Comparison and Evaluation of the Quality and Storage Stability of Soy and Peanut butter

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ABSTRACT

Soy butter and peanut butter were processed and stored for 40 days at ambient temperature (25°C on average) in plastic containers and analysed for comparison of their proximate composition, sensory quality, oxidation and fungal stability. Mean peroxide value was higher in soy butter (11.75 meq/kg) than in peanut butter (8.50 meq/kg). Maximum mean population of yeasts and moulds was greater in peanut butter (8.5 log CFU/g) than in soy butter (6.5 log CFU/g) after 20 days of storage. The average protein was significantly (p<0.05) higher in soy butter (23.25%) than in peanut butter (13.50%). Total fat was significantly (p<0.05) greater in peanut butter (52.70% on average) than in soy butter (31.40% on average). No significant (p>0.05) difference was found in ash or moisture contents between soy butter and peanut butter. The same was observed for all sensory parameters (colour, appearance, consistency, spreadability, taste and smell) evaluated by the sensory panel. It was concluded from the findings of this research work that the sensory quality of soy butter might be as acceptable as that of peanut butter to consumers. However, soy butter could be less stable to oxidation, but less prone towards fungal growth than peanut butter. Further research would be necessary to appraise available appropriate technologies to stabilise soy butter towards oxidation process and further detail the fungal spoilage of this food spread.

Key words: soy butter, peanut butter, composition, acceptability, stability

INTRODUCTION

Soybean (Glycine max) is one of the most important crops worldwide; it is a leguminous plant related to clover, peas, and alfalfa. It belongs to the same family of leguminosae as peanut (Arachis hypogaea) (Maria and Carelli, 2010). Its seeds are important sources of protein meal and cooking oil. The meal is used as animal feed as well. Soybeans are rich sources of protein containing about 38% (Messina, 1999) and about 18% of oil (0.5% lecithin); are rich in polyunsaturated fatty acids (54% linoleic acid, 22% oleic acid, and 7.5% linolenic acid) but contain no cholesterol (Singh et al., 2008). They additionally contain a good number of various phytochemicals. These include but are not limited to isoflavones, catechines, p-coumaric acid, ferrucic acid, gallic acid and vanillic acid (Wittanalai et al., 2012), which have a wide range of health benefits. These polyphenols and other phytochemicals are believed to play an important role in the prevention of cancer and other non-communicable chronic diseases (Messina and Barnes, 1991) and are also known for their antioxidant properties. Food that provides health benefits beyond its nutritional provision is termed as functional food. Soy beans are unique functional foods among legumes as they have the highest concentration of isoflavones (Bosman et al., 2009). Isoflavones are powerful inhibitors against tumour development and cancer cell proliferation, whilst soy proteins are known to have the lowering effect on total and LDL cholesterol (Vesanto and Brenda, 2003). Thus, soy and soy ingredients containing food products might be considered as having a protective effect against heart diseases.

The use of soy as food ingredient has recently grown in food industry as a result of its health benefits, technological and functional properties (Petra, 2008). Soybeans are used for making various food products including soy milk, tofu, soy sauce and soy cheese to just name a few. They are additionally processed into soy butter as peanuts into peanut butter, which is the most popular nut butter. However, soy butter is a good alternative for people with peanut allergy. Peanut and soy butter can best be described as typical examples of lipophilic suspensions of food that contain fine solids dispersed in a lipophilic, continuous phase (Franke and Heinzelmann, 2012). The shelf life of peanut butter and other peanuts derived products is greatly limited by rancidity that results from the oxidation of mainly unsaturated fatty acids (Nepote et al., 2006a). The oxidative and/or hydrolytic rancidity might be equally the limiting factor to the shelf life of soy butter and other soy-based products as soybeans contain large amounts of poly-unsaturated fatty acids. The oxidative and hydrolytic rancidity process is accelerated by high temperature, oxygen and enzyme. The lipolytic enzymes of yeasts and moulds are also known to

