Flavor and Oxidative Stability of Peanut–Sesame–Soy Blends


Abstract: Five spreads were formulated from roasted high-oleic acid peanuts and sesame paste (HOPS), normal-oleic acid peanuts and sesame paste (NOPS), high-oleic acid peanuts, sesame paste and soy (HOPSS), normal-oleic peanuts, sesame paste and soy (NOPSS), and normal-oleic acid peanuts only (NOP). Spreads were evaluated during 12 wk at 40 °C for sensory attributes: roast peanut, sesame, sweetness, bitterness, cardboardy, and painty. Roast peanut and sesame flavor generally decreased, and HOPSS and NOPSS had lower roasted peanut flavor. Cardboardy and painty increased in NOP, and HOPS had the lowest cardboardy and painty flavors. Peroxide values increased, with the highest value in NOP and lowest in HOPS. Sesame paste limited oxidation in products containing NOP and soy.

Key Words: flavor, oxidation, peanut, high-oleic peanut, sesame, soy

Introduction

Peanut butter is typically made from selected, blanched, dry roasted peanuts with salt, dextrose, and hydrogenated vegetable oil (Woodroof 1983). Peanut butter is subject to oxidation once the container is opened and has a limited shelf life. Adding complementary flavors to peanut butter is practiced commercially, where different types of jams, honey, chocolate, and spices are combined with peanut to give different flavors (Woodroof 1983). Sesame paste (tehinah) is a popular food in East Asian and Middle Eastern countries (Pellet and Shadarevian 1970; Johnson and others 1979; Saway and others 1985; Ayaz and others 1986; Kotzekidou, 1998). Tehinah (also known as tahinah and tehineh) is made from ground, dehulled, dry roasted sesame seeds in the form of a paste product. Tehinah has a somewhat similar flavor to roasted peanuts (Shahidi and others 1997) and is also high in oil (approximately 60%), which makes it more liquid than peanut butter. Sesame paste has remarkable oil stability and resistance to oxidative deterioration (Namiki 1995; Shahidi and others 1997; Kamal-Edin and others 1994,a,b; Yen 1991; Fukuda 1986) and does not require refrigeration to minimize oxidation. This resistance to oxidation is due to endogenous antioxidants (sesamol and sesaminol) together with tocopherols. These 2 lignans are liberated from sesamolin by heating and subsequent storage of raw oil (Kamal-Edin and others 1994a,b; Namiki 1995).

Reports indicate that soybeans have an anticarcinogenic effect on human breast and prostate cancer (Messina and Barnes 1991; Kennedy 1995). However, soy is very susceptible to oxidation (Yen 1991).

The University of Florida has developed lines of peanuts with high oleic and low linoleic traits, up to 80% oleic acid and 2% to 4% linoleic acid (Gorbet and Knauft 1997). These new lines of peanuts, the high-oleic peanuts (HOP), have greater flavor and oxidative stability compared to normal oleic peanuts (NOP), which are usually used in making peanut butter (Mugendi and others 1997, 1998; O’Keefe and others 1993; Braddock and others 1995; Braddock 1994). The objectives of this research were to determine if oxidation of HOP, NOP, and soy spreads could be reduced by sesame paste and to compare the flavor characterization of these products.

Results and Discussion

Texture

Texture data of the spreads are presented in Fig. 1. The 2 soy-containing products (HOPSS and NOPSS) were harder (P < 0.05) (higher maximum load) than the other 3 products, which were not significantly different from each other. Soybeans contain 1.5% to 3.0% phospholipids, and these have been shown to improve moisture retention and emulsions stability (Wolf and Cowan 1979). Soy is also high in protein, which may affect dimensional structure stability and oil-binding capacity (Damodaran 1994; Rhee 1994). Microscopic examination of similar products (sunflower-sesame paste/butter) indicate that the structural system consists of disintegrated solid particles of the ground kernels in a continuous oil phase (Damir 1984).

Fatty acids composition

The ratio of oleic acid (18:1) to linoleic acid (18:2) (O/L ratio) of the products HOPS, NOPS, HOPSS, NOPSS, and NOP, were 5.24, 1.71, 1.93, 1.19, and 1.72, respectively (Table 1). There were
High-oleic Peanut–Sesame–Soy Spreads . . .

only very minor differences in fatty acid profiles for the products NOPS, HOPSS, NOPSS, and NOP, except for the oleic and linoleic acid contents. Oleic acid (wt%) was the highest (67) and linoleic acid (wt%) the lowest (12) in HOPS, and oleic the lowest (41) and linoleic the highest (35) in product NOPSS.

