clamps and a threaded faucet connection ran me about $30. For the hoses I lucked out. My cousin, Bill Moylan, worked in Saudi Arabia for a few years and brought home all this good rubber tubing used when brewing beer to quench his thirst in the hot desert sun. Cost of the tubing was a few bottles of homebrew rather than about 50 cents a foot. Funny thing, his brother, Jim Moylan, got me started homebrewing. He sent me a bottle capper, hydrometer, tubing — what is it with my cousins and tubing? — Irish moss and other sundries. Coming from a big family I guess I'm just used to hand-me-downs.

Other bargains added to my setup include a dial thermometer for $5 from a surplus store

5 Two-liter pop bottles filled with water and frozen are a cheap wort chiller. Professor Surfeit liked this idea from a *Zymurgy* reader, but stressed the need to sanitize the pop bottles.

6 Use an aluminum pot. Aluminum pots are the least expensive and aluminum's effect on beer flavor is still being debated in homebrew circles.

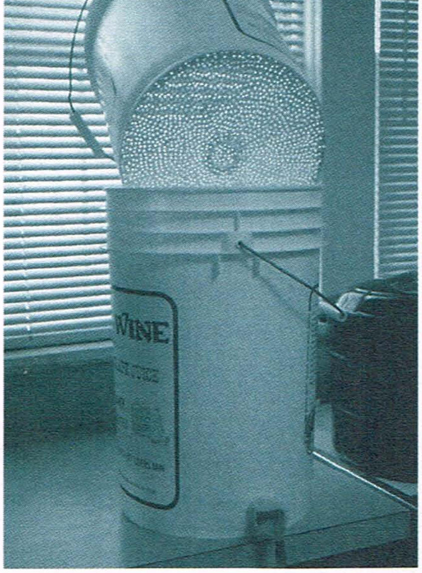
7 Watch the classified ads for used restaurant supplies. Big stainless-steel pots are the first to go, so count on a little luck to get what you need.

8 Double up with a brewing buddy. This is half the cost and very little hassle if you get some basic rules on paper to avoid any misunderstandings.

9 Tell your spouse what you want for Christmas or an anniversary and leave the ad for the *exact* equipment on the kitchen counter. Trust me on this one.

10 Steal everything. (Plan on having a captive audience for your homebrew and try to make a beer the warden likes.)

PHOTOS BY DOUG CANNELL



To make a Zapap-style lauter tun you need two buckets, one with a lot of holes drilled in the bottom and another with a plastic spigot.

in Chicago, tincture of iodine from the local drugstore to test starch conversion (less than $1) and a full-length white apron for which I traded a few homebrews from a friend who runs a restaurant.

The items I have not listed are the homebrewing books I have bought as I continue to brew. The information is invaluable. I am confident enough in my brewing skills to have two or three different books in the kitchen while I brew. Any time I get hit with self-doubt or excessive worry about how the beer is going to turn out I flip open one of the books and it calms me down.

Each author is like a good friend who calls out through the print in either a church whisper or a megaphone shout, "Keep going, you're doing fine," while I'm puttering away over the mash fretting about temperatures or waiting for the wort to cool down and think I see uninvited bacteria going for my pot. Every homebrewing author has added something good to my homebrew.

Charlie Papazian is like a favorite coach coaxing the best out of any brewing effort. Dave Miller is an excellent instructor, though he describes extraction rates that only seem possible for homebrewers from the planet Krypton. Still, he's set a goal to shoot for and his recipes are delicious. Byron Burch always gives very sound advice. Greg Noonan makes an iodine test a study in color variation that rivals the nuances of the differences between D sharp and E flat on the musical scale. And my ***Zymurgy*** collection makes the brewing process fun because it's chock full of helpful tidbits I use to tweak my own recipes. It's this information that helps me operate my inexpensive all-grain gear to limits I could never have imagined.

If you are thinking about going all-grain, but have been holding off because of the investment, hold off no more. Buy the best equipment you can afford, but if you're itching to brew all-grain beer and are short on funds there is a way to get there. Search out the bargains. Improvise and adapt items to get you where you want to go. Put that Mensa membership to good use and invent a better way to make beer with what's on hand.

You'll get the feel for all-grain brewing the best way of all, by doing it. As you continue and decide you love all-grain brewing — yes, you will fall in love with the process and the beer — then you can replace your jury-rigged setup with fancier stuff. Or maybe you'll like your homemade gear so much you'll never part with it.

Myself, I'm waiting to replace it as I wear out my present equipment and will get new things piece by piece. Of course, it will have to be on sale. Force of habit I suppose.

Mash Systems & Components

Mash Tuns

The heart of any mashing system is the mash tun. The mash tun is where the grain and water are mixed together and held at the proper mashing temperatures. You can mash and lauter in the same vessel if it has a method of straining and draining and liquid, or you can transfer the mash to a separate lauter tun. Mash temperature can be maintained on the stove top, in an oven or in an insulated box. Mashing in a brew kettle can make temperature control simple (my first few batches were done this way), but adds the extra step of transferring hot mash to a lauter tun for sparging (unless the kettle is fitted with a spigot and straining device), not to mention the potential for extra mess.

Let no one fool you, all-grain brewing is more work than extract brewing. You may choose to approach mashing with just a few extra pieces of equipment, or you could put together a system of parts designed to work together to make mashing simple and controllable. If this sounds intimidating to those of you who haven't mashed yet, don't worry. The rewards far outweigh the extra work, and a little thought (and possibly a few fun gadgets) can take much of the effort out of the mashing process.

Before we get to specifics, let's review the mashing process. First a measured amount of strike water (water heated to a certain temperature) and grains are mixed. The resulting mixture of grain and water is called the mash and must be held at one or more temperatures until starch conversion is complete. There are a variety of ways to heat the mash and maintain temperature, depending on the mashing technique (infusion, decoction) you plan to use. Once conversion is accomplished it is time to drain the liquid called sweet wort from the grains. This process is repeated until the wort runs clear. Heated water (called sparge water) is then sprinkled evenly over the grain bed and the wort is drained until the established quantity is collected. That's it. The whole mash. Sounds easy, doesn't it? It is! The right equipment can make it even easier.

The type of system you put together will depend on your needs. The size of your system will depend on what batch size you want to brew, the space you have to brew and store the gear and how much money you want to put into it. The types of materials you use will affect durability, cost and ease of use. In general, plastic is the easiest to work with and the least expensive material, but tends to be more difficult to clean and will not last as long as stainless steel, the most expensive material. The material your system is constructed of will also affect how you heat your mash and maintain temperatures. Other factors to consider are the weight of the equipment and how easily you can store it. Let's look at some different mashing setups and how they work.

Mash/Lauter Tuns

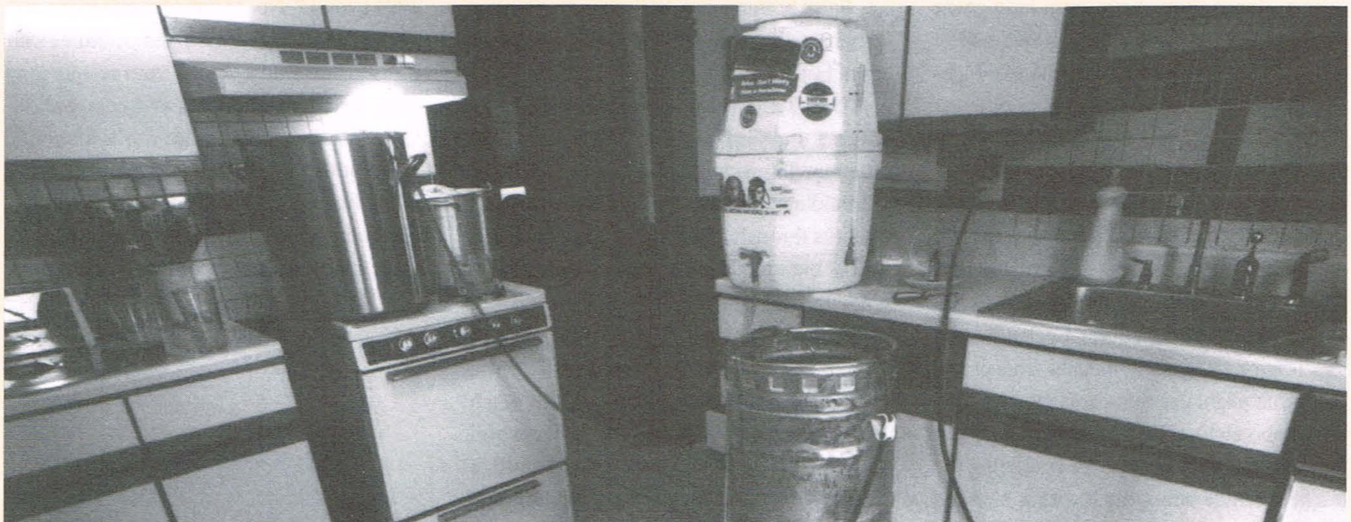
Mash/lauter combination setups are easier to use, require less cleaning (always a good thing) and less storage space. There are several options if you want to purchase a mash/lauter tun setup, and plenty of easy models to build. The required component of these mash/lauter tuns is either a false bottom or some other straining/draining device.

A false bottom is exactly what it sounds like: a device that rests at or near the bottom of the tun that allows the wort to be separated from the grain prior to draining. They can be made of perforated stainless steel, By John Roberts

My Setup

After almost two years of mashing five-gallon batches in my double-bucket system, I decided to go to a 10-gallon (30-L) batch size. I was determined to make my new system as ergonomic as possible. Lifting large amounts of hot liquids isn't fun, and can be dangerous. So I put together this system after some research and trial and error. My mash tun is a 15 1/2-gallon (58.7-L) stainless-steel keg. I cut the top off with a reciprocal saw. If you try to do this yourself, make sure you wear hearing protection. It didn't occur to me until blade met steel that a keg is basically a bell with a top on it. I use a modified Easymasher™ for a drain system. Because of the curve of the bottom of the keg, the copper dip tube didn't reach the bottom. I cut another piece of three-eighths-inch copper tubing a little longer than the one that came with the unit. Then I gently bent it to about the same curve as the original piece and pushed a compression fitting onto it. The screen tube now sits flat on the bottom of the keg. A small piece of three-eighths-inch plastic tubing slid inside a one-half-inch plastic tube connects the drain spigot with a Little Giant model 3-MDX pump. The pump speed is controlled with a Dalton model 4X796D Motor Speed Controller. The pump cost about $80 and the controller about $15 through Grainger. A one-kilowatt electric heating element mounted inside a piece of 1 1/2-inch copper tubing heats the wort as it is pumped through. The element (also from Grainger) is a Vulcan Electric model WTP-906 with a built-in thermostat and indicator light. Wort is returned to the mash tun in one-half-inch plastic tubing held in place with a clamp. The returning wort pours onto a cutoff slotted paddle that rests on top of a copper sparge ring. The sparge ring is three-eighths-inch soft copper tubing bent into shape and drilled with one-eighth-inch holes on the top side. My old insulated double-bucket mash tun acts as my hot liquor back. It will hold more then five gallons (19 L) of sparge water at 168 degrees F (76 degrees C) for hours.

I begin by heating strike water in the brew kettle. Once I reach the desired temperature, I pour the water into the mash tun and mix in the grains. When I'm ready to boost the temperature, I prime the pump by opening the spigot on the Easymasher. The pump is then turned on and the wort begins to recirculate. The heater is switched on after a minute or two. The temperature rises about one degree per minute in a 10-gallon (38-L) batch (about 22 pounds of grain), faster with smaller grain beds, slower with larger ones. A one-gallon (3.8-L) infusion of boiling water can help speed the process. I mash-out at 168 degrees F (76 degrees C). A piece of three-eighths-inch plastic tubing is slid inside the one-half-inch return line to divert the wort to the brew kettle. Sparge water is added to the grain bed at about the same rate as the wort flows into the kettle. When the proper amount of sweet wort is collected, the spigot is closed and the pump shut off. The recirculating system is cleaned by connecting a hose to the return line and back flushing it with hot water. An iodophor solution is then run through and allowed to dry. I'm quite happy with this system. It's easy to use and to clean and stores neatly in my brew closet.



John's setup, including a stainless-steel keg that works as a mash tun with a modified Easymasher, a Little Giant pump and various other elements, all fits neatly into his brew closet when not in use.

PHOTO BY BARRY SILVERMAN

stainless screen or plastic. There are many false-bottom designs on the market today.

Probably the most common mash/lauter tun unit used by homebrewers is the double bucket, or "Zapap," as Charlie Papazian calls it. It consists of a plastic bucket with hundreds of one-sixteenth-inch holes drilled in the bottom which is inserted into another bucket with a spigot installed one inch from the bottom. The buckets should be the same size (both five gallons or 19 L) and made of food-grade plastic. The inside bucket with all the holes forms the false bottom, holding the grains above the "real" bottom allowing the wort to flow out the spigot or outlet. One advantage of this type of mash tun is that it can be built from parts most brewers already own. A bottling bucket works great as the outside bucket (the bottling spigot should be changed to a drum tap spigot) and a plastic fermenter can be modified and used as the inside bucket. The whole setup can be built new for less than $20.

If you plan to do partial mashes, 3 1/2-gallon (13.25-L) buckets will work. Most bakeries or donut shops have extra food-grade buckets. For mashing a typical five-gallon batch, five-gallon buckets are fine. For higher gravity five-gallon (19-L) batches or lower gravity (OG 1.042 to 1.044 or lower) 10-gallon (37.85-L) batches, seven-gallon (26.5-L) buckets are recommended.

Insulating the double bucket system is an option. Seven-gallon (26.5-L) carboys that once held nitric acid come in Styrofoam® containers that make functional bucket insulators. (Check with your homebrew store or any place that might use nitric acid.) By the way, the jumbo eight-gallon carboys make great fermenters. Other options for insulating the bucket include wrapping it with a blanket, foam mat or taping on strips of Styrofoam.

Modifying a picnic cooler by adding a "slotted pipe" is another way to build a mash/lauter tun. The shape of the cooler isn't as important as its volume. A 20-quart (19-L) cooler will accommodate most low-to medium-gravity five-gallon (18.93-L) batches, but higher gravity brews like barley wines will require a 32- or 40-quart (30- or 38-L) cooler. Find a cooler that can accommodate hot or cold liquids. Copper or stainless-steel tubing are the best choices, but food-grade PVC pipe is another option. Slit the tubing about one-third of the way through every one-half inch or so with a hacksaw. Assemble the tubing so it lies in three parallel rows, slits facing downward, along the length of the cooler. You can design your own configuration, but just cap the dead ends and connect the opposite ends to direct the flow out of the cooler. If you have chosen your cooler wisely, you can direct the tubing through the cooler's drain plug. A valve to regulate the run off is a good option to add. Two sample picnic-cooler lauter tuns are illustrated on page 62. There are numerous plans available for such cooler designs including one in ***Zymurgy*** 1992 Gadgets and Equipment Special Issue (Vol. 15, No. 4).

Another popular mash/lauter tun employs a sparge bag. This setup consists of a large, mesh grain bag suspended in a bucket or insulated cooler with a spigot at the bottom. A vegetable steamer (the expandable metal type) can be used to support the bag. This setup is simple to build and, when made with an insulated cooler, is well-suited for infusion mashing.

False bottoms can be built from plans or purchased. It's not too difficult to build your own, but some designs require special tools.

The alternative to a false bottom is some kind of draining/straining component. One commercial example, the Easymasher™ by Schmidling Productions, consists of a spigot that fits through a hole in the side of a mash tun or brew kettle and a copper dip tube that ends in a tube of stainless-steel screen that is crimped at the end. The dip tube attaches to the spigot with a compression fitting. The extraction rate achieved compares to much more expensive false-bottom systems and converting a brew kettle or keg into a mash/lauter tun is as easy as drilling a three-eighths-inch hole near the bottom and screwing the spigot in.

Heat Sources

So now you have your mash tun or mash/lauter tun, but how do you heat it? Again you have options. If you're using a brew kettle as a mash tun you can set it on the stove. Modified kegs and kettles larger than about five gallons may require a heat source larger than a kitchen stove. A propane-fired burner that stands by itself is a good choice. These usually are available at sporting goods stores. These burners put out a lot of heat and fumes, so they must be used outside or under an exhaust hood. Direct flame will require a good deal of gentle stirring during heating to prevent the grain from scorching. Stirring also helps distribute the heat through the grain bed.

If you're using a plastic mash tun you'll have to use something else. Water infusion works well, but takes some experimenting to get exact temperature increases. Using this method, boiling water is stirred into the mash to raise the temperature. Start the mash thick if you're doing multiple temperature rests, otherwise your mash tun may overflow. About 1 1/2 gallons (5.68 L) of boiling water added to a 10-pound (4.54 kg) mash will bring the temperature up about 20 degrees. For a complete chart on infusion amounts in different size mashes, see *The New Complete Joy of Home Brewing* (Avon, 1991). The article "Heat Capacity Calculations for Mashing" by Kurt Froning in ***Zymurgy*** Spring 1994 (Vol. 17, No. 1) provides equations and guidelines for raising mash temperatures with infusions of water. Again, your results may vary, so keep good notes and compare different mashes to find what works for you.

Another method of heating a mash is the inline heater. This is used in the RIMS (recirculating infusion mash system) and works quite nicely. A hot water heater element is mounted onto a piece of 1 1/4-inch copper tubing with fittings to allow the sweet wort

HOMEBREW HARDWARE STORE

Many companies sell mash systems and components. Call for complete product catalogs and current price lists. Here is a short list of companies and some available mash system-related products. Prices are approximate.

COMPANY	MASH PRODUCTS	PRICE RANGE
AMERICAN SCIENCE & SURPLUS 3605 Howard Skokie, IL 60076 (708) 982-0870	always changing: stainless-steel pumps, thermometers, misc. doohickies	Call
THE BEVERAGE PEOPLE 840 Piner Road, #14 Santa Rosa, CA 95403 (800) 544-1867	10-, 15-, and 20-gal. systems custom vessel/system fabrication mash screens, wort chillers temperature probes, sight glasses	$426 (full-mash kettle) $1461 (3-kettle system) $60 (mash screen) $45 (blank SS screen 17″ x 18″)
BREWCO PO Box 1063 Boone, NC 28607 (704) 297-7837	10-gal., three-tier gravity system (Includes three modified stainless-steel kegs with spigots and mash screens, sparge nozzle, three-level stand with built-in burners.)	$850 (full system)
BREWCRAFT LTD. PO Box 112205 Carrollton, TX 75011 (214) 446-3406	7-gal. HDPE bucket with 2,750 watt, 12.5 Amp., 2201 240 volt element	$60
BREWERS WAREHOUSE 4520 Union Bay Pl. N.E. Seattle, WA 98105 (206) 527-5047	RIMS power, temperature and speed controllers; RIMS inline heaters; temperature probes	$99.95 – $149.95 (controllers) $79.95 (heaters) $9.95 (probes)
GRAINGER 5959 W. Howard St. Chicago, IL 60648 (800) 323-0620 (Check Yellow Pages for local office)	variety of pumps, temperature probes, motors, speed controllers, immersion heaters, etc.	Call
JACK SCHMIDLING PRODUCTIONS 18016 Church Rd. Marengo, IL 60152 (815) 923-0031	Easymasher™, Easysparger™	Wholesale Approximate retail prices $25-30
LISTERMANN MFG. CO. 1776 Mentor Ave. Norwood, OH 45212 (513) 731-1130	5-gal. plastic mash systems plastic false bottoms, rotating sparge arms	Wholesale Approximate retail prices $35 (mash system) $15 (individual parts)
McMASTER CARR PO Box 4355 Chicago, IL 60600 (708) 834-9600	hose, tubing, valve, nut, bolt, perforated steel, stainless-steel screen, etc.	Call
PICO-BREWING SYSTEMS INC. 8383 Geddes Rd. Ypsilanti, MI 48198-9404 (313) 482-8565	55-gal. steam-fired system, 15.5-gal. system, 5-gal. stove-top system, 15.5-gal. mash kettles, pumps mash screens sparge heads, mixing paddle	Call
SABCO 4511 South Ave. Toledo, OH 43615 (419) 531-5347	Modified 15.5-gal. kegs (mash/brew kettles), mash screens, valves, well thermometers, etc. Full mashings systems (Brew Magic) Custom modifications available	Call $289.95 (full-mash kettle) to $2,995.95 (Brew Magic)
STOELTING 502 Highway 67 Kiel, WA 53042 (800) 336-BREW	stainless-steel brew kettles and mash screens for 7-, 10-, 16- and 20-gal. sizes, gas and electric burners, etc.	Call

to run through it. A pump recirculates the wort from the tun through the heater then back on top of the grain. A thermostat regulates the temperature, or the heater can be turned off manually when the desired temperature is reached. More about RIMS later.

Sparge Gear

Now you've completed the starch conversion, it's time to sparge! Sparging should be done as gently and evenly as possible to prevent disturbing the grain bed. Sparge water can be simply poured over the grain by hand. I recommend using some type of diverter on top of the grain to help achieve even distribution of sparge water and clear runoff. Even distribution of sparge water means sugars will be rinsed from all the grain, not just one area of the mash. A large spoon can be rested on top of the grain as a diverter. Another option is a plastic bucket smaller in diameter than the mash tun with one-sixteenth inch holes drilled in the bottom to divert the sparge water. Drill two holes exactly opposite each other near the top of the smaller bucket and push a dowel long enough to span the top of the mash tun through to suspend the smaller bucket just above the grain bed. Keep between one and two inches of sparge water above the level of the grain bed to avoid compacting it.

Other sparging options are sparge arms and rings. These require the use of a hot liquor tank (the term liquor refers to brewing water, not alcohol). A hot liquor tank is just a container that holds heated sparge water. Sparge water flows from the hot liquor tank into the sparge arm, which sprays water over the grain bed. A ring of copper or plastic with one-eighth-inch holes drilled along the top edge can be suspended above the grain or even rested on top. Again, water flows from the hot liquor tank through the ring and is sprayed on the grain. A bottling bucket can be used as a hot liquor tank. I recommend insulating it to keep the sparge water at a constant temperature. Insulating also allows the hot liquor back to be filled in advance, which makes coordinating the mash easier. An extra brew kettle fitted with a spigot can be used as a hot liquor tank. Simply maintain sparge water temperature on the stove top or burner.

