The Cooking of Cottonseed Meats in Various Gases

The Effect on the Properties of the Expressed Oil

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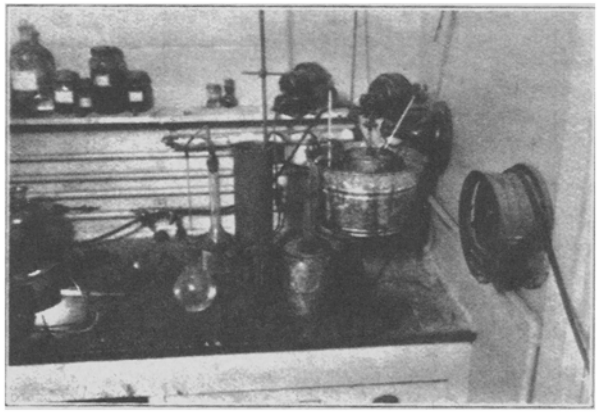
It has been said of cottonseed oil that low refining losses are made in the crude mill. While this does not tell the whole story, we know that most factors involved in the cooking of cottonseed meats have a considerable bearing on the quality of the oil produced. Many of these were studied by the Crude Mill Operations Committee of 1928 and 1929 under the chairmanship of Mr. A. K. Schwartz[1, 2]. The investigation consisted of studying the effect of varying most of the conditions involved in the cooking process.

One cooking factor, however, which has received but scant attention is atmospheric oxidation of cooking meats, and its effect on the quality of products made. The injection of live steam into the cooker has been practiced to some extent, and its use has resulted generally in improved extraction and better oil quality. Commenting on an experiment in the work referred to above Schwartz says: "It was found that the addition of live steam improved the extraction, particularly where low jacket pressures were employed. . . . The addition of direct steam consistently lowered the loss. . . . This was obtained without any detrimental effect upon the color of the refined and bleached oil. The color of the crude oil appeared lighter when steam was applied."

It should be observed that the use of live steam modifies other conditions besides excluding oxygen. The moisture content of the meats is changed and the rate of heating accelerated; and these factors were shown in the work quoted above to have a marked effect on extraction standard and oil quality. A further result of using any sweeping gas in cooking is the more rapid removal of the gaseous products of decomposition which form. This itself, may have some effect on the products. Marrs[3] studied the evolution of carbon dioxide and ammonia from meats cooked in streams of moist and dry air and reported that neither gas was evolved when the air was replaced by an inert gas, CO_2—free



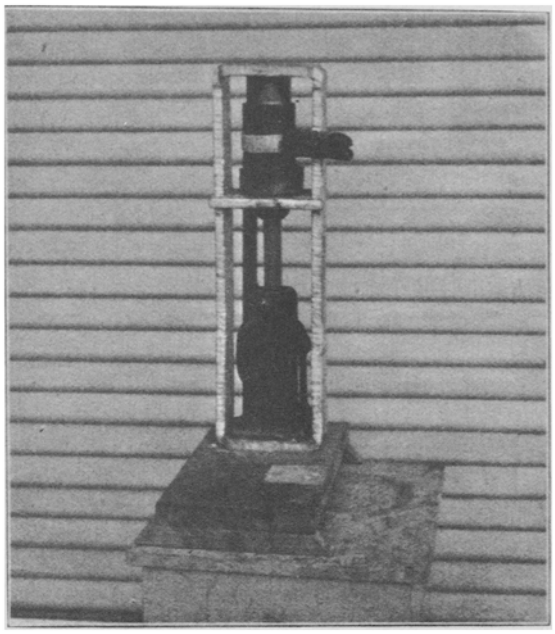
Apparatus for Cooking Cottonseed Meats in Streams of Gases

methane, being used. It was also claimed that the benzene extract of the cottonseed meats cooked in an atmosphere of methane was of light greenish-yellow color, whereas a benzene extract of the original meats was highly colored in the red.

This last rather startling observation led to the writer's making the experiments reported in this paper. It was desired especially to confirm it with respect to the oil extracted by pressing.

