can be used without danger than when agitation is taking place, but even after a settle the heat can be raised high enough to cause part of the stock to swell and rise to the surface of the oil. Aside from the swelling of the stock and its taking up oil we find that when this lye from the stock enters the oil again it generally has a bad effect. If this lye is strong enough, a complete refining may take place in the remaining oil. If it is weaker, an emulsion may be formed and stick in the emulsion stage of the refining. If the lye and soap solution that is squeezed from the stock is very weak the surface tension of this solution will be so nearly that of the oil that it goes into solution in the oil to all appearances. It will take the coloring matter with it and we find a red oil hard to do anything with. As the refiner says, the color has gone back in the oil and it is red and wet.

We see that too strong lye cannot be used as a good emulsion will not be formed on account of the too great difference in the surface tension between the liquids, also that too weak lye is not good on account of the fact that part of the lye will be squeezed into the oil if used in large enough volume to cause the stock to contract. So that the refiners' choice of lyes falls within rather narrow limits. It is doubtful if the lye that gives the best emulsion ever gives the best settle, and so the refiner uses lye that gives the best result, everything considered. It is general practise to use a lye which requires the addition of heat to complete the break. This leaves a weaker lye in the stock than one that breaks cold. It sometimes happens that the refiner under estimates the lye required and the refining sticks in some stage. If it were possible to add the lye directly to the tiny pieces of soap stock, it would proceed nicely, but the only way to do this is to add more lye to the whole mass and it rarely will show as low a loss as if the proper lye was added at first. It is also possible to add other substances like salt, etc., which will cause contraction of the soap stock to take place. I do not find this practise very satisfactory, as it, like the addition of too much heat, causes contraction to take place unevenly and part of the lye is squeezed out into the oil with the bad results as stated. After many thousand trials the process of refining has developed to a high state, but even yet, although not as often as formerly, the simple reaction, fatty acids and lye produce soap, will persist in showing many curious and unexpected variations in the refining kettle. In this article not much mention is made of color and while some of the larger particles of impurities are ensnared and carried down with stock, the removal of the color from the oil is largely a matter concerning a different chemical reaction than the one we are considering. The reactions in the removing of color are closely related to removing the fatty acids; however they are different, and the choice of lyes, etc., are those necessary without regard to color.

DEATH OF DR. WILLIAM FREAR

With the death of Dr. Wm. Frear, Director of the Pennsylvania State Experiment Station, and Chairman of the Joint State and Federal Committee on Definitions and Standard for Food Products, the agricultural chemists of the country lost one of their great men. He died suddenly at his home at State College, Pa., January 6th, at the age of 62. As an associate of Dr. Armsby he contributed not a little to our knowledge of animal metabolism, but it was as a food chemist that he was most widely known. He was associated with Dr. Wiley on the first committee to form definite standards for food products.

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The following referee chemists were certified for
subjects as enumerated:

William J. Gascoyne, Jr., Baltimore, Md.—Cotton-
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John R. Holland, Wiley and Co., Baltimore, Md.—
Cottonseed Meal and Fertilizer.
Harry G. Lewis (Little Rock Lab.), Little Rock,
Ark.—Cottonseed Mill Products, Fertilizer and Crude
Oil.
H. S. Montague (Little Rock Lab.), Little Rock,
Ark.—Cottonseed Mill Products and Fertilizer.
Clinton Morris (Morris-Flinn Co.), Macon, Ga.—
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Jere M. Newbold, Kershaw, S. C.—All materials
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ciation with exception of oils.
Francis B. Parker (Parker Lab.), Charleston, S. C.—
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A. W. Horrell (Barrow-Agee Lab.), Jackson, Miss.—Cottonseed Meal, Cottonseed, Peanuts and Fertilizers.

Smith, Emery and Company, San Francisco, Calif.—Cocoanut Oil Products.

OBSERVATIONS ON THE INFLUENCE OF FREE FATTY ACIDS ON COLOR CHANGES IN CORN OIL

By A. F. Sievers and J. D. McIntyre

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In connection with some investigations on corn oil it was frequently observed that the oil underwent considerable color changes while standing in bottles in the laboratory. Refined oils were found in some cases to become almost water white but much less bleaching was noticeable in the case of crude oils. While this bleaching effect was observed mostly in connection with oils placed near windows it was also distinctly noticeable in several refined oils kept in closed cupboards.

The statement is frequently heard that the presence of free fatty acids has a tendency to darken oil upon standing. Since this matter is of some interest and importance in connection with the refining and storing of vegetable oils it was decided to make a few experiments to secure actual data on this question.