Pumps

One more advanced piece of mash gear that is certainly not essential but can make brewing easier is a food-grade pump. Recirculating infusion mash systems use small food-grade pumps to recirculate the wort through an inline heater and back onto the grain bed. Recirculating helps clarify the sweet wort and accelerates the conversion process. It also can cause hot-side aeration and excessive grain taste in the finished beer if not done carefully. Speed control is vital. The pump should have a magnetic-drive, heat-resistant pump head. It should pump at least four gallons (15 L) per minute at a one-foot head pressure and the speed should be controllable.

Summary

Building a mashing system can be fun and challenging. Building it yourself allows the flexibility of customizing the system to your specific needs. If you are an extract brewer not quite sure if grain brewing is for you, a simple mash tun can be assembled from parts on hand at very little cost. Building equipment is not for everybody. There are many great systems on the market costing from $30 to $2,500 (see Homebrew Hardware Store on page 95). However you decide to put your mash system together, keep in mind your needs: balance durability, flexibility and efficiency with cost and ease of use (see ***Zymurgy*** Road Test: Lautering Systems, page 97). Above all, remember great beer can be made in just about any system, so relax, don't worry and have fun mashing.

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By Al Korzonas

Zymurgy Road Test: Lautering Systems

AHA RESEARCH DEPT

The AHA funded the following research project in which six lauter tuns were put to the test. Grain for the 30-gallon batch and miscellaneous plumbing supplies were paid for by the AHA. -Ed.

You've heard, "Mad dogs and Englishmen don't have the sense to come in out of the midday sun," haven't you? Well, either we have some English blood or you'll have to add homebrewers to that list. On one of the hottest days of the year, with the temperature hovering around 100 degrees F and relative humidity more than 90 percent, Steve Hamburg and I mashed 46 pounds (20.9 kg) of grain, split it between six different lauter tun systems and took 42 gallons (159 L) of runnings. To prove it could be done? To verify that we are crazy? No, to compare the relative efficiency of the various lauter tun designs.

The Mash

The mash was a typical bitter recipe for 30 gallons (113.6 L) of beer:

36 lb Munton & Fison pale ale malt (16.3 kg)
6 lb Munton & Fison mild ale malt (2.7 kg)
3 lb DeWolf-Cosyns CaraVienne malt (1.4 kg)
1 lb DeWolf-Cosyns CaraMunich malt (0.5 kg)

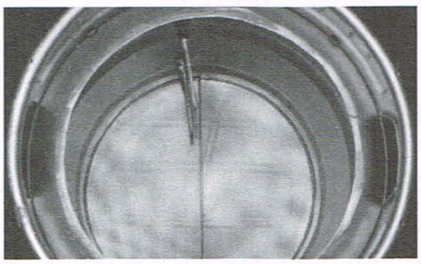
The grain was milled using a motorized Jack Schmidling Productions MaltMill™ and split evenly between two pico-Brewing Systems mash tuns. We mashed-in with eight gallons (30.3 L) of 170-degree-F (77-degree-C) strike water into each of the tuns. The initial temperature was 154 degrees F (68 degrees C). After a two-hour mash, with several direct heat additions, the mash was heated to mash-out at 168 degrees F (76 degrees C).

Steve Hamburg checks the level of the sparge water which is being distributed to the six lauter tuns.

PHOTOS BY AL KORZONAS

slotted pipe in picnic cooler

Phil's Phalse Bottom™ in picnic cooler



pico-Brewing Systems perforated copper false system

Lauter Tuns

We used six different lauter tuns designs: slotted copper pipe in a rectangular picnic cooler, Phil's Phalse Bottom™, pico-Brewing Systems™ perforated copper false bottom, Zapap, JSP Easymasher™ and a mesh bag in a plastic bucket with a drum tap. Since the transfer of the mash into the lauter tuns would be slower than normal (six times slower), we insulated the Zapap, Easymasher and mesh bag systems with foil-backed bubblepack insulation.

The slotted pipe system was made from one-half-inch outside diameter rigid copper pipe, the downward-facing slits were cut with a hacksaw about one inch apart. The cooler was a 55-quart (52-L) Thermos™ brand with a hollow (uninsulated) lid.

The 12-inch Phil's Phalse Bottom was mounted in a 10-gallon (38-L) Gott™ cooler which also had a hollow (uninsulated) lid. The tubing from the false bottom was attached to a brass garden-hose valve which was mounted in place of the normal cooler spigot.

The pico-Brewing Systems tun was fabricated from a 15.5-gallon (58.7-L), straight-sided stainless-steel keg and had a snug-fitting, two-piece, copper false bottom into which perhaps 200 one-half-inch long slots were cut. Below the false bottom, the tun holds approximately 1 1/2 gallons (5.7 L) of liquid. In all fairness, this system is designed for much larger, 10- to 15-gallon (37.9- to 56.8-L) batches so this large underlet is not very practical for five-gallon (18.9-L) batches. Also, it is meant to be used with pumps so recirculation can be automated.

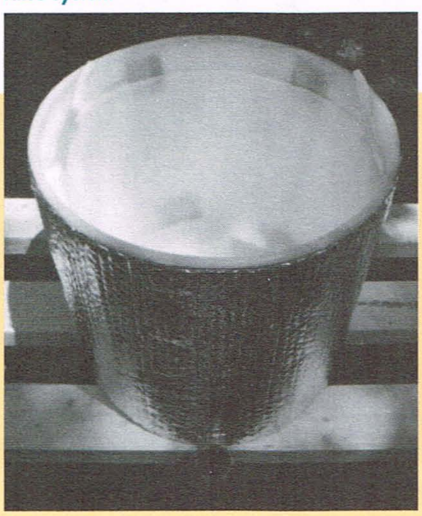
The Zapap was made from two 7 1/2-gallon (28.4-L) plastic fermenter buckets (with molded handles). The inside bucket had perhaps 500 one-sixteenth-inch holes. A drum tap was mounted in the outside bucket and the whole tun was insulated with foil-backed bubblepack insulation.

The Easymasher was purchased assembled with the stainless-steel, copper and brass screen assembly mounted in an eight-gallon (30-L) enamel kettle, which was insulated with foil-backed bubblepack insulation.

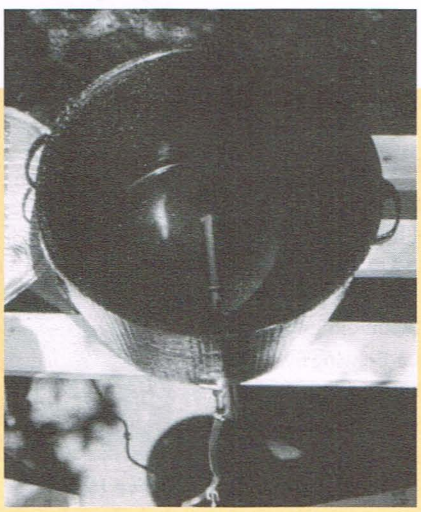
The "mesh bag in a plastic bucket with a drum tap" system had a plastic drum tap mounted in a hole at the bottom of the bucket. A "sparging" bag with a mesh bottom (only the bottom was mesh — the sides were finely woven, thick white canvas material) was dropped in and affixed to the bucket with a drawstring. The bucket was insulated with foil-backed bubblepack insulation.

Lautering

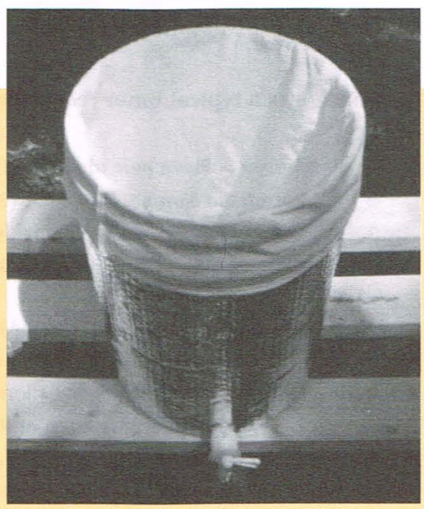
The mash from the two mash tuns was evenly distributed using saucepans (one level scoop into each tun, in a serial fash-



insulated Zapap double-bucket system



Easymasher™



grain bag in insulated bucket

PHOTO OF PHIL'S PHALSE BOTTOM™ BY DAN LISTERMANN ion). We did not underlet the tuns with sparge water as would be advisable under normal conditions. After all the grain was transferred, the liquid under the false bottoms was also evenly distributed to each of the tuns using a Pyrex™ measuring cup. Recirculation was done individually and the volume of wort recirculated to achieve clear runnings was measured. The tuns received sparge water from a six-way manifold which was connected to a pico-Brewing Systems kettle via an electric pump. The five-sixteenths-inch interior diameter hoses leading to each tun were of equal length and the valves on the manifold allowed the rate of the sparge to be adjusted so it was equal to each tun. The sparge water was 180 degrees F (82 degrees C), but this temperature varied slightly as water was added from other kettles which were used to generate the 38 gallons (143.8 L) of sparge water needed.

Results

The figures for recirculation represent the volume of runnings that had to be collected before the runnings were clear.

Figures for wort temperature represent the temperature of the final volume of collected wort and indicate how well the lauter tun retained heat.

Seven gallons (26.5 L) of runnings were taken simultaneously from the six tuns and the runoff and sparge rates were adjusted so that the sparge took about one hour. Only the grain bag system took longer. Even with the tap wide open, we couldn't get the runnings to drain any faster. After seven gallons of runnings were taken, the temperature and gravity of each wort was measured.

The "points per pound per gallon" is a measure of how many gravity points you get from a pound of grain in a gallon of wort. It is calculated using the following formula:

$$PPG = \frac{(SG - 1) \times 1000 \times \text{gallons of wort}}{\text{pounds of grain}}$$

ROAD TEST RESULTS

SYSTEM	RECIRCULATION	WORT TEMP.	POINTS PER POUND PER GALLON	NOTES
slotted pipe in cooler	40 oz	125°F (52°C)	31.98	This tun had the largest cross-sectional grain bed area, so it had the shallowest grain bed and largest surface area, which would explain the heat loss. The press-fit connections had a tendency to come apart before the mash was added, but held tight with the grain bed in place. Cutting or stirring the mash (which we did not do) might cause problems with the fittings.
Phil's Phalse Bottom	24 oz	130°F (54°C)	33.48	This system worked flawlessly and gave very good extraction. The only negative was the large diameter of the hose on the outside of the tun which may have aerated the wort a little bit — use a small inside-diameter hose for smoother flow.
pico-Brewing Systems	144+ oz	130°F (54°C)	32.31	This system is designed for much larger batches, but it performed admirably despite the relatively shallow grain bed. An additional benefit of the system is the ability to add heat directly (which we didn't do for this experiment) to perform temperature-controlled mashes and lauter without hot-water infusions and to lauter without the need to transfer the mash.
Zapap	32 oz	132°F (56°C)	31.07	This old standby worked as easily as the others. Wort ran clear remarkably quickly and the system gave decent extraction rates. One sour point was that the particular brand of drum tap used tended to suck some air into the runnings.
Easy-masher	12 oz	132°F (56°C)	32.18	This system ran clear with the least recirculation, An additional benefit of the system is the ability to add heat directly (which we didn't do for this experiment) to perform temperature-controlled mashes without hot water infusions and to lauter without the need to transfer the mash.
grain bag	104 oz	127°F (53°C)	30.16	This system gave us the most problems and it took two hours to collect the seven gallons (26.5 L) of runnings. Raising the bottom of the grain bag with a colander or vegetable steamer basket might help.

Summary

This is not real science. The measurement errors in the distribution of the grain and the errors in the measurement of the volume of runnings are enough to account for the 3.32 points between the highest and lowest extractions. However, this experiment does prove several things:

1. **All these systems can be used to get 30 plus points per pound per gallon,**
2. **Only the grain bag system ran slower than we wished, and**
3. **None of the systems showed any risk of a set mash (even the "grain bag" system ran smoothly and continuously, albeit slowly).**

I recommend insulating the mash tun even if you are not crazy enough to try this kind of experiment. I also believe the quality of the milling had a lot to do with the smoothness of the lautering. If you are getting only 20 points per pound per gallon, make sure you:

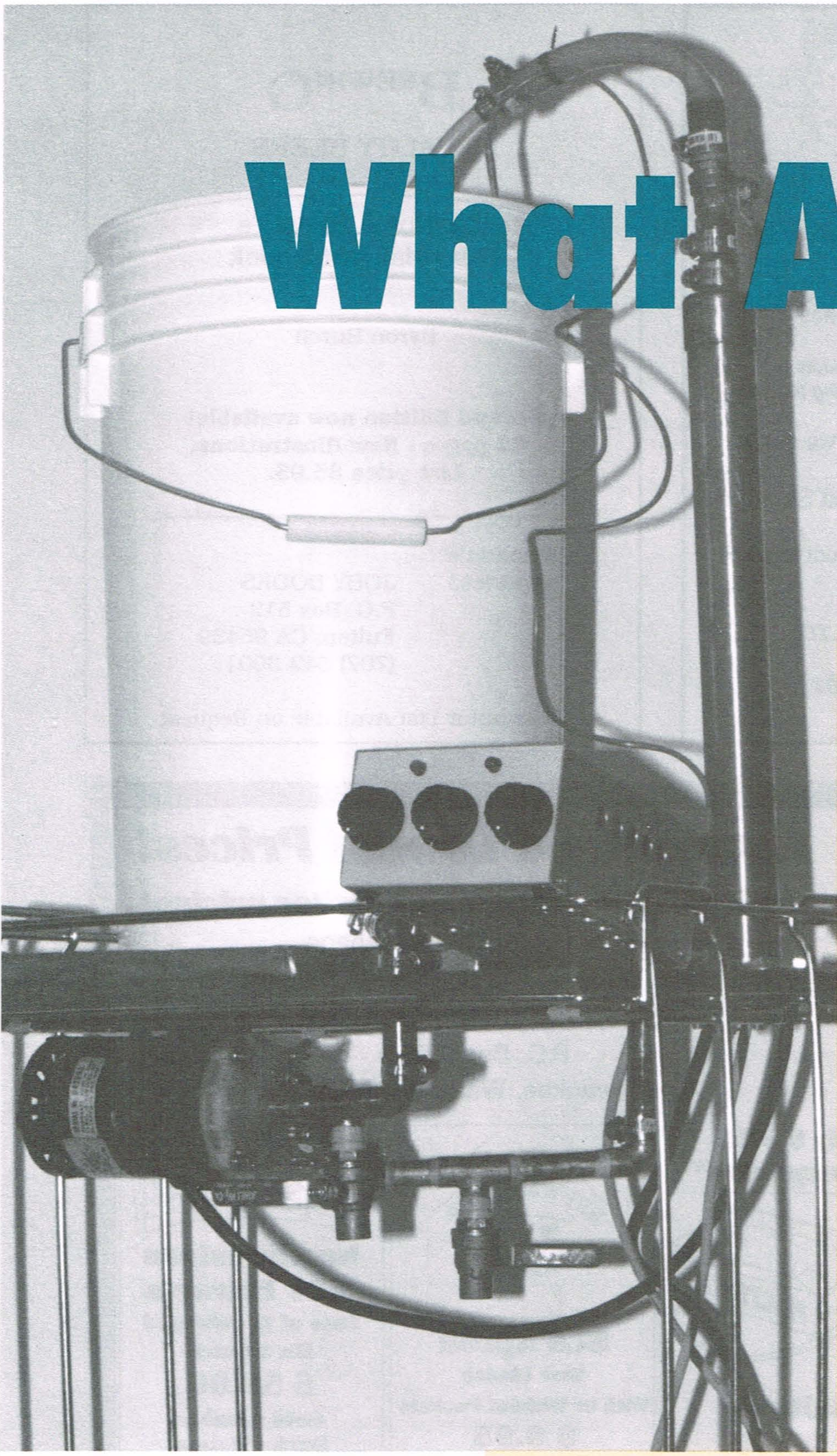
- **Don't forget to compensate the temperature when measuring the specific gravity,**
- **Are taking at least 6 1/2 gallons (24.6 L) of runnings for a five-gallon (18.9 L) batch,**
- **Make sure you don't overshoot your saccharification temperature,**
- **Use fresh malt,**
- **Don't rush — take at least 45 minutes to get seven gallons (26.5 L) of runnings,**
- **Crush the malt well, but try to keep the husks intact, and**
- **Adjust the pH of your mash so it is between 5.0 and 5.5.**

Don't blame your lauter tun for poor extraction — first look at other factors. If you are having problems with set mashes:

- **Look at your crushed grain — are the husks pulverized?**
- **What's the temperature of the grain bed? Try to keep it above 150 degrees F (66 degrees C)**
- **Make sure there is at least two feet of height difference between the bottom of the mash tun and the top of the wort in the collection vessel**
- **Don't let the grain bed run dry (which would compact the grain bed). Keep the level of sparge water at least two inches above the grain bed**

You can make great beer with any of these lauter tun designs. Choose the design that's right for you based on your budget and what kind of mashing methods you plan to use.

What About



A RIMS can be added to your current brewing equipment.

Homebrewers, by tradition, have promptly embraced new technologies whenever these innovations saved time, reduced cost or, more importantly, produced better beer. We homebrewers, through the relatively small scale of our brewing operations, possess a decided advantage over larger commercial brewers in adoption and implementation of new techniques. The recirculating infusion mash system (RIMS) developed by Rodney Morris and described in ***Zymurgy*** 1992 Special Issue (Vol. 15, No. 14) truly illustrates these points.

By Kerry S. Hauptli

GEAR AND SYSTEMS

RIMS

The RIMS Concept

Understanding the workings of RIMS best begins with a review of traditional mashing systems. The simplest form of mashing involves an infusion of water at a pre-calculated temperature to a mixture of grains. Brewers achieve a target temperature, usually around 152 degrees F (67 degrees C), at which appropriate diastatic enzymes dutifully convert much of the available starch to a menu of sugars, mostly fermentable. With infusion mashing the brewer relies on diffusion of chemical reactants within the mash and a means of maintaining the temperature of the grain bed. An insulated mash tun may obviate the need for the addition of heat, but temperature control requires a mix of skill and some luck.

Traditional infusion mashing can be expanded into a series of temperature steps in which a specific enzymatic activity takes place; for example, acidification of the wort, protein breakdown or saccharification at enzyme-specific temperatures. Temperature steps from one rest to another are achieved via the addition of hot water or the application of heat. Decoction mashing achieves these temperature steps by removing of a portion of the mash, boiling that portion and returning it to the mash tun.

As a general rule, both speed and yield of chemical reactions can be enhanced by mixing of the reactants. In the chemistry lab, this mixing may involve stirring, shaking or recirculation of fluids. With RIMS, mixing is accomplished by continuous circulation of wort out from under the grain bed and reintroduction at the top. Grain brewers who recycle wort at the end of the mash to set the grain bed before sparging are already familiar with this process. With RIMS, the work is automated, and the filter bed is set throughout the mash. RIMS includes an electronically controlled heater to regulate the temperature of the mash precisely.

How the RIMS Circuit Works

The RIMS temperature controller circuit, attributable to Morris, is simple and reliable. A single operational amplifier chip monitors and compares two inputs. One input arrives from a negative temperature coefficient thermistor placed in the wort flow or directly in the mash. As temperature increases, this device presents decreasing resistance. The second input derives from a potentiometer that the brewer controls. As with a radio volume control, resistance decreases as the potentiometer is advanced clockwise.

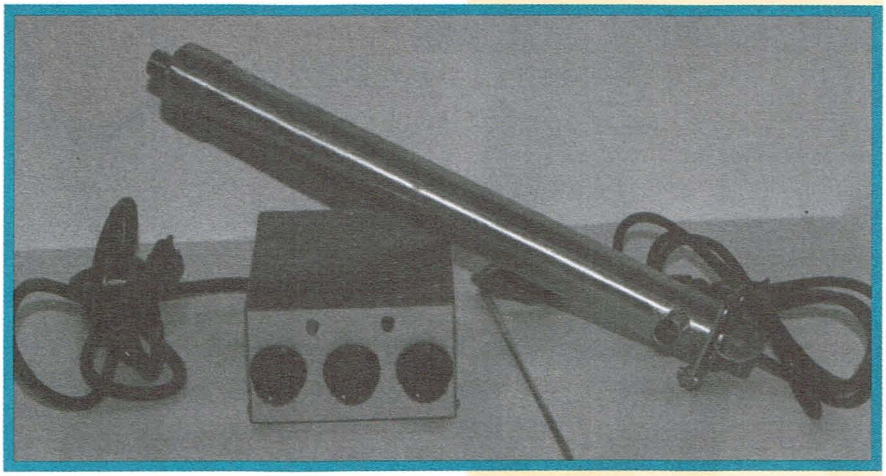
When the thermistor's resistance exceeds the potentiometer's, the wort is cooler than the brewer's selected setting and additional heat is needed. As wort temperature approaches the brewer's target, the heater is pulsed on and off, indicating achievement of a set point. In order to maintain an exact temperature, the controller varies the width of these pulses to the heater. An inexpensive power indicator on the controller blinks about once a second, telling the brewer that the controller is maintaining a set point.

RIMS Benefits

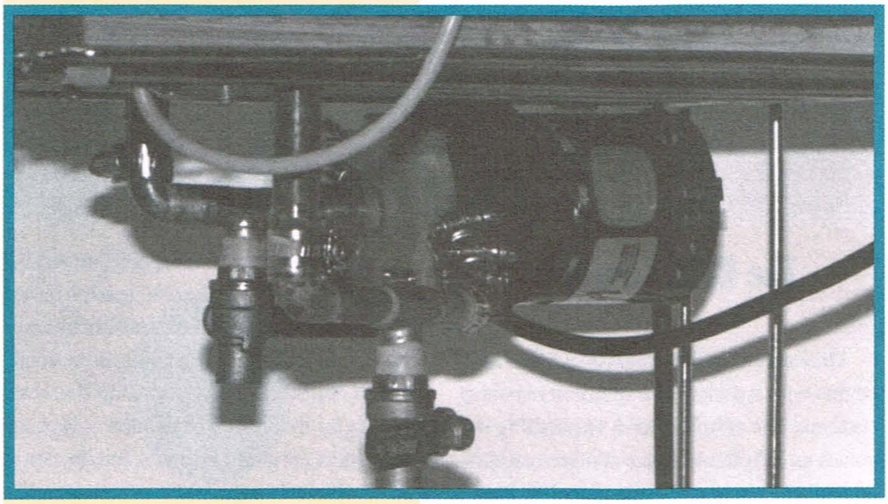
RIMS can reward the brewer in a number of ways, some quite surprising. With careful sparging, RIMS can provide incredibly efficient extract yields. In fact, complete starch conversion can occur in as few as 10 to 15 minutes. Wort clarity during recirculation actually is an indicator that conversion is complete. (Starch is insoluble and therefore visible in solution and sugar is the opposite.)

