Effects of Ascorbyl Palmitate and Silicone on Frying Performance of Palm Olein

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ABSTRACT

The quality changes in palm olein used for the intermittent frying of banana slices over a 5 h interval per day for 4 consecutive days was studied. Assessment of % polar components, iodine value, acid value, C18:2/C16:0 ratio and % C18:2 remaining indicated that the addition of 2 mg kg⁻¹ silicone alone and that of 200 mg kg⁻¹ ascorbyl palmitate (AP) plus 2 mg kg⁻¹ silicone to palm olein significantly reduced (p < 0.05) the rate of oil deterioration during frying. The addition of 200 mg kg⁻¹ AP alone to palm olein did not have a significant effect (p > 0.05) on oil deterioration although it was evident that the values for changes in % polar components, iodine value, acid value, C18:2/C16:0 ratio and % C18:2 remaining in the oil were generally less than those in oil without additives. Linear relationships were found between % polar components and iodine value and between iodine value and C18:2/C16:0 in the frying systems studied.

INTRODUCTION

The deterioration of fats under frying conditions has been studied by many workers (Krishnamurthy, 1965; Roth and Rock 1972, Chang et al. 1978; Fritsch 1981; Stevenson et al. 1984). Deterioration of the frying oil results in the accumulation of numerous decomposition products which affect the functional, sensory and nutritional quality of the oil. The quality of the fried food is also affected.

There is interest in the use of various methods for extending the frying life of an oil. The impetus has been the economic gains that would be realized with extension of the useful frying life of the oil. Various workers have studied the effects of a variety of additives and treatments for extending fry-life. Martin (1953) and Babayan (1961) have patents on the use of methyl silicone for protecting oil against oxidative deterioration and raising the smoke point of the oil. Freeman et al. (1973) showed that silicones could greatly increase the oxidative stability of oils at high temperatures. Frankel et al. (1985) found that addition of methyl silicone significantly improved cooking oil performance. Ascorbyl palmitate (AP) which was listed as a substance Generally Regarded as Safe (GRAS) in 1982 was found to be effective for retarding de-
terioration of oil during frying (Gwo et al. 1985). However, Mancini-Filho et al. (1986) reported that the addition of 200 ppm AP after each day's frying of french fries during a 6-day period retarded the development of free fatty acids but increased the colour and magnitude of change in dielectric constant of the oil as compared to the untreated oil sample. Augustin et al. (1987b) reported that the rate of deterioration of oil used for frying of prawn crackers in the presence of AP was comparable to that of oil without additives.

Different conditions of frying and different methods of assessment have been used to assess frying performance. However, the frying performance is complex and no single indicator of deterioration is appropriate under all conditions (Fritsch 1981). In this work, the effects of ascorbyl palmitate and silicone on the rate of deteriorative changes in palm olein during the frying of banana chips were monitored. A variety of assessment procedures were used to assess frying performance.

MATERIALS AND METHODS

Materials

Refined, bleached and deodorized palm olein was obtained from a local refinery. Ascorbyl palmitate was from Merck. The silicone fluid used was Dow Corning 200 fluid, food grade, 350 S. The fluid is a clear water white dimethyl polysiloxane fluid. A local variety of bananas, (“pisang tandok”) which was at the matured but unripe stage, was obtained from a local market.

Frying Experiments

Bananas were peeled and cut to a thickness of 2mm. The banana slices were soaked in 2% NaCl for 30 min before use. The banana chips were fried in 4 different systems. These were (a) palm olein without additives (control), (b) palm olein with 200 mg kg⁻¹ AP, (c) palm olein with 2 mg kg⁻¹ silicone and (d) palm olein with 200 mg kg⁻¹ AP and 2 mg kg⁻¹ silicone.

