The Stability of Soybean Oil: Effect of Time and Temperature on Deodorization[1]

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Abstract

A comparison of the flavor and oxidative stability of soybean oil deodorized at different temperatures for different periods of time was studied using laboratory deodorized oil. Flavor and oxidative tests were in good agreement and showed that some combinations of time and temperature of deodorization gave significantly more flavor stable oils than others.

FLAVOR AND OXIDATIVE stability of vegetable oils is usually improved by deodorization (11). Baldwin (1) reported that stabilities of vegetable oils, determined by AOM method, increased rapidly to a maximum as deodorization progressed. In the development of a new laboratory deodorizer, J. Heide-Jensen (3) found the flavor of soybean oil deodorized at 210C for either 30 min or 2 hr was preferred to soybean oil deodorized at 180C and 240C for the same length of time. Even though differences at all three temperatures were more pronounced in the oils deodorized for 2 hr than 30 min, he concluded that 30 min was sufficient. A comparison of flavor and oxidative stability of soybean oil deodorized at 240, 270, and 295C by Yasuda et al. (14) showed that oils deodorized at higher temperatures were less stable. However, in order to obtain greater capacity, recent trends are to deodorize at higher temperatures for shorter times to achieve quality products. Although initial quality of the oil may be good, the overall effect on stability may be decreased.

In preliminary studies (10), our laboratory found temperatures of 100C and 150C inadequate even with 3-hr deodorization at extremely low vacuum. Although soybean oils deodorized at 150C were about twice as stable as those deodorized at 100C, they were neither flavor nor oxidatively stable. In this study, a wider range of times and temperatures was investigated to study the flavor and oxidative changes associated with changes in time and temperature of deodorization.

Experimental

Controlled deodorizations have been carried out in a four-unit all-glass deodorizer, which permits the deodorization of samples under reproducible conditins (9). Since time is a function of the temperature, pressure and rate of steam flow (11), the design of this laboratory deodorizer provides means to measure and control steam flow, to prevent bumping, to "break" the vacuum and to heat and cool the sample rapidly.

Commercially alkali-refined and bleached soybean oil was deodorized for different periods of time and at different temperatures. In each test, 900 ml of oil was deodorized at predetermined temperatures of 190, 210, 230, 250 and 270C and at each of these temperatures for periods of ½, 1, 2 and 3 hr. Stability of the deodorized oil was determined by three methods: flavor (6), active oxygen (AOM) (4) and oven weight (7).

Flavor evaluations were made by a taste panel of 18 trained tasters following the established procedure at the Northern Laboratory (6). Oils were evaluated for initial flavor immediately after deodorization and for flavor after 4 days' storage at 60C.

In the AOM stability test, a controlled stream of air is bubbled through a tube containing 20 ml of oil for a given time at 98.8C. After 8 hr, peroxide values are determined, and those samples having the lowest peroxide values usually exhibit the greatest stability. Samples that have a low AOM value would be expected to have a longer shelf life than oils with a high AOM value.

The oven-weight method, introduced by Olcott and Einset in 1958 (7), was used to determine the induction period of the time-temperature samples. In this method, a 1-g sample of oil is weighed into a 30-ml beaker, which is covered with a watch glass and placed in a constant temperature oven at 60C. Every 24 hr the beakers are removed from the oven, cooled to room temperature, weighed and replaced in the oven. The increase in weight is plotted and the end of the induction period is marked by a sharp increase in weight and consequently a sharp break in the curve. Each sample was run in quadruplicate and reproducibility of results was excellent.

Data from three lots of oil were analyzed. Since the standard error of the means was low, the data have been pooled and analyzed for this presentation. Duncan's multiple range test (2) was used to locate any differences shown by analysis of variance.

Results and Discussion

Initial flavor (Table I) indicates that freshly deodorized oils differed little at each time and temperature. Peroxide values determined at the time of tasting showed little difference in the initial samples. Analysis of variance was used to determine if any significance could be attached to differences observed in flavor data for each temperature studied. No significance was shown when the initial values were analyzed, but differences were apparent in the stored samples.

To show the complete data for oil deodorized at one temperature, flavor scores for oils after storage

TABLE I

Effect of Time and Temperature of Deodorization on Initial Flavor Evaluation of Soybean Oils

Temp, C	Time, hr			
	0.5	1	2	3
190	6.3	7.0	7.2	7.8
210	7.5	8.0	8.1	7.8
230	7.5	7.6	7.7	7.7
250	7.9	7.2	8.0	7.6
270	7.3	7.0	6.3	8.3

Scoring system 10–1; 8–9 = Good, 6–7 = Fair.

