Plant Scale Comparisons of Various Refining Methods for Cottonseed Oil

G. C. CAVANAGH, Research Department, Ranchers Cotton Oil, Fresno, California

Three different refining processes were commercially compared by processing 15,148 metric tons of cottonseed oil, with free fatty acid content varying between 7.1% and 8.9%. All of the seed was prepressed and solvent extracted in the Sanbran plant at Bauru, Brazil. The Ranchers Miscella refining process operating on seed averaging 8.5% F.F.A. yielded more oil of lighter color per ton of seed processed than either of the other processes compared, even though the average F.F.A. of the seed processed during the Ranchers Miscella Refining test averaged 1.7% higher than the seed used in the Sanbran process and 1.1% higher than the average F.F.A. for the seed used in the Low Loss Refining test.

In another comparison, screw pressed oil, Modified Soda Ash refining was compared to Ranchers Miscella refining with seed containing about 0.5% F.F.A. The results showed 42% lower refining loss and a color of 3.5 Lovibond units less for Ranchers Miscella refined oil than for Modified Soda Ash refined oil.

The average cost of converting crude cottonseed oil to prime bleachable summer yellow oil by the miscella refining process described is 20.8¢ per hundred weight of oil (not including refining loss). These costs include the prorated cost of control laboratory, plant labor and supervision, fuel, power, chemicals, depreciation, taxes and insurance.

Of the commercially significant edible vegetable oils processed, one of the most difficult to refine with respect to color or flavor is cottonseed oil (12). Vegetable oil refiners, processing cottonseed oil or similar highly pigmented oils by conventional methods, continuously compromise between high refining loss resulting from the use of strong caustic on the one hand and highly colored oils which meet consumer resistance on the other. Re-refining and bleaching may improve the color of the product but these processes add to the production cost, decrease the yield of finished product and contribute to the instability of the finished product (1,8).

In April 1956 a paper was presented before the A.O.C.S. describing a new integrated miscella refining process for edible oils (2). E. M. James favorably reported on miscella refining in April 1957 in a paper comparing various refining methods (10). An acetone miscella refining process was described in the March 1961 J.A.O.C.S. (15). The advantages of lighter color and greater yields of excellent quality finished oil per ton of source material are real and demonstrable when oil is immediately miscella refined subsequent to solve extraction with the exclusion of air and light (2).

This report presents plant refining data comparing four different refining processes operating on cottonseed oil of moderately high and very low free fatty acid content. The refining methods compared are Ranchers Miscella, Low Loss, Modified Soda Ash, and Sanbra. (Sanbra is the Brazilian affiliate of Bunge.)

Description of Refining Processes

Ranchers Miscella Refining Process actually starts with the cooking of the meats and consists of the following steps: 1) Conditioning meats to contain 10-12% moisture at cooker discharge; 2) adding granular soda ash to the cooked meats to control the F.F.A. of the crude oil within desired limits (3); 3) batching crude 50% miscella in make-up tanks. (Two tanks make continuous operation possible.) 4) Continuously adding 8° to 20° Bé caustic soda through a rotometer into the suction side of the single crude miscella pump; 5) intermittently contracting the dilute caustic with the crude miscella in an homogenizer (4); 6) heating the miscella to cause the soapstock to melt; 7) cooling the miscella to form a two-phase system for centrifugal separation (5); 8) separation of refined miscella and soapstock in vapor tight tubular bowl centrifuges. 9) Soapstock containing approximately 15% by weight of hexane may be desolventized in commercially available equipment and subsequently processed as ordinary caustic soapstock, or if the F.F.A. of the crude oil does not exceed 3% and economic conditions warrant, it may be added to the solvent-wet meal from the extractor with decidedly beneficial results to the quality of the meal (9). 10) The refined miscella may be contacted with a soap removing acid wash (6) or, in some instances, filtering through diatomaceous earth in a totally enclosed filter is preferred to water washing. Oils miscella refined according to the above procedure are very light in color. If bleaching is desired, bleaching earth can be substituted for the diatomaceous earth in the filter press and colors as light as required can be obtained with virtually no loss of oil in the filter clay. 11) If winterization is desired, this can be very effectively done in solvent at this stage of processing. Continuous separation of the stearine in valve operated disk type centrifuge gives about 87% yield of 20 hr. cold test cottonseed salad oil and 13% of 73 Iodine Value stearine. 12) Solvent is recovered in conventional equipment with the decided advantage that the distillation equipment operating on refined miscella never has to be cleaned. Ranchers Miscella Refinery and winterizer are preferably located in the solvent extraction plant so that the same operator(s) control all phases of the solvent extraction, refining, winterizing, solvent recovery, and deodorization processes.

