Studies in the Expression of Oil From Tung Fruit*

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Effect of Moisture and Shell Content on Pressing Efficiency

ONE of the objects of the investigations of our Tung Oil Laboratories at Gainesville, Florida, and Bogalusa, Louisiana, has been to ascertain means by which the commercial yield of tung oil by expression can be improved.

In studies to determine the effect of various temperatures used in drying tung fruit and of moisture content on the expression of oil from ground tung kernels, a laboratory press was used in a number of comparative tests. In these tests, a four-inch test cylinder was preheated to 100-105°C. By means of electric hot plates, using a variable resistance (Voltrol) rheostat for temperature control; a 50-gram sample of tung meal was placed in the cylinder on a filter pad and a second filter pad was placed above the sample. Pressure was applied gradually for a period of five minutes, at the end of which time a pressure of 5000 pounds per square inch had been reached and this pressure was maintained for 15 minutes to allow the oil to drain from the meal.

Expression yields obtained in these tests were considerably lower than those obtained in commercial practice, due probably to inadequate drainage in the press cylinder; therefore it was found difficult to draw definite conclusions from these tests regarding the influence of temperature and moisture on the yield of tung oil by the expression process. However indications were that tung kernels can be subjected to considerable temperature without adversely affecting the yield or quality of tung oil by expression and that a low-moisture content, such as 3%, is better for expression purposes than a higher moisture content, such as 6.3%.

Arrangements were made with the manufacturer of a commercial oil expeller for the loan of a small-size expeller to conduct tests on the expression of tung oil. The tung fruit has an outer portion of hull containing usually five seeds. The tung seed has a hard seed coat or shell covering the oily white kernel. In tung mills in the South, tung fruit is passed through a decorticator and then through a separator, where the hulls and loose shell are removed from the mixture of tung kernels and tung seed (kernels plus shell). The mixture of tung kernels and tung seed is ground and passed through a drier, or a tempering bin and dryer, and then passed through the expeller. Considerable difference of opinion existed at the tung mills in regard to the amount of shell that should be left on the dehulled tung fruit, although it is generally agreed that some shell must be left with the kernels to pro-

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TABLE 1

Results With Small Expeller

Run No.	Wt. Kernels in Grams	% Shell Added	% Moisture in		% Oil in		% Crude Oil**	% Filtered Oil**	% Filter Cake***
			Meal	P. C.*	Kernels	P. C.*			
1	1814	0	4.3	......	......	......	......	......	......
2	1814	5	6.7	6.8	58.9	38.4	39.6	25.7	13.9
3	1814	10	3.5	4.3	......	5.7	59.9	36.3	23.6
4	1814	10	7.0	7.6	57.0	8.8	52.6	44.4	8.2
5	1814	10	10.9	11.7	57.5	6.3	48.2	41.3	7.9
6	1814	15	1.9	......	......	......	40.0	22.6	17.4
7	1814	15	4.6	5.1	65.7	7.0	61.7	41.1	20.4
8	1814	15	6.7	8.5	62.5	7.0	68.6	48.6	20.0
9	1814	15	11.0	11.6	57.0	5.9	43.7	40.2	3.5
10	1814	20	2.6	2.8	65.7	4.3	62.7	47.9	14.8
11	1814	20	4.2	4.8	......	4.8	68.8	48.7	20.1
12	1814	20	6.4	7.8	......	6.9	51.7	37.8	13.9
13	1814	20	9.1	10.1	......	4.9	53.3	45 9	7.5
14	1814	20	9.5	9.2	......	10.0	47.8	30.0	17.8
15	1814	30	3.5	4.0	67.2	4.9	64.6	47.6	17.0
16	1814	30	6.8	7.2	59.6	5.4	52.0	45.4	6.6
17	1814	30	9.7	11.7	......	6.8	45.3	40.8	4.5
18	1814	30****	3.0	2.6	65.2	10.4	45.2	27.9	17.3
19	1814	30****	5.0	4.6	65.2	4.6	60.3	32.3	28.0

*Press cake. **Basis of kernels used. ***Basis of crude oil filtered. ****Estimated for sample dried by a manufacturing firm.

REMARKS ON TABLE 1

Run

1. Meal became sticky and rolled into balls in tempering bin. Foots oozed through bars of cage. Impossible to complete run as conveyer stopped feeding meal into the expeller.
2. Cake was never formed. When choke was closed, foots oozed from the cage and pressed meal stopped coming out of expeller.
4. Cake was thick and soft. A small amount of foots oozed from the cage.
5. Cake formed immediately but never became hard. Foots oozed from sides of cage.
6. Meal became sticky and oozed through the bars of cage.
7. Part of meal did not form cake. Unusually long time required for formation of cake.