Sensory

Statistical analysis indicated that the main effects of products and storage time, and their interaction, were significant ($p < 0.05$) for all sensory attributes (Table 2 and Fig. 2 to 7). Roast peanut flavor generally decreased with time for all products (Fig. 2).

The NOP spread had lower peanut flavor than the HOPS and NOPS spreads after 12 wk storage. HOPSS and NOPSS were consistently lower in roasted peanut flavor ($p < 0.05$) than the other products, probably due to the lower percentage of peanut in the blend.

The ratings for sesame flavor were significantly different between some products (Table 2 and Fig. 3). Sesame flavor was low in NOP throughout storage since the product had no sesame paste. Sesame flavor intensity for the other products were similar throughout storage although ratings for sesame flavor generally declined during storage (Fig. 3).

Table 1—Fatty acid (wt %) profiles of peanut-sesame-soy spreads

<table>
<thead>
<tr>
<th>Fatty acid (wt%)</th>
<th>HOPS</th>
<th>NOPS</th>
<th>HOPSS</th>
<th>NOPSS</th>
<th>NOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>16:0</td>
<td>6.82</td>
<td>10.18</td>
<td>9.08</td>
<td>10.99</td>
<td>10.98</td>
</tr>
<tr>
<td>16:1n7</td>
<td>0.14</td>
<td>0.02</td>
<td>0.08</td>
<td>0.10</td>
<td>0.11</td>
</tr>
<tr>
<td>18:0</td>
<td>4.59</td>
<td>4.50</td>
<td>4.92</td>
<td>5.78</td>
<td>3.17</td>
</tr>
<tr>
<td>18:1n9</td>
<td>67.33</td>
<td>50.04</td>
<td>53.20</td>
<td>41.23</td>
<td>49.21</td>
</tr>
<tr>
<td>18:2n6</td>
<td>12.85</td>
<td>29.20</td>
<td>27.58</td>
<td>35.27</td>
<td>28.67</td>
</tr>
<tr>
<td>18:3n3</td>
<td>0.37</td>
<td>0.30</td>
<td>1.29</td>
<td>2.32</td>
<td>0.37</td>
</tr>
<tr>
<td>20:0</td>
<td>2.43</td>
<td>1.10</td>
<td>0.86</td>
<td>0.98</td>
<td>1.24</td>
</tr>
<tr>
<td>20:1n9</td>
<td>1.68</td>
<td>1.17</td>
<td>0.78</td>
<td>0.62</td>
<td>1.17</td>
</tr>
<tr>
<td>22:0</td>
<td>2.43</td>
<td>2.42</td>
<td>1.55</td>
<td>1.99</td>
<td>2.98</td>
</tr>
<tr>
<td>22:1n11</td>
<td>0.13</td>
<td>0.03</td>
<td>0.04</td>
<td>0.11</td>
<td>0.07</td>
</tr>
<tr>
<td>24:0</td>
<td>1.23</td>
<td>1.04</td>
<td>0.53</td>
<td>0.60</td>
<td>2.03</td>
</tr>
<tr>
<td>18:1/18:2</td>
<td>5.24</td>
<td>1.71</td>
<td>1.93</td>
<td>1.19</td>
<td>1.72</td>
</tr>
</tbody>
</table>

The NOP spread had lower peanut flavor than the HOPS and NOPS spreads after 12 wk storage. HOPSS and NOPSS were consistently lower in roasted peanut flavor ($p < 0.05$) than the other products, probably due to the lower percentage of peanut in the blend.

The ratings for sesame flavor were significantly different between some products (Table 2 and Fig. 3). Sesame flavor was low in NOP throughout storage since the product had no sesame paste. Sesame flavor intensity for the other products were similar throughout storage although ratings for sesame flavor generally declined during storage (Fig. 3).