The corn oil which was used in the experiments was a sample of commercial crude expeller oil obtained from dry process germs. It was first treated according to the usual standard methods of neutralizing, bleaching, and deodorizing, which resulted in an oil of fine quality containing 0.048 per cent of free fatty acids and with a color corresponding to 7.4 yellow and 1.0 red on the Lovibond scale in a 2-inch cell. From a portion of this oil the free fatty acids were prepared by the usual method of saponification with subsequent neutralization with hydrochloric acid. These fatty acids

were then added to four samples of the oil in concentrations of 0.5, 1.0, 3.0, and 5.0 per cent, respectively. Each of these four samples of oils were then divided into two portions, one to be set aside in diffused daylight and the other in total darkness. All samples were kept in two-ounce bottles completely filled at the start. The color readings of the oil were made immediately after the fatty acids were added and thereafter at varying intervals over a period of 21 months. Free fatty acid determinations were also made after 12 months and at the end of the period of observation. Control samples of the same oil to which no free acids had been added were included. For purposes of convenience the oils were designated as follows: All oils kept in diffused daylight were labeled L, and all those kept in the dark were designated as D. The control samples were marked I, and all those to which free acids had been added were marked II. Table I is a summary of the data obtained during the period of observation.

From a study of Table I and Figures 1 and 2, several facts are immediately apparent. (1) The presence of more than 1 per cent of free fatty acids has a marked influence on the color changes in corn oil. (2) Refined oil containing up to 1 per cent of free acids bleach during the first six months, after which they remain practically the same for the next 15 months. (3) Oils containing 3 and 5 per cent of free acids also bleach during the first months, but to a less extent. For the remainder of the first year their color undergoes only minor changes, but during the following nine months the oils increase noticeably in color, especially the yellow. From the graphs it appears that this increase in color would be likely to continue for some time beyond the period of observation covered by this experiment. (4) At the end of 21 months all the oils except two (L¹ and D¹) were actually lighter in yellow than at the start in spite of the steady darkening during the last nine months because of the very extensive bleaching which occurred in the oils during the first few months. The important point is that after the initial bleaching action a steady darkening sets in which in the case of oils with over 3 per cent of free fatty acids would in time no doubt increase the color considerably beyond that of the original oil. (5) The influence of light is relatively slight. The final readings on yellow were somewhat higher, however, in each case in those oils which had been in the dark. It is apparent that the color in corn oil undergoes certain changes in intensity upon standing, and such changes are largely independent of daylight. (6) The per-

TABLE I. Color readings and free fatty acid content of corn oils at several intervals during period of observation.

Oils		Free Fatty Acids				COLOR (Lovibond scale in 2-inch cell.)												
						Yellow						Red						
		Start	March	January	April	June	Aug.	Nov.	Mar.	June	Jan.	April	June	Aug.	Nov.	Mar.	June	Jan.
	L	Per cent	Per cent	Per cent	(Start)													
I	L	0.048 ⁽¹⁾	0.18	0.16	7.4	7.0	5.4	4.7	4.7	4.0	2.9	1.0	1.15	0.34	0.7	0.7	0.7	0.5
II (°)	L ¹	0.5	0.77	0.53	9.2	5.4	5.2	5.2	5.2	4.8	4.5	1.2	1.2	0.54	0.78	0.78	0.78	1.0
	L ²	1.0	1.04	0.82	9.8	5.4	5.4	5.2	5.2	5.2	5.0	1.3	1.2	0.76	0.78	0.78	0.84	1.0
	L ³	3.0	2.61	2.44	10.4	5.8	6.0	6.4	6.4	6.6	8.4	1.5	1.3	1.05	0.82	0.82	0.84	1.0
	L ⁴	5.0	4.14	4.06	11.0	7.6	7.8	7.8	7.8	9.2	11.5	1.6	1.5	1.3	0.70	0.70	1.0	0.95
I	D	0.048 ⁽¹⁾	0.12	0.12	7.4	9.4	7.4	5.2	5.2	5.2	4.1	1.0	1.0	0.54	0.8	0.8	0.76	0.3
II (°)	D ¹	0.5	0.62	0.51	9.2	5.8	5.6	5.6	5.6	5.4	5.6	1.2	1.2	0.62	0.82	0.82	0.78	0.76
	D ²	1.0	1.09	0.90	9.8	6.0	6.0	5.8	6.8	6.2	6.0	1.3	1.3	0.90	0.86	0.86	0.82	0.95
	D ³	3.0	2.80	2.66	10.4	6.8	7.4	6.8	6.8	7.6	9.2	1.5	1.5	1.10	0.86	0.86	0.86	0.95
	D ⁴	5.0	4.58	4.45	11.0	7.8	8.8	8.2	8.2	10.8	12.5	1.6	1.65	1.5	1.15	1.15	1.25	0.90

(1) No acids were added but the oils contained 0.048 per cent of free acids.

(2) The amount of free acids given as being present at the start represents the amount added. The total percentage present was slightly greater owing to the traces already present in the oil.