Palm olein (4 kg) was put into a Valentine Fryer. The temperature of the oil was raised to 60°C and the additives were added at this stage. AP was added directly to the oil and the oil was stirred to disperse the additive. The method of Freeman et al. (1973) was used for addition of silicone. Silicone was dissolved in 30 ml hexane and poured over the surface of the oil. The temperature of the oil was then raised to 180°C. Fryings were started 1/2 h after the oil reached 180°C and frying of banana slices was carried out at 1/2 h intervals over a total of 5 h at 180°C. For the frying, banana slices (25 g) were fried for 3 min. The fryer was left uncovered between fryings. Ten fryings over a 5 h interval were done per day for 4 consecutive days. At the end of each frying day, the fryer was switched off, an oil sample (100 g) was removed and the lid of the fryer was replaced.

Analyses of Oil

Peroxide and iodine values were determined according to the AACS (1974) Official Method. The IUPAC (1979) method was used for evaluation of acid value. The % total polar components was determined using the method of Billek et al. (1979). Fatty acid profiles were determined by gas chromatography on a SP 2330 column after preparation of fatty acid methyl esters by a base catalysed transesterification procedure (Christopherson and Glass 1967; Timms 1973). The C18:2/C16:0 ratio gives the ratio of the glycerol bound fatty acids. % C18:2 remaining was taken as:

\[
\frac{(\text{C18:2/C16:0}) \text{ of used oil}}{(\text{C18:2/C16:0}) \text{ of fresh oil}} \times 100\%
\]

RESULTS AND DISCUSSION

The quality characteristics and fatty acid composition of the palm olein used are given in Table 1. The low oxidation values and acid values indicate that the oil used was of good quality.

Effect of Ascorbyl Palmitate and Silicone on Oil Deterioration during Frying

The changes in % polar components, iodine value, acid value, % C18:2/C16:0 ratio and % C18:2 remaining over 4 days of frying are shown in Figs. 1-5. All indicators of frying oil deterioration in this study showed that the addition of 2 mg kg⁻¹ silicone alone and the addition of 200 mg kg⁻¹ AP plus 2 mg kg⁻¹ silicone significantly reduced (p < 0.05) the rate of oil deterioration during frying. The addition of 200 mg kg⁻¹ AP to palm olein did not have a significant effect (p > 0.05) on deterioration although it was evident that values for changes in % polar components, iodine value, acid value, % C18:2/C16:0 ratio and % C18:2 remaining oil containing AP were generally less than those for oil without additives. Similarly, the quality changes in oil containing 2 mg kg⁻¹ silicone alone and oil with 200 mg kg⁻¹ AP plus 2 mg kg⁻¹ silicone show that the rate of oil deterioration in systems with 2
EFFECTS OF ASCORBYL PALMITATE AND SILICONE ON FRYING PERFORMANCE OF PALM OLEIN

TABLE 1
Characteristics of fresh palm olein

<table>
<thead>
<tr>
<th>Characteristics of palm olein</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Peroxide value (meq/kg)</td>
<td>1.1</td>
</tr>
<tr>
<td>p-Anisidine value</td>
<td>1.6</td>
</tr>
<tr>
<td>Acid value (mg KOH/g)</td>
<td>0.17</td>
</tr>
<tr>
<td>Iodine value</td>
<td>56.6</td>
</tr>
<tr>
<td>Fatty acid composition (%)</td>
<td></td>
</tr>
<tr>
<td>C12:0</td>
<td>0.23</td>
</tr>
<tr>
<td>C14:0</td>
<td>1.02</td>
</tr>
<tr>
<td>C16:0</td>
<td>39.76</td>
</tr>
<tr>
<td>C18:0</td>
<td>3.83</td>
</tr>
<tr>
<td>C18:1</td>
<td>44.42</td>
</tr>
<tr>
<td>C18:2</td>
<td>10.61</td>
</tr>
<tr>
<td>Others</td>
<td>0.13</td>
</tr>
</tbody>
</table>