Table 2—Statistical probability values of the F-values of main effects of product, storage time, and their interaction. Effects are considered significant at $P < 0.05$.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Product</th>
<th>Storage time</th>
<th>Product X Storage time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roast peanut flavor</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
</tr>
<tr>
<td>Sesame flavor</td>
<td>0.0001</td>
<td>0.0039</td>
<td>0.0057</td>
</tr>
<tr>
<td>Sweetness</td>
<td>0.0001</td>
<td>0.02175</td>
<td>0.0030</td>
</tr>
<tr>
<td>Bitterness</td>
<td>0.0001</td>
<td>0.0201</td>
<td>0.0006</td>
</tr>
<tr>
<td>Cardboard flavor</td>
<td>0.0001</td>
<td>0.0005</td>
<td>0.0001</td>
</tr>
<tr>
<td>Painty flavor</td>
<td>0.0001</td>
<td>0.0002</td>
<td>0.0001</td>
</tr>
<tr>
<td>Peroxide value</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
</tr>
</tbody>
</table>
Cardboard and painty flavors are measures of oxidation in peanut products. Cardboardy and painty flavor ratings were significantly higher in NOP after 8 wk (Figs 4 to 5). The other spreads had similar painty and cardboardy ratings throughout storage. Products NOPS and NOPSS contained NOP and sesame paste. This is an indication that sesame paste suppresses the development of painty flavor and contributes to oxidative stability of these products. It is well documented that sesame paste contains phenolic antioxidants (lignans) and tocopherols, almost completely in the form of γ - isomer, and these act synergistically to enhance the antioxidant property of sesame paste (Kamal-Edin and others 1994a,b; Namiki 1995; Fukuda and others 1985, 1986). Mugendi and others (1998) compared the stability of HOP and NOP and found HOP more stable and less oxidized than NOP. They attributed this effect to the difference in fatty acids composition, where NOP had O/L ratios of 29-26 and NOP approx. 2. These O/L ratios in products NOPS and NOPSS in this study were 1.71 and 1.19 (Table 1), which is close to the ratio observed for NOP in the previous study. Thus, the stability of these spreads cannot be explained on the basis of fatty acid composition, since NOP, NOPS, and NOPSS had similar O/L ratios. The sesame paste stabilized these spreads containing NOP and soy, apparently due to its endogenous antioxidants.

There were significant differences in bitterness between spreads (Fig. 6). Products containing sesame and soybean (HOPSS, NOPSS) had the highest bitterness of all products at 8 and 12 wk storage. NOP always had the lowest bitterness ratings and the highest sweetness rating (Fig 7). All other spreads had less sweetness than NOP. The two products containing sesame were less sweet, and the lowest sweetness was in the products containing soybean.

**Peroxide values (POV)**

The POV in all products increased with time (Table 2 and Fig. 8), with the POV for NOP increasing from 1.0 meq/kg at 0 wk to 5.6 meq/kg after 12 wk. Although there were significant increases in POV during storage (Table 2), the highest values in the other products at 12 wk were 1.75, 2.1, 2.33, and 2.94. These increases in POV with time were linear during storage (Fig. 8). The correlation coefficient of POV with time ranged from 0.906 to 0.985. The slope of POV-time curves were 0.084, 0.101, 0.104, 0.132, and 0.321 for products HOPS, NOPS, HOPSS, NOPSS, and NOP, respectively. Thus, the increase in POV was about 2 to 3 times greater for NOP than for the others products, which all included sesame paste (Table 3). This also indicates that addition of sesame paste to peanut butter-like products can enhance stability by delaying the onset of oxidative deterioration. The importance of these results can be valued especially with the products containing soy (HOPSS and NOPSS), which did not oxidize appreciably. The relationship between POV values and painty flavor had a high positive correlation (slope 2.254; R 0.994), but the relationship between POV values and cardboardy flavor was not as high (slope 2.19; R 0.657). There was also a good, inverse relationship between POV and peanutty flavor ratings (slope −0.66; R 0.877).

**Conclusion**

Painty and roast peanut flavors correlated highly with peroxide values during storage at 40 °C. The NOP spread had a 2 to 3 fold increase in POV values after 12 wk storage compared to other products. The combined effect of HOP and sesame paste proved to be effective in limiting oxidation and maintaining flavor quality of peanut butter type spreads. The results indicate that incorporation of sesame paste in spread products containing Florunner peanuts and soybeans could extend the shelf life by suppressing lipid oxidation.
Material and Methods

Sesame paste (Tehinah)
A commercial spread product (a standard product made from *Sesamum indicum*, *linn.* ) was purchased from Lebanon (AL-Kanater Factory, Beirut, Lebanon) and kept at 2 °C until used.

Peanuts and Soybeans
Florunner peanuts (NOP) and high oleic peanuts (HOP), line SunOleic 97R, from the 1998 crop were obtained from the University of Florida Agronomy Department. Split and discolored seeds were removed, and the raw peanuts were immediately placed in a glass jar, flushed with nitrogen and stored at 2 °C. Mature soybeans of cultivar F-91-2161 from the 1998 crop were obtained from the Agronomy Department, University of Florida. Soybean were boiled in 0.5 % sodium bicarbonate solution for 45 min, washed in cold water and hand rubbed to aid removing the hulls. Dehulled soybeans were then dried in a forced air oven at 70 °C, placed in glass jars, flushed with nitrogen and stored at 2 °C.

