Physicochemical Characteristics and Organoleptic Properties of Peanuts Milk-Based Yoghurt Fortified With Skimmed Milk Powder

Mohamed O. Elsamani\textsuperscript{a}, Isam A. Mohamed\textsuperscript{a,b,}\textsuperscript{*}

\textsuperscript{a}Department of Food Science and Technology, Faculty of Agriculture, Omdurman Islamic University, Omdurman, Sudan
\textsuperscript{b}Department of Food Science and Technology, Faculty of Agriculture, University of Khartoum, Khartoum North, Shambat, Sudan
\textsuperscript{c}Arid Land Research Center, Tottori University, 1390 Hamsaka, Tottori 680-0001, Japan

\textsuperscript{*}Corresponding Author Email: isammawa@yahoo.com

Abstract: Improving the protein quality of foods by incorporating legumes or cereal protein isolates and/or flour in blends is one of the main focuses of the international research community. The aim of this study was to produce peanut milk based yoghurt and to evaluate its physicochemical and organoleptic characteristics. Yoghurt samples were produced from blends of peanuts milk and skimmed milk powder together with the starter culture of Lactobacillus helveticus, Streptococcus thermophiles and Lactobacillus bulgaricus. The skimmed milk powder was added to peanuts milk at the concentration of 0\% (sample A), 5\% (sample B), 10\% (sample C), and 15\% (sample D). The physicochemical and sensory characteristics of the products were subsequently analyzed at 0, 5, and 10 days. The results of chemical analysis showed protein contents of 11.55, 14.7, 18.55, and 20.65\% for the samples A, B, C, and D, respectively. Fat contents was varied and in the range of 3.35-4.55\%, while total solid was ranged from 19.7 to 27.09\%. The pH value varied between 4.41 to 4.76 while acidity (P ≤ 0.05) was increased from 1.28, to 1.78\% with increasing levels of skimmed powder milk. In all samples, the moisture contents of the samples was significantly decreased with increasing levels of skim powder milk. Among all types of yoghurts, peanuts milk-based yoghurt fortified with 10 g/100 ml skimmed milk represented highest (P ≤ 0.05) scores of all sensory attributes and remain superior in this regards in both fresh and mature yoghurt.

Keywords: Organoleptic Properties, Peanuts Milk, Physicochemical Characteristics, Skimmed Milk, Yoghurt.

Introduction

Peanuts or Groundnut (Arachis hypogaea) is an important food and/or cash crop in the Sudan and in 2007 the country produced about 460.000 tons of the total world production of peanuts, and ranked number nine in the world (FAO, 2008). It has been used as a major source of edible oil and protein meal and considered highly valuable for human and animal nutrition in developing countries (Fekria et al., 2012). Peanuts are rich source of multiple nutrients and their consumption is associated with various health benefits, including reduced cardiovascular disease risk (Mattes et al., 2008). It has been reported that eating peanuts or peanut butter could provide the body with the daily requirements of many of the essential vitamins and minerals such as vitamin A, vitamin E, folate, magnesium, zinc, iron, calcium, and dietary fiber (Griel et al., 2004).

These huge benefits of peanuts have encouraged recommendations to increase its consumption and thus processing in many forms (Mattes et al., 2008). Providing safe, nutritious, and wholesome food for poor and malnourished populations has been a major challenge for the developing world. Hence, the past decade is witnessed by increased consumption of vegetable proteins in many food products. This because of the shortage of animal protein, animal diseases, strong demand for wholesome and religious (halal) food, and economic reasons (Asgar et al., 2010). Thus,
the development of nutritionally balanced protein foods to feed the growing population in developing countries, as well as to eliminate the so-called protein calories malnutrition problem is receiving increasing attention of the food scientists and nutritionists (Fekria et al., 2012). Accordingly, principal raw materials, oil seeds and grain legumes proteins are utilized to manufacture and market high protein foods at reasonably low prices (Asgar et al., 2010). Of them, peanuts have been developed into a food for infants suffering from various forms of malnutrition and for individual with lactose intolerance allergies (Considine & Considine, 1997). Milk-like beverages manufactured from soya beans and peanut have also been renowned as potential nutritional substitutes in cultures where cow is in insufficient quantity, too expensive or indigestible (Isanga & Zhang, 2009).

Yoghurt-like products were prepared from cowpea and mung beans that have poor protein extractibilities as 23% for cowpea and 34% for Mung beans (Rao et al., 1988). Whereas, yoghurt made from banana milk did not develop any difference from the plain yoghurt (Wheeler & Gillfies 1973). The beverage being a blend of legume and cereal was found to be highly digestible and widely acceptable by both children and adults (Omueti et al., 2000). Peanut milk is of considerable interest to nutritionist as possible substitute for cow and human milk. In this regards, peanuts milk has been used in combination with cowpea for the preparation of vegetables milk chocolates (Aidoo et al., 2010), or with soy bean and cow milk for the preparation of yoghurt (Kpodol et al., 2014a).

Indeed, very view research reports on the physicochemical of yoghurt made by fortifying peanut milk (12 g/100g total solids) with 4 g/100g skimmed milk powder has recently been published (Isanga & Zhang, 2009). However, physicochemical and sensory quality studies on the production peanuts-based yoghurt by different combination of peanuts milk and skimmed milk powder has not been reported yet. Therefore, the objectives of the study were to find local substitute for milk based product with high protein content and high digestibility and to determine the physicochemical and sensory characteristics of peanuts milk based yoghurt with a view of knowing the consumer acceptability of the product.