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hydrolyse lipids into free fatty acids and thus promote the hydrolytic rancidity (Sacks et al., 2006). Lipid oxidation is a main factor that lowers the quality of oil. Peroxide value is the widely used parameter for expressing the extent of lipid oxidation. The peroxide value of roasted peanuts increases with storage time and temperature (Abayomi et al., 2002). The same might be true for other products containing peanuts and soybeans as well. The available literature shows that much work has been so far done on peanut butter, whilst little has been so far done on soy butter. More research on soy butter and other soy products is crucial to satisfy an increased demand for good quality, safe and functional soy food products by consumers. No detailed study has so far been conducted to determine the stability, chemical composition and the sensorial acceptance of soy butter in Rwanda to the best of our knowledge. Therefore, need exists to study the proximate composition, sensory acceptability, oxidation and microbiological stability of soy butter in comparison to peanut butter, which is the most popular nut butter. This study aims at processing soy butter and peanut butter and comparing their proximate composition, sensory acceptability and their oxidation and microbiological stability

MATERIALS AND METHODS

Procurement of materials

Soybeans and peanuts used for this study were obtained from Rwanda Agriculture Board (RAB) located at Rubilizi in Kigali City, Rwanda. The varieties were PEKA6 and ANG17 for soybeans and peanuts, respectively.

Samples preparation

Soy beans and peanuts were sorted out for damaged and bruised grains. Thereafter, soy beans or peanuts grains were soaked in tap water at ambient temperature (25°C) for 16 hours. Then, they were de-hulled and dried in drier at 50°C for 3 hours, prior to roasting until brown colour was observed. The roasted grains were milled into flour, which was processed into soy butter or peanut butter.

Processing soy butter and peanut butter

The flour of soy beans or peanuts was mixed with cold heated soy oil and the other ingredients: sugar, salt and honey in the proportions shown in Table 1. Thereafter, the mixture obtained was ground into fine and creamy paste to obtain soy butter or peanut butter, which was stored in plastic bottles kept at ambient temperature (25°C) for further analysis.

Chemical Analysis

Protein: The protein content was determined using Biuret test assay method (Dorey and Draves, 1998), by which the Biuret reagent was diluted in albumin: distilled water solution (1:2). Then the absorbance of this standard solution was measured at 540nm and the standard curve was constructed. Then, the concentration of protein in sample (soy butter or peanut butter) was determined from the standard curve by extrapolation.

Moisture content of sample

The moisture content (MC) was determined by the oven drying method according to AOAC (1999): samples (soy butter or peanut butter) were oven dried at 105°C for 3 hours to have constant weight. Thereafter MC was expressed as the percentage of the ratio of the differences in weight of samples before and after drying to the original weight of sample used.

Ash content of sample

The ash content was determined by incinerating the sample (5g) in muffle furnace overnight. The remainder after the incineration was then cooled and expressed as the percentage of ash (AOAC, 2005)

Fat content of sample

The crude fat was determined by using soxhlet extraction method (AOAC, 2005). The samples (20 g) of soy butter or peanut butter were separately treated with hydrochloric acid to release lipids from lipid-protein complex. The digested mixture was filtered by using filter paper and dried in the oven for about 2 hours at 105°C. Thereafter, the dried sample was put in the extraction thimble and fat was extracted by using organic solvents: diethyl ether and acetone. Thereafter, the fat extract was dried in rotary evaporator. The remaining solvent was removed by heating the flask in oven at 105°C for 30 minutes

Peroxide value of sample

Peroxide value was determined by using the American Oil Chemists’ Society (AOCS) official methods (AOCS, 1991). One gram fat extracted from samples (soy butter or peanut butter) was dissolved into 10 ml of the solvent (3/2 mixture of glacial acetic acid/chloroform) and 0.2 ml of potassium iodide solution. Mixture obtained was left to stand in the dark for about 1 minute, and thereafter 20 ml of the diluted starch solution were added, prior to titration with 0.1N sodium thiosulphate solution. The volume of the sodium thiosulphate used was recorded. A blank was also prepared in the same conditions. Finally, the peroxide value was expressed as milliequivalent per kilogramme of butter.
Microbiological analysis

The growth of yeasts and moulds in soy butter or peanut butter was evaluated. Twenty five grams of samples (soy butter or peanut butter) was diluted in 225 ml of 0.1 % peptone water. The appropriate volume (0.1 ml) was spread on Sabouraud Dextrose Agar. The plates were incubated upside down at 25°C for 2 days. Thereafter the visible colonies were counted.

Sensory analysis

The sensory quality parameters of soy butter and peanut butter evaluated were colour, appearance, consistence, spreadability, smell and taste using the 9 points hedonic scale. The coded samples were presented to panellists and were asked to rank the aforementioned quality parameters from 1: dislike extremely to 9: like extremely.