RIMS also delivers a brilliantly clear finished product, vibrant color extraction and clean taste. When the RIMS pump turns on, the grain bed begins to set. After a 60-minute mash and a slow sparge of at least 45 minutes, the runoff should be absolutely clear.

PHOTOS BY BOB CALHOUN



RIMS pump and temperature controller (left), recirculation pump (below)



By mildly acidifying the sparge water to pH 5.5, boiling at least 60 minutes and achieving strong hot and cold breaks, homebrewers should have no problems making haze-free beer.

Because RIMS eliminates the need for manual recycling of wort at the end of the mash, some time savings are apparent. Further small time savings derive from mashing and lautering in the same vessel versus two-vessel systems.

Brewing control and batch repeatability join the list of RIMS payoffs. Small differences in mash temperatures can cause variation among beers. Exact temperature control helps minimize this batch-to-batch variability.

RIMS Drawbacks

RIMS drawbacks are (1) cost and time to build, (2) safety precautions with respect to heat and electric current and (3) storage space required for a full three-tier system (if you choose this size). There are alternatives to drawbacks one and three which are discussed later. The safety issue isn't a new consideration, and with proper precautions, RIMS brewing is as safe as any other means.

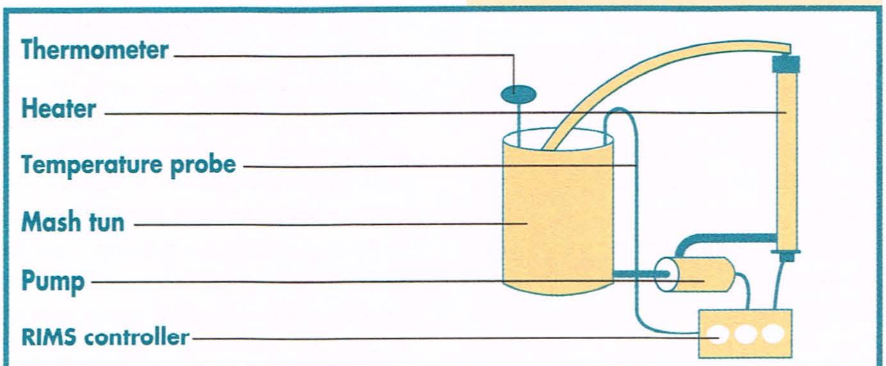


FIGURE 1. Components needed for RIMS.

Implementing RIMS

Almost any existing mashing system may be fashioned into a RIMS with the addition of the three essential RIMS ingredients: a pump for recirculation, a heater and an electronic control unit to adjust pump speed and heater temperature.

While RIMS may evoke images of sparkling stainless-steel kettles with separate heat sources, much simpler versions of RIMS can be implemented economically. My initial system consisted of a Listermann mash-sparge bucket and false bottom, a pump attached with flexible hose, a heater unit and a hose running back to the top of the mash tun. The temperature and motor speed controllers were essentially the same circuits I use today.

An existing mash-sparge system capable of recirculation can be enhanced to RIMS for as little as several hundred dollars. Figure 1 illustrates just how simply such a system can be assembled.

RIMS Brewing Practices

For the brewer now doughing-in, mashing, sparging, boiling, chilling and pitching, adoption of RIMS poses little disruption to this routine. Where a single temperature mash is scheduled, sufficient liquid must be provided for recirculation. Because hydrostatic pressure within the grain bed (which could cause a compacted bed and stuck runoff) is far less a concern with RIMS than with static mashes, the water levels may rise several inches above the grain bed. As with sparging, the grain bed should be protected with baffles from the returning flow so the bed is not disrupted.

When a recipe calls for a protein rest, the grains should be doughed-in thick without recirculation. At completion of this rest, use a hot water infusion (or even partial decoction) to elevate the temperature of the main mash. While the RIMS heater could be used to step the temperature up, compelling reasons make this practice unwise. The heating unit is capable of providing enough heat to raise mash temperature about one degree F per minute. Thus, a step from 122 to 155 degrees F (50 to 68 degrees C) would take more than one-half hour. If the brewer desires a full-bodied, dextrin-rich beer, the foregoing technique will likely provide a beer much thinner than expected. During the 30 minutes required to achieve that temperature step, all enzymatic reactions at the lower temperatures will have taken place. Running the heater at full power also increases the possibility of scorching the wort.

Safety Considerations

Whenever very hot fluid and high electric current levels are concerned, brewers should develop personal safety checklists. Line voltage must flow through a ground fault circuit interrupt breaker if the controller does not provide this protection. Fluid connections should be secured carefully with hose clamps to make sure no element can come loose during the mash or sparge. Systems must never be operated unattended because a stuck run off could result in the heater running empty with no outlet for significant heat. Contact with certain hot surfaces, such as the heater and temperature controller's internal heat sink, should be avoided. Finally, it's a good habit to turn off the heater at the end of the mash and let it cool before cleaning.

I encourage all homebrewers brewing from grains to investigate the possibility of adding RIMS to their brewing routine. While many brewers can build their own RIMS (see "Homebrew Hardware Store" on page 95), all individual RIMS components also are commercially available for those preferring to purchase some or all of their system.

References

Morris, Rodney. "Recirculating Infusion Mash System Revisited," **Zymurgy** Special Issue 1992 (Vol. 15, No. 2).

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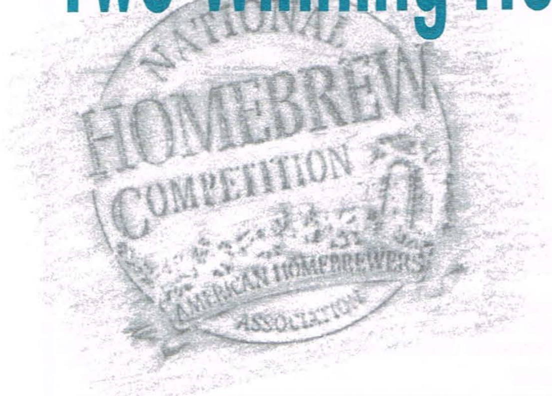
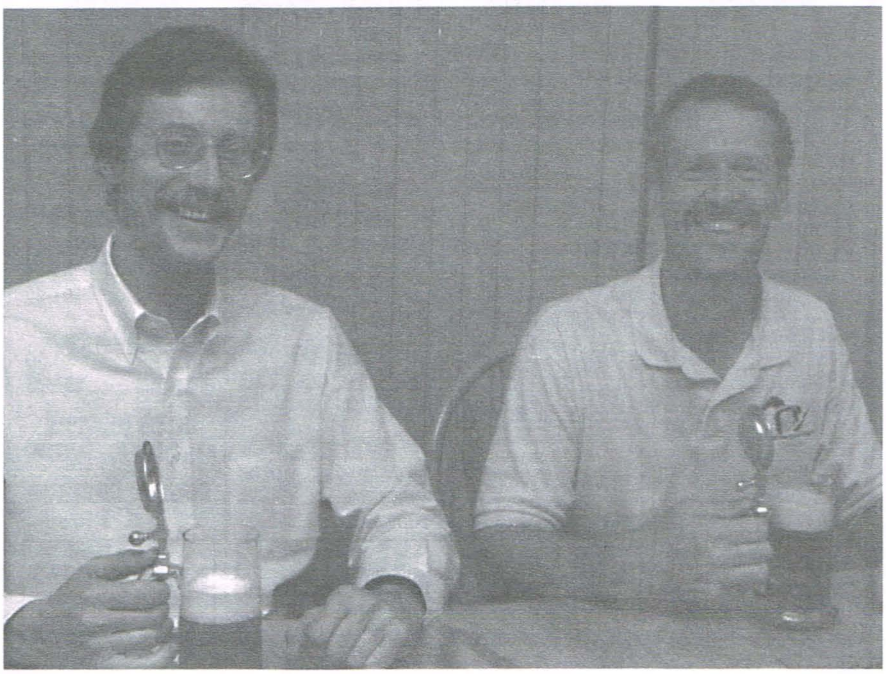
Brewing for Gold

Two Winning Homebrewers and Their Gear




Alan and Dave enjoying their award-winning brews.

There are as many different ways to brew beer as there are homebrewers. Some swear by their time-tested methods, while others change methods as they acquire new equipment or brew different beer styles. Either way, every batch of beer is an experiment and an opportunity to learn what makes good, if not great, beer. Whether they employ simple means and economical equipment or more complex procedures and costly equipment, most homebrewers invest a great deal of pride in their craft.

Alan Pagliere and Dave West are two dedicated homebrewers and members of the Ann Arbor Brewer's Guild. They brew about 10 batches per year and have been home-brewing for seven years. Each won a gold medal in the AHA 1994 National Homebrew Competition — Alan for a Bohemian Pilsener and Dave for a barley wine brewed with Bill Pankratz. See ***Zymurgy*** Special Issue 1994, Vol. 17, No. 4, for their recipes. Alan and Dave are examples of homebrewers who use different equipment and techniques to make outstanding beer. Alan brews five-gallon batches in his kitchen using a stockpot mash-tun and bucket lauter tun. Dave brews 10- to 25-gallon (38- to 95-L) batches in his garage using a three-kettle pico-Brewing System. What follows is a description of the ingredients, equipment and techniques they use for making award-winning beer.

By Bill Holmes

GEAR AND SYSTEMS

Alan Pagliere's Weizen-heimer

Ingredients for 5 gal (19 L)

- 5 lb Hugh Baird two-row pale ale malt (2.27 kg)
- 5 lb German wheat malt (2.27 kg)
- 10 oz Ireks two-row light crystal malt (284 g)
- 1 oz German Hallertauer Hersbrucker hops, 3.8% alpha acid (28 g) (60 min.)
- 1 tsp Irish moss (4.9 mL) (10 min.)
- 1/4 oz German Hallertauer Hersbrucker hops, 3.8% alpha acid (7 g) (5 min.)
- Yeast Lab W51 Bavarian weizen liquid yeast culture
- 1 pint reserved wort (0.47L) (to prime)
- Yeast Lab L32 Bavarian lager liquid yeast culture in 1-pint reserved wort starter (to prime)

- Original specific gravity: 1.050
- Final specific gravity: 1.016

Brew with soft to medium water. Use a three-step infusion mash with a 30-minute protein rest at 131 degrees F (55 degrees C), a 30-minute starch conversion rest at 154 degrees F (68 degrees C) and a 30 minute rest at 158 degrees F (70 degrees C). Mash-out at 168 degrees F (76 degrees C) and sparge with 168-degree-F (76-degree-C) water to collect 3 1/2 to 4 gallons (13.25 to 15 L) of wort. Boil with hops, then chill and reserve 1 pint (0.47 L) wort for kraeusening. Top the fermenter up to 5 gallons (19 L), aerate wort and pitch the yeast starter. Ferment at 50 to 55 degrees F (10 to 13 degrees C). Bottle with prepared lager yeast starter using reserved wort. Leave bottles at room temperature for four to seven days, then lager at 41 to 46 degrees F (5 to 8 degrees C) for four weeks.

Ingredients

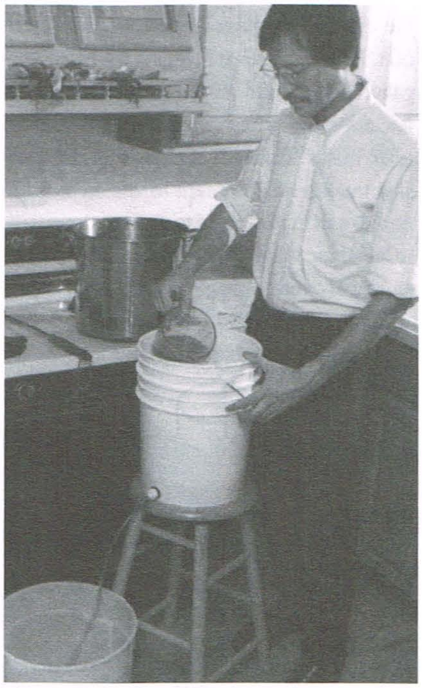
Alan and Dave prefer to brew with distilled water and customize the mineral profile by adding gypsum or other salts. Dave sometimes blends distilled water with some high bicarbonate artesian well water or softened tap water of known mineral content. The goal is to closely replicate the brewing water of the city or brewery where a particular beer style originated. Dave says the significance of doing this when brewing different beer styles is to avoid developing a "house flavor."

Alan and Dave agree it is important to select the most appropriate available malt types, hop varieties and yeast strain for each beer style. For example, for his gold-medal Pilsener, Alan used Ireks two-row Pilsener malt, Czech Saaz hop plugs and a Bohemian Pilsener yeast strain. Dave says when he brews English ales and European-style lagers, he substitutes 10 to 20 percent American two-row malt for the English or German pale malt to ensure complete starch conversion. Both brewers use only pure liquid yeast cultures and prepare yeast starters. Alan generally prepares yeast starters in three stages. First, he cultures a few yeast cells from a slant into 250 milliliters of sterile wort. Then he successively pitches into 500-milliliter and one-liter volumes of wort as kraeusen is reached at each stage. Dave usually prepares a one-gallon yeast starter for his 10- to 15-gallon (38- to 57-L) batches. He often repitches yeast, finding that yeast performance improves over the first three batches. However, he recommends repitching no more than five times because of the increasing potential for contamination.

Equipment and Techniques

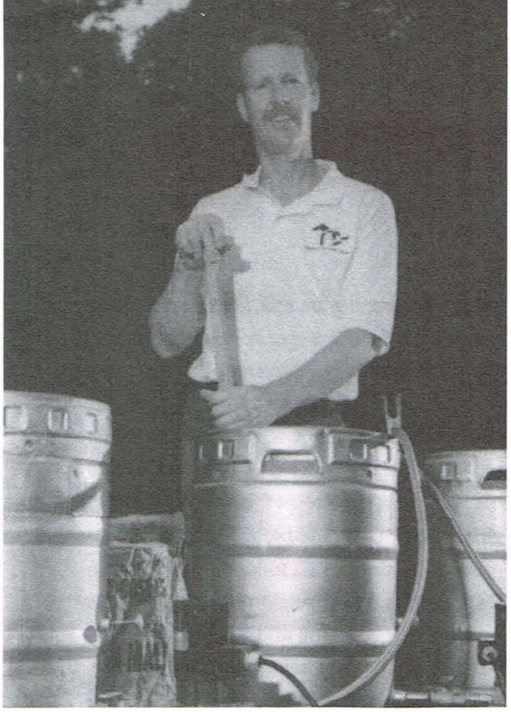
Alan brewed his Bohemian Pilsener with a two-step infusion mashing procedure using a five-gallon (19-L) stainless-steel stockpot on an electric stove and a Zapap lauter tun. The start-up cost for his brewing equipment, including a Corona grain mill, floating glass thermometer and stirring spoon, was about $100. Truly a budget brewing system!

Alan's mashing procedure is as straightforward as his equipment. He mashes-in eight to 10 pounds (4 to 4.5 kg) of malt and adjusts the mash temperature on the stove top. He begins with a 30-minute protein rest at 132 degrees F (56 degrees C) followed by a one- to two-hour starch conversion rest between 148 and 158 degrees F (64 and 70 degrees C), depending on the malt balance of the beer style. For his Pilsener he targeted 154 degrees F (68 degrees C), but the judges commented that the beer could use more maltiness. He raises and holds the mash temperature at 168 degrees F (76 degrees C) for 10 minutes for mash-out. Then he transfers the mash with minimal splashing to his plastic, uninsulated lauter tun and collects the wort without recirculating. The 168- to 170-degree-F (76- to 77-degree-C) sparge water is the same mineral-adjusted distilled water that he uses for the mash.



Alan Pagliere transfers mash from his stove-top mash tun to a Zapap lauter tun.

PHOTOS BY JIM JOHNSTON



Dave West shows his pico-Brewing System featuring (from left to right) a hot water kettle, mash/lauter tun and boiling kettle.

He does not test for starch conversion, but because he is working with the mash almost constantly, he is comfortable observing changes in the appearance (clarity) and taste (sweetness) of the mash liquid that indicate complete starch conversion. Nor does he check the pH or specific gravity of the wort toward the end of the sparge to determine when to quit. Rather, he stops sparging when his five-gallon kettle is full, which usually is long before any tannins have been extracted from the grain husks. This reduces mashing efficiency slightly, but he is content to use some additional malt in the recipe to shorten the sparge to less than 30 minutes and minimize the possibility of oversparging.

Alan normally boils the wort for 30 minutes before adding hops and boils the hops no more than 60 minutes. To improve the clarity of the finished beer, he usually boils one-half tablespoon (7.4 ml) of Irish moss for about 15 minutes. After chilling to fermentation temperature with an immersion-type wort chiller, he siphons the wort off the trub into a plastic bucket and agitates it to aerate. The entire brewing process takes five to six hours from crushed grain to chilled wort.

Dave brews with a three-kettle pico-Brewing System that he designed and built with business partner Mike O'Brien. The three kettles are reconditioned half-barrel (15.5 gallon) stainless-steel kegs. Each is fitted with a half-inch ball-valve spigot, two thermometer ports and a lid. The first kettle is used to heat sparge water, a second serves as the mash/lauter tun, and the third is the boiling kettle. The last two have removable slotted-copper false bottoms that rest on stainless-steel supports. Each kettle sits on a 200,000 b.t.u. propane burner. Two magnetic-drive pumps with flexible braided stainless-steel, rubber-lined hoses are used to transfer water and wort between kettles and to recirculate hot wort during mashing and chilling. Dave uses a motor-driven, two-roller malt mill to crush grain. He has invested about $1,200 in his system.

Dave says his system is well-suited to perform step-infusion mashing, but he only occasionally includes the protein rest in his mash schedule. For a 10-gallon (38-L) batch, he heats about eight gallons (30 L) of water in the mash tun and additional water in the hot water kettle to 15 degrees F above the targeted starch conversion temperature. He stirs in the grain with a wood paddle and adjusts the mash temperature using the burner. He thins the mash with additional hot water if necessary, and turns on the pump to gently recirculate the mash liquid from below the copper false bottom to the top of the mash.

Recirculation maintains a relatively uniform temperature throughout the mash and speeds starch conversion, which is usually complete in an hour. He boosts the temperature to 168 degrees F (76 degrees C) for mash out, at which time the wort runs clear. Sparging commences simply by moving the pump outlet hose to the boiling kettle. A second pump is used to transfer sparge water to the mash tun at the same rate that wort is pumped to the boiling kettle. Dave heats the wort as it fills the kettle and in 30 minutes he's done sparging and has a full kettle of boiling wort.

Dave collects 13 to 15 gallons (49 to 57 L) of wort for a 10-gallon (38-L) batch and boils for 1 1/2 to 3 hours in two kettles (the hot water kettle acts as an auxiliary boiling kettle). The copper false bottom in the boiling kettle, held down by the weight of a copper wort chiller during the boil, allows clear wort to be separated from the hops and break material after chilling. The removal of hops and break material also is aided by the whirlpool action created in the boiling kettle when using one of the pumps to recirculate the wort during the chill. The whole process takes four to six hours, depending on the length of the boil.

Motivation

The techniques outlined above are by no means the quickest or easiest ways to brew, but they have proven effective in making award-winning beer. What motivates these homebrewers is not saving money or winning competitions, but pure fascination with the brewing process. Dave especially enjoys building equipment and gadgets, and also likes sharing beer and teaching others all-grain brewing techniques. He encourages anyone intrigued by the brewing process to get into brewing with grain because, in the long run, the money saved on ingredients will pay for the investment in equipment.

Alan's philosophy is that learning to make great beer is like learning an art form, such as calligraphy, from a master. One learns the art by copying a master's style and practicing it. Alan considers himself a student of the art of brewing. To learn all-grain brewing, he advises homebrewers to choose a beer style and practice brewing it. By targeting a spe-

Alan and Dave's KEYS TO BREWING GREAT BEER

1. Prepare yeast starters using a quality pure liquid yeast culture or yeast slant. Carefully control fermentation temperature.
2. Adjust the mineral profile of brewing water according to beer style.
3. Select high-quality, fresh malt and hops and use mash and hop schedules that are appropriate for the beer style.
4. Keep brewing gear clean and sanitized.

cific style, they can gain valuable feedback from experienced homebrewers and learn how ingredients and techniques affect various beer characteristics.

Practice, Learn and Tinker

Today, Alan continues learning and practicing his brewing techniques, while Dave spends time designing and tinkering. In the past year, Alan has brewed with the club-owned pico-Brewing System and has begun practicing decoction mashing with another Ann Arbor Brewer's Guild member, Spencer Thomas. After attending a presentation by George Fix on the importance of pH in brewing, Alan plans to invest in a pH meter to monitor mash and sparge pH. Dave and Mike O'Brien have come up with a scaled-down version of the pico-Brewing System that can be used on the stovetop. The five-gallon femto-Brewing System is based on beautiful 18-gauge stainless-steel copper-clad kettles. The work of all of these homebrewers is an inspiration to other brewers, beginning and experienced alike, to get mashing!

Dave West's Milford Pale Ale (A Chico-style Ale)

Ingredients for 5 gal (19 L)

- **9 lb two-row American pale ale malt (4 kg) (substitute 2 to 3 lb Munich malt for the two-row if you prefer a maltier beer)**
- **2 lb 10 °L crystal malt (0.9 kg) (substitute 1/2 to 3/4 lb dark crystal malt for a more red beer)**
- **1 oz Northern Brewer hops, 8.5% alpha acid (28 g) (90 min.)**
- **1 tsp Irish moss (4.9 mL) (30 min.)**
- **1 oz Cascade hops, 5% alpha acid (28 g) (20 min.)**
- **1 oz Cascade hop pellets, 5% alpha acid (28 g) (dry in primary fermenter)**
- **Yeast Lab A02 American ale liquid yeast culture**

- **Original specific gravity: 1.050**
- **Final specific gravity: 1.014**

Use a single-step infusion mash at 158 to 160 degrees F (70 to 71 degrees C) for 60 to 90 minutes or until starch converts. Mash out at 170 degrees F (77 degrees C). Sparge with 170-degree-F (77-degree-C) water until 6 1/2 gallons (24.6 L) of wort have been collected. After boiling and cooling adjust volume of wort in the primary fermenter to 5 gallons (19 L) with distilled water if necessary. Keg from the primary fermenter two to four days after fermentation activity stops and yeast settles. Force carbonate and lager for 10 to 14 days at 34 degrees F (1 degree C).