Apparatus:

The cooker used in all experiments except one was made from a one gallon seed sample can, which was

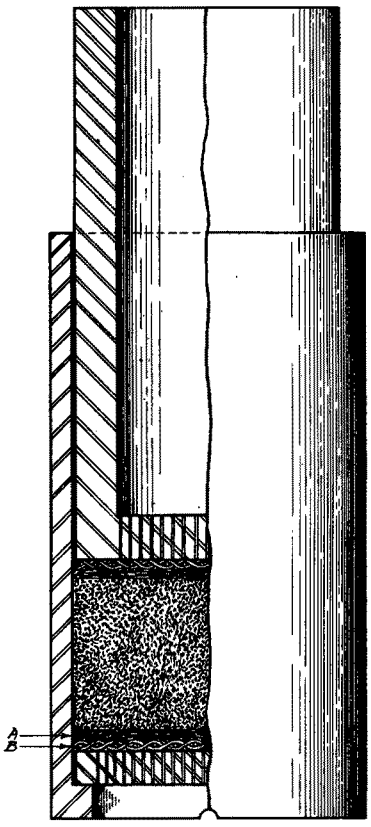


Hydraulic Oil Press

equipped with inlet and outlet tubes, the former being soldered in at the bottom, and a two blade staggered agitator, which was driven through a flexible connection by the slow motion mechanism on an oscillating fan. This arrangement is shown in the photograph which also illustrates the oil bath, contained in a small galvanized tub, and the steam superheater, composed of a coil of ⅜ inch copper tubing contained in the 4 inch vertical pipe. There is also a steam trap with glass tube to indicate the pressure, a soda-lime tube for removing CO_2 from the natural gas, and a saturator for loading the gas with moisture, without which the cooked meats were so dry that the oil yields on pressing were impractically low. The gas was saturated by bubbling through water in a Kjeldahl flask contained in a seed sample can having two holes cut in the cover, the smaller one for leading in live steam by which the water was kept near the boiling point. The gases used, other than steam, were preheated to cooking temperature by passing through a copper coil in the oil bath encircling the cooker. Unless this was done, it was found difficult to keep the meats at the proper temperature without using too slow a gas flow or an excessive bath temperature, which it was desired to avoid on account of the possibility of local scorching. Even so, an oil bath temperature of 115° to 125° C. was required for a meats temperature of 105° to 110° C. (221° to 230° F.).

The hydraulic press used was built on the premises at comparatively small cost, and since other laboratories may find it desirable to construct one, the following de-

scription is given: Its construction is evident from photograph and drawing. The jack is of 7 tons capacity and as the cell plunger (3 inch in diameter) has an area of 7 square inches we have $\frac{7 \text{ tons} \times 2000 \text{ lb./ton}}{7 \text{ sq. in.}} = 2000$ lb./sq. in., the pressure on the cake. This is the same as occurs in ordinary mill practice. Since a hydraulic jack may be injured by overloading, it was desired to know the value of the pressure applied at any time, this being also necessary to insure equal pressure on the meats of different runs on which comparisons were to be made. The purchase of a high pressure gauge was avoided by the following expedient. Various known loads (motor trucks) were lifted by the jack and the force in pounds necessary to pull down the handle at a definite distance was noted. This was determined by interposing a spring scale between the hand and the jack handle. A graph was then made on which the load was given as a function of the force on the handle. The mechanical advantage was found to be 200:1 for a handle length of 20.5 inches.



Press Pot

It is noticed that the drainage of oil from the cake is aided by using a hollow plunger perforated at the bottom, and also by interposing a heavy ¼ inch mesh screen between the ¼ inch thick felt filter discs and the perforated plates. No efforts were made to secure low extraction standards, as it was more practical to obtain the maximum quantity of oil by pressing plenty of meats. A cake of 6.5 per cent oil content was made, however, which was 1¼ inch thick. Much more efficient extraction could be obtained by making thinner cakes.

Experimental Procedure and Analysis

With each cooking run was made a control run in which were duplicated as nearly as possible actual press room conditions. That is, the effect of cooking in each streaming gas was compared with cooking in still air, or in such steam as was driven off. All such double runs were made on the same day, since the free fatty acid contents of the rolled meats stocks increased rapidly. The meats were taken from the rolls of an oil mill and stored in friction top cans in an ice box between runs. A cooker charge was 1.5 liters, which gave two press charges. While the first of these was being pressed, it was endeavored to keep the remaining cooked meats up to temperature and in contact with the gas used.

The following observations were made in three runs with steam and one regular run:

	First Pressing, %	Second Pressing, %
Steam, F. F. A.	3.1	3.1
Steam, Oil Color	3.5 Red	4.0 Red
Steam, Oil Color	5.4	5.6
Regular, Oil Color	7.0	7.8

The meats of the second pressing were unprotected from the atmosphere during the time the first pressing was made, that is, about fifteen minutes, in which interval sufficient oxidation or decomposition occurred to increase the color by as much as 0.8-Red.