RESULTS AND DISCUSSION

Proximate composition

The moisture content was found to slightly decrease in both peanut butter and soy butter during storage, from 13.5 to 10% in peanut butter, and 16 to 12% in soy butter. Difference in moisture content of peanut butter and soy butter was not statistically significant over 39 days of storage (Table 2). This table shows the same was true with regard to ash content. Indeed ash amounted to 3.2% in peanut butter and 3.60% in soy butter, on average. Similar moisture contents may suggest that no difference might exist in the quality factors determined by water content like consistency and spreadability between peanut butter and soy butter. The moisture content (11.45%) of peanut butter found in this study was nearly similar to the one of peanut butter tarts done with supplemented 20% honey in previous study (McWatters et al., 2006). In this study, the authors investigated the proximate composition and sensory acceptability of tarts made up with peanut butter with 20% honey and found that it ranged between 8.90 and 11.40%. Unlike insignificant difference in moisture and ash content observed between peanut butter and soy butter, protein and crude fat contents of soy butter significantly differed from the ones of peanut butter. The fat content was significantly higher in peanut butter (52.70%) than it was in soy butter (31.40%). The protein content of soy butter (23.25%) was nearly twofold that of peanut butter (13.5%). Variation in fat and proteins contents between peanut and soy butter might be explained by difference in these chemical constituents between peanuts and soybeans grains (Perez-Maldonado et al., 2003 and Asibuo et al., 2008).

Oxidation and fungal stability

Oxidation is an undesirable series of chemical reactions involving oxygen that degrades the quality of oil; it eventually produces rancidity that accompanies off flavours and smells. Oxidation progresses at different rates depending on factors such as type of oil, temperature, light, availability of oxygen, and the presence of moisture and metals such as iron ( Miller, ). Primary oxidation processes in oil mainly form hydroperoxides, which are measured by the Peroxide values. The trends in peroxide value of peanut butter and soy butter processed are presented in Fig. 1, whilst the estimates of the growth parameters of yeasts and moulds that have grown in peanut butter and soy butter are shown in Table (3).

It is clear from Figure (2) that the peroxide value of peanut butter was lower than that of soy butter over storage period. The mean peroxide value of soy butter (11.75 meq/kg) was nearly three units higher than that of peanut butter (8.50 meq/kg). Additionally, the peroxide value of peanut butter reached 10 meq /kg after 7 days of storage, whilst that of soy butter got to this threshold for the onset of rancid smell and off-flavour just after two days of room storage (25°C). In previous study that was carried out by Nepote et al (2006b) on roasted peanuts, 10 meq /kg was reached after 6 days of storage at room temperature (23°C). These results indicate that peroxide value in peanut butter reached 10 meq/kg after nearly same time that roasted peanuts did, though these two products are not completely identical.

Soy butter might thus develop rancid flavour earlier than peanut butter could do, unless other antioxidants are used. This is contrary to common belief stating that more fat in food formulation, the higher chance for rancidity, rather stresses the importance of fatty acids composition for lipid oxidation. Thus, difference in susceptibility to oxidative rancidity between soy and peanut butter might be due to variation in their lipids composition rather than...
the differences in their total fat contents. Soybeans are
rich in polyunsaturated fatty acids (Anuonye et al., 2010),
whilst the major part of peanuts’ unsaturated fat is mono-
unsaturated fatty acids like oleic acids (Carrin and
Carelli, 2010). Soybeans contain more linoleic acids
(51.5%) and linoleinic acids (7.3%) than peanuts, which
contain 31.0% of linoleic acid and do not contain
linoleinic acids (McKevith, 2005). Higher percentage of
polyunsaturated fat of soybeans might be the reason for
higher sensitivity of soy butter to oxidation than peanut
butter whose fatty acid composition is majorly palmitic
and oleic acid (Maria and Carelli, 2010). It is well known
from literature that greater the number of double bonds
contained in fat, more it is prone to oxidation
deterioration (Erickson and Frey, 1994; Sardesai, 2003;
Fennema, 1985). Unlike the lipid oxidation rate, the
estimates of the growth parameters of yeasts and moulds
in soy butter did not significantly differ from the ones of
yeasts and moulds grown in peanut butter. Similar
estimates of the growth parameters of yeasts and moulds
grown in soy butter and peanut butter suggest that soy
butter might be as stable as peanut butters towards the

