Sunflower Butter: Nutritional Evaluation and Consumer Acceptance

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ABSTRACT

The nutritional and sensory quality and physical characteristics of commercially and experimentally processed sunflower butters were evaluated. The analyses included: proximate analyses, calories, available lysine, in vitro protein digestibility, C- and DC-PER, phytic acid, a 9-point hedonic test. Gardner color, and spreadability determinations. Sunflower butter was found to have a good overall nutritional value with a protein quality approximately equal to that of peanuts. Roasting conditions had a significant impact on nutritional and sensory quality, color and spreadability of sunflower butter. Taste panelists generally rated sunflower butter lower than peanut butter.

INTRODUCTION

THE USE OF OILSEEDS in human foods has become increasingly important. Sunflower seeds in particular have unique sensory, nutritional and functional properties which could expand the range of their use in foods (Sosulski, 1979). For example, sunflower seeds have been used as a nut substitute in confectionery and bakery formulations and have been found to be very acceptable (Lorenz, 1978).

Recently, sunflower butter and spreads have appeared on supermarket shelves in several Midwestern and New England states and have become available for institutional markets throughout the USA (Hannigan, 1981; Lynch, 1981). According to Lynch (1981), the incentive behind the increased availability of sunflower butter was the 1980 peanut crop shortfall that caused peanut butter prices to rise and decreased product availability. Although sunflower butter can be used like peanut butter, it must be stressed that sunflower butter does not taste or look like peanut butter. The chlorogenic acid present in sunflower products may cause a greenish-gray color and distinct bitter flavor. Sunflower butter was shown to be lower in protein, fat and calories, and higher in calcium, phosphorus, iron and many B-vitamins than peanut butter (Falk and Holm, 1981).

With the expanding interest in food nutritional quality and the importance of consumer acceptance in the introduction of new products, sunflower butter needs extensive evaluation. Sunflower butter could potentially constitute the single largest end product prepared from confectionery sunflower seeds. In this study, the nutritional, sensory quality and physical characteristics of commercially available sunflower butters and sunflower butters prepared in the laboratory under various roasting conditions were evaluated.

MATERIALS & METHODS

Samples and treatments

The sunflower butters (200g sample size) used included commercially available sunflower butter samples purchased from a supermarket (Sigco Sun Products) and a health food store (Erewhon, Inc.), and experimentally prepared sunflower butters which simulated home preparation techniques. The experimental butters were prepared from sunflower seeds supplied by a local company. Seeds were divided into three treatment groups: raw (untreated), conventionally roasted and microwave roasted. Seeds were roasted in a force air oven at 165°C for 20 min (Falk and Holm, 1981). Microwave roasted seeds were prepared in a Genius II Panasonic microwave oven for 4 min per 1.5 cups at the high power select setting. Peanut butter samples consisted of three name brands and one health food brand (old fashion style) for use in calorie and sensory analyses.

A 200g sample from each treatment was processed into sunflower butter by grinding in a food processor for 10 min. Myristex (stabilizer) — 1.5%, dextrose — 5.5% and salt — 2.0% were added to all the laboratory samples prior to grinding in the food processor for another 10 min (Falk and Holm, 1981).

Nutritional evaluation

All analyses were done in triplicate. Proximate analyses of moisture, ash, fat and protein (6.25 X N) were determined according to standard methods (AOAC, 1980). Calories were determined by Parr bomb calorimetry. DNF-lysine (available lysine) was separated and quantified by high pressure liquid chromatography using a UV detector set at 436 nm (Carpenter, 1960; Peterson and Warthesen, 1979). In vitro protein digestibility was determined by two methods: an enzymatic method (Hau et al., 1977) and a discriminant method (Jewell et al., 1980). Protein hydrolysis was done in 6N HCl under vacuum at 105°C for 24 hr using norleucine as an internal standard (Tkachuk and Irvine, 1969). All amino acids except tryptophan were determined on a Beckman amino acid analyzer (Spackman et al., 1958). Tryptophan was determined by using a modification of the Hopkins-Coie method (Voiturer, 1972). Chemicul scores were determined by the FAO (1973), and Osborne and Voogt (1978) method. The C-PER and DC-PER values were calculated according to the methods of Satterlee et al. (1979) and Jewell et al. (1980). Phytic acid was assayed by the method of Hasland and Oberleas (1977). Dietary fiber was determined by the enzyme-modified neutral detergent fiber (ENDF), (Robertson and Van Soest, 1977).