Run

9. Cage took longer than usual to heat up. To build up sufficient pressure choke was closed until press cake came out in thin sheets. A considerable quantity of foots oozed out on the motor side of the cage.
13. Cake formed immediately; pressed well and quickly.
14. Did not have full set of pressing worms in expeller; full number added after this experiment and full set was used in all other runs.
15. Cake formed immediately, but remained medium-hard through the pressing. Small amount of foots oozed through the bars of the cage.
16. Cake formed immediately and was medium hard.
17. Very little cake formed; that which did was soft. It appeared that at a higher amperage, cake would have formed.
18. Cake formed at about 10 amperes.

vide friction and drainage in the expression process. In a series of pressing tests with the small-size expeller, the shell content of the tung meal was varied from none to 30 percent, while the moisture was varied from 1.9 to 10.9 percent. The expeller was built to operate at about 12 amperes of current. When attempts were made to make pressing tests on tung meals containing more than 30 percent of shell considerably more current was required due to increased friction in the press. As a result, 15-ampere fuses were burned out and it was believed inadvisable to resort to the use of higher amperage fuses because of the possibility of injury to the motor. The results of these tests are shown in Table 1.

THE best results in yields of crude and filtered tung oil were obtained in run No. 11 with a meal containing 4.2 percent moisture and 20 percent shell. In run No. 10, with 2.6 percent moisture and 20 percent shell, a press cake of somewhat lower oil content was obtained than was the case in other experiment (4.3% instead of 4.8%). Only slightly less favorable results were obtained in run No. 15 with a meal containing 3.5 percent moisture and 30 percent of shell. Runs No. 18 and No. 19 are of particular interest, since this meal had been dried by a commercial firm in a special type of hot air dryer using an initial air temperature of 320°F. The results obtained in run No. 18, using this meal, were much less favorable than those obtained in run No. 15 in which a meal of similar composition was used, except that in this case the unbroken kernels were dried at a relatively low temperature before they were ground to a meal and expressed. Slightly better results were obtained with the commercially dried meal in run No. 19 wherein sufficient water was added to raise the moisture content of the meal to five percent. However, in both runs with the commercially dried meal, the amount of filtered oil obtained was much lower than was the case with the laboratory dried sample; only 27.9 percent and 32.3 percent of filtered oil was obtained while the laboratory-dried sample yielded 47.6 percent of filtered oil. The Wijs iodine value of the filtered oil expressed from the commercially dried meal was appreciably lower than that of the meal in which the kernels had been dried in the laboratory (160.8 in the former case, and 166.9 in the latter).

Observations and tests at tung oil mills in the Florida, Georgia and Alabama areas have substantially verified the results obtained in the laboratory with the small-size expeller. Press cake of minimum oil content was obtained when the tung meal entering the expeller contained about four percent moisture. At times, however, the tung mill operator appears to obtain better expression results when the tung meal contains about five percent moisture, as difficulty is experienced in properly regulating the flow of meal to the press and in obtaining a good press cake with the drier meal. This is not surprising, since at the present time the quality of the tung fruit and the amount of shell left on the tung seed varies considerably, and since there are five different types of presses in operation in the tung oil area and each type of press has somewhat different operation characteristics. Excellent expression results have been observed at several tung oil mills where the operators produced a tung meal containing between thirty and forty percent of shell; the loss of oil in the hulling operation appeared to be at a minimum when most of the shell was left on the tung seed.

Disposal of Filter Cake

THE tung oil expressed in the United States has been found to be quite low in free fatty acid and, therefore, requires no alkaline refining. However, the crude tung oil produced at the mill contains considerable amounts of foots which are derived principally from the ground tung kernels and shell present in a tung meal; it is necessary, therefore, to filter the crude tung oil to remove these non-oil constituents. This is usually accomplished at the tung oil mill by passing the oil from the expeller to a steam-jacketed tank, where it is heated to about 180°F., agitated with about one percent of diatomaceous filter-aid and then filtered under about 40 pounds per square inch of pressure through a filter press having plates precoated with a thin layer of filter aid. Filtration is continued until an excessive amount of pressure is required to maintain the flow of filtered oil. The flow of crude oil to the filter press is then shut off and air is blown through the press to remove as much oil as possible from the cake, which is then removed from the press.