Crude oil colors were determined by filtering one gram of oil into a color tube and reading in the usual way. The same tube was used throughout this work and care was taken that no oil was on the walls of the tube.

The oil was bleached and refined in the following manner: To 80 grams of the oil in a four ounce sample bottle was added the proper amount of lye at 20° to 24° C. This was shaken for five minutes, heated in a 60° C. water bath and then tilted slowly back and forth until the soap began to settle. It was then centrifuged until the soap formed a compact mass. Then the usual procedure was followed. The bleach was made by heating the refined oil in an oil sample bottle to 125° C. in an oil bath, then adding 6% of earth and shaking for five minutes. In every experiment the oil of the control run was refined and bleached concurrently with that with which comparison was required; so that conditions such as time and intensity of shaking, temperature, etc., were the same. A trial refining on an oil that had been refined by the Official Method was made with the following results:

Bottle refining	6.8% Loss
Official method	6.6% Loss

Rates of gas and steam flow were not measured, nor was the steam temperature determined. The duration of all cooking runs was 60 or 120 minutes after the meats reached the desired temperature, about 15 minutes being required for this. During the period of heating up the gas being studied was streaming through the meats.

Results and Conclusions

The first experiment was made primarily to check Marrs' observation on the yellow color of oil from meats cooked in methane, and to determine if there was any parallelism between the colors of the crudes from the methane cook and that of the crude from the regular cook, as extracted from the meats by various means.

The following table shows the results:

TABLE I

Method of Extraction	Methane Cook	Regular Cook	CH_4/Reg.
Skelleysolve	4.2 Red	5.3 Red	.79
Benzol	25.3	33.0	.77
Pressing No. 1	9.6	11.9	.81
Pressing No. 2	8.2	11.0	.75

It is thus seen that, while there is a wide variation in the colors of the oil from meats cooked in a particular way depending on the method of extraction, the ratio

of the colors of oils from meats cooked by the two methods is about the same regardless of how the oil was extracted. In no case was an oil obtained that could be called yellow, nor, except in one case, was any oil obtained in this work as light in color as the petroleum ether extract ordinarily obtained from prime uncooked meats, as for the free fatty acid determination. All the results are shown in tables, II and IV. These are further summarized in table III.

The data of table IV were obtained at the close of the crushing season, using one batch of meats, which deteriorated rapidly. The experiments were made in an effort to obtain a yellow crude oil by varying the time and temperature of cooking.* Methane cook No. 1 gave a crude pressed oil containing about 1/5 as much red color as was in the oil of the control cook, and somewhat less than was in the petroleum ether extracted oil from the uncooked meats. The cooked meats contained so much moisture that they "crawled" in the press, and such a poor yield of oil was obtained that a refining loss determination could not be made. Every subsequent effort to produce an oil of such light color failed. The only respect in which methane run No. 1 differed from Nos. 4 and 5 (aside from the difference in original free fatty acid content) was that No. 1 was cooked very wet. Run 5 was made as an attempt to duplicate Run 1, but despite the high temperature of the water through which the gas was bubbled, the moisture content was normal; so that for proper control of moisture, it is evident that the rate of gas flow will, in further work, have to be regulated.

One of these experiments, at least, shows that it is possible to make an unusually light colored crude oil by exclusion of oxygen in the cooking process. Whether this may be done with practical yields and without damage to the cake, and whether the refining loss and color of refined and bleached oil is also improved, remains for further work to determine. The problem will therefore be pursued further in this laboratory and associated oil mills during the next crushing season.