TABLE 2
Relationships between indicators of frying oil deterioration

<table>
<thead>
<tr>
<th>System&lt;sup&gt;a&lt;/sup&gt;</th>
<th>No. of values</th>
<th>Equation</th>
<th>Correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>% polar components versus iodine value</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>y = -3.571x + 210.273</td>
<td>-0.99</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>y = -4.092x + 239.553</td>
<td>-0.99</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>y = -3.890x + 227.036</td>
<td>-0.99</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>y = -4.058x + 236.721</td>
<td>-0.97</td>
</tr>
<tr>
<td>Iodine value versus C18:2/C16:0 ratio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>y = 60.260x + 40.730</td>
<td>0.99</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>y = 51.020x + 43.085</td>
<td>0.99</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>y = 44.166x + 44.705</td>
<td>0.98</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>y = 42.328x + 45.196</td>
<td>0.98</td>
</tr>
</tbody>
</table>

System 1: Palm olein without additives (Control)
System 2: Palm olein with 200 mg kg<sup>-1</sup> AP
System 3: Palm olein with 2 mg kg<sup>-1</sup> silicone
System 4: Palm olein with 200 mg kg<sup>-1</sup> AP plus 2 mg kg<sup>-1</sup> silicone

mg kg<sup>-1</sup> AP plus 2 mg kg<sup>-1</sup> silicone was slightly less than that in systems containing 2 mg kg<sup>-1</sup> silicone alone.

These results indicate that the major protective effect is due to the presence of silicone. In this respect, these results corroborate with those obtained during the frying of prawn crackers (Augustin et al. 1987b). In systems used for frying of banana slices, the results of a number of quality parameters showed that there was a slight, though not significant, improvement in oil quality with the addition of AP. However, during the frying of prawn crackers, the rate of quality deterioration in the presence of AP was comparable to that of oil without additive (Augustin et al. 1987b).

There are many indicators which have been used to monitor frying oil deterioration. Fritsch (1981) considers that % polar components is one of the more reliable indicators and Billek et al. (1978) suggests that a level of 27% polar components should be taken as the end of frying life of a frying fat. Based on this level, palm olein with-
Changes in acid value during frying

Fig. 3: Changes in % acid value during frying

- - - : Palm olein without additives (Control);
+ + + : Palm olein with 200 mg kg\(^{-1}\) AP
\(\downarrow\) - - : Palm olein with 2 mg kg\(^{-1}\) silicone
\(\uparrow\) - - : Palm olein with 200 mg kg\(^{-1}\) AP
plus 2 mg kg\(^{-1}\) silicone)

Changes in \(\%\) C18:2/C16:0 ratio during frying

Fig. 4: Changes in % C18:2/C16:0 ratio during frying

- - - : Palm olein without additives (Control);
+ + + : Palm olein with 200 mg kg\(^{-1}\) AP
\(\downarrow\) - - : Palm olein with 2 mg kg\(^{-1}\) silicone
\(\uparrow\) - - : Palm olein with 200 mg kg\(^{-1}\) AP
plus 2 mg kg\(^{-1}\) silicone)

The effect of addition of ascorbyl palmitate and silicone to the frying medium on the storage life of fried banana chips were evaluated in a related study (Kamsiah Ibrahim et al. 1988). The results indicated that the addition of 200 mg kg\(^{-1}\) AP alone to the frying medium lengthened the shelf-life of the fried product. It appears that the major benefit of addition of AP to the frying medium is the carry-through stability inferred by AP in the fried product. With the addition of silicone however, there are significant effects on retardation of oil deterioration of the frying medium as well as on the shelf-life of the fried product. The usefulness of silicones in preventing hydrolysis and oxidative deterioration of frying oils was also shown by Sakata et al. (1985).

Relationships between Indicators of Frying Oil Deterioration

There were significant linear relationships between % polar components versus iodine value and iodine value versus C18:2/C16:0 ratio in each of the frying systems although the equations which describe the relationship were different in different systems (Table 2). Linear relationships between these indicators of frying have also been found in other frying systems (Augustin et al. 1987a) where was also similarly found that equations which describe the relationships between indicators of frying are affected by the presence of additives the system.

CONCLUSION

This study has indicated the effectiveness of adding silicone to the frying medium for extension of frying life of palm olein. The addition of AP was comparatively less effective in protecting the deterioration of palm olein during frying of banana crisps than silicone.
ACKNOWLEDGEMENTS

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