Oxidative Stability of Potato Chips Determined by Rancimat[1]

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During recent years the Rancimat apparatus has been used extensively to determine the stability of fats and oils. Most stability tests for fat-containing foods are performed on the extracted oil. The objective of this research was to observe the behavior of potato chips in the rancimat without oil extraction. Determinations were carried out at 110°C and 20 L/hr air flow. The curves for the ground chips were completely different from those obtained with extracted oils. Curves for fresh potato chips showed two inflection points after approximately 5 and 20 hr, respectively. Sensory analyses (odor score) of samples withdrawn from the Rancimat after 0, 5, 10, 20 and 25 hr showed significant differences ($P < 0.01$). An odor score of 5 was considered the rejection point, and was equivalent to 10.8 hr and corresponded to 150 μs of electric conductivity. At this point, the curves started to level off between the first and second inflection points. Curves obtained with potato chips stored at 25°C for 2, 4, 6, 8, 10 and 12 wk showed the same basic pattern, although prolonged storage corresponded with lower induction time. Correlation of induction values between ground potato chips and extracted oil was high ($r > 0.87$). From these results, it seems that it is possible to estimate the oxidative stability of fat-containing foods without prior extraction.

KEY WORDS: Fat-containing foods, induction period, oxidative stability, potato chips, Rancimat apparatus, sensory analyses.

The Rancimat method developed by Hadorn and Zurcher (1) has been used extensively in recent years for the determination of the induction period of fats and oils (2–4). Studies on correlations between Rancimat and peroxide value and active oxygen method (AOM) to measure oil stability have been published elsewhere (5–8). Improved Rancimats, linked to microprocessors and with disposable glassware, have significantly improved the efficiency of the technique.

Although Rancimat use for fats and oils is common, there is no information on its application for determining the stability of foods containing fats and oils. For this kind of determination, the lipid fraction has to be extracted, causing inevitable alterations by handling that could affect the induction period.

The objective of this study was to assay potato chips in the Rancimat and to determine its induction period without extraction of the lipid fraction.

EXPERIMENTAL PROCEDURES

Commercially available and freshly made potato chips were procured from Elma Chips Pepsi Co. (Itú SP, Brazil). Chips were fried in partially hydrogenated cottonseed oil and assayed for oil content (Method Ac 3-44) and fatty acid composition according to AOCS procedures (9). A model 617 Rancimat apparatus (Metrohm, Herisau, Switzerland) was operated under the following testing conditions: 110°C, 20 L/hr air flow, sample weight 6.7 g for potato chips and 2.5 g for extracted oil.

Potato chips and extracted oil (10) where oxidized under accelerated conditions in the Rancimat for 5, 10, 20 and 25 hr, and then products were analyzed for peroxide value (Method Cd 8-53) (9).

Potato chip samples were graded for odor by a nonstructured scale (9 cm) where the initial and final points meant totally unacceptable and totally acceptable odor (recently made potato chips), respectively. Panel members were selected based on their ability to discriminate fresh samples from similar samples subjected to different degrees of oxidation. The trained members (8 panelists) were offered the control and 3 experimental samples, which were previously ground separately in a blender. Experimental design was an incomplete block type V, where $t = 7$, $b = 7$, $k = 4$, $r = 4$, $\lambda = 2$ and $E = 0.88$ (11). Test samples were placed in 100-mL beakers, heated for 20 min in a water bath at 40°C and immediately evaluated. Each sample was evaluated four times.

In addition, fresh potato chips (80 g) placed in a sealed aluminum package were stored for 12 wk in an oven set at 25°C. Bags were sampled every other week and tested by Rancimat. The induction periods for the whole/ground sample and the extracted oil were determined. Peroxide value and odor scores were concurrently evaluated according to the procedures described above.

RESULTS AND DISCUSSION

Potato chips contained 36.6% ether extract with the following fatty acid composition: C14:0 (0.8%), C16:0 (23.0%), C16:1 (0.4%), C18:0 (3.3%), C18:1 (54.8%), C18:2 (15.0%), C18:3 (0.1%), C20:0 (0.3%) and unknown (sum of 3 peaks = 2.0%).