GEAR AND SYSTEMS

By Kurt Froning

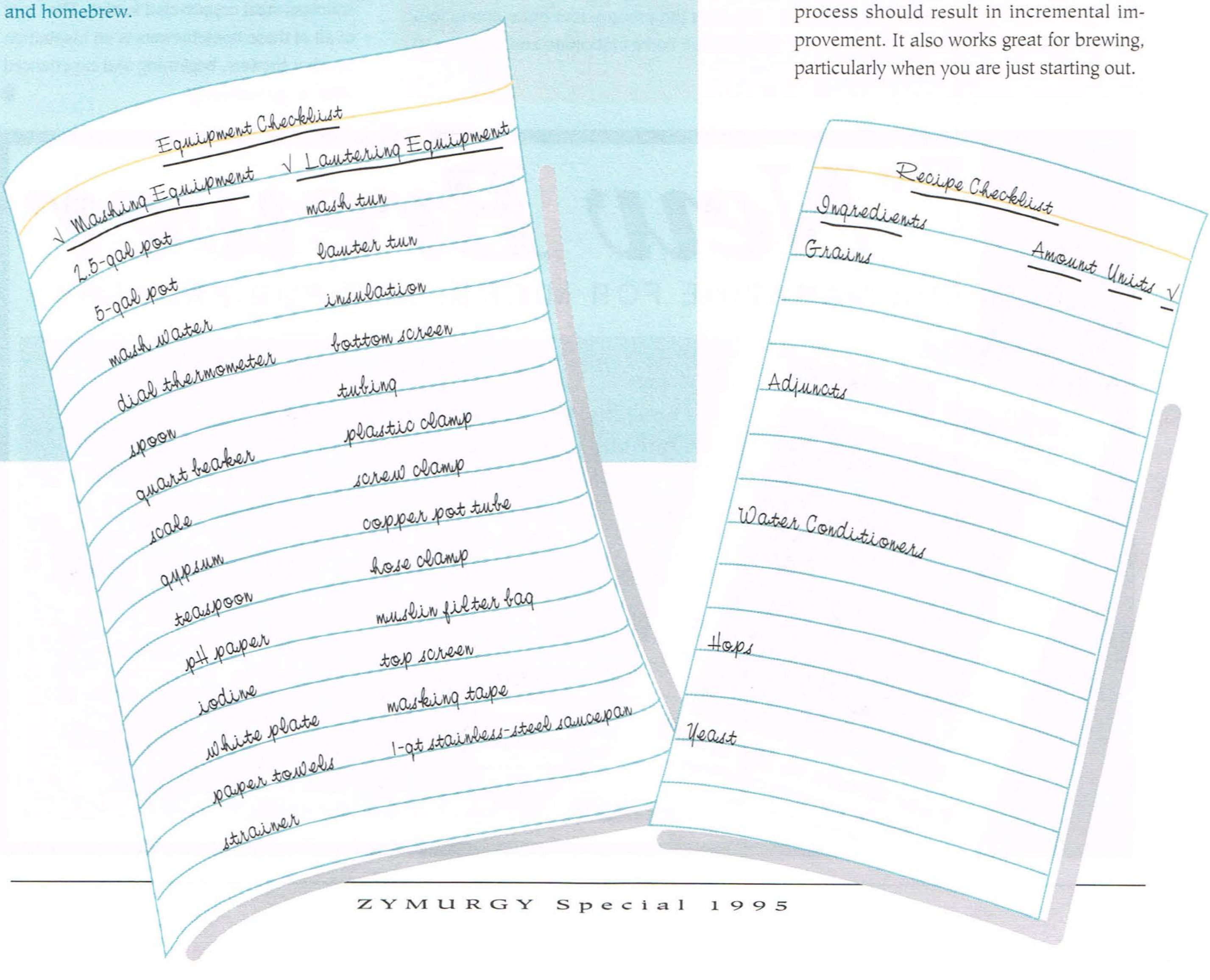
Thinking Through Your Brews

You've been reading brewing books and magazines for weeks and now you're ready to begin. You've got all the homebrewing equipment in the kitchen and the brewing book is folded back to the chapter, "So You Want to Mash?" You start and things are working out OK — check the temperature, check the pH, read the directions: "Adjust pH with gypsum." Gypsum, what gypsum? What did that paragraph say? Panic!

It can happen to all of us. All tasks have a learning curve and mashing can seem complicated. You need to remember quite a few details and keep track of some equipment. I've added something to my brewing paraphernalia to help keep things straight — it's a checklist. Properly used, a checklist, along with a written procedure, can make brewing a little less hectic and improve your brewing procedures and homebrew.

The concept is simple. Think about what you want to do ahead of time and write it down. While brewing, check off each task as you complete it. I first started using checklists after a batch I made turned out less than perfect. I must have done something wrong, but what? I went back and looked at my notes, but they were just too skimpy. I couldn't remember exactly what I had done, so how could I know what I had done wrong?

I decided to use a management technique that has become a standard in many businesses today. It can be summed up in four steps: plan, implement, assess and adjust. Think of it as a circle. Each time through the process should result in incremental improvement. It also works great for brewing, particularly when you are just starting out.



Here is what to do. As you begin to collect all the things you need for your first mash, use the directions you will be following to gather all the equipment for a dry run. Think about how you will do things, then make a list of equipment you will use. Put the items in the order you will use them: mash kettle and thermometer first, primary fermenter and its pieces last. When it comes time to mash, gather your equipment, look at the list and check off each item present. See page 110 for my equipment list (and remember, your lists may contain different items). Keep some notes during the process and after you are finished. Did you forget something? Were you scrambling around for a strainer or a roll of paper towels? Did you think of something that will help the next time? Simply add them to your list.

The second type of list I use is what I call a standard operating procedure. In this document, I list all the important steps or procedures I want to be sure I complete during brewing. Write down everything, using short sentences, to describe what you want to remember. It is similar to outlining. I include space to write down temperatures and other data that I want to have in my batch record. The list includes the basic steps, plus steps specific to my setup or procedure that I want to use each time I brew. The list also notes steps that I've included because I think they will improve my beer. If I change something, I note it.

For your own list, start out simply. Just outline your chosen procedure. Include notes for the steps about which you are most unsure. Make the list so there is space to check off each step as you complete it. The check-off step is important because the only time you can be absolutely sure of when you did something right is after you did it. That's the time to catch mistakes. Did you feel like you messed up? Write down what you did and keep it in the batch record.

After you finish brewing, relax and think about how things went. Could you improve your process? Make some changes or notes to your list. As you learn more about brewing, add things that you think will help. Is your beer getting better? If so, keep the procedures. When a failure occurs, track down the problem. Add the corrective procedure to the list. Remember to eliminate the steps you don't need anymore. A good source for corrective actions is the multitude of good books and magazines on brewing now available. For example, suppose you make a batch and it tastes like Band-Aids®. From an article by Charlie Papazian, "What To Aim For In Flavor Profiling," in *Evaluating Beer* (Brewers Publications, 1993) I learned to be more careful rinsing the equipment I have sanitized with bleach. The step I add to my list might read, "Rinse twice with preboiled tap water."

I have found that using lists has really helped my brewing. I've settled into a couple of recipes and am in the process of tweaking them. I change the mash temperatures each time, make a couple of procedural changes, but always build off my existing recipe. It is best to change one ingredient or procedure at a time so you know exactly what the effect of the change was. The lists are ideal for this process. Remember: plan, implement, assess, adjust.

ILLUSTRATIONS BY STEPHANIE JOHNSON

About the Authors

Tom Altenbach has 12 years of homebrewing experience, and has specialized in grain brewing since his second batch. He is a Certified BJCP judge and frequent competitor in homebrew events and cross country ski races. Recipes for some of his German lagers can be found in "Winners Circle" ***Zymurgy*** Fall 1995 (Vol. 18, No. 2) and Spring 1995 (Vol. 18, No. 1).

Shawn Bosch, a homebrewer for five years, is a wine and beer making consultant at Brews Brothers at KEDCO Beer and Wine Supply Store in Farmingdale, N.Y. He is a kit, extract, partial and full-mash brewer. He has won various local and regional awards for brewing including the gold medal in the Belgian and French category in the AHA 1994 National Homebrew Competition. When Shawn isn't brewing he enjoys playing guitar, being outdoors, gardening, spending time with his family and sampling beer.

Ray Daniels is an award-winning homebrewer, frequent contributor to ***Zymurgy*** and a recent graduate of the Siebel Institute of Technology's diploma course in brewing. He is preparing to launch a microbrewery in his home town of Chicago. Ray's book on recipe formulation, *Designing Great Beers*, will be published by Brewers Publications in 1996.

Tom Flores is opening the Clipper City Brewery in Baltimore, Md., with Hugh Sisson, a local maverick for pubs in Baltimore. Tom started homebrewing in college, then worked a short time with the Wild Goose Brewery in Cambridge, Md. By then Tom had made up his mind to have a career in brewing and went to the University of California, Davis to get a masters of science in food science and technology under Michael Lewis, Ph.D. While there, he studied for and passed the associate membership examination for the Institute of Brewing, London.

Kurt Froning, a brewer for 4 1/2 years, has a chemical engineering degree (among others) and works in manufacturing for a large medical supply distributor. The history of food and cooking methods first got him into brewing. One of Kurt's meads advanced to the second round of the AHA National Homebrew Competition in 1993.

John R. Griffiths, a Welshman transplanted via Australia and Canada to Fayetteville, Ark., is a founding member and the Primary Fermenter (president) of FLOPS (Fayetteville Lovers of Pure Suds), the second oldest homebrew club in Arkansas. He has been a homebrewer for seven years, largely self-taught in the days before he met other homebrewers and organized FLOPS. His all-grain beers have won more than a dozen awards in local, regional and national competitions, and he has formulated and brewed a 10-barrel guest batch of "Dr. John's Magic Stout" at the Ozark Brewing Co. in Fayetteville.

Robert Grossman, a Certified BJCP judge, has been homebrewing for six years and was the 1994 Delaware Valley Homebrewer of the Year. He enjoys introducing people to the fine art of beer appreciation and beer styles by teaching beginning to advanced homebrewing classes. An interest in recreating old British beers has led him into specializing in brewing strong old ales and barley wines. His extract-based barley wine won first place in the 1991 AHA National Homebrew Competition.

Neil C. Gudmestad and **Raymond J. Taylor** are two of the founding fathers of the Prairie Homebrewing Companions of the Fargo, N.D., and Moorhead, Minn., area. They each hold a Ph.D. in plant pathology, are Certified BJCP judges and brew together frequently. Neil and Ray implement with vigor their club's motto, "It Takes Beer To Make Beer!" They have won numerous awards at the local, regional and national level. Ray recently accepted the head brewer position at the Great Northern Restaurant and Brewery that will open in the historic Great Northern railway depot in downtown Fargo.

Paul Hale, who received a Ph.D. in chemistry from Northwestern University, is laboratory director for a laboratory instrumentation company. He has been brewing for nine years and has won more than 30 awards in homebrew competitions, including two Vermont Homebrewer of the Year titles. Paul is a member of the Green Mountain Mashers homebrew club in Burlington, Vt.

Kerry S. Hauptli, a devoted RIMS proponent, founded BrewCraft in 1995 to supply economical RIMS components to homebrewers. Kerry is a Certified BJCP judge who recently took first place in the classic Pilsener category at the Bluebonnet. He is a member of the Denton (Texas) Fermented Brewers Society, North Texas Homebrewers Association and the Virtual Village Homebrew Society on CompuServe.

Bill Holmes, a Ph.D. candidate in forest resource science at the University of Michigan, has been homebrewing for four years. He loves it so much he started teaching homebrewing courses in the continuing education programs of two local colleges.

Roger Jones of Lake Dallas, Texas, is a prosecutor in the Denton County District Attorney's Office in charge of the DWI unit. An all-grain brewer for two years, he is a member of the Denton Fermented Brewers Society and regular contestant in Texas homebrewing competitions.

Al Korzonas, a Master BJCP judge, is a technical editor for ***Zymurgy*** and an active member of the Chicago Beer Society, Brewers of South Suburbia and the Urban Knaves of Grain. Al owns Sheaf and Vine Brewing Supply in Countryside, Ill., and is working on a two-volume set of homebrewing books.

Dan Leithauser, a homebrewer for two years, is a chemist specializing in industrial water treatment. He is a member of the AHA and the Institute for Brewing Studies. Dan enjoys the mountains of Colorado and the wide variety of microbreweries in the area. The thought of brewing commercially has entered his mind, but he enjoys his current day job.

Mark Moylan is a free-lance writer in Michigan. He claims wrangling yeast is a spiritual experience, but refuses to elaborate unless asked. He also makes a good glass of beer and will offer one without being asked.

Jeff Niggemeyer has been brewing for six years, the last two using all grain. He is a Recognized BJCP judge and a two-time AHA National Homebrew Competition medal winner. Jeff belongs to the Impaling Alers Homebrew Club of Kent, Wash., and acts as competition organizer.

Gregory J. Noonan is brewmaster at the Vermont Pub and Brewery in Burlington. He is author of *Brewing Lager Beer* and *Scotch Ale* (Brewers Publications 1986, 1993).

Darryl Richman, a homebrewer for 10 years, is the author of *Bock* (Brewers Publications, 1994), the ninth in the Classic Beer Style Series. Although his work on *Bock* has focused his views on traditional Czech and German brewing, he is fermenting a batch of English mild.

John Roberts, a homebrewer for nearly five years, is brewery manager at Barleymalt and Vine's brew-on-premise in Boston, Mass.

Charlie Wiemann sells energy management systems by day and splits his nights between brewing, running, jazz, eating and occasionally sleeping. With a modest homebrewery staffed by his wife, Donna, and three cats, Charlie has been a homebrewer for four years.

Ginger Wotring is finishing her Ph.D. in neurophysiology. Her tendency to boss people around has led her to preside over the North Florida Brewers' League and the St. Louis Brews homebrew clubs. She is a National BJCP judge and organizer for the St. Louis Brews Happy Holidays homebrew competition.

WINNERS CIRCLE

James Spence

We're beginning another year of medal-winning recipes from the AHA National Homebrew Competition. The *Zymurgy* Special Issue hallmarks the 29 gold-medal winning recipes of 1995, with silver and bronze medal winners showcased in the next four issues of the magazine.

The AHA 1995 National Homebrew Competition was one of the most exciting. A starting pool of 3,067 entries was narrowed down to 400 second-round entries during the first round of competition. These 400 entries were brewed by about 280 brewers. On June 14, 1995, in Baltimore, Md., nearly 100 judges chose the top three brews in each of the beer and mead categories. The next morning, best-of-show judges chose the best beer and mead from the gold-medal winners.

The biggest surprise this year was the double win by Rhett Rebold of Burke, Va. Rhett won both the Ninkasi Award and was named AHA Homebrewer of the Year! Winning two gold medals earned him the points needed for the Ninkasi Award, and his gold-medal Munich Helles was chosen from among 24 other beers as Best of Show. It was smooth and delicious, and his recipe is highly recommended. Rhett wins a trip for two to the Great American Beer Festival®, Oct. 5 through 7, 1995, in Denver, Colo., courtesy of Munton and Fison and the Great American Beer Festival. Rhett will be attending a short course in brewing at The Siebel Institute of Technology courtesy of Pete's Brewing Co. of Palo Alto, Calif. Pete's Brewing will also work with Rhett to produce a Pete's Wicked seasonal beer, and provide travel and accommodations so Rhett can attend its first brewing.

Paddy Giffen of Rohnert Park, Calif., once again demonstrated his brewing skill by winning Meadmaker of the Year. Paddy was Homebrewer of the Year in 1993, and has won 16 awards in the AHA National Homebrew Competition.

No one was very surprised when the Sonoma Beerocrats of California, for the 10th consecutive year, became Homebrew Club of the Year. Tieing for second place was the Brewers United for Real Potables (BURP) of Virginia and the Foam Rangers of Texas. Underscoring the importance of entering the six club-only competitions sponsored by the AHA during the year, the Seattle Brews Brothers earned third place simply on the strength of two first-place wins in the club-only series.

Other awards went to Robert and Renée Mattie of Downingtown, Pa., Cidermakers of the Year, and Charles Hessom of Redwood Valley, Calif., Sakémaker of the Year.

Overall, almost 20,000 homebrewed beverages have competed in the National Homebrew Competition in its 17 years of existence.

An issue that has become increasingly important is the accuracy of the ingredients, brewing procedures and beer specifications in the recipes published in "Winners Circle." Will you be able to duplicate an award-winning beer by following the recipe? Maybe. When looking at these recipes, consider your own brewing procedures and adjust the recipes if you see the need. Homebrewing is an art and to a science — brewers don't always end up with what they intended, sometimes it's better sometimes it's worse. Homebrewing is characterized by its variety and inconsistency among brewers and brewing techniques. What works for one brewer may not work for another. Please keep these things in mind when using these recipes. It is the creativity and flexibility that makes this hobby fun.

BARLEY WINE

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
Edme Ltd., Mistley, Manningtree, England

GORDON OLSON
LOS ALAMOS, NEW MEXICO
"BARLEY WINE #4"
BARLEY WINE

Ingredients for 5 gal (19 L)

- 4 lb Alexander pale malt extract syrup (1.81 kg)
- 12 lb Briess two-row malt (5.44 kg)
- 8 oz American six-row crystal malt (227 g)
- 1 lb toasted Briess malt (0.45 kg)
- 10 oz 70 °L CaraMunich malt (283 g)
- 1 20 °L Ireks light crystal malt (0.45 kg)
- 1 lb malted wheat (0.45 kg)
- 1 oz chocolate malt (28 g)
- 1 oz Galena hop pellets, 13.8% alpha acid (28 g) (90 min.)
- 1 oz Chinook hop pellets, 11.5% alpha acid (28 g) (90 min.)
- 1 oz Nugget hop pellets, 12.8% alpha acid (28 g) (90 min.)
- 1 oz Northern Brewer hop pellets, 7.5% alpha acid (28 g) (60 min.)
- 1 oz Mt. Hood hop pellets, 3.9% alpha acid (28 g) (15 min.)
- 1/2 tsp Irish moss, rehydrated (2.5 mL) (20 min.)
- 1 tsp Polyclar® (4.9 mL) (15 min.)
- 1 oz Saaz hop pellets, 5.4% alpha acid (28 g) finish)
- 1 oz Saaz hop pellets, 5.4% alpha acid (28 g) (dry, 1 week)
- CL-170 Classic British ale yeast culture
- 1/2 cup dextrose (118 mL) (to prime)

- Original specific gravity: 1.097
- Final specific gravity: 1.037
- Boiling time: 90 min.
- Primary fermentation: two weeks at 65 degrees F (18 degrees C) in glass
- Secondary fermentation: two weeks at 65 degrees F (18 degrees C) in glass
- Age when judged (since bottling): six months

Brewer's specifics

Mash grain at 130 degrees F (54 degrees C) for 20 minutes. Add 1 gallon (0.95 L) boiling water to raise to 150 degrees F (66 degrees C). Hold between 152 and 156 degrees F (67 and 69 degrees C) for 90 minutes, then raise to 165 degrees F (74 degrees C) for 10 minutes. Collect 6 gallons (22.7 L) wort and add extract. Boil 90 minutes, cool aerate and pitch a pint (0.47 L) yeast starter.

Judges' comments

"Sweet malty, creamy taste. Not much bitterness comes through. Warming alcohol taste. On the malty-sweet side of the scale, but very drinkable."

"Lots of malt. Needs more bittering hops to balance. Alcohol comes through and warms you up. Increase the hops a little, and I'd want lots of this on a winter night."

BELGIAN AND FRENCH ALE

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
Manneken-Brussel Imports Inc., Austin, Texas

ERIC A. MUNGER
SALEM, OREGON
"PLATO TONIC TRIPEL"
TRIPEL

Ingredients for 5 gal (19 L)

- 14 lb Belgian Pils malt (6.35 kg)
- 2 lb dextrose (0.91 kg)
- 1 oz Ultra hops, 2.9% alpha acid (28 g) (50 min.)
- 1 oz Perle hops, 7.3% alpha acid (28 g) (30 min.)
- Wyeast No. 3944 Belgian white liquid yeast culture
- 3/4 cup dextrose (113 g) (to prime)

- Original specific gravity: 1.081
- Final specific gravity: 1.012
- Boiling time: 90 min.
- Primary fermentation: 11 days at 62 degrees F (17 degrees C) in glass
- Secondary fermentation: two weeks at 62 degrees F (17 degrees C) in glass
- Age when judged (since bottling): four months

Brewer's specifics

Mash grain at 151 degrees F (66 degrees C) for 90 minutes. Boil 2 pounds dextrose (0.91 kg) for 40 minutes.

Judges' comments

"Low to medium malt flavor. Some spicy hop flavor. Good conditioning. Nicely balanced. Good clean tripel. Perhaps a bit astringent."

"Spicy, malt flavor. Estery character – more pineapple than banana. Initial sweet spiciness is a little too prominent, but a very nice beer."

"Very nice! Smooth malt foundation leads to big alcoholic and warming finish. A great example. A bit too much of some of the esters and alcohols, but with a big beer like this it's difficult. I prefer a tripel that hides the alcohol better, but this is minor."

"Warming, alcohol presence is noticeable. Slightly sweet, a little clove. Outstanding beer. Perhaps the alcohol is a bit too noticeable, but otherwise a dynamite beer."