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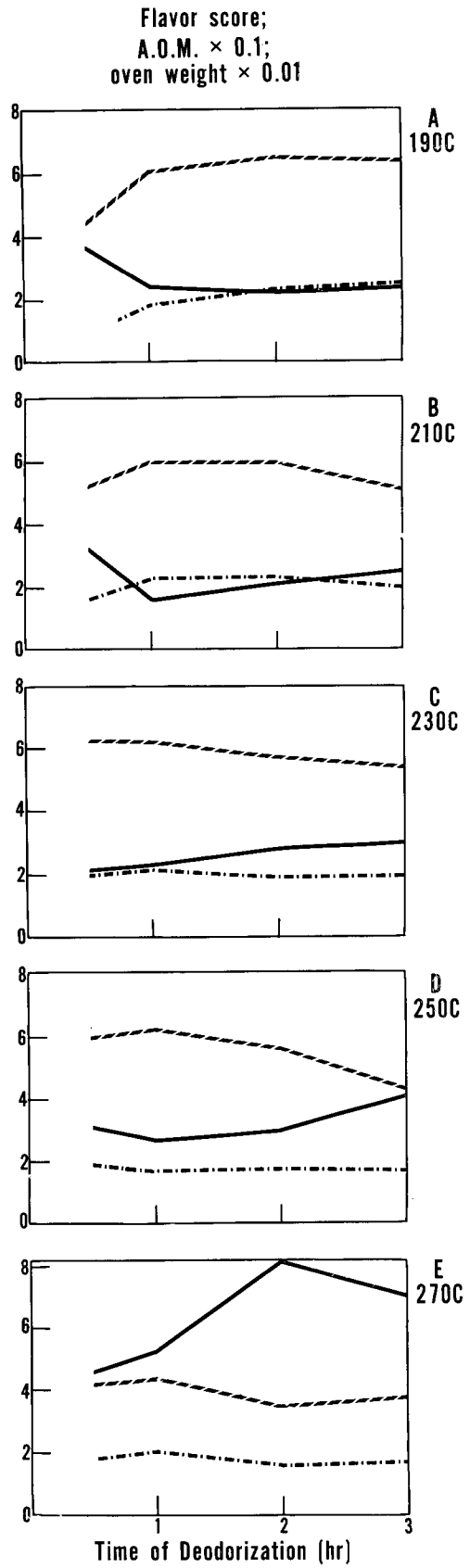

FIG. 1. Key: Flavor and oxidative stability of soybean oils deodorized at different times and temperatures.

- Flavor score after 4 days' storage at 60C.
- AOM value determined as peroxide value (PV) after 8 hr under AOM conditions.
- Induction period in hours, oven weight method.

for 4 days at 60C are plotted on a scale of 1 to 10; the higher the value, the more acceptable the oil. The AOM values have been divided by a factor of 10; the lower the value, the more stable the oil. The oven-weight test values have been divided by a factor of 100; the higher the value, the more stable the oil.

Figure 1A presents data for soybean oil deodorized at 190C. The stability of the oil deodorized for ½ hr was poor. This instability could be due to incomplete deodorization. Oils deodorized for 1, 2 and 3 hr at this temperature were stable and significantly higher in quality than the ½-hr sample. Both AOM and oven-weight tests confirmed these results. As the flavor became more acceptable, the AOM value decreased and the oven-weight value increased, which indicates better stability. For example, the aged flavor score for the oil deodorized for ½ hr was 4.4, whereas the score for the oil deodorized for 1 hr was 6.0; the AOM value dropped from a peroxide value of 36 to 24 and the oven-weight values increased from 125 to 184 hr.

Figure 1B shows data for deodorization of soybean oil at 210C. Again, AOM and oven test values substantiate the flavor results. Soybean oil deodorized for ½ hr is not so stable as that deodorized for 1 and 2 hr; and oil deodorized for 3 hr shows the adverse effect of a longer time at the higher temperature.

Results for soybean oil deodorized at 230C are given in Figure 1C. At this temperature effects typical of deodorization at higher temperatures appear. The shorter periods of deodorization, ½ and 1 hr, produce more stable oils. After 2 hr deodorization at 230C, AOM values have increased considerably. These two tests were verified by the oven-weight test where the values decreased after the 1-hr deodorization period.

At 250C the effects of high temperature are more pronounced (Fig. 1D). The stability of the oils drops off noticeably after 1 hr of deodorization at this temperature. The peroxide values determined from the AOM test also increase with the increase in time of deodorization. Stability as measured by the oven-weight method shows less difference than the flavor and AOM measurements at this temperature.

The highest temperature studied was 270C. Although the oils had an acceptable initial flavor, the harmful effect of the high temperature shows in the stability of the oil (Fig. 1E). After storage for 4 days at 60C, the flavor quality of the oils was poor. The ½- and 1-hr deodorizations gave more stable oils, but even these were much poorer than oils deodorized at lower temperatures.

The results of this investigation are summarized in Table II.

At 190C, stable oils were obtained with 1, 2 and 3 hr of deodorization; at 210C, 1 and 2 hr gave the most stable oils; at 230 and 250, oils were most sta-

TABLE II

Times and Temperatures of Deodorization Producing Most Stable Soybean Oils

Temp, C	Time, hr			
	0.5	1	2	3
190		X	X	X
210		X	X	
230	X	X		
250	X	X		
270	X	X		

ble and acceptable after ½ and 1 hr; and at 270C, oil deodorized for ½ and 1 hr gave more stable oils than those deodorized for 2 and 3 hr, but even these were of poor quality.

When a low temperature is used, more stable oils are obtained when the deodorization period is lengthened; when a high temperature is used, flavors and oxidative-stable oils are more likely when the deodorization period is short.

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