Typical conductivity curves for ground potato chips and oil extracted from freshly made chips are presented in Figure 1. The curve for ground potato chips developed in a different way than the one for extracted oil. Curves for whole potato chips had three well-defined regions and two inflection points. The difference in the two curves occurred mainly in the first portion of the curve. This is likely due to the presence of chemical compounds capable of producing carbonyl groups and other volatiles present in the non-oil fraction that somehow affected electrical conductivity. Min & Schweizer (12) determined the correlations between volatile compounds, oxygen contact and peroxide value in potato chips and further indicated that the major volatile compound changes during storage were mainly due to the oxidation of the oil fraction.

In the curve for extracted oil (Fig. 1), the induction period was calculated by the intersection of the tangent projected on the time axis (point E). In the curve for ground potato chips, there were more possibilities for the estimation of induction period due to the presence of two inflection points (Fig. 1 and Table 1). A highly significant correlation between the induction periods for the various

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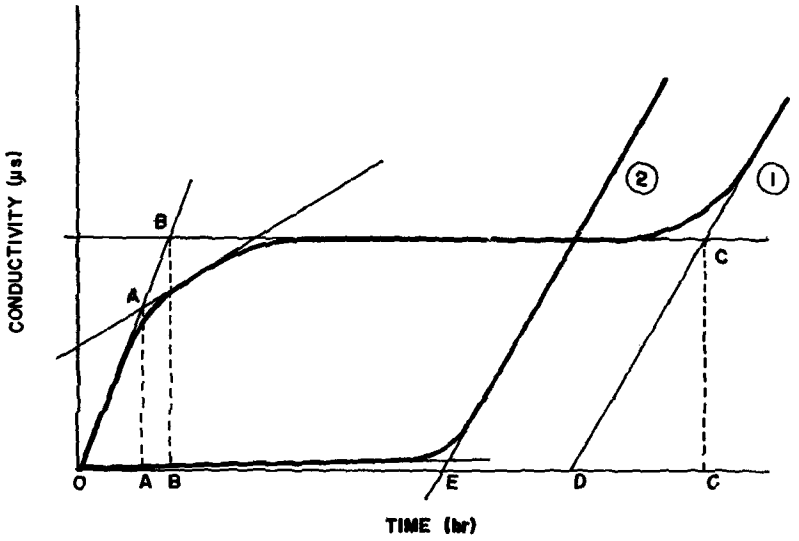

FIG. 1. Typical Rancimat curve of potato chips (1) and oil extracted from potato chips (2).

TABLE 1

Rancimat Induction Period[a] of Stored Potato Chips from Different Calculation Methods

Time (wk)	Rancimat induction period (hr)					Odor score	Peroxide value (meq/kg)
	Extracted oil	Calculation method[b]					
		A-C	B-C	0-C	0-D		
0	13.1	20.1	19.1	22.1	20.3	7.3	0
2	12.5	18.7	16.3	20.8	19.2	6.2	0.73
4	12.7	18.9	17.7	21.4	19.4	5.6	1.33
6	10.0	18.2	17.6	19.8	17.5	4.7	1.58
8	6.8	15.2	14.5	16.4	13.0	4.5	1.88
12	5.8	10.3	10.0	10.8	6.0	3.5	2.35
r^c	—	0.92	0.87	0.93	0.94		

[a]All tests were conducted at 110°C, air flow 20 L/hr and sample weight 6.7 g.

[b]Letters represent points in Figure 1.

[c]Correlation coefficients between extracted oil and ground potato chip induction periods were $p < 0.01$ in all cases.

storage determinations with ground potato chips and extracted oil was observed. The best correlation coefficients ($r = 0.94$) were observed when the measurements were made between the origin (letter "O" in Fig. 1) and the tangent of the curve after the second inflection point D or inflection point C (Fig. 1) projected to the time axis. Similar criteria to test induction periods in commercial oils were reported by Laubli & Bruttel (7). However, the authors failed to discuss the alternatives to evaluate curves with an initial increase in electrical conductivity as happened in whole potato chip samples tested in this study.

An odor score value of 5 or less was considered as the level of rejection and occurred between the fourth and sixth week of storage (Table 1). At this particular point in time the corresponding peroxide values exceeded 1.4 meq/kg.