Sensory evaluation

Sensory quality attributes including appearance, aroma, texture, flavor and aftertaste were measured by 66 untrained consumer panelists using a 9-point hedonic rating scale (9 — like extremely to 1 — dislike extremely) (Amerine et al., 1965; Johnston, 1979). The panel members consisted of faculty, staff and students. The test was performed in partitioned booths with fluorescent lighting. Samples were randomly coded and served individually with water and unsalted crackers distributed between samples. Sample size consisted of one Tbl of each butter served in individual containers.

Physical characteristics

Sample color was determined on a Gardner Tristimulus IX-23 Colorimeter using the L, a, b scale compared to the white standard (X-L-2-246-D). Spreadability was assayed on a Stevens-LFRA Texture Analyzer at 22°C with a 60° cone plunger, a 20 mm penetration distance, and a speed of 0.5 mm/sec.

Statistics

All data were statistically analyzed by analysis of variance (P < 0.05) and Duncan’s multiple-range test (Steel and Torrie, 1980).

RESULTS & DISCUSSION

Proximate analyses

The proximate analyses of the sunflower butter samples

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are shown in Table 1. Moisture levels for the commercial samples ranged from 0.5–1.3% and the experimental sample values ranged from 1.5–1.8%. The health food store brand contained significantly lower moisture. The oil content of the commercial samples ranged from 46.0–49.0% and that of the experimental samples ranged from 43.0–47.0%. Generally, sunflower butter contains slightly lower oil content than peanut butter (McWatters and Young, 1978). The protein content of the commercial samples ranged from 2.2–25.0% and experimental sample values ranged from 22.0–24.0%. The health food store brand had significantly higher protein content than the supermarket brand. This can be attributed to the added sugar, salt and stabilizers found in the supermarket brand. Sunflower butter contains the same protein level as peanut butter (McWatters and Young, 1978). The ash content of the commercial samples ranged from 3.4–3.9% and the experimental sample values ranged from 3.7–4.4%. According to Falk and Holm (1981), the high level of minerals in sunflower butter can be accounted for by calcium, phosphorus, iron, sodium and potassium. Finally, the ENDF levels for commercial samples ranged from 2.6–4.6% and the experimental sample values ranged from 5.7–5.9%. The health food store and experimental samples had significantly higher dietary fiber levels than the supermarket sample. As expected, there were only slight differences between the proximate analyses of the experimental sunflower butter samples.

**Nutritional quality**

The amino acid and protein quality data on sunflower butter samples are shown in Tables 2 and 3. The chemical scores of the amino acid profile for the commercial samples ranged from 65–75 and for the experimental samples from 57–77. According to Osborne and Voogt (1978), the maximal chemical score (whole egg) is 100. The most limiting amino acid for all the sunflower butters was lysine. Of the experimental samples, raw sunflower butter had a better score than the roasted samples with the conventionally roasted sample having the lowest value. The in vitro protein digestibilities for the commercial samples ranged from 81–83% and those of the experimental samples from 80–81%. According to Jewell et al. (1980), the sunflower protein digestibility was approximately equal to the digestibilities of soy and cottonseed protein. Since a human protein quality (PQ) predictive model has not been finalized, both C-PER and DC-PER were evaluated in this study (Jewell et al., 1980). The ANRC casein values for C-PER and DC-PER were 2.7 and 2.6, respectively, compared to 2.5 for the in vivo PER method. The C-PER's for the commercial samples ranged from 2.3–2.5 and the experimental samples ranged from 2.2–2.5. The DC-PER's for the commercial samples were 1.8 and the values for the experimental samples ranged from 1.4–2.1. Of the experimental samples the conventionally and microwave roasted samples had lower in vitro protein values than the raw samples. According to Jewell et al. (1980) peanut flour has a C-PER and DC-PER of 2.1 and 1.6, respectively. By comparison, sunflower and peanut protein have approximately the same protein quality.

The nutritional values of the sunflower butter samples are shown in Table 3. Calories for the commercial samples ranged from 7.2–7.3 Kcal/g and the values for the experimental samples ranged from 6.9–7.0 Kcal/g. The calorie content of the sunflower butter was approximately equivalent to the peanut butter samples evaluated which ranged from 6.8–7.1 Kcal/g. Available lysine for the commercial samples ranged from 4.8–7.5 mg/g on a defatted, dry weight basis and the values for the experimental samples ranged from 5.3–6.2 mg/g. The phytic acid level of the commercial samples ranged from 1.4–1.6% on a defatted, dry weight basis and the values for the experimental samples

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**Table 1—Proximate analyses of sunflower butter**