BELGIAN-STYLE LAMBIC

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
L.D. Carlson Co., Kent, Ohio

GREGG C. RENTKO
MADISON, NEW JERSEY
"CHERRIES JUBILEE"
FRUIT LAMBIC

Ingredients for 5 gal (19 L)

- 2 lb unmalted wheat berries (0.91 kg)
- 1 1/2 lb two-row pale malt (0.68 kg)
- 5 lb light dry malt extract (2.27 kg)
- 1 lb light dry malt extract (0.45 kg)
- 10 lb Washington state cherries (stems removed) (4.54 kg)
- 1 oz Saaz hops, 2.8% alpha acid, (28 g) crushed and aged for four to six weeks (15 min.)
- Wyeast *Brettanomyces bruxellensis* culture
- Whitbread English ale yeast culture
- *Brettanomyces lambicus* culture in 1-qt starter
- *Pediococcus* culture in 1-qt starter
- 3/4 cup dextrose (113 g) (to prime)

- Original specific gravity: unknown
- Final specific gravity: 1.011
- Boiling time: 45 min.
- Primary fermentation: four weeks at 65 to 70 degrees F (18 to 21 degrees C) in glass
- Secondary fermentation: eight weeks at 65 to 70 degrees F (18 to 21 degrees C) in glass
- Tertiary fermentation: four weeks at 65 degrees F (18 degrees C) in glass
- Age when judged (since bottling): nine months

Brewer's specifics

Cook cracked wheat berries in 6 quarts (5.68 L) boiling water for 30 minutes. Cool to 145 degrees F (63 degrees C) and add malt. Rest at 120 degrees F (49 degrees C) for 30 minutes. Raise to 130 degrees F (54 degrees C) and add 1 quart (0.95 L) of boiling water. Raise to 150 degrees F (66 degrees C) for 10 minutes then to 158 degrees F (70 degrees C) for 20 minutes. Sparge with 2 quarts (1.89 L) 170-degree-F (77-degree-C) water. Boil wort with malt extract. Cool and pitch *B. bruxellensis* and Whitbread yeast. After four weeks, soak cherries in 180-degree-F (82-degree-C) water for 15 minutes and boil 1 pound (0.45 kg) of dry malt extract in 1 quart (0.95 L) of water for 15 minutes. Add cherries to secondary fermenter. Add the of malt extract and starters of *B. lambicus* and *Pediococcus* cultures.

Judges' comments

"Sour, very acetic. Not much fruit contribution. Dry and sour aftertaste. Needs more *Brettanomyces* character. Good overall balance and a good effort."

BROWN ALE

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
Premier Malt Products, Grosse Pointe, Mich.

JOHN SULLIVAN
ST. LOUIS, MISSOURI
"WILD CHILD MILD"
ENGLISH MILD

Ingredients for 10 gal (38 L)

6	lb Belgian Munich malt (2.72 kg)
5 1/2	lb Belgian pale ale malt (2.49 kg)
1	lb dextrin malt (0.45 kg)
1/4	lb chocolate malt (0.11 kg)
1/4	lb black patent malt (0.11 kg)
1/4	lb Belgian aromatic malt (0.11 kg)
1/4	lb CaraVienne malt (0.11 kg)
1/4	lb CaraMunich malt (0.11 kg)
1/4	lb Belgian Special "B" malt (0.11 kg)
2	lb biscuit malt (0.91 kg)
3	oz Willamette hops, 4.2% alpha acid (85 g) (60 min.)
	Wyeast Scottish ale liquid yeast culture
3/4	cup corn sugar (113 g) (to prime)

- Original specific gravity: 1.041
- Final specific gravity: 1.010
- Boiling time: 60 min.
- Primary fermentation: six days at 62 degrees F (17 degrees C) in glass
- Secondary fermentation: eight days at 62 degrees F (17 degrees C) in glass
- Age when judged (since bottling): six months

Brewer's specifics

Mash grain at 152 degrees F (67 degrees C) for 120 minutes.

Judges' comments

"Roasty flavor as in the aroma. Some hop flavor. A little bitterness. No residual sweetness. Nice drinkable beer but too much roast flavor."

"Too much roastiness in flavor. Cut back on black patent malt. This beer is fine with very few flaws."

ENGLISH-STYLE PALE ALE

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
Wynkoop Brewing Co., Denver, Colo.

DAVE SHAFFER
LAFAYETTE, COLORADO
"MULLETHEAD ALE"
CLASSIC ENGLISH PALE ALE

Ingredients for 10 gal (38 L)

16	lb Klages malt (7.26 kg)
1	lb Ireks dark crystal malt (0.45 kg)
1	lb 35 °L crystal malt (0.45 kg)
1	lb special roast malt (0.45 kg)
1	lb Victory malt (0.45 kg)
1	lb Munich malt (0.45 kg)
1	lb CaraPils malt (0.45 kg)
1	lb wheat malt (0.45 kg)
1	oz Perle hops, 7.5% alpha acid (28 g) (80 min.)
1	oz U.S. Hallertauer hops, 5.2% alpha acid (28 g) (80 min.)
1 1/2	oz Saaz hop pellets, 3.6% alpha acid (43 g) (12 min.)
1 1/2	oz Hallertauer Hersbrucker hop pellets, 2.6% alpha acid (43 g) (12 min.)
1 1/2	oz Hallertauer Hersbrucker hop pellets, 2.6% alpha acid (43 g) (3 min.)
1	oz Tettnanger hop pellets, 4.3% alpha acid (28 g) (3 min.)
1 1/2	oz Hallertauer hop pellets, 5.2% alpha acid (43 g) (dry)
1 1/2	oz Saaz hop pellets, 3.6% alpha acid (43 g) (dry)
	Wyeast No. 1056 liquid yeast culture
3/4	cup dextrose (113 g) (to prime)

- Original specific gravity: 1.054
- Final specific gravity: 1.013
- Boiling time: 95 min.
- Primary fermentation: 23 days at 63 degrees F (17 degrees C) in glass
- Secondary fermentation: 16 days at 63 degrees F (17 degrees C) in glass
- Age when judged (since bottling): three months

Brewer's specifics

Mash grain at 132 degrees F (68 degrees C) for 31 minutes. Raise to 154 degrees F (68 degrees C) for 70 minutes. Sparge with 170 degree F (77 degrees C) water to collect 13 1/2 gallons (51 L) of wort.

Judges' comments

"Slight malt character with lingering hop finish. Slight woody character adds complexity. Could use more bittering hops. Nice British character."

AMERICAN-STYLE ALE

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
Northwestern Extract Co., Brookfield, Wis.

JOHN M. ARENDS
CALISTOGA, CALIFORNIA
"IAN'S ALE"
AMERICAN PALE ALE

Ingredients for 10 gal (38 L)

18	lb two-row malt (8.17 kg)
1	lb 40 °L crystal malt (0.45 kg)
1	lb 20 °L crystal malt (0.45 kg)
1	lb 10 °L Munich malt (0.45 kg)
1	lb wheat malt (0.45 kg)
1/2	oz Chinook hop pellets, 11.3% alpha acid (14 g) (60 min.)
1/2	oz Chinook hop pellets, 11.3% alpha acid (14 g) (30 min.)
3	oz Cascade hop pellets, 6% alpha acid (85 g) (30 min.)
2	oz Cascade hop pellets, 6% alpha acid (57 g) (2 min.)
3	oz Cascade hop pellets, 6% alpha acid (85 g) (dry)
	Wyeast No. 1056 liquid yeast culture
3/4	cup corn sugar (113 g) (to prime)

- Original specific gravity: 1.054
- Final specific gravity: 1.010
- Boiling time: 75 min.
- Primary fermentation: 13 days at 66 degrees F (19 degrees C) in glass
- Secondary fermentation: 10 days at 66 degrees F (19 degrees C) in glass
- Age when judged (since bottling): three months

Brewer's specifics

Mash grain at 154 degrees F (68 degrees C) for 75 minutes.

Judges' comments

"Caramel sweetness. Hop bitterness on the low side of high but is a smooth bitterness. An excellent beer! A touch more bittering hops would be truer to style."

"Excellent balance of hops and malt. Slightly overcarbonated. Very good beer. A little more finishing hops would really put this over the edge."

ENGLISH BITTER

GOLD MEDAL

1995 Homebrewer of the Year and Ninkasi Award Winner

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
Alternative Beverage, Charlotte, N.C.

RHETT REBOLD
BURKE, VIRGINIA
"REAL BITTER"
ENGLISH SPECIAL

Ingredients for 11 1/2 gal (43.5 L)

15 1/2 lb British pale malt (7.03 kg)
1 1/3 lb 60 °L crystal malt (0.60 kg)
2 1/5 oz Belgian aromatic malt (0.12 kg)
6 oz Belgian biscuit malt (170 g)
6 oz flaked wheat (170 g)
6 2/5 oz Demarara sugar (181.4 g)
1/4 lb unrefined sugar (113 g)
1 1/3 oz Fuggles hops, 4% alpha acid (37 g) (55 min.)
2 oz East Kent Goldings hops, 5.1% alpha acid (60 g) (55 min.)
1 4/5 oz East Kent Goldings hops, 5.1% alpha acid (60 g) (15 min.)
Wyeast Scottish ale liquid yeast culture
force carbonated (2.5 volumes) in keg

- Original specific gravity: 1.045
- Final specific gravity: 1.012
- Boiling time: 90 min.
- Primary fermentation: eight days at 64 degrees F (18 degrees C) in glass
- Secondary fermentation: 23 days at 64 degrees F (18 degrees C) in glass
- Age when judged (since bottling): three months

Brewer's specifics

Mash grain at 152 degrees F (67 degrees C) for 120 minutes.

Judges' comments

"Malt dominates balance with plenty of expression up front. Middle reveals a solid kettle hop addition, which lasts through a dry, firm finish. It may be a bit 'big' for a special — indeed, it could do well as an ESB."

"Chocolate, crystal, some smoke. Good bitterness. A very complex beer. May be a little too much body for style. A very good example of style."

"Malt expressed clearly. A little heavy flavor characteristic that reminds me of pipe tobacco. Nice balance. Body very full for style."

SCOTTISH ALE

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
Something's Brewing, Burlington, Vt.

DAN GATES
FRANKLIN, VERMONT
"SCOTTISH EXPORT ALE"
SCOTTISH EXPORT

Ingredients for 4 3/4 gal (17.98 L)

8 lb DeWolf-Cosyns two-row malt (3.63 kg)
1 lb DeWolf-Cosyns biscuit malt (0.45 kg)
1/2 lb CaraMunich malt (0.23 kg)
1/4 lb medium crystal malt (113 g)
1/4 lb dark crystal malt (113 g)
1 oz roasted barley (28 g)
1 lb Laaglander amber dried malt extract (0.45 kg)
1/4 oz Goldings hops 5.4% alpha acid (7 g) (70 min.)
1/2 oz Pride of Ringwood hops 6.7% alpha acid (14 g) (60 min.)
3/4 oz Goldings hops 5.4% alpha acid (21 g) (45 min.)
Wyeast Scottish Ale liquid yeast culture
force carbonated in keg

- Original specific gravity: 1.069
- Final specific gravity: unknown
- Boiling time: 70 min.
- Primary fermentation: two weeks at 52 to 54 degrees F (11 to 12 degrees C) in glass
- Secondary fermentation: two weeks at 48 to 52 degrees F (9 to 11 degrees C) in glass
- Tertiary fermentation: one month at 46 to 48 degrees F (8 to 9 degrees C) in keg
- Age when judged (since bottling): six months

Brewer's specifics

Mash grain at 155 degrees F (68 degrees C) for 60 minutes.

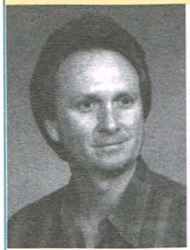
Judges' comments

"Malt and caramel up front with a bit of hop bitterness in middle and finish. Lingering bitterness a bit off-style. A nice beer with a hair too much hops in finish. Cut back a bit on bittering and keep everything else as is."

"Some grain taste with big hops in flavor. Very drinkable beer with a bit too much hops and a mild phenolic taste."

"Malty, roastiness in flavor, otherwise clean. Excellent beer. I would try to cut down on roastiness, otherwise don't change a thing."

PORTER



GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
The Cellar, Seattle, Wash.

FRED GIBSON
PASADENA, TEXAS
"PREHISTORIC PORTER"
ROBUST PORTER

Ingredients for 10 gal (38 L)

19 lb Harrington malt (8.62 kg)
2 lb chocolate malt (0.91 kg)
1 1/2 lb medium crystal malt (0.68 kg)
2 oz Cluster hops, 7% alpha acid (57 g) (60 min.)
2 oz Cluster hops, 7% alpha acid (57 g) (30 min.)
2 oz Cascade hops, 6% alpha acid (57 g) (finish)
Wyeast No. 1056 liquid yeast culture
force carbonated in keg

- Original specific gravity: 1.055
- Final specific gravity: 1.014
- Boiling time: 60 min.
- Primary fermentation: five days at 70 degrees F (21 degrees C) in stainless steel
- Secondary fermentation: 14 days at 70 degrees F (21 degrees C) in stainless steel
- Age when judged (since bottling): 2 1/2 months

Brewer's specifics

Mash grain at 155 degrees F (68 degrees C) for 90 minutes.

Judges' comments

"Chocolate malt comes through — could use a little more bitterness from either black malt or bittering hops. Nice beer. A tad more black malt flavor or bittering hops would make this better."

"Very good robust flavor profile. I like the mouthfeel. Perfect balance of malt sweetness and burnt flavors. This is great porter."

"Good roast malt and hops up front. May need a bit more hop bitterness but still very good. I wouldn't change a thing except a bit more body and a touch more bitterness."

PHOTO OF RHETT REBOLD BY KEN GRAHAM PHOTOGRAPHY

ENGLISH AND SCOTTISH STRONG ALE

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Wine & Hop Shop, Denver, Colo.

GRANT HEATH
HUNTSVILLE, ALABAMA
"NESSIE"
STRONG "SCOTCH" ALE

Ingredients for 15 gal (57 L)

- 21 lb Belgian Pilsener malt (9.53 kg)
- 7 lb British pale ale malt (3.18 kg)
- 2 lb CaraVienne malt (0.91 kg)
- 2 lb German dark crystal malt (0.91 kg)
- 1 lb Belgian Special "B" malt (0.45 kg)
- 6 1/4 lb amber dried malt extract (2.84 kg)
- 1 1/2 oz Kent Goldings hops, 5.2% alpha acid (45 grams) (60 min.)
- 1/2 oz Kent Goldings hops, 5.2% alpha acid (18 grams) (30 min.)
- Wyeast Scottish ale liquid yeast culture
- force carbonated in keg

- Original specific gravity: 1.085
- Final specific gravity: 1.030
- Boiling time: 90 min.
- Primary fermentation: eight days at 60 degrees F (15.5 degrees C) in glass
- Secondary fermentation: 15 days at 60 degrees F (15.5 degrees C) in glass
- Tertiary fermentation: two weeks at 32 degrees F (0 degrees C) in stainless steel
- Age when judged (since bottling): 6 1/2 months

Brewer's specifics

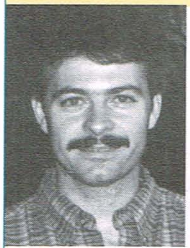
Mash grain at 156 degrees F (69 degrees C) for 60 minutes.

Judges' comments

"Nice malt. Slight astringency and a bit over-carbonated. Alcohol balances with malt."

"Little fruitiness detected in taste. Also picking up some esters after fruit fades. Great balance with malt-alcohol. Back down on fruitiness and esters."

STOUT



GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Alternative Garden Supply, Streamwood, Ill.

ROB SCHUTTE
CINCINNATI, OHIO
"DECK-HEAD STOUT"
CLASSIC DRY STOUT

Ingredients for 5 gal (19 L)

- 8 lb British two-row pale malt (3.63 kg)
- 1 1/2 lb flaked barley (0.68 kg)
- 1 lb roasted barley (0.45 kg)
- 3/4 lb CaraPils malt (0.34 kg)
- 1/2 lb 40 °L crystal malt (0.23 kg)
- 1 oz Northern Brewer hops, 6.4% alpha acid (28 g) (70 min.)
- 1 1/2 oz Kent Goldings hop plugs, 5% alpha acid (43 g) (70 min.)
- Wyeast No. 1084 liquid yeast culture
- 2/3 cup corn sugar (113 g) (to prime)

- Original specific gravity: 1.054
- Final specific gravity: 1.020
- Boiling time: 70 min.
- Primary fermentation: six days at 63 degrees F (17 degrees C) in glass
- Secondary fermentation: nine days at 63 degrees F (17 degrees C) in glass
- Age when judged (since bottling): six months

Brewer's specifics

Mash grain at 98 degrees F (37 degrees C) for 20 minutes. Raise to 122 degrees F (50 degrees C) and hold for 20 minutes. Raise to 154 degrees F (68 degrees C) for 65 minutes. Raise to 170 degrees F (77 degrees C) for five minutes.

Judges' comments

"Nicely balanced beer. Some residual bitterness. Roasted barley and malt sweetness blend together well. Very good job at style. The malt profile is right on."

"Good roast and malt character. Bitterness very good. Perfect conditioning. Nice malt-roast-bitter in finish — maybe too bitter?"

BOCK

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Washington Hop Commission, Yakima, Wash.

DENNIS DAVISON
GREENFIELD, WISCONSIN
"EKU 27.5"
EISBOCK

Ingredients for 10 gal (38 L)

- 23 lb Munton and Fison light malt extract (10.44 kg)
- 5 lb DeWolf-Cosyns Pils malt (2.27 kg)
- 5 lb DeWolf-Cosyns CaraPils malt (2.27 kg)
- 5 lb DeWolf-Cosyns CaraMunich malt (2.27 kg)
- 2 oz Perle hops, 8.1% alpha acid (57 g) (60 min.)
- 1 oz Perle hops, 8.1% alpha acid (28 g) (45 min.)
- 1 oz Hallertauer hops, 3.2% alpha acid (28 g) (10 min.)
- Wyeast Pilsen liquid yeast culture
- force carbonated in keg

- Original specific gravity: 1.116
- Final specific gravity: 1.024
- Boiling time: 90 min.
- Primary fermentation: two weeks at 55 degrees F (13 degrees C) in glass
- Secondary fermentation: six months at 32 degrees F (0 degrees C) in glass
- Age when judged (since bottling): nine months

Brewer's specifics

Mash grain at 154 degrees F (68 degrees C) until conversion. Place the keg outdoors at -30 degrees F (-34 degrees C) until you can hear the sound of ice crystals hitting the side of the keg. Siphon under pressure to a clean keg when shaken. Repeat procedure until a total of 1 gallon (3.79 L) of ice/water has been collected.

Judges' comments

"Alcohol apparent. Maltiness rounds it out. Still a high alcohol without the nastiness of fusels. Very impressive. A hard style to hit without overpowering the alcohol or getting off-tastes."

"Sweet, cloying. Strong. Alcohol is soft. Dry finish. Warms all the way down. Hint of hops is nice. Only 50 I've given in 10 years of judging."

"Malt and alcohol, malt and alcohol. Great balance. The only thing wrong with this beer is there is only one bottle. This is my first 50 ever."

PHOTO OF DENNIS DAVISON BY KEN GRAHAM PHOTOGRAPHY

BAVARIAN DARK

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
Crosby & Baker, Westport, Mass.

PAUL SULLIVAN
BROOKLYN, NEW YORK
"BLACK MARIAH"
SCHWARZBIER

Ingredients for 11 gal (42 L)

- 15 lb two-row Briess malt (6.81 kg)
- 1 lb chocolate malt (0.45 kg)
- 1/2 lb black patent malt (0.23 kg)
- 2 lb Ireks Munich malt (0.91 kg)
- 1 lb Munton and Fison crystal malt (0.45 kg)
- 2 oz Hallertauer hops, 4.5% alpha acid (57 g) (75 min.)
- 1 oz Hallertauer hops, 4.5% alpha acid (28 g) (30 min.)
- 1 oz Hallertauer hops, 4.5% alpha acid (28 g) (5 min.)
- yeast culture from Zip City Brewing Co.
- 3/4 cup corn sugar (113 g) (to prime)

- Original specific gravity: 1.052
- Final specific gravity: 1.010
- Boiling time: 90 min.
- Primary fermentation: three weeks at 48 degrees F (9 degrees C) in glass
- Secondary fermentation: three weeks at 40 degrees F (4 degrees C) in glass
- Age when judged (since bottling): three months

Brewer's specifics

Mash grain at 152 degrees F (68 degrees C) for 90 minutes.

Judges' comments

"Roasty malt. Sweetness a little high for style. Low bitterness from roast malt. Very drinkable. Smooth Schwarzbier."

"Dry finish. Sharp roastiness present without excess. Lingering mellow bitterness. Across-the-board balanced. Malt firmness complements bitter chocolate flavors."

"I like the bitter chocolate. Nice rich maltiness without being too aggressive. Noble-spicy hops in background. Some dark malt acidity in finish."

GERMAN LIGHT LAGER

GOLD MEDAL

1995 Homebrewer of the Year and Ninkasi Award Winner

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
Breiss Malting Co., Chilton, Wis.

RHETT REBOLD
BURKE, VIRGINIA
"CENTRAL EUROPEAN PILS"
MUNICH HELLES

Ingredients for 12 gal (45.5 L)

- 11 lb German Pils malt (4.99 kg)
- 8 lb Belgian Pils malt (3.63 kg)
- 1 1/2 lb German Vienna malt (0.68 kg)
- 1 1/2 lb CaraPils malt (0.68 kg)
- 3 oz Saaz hops, 4.2% alpha acid (88 g) (50 min.)
- 1 2/3 oz Saaz hops, 4.2% alpha acid (46 g) (25 min.)
- 4 1/2 oz Saaz hops, 4.2% alpha acid (128 g) (5 min.)
- Wyeast No. 2124 liquid yeast culture
- force carbonated in keg

- Original specific gravity: 1.048
- Final specific gravity: 1.013
- Boiling time: 120 min.
- Primary fermentation: 18 days at 54 degrees F (12 degrees C) in glass
- Secondary fermentation: 30 days at 38 degrees F (3 degrees C) in glass
- Age when judged (since bottling): 10 months

Brewer's specifics

Mash grain at 152 degrees F (67 degrees C) for three hours.

Judges' comments

"Wonderful malt flavor. Nice hops. Clean finish. Great beer — most balanced I've had all day. Truly Munich."

"Great balance. Very good beer. Great balance on the side of bitterness toward a Dortmund Export, but OK for style."

CLASSIC PILSENER

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
California Concentrates, Acampo, Calif.