This filter cake usually contains about 50 percent of tung oil and amounts to 20 percent of the weight of the crude tung oil filtered; therefore, it is necessary to recover as much oil as possible from this material. This is accomplished either by adding the filter cake, a little at a time, to the tung meal while it is on its way to the expeller or by allowing the filter cake to accumulate and, at about weekly intervals, making a separate expression of this material after it has been thoroughly mixed with considerable quantities of tung oil press cake and tung hulls. Neither process appears to be very satisfactory. The oil present in this filter cake oxidizes more readily than that in tung meals, particularly at elevated temperatures; also this filter cake ignites spontaneously if due care is not used in its handling.

Since filter cake contains notable quantities of the diatomaceous earth used as a filter aid, its addition to a tung meal probably increases wear on the expeller. It appears, also, that this fine material tends to pass through the bars of the cage with the crude oil, since it has been found that the suspended solids of a crude oil may contain a high ash content (16.0%) much of which must be derived from the filter aid added to previous batches of crude tung oil for filtration purposes. In tests made at a tung oil mill it was found that a press cake of higher oil content was obtained when filter cake was added to the tung meal than when no filter cake was added to the meal, the values being 5.5% and 4.5% respectively. Also, mill managers have reported that the capacity of the expeller was materially less when filter cake is added to the tung meal.

When filter cake is expressed separately after mixing it with considerable quantities of press cake and hulls, it has been found difficult to obtain a press cake of a low oil content. The loss of oil in this case is augmented by the fact that the added press cake and hulls have absorbed their quota of the oil which is found in the resulting press cake.

In studying the effect of temperature on the processing of tung fruit at a tung oil mill, some evidence was obtained that the use of temperatures in the range of 265-300°F. in the drying of tung meals resulted in a marked increase in the amount of foots in the crude tung oil and consequently in the amount of filter cake separated from the crude tung oil. To obtain information on this matter a laboratory filtration test was developed for determining the amount of foots in a crude tung oil. In this test a No. 2 qualitative filter paper is placed in a four-inch steam-jacketed Buchner funnel, and the filter paper is coated with one gram of diatomaceous filter aid by filtering a suspension of the material in a warm previously filtered tung oil. One hundred grams of the crude tung oil to be tested is heated to 80°C., stirred at this temperature for ten minutes with one gram of the filter aid, and poured onto the paper. The mixture in the funnel is kept at 80°C. by passing steam through the jacket of the funnel, and the atmospheric pressure within the filtering flask is maintained at 5 inches below the prevailing pressure, during the filtration. The filtering time is noted, the end point being taken at the time when the last of the oil is absorbed by the filter paper. The filter cake is then weighed and analyzed for oil and moisture content.

By this test the amount of foots in a crude tung oil can be readily determined. Moreover, from comparative mill filtration tests, it appears that this test has some value in determining the relative rate of filtration of different crude tung oils and in determining the relative filtration efficiencies of different types of filter aid at the same temperature and of a particular filter aid at different temperatures. It is recognized, however, that this small-scale filtration is not equivalent to plant-scale pressure filtration in a filter press; therefore the results obtained are taken merely as an indication of possible trends. The filtration test was found useful in connection with some of the following expression tests using the small expeller.

Two test runs were made with the small expeller, where, in each case, one pound of filter cake was mixed with eight pounds of ground tung kernels and two pounds of ground shell and the resulting meal was expressed for oil. The results of these test runs, No. 20 and No. 21, are given in Table 2. In test run No. 20 some difficulty was experienced in properly adjusting the choke of the expeller and consequently the resulting press cake was relatively high in oil content (7.72%). On the other hand, the foots content of the crude tung oil was not excessively high (20.5%). In test run No. 21 the choke was adjusted very gradually to prevent the expeller from stopping up as it had done several times during the previous run. In this case the press cake contained only 5.76% oil but the resulting crude oil contained much more foots material (30.3%).

In test run No. 22 eight pounds of tung kernels and two pounds of tung shell were ground coarsely and pressed in the small expeller. No difficulty was experienced in this test; the press cake contained 5.90% oil, and the crude oil contained only 14.1% of foots. The oil content of this press cake was much lower than that in test run No. 20, which was made on tung meal containing about nine percent of filter cake. The amount of foots material present in the crude oil from test run No. 22 was less than half as much as in test run No. 21, which was made on tung meal containing filter cake material.