<table>
<thead>
<tr>
<th>Amino acids</th>
<th>Supermarket brand</th>
<th>Health food store brand</th>
<th>Experimental</th>
<th>R</th>
<th>CR</th>
<th>MR</th>
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<tbody>
<tr>
<td>Lysine</td>
<td>5.0</td>
<td>4.1</td>
<td>4.9</td>
<td>4.8</td>
<td>4.7</td>
<td>4.4</td>
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<tr>
<td>Methionine</td>
<td>2.8</td>
<td>2.3</td>
<td>2.3</td>
<td>2.7</td>
<td>2.2</td>
<td>2.2</td>
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<tr>
<td>Cystine</td>
<td>1.4</td>
<td>1.3</td>
<td>1.3</td>
<td>1.4</td>
<td>1.3</td>
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<tr>
<td>Threonine</td>
<td>3.5</td>
<td>4.5</td>
<td>4.2</td>
<td>4.5</td>
<td>4.7</td>
<td>4.7</td>
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<tr>
<td>Isoleucine</td>
<td>5.2</td>
<td>4.6</td>
<td>5.3</td>
<td>5.2</td>
<td>4.8</td>
<td>4.8</td>
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<tr>
<td>Leucine</td>
<td>9.8</td>
<td>8.7</td>
<td>8.9</td>
<td>9.0</td>
<td>8.3</td>
<td>8.3</td>
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<tr>
<td>Valine</td>
<td>6.0</td>
<td>5.5</td>
<td>6.7</td>
<td>6.1</td>
<td>5.6</td>
<td>5.6</td>
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<tr>
<td>Phenylalanine</td>
<td>8.5</td>
<td>7.8</td>
<td>8.5</td>
<td>8.1</td>
<td>6.8</td>
<td>6.8</td>
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<tr>
<td>Tyrosine</td>
<td>3.7</td>
<td>3.8</td>
<td>4.3</td>
<td>3.7</td>
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<td>Tryptophan</td>
<td>1.6</td>
<td>1.4</td>
<td>1.5</td>
<td>1.5</td>
<td>1.2</td>
<td>1.2</td>
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<td>Aspartic acid</td>
<td>11.2</td>
<td>11.5</td>
<td>10.5</td>
<td>12.2</td>
<td>11.6</td>
<td>11.6</td>
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<tr>
<td>Proline</td>
<td>7.2</td>
<td>6.2</td>
<td>6.1</td>
<td>7.9</td>
<td>7.6</td>
<td>7.6</td>
</tr>
<tr>
<td>Serine</td>
<td>5.0</td>
<td>5.7</td>
<td>5.0</td>
<td>5.8</td>
<td>5.4</td>
<td>5.4</td>
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<tr>
<td>Glutamic acid</td>
<td>22.8</td>
<td>20.2</td>
<td>20.8</td>
<td>20.1</td>
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<td>19.7</td>
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<tr>
<td>Glycine</td>
<td>7.5</td>
<td>6.3</td>
<td>6.3</td>
<td>6.8</td>
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<td>6.3</td>
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<tr>
<td>Alanine</td>
<td>5.5</td>
<td>6.0</td>
<td>5.4</td>
<td>6.7</td>
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<td>5.8</td>
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<tr>
<td>Histidine</td>
<td>6.9</td>
<td>4.9</td>
<td>5.3</td>
<td>4.8</td>
<td>7.1</td>
<td>7.1</td>
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<tr>
<td>Arginine</td>
<td>8.9</td>
<td>12.1</td>
<td>11.5</td>
<td>10.4</td>
<td>12.7</td>
<td>12.7</td>
</tr>
<tr>
<td>Asparagine</td>
<td>4.9</td>
<td>3.8</td>
<td>3.2</td>
<td>3.7</td>
<td>3.6</td>
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</table>

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**Table 2—Amino acid content of sunflower butter**

<table>
<thead>
<tr>
<th>Protein content</th>
<th>Supermarket brand</th>
<th>Health food store brand</th>
<th>Experimental</th>
<th>R</th>
<th>CR</th>
<th>MR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>1.3a</td>
<td>49.0a</td>
<td>22.0a</td>
<td>3.9a</td>
<td>2.6a</td>
<td>2.6a</td>
</tr>
<tr>
<td>Oil (%)</td>
<td>0.5b</td>
<td>46.0ab</td>
<td>25.0b</td>
<td>3.4b</td>
<td>4.6b</td>
<td>4.6b</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>1.5ac</td>
<td>46.0ab</td>
<td>23.0a</td>
<td>4.2c</td>
<td>5.9c</td>
<td>5.9c</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>1.7e</td>
<td>43.0b</td>
<td>22.0a</td>
<td>3.7e</td>
<td>6.7e</td>
<td>6.7e</td>
</tr>
</tbody>
</table>

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**Table 3—Nutritional quality of sunflower butter**