PAUL QUASARANO
FRANKLIN, MICHIGAN
"CZECH MATE"
GERMAN PILSENER

Ingredients for 5 gal (19 L)

- 6 lb German Pilsener malt (2.72 kg)
- 1/4 lb 10 °L crystal malt (0.11 kg)
- 1/4 lb CaraMunich malt (0.11 kg)
- 1/2 lb Vienna malt (0.23 kg)
- one pinch of black patent malt
- 1 lb light dry malt extract (0.45 kg)
- 3 oz Hallertauer Mittelfrüeh hops, 4.7% alpha acid (85 g) (70 min.)
- 1 oz Hallertauer Mittelfrüeh hops, 4.7% alpha acid (28 g) (20 min.)
- 1/2 oz Hallertauer Mittelfrüeh hops, 4.7% alpha acid (14 g) (10 min.)
- 1/2 oz Saaz hops, 4% alpha acid (14 g) (10 min.)
- 1/2 oz Hallertauer Mittelfrüeh hops, 4.7% alpha acid (14 g) (2 min.)
- 1/2 oz Saaz hops, 4% alpha acid (14 g) (2 min.)
- Wyeast Czech Pils liquid yeast culture
- 3/4 cup corn sugar (113g) (to prime)

- Original specific gravity: 1.055
- Final specific gravity: 1.014
- Boiling time: 70 min.
- Primary fermentation: 10 days at 68 to 45 degrees F (20 to 7 degrees C) in plastic
- Secondary fermentation: 11 days at 45 to 25 degrees F (7 to 4 degrees C) in glass
- Tertiary fermentation: 15 days at 50 degrees F (10 degrees C) in glass
- Age when judged (since bottling): four months

Brewer's specifics

Mash grain at 125 degrees F (52 degrees C) for 30 minutes. Raise to 145 to 150 degrees F (63 to 66 degrees C) for 15 minutes. Remove 2 lb (0.91 kg) of mash and boil for 10 minutes. Add back to main mash and raise to 155 to 160 degrees F (68 to 71 degrees C) for 40 minutes. Sparge with 170-degree-F (77-degree-C) water.

Judges' comments

"Malty, hoppy beer. Great effort. Clean."

"Some bite in the aftertaste. Pay attention to water treatment and pH of wort in boil. Very nice beer with just a hint of roughness."

PHOTOS OF PAUL SULLIVAN AND RHETT REBOLD BY KEN GRAHAM PHOTOGRAPHY

AMERICAN LAGER

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
Pabst Brewing Co., Milwaukee, Wis.

ARTHUR METZNER
FORT WASHINGTON, MARYLAND
"SUNRISE LAGER"
AMERICAN STANDARD

Ingredients for 5 gal (19 L)

- 5 lb two-row lager malt (2.27 kg)
- 2 lb flaked barley (0.91 kg)
- 1 lb flaked maize (0.45 kg)
- 2 oz crystal malt (28 g)
- 1/2 lb CaraPils dextrin malt (0.23 kg)
- 1/2 lb extra light dry malt extract (0.23 kg)
- 3/5 oz Cascade hops, 6.1% alpha acid (16 g) (45 min.)
- 2/5 oz Cascade hops, 6.1% alpha acid (12 g) (33 min.)
- Wyeast No. 2007 St. Louis lager liquid yeast culture
- 7/8 cup corn sugar (131 g) (to prime)

- Original specific gravity: 1.040
- Final specific gravity: unknown
- Boiling time: 55 min.
- Primary fermentation: 15 days at 50 degrees F (10 degrees C) in plastic
- Secondary fermentation: six days at 50 degrees F (10 degrees C) in glass
- Age when judged (since bottling): five months

Brewer's specifics

Mash grain at 115 degrees F (46 degrees C) for one hour. Remove and boil enough of the mash so that when added back to the main mash the temperature stabilizes at 145 to 150 degrees F (63 to 66 degrees C). Let sit for 1 to 1 1/2 hours. Again remove and boil enough of the mash so that when added back to the main mash the temperature stabilizes at 160 degrees F (71 degrees C).

Judges' comments

"Malty with just the kiss of the hops. Carbonation high, but appropriate. Very good beer. Very close to commercial standards."

"Grainy flavor up front. Low malt and hop flavor. Tastes like Michelob, really well-done."

"Clean flavor, good balance. A bit too much corn and grain flavors."

VIENNA/MÄRZEN/ OKTOBERFEST

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
F.H. Steinbart, Portland, Ore.

TODD KELLENBENZ
HOUSTON, TEXAS
"OKTOBERINTEXASFEST"
MÄRZEN/OKTOBERFEST

Ingredients for 10 gal (38 L)

- 16 lb Durst Pils malt (7.26 kg)
- 7 lb Munich malt (3.18 kg)
- 1 1/4 lb 10 °L crystal malt (0.57 kg)
- 1 1/4 lb 40 °L crystal malt (0.57 kg)
- 1 1/4 lb 90 °L crystal malt (0.57 kg)
- 2 oz Styrian Goldings hops, 5% alpha acid (57 g) (45 min.)
- 3 oz Saaz hops, 3.3% alpha acid (85 g) (30 min.)
- 3 oz Saaz hops, 3.3% alpha acid (85 g) (10 min.)
- Wyeast No. 2206 liquid yeast culture
- force carbonated in keg

- Original specific gravity: 1.057
- Final specific gravity: 1.016
- Boiling time: 75 min.
- Primary fermentation: two weeks at 48 degrees F (9 degrees C) in plastic
- Secondary fermentation: two weeks at 48 degrees F (9 degrees C) in stainless steel
- Tertiary fermentation: three weeks at 48 degrees F (9 degrees C) in stainless steel
- Age when judged (since bottling): three months

Brewer's specifics

Mash grain at 152 degrees F (67 degrees C) for 60 minutes.

Judges' comments

"Nice malt, good toastiness. Hop bitterness a bit assertive at this point, but will mellow out with age. Excellent beer. Only major problem is it seems a bit overhopped or just undermalted."

"Lacks sweet malty character in flavor profile. Too dry. Hops are at the right level but malt does not balance it well."

"Toasted malt flavor. Low to medium bitterness. Hop flavor a tad too pronounced. Hop aroma and flavor could be cut back a little. Nice job."

GERMAN-STYLE ALE

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
BRISTOL BREWHOUSE, Milwaukee, Wis.

BENNETT M. DAWSON
ST. ALBANS, VERMONT
"KÖLSCH #4"
KÖLSCH

Ingredients for 5 gal (19 L)

- 3 lb two-row malt (1.36 kg)
- 3 lb DeWolf-Cosyns Pilsen malt (1.36 kg)
- 4 oz DeWolf-Cosyns CaraVienne malt (113 g)
- 4 oz DeWolf-Cosyns CaraPils malt (113 g)
- 4 oz DeWolf-Cosyns wheat malt (113 g)
- 1 1/2 oz Hallertauer Hersbrucker hops, 3.5% alpha acid (43 g) (75 min.)
- 1/2 oz Hallertauer Hersbrucker hops, 3.5% alpha acid (14 g) (15 min.)
- 1/2 oz Czech Saaz hops, 3.1% alpha acid (14 g) (5 min.)
- Wyeast No. 2565 liquid yeast culture
- force carbonated in keg

- Original specific gravity: 1.046
- Final specific gravity: 1.006
- Boiling time: 90 min.
- Primary fermentation: seven days at 55 degrees F (13 degrees C) in glass
- Secondary fermentation: 12 days at 55 degrees F (13 degrees C) in glass
- Age when judged (since bottling): three months

Brewer's specifics

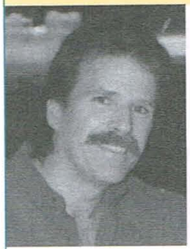
Mash grain at 122 degrees F (50 degrees C) for 30 minutes. Raise to 146 degrees F (63 degrees C) for 90 minutes. Raise to 152 degrees F (67 degrees C) for 30 minutes. Raise to 158 degrees F (70 degrees C) for 15 minutes. Mash out at 170 degrees F (77 degrees C). Sparge with 5 gallons (19 L) of 170-degree-F (77-degree-C) water.

Judges' comments

"A good dry flavor. Some malt sweetness evident. Hop-malt balance good for style. A drinkable beer."

"Initial delicate malty sweetness. Hop bitterness is acceptable but could be higher to offset sweet character. I would love to have a basement full of this beer!"

FRUIT BEER



GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
The Purple Foot, Milwaukee, Wis.

RUSS BEE
ROCKWALL, TEXAS
"SUSIE'S BELGIAN PÊCHEBIER"
FRUIT BEER

Ingredients for 5 gal (19 L)

- 7 1/4 lb pale malt extract (3.29 kg)
- 1 lb American two-row pale malt (0.45 kg)
- 1 1/2 lb American 20 °L crystal malt (0.68 kg)
- 3/4 oz Hallertauer hops, 7.5% alpha acid (21 g) (45 min.)
- 4 oz natural peach extract (118 mL)
- Wyeast No. 1056 liquid yeast culture
- 3/4 cup corn sugar (113 g) (to prime)

- Original specific gravity: 1.056
- Final specific gravity: 1.012
- Boiling time: 60 min.
- Primary fermentation: six days at 72 degrees F (22 degrees C) in glass
- Secondary fermentation: five days at 72 degrees F (22 degrees C) in glass
- Age when judged (since bottling): 7 1/2 months

Brewer's specifics

Mash grain at 151 degrees F (66 degrees C) for 60 minutes. Add peach extract at bottling with priming sugar.

Judges' comments

"Strong peach bouquet, very pleasing. Alcoholic aftertaste. Fine and tasty. Carbonation is excellent. Aftertaste is only drawback."

"Peach is up front. Slight astringency is evident. A fine effort. Next time be a little more careful with wort transfer methods."

"Peach, caramel malt, hops all balanced. Slight metallic aftertaste. A little bitter, astringent. Great dessert fruit beer."

HERB BEER

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
Marin Brewing Co., Larkspur, Calif.

THOMAS ALTENBACH
TRACY, CALIFORNIA
HERB BEER

Ingredients for 10 gal (38 L)

- 18 lb pale malt (8.17 kg)
- 3 lb Munich malt (1.36 kg)
- 1/3 oz Hallertauer hops, 4.6% alpha acid (10 g) (60 min.)
- 3/4 oz Northern Brewer hops, 7.4% alpha acid (21 g) (60 min.)
- 1/3 oz Hallertauer hops, 4.6% alpha acid (10 g) (60 min.)
- 3/4 oz Hallertauer hops, 4.6% alpha acid (21 g) (30 min.)
- 1 oz Hallertauer hops, 4.6% alpha acid (28 g) (10 min.)
- 3 oz Hallertauer hops, 4.6% alpha acid (85 g) (finish)
- 1 oz Tettnanger hops, 5.5% alpha acid (28 g) (finish)
- 23 serrano chili peppers, puréed in blender
- Wyeast Triple lager liquid yeast culture
- 6 serrano chili peppers, sliced and steamed 10 min. (per 5 gal., in primary fermentation)
- 3/4 cup corn sugar (113 g) (to prime)

- Original specific gravity: 1.067
- Final specific gravity: 1.019
- Boiling time: 90 min.
- Primary fermentation: 20 days at 50 degrees F (10 degrees C) in glass
- Secondary fermentation: 22 days at 50 degrees F (10 degrees C) in glass
- Age when judged since bottling): six months

Brewer's specifics

Mash grain at 155 degrees F (68 degrees C) for 90 minutes. Add puréed chilies at the end of the boil.

Judges' comments

"Hot! Great chili flavor, though. Decent malty beer underneath. A pretty nice but very hot chili ale."

"Malt and chili flavors are quite pure and true to character. Enough malt supporting green chili fruity complexity. Not for tender palates, but clean and expresses ingredients well."

"Hot, hot, hot. After that, it's a very clean beer. Well done!"

SPECIALTY BEER

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
Homebrew Headquarters, Dallas, Texas

STROM C. THACKER
GAINESVILLE, GEORGIA
"XMAS ALE 1994"
SPECIALTY BEER

Ingredients for 6 gal (23 L)

- 8 lb Briess two-row pale malt (3.63 kg)
- 1 lb Briess special roast malt (0.45 kg)
- 1 lb Briess 20 °L crystal malt (0.45 kg)
- 1 lb Briess CaraPils malt (0.45 kg)
- 1/2 oz Northern Brewer hops, 7.1% alpha acid (14 g) (60 min.)
- 1/2 oz Northern Brewer hops, 6.5% alpha acid (14g) (60 min.)
- 1/2 oz British Columbia Goldings hops, 4.6% alpha acid (14 g) (30 min.)
- 1/2 oz British Columbia Goldings hops, 4.6% alpha acid (14 g) (2 min.)
- 1 lb wildflower honey in boil (0.45 kg)
- 1 1/2 tsp cinnamon (7.4 mL) (in secondary)
- 3/4 tsp nutmeg (3.7 mL) (in secondary)
- 3/4 tsp allspice (3.7 mL) (in secondary)
- 3/4 tsp mace (3.7 mL) (in secondary)
- 1/4 tsp cloves (1.2 mL) (in secondary)
- Wyeast No. 1056 liquid yeast culture
- 3/4 cup corn sugar (113 g) (to prime)

- Original specific gravity: 1.061
- Final specific gravity: 1.017
- Boiling time: 90 min.
- Primary fermentation: 10 days at 65 degrees F (18 degrees C) in glass
- Secondary fermentation: 16 days at 65 degrees F (18 degrees C) in glass
- Age when judged (since bottling): seven months

Brewer's specifics

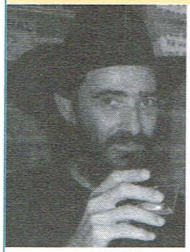
Mash grain at 158 degrees F (70 degrees C) for 60 minutes.

Judges' comments

"Not at all disappointed. Great balance of specialties with malt and hops displaying a complex taste profile with wonderful finish."

"Very tasty. A nicely balanced blend of ingredients. Honey character manages to come through all the rest. With all those ingredients it is still possible to detect almost all."

SMOKED BEER



GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
Jim's Homebrew Supply, Spokane, Wash.

CARLOS KELLEY
FORT WORTH, TEXAS
"SMOKE THIS!"
BAMBERG-STYLE RAUCHBIER

Ingredients for 10 gal (38 L)

- 12 lb two-row pale malt (5.44 kg)
- 5 lb Belgian Munich malt (2.27 kg)
- 5 lb smoked two-row malt (2.27 kg)
- 4 oz Hallertauer Hersbrucker hops, 4.2% alpha acid (113 g) (60 min.)
- 1 oz Hallertauer Hersbrucker hops, 4.2% alpha acid (28 g) (10 min.)
- Wyeast Triple lager liquid yeast culture
- 1 1/2 cup corn sugar (225 g) (to prime)

- Original specific gravity: 1.056
- Final specific gravity: 1.014
- Boiling time: 60 min.
- Primary fermentation: 30 days at 45 degrees F (7 degrees C) in glass
- Secondary fermentation: 60 days at 40 degrees F (4 degrees C) in glass
- Age when judged (since bottling): five months

Brewer's specifics

Smoke grain over cool sugar maple smoke 110 to 120 degrees F (43 to 49 degrees C) for 90 minutes. Mash grain at 152 degrees F (67 degrees C) for 90 minutes.

Judges' comments

"Very nice balance of smoke and malt sweetness. Astringency noticeable. Good conditioning. Long aftertaste. A better than average example."

"Malt is a little low for style. Good low hop flavor. Slight astringent aftertaste."

"Good smoke flavor. Astringent aftertaste. Nice drinking beer, could use a little work."

CALIFORNIA COMMON BEER

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
Anchor Brewing Co., San Francisco, Calif.

ED WOLFE AND CAROL LIQUORI
IOWA CITY, IOWA
"STEAM ROLLER"
CALIFORNIA COMMON BEER

Ingredients for 7 gal (26.5 L)

- 10 lb pale malt (4.54 kg)
- 1 lb 60 °L crystal malt (0.45 kg)
- 1 lb toasted malt (0.45 kg)
- 1 1/2 oz Centennial hops, 10.9% alpha acid (43 g) (60 min.)
- 1 oz Cascade hops, 4.9% alpha acid (28 g) (15 min.)
- 1 oz Fuggles hops, 3.5% alpha acid (28 g) (15 min.)
- 1/2 oz Cascade hops, 4.9% alpha acid (14 g) (steep 30 min.)
- 1/2 oz Fuggles hops, 3.5% alpha acid (14 g) (steep 30 min.)
- 1/2 oz Cascade hops, 4.9% alpha acid (14 g) (dry, 14 days)
- 1/2 oz Fuggles hops, 3.5% alpha acid (14 g) (dry, 14 days)
- Aeonbrau's California Common yeast
- 2/3 cup corn sugar (100 g) (to prime)

- Original specific gravity: 1.050
- Final specific gravity: 1.015
- Boiling time: 75 min.
- Primary fermentation: seven days at 55 degrees F (13 degrees C) in glass
- Secondary fermentation: 21 days at 55 degrees F (13 degrees C) in glass
- Age when judged (since bottling): four months

Brewers' specifics

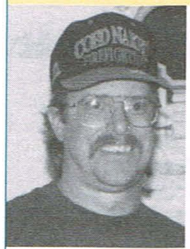
Mash grain at 147 degrees F (64 degrees C) for 90 minutes.

Judges' comments

"Toasted malt. Sweet. Medium hop bitterness. Good hop flavor. Sweet astringency in aftertaste would keep me from drinking a second. It's much better as it warms."

"Rich and full but with yeast flavors. Good flavor with aftertaste."

GERMAN-STYLE WHEAT BEER



GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by
Tabernash Brewing Co., Denver, Colo.

BERT ZELTEN
KEWAUNEE, WISCONSIN
"HO WHEAT BREW"
WEIZEN/WEISSBIER

Ingredients for 10 gal (37.8 L)

- 11 lb wheat malt (4.99 kg)
- 7 lb two-row malt (3.18 kg)
- 1/2 oz Saaz hops, 3.6% alpha acid (14 g) (60 min.)
- 1/2 oz Saaz hops, 3.6% alpha acid (14 g) (15 min.)
- Brewer's Choice No. 3068 liquid yeast culture
- 11/2 cup corn sugar (355 mL) (to prime)

- Original specific gravity: 1.046
- Final specific gravity: 1.015
- Boiling time: 60 min.
- Primary fermentation: seven days at 66 degrees F (19 degrees C) in glass
- Secondary fermentation: 10 days at 66 degrees F (19 degrees C) in glass
- Age when judged (since bottling): three months

Brewer's specifics

Double decoction mashing technique used.

Judges' comments

"Nice sweet flavor. Overcarbonation tingles, taking away some flavor. Good spiciness. Smooth, sweet, spicy. A very good beer."

"Wonderful blend of spiciness: banana, bubble gum. Fruitiness and malty sweetness. Excellent example."

TRADITIONAL MEAD AND BRAGGOT

GOLD MEDAL

1995 Meadmaker of the Year

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by BEERCRAFTERS INC., Turnersville, N.J.

PADDY GIFFEN
ROHNERT PARK, CALIFORNIA
STILL TRADITIONAL MEAD

Ingredients for 3 gal (11 L)

12 1/2 lb citrus honey (5.67 kg)
Prise de Mousse yeast
2 oz Beverage People mead yeast nutrient (57 g)

- Original specific gravity: 1.121
- Final specific gravity: 1.028
- Primary fermentation: six weeks at 68 degrees F (20 degrees C) in glass
- Secondary fermentation: four months at 68 degrees F (20 degrees C) in glass
- Age when judged (since bottling): three months

Judges' comments

"Good honey balance but alcohol is a little prickly and hot. Very nice body. This is a nice sweet still mead."

"Very good balance. Orange comes through nicely. Very good!"

"Sweet, full honey flavor. Good balance with alcohol flavor and warmth. Excellent mead."

FRUIT MEAD

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by The National Honey Board, Longmont, Colo.

DOUGLAS BROWN
HUDSON, MASSACHUSETTS
"APPLE COUNTRY CYSER"
STILL CYSER

Ingredients for 5 gal (19 L)

7 1/2 lb light clover honey (3.40 kg)
4 1/2 gallons fresh unfiltered apple ciders (Macintosh, Gravenstein, Cort) (17 L)
9 cracked juniper berries
2 1/4 cinnamon sticks
1/2 tsp rosemary (2.5 mL)
4 whole allspice
Wyeast German ale liquid yeast culture

- Original specific gravity: 1.087
- Final specific gravity: 1.025
- Primary fermentation: 30 days at 67 degrees F (19 degrees C) in glass
- Secondary fermentation: 120 days at 63 degrees F (17 degrees C) in glass
- Tertiary fermentation: 30 days at 63 degrees F (17 degrees C) in glass
- Age when judged since bottling): four months

Brewer's specifics

Mix cider and honey. Add spices and herbs plus one Campden tablet. Heat to 160 degrees F (71 degrees C) then transfer to fermenter. Pitch yeast when must reaches 70 degrees F (21 degrees C). Rack after one month, lower temperature to 63 degrees F (17 degrees C). Rack again after four months and add one Campden tablet. Bottle after one month or when clear.

Judges' comments

"Wahoo. Finally, menage à trois of honey, alcohol and apple. Wonderful aftertaste. Deliciously still. Fabulous cyser."

"Very nice golden color. Nice sweet apple flavor and honey support."

"Very slightly astringent. Very good cider flavor."

HERB MEAD

GOLD MEDAL

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Madhava's Mountain Gold Honey, Lyons, Colo.

GUNTHER JENSEN
PACOIMA, CALIFORNIA
"BLUE"
STILL METHEGLIN

Ingredients for 5 gal (19 L)

15 lb Bennet/Lake Piru raw orange blossom honey (6.81 kg)
3 cloves
2 oz cinnamon (55 g)
vanilla bean (1 g)
3 allspice berries
pinch mace (1 g)
1/5 oz nutmeg (5 g)
Pasteur Champagne yeast

- Original specific gravity: 1.114
- Final specific gravity: 1.017
- Primary fermentation: 4 1/2 months at 65 to 70 degrees F (18 to 21 degrees C) in glass
- Secondary fermentation: five months at 60 to 70 degrees F (16 to 21 degrees C) in glass
- Age when judged (since bottling): 5 1/2 months

Judges' comments

"Honey is overpowered by spices, balanced a little too much toward the acidic. Tart, but OK. The color is amazing. Spices are complex."

"Wow! I get the honey second. The spices working together like a world-class orchestra. Acidity balances the sweetness perfectly. Excellent job!"