TABLE 2

Results in Expression Tests With Small Expeller

Run No.	20	21	22	23	24	25
Weight of new kernels in meal, pounds	8.0	8.0	8.0	0.0	6.0	12.6
Weight of old kernels in meal, pounds	0.0	0.0	0.0	20.0	2.0	0.0
Oil in kernels, %	59.0	64.9	59.0	59.0	59.0	65.25
Moisture in kernels, %	....	....	....	3.3	....	4.35
Weight of shell in meal, pounds	2.0	2.0	2.0	5.0	2.0	3.5
Filter cake in meal, pounds	1.0	1.0	0.0	0.0	0.0	0.0
Oil in filter cake, %	45.8	45.8	....	....	....	....
Oil in meal, %	47.1	51.3	47.2	47.2	47.2	51.4
Moisture in meal, %	7.5	5.65	8.0	4.92	7.3	5.68
Weight of press cake, grams	2267.2	1729.5	2006.4	....	1994 2	2739 2
Oil in press cake, %	7.72	5.76	5.9	18.6	6.8	5.91
Moisture in press cake, %	8.62	6.77	8.9	2.57	8 3	5.84
Weight of crude oil, grams	2176.5	2631.7	1998.0	936.1	1941.5	3605.5
Weight of filtered oil, grams	1730.2	1833.3	1717.2	441.1	1552.9	3053.0
Refractive index of filtered oil (25°C.)	....	....	....	1.5178	....	1.5180
Weight of filter cake from crude oil, gms	446.3	798.4	280 8	495.0	388.6	552.5
Filter cake in crude oil, %	20.5	30.3	14.1	52.9	20.0	15.3
Oil in filter cake, %	47.9	47.3	47.6	58.8	52.4	48.4
Moisture in filter cake, %	5.16	4.41	5.9	1.5	4.71	4.56
Filtration time 100 gms. crude oil, min	29	38	22	....	20	....
Crude oil recovered from meal, %	43.7	52.8	44.1	8.3	42.9	49.3
Filtered oil recovered from meal, %	34.7	36.7	37.9	3.9	34 2	41.8
Percentage of oil in meal recovered	73.6	71.7	79.7	8.4	72.5	82.0

REMARKS ON TABLE 2

Run

20. In this run, using 9.1% of filter cake in the tung meal, the expeller stopped up several times and it was necessary to release the choke each time this happened and then slowly tighten it.

21. In this run, using 9.1% of filter cake in the meal, the choke was tightened very slowly and the expeller did not stop up as it did in run No. 20. However, it took a much longer time than is normal to run the eleven pounds of material, which may have indicated that the expeller was partly stopped up but not sufficiently so to stop the operation of the expeller.

22. In this run, using only new kernels in the meal, no difficulty was experienced.

23. In this run, using only old kernels in the meal, it was impossible to obtain cake formation. When the choke was tightened considerably, foots came through the bars and at the inlet end of the expeller and it was necessary to shut down the machine.

24. In this run, using a mixture of old and new kernels, no difficulty was experienced. It was observed that it is necessary to set the choke much tighter in pressing this material than is the case when pressing a tung meal containing only new kernels.

25. In this run, using tung kernels and seeds obtained from the dehulling of moist tung fruit, considerable difficulty was experienced in obtaining a continuous flow of cake from the expeller. It was, therefore, necessary to release the choke several times and remove the hard cake in the exit before continuing with the experiment.

Effect of Age of Nut on Pressing Efficiency

THE expression of the oil, from tung fruits left over from the preceding season or of tung fruits in the late summer of the current season has constituted a problem for the tung oil mills. It has been found that if the tung fruits are kept cool, it is possible to obtain good oil expression in the tung mill at a later date than is possible under normal storage.

It has been reported that difficulty is sometimes experienced with old tung kernels even when analysis indicates a good oil content. Test run No. 23 was made in December, 1943, with the small expeller, using tung kernels from the 1942 crop of tung fruits. These kernels showed some evidence of deterioration but still contained 59.0% of tung oil. It was found impossible to efficiently express the oil from a meal consisting of these old kernels ground and mixed with 20 percent of shell. In spite of long effort, this material would not form a cake and finally an oily mush oozed from the inlet-end of the expeller. The residue obtained from this expression test still contained 18.6 percent of oil and the relatively small amount of crude oil, obtained before it was necessary to shut down the expeller, contained an excessive amount of foots (52.9%). The results of this test are shown in Table 2.