<table>
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<tr>
<th>S/N</th>
<th>Ingredients</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Soy flour/peanut flour (g)</td>
<td>367.7</td>
</tr>
<tr>
<td>2</td>
<td>Boiling water (ml)</td>
<td>125</td>
</tr>
<tr>
<td>3</td>
<td>Sugar (g)</td>
<td>29.4</td>
</tr>
<tr>
<td>4</td>
<td>Cooking soy oil (ml)</td>
<td>12.5</td>
</tr>
<tr>
<td>5</td>
<td>Salt (g)</td>
<td>3.7</td>
</tr>
<tr>
<td>6</td>
<td>Honey (Tbsp)</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 2 Comparison of proximate composition (%) of peanut and soy butter

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Products</th>
<th>Peanut butter</th>
<th>Soy butter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat</td>
<td></td>
<td>52.70±4.45</td>
<td>31.40±3.41</td>
</tr>
<tr>
<td>Moisture</td>
<td></td>
<td>11.45±1.20</td>
<td>14.10±1.61</td>
</tr>
<tr>
<td>Protein</td>
<td></td>
<td>13.50±1.29</td>
<td>23.25±1.70</td>
</tr>
<tr>
<td>Ash</td>
<td></td>
<td>3.20±0.97</td>
<td>3.60±1.60</td>
</tr>
</tbody>
</table>

Table 3. Estimated growth parameters of yeasts and moulds in soy butter relative to peanut butter

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Soy butter</th>
<th>Peanut butter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum growth rate (d⁻¹)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimate</td>
<td>0.94</td>
<td>0.60</td>
</tr>
<tr>
<td>95% Confidence Interval</td>
<td>0.00-0.99</td>
<td>0.00-1.64</td>
</tr>
<tr>
<td>Maximum count (log CFU/g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimate</td>
<td>6.60</td>
<td>8.71</td>
</tr>
<tr>
<td>95% Confidence Interval</td>
<td>4.06-9.14</td>
<td>7.86-9.56</td>
</tr>
<tr>
<td>Lag phase (d)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimate</td>
<td>12.00</td>
<td>7.80</td>
</tr>
<tr>
<td>95% Confidence Interval</td>
<td>0.00-26.67</td>
<td>0.00-17.12</td>
</tr>
</tbody>
</table>

*Different superscript letters indicate significant difference based on 95% confidence interval
fungal growth, however this might need further clarification as the maximum fungal population in peanut (8.71 log CFU/g) was nearly two log units greater than the one (6.60 log CFU/g) of those grown in soy butter. Moreover, the estimate of lag phase was longer for the yeasts and moulds grown in soy butter (12.00 days) than the one of those grown in peanut butter (7.80 days)

**Sensory evaluation**
The underlying fat crystal network in peanut and soy butter influence many of the sensory attributes such as spreadability, mouth feel and texture (Fabiana et al., 2012). The scores of the parameters evaluated (colour, consistency, spreadability, taste, smell and appearance) by the sensory panel are presented in Figure 2. From this (Table 3) suggesting that soy butter could be more stable towards fungal invasion than peanut butter. This also may lead to the thinking that oxidative rancidity might be more important than hydrolytic rancidity as lipid hydrolysis is mainly enhanced by lipase activities, which could be expected to be high in peanut butter than in soy butter in view of present findings on the fungal growth in soy butter compared to peanut butter.

Figure, it could be observed that no significant difference (p>0.05) was detected by panellists between the quality attributes of peanut butter and soy butter investigated in the current study. These findings reveal that the sensory acceptability of soy butter would not differ much from that of peanut butter.
CONCLUSION

The present study aimed to compare proximate composition, sensory quality and stability of soy butter and peanut butter. It has been concluded that soy butter might be organoleptically as acceptable as peanut butter and provide human body more proteins than peanut butter. It might, however, be more susceptible to oxidation, but less invaded by yeasts and moulds than peanut butter. Further studies would be necessary to explicitly clarify the fungal spoilage of soy butter and investigate appropriate approach to stabilize it against the oxidation phenomenon in order for this food spread to keep longer and satisfy higher demand for consumers, who seek its nutrients and health benefits. Alternatively, a blend of the two could also be used to develop peanut – soy butter that might be nutritionally richer in proteins than the commonly used peanut butter.

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