"Smooth. Good balance. Honey is lost in the complexity but I think that's OK. Very drinkable. I'm not sure I would change a thing."

PHOTO OF PADDY GIFFEN BY RICK LUBRANT

CIDER

GOLD MEDAL

1995 Cidermaker of the Year

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Lyon's Brewery of Dublin, Calif.

ROBERT AND RENÉE MATTIE
DOWNINGTOWN, PENNSYLVANIA
"GUILFORD GOLD"
NEW ENGLAND-STYLE CIDER

Ingredients for 4 1/2 gal (17 L)

- 3 1/2 gal Bishops cider (13.25 L)
- 4 qts crabapples (3.79 L)
- 2 lb light brown sugar (0.91 kg)
- 2 oz oak chips (57 g)
- 2 cups water (473 mL)
- 1/4 cup corn sugar (37 g) (to prime)

- Original specific gravity: 1.061
- Final specific gravity: 1.002
- Primary fermentation: five months at 45 degrees F (7 degrees C) in glass
- Age when judged (since bottling): 16 1/2 months

Brewers' specifics

Boil brown sugar and oak chips in water. Crush apples in a food grinder. Mix all ingredients together in fermenter.

Judges' comments

"Sweet apple. Dry oak taste. Pleasant and refreshing, but oakiness will limit how many I could drink. Back off on the oak chips, or whatever you used."

"Fruity, sweet with some balancing dryness from acid. A nice entry."

"Starts with raspberries, then dries out. Good balance. I'd like a little more sweetness for the fruity taste, though."

"Acid and fruit profiles are well-done in this cider. A dry tannic finish and plenty of complexity."

"Sweet, clean. Could use more acidity in balance and astringency."

"Good carbonation. Nicely balanced, good body. Sweet with tart finish."

SAKÉ

GOLD MEDAL

1995 Sakémaker of the Year

AHA 1995 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Kohnan Inc., Napa, Calif.

CHARLES HESSOM
REDWOOD VALLEY, CALIFORNIA
"YODELING YODAN"
SAKÉ (JAPANESE RICE BEER)

Ingredients for 3 gal (11 L)

- 15 lb Hinode medium-grain rice (6.81 kg)
- Wyeast No. 3134 liquid culture
- Gem cultures koji starter
- 3 tsp Sparkolloid® (tertiary fermentation)

- Original specific gravity: unknown
- Final specific gravity: 0.998
- Primary fermentation: 41 days at 60 degrees F (16 degrees C) in plastic
- Secondary fermentation: 10 days at 50 degrees F (10 degrees C) in glass
- Tertiary fermentation: 34 days at 40 degrees F (4 degrees C) in glass
- Age when judged (since bottling): 2 1/2 months

Brewer's specifics

This recipe follows the recipe published by Fred Eckhardt with the following changes:

Use Hinode medium-grain rice. Retain 19 ounces (539 g) of rice and 20 ounces (591 mL) of water from tomezoe addition during moromi ferment and add these at yodan addition on day 21 of the moromi ferment. Pasteurize saké on day 51 of ferment when specific gravity reaches 0.998 to prevent it from becoming too dry. Fine with 1 teaspoon (4.9 mL) Sparkolloid® per gallon when racking to tertiary.

Judges' comments

"Rounded, harmonious tastes. Slightly alcoholic aftertaste. Very nice. The alcohol makes it seem a bit sweet and warm."

"If this saké has any flaw it is that it is too clean. Lacking character?"

"Comparable to all U.S.-brewed commercial saké."

PHOTO OF ROBERT AND RENÉE MATTIE BY KEN GRAHAM PHOTOGRAPHY

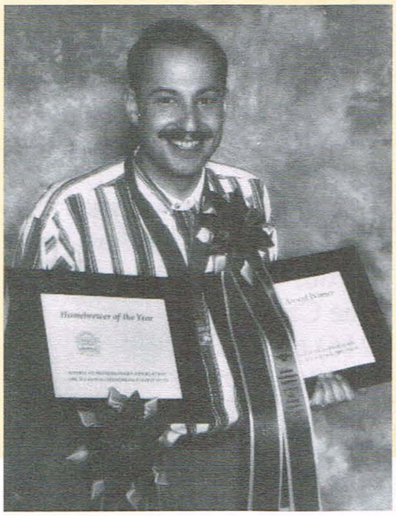
1995 Homebrewer of the Year

Award sponsored by Munton & Fison of England and the Great American Beer Festival®

Ninkasi Award Winner

Award sponsored by Pete's Brewing Co., Palo Alto, Calif.

By Caroline Duncker



Rhett Rebold, Burke, Va.

It's never happened before, but there was always the possibility that the Homebrewer of the Year at the AHA National Homebrew Competition would also be Ninkasi Award winner (the high-point brewer). That's exactly what happened in 1995. Rhett Rebold of Burke, Va., came out on top twice!

Rhett began brewing in 1982 while attending college at Virginia Commonwealth University in Richmond. He brewed with friends and joined a local homebrew club, the James River Brewers, after one year of brewing. "It's a lot like cooking. I like making Chinese and Southeastern Asian food and brewing is an extension of that interest," he says. He is attracted by the blend of technical information and creativity in brewing. "It's a great mix." Now that Rhett lives in northern Virginia he has joined the Brewers United for Real Potables but, remembering his roots, he retains his membership with James River Brewers.

Rhett began like most homebrewers brewing malt extract beers but quickly moved to all-grain mashes. Dave Miller's book, *Brewing the World's Great Beers* (Storey Publishing, 1992) was instrumental in helping him take that step. Rhett currently enjoys brewing with a modified keg system that he constructed. He brews outside over a "Cajun cooker."

Rhett brews 10-gallon batches about four or five times a year. His gold-medal and Best-of-Show winner, a Munich Helles, was brewed one year ago. "It was intended to be a Czechoslovakian Pilsener but the final gravity finished too high for that. It was a bit too chewy with a lot of Saaz hop character," he explains. He filtered and counterpressure bottled the beer. It received second best of show in the Beast of the East, Troy, New York, competition last February. "I had not entered the AHA nationals for two years, and I knew the competition was stiff, but this was a good beer."

When asked what was on his brewing wish list, Rhett replied, "I feel that I'm having better luck with lagers but my refrigerator is crowded. I'd like to have two more refrigerators, not a fridge junkyard or anything, but more room to lager."

Rhett enjoys British ales, too. He has traveled to England twice and knows what a true bitter should taste like. His second gold medal was awarded for his Real Bitter. "I didn't think I had a chance with the bitter," Rhett mused. "It is harder for judges to pick the lower gravity beers." He used about three ounces of Sucanut, dehydrated natural sugar juice, because unrefined sugars add the right characteristics.

Rhett filters and counterpressure bottles all his beers. He uses a five-micron filter so all the flavors remain apparent but some of the yeast is filtered out. Filtering is the best method to limit the yeast content which is hard on his allergies.

To improve their brewing, Rhett encourages homebrewers to join a club, find the best brewers and ask them questions. "The next best thing to do is read a lot on the subject and sample the commercial examples. I am always going after a beer I haven't had before."

Rhett will receive a trip for two to the 1995 Great American Beer Festival® Oct. 5, 6 and 7, in Denver, Colo., as part of his Homebrewer of the Year award. As the Ninkasi Award winner, Rhett will work with Pete Slosberg to develop a recipe for a seasonal beer to be brewed by Pete's Brewing Co. Rhett and Pete are thinking of a Scottish ale or an Oktoberfest/Vienna. Rhett will receive name recognition on each bottle of Pete's seasonal brew. Rhett doesn't have any ideas of going professional, however. "Professional brewing might destroy a really great hobby. I don't want to limit myself to brewing a certain number of beers or having them meet a consistency test," Rhett says.

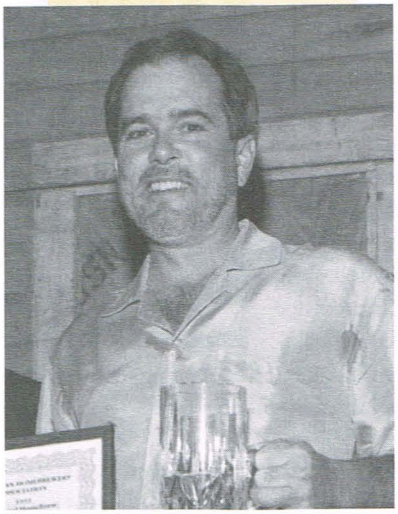
He does have thoughts of becoming a beer importer one of these days, but for now he'll stick to homebrewing. "Homebrewing is a great outlet and good for my mental health."

PHOTO BY KEN GRAHAM PHOTOGRAPHY

1995 Meadmaker of the Year

By Caroline Duncker

Award Sponsored by the American Mead Association, Grand Junction, Colo.



Paddy Giffen, Rohnert, Calif.

Paddy Giffen is one of only two brewers who has won both Homebrewer of the Year and Meadmaker of the Year awards. (Paddy won Homebrewer of the Year in 1993, Byron Burch in 1986, and Byron took Meadmaker of the Year honors in 1994 and 1992.) Paddy has been brewing beer for about 10 years, but didn't start making mead until 1990. "It was after the AHA 1990 National Homebrewers Conference in Oakland with Charlie Papazian's presentation on mead showcasing his prickly pear cactus mead, plus all the other homebrewers' meads there for the tasting," says Paddy. "Then I was turned on to meadmaking." Paddy thinks his winemaking background helps. "I take my meadmaking techniques from the roots of winemaking."

Paddy makes what he calls his "sack" meads, or traditional meads, in late summer or early fall. In the spring he makes fruit meads. He has experimented with many of the fresh fruits available in northern California, including blackberries, red raspberries, golden raspberries, rhubarb, pomegranate and plums. In late spring he blends his "sack" meads with the fruit meads to accomplish the right acid balance and honey flavor.

"I have had good luck with mesquite honey out of Tucson, Ariz. I use that almost exclusively," says Paddy. However, his winning still traditional mead was made with a star thistle honey. He traded Vern Wolfe, of Esparto, Calif., some grain for the honey and brewed a three-gallon experimental batch. "It's a young mead, brewed in July last year, but I am pleased with the results," says Giffen.

Paddy has been known to blend four- or five-year-old traditional meads with young fruit meads and rebottle them to achieve the right flavor. He uses Prisse de Mousse yeast exclusively and yeast nutrient from The Beverage People. He also believes in using sulfites for mead as with wine. He adds sulfite six to eight hours prior to pitching the yeast. "I boil the mead for 10 to 15 minutes and skim off the protein and break material," explains Paddy. If a mead is too dry, he makes what he calls a Champagne mead that is dry and fruity. "I'll take that same mead and blend it back to still and sweet."

Paddy has won at least one award in each of the nine years he has been competing in the AHA National Homebrew Competitions. He has placed first, second or third for his mead entries in 1991, 1993, 1994 and 1995. Paddy attributes his successful meadmaking to Byron Burch and Nancy Vineyard who provided education and helped refine his meadmaking techniques. Paddy has worked for The Beverage People and brewed professionally for Marin Brewing Co. in Larkspur, Calif.

He is opening a brewery in Novato, Calif., called Moylan's Brewery and Restaurant, a 20-barrel brewhouse with a 40-barrel fermenter. Paddy still plans to make mead in the late summer and spring as he has done for the last five years. "I look forward to making another mead with rhubarb," he muses, "perhaps a strawberry rhubarb mead."

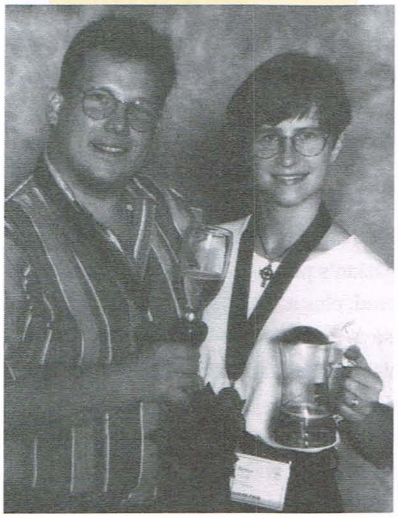
His dream is to open a cottage meadery after retirement. "There are a few meaderies in California, but people are still very ignorant about mead." Paddy is hoping to change that.

LEFT PHOTO BY RICK LUBRANT
RIGHT PHOTO BY GALEN NATHANSON

1995 Cidermakers of the Year

Award sponsored by Lyon's Brewery of Dublin, Dublin, Calif.

By Caroline Duncker



Robert and Renée Mattie, Downingtown, Pa.

Renée and Robert Mattie are new at the craft of cidermaking, and when they named their cider "Guilford Gold" they were referring to the place in Connecticut where they bought the apple cider blend. It also refers to the color of the cider — a beautiful golden hue, but they had no idea it would be the 1995 gold-medal-winning cider.

Renée and Robert started homebrewing on Renée's birthday in 1988. They were living in Florida and temperatures were too warm for beer fermentations. As a result most of their homebrew tasted cidery. Three years ago they turned their talents to cidermaking.

Robert describes himself as an appleholic. "I have fond memories of going to my grandmother's house in Connecticut where the smell of apples would predominate — apple pies, cider and dehydrated apples," Robert says.

They entered their first batch of cider, brewed in 1992, in the AHA 1994 National Homebrew Competition but it did not advance to the second round. They made their second batch in the fall of 1993 and won best of show in the First Annual BUZZ-Off Homebrew Competition, Malverne, Pa., in June 1994. They bottled the cider young, so it was rough, with some solvent-like flavors, but pretty good, according to Renée. After one month in the bottle, the flavor was quite complex with pear, papaya and apple aromas predominating. After one year the flavors had mellowed and blended to form an award-winning New England-style cider and the gold-medal winner in the 1995 National Homebrew Competition.

For all of their batches Renée and Robert search for the right blend of apple ciders. They enjoy the aroma of Macintosh apples that Bishops Orchard in Guilford, Conn., achieves in their orchard. They add sugar and ferment on oak chips. Their award winner, "Guilford Gold," sat in the garage all winter at about 40 degrees F (4 degrees C). The cider stayed cloudy and, in both of their minds, "looked terrible!" They allow it to remain on the lees, or the bits of apple and apple skin, and ferment with the wild yeast that occurs naturally on the apple. Their approach is rather simple — find a good apple blend, make the cider (chop the apples and combine the remaining ingredients), put it in a carboy and forget about it. When the cider clears it is time to bottle. Both were emphatic, "Don't make cider into beer!"

Robert explains, "There is no secondary [fermentation] with cider, no need to rack off the lees, nor is there any reason to use beer yeast, Sparkolloid® or any other fining. The cider will clear on its own and then it is time to bottle." Robert and Renée recommend that homebrewers just getting involved read *Sweet & Hard Cider — Making it, Using it & Enjoying It* by Annie Proulx and Len Nichols (Gardon Way Publishers, 1980) and *The Art of Cidermaking* by Paul Correnty (Brewer's Publications, 1995). They encourage homebrewers to find and taste commercial cider examples.

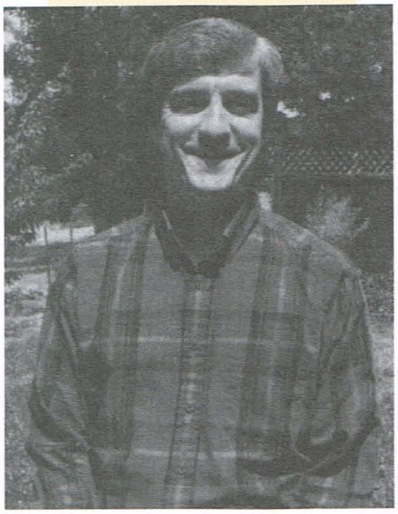
Robert and Renée have found an apple cider blend that produces award-winning ciders, and they attribute this success partly to the natural yeast they have cultured. They hope that in the near future there will be a culturing bank for cider yeast.

PHOTO BY KEN GRAHAM PHOTOGRAPHY
ILLUSTRATION BY GREG DYE

1995 Sakémaker of the Year

By Caroline Duncker

Award Sponsored by Kohnan Inc., Napa, Calif.



Charles Hessom, Redwood Valley, Calif.

酒

Charles Hessom became a homebrewer a long time ago when good information and quality ingredients weren't widely available. He brewed his first batch in 1976 and then put his supplies away for awhile — 15 years to be exact. In 1991 he brewed beer again for two years before deciding to make saké in 1993.

"I love Japanese food and culture. My wife and I ate sushi before it became the trend," says Charles. The food and culture are just part of his attraction to saké. Charles describes himself as a "fermentable anthropologist. "I am very interested in fermented beverages. I made a chicha beer based largely on the article in the ***Zymurgy*** 1994 Special Issue [Vol. 17, No. 4] and I look forward to brewing a sour sorghum beer," he explains.

The first time he brewed saké he entered it in the AHA 1994 National Homebrew Competition, earning third place. After tasting his second batch, he knew it was better than the first. "It was less harsh and not as acidic," says Charles. "I held back on the fourth addition of rice and water called the yodan. I terminated the fermentation early and pasteurized it to keep it from going dry."

Charles uses a medium-grain white rice from the supermarket. A highly polished rice without the protein coat also is available and he plans to use this type in future sakés. He receives his koji culture from Gem Cultures in California through mail order. Charles notes that Wyeast has a liquid saké yeast culture available as well. Charles cultures his own yeast and is preparing a yeast bank for future saké brewing. He uses distilled water for brewing and adds a pinch of Epsom salt, table salt and yeast nutrient. He says it is important to have distilled water because too much iron in the water can darken the saké.

Charles used Fred Eckhardt's recipe with a few slight modifications in procedure to make his award-winning Yodeling Yodan. "It's really quite easy to brew a quality saké following Fred's recipe," Charles says encouragingly. "Don't be intimidated by the process." He recommends reading Fred Eckhardt's book, *Sake U.S.A.* (Fred Eckhardt Communications, 1992), and subscribing to the Sake Connection newsletter, available in homebrew shops. Fred's saké recipe has been updated and is available through the Sake Connection.

Charles mixes the rice the traditional way, with his bare hands. "It takes 15 to 20 minutes to mix in the rice and afterwards my hands are chapped from the acidic solution," he says. During the main fermentation the mash substance becomes very doughy and is described as a "dancing" fermentation.

Charles recommends that homebrewers join a homebrew club, because questions can be answered there and it is a good social outlet. He is a member of the Sonoma Beerocrats, the Homebrew Club of the Year for the last 10 years. One notable member, Byron Burch, helped Charles get started in homebrewing with his book, *Brewing Quality Beers* (Joby Books, 1986). Charles plans to brew another saké this winter. His motto is to "have heart and have at it."

JAPANESE SYMBOL MEANS "SAKÉ"

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317-A Old County Rd.
Belmont, CA 94002
(415) 637-9844

Doc's Cellar
470 Price St.
Pismo Beach, CA 93449
(805) 773-3151

Double Spring Homebrew Supply
4697 Double Springs Rd.
Valley Springs, CA 95252
(209) 754-4888; (800) 465-4888

Fermentation Settlement
1530 Saratoga-Sunnyvale Rd.
San Jose, CA 95129
(408) 973-8970

Fermentation Frenzy
991 N. San Antonio Rd.
Los Altos, CA 94022
(415) 941-9289

Fremont Homebrew Supply
37918 Stenhammer Dr.
Fremont, CA 94536
(800) 655-6060; (510) 794-8694;
FAX (510) 794-8072

Great Fermentations of Marin
87M Larkspur
San Rafael, CA 94901
(415) 459-2520; (800) 570-BEER

Home Brew Mart
5401 Linda Vista Rd., Suite 406
San Diego, CA 92110
(619) 295-2337

The Home Brewery
24723 Redlands Blvd. #F
San Bernardino, CA 92408
(909) 796-0699; (800) 622-7393

HopTech
3015 Hopyard Rd., Suite E
Pleasanton, CA 94588
(510) 426-1450; (800) DRY-HOPS;
FAX (510) 736-7950

Liquorama
901 A W. Foothill
Upland, CA 91786
(909) 985-3131

Napa Fermentation Supplies
PO Box 5839
575 Third St., Suite A
Napa, CA 94581
(707) 255-6372; (800) 242-8585

Oak Barrel Winecraft Inc.
1443 San Pablo Ave.
Berkeley, CA 94702
(510) 849-0400

Portable Potables
1011 41st Ave.
Santa Cruz, CA 95062
(408) 476-5444

R & R Home Fermentation Supplies
8385 Jackson Rd.
Sacramento, CA 95826
(916) 383-7702

Ruud-Rick's Homebrew Supply
7273 Murray Dr. #17
Stockton, CA 95210
(209) 957-4549

San Francisco Brewcraft
1555 Clement St.
San Francisco, CA 94118
(415) 751-9338

Santa Cruz Homebrew
616 California St.
Santa Cruz, CA 95060
(408) 459-0178

South Bay Homebrew Supply
PO Box 3798
Torrance, CA 90510
(310) 517-1841

Stein Fillers
4180 Viking Way
Long Beach, CA 90808
(310) 425-0588

COLORADO

The BREW-IT Co.
120 W. Olive St.
Fort Collins, CO 80524
(800) 748-2226; (303) 484-9813

Doc's Brew Shop
3150-B1 S. Peoria
Aurora, CO 80014
(303) 750-6382

Front Range Bierhaus
3117 N. Hancock Ave.
Colorado Springs, CO 80907
(719) 473-3776

Highlander Home Brew Inc.
151 W. Mineral Ave., Suite 113
Littleton, CO 80120
(303) 794-3923; (800) 388-3923

The Homebrew Hut
555 I Hwy. 287
Broomfield, CO 80020
(303) 460-1776

Liquor Mart Inc.
1750 15th St.
Boulder, CO 80302
(303) 449-3374; (800) 597-4440

North Denver Cellar
3475 W. 32nd Ave.
Denver, CO 80211
(303) 433-5998

Old West Homebrew Supply
301 B E. Pikes Peak Ave.
Colorado Springs, CO 80903
(719) 635-2443; (800) ILV-BREW

Pearl Street Brew Works
1540A S. Pearl St.
Denver, CO 80210
(303) 722-9050
Internet: swrogerØ@csn.net

Rocky Mountain Homebrew
7292 N. Federal Blvd.
Westminster, CO 80030
(303) 427-5076