Peanut and Soybean Roasting
Prior to roasting, the peanuts and soybeans were brought to room temperature, placed in rotary roaster at 180 °C for 45 min and roasted to a Hunter L value of 51-52 for peanut and 41-42 for soy. The roasted peanuts were blanched by hand, and any split or discolored peanuts were discarded. To determine the color, 55 g peanuts or soybeans were placed in the optical cup and five reading (L,a,b) were taken using a Gardner tristimulus colorimeter (Model D 25-2, BYK-Gardner, Inc., Silver springs, MD).

Peanut – Sesame – Soy Spread Composition
Table 1 indicates the composition of the 5 spreads. The first four products contained sesame paste, and included HOPS (HOP and sesame paste), NOPS (NOP and sesame paste), HOPSS (HOP, sesame paste and soy), and NOPSS (NOP, sesame paste soy). The fifth product served as the control and contained only Florunner peanuts (NOP). All products had the same quantity of fructose syrup (81 % Brix), monoglyceride (1 %) (Myvatex Monoset, Quest) and salt (1 %) added. The peanuts and soybeans were ground in a coffee mill, mixed with the other ingredients (fructose syrup, monoglyceride and salt), and milled again to achieve homogeneity of the products. They were stored in covered plastic buckets at 40 °C in an oven for sensory evaluation over 12 wk.

Sensory evaluation
Descriptive analysis was used to evaluate intensities of flavor attributes in samples during storage. A simplified lexicon of peanut flavor as described previously by Johnsen and others (1987), Mugendi and others (1997, 1998), and Braddock (1994) was used, with the addition of sesame flavor. Fifteen panelists from the Food Science and Human Nutrition Department, who had previous experience in peanut sensory evaluation, participated in this study. Two training sessions were held to train the panelists to identify and rate intensities of the following attributes: roasted peanut, sweetness, bitterness, cardboardy, piny and sesame flavor. During training sessions, panelists were presented with fresh ground roasted raw materials and oxidized samples of peanut butter and peanut-sesame-soy spreads (cardboardy and piny). A reference sample was chosen as a standard with the following anchor points for roasted peanut (7 – 9), sweetness (5 – 7), bitterness (1 – 3), cardboardy (1), piny (1), and sesame flavor (1). The 10 point scale was anchored by low (1) and high (10). Samples were evaluated at 0, 2, 6, 8, and 12 wk. At every session, the reference sample (freshly ground roasted peanut butter stored at –30 °C in glass jars flushed with nitrogen ) was presented at room temperature along with two oxidized samples to standardize the panelists. The spread products (5) at room temperature (ca. 25 °C) were presented in random order (order of presentation was chosen at random for each panelist) in coded, covered 4-oz plastic cups with approximately 10 g product. All samples were presented at the same time on the same tray. Evaluation was carried out in individual booths under incandescent light. Panelists were provided with unsalted crackers and deionized water. Each panel session was replicated after 24 h using the same procedure, with different orders of presentation for each panelist.

Water Activity Measurement
Water activity of the products during storage was measured using a Rotrom Hygroskop DT hydrometer at 25 °C. Ambient relative humidity inside the oven at 40 °C and in the laboratory was continuously recorded and two readings were noted in the morning and after 12 h, using a Fisher digital humidity/temperature meter. Moisture contents of the products were determined using the AOAC method #925.40 (1990), in which 2 g was dried to constant weight at 95 ± 100 °C (under pressure (100 mmHg). The moisture in all products ranged from 4.40 – 4.77 %.

Oil extraction and measurement of oxidative rancidity
Oil from samples was extracted using the Christie (1982) modification of the Bligh and Dyer (1959) extraction procedure. Twenty g of sample and 80 mL water were blended for 4 min in a Waring blender with 100 mL chloroform and 200 mL methanol. The mixture was filtered through a Buchner funnel using No. 4 Whatman filter paper. The material on the filter paper was added back to the blender and blended again with 100 mL Chloroform. The mixture was filtered again and the combined filtrates transferred to a 1 L separatory funnel and 100 mL of 0.88 % KCl in water were added. The solution was mixed, flushed with nitrogen, allowed to settle, and the lower layer was removed. Sodium sulfate (25 g) was then added to remove any excess water and filtered again. The filtrate was transferred to a round bottom flask and the solvent was removed using a rotary evaporator. Oxidation levels in the extracted oils were measured using the official AOCS (1990) Peroxide Value (POV) method Cd 8-53. This iodometric titration procedure measures peroxides and hydroxides which are ini-