The Low Loss process is a two stage refining process usually followed by double water washing to remove soap. The crude oil is first conditioned by admixture with 0.1% of citric or orthophosphoric acid. In the neutralization stage the conditioned oil is heated to 150°F and then a stoichiometric amount of caustic soda is added to the oil and the resultant soapstock
centrifuqally separated. A color removal step using a small amount of strong caustic soda follows the initial soapstock removal step. This refining method is extensively used in South America and parts of Europe.

Modified Soda Ash process is similar to the Low Loss process, the main differences being that the acid conditioning step is eliminated and a 250% excess of 20° Bé soda ash is used in the initial neutralization stage instead of a stoichiometric amount of caustic soda. Briefly described, the Modified Soda Ash process consists of the following steps: 1) A continuous stream of crude oil, heated to approximately 140° F., is admixed with about 2.5 times the theoretical amount of 20° Bé soda ash required to neutralize the free fatty acid in the oil, and this mixture is further heated to about 200° F. 2) The soapstock and coagulated gums are centrifugally separated. 3) The partially refined dark oil is cooled to about 100° F. and mixed continuously with a small amount of 20°- 40° Bé caustic soda solution, the oil-caustic mix is agitated, heated to 160-180° F., and then centrifugally separated. 4) Finally the oil is washed once or twice with water, vacuum dried, and sent to storage. The details of this process are well known and are adequately described in the literature (10, 13, 14, 1, 7, 11).

The Sanbra process is an experimental process which was used in South America as a basis for comparison between Low Loss and Ranchers Miscella Refining processes. The Sanbra process is described as a double neutralization process in which the crude miscella is first degummed with a stoichiometric amount of caustic soda-soda ash solution at room temperature, followed by centrifugation. In the second step the miscella is violently agitated with a small amount of concentrated caustic soda solution, heated to 40° C, and centrifuged.

The Sanbra process and the Ranchers Miscella Refining process were both carried out in the same refinery at Bauru, Brazil. The caustic soda miscella mixture was not agitated in an homogenizer in the Sanbra process.

Essentially the Sanbra process is the Low Loss process carried out in approximately 50% concentration miscella.

**Experimental**

Moderately high free fatty acid seed were processed and refined in the Sanbra prepress solvent extraction plant in Bauru, by the Low Loss, Sanbra, and Ranchers Miscella Refining processes. This plant has a capacity of approximately 250 metric tons of cottonseed per 24 hr. The miscella refinery has a capacity of 150,000 pounds of refined oil per 24 hr. day. Table I shows the weight and analysis of the seed processed during the various trial runs. It is apparent from these data that the seed processed during the Ranchers Miscella Refining test was 4% higher in moisture and over 1% higher in F.F.A. than the seed processed by the other two refining methods.

Table II compares the oil yields and refining data of the three refining methods in lb. per short ton. The total oil per ton of seed was calculated from the analysis in Table I. The yield of crude oil per ton was calculated from the weight and analysis of residual oil in the meal and hulls. The refined oil was weighed and refining loss was determined from the calculated weight of crude oil and the actual weight of refined oil. Because the soda ash added to the cooked meats in the Ranchers Miscella Refining Method neutralized 1.34% of the F.F.A. in the crude oil, the refining loss factor in all cases was determined by dividing the refining loss by the F.F.A. in the seed.

Using the refining loss factors from Table II and assuming 8% F.F.A. and a yield of 300 lb. of crude oil per ton of seed, then the Low Loss refining process would yield 250.0 lb. of refined oil per ton of seed; the Sanbra process would yield 253.2 lb. and Ranchers Miscella Process would yield 258.7 lb.

Table III compares the once refined oil color, bleached color, and soap in refined oil. The average Lovibond red color was 12.6 Low Loss, 12.8 Sanbra, and 13.5 Ranchers Miscella. Soap in refined oil: Low Loss 3388 P.P.M., Sanbra 1710 P.P.M., and Ranchers 388 P.P.M. In a soap removing step, bleaching earth gave 5.9 Red for Sanbra; and 0.30% of the weight of the oil gave 9.2 Red. Lovebord red color was 12.6 Low Loss, 12.8 Sanbra, and 13.5 Ranchers Miscella.

In a second test, Modified Soda Ash refining was compared to Ranchers Miscella refining on seed of