Silverthorne Homebrewers Supply
301 Lagoon Lane
PO Box 978
Silverthorne, CO 80498-0978
(303) 468-8330; (800) 235-8330

What's Brewin'
2886 Bluff St.
Boulder, CO 80301
(303) 444-9433

Wine & Hop Shop
705 E. 6th Ave.
Denver, CO 80203
(303) 831-7229

The Wine Works
5175 W. Alameda Ave.
Denver, CO 80219
(303) 936-4422

CONNECTICUT

Brother Logan Home Brewing Supplies
60 Jerry Daniels Rd.
Marlborough, CT 06447
(203) 295-8620

Great American Home Brew Supplies at Geremia Gardens
1720 West St.
Southington, CT 06489
(203) 620-0332; (800) 94-UBREW

Just Brew It, LLC
946 Hope St., Suite 156
Stamford, CT 06907
(203) 329-8668; (800) 953-BREW

The Mad Capper
PO Box 161
Glastonbury, CT 06033
(203) 659-8588

S.E.C.T. Brewing Supply
c/o SIMTAC
20 Attawan Rd.
Niantic, CT 06357
(203) 739-3609

Wine and Beer Art of Smith Tompkins
1501 E. Main St., Route 202
Torrington, CT 06790
(203) 489-4560

DELAWARE

Delmarya Brewing Craft
Rt. 3, Box 190, County Rd. 411
Millsboro, DE 19966
(302) 934-8588

Wine Hobby USA
2306 W. Newport Pike
Stanton, DE 19804
(302) 998-8303; (800) 847-HOPS

FLORIDA

Brew Shack
4025 W. Waters Ave.
(Waterside Plaza)
Tampa, FL 33614
(813) 889-9495; (800) 646-BREW

BrewCrafters
6621 Gateway Ave.
Sarasota, FL 34231
(813) 925-9499; (800) HOT-WORT

The Home Brewery
416 S. Broad St.
PO Box 575
Brooksville, FL 34601
(904) 799-3004; (800) 245-BREW

Worm's Way Florida
4402 N. 56th St.
Tampa, FL 33610
(813) 621-1792; (800) 283-9676

GEORGIA

Brew Your Own Beverages Inc.
20 E. Andrews Dr. N.W.
Atlanta, GA 30305
(404) 365-0420; (800) 477-BYOB

Wine Craft of Atlanta
5920 Roswell Rd.
Parkside Shopping Center
Atlanta, GA 30328
(404) 252-5606

ILLINOIS

Beer In A Box
27W460 Beecher St.
Winfield, IL 60190
(708) 690-8150; (800) 506-BREW

Bev Art Homebrew & Wine Making Supply
10035 S. Western Ave.
Chicago, IL 60643
(312) 233-7579; (312) BEER579

The Brewer's Coop
1010 N. Washington St.
Naperville, IL 60563
(800) 451-6348

Chicago Indoor Garden Supply
297 N. Barrington Rd.
Streamwood, IL 60107
(708) 885-8282; (800) 444-2837

Chicago Homebrew Supplies
1444 W. Chicago Ave.
Chicago, IL 60622
(800) 213-BEER

Chicagoland Winemakers Inc.
689 W. North Ave.
Elmhurst, IL 60126-2132
(708) 834-0507; (800) 226-BREW

Crystal Lake Health Food Store
25 E. Crystal Lake Ave.
Crystal Lake, IL 60014
(815) 459-7942

CZ Tech
333 S. Cross St.
Wheaton, IL 60187-5405
(708) 688-7886

Evanston First Liquors Homebrewing
1019 W. Davis St.
Evanston, IL 60201
(708) 328-9651

Fleming's Winery
RR 2 Box 1
Oakwood, IL 61858
(217) 354-4555; (800) 832-4292

Home Brewing & Wine Making Emporium
28 W. 685 Rogers Ave.
Warrenville, IL 60555
(708) 393-2337; (800) 455-BREW

Home Brew Shop
307 W. Main St.
St. Charles, IL 60174
(708) 377-1338

Koski Home Brew Fixen's Ltd.
1415 5th Ave.
Moline, IL 61265
(309) 797-2130; (800) 788-BREW

Lil' Olde Winemaking Shoppe
4 S. 245 Wiltshire Lane
Sugar Grove, IL 60554
(708) 557-2523

Old Town Liquors
514 S. Illinois Ave.
Carbondale, IL 62901
(618) 457-3513

Rock River Brewing Supply
PO Box 6242
Rockford, IL 61108
(815) 227-HOPS

Sheaf & Vine Brewing Supply
Inside Mainstreet Deli & Liquors
5424 S. LaGrange Rd.
Countryside, IL 60525
(708) 430-HOPS

You-Brew Country Food & Liquor
19454 S. Route 45
Mokena, IL 60448
(708) 479-2900

INDIANA

Worm's Way Indiana
3151 South Hwy. 446
Bloomington, IN 47401
(812) 331-0300; (800) 274-9676

KANSAS

Bacchus & Barleycorn Ltd.
8725 Johnson Dr.
Merriam, KS 66202-2150
(913) 262-4243

KENTUCKY

The Home Brewery
114 N. 3rd St.
Bardstown, KY 40004
(502) 349-1001; (800) 992-BREW

Nuts N Stuff Inc., Bulk Foods
2022 Preston St.
Louisville, KY 40217
(502) 634-0508; (800) 867-NUTS

Winemakers Supply & Pipe Shop
9477 Westport Rd.
Westport Plaza
Louisville, KY 40241
(502) 425-1692; (800) 641-1692

MAINE

The Purple Foot Downeast
116 Main St., Dept. Z
Waldoboro, ME 04572
(207) 832-6286

MARYLAND

Brew N' Kettle
1017 Light St.
Baltimore, MD 21230
(410) 783-1258

Brew Masters Ltd.
12266 Wilkins Ave.
Rockville, MD 20852
(301) 984-9557; (800) 466-9557

Cellar Works
at Fullerton Liquors
7542 Belair Rd.
Baltimore, MD 21236
(410) 665-2900

Chesapeake Homebrew
14 Aventura Ct.
Randallstown, MD 21133
(800) 948-9776

The Flying Barrel
111 S. Carroll St.
Fredrick, MD 21701
(301) 663-4491

Happy Homebrewing Supply Co.
Old Salisbury Mall
351 Civic Ave.
Salisbury, MD 21801
(410) 543-9616

Maryland Homebrew
9009-D Mendenhall Ct.
Columbia, MD 21045
(410) 290-FROTH

Olde Towne Homebrew Supply
302 B E. Diamond Ave.
Gaithersburg, MD 20877
(301) 330-8881

MASSACHUSETTS

Barleymalt and Vine
26 Elliot St.
Newton, MA 02161
(800) 666-7026

Beer and Wine Hobby
180 New Boston St.
Woburn, MA 01801
(617) 933-8818; (800) 523-5423

Boston Brewers Supply Co.
48 South St.
Jamaica Plain, MA 02130
(617) 983-1710

The Hoppy Brewer Supply Co.
550 Central Ave.
Seekonk, MA 02771
(508) 761-6615

The Keg & Vine
697 Main St.
Holden, MA 01520
(508) 829-6717

Luke's Super Liquor Stores
511 Route 28
West Yarmouth, MA 02673
(508) 775-6364; (508) 775-2979;
FAX (508) 778-4668

The Modern Brewer Co.
2304 Massachusetts Ave.
Cambridge, MA 02140
(617) 868-5580; 800-Send-Ale

Stella Brew Homebrew Supply
16 State Rd., Rt. 20
Charlton City, MA 01508
(508) 248-6823; (800) 248-6823

Stella Brew Homebrew Supply
197 Main St.
Marlboro, MA 01752
(508) 460-5050; (800) 248-6823

Stella Brew @ Grovers
104 Highland St.
Worcester, MA 01609
(508) 797-9626; (800) 248-6823

The Vineyard — Home Brewers and Vintners Supply Shop
123 Glen Ave.
PO Box 80
Upton, MA 01568
(508) 529-6014; (800) 626-2371

Worm's Way Massachusetts
1200 Millbury St.
Worcester, MA 01607
(508) 797-1156; (800) 284-9676

MICHIGAN

Brew & Grow
33523 W. 8 Mile, #F-5
Livonia, MI 48152
(313) 442-7939

Brew-it Yourself Center
13262 Northline Rd.
Southgate, MI 48195
(313) 284-9529

Lake Superior Brewing Co.
7206 Rix St.
Ada, MI 49301-9189
(616) 682-0091

Plum Creek Spirits
PO Box 414
Vernon, MI 48476
(517) 288-6778; (800) 405-4-ALE

Red Wagon Wine Shoppe
2940 S. Rochester Rd.
Rochester Hills, MI 48307
(810) 852-9307

Wine Barrel Plus
30303 Plymouth Rd.
Livonia, MI 48150
(313) 522-9463

MINNESOTA

America Brews
9925 Lyndale Ave. S.
Bloomington, MN 55420
(612) 884-2039

Brew-N-Grow
8179 University Ave. N.E.
Fridley, MN 55432
(612) 780-8191

WindRiver Brewing Co. Inc.
7212 Washington Ave. S.
Eden Prairie, MN 55344
(612) 942-0589; (800) 266-HOPS;
FAX (612) 942-0635

MISSOURI

Cool Stuff
120 S. Ninth St.
Columbia, MO 65201
(314) 875-7912

The Home Brewery
S. Old Highway 65
PO Box 730
Ozark, MO 65721
(417) 485-0963; (800) 321-BREW

Johnny Brew-Meister's
Crossroads West Shopping Center
2101 W. Broadway
Columbia, MO 65203
(314) 446-8030;
FAX (314) 446-8031

St. Louis Wine & Beermaking
251 Lamp & Lantern Village
Chesterfield, MO 63017
(314) 230-8277

St. Louis Wine & Beermaking
9971 LinFerry Dr. (South County)
St. Louis, MO 63123
(314) 843-9463

Stout Marketing Custom Signage
6425 W. Florissant
St. Louis, MO 63136
(800) 325-8530

Third Fork
690 Walnut
Union Star, MO 64494
(816) 593-2357

Winemaker's Market
4349 N. Essex Ave.
Springfield, MO 65803
(417) 833-4145

Witt Wort Works
1032 S. Bishop Ave.
Rolla, MO 65401
(314) 341-3311

Worm's Way Missouri
2063 Concourse
St. Louis, MO 63146
(314) 994-3900; (800) 285-9676

NEVADA

The Home Brewery
4300 N. Pecos Rd. #13
North Las Vegas, NV 89115
(702) 644-7002; (800) 288-DARK

Mr. Radz Homebrew Supply Shop
4972 S. Maryland Pkwy. #12
Las Vegas, NV 89119
(702) 736-8504; Outside NV
(800) 465-4723; FAX (702) 736-7942

NEW HAMPSHIRE

Amber Waves Homebrew Supply
5 Central Ave.
Rochester, NH 03867
(603) 335-4707; (800) 813-4707

Beer Essentials
611 Front St.
Manchester, NH 03102
(603) 624-1080; (800) 608-BEER

Brewer & Associates/Maine Hopper
112 State St./PO Box 6555
Portsmouth, NH 03801
(603) 436-5918

The Seven Barrel Brewery Shop
Rt. 12-A at Exit 20, Interstate 89
West Lebanon, NH 03784
(603) 298-5566

The Stout House
Eastern Slope Plaza
North Conway, NH 03860
(603) 356-5290; (800) 842-BREW

NEW JERSEY

The Barnegat Bay Brewing Co.
215 Route 37 W.
Toms River, NJ 08755
(800) HOP-ON-IT

BEERCRAFTERS Inc.
110A Greentree Rd.
Turnersville, NJ 08012
(609) 2 BREW IT

The Brewer's & Vintner's Supply Co.
290 Cassville Rd.
Jackson, NJ 08527
(908) 928-4045; (800) 293-5816

The Brewmeister
115 N. Union Ave.
Cranford, NJ 07016
(908) 709-9295; (800) 322-3020

Coffee Thyme 'N More
201 N. Broadway
Gloucester, NJ 08030
(609) 456-8833

The Home Brewery
56 W. Main St.
Bogota, NJ 07603
(201) 525-1833; (800) 426-BREW

Homebrew Unlimited (inside Frames Unlimited)
2663 Nottigham Way
Trenton, NJ 08619
(609) 586-7837

Hop & Vine
11 DeHart St.
Morristown, NJ 07960
(201) 993-3191

Hunterdon Homebrew Shoppe
10 Bridge St.
Frenchtown, NJ 08825
(908) 996-6008

Red Bank Brewing Supply
67 Monmouth St.
Red Bank, NJ 07701
(908) 842-7507; (800) 779-7507

Richland General Store
Route 40, PO Box 185
Richland, NJ 08350
(609) 697-1720

Tully's Brew-N-Barrel
476B Bloomfield Ave.
Verona, NJ 07044
(201) 857-5199

U-Brew Co.
319 1/2 Millburn Ave.
Millburn, NJ 07041
(201) 376-0973

Wine Rack
293 Route 206
Flanders, NJ 07836
(201) 584-0333

NEW YORK

Arbor Wine & Beermaking Supplies Inc.
74 W. Main St.
East Islip, NY 11730
(516) 277-3004; FAX (516) 277-3027

The Brew Shop @ Cornell's
310 White Plains Rd.
Eastchester, NY 10707
(800) 961-BREW;
FAX (914) 961-8443

Brew By You Inc.
119 Rockland Center, Suite 293
Nanuet, NY 10954
(800) 9-TO-BREW;
FAX (914) 732-8213

Brewers Den
24 Bellemeade Ave.
Smithtown, NY 11787
(516) 979-3438; (800) 499-BREW

The Brewery
11 Market St.
Potsdam, NY 13676
(315) 265-0422; (800) 762-2560

The Brews Brothers at KEDCO - Beer & Wine Supply Store
564 Smith St.
Farmingdale, L.I., NY 11735-1168
(516) 454-7800;
(800) 654-9988 (outside N.Y.only);
FAX (516) 454-4876

D.P. Homebrew Supply
1998 E. Main St., Route 6
Mohegan Lake, NY 10547
(914) 528-6219

E.J. Wren Homebrewer Inc.
Ponderosa Plaza (behind Heids)
209 Oswego St.
Liverpool, NY 13088
(315) 457-2282

East Coast Brewing Supply
124 Jacques Ave.
PO Box 060904
Staten Island, NY 10306
(718) 667-4459;
FAX (718) 987-3942

Great Lakes Brew Supply
310 Adams Ave.
Endicott, NY 13760
(607) 785-4233; (800) 859-GLBS

Heller's Homebrew Supplies Inc.
120 Milton Ave.
Syracuse, NY 13204
(315) 426-1044; (800) BREW666
(outside 315 area code)

Hop, Skip & A Brew
58-07 Metropolitan Ave.
Ridgewood, NY 11385
(718) 821-6022

Little Shop of Hops Home Brewing Supply Co.
15 W. 39th St.
New York, NY 10018
(212) 704-4248; (800) 343-HOPS;
FAX (212) 704-9611

Mountain Malt and Hop Shoppe
54 Leggs Mills Rd.
Lake Katrine, NY 12449
(800) 295-MALT; (914) 336-7688

The New York Homebrew
221 Old Country Rd.
Carle Place, NY 11514
(800) YOO-BREW;
FAX (516) 294-1872

Niagara Tradition Homebrewing Supplies
7703 Niagara Falls Blvd.
Niagara Falls, NY 14304
(716) 283-4418; (800) 283-4418

Party Creations
RD 2 Box 35 Rokeby Rd.
Red Hook, NY 12571
(914) 758-0661

NORTH CAROLINA

Alternative Beverage
114-0 Freeland Lane
Charlotte, NC 28217
(704) 527-9643; (800) 365-BREW

American Brewmaster
3021-5 Stoneybrook Dr.
Raleigh, NC 27604
(919) 850-0095

Assembly Required
142 E. Third Ave.
Hendersonville, NC 28739
(704) 692-9677; (800) 486-2592

Brew Better Supply
10207 C Chapel Hill Rd.
Morrisville, NC 27560
(919) 467-8934; (800) 915-BREW
BREWBETTER @AOL.COM

NORTH DAKOTA

The Home Brewery at Happy Harry's Bottle Shop
2151 32nd Ave. S.
Grand Forks, ND 58201
(701) 780-0902; (800) 367-BREW

OHIO

The Grape and Granary
1302 E. Tallmadge Ave.
Akron, OH 44310
(216) 633-7223

OKLAHOMA

Bob's Brewhaus
724 W. Cantwell Ave.
Stillwater, OK 74075
(405) 372-4477

Professional Brewers LLC
10902 N. Pennsylvania
Oklahoma City, OK 73120
(405) 752-7380

OREGON

Aycock Knives & Beer Supply
120 Columbia St. N.E.
Salem, OR 97303
(503) 378-0774

F.H. Steinbart Co.
234 S.E. 12th St.
Portland, OR 97214
(503) 232-8793

Home Fermenter Center
123 Monroe St.
Eugene, OR 97402
(503) 485-6238

Homebrew Heaven
1292 12th St. S.E.
Salem, OR 97302
(503) 375-3521

PENNSYLVANIA

Beer Unlimited
515 Fayette St.
Conshohocken, PA 19428
(610) 397-0666

Beer Unlimited
Routes 30 and 401,
Great Valley Shopping Center
Malvern, PA 19355
(215) 889-0905

BREW by YOU
3504 Cottman Ave.
Philadelphia, PA 19149
(215) 335-BREW

The BREWSMITH Ltd.
323 E. Main St.
Collegeville, PA 19426
(610) 489-8986

Country Wines
3333 Babcock Blvd.
Pittsburgh, PA 15237-2421
(412) 366-0151

Home Sweet Homebrew
2008 Sansom St.
Philadelphia, PA 19103
(215) 569-9469; FAX (215) 569-4633

Homebrewer's Outlet
10 Lincoln Circle
Fairless Hills, PA 19030
(215) 943-8569

Keystone Homebrew Supply
779 Bethlehem Pike
Montgomeryville, PA 18936
(215) 855-0100; FAX (215) 855-4567

Mr. Steve's Homebrew Supplies
4342 N. George St.
Manchester, PA 17345
(717) 266-5954

Neibert's Spielgrund Wine & Gift Shop
3528 E. Market St.
York, PA 17402
(717) 755-3384

RHODE ISLAND

Basement Brew-Hah Inc.
PO Box 7574
Warwick, RI 02887
(401) 727-1150; (800) 213-BREW

Brew Horizons
884 Tiogue Ave.
Coventry, RI 02816
(401) 826-3500; (800) 589-BREW

SOUTH CAROLINA

Carolina Wine and Cheese
54 1/2 Wentworth St.
Charleston, SC 29401
(803) 577-6144

TENNESSEE

Allen Biermakens
4111 Martin Mill Pike
Knoxville, TN 37920
(615) 577-2430; (800) 873-6258

The Winery & Brew Shoppe
60 S. Cooper St.
Memphis, TN 38104
(901) 278-2682

TEXAS

Bulldog Brewing Supply
2217 Babalos
Dallas, TX 75228
(214) 324-4480; (800) 267-2993

C & E Discount Supply
PO Box 30660
Paris, TX 75462
(903) 785-7232

DeFalco's Home Wine & Beer Supplies
5611 Morningside Dr., Dept. Z
Houston, TX 77005
(713) 523-8154; FAX (713) 523-5284

Homebrew Supply of Dallas
777 South Central Expwy.,
Suite 1-P
Richardson, TX 75080
(214) 234-5922

Homebrew Headquarters
2810 Greenville
Dallas, TX 75206
(214) 821-7444; Order lines:
(800) 966-4144, (800) 862-7474

Homebrew Headquarters — North
13929 N. Central Expwy.,
Suite 449
Dallas, TX 75243
(214) 234-4411; (800) 966-4144

Homebrew Headquarters — West
900 E. Copeland, Suite 120
Arlington, TX 76011
(817) 792-3940; (800) 862-7474

Southwest Brewcenter
2412 Broadway St.
Lubbock, TX 79401
(806) 744-6808

St. Patrick's of Texas Brewers Supply
12922 Staton Dr.
Austin, TX 78727
(512) 832-9045; (800) 448-4224

The Winemaker Shop
5356 W. Vickery
Fort Worth, TX 76107
(817) 377-4488; (800) IT BREWS;
FAX (817) 732-4327

UTAH

The Beer Nut Inc.
1200 S. State
Salt Lake City, UT 84111
(801) 531-8182; (800) 626-2739

Brew-Yers
1879 South Main St., Suite 160
Salt Lake City, UT 84115
(801) 484-8809

VERMONT

Something's Brewing
196 Battery St.
Burlington, VT 05401
(802) 660-9007

Vermont Homebrewer's Supply
20 Susie Wilson Rd.
Essex, VT 05451
(802) 879-2920;
(800) 456-BREW

VIRGINIA

Brew America
138 Church St. N.E., Suite F
Vienna, VA 22180
(703) 938-4805

The Brewmeister
1215G George Washington
Memorial Hwy.
Yorktown, VA 23693
(804) 595-HOPS

James River Brewing Co.
2602 W. Main St.
Richmond, VA 23220
(804) 353-5006

Vintage Cellar
1313 S. Main St.
Blacksburg, VA 24060
(703) 953-CORK;
(800) 672-WINE

WASHINGTON

The Beer Essentials
15219 Pacific Ave. S.
Spanaway, WA 98444
(206) 536-8840

Brewmasters
6122 Motor Ave. S.W.
Tacoma/Lakewood, WA 98499
(206) 589-BREW

Brewer's Warehouse
4520 Union Bay Place N.E.
Seattle, WA 98105
(206) 527-5047

Cascade Brewing Supplies
224 Puyallup Ave.
Tacoma, WA 98421
(206) 383-8980

The Cellar Home Brew
14411 Greenwood N.
Seattle, WA 98133
(206) 365-7660; (800) 342-1871

Evergreen Brewing Supply
12121 N.E. Northup Way,
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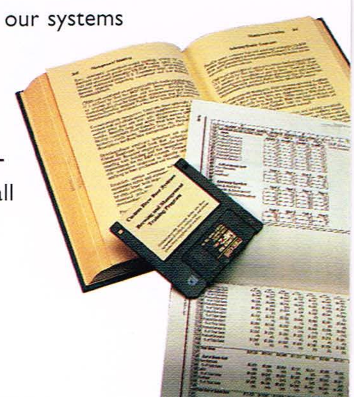


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