### Table 3—Ingredients of spreads as a percent of total weight

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>HOPS</th>
<th>NOPS</th>
<th>HOPSS</th>
<th>NOPSS</th>
<th>NOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>SunOleic97R HOP</td>
<td>65</td>
<td>—</td>
<td>30</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Florunner NOP</td>
<td>—</td>
<td>65</td>
<td>—</td>
<td>30</td>
<td>90</td>
</tr>
<tr>
<td>Sesame Paste</td>
<td>25</td>
<td>25</td>
<td>—</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Monoglyceride</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fructose Syrup (81 Brix)</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Salt</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>—</td>
</tr>
</tbody>
</table>
Fatty Acid Analysis

Fatty acid methyl esters were analyzed using a Shimadzu GC-14A gas chromatograph equipped with a cyanopropylphenyl, DB-225 fused silica column (30 m × 0.25 mm id., 0.25 μm film thickness, purchased from Altech Associate Inc., Deerfield, IL.), split-splitless injector and a flame ionization detector (Shimadzu Scientific, Norcross, Ga., U.S.A.). Fatty acid methyl esters (FAME) were prepared in screw-cap tubes by the method of Maxwell and Marmer (1983). Approximately one drop (20 mg) of oil was placed into a screw tube and dissolved in 2 mL isooctane and 200 μL of 2N KOH in methanol. The tube was vortexed for 1 min and centrifuged (2000 × g) for 5 min. The lower methanol layer was discarded and 200 μL saturated ammonium acetate (aq.) was added to the remaining mixture. The water was separated and centrifuged again. The lower layer was discarded and the organic phase was washed with 0.5 mL deionized water. The top layer containing the methyl esters was removed after centrifuging and placed in a GC vial. Samples were injected in duplicate using an isothermal temperature program maintained at 225 °C. Injector and detector were maintained at 250 °C. Helium was the carrier gas with linear velocity of 25 mL/sec. The split ratio was 40:1. Fatty acid methyl ester standards GLS 68A (20mg/mL) were used as references (Nu-Chek-Prep., Inc., Elysian, Minn., U.S.A.).

Statistical Analysis

Data were subjected to analysis of variance using SAS, version 6.12 (SAS Institute, Cary, N.C., U.S.A.). Duncan’s multiple range test was used to separate means when a significant F-value was obtained (P < 0.05). The sensory data for each storage time were analyzed separately, with sources of variation in the model including panelist, product, panelist × product and replication. In addition, all sensory data for all storage times were analyzed as a split-plot design, where the sources of variation in the model were panelist, storage time, replication, panelist × product, product × storage time, panelist × storage time and panelist × product × storage time. For POV and texture analyses, a completely randomized design was used. The main effects of product and storage time, and their interactions, were considered significant at P < 0.05.

References


Gorbet DW, Knauff DA. 1987. Sun Oliebrie97 peanut, improved oil chemistry, Runner type. Marrianna, Fla.: Florida Agricultural Experimental Station, Institute of Food and Agriculture Sciences, University of Florida. Circular No. 5400. 6 p.


Author Sumainah thanks Damascus University and the Fulbright Foreign Scholarship Board for partial financial support during the course of this study, and appreciates the support from Dr. Douglas L. Archer, Chair, FSHN at University of Florida, Gainesville, Fla. Chemical stability and storage time were analyzed as a split-plot design, where the sources of variation in the model were panelist, storage time, replication, panelist × product, product × storage time, panelist × storage time and panelist × product × storage time. For POV and texture analyses, a completely randomized design was used. The main effects of product and storage time, and their interactions, were considered significant at P < 0.05.

Author Sumainah is with the Food Science Department, University of Damascus, Damascus, POBOX 9198, Syria. Authors Sims, Bates and O’Keefe are with the Food Science and Human Nutrition Department, University of Florida, Gainesville. FL 32611. All the work was done at the University of Florida, Gainesville, when author Sumainah was on sabbatical leave. Direct inquiries to Charles Sims (E-mail cas@gnv.ifas.ufl.edu).

Texture

To measure the differences in texture between products, samples of spread (100 g) in 4 oz. containers were tested using a stainless cone probe (30 mm long, 26 mm wide and an 80° angle) attached to an Instron Universal Testing machine (Model 4411, Canton MA) with a 50 Kg load cell. The samples were equilibrated to room temperature (25° C) before testing. The maximum force (Kg) required for the cone to penetrate a distance of 7 mm into the spreads at a crosshead speed of 60 mm/min were determined in ten replicates from different points in the containers.