In Figure 2, the curves obtained in the Rancimat for potato chips stored for up to 12 wk are presented. All samples gave similar curve shapes, but a decrease in the induction period due to prolonged storage can be observed.

In Figure 3, the evolution of peroxides and the odor score for freshly made potato chips subjected to the Rancimat for fixed periods are presented. It can be observed that marks below 5 in the odor score were obtained after 10.8 hr accelerated oxidation in the Rancimat, corresponding with peroxide values greater than 12 and more than 150 μs on the rancimat conductivity curve.

It can be concluded that it is possible to determine the induction period or stability of potato chips directly from the food sample. Therefore, the Rancimat is capable of testing oil-based foods in a real system rather than from the extracted oil. This probably can be applied to other

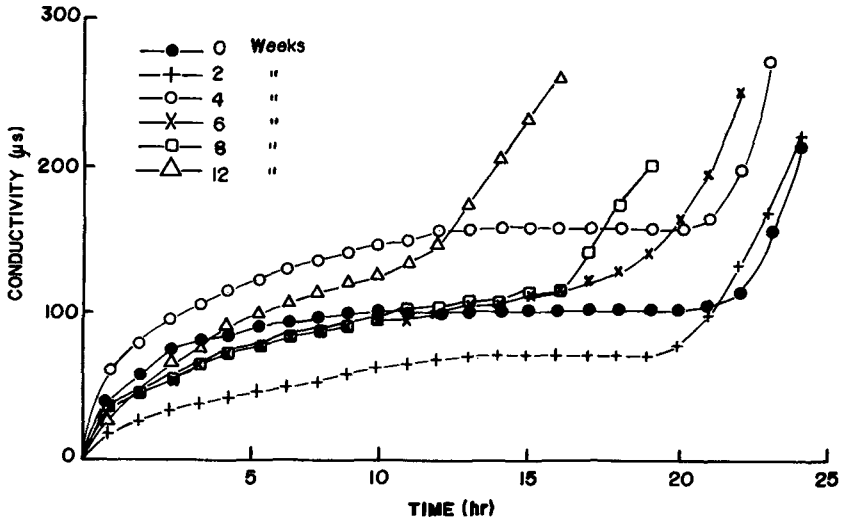

FIG. 2. Rancimat curves of stored potato chips.

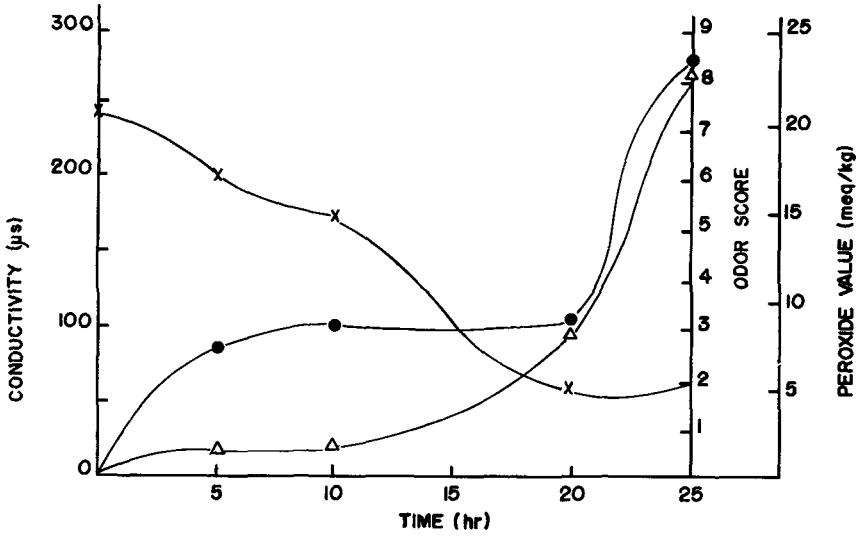

FIG. 3. Rancimat curve of freshly made potato chips (-●-), odor score (-X-) and peroxide value (-△-).

solid foods with high lipid content, but more research on the effects of other food components in the determination of the oxidative stability is necessary.

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