Laboratory tests indicated that the oil-free meal from old tung kernels will not plasticize when subjected to heat and pressure, whereas the material obtained from fresh tung kernels plasticizes readily under these conditions. Therefore, in test run No. 24, old tung kernels were mixed with new tung kernels in the ratio of one to three. In this test, results of which are shown in Table 2, there was no difficulty in obtaining cake formation in the expeller. The oil content of the press cake (6.8%) and the amount of foots in the crude oil (20.0%) did not appear to be excessive; however, the results were not as favorable as those obtained in run No. 22 wherein only new tung kernels and shell were used in the meal.

Since the tung fruit producers have been considering for some time the possibility of hulling the moist, newly ripened tung fruit in the grove, a test was made to determine if the oil can be efficiently expressed from such dehulled tung fruits after they have been dried. In this study, moist tung fruits were dehulled in a modified walnut huller and the dehulled tung fruits were air dried. The shells were removed from half of the seeds and the mixture of tung kernels and seeds was ground and expressed in the small expeller. The results of this test, run No. 25, are shown in Table 2. In this test, a press cake containing 5.91% oil was obtained and the crude tung oil contained a normal amount of foots material (15.3%). This latter result, and the good yield of crude and filtered oil (49.3 and 41.8%, respectively), indicated that hulling the moist tung fruit in the grove will not interfere with the efficient expression of the oil at the mill if the moist dehulled tung fruits are properly dried.

Clarification of Tung Oil

BECAUSE of the difficulties experienced in handling tung oil filter cake at the mill, thought was given to the development of a process of producing a clear tung oil by treating the crude tung oil with a chemical agent which will precipitate the non-oil constituents. It appeared possible to accomplish the desired result by the addition of either an acid or mild alkali, but it seemed best to do this by adding an acid salt, such as sodium bisulfite, which causes the precipitation of the lignin derived from shell material. After this treatment, it was possible to produce a clarified oil either by the application of pressure filtration or by centrifuging. In a mill test, 200 gallons of crude tung oil were mixed with a concentrated solution of sodium bisulfite (5 pounds dissolved in about 2 gallons of water at 80°C.) for ten minutes, after which the warm mixture was filtered under pressure through a filter press having its plates precoated with diatomaceous earth. The filtered oil appeared to be excellent in clarity and quality. A sample of this oil has been stored in the laboratory for about a year and no adverse change has been noted. In a laboratory filtration test, such as that already described, on crude tung oil it was found that 28 minutes were required to filter this oil; the filter cake constituted 44.3% of the crude oil and contained 60.9% of oil. In another laboratory filtration test 0.1% of powdered sodium bisulfite was added to a 100-gram sample of the crude tung oil and the mixture was heated to 80°C. with stirring, after which the hot mixture was poured upon a No. 2 filter paper not previously coated with diatomaceous filter-aid. It required 28¾ minutes for this oil to filter; the filter cake constituted 41.2% of the crude oil and contained 60.2% of oil. These tests indicate that this chemical precipitation can be used in the clarification of a crude tung oil, thereby eliminating all or at least a considerable portion of the diatomaceous filter aid usually employed in filtration.

Solvent Extraction of Tung Filter Cake

The recovery of oil from tung oil filter cake by extraction with petroleum solvents appears to offer interesting possibilities. The compact nature of the cake does not appear to lend itself readily to solvent extraction by a continuous process unless it is mixed with a more porous material. Experiments have shown that when tung oil press cake is mixed in equal proportions with tung oil filter cake, over 98 percent of the oil in the filter cake can be extracted with petroleum solvents without difficulty.

Summary

1. Tests indicated that best results in yield of crude and filtered oil by an expression procedure are obtained with a tung meal containing 4.2% moisture and 20% shell.

2. The drying of tung meal using an initial air temperature of 320°F. appeared to adversely affect the yield of filtered oil from the expeller process.

3. A filtration test was developed for determining the amount of foots in a crude tung oil.

4. It was found difficult to obtain efficient oil expression from tung meals containing filter cake; in one test with this material the resulting press cake was high in oil content, while in another test the crude tung oil contained about twice as much foots material as was present in crude tung oil from tung meal containing no filter cake.

5. The expression of tung oil from a tung meal consisting of ground old tung kernels and tung shell was found difficult if not impossible. This difficulty appeared to be due, at least partly, to the fact that

the meal from old kernels will not plasticize when subjected to heat and pressure. When these kernels were mixed with new kernels no difficulty was experienced in expressing the tung oil from the meal.

6. Tests indicated that hulling the moist tung fruit in the grove does not interfere with the expression of the oil if the moist dehulled tung fruits are properly dried before pressing.