TABLE II

	Crude Oil FFA %	Refined Oil Color	Refined Oil Loss %	Bleached Oil Color	Bleached Oil Color	Cake Oil %	Cake H_2O %	Cake Color
No. 1—								
Original meats.	..	..	..	..	..	..	..	..
Regular cook..	4.0	11.5R	15.4	7.8R	3.5R	..	..	..
Methane cook..	3.8	8.9	13.9	7.8	3.4	..	..	..
No 2—								
Rolled meats..	4.4	..	..	..	..	..	..	..
Regular cook..	4.4	9.1R	..	..	..	..	..	..
Methane cook..	4.6	5.2	..	..	..	..	..	..
CO_2 cook	4.3	6.4	..	..	..	..	..	..
No. 3—								
Rolled meats..	2.7	3.0	..	..	..	..	..	..
Regular cook..	3.8	8.2	10.3	6.2	3.3	8.5	6.5	Light
Steam cook....	3.1	3.7	8.3	5.7	3.1	10.3	10.8	Dark
No. 4—								
Rolled meats..	6.5	3.6	..	..	..	..	..	..
Regular cook..	6.9	9.6	18.3	6.7	3.3	10.9	6.8	3
Flowing air....	6.6	10.0	..	..	..	12.6	6.8	2
Flowing oxygen	6.1	10.0	19.8	6.7	..	9.4	6.4	1
Flowing steam	6.1	6.6	13.9	7.2	3.6	7.8	11.3	4
No. 5—								
Rolled meats..	1.4	..	..	..	..	..	..	..
Regular cook..	1.7	7.4	9.6	4.4	3.0	7.9	8.2	..
Steam cook....	1.6	5.5	9.1	4.3	3.4	9.1	8.3	..

TABLE III

F.F.A. Original Meats, %	Gas Used	Reduction In FFA,%	Loss, %	Color	Bleach
6.5	Steam	0.8	4.4	—0.5	—0.3
3.5	Methane	0.2	1.5	0.0	0.1
2.7	Steam	0.7	2.0	0.5	0.2
1.4	Steam	0.1	0.5	0.1	—0.3

*Marrs assumed that the temperature of the meats was the same as his bath temperature, but it is seen that a 10° C. difference exists.

TABLE IV

	Air, Regular	Flowing Methane I	II	III	IV	V
Time of cook, hrs.....	2½	2½	1	2½	2½	2½
Temp. of bath (°C.)..	110	110	110	119	110	110
Temp. of meats (°C.).	100	100	100	109	100	100
Temp. of water (°C.).	...	90	90	60	60	90
Original meats, FFA, %	1.5	1.7	1.9	2.7	2.7	3.6
Orig. meats, color (R)	2.5	2.5	2.5	2.5	2.5	3.4
Crude oil, FFA.....	2.1	1.9	2.4	3.0	3.4	3.4
Crude oil, color.....	7.5	1.6	10.0	10.0	9.2	7.7
Refining loss	8.6	..	10.9	13.1	10.7	13.6
Expected loss	9.5	..	10.2	11.4	12.1	12.1
Refined oil color.....	4.4	..	4.1	5.0	5.3	4.3
Cake (%) oil.....	13.1	10.9	12.0	14.1	11.3	11.4
Cake (%) ammonia...	8.76	7.18	8.19	9.16	8.62	8.83
Cake, standard	150	152	147	154	131	129
Cake (%) moisture...	6.2	12.6	8.6	4.3	8.3	7.7
Cake, color	Light	Very Dark	Medium	Light	Medium	Medium

Summary

Laboratory cooking experiments have been made to ascertain the effects of various gases on the quality of crude cottonseed oil expressed. It is shown that lower refining losses and lower crude oil colors result from excluding oxygen from the cooking meats, but that the improvement in color in the refined and bleached oil is negligible or absent. The effects assignable to varying moisture contents have not been satisfactorily determined in this work. It has also been shown that the effect of any carbon dioxide evolved from cooking meats is negligible. Further work is planned.

Houston, Texas,
April 8, 1933.

Industrial Chemical Sales Opens Columbus Office

The Industrial Chemical Sales Co., Inc., 230 Park avenue, New York City, manufacturers of well known brands of NUCHAR Activated Carbons, will open branch offices July 10, at 370 West Broad street, Columbus, Ohio, phone Main 4142. Mr. Richard N. Statham, formerly assistant manager of their Chicago office, will be in charge.

McLeod & Henry Co., manufacturers of Furnace Refractories for 108 years, recently published a 16-page bulletin describing their new "Steel Mixture" oil brand firebrick for oil-fired furnaces, CARBEX silicon-carbide brick for boiler, stoker and industrial furnace linings, high temperature fire cements, furnace linings and arches, etc. It contains information of value to purchasing agents, chief engineers and plant managers on the selection and care of firebrick furnace linings. Copies may be had by addressing McLeod & Henry Co., Troy, N. Y., and asking for Bulletin F-134.

Notice of Application—(First Publication)

Robert M. Simpson of Chas. W. Rice & Co., Columbia, S. C., has applied for a Referee Chemist Certificate of the American Oil Chemists' Society.