<table>
<thead>
<tr>
<th>Protein digestibility (%)</th>
<th>C-PER</th>
<th>DC-PER</th>
<th>Available lysine (mg/g)</th>
<th>Phytic acid (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supermarket brands</td>
<td>83.0a</td>
<td>2.5a</td>
<td>1.8a</td>
<td>1.6a</td>
</tr>
<tr>
<td>Health food store brand</td>
<td>81.0ab</td>
<td>2.3b</td>
<td>1.8a</td>
<td>1.6a</td>
</tr>
<tr>
<td>Experimental</td>
<td>80.0b</td>
<td>2.5c</td>
<td>21.1b</td>
<td>6.3c</td>
</tr>
<tr>
<td>Conventionally roasted</td>
<td>81.0ab</td>
<td>2.2b</td>
<td>1.4c</td>
<td>6.2d</td>
</tr>
<tr>
<td>Microwave roasted</td>
<td>81.0ab</td>
<td>2.2b</td>
<td>1.8a</td>
<td>5.9d</td>
</tr>
</tbody>
</table>

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*Values in an entire column followed by a common letter are not significantly different at P < 0.05 (a through e). The letters in each column are presented for ease of comparison within the categories of brands and experimental butters.*

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*S/D values on a defatted, dry weight basis.*

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*R=Raw, CR=Conventionally roasted, and MR=Microwave roasted.*
were all 1.8%. Cheryan (1980) showed defatted peanut meal to have 1.7% phytic acid which is approximately equivalent to that of defatted sunflower butter. Although Falk and Holm (1981) noted that sunflower butter has high levels of calcium and iron, the bioavailability of these minerals needs to be evaluated due to the phytic acid level present.

Sensory quality

The sensory analyses data for the sunflower and peanut butter samples are shown in Table 4. The supermarket sunflower butter sample was rated significantly higher in all sensory attributes than either the health food store or the experimental samples. The conventionally roasted sample was rated higher in all attributes except for that of flavor than either the raw or microwave roasted samples. The flavor rating for both conventionally and microwave roasted samples were the same. At best, sunflower butter’s sensory qualities were rated in the categories (a) neither like nor dislike or (b) like slightly. In general, the commercial sunflower butters were rated lower in all attributes than their corresponding peanut butter samples. However, the supermarket sunflower butter sample was rated approximately equivalent in most sensory attributes to the old fashion style of peanut butter sample. Enhancement of all sunflower butter sensory characteristics will be required before a significant impact on consumer acceptance can occur.

Physical characteristics

The color and spreadability values of sunflower butter samples are shown in Table 5. The color values for the commercial samples were (a) L values reflecting the degree of lightness, ranged from 37.7–41.9, (b) a values reflecting the degree of redness, ranged from 2.9–7.3, and (c) b values reflecting the degree of yellowness, ranged from 15.3–17.3. Generally, the sunflower butters evaluated were darker and less red and yellow than the peanut butter samples evaluated by McWatters and Young (1978). Of the experimental samples the conventionally roasted sunflower butter was darker than the raw or microwave roasted samples. This probably helped to mask the slight gray-greenish color inherent in sunflower products due to chlorogenic acid (Robertson, 1975). The spreadability scores for the commercial sunflower butters ranged from 128–386g and the experimental samples ranged from 303–508g. The health food brand had lower spreadability than the supermarket brand. The poor spreadability of the health food brand was probably due to the absence of stabilizers, allowing oil separation. The experimental sunflower butters showed an inverse relationship between spreadability and the degree of roasting (raw samples had the highest spreadability while the conventionally roasted sample had the lowest spreadability). Both roasted sunflower butters had better spreadability than the raw sample, which was too firm. The load/penetration values from the Stevens LFRA Texture Analyzer have been shown to correlate favorably with taste panel spreadability scores (Marrs et al., 1980).

CONCLUSIONS

The data presented in this study show that sunflower butter has good nutritional value and moderate to low sensory scores. The proximate analyses of the sunflower butter samples showed it to have slightly less oil content and equivalent protein level when compared to literature peanut butter values. The nutritional analyses of sunflower butter showed the C-PER values to range from 2.2–2.5 and the DC-PER values to range from 1.4–2.1 with the raw sunflower butter having slightly higher protein quality than the other samples. Sunflower butter and peanut butter had approximately the same protein quality, calorie content and phytic acid level. Taste panelists rated sunflower butter lower than peanut butter in all sensory attributes evaluated. Of the commercial samples, the supermarket sunflower butter sample was rated approximately equivalent in sensory quality to the old fashion style of peanut butter. In the experimental sunflower butters the conventionally roasted samples had higher sensory scores, darker color and better spreadability than the raw samples. Additional studies are needed to help improve the sensory attributes of sunflower butter, thereby improving consumer acceptance of this unique product.

REFERENCES


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