7. A process was developed for producing a clear tung oil by treating the crude oil with a chemical agent to precipitate certain non-oil constituents in the crude tung oil followed by either pressure filtration or centrifugation.

8. When tung oil filter cake was mixed with an equal amount of tung press cake, over 98 percent of the oil could be solvent-extracted by petroleum solvents.

Predicting the Flavor Stability of Soybean Oil

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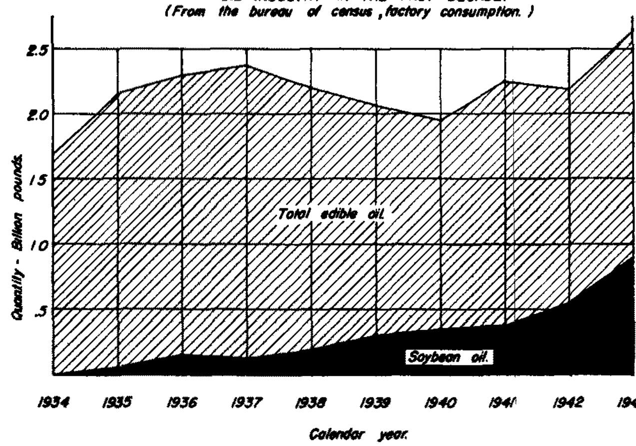
FOR upwards of 5,000 years the flavor of soybean oil has been of interest to man (1). The crude oil has been and is today one of the principal foods to the poorer classes of China. It was not until 1910 (2), however, that industry in the U. S. became actively interested in the soybean as a source of oil. The soap and paint manufacturers consumed most of the oil produced. By 1918, however, due to a wartime shortage of edible fats, soybean oil usage in margarine and shortenings had reached a total of 62½ million pounds annually—about 5% of the total U. S. production of these products. The poorer flavor of these earlier soybean oil products did not encourage development of a domestic soybean crop as a source of edible oil. In the early 1930's, due to a number of factors, the domestic soybean crop expanded rapidly; and once again the oil became of increasing importance to the edible oil industry, until today it has become a major raw material. Perhaps it will be of interest to you to trace the usage of the oil in the food industry over the past decade. In 1934 the amount of soybean oil used as edible oil was about 3 million pounds, or 0.2% of the total edible oil produced in the United States. In 1939, at the start of World War II, the quantity had reached 300 million pounds, equivalent to 15% of the total. By 1943 it had reached 891 million pounds, or one-third of the total. While wartime needs may have raised the proportion of soybean oil to a higher level than peacetime conditions will support, there is no doubt that soybean oil will remain an important raw material to the edible oil industry.

As in the case of any vegetable oil, and perhaps to a greater extent in the case of soybean oil, the flavor quality of the derived food products is affected by the history of the bean both on the farm and in the oil mill. It is important to the refiner and to the processor alike that the segregation into quality classes be made as early in the history of the oil as possible. The purpose of this paper is to suggest a basis on which such segregation can be made.

Experimental

OIL samples were obtained from tank car receipts of crude soybean oil by the official A.O.C.S. sampling procedure. Good coverage of the bean producing areas was obtained by testing tank car receipts from all sections and from all suppliers. The sampling period covered most of the crushing season.

FIGURE-1
THE INCREASED USAGE OF SOYBEAN OIL IN THE EDIBLE OIL INDUSTRY IN THE PAST DECADE.
(From the bureau of census, factory consumption.)



For a study of the effect of frost damaged and field damaged beans on oil quality, beans were obtained directly from the producing areas, and processed in our pilot plant equipment.

Crude oils thus obtained were processed to finished edible products in the laboratory, under conditions simulating commercial operations. The flavor characteristics of the finished oils were correlated with the more commonly used physical characteristics of the crude and refined oils.

No attempt was made to determine by chemical analysis any variation in the usual minor constituents of the glyceride oil. Markley and Goss in their recent book have covered thoroughly the chemical composition of the oil (3).

More should be said about the laboratory method of processing these crude oils into edible fats. The overall procedure is defined among ourselves as the "edibility test".

Figure 2 shows the unit in which gallon quantities of the crude oils are alkali refined. Four samples can be carried as a group through the refining operation. After refining, the oils are settled overnight, decanted from the soap stock, and clarified by filtration.

Figure 3 shows the bleaching unit in which the refined and filtered oil (designated hereafter as RF oil) is treated with commercial bleaching earth. A portion of this bleached oil (designated hereafter as RB oil), is deodorized, and a second portion hydrogenated to an iodine value of 75—about the range for shortening or margarine oil.