**Materials and Methods**

Peanuts seeds were obtained from the Food Research Center, Shambat, Khartoum, and Sudan. Skimmed milk powder with protein content of 32.7 % (Holland) was supplied by Kuki Dairy Plant, Khartoum North, and Sudan. Commercially available yoghurt starter cultures (Streptococcus thermophilus and Lactobacillus bulgaricus) were obtained from local market (Khartoum, Sudan).

**Preparation of peanuts milk**

Milk extract of peanuts was prepared following the traditional Sudanese methods in which peanuts were first sorted and cleaned from dust and stones. Then, about 2kg the samples were soaked in 2 L of 0.06 M NaHCO$_3$ for 16 h. The samples were de-coated, drained and then rinsed twice with tap water. The peanuts seeds were wet milled and homogenized with 5 L of water in a warming blender at room temperature. The resultant slurry was filtered through cheese cloth (0.04 mm) to obtain peanut milk. The milk was thermally treated at 100 °C for 20 min to inactivate the lipoxygenase, and then cooled to 4 °C. The milk samples were stored at 4 °C for further use.

**Preparation of peanuts milk/skimmed powder blends**

The blends were prepared from pure peanuts milk fortified with different levels of skimmed milk powder at concentrations of 0% (sample A), 5% (sample B), 10% (sample C) and 15% (sample D) for peanuts milk. The blends (5 kg each) were pasteurized at 73°C for 1 min and then cooled to 45°C. Thereafter, two table spoon of mixed starter culture (Streptococcus thermophilus and Lactobacillus bulgaricus) were added and then incubated at 45°C for 4 h. The samples were placed in the refrigerator for 3 h to stop fermentation at the end of the incubation period.

**Chemical analysis**

The moisture and total solid contents of the produced yoghurt were determined using the official methods (AOAC, 1990). Fat content was determined following the Werner-Schmid method (Egan et al., 1981). Protein was evaluated using Formol titration method. The pH of the samples were determine using Dye unicon pH meter (model, 290 MK2) while the titratable acidity was determined using the method described by Olubamiwa et al. (2006).

**Sensory evaluation**

The yoghurt samples were presented to an untrained 10-member panel of judges who were familiar with the consumption of yoghurt. The samples were assessed for color, flavor, texture, taste and overall acceptability using a nine-point hedonic scale, where 9 indicated “like extremely” and 1 indicated “dislike extremely”. Each panelist was provided with enough privacy to avoid biased assessment.
Statistical analysis

Data obtained were analyzed statistically using analysis of variance (ANOVA) and means were separated using the least significant difference (LSD) according to Obi (1995).

Results

Biochemical characteristics of peanut milk-based yoghurt

The results in table 1 shows the biochemical characteristics of the peanut milk and fresh yoghurt made from peanuts milk fortified with different concentration of skim milk powder. The concentrations of protein, fat, total solids and acidity were significantly \( (P \leq 0.05) \) increased with increasing skim milk powder level in fresh yoghurt compared to pure peanut milk yoghurt. On the other hand, the pH showed a significant \( (P \leq 0.05) \) reduction as the level of skim milk powder increased. Both the protein and fat contents of yoghurt increased gradually with increasing levels of skim milk powder. Sample A has 19.7 g/100 g total solid (100% peanut yoghurt), Sample B has 21.3 g/100 g total solids (5 % powder milk yoghurt) while Sample C has 25.5 g/100 g total solids (10% powder milk yoghurt).

Moisture content of 72.91 g/100g obtained for sample D is lower than other samples (80.3 g/100 g for A, 78.7 g/100 g for B, and 74.65 g/100 g for C. This may be due the addition of skim milk powder in form of milk slurry has thickened the peanut yoghurt. The acidic nature of powder milk protein could be responsible for high titratable acidities recorded for both samples C and B respectively (1.59 and 1.78%) when compared with sample A (0.76%). Acid production in the medium depends on the growth of microorganisms and their ability to ferment the available protein.

Table 1. Biochemical composition of peanuts milk and fresh (day 0) and mature (day 10) yoghurt manufactured from peanut milk fortified with different levels of skim powder milk.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Peanuts milk</th>
<th>Fresh yoghurt (day 0)</th>
<th>Mature yoghurt (day 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Concentration of skimmed milk (g/100 mL)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Moisture content (g/100 g)</td>
<td>85.30</td>
<td>80.30&lt;sup&gt;a&lt;/sup&gt;</td>
<td>78.7&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Protein (g/100 g)</td>
<td>5.60</td>
<td>11.55&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14.7&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fat (g/100 g)</td>
<td>5.40</td>
<td>4.40&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.45&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total solids (g/100 g)</td>
<td>14.70</td>
<td>19.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>21.3&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Acidity (% lactic acid)</td>
<td>0.09</td>
<td>0.76&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.28&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>pH</td>
<td>7.30</td>
<td>4.74&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.49&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Mean values in the same column with different letters in the superscript are significantly different \((p<0.05)\), yoghurt produced using peanut milk fortified with different concentrations \((0, 5, 10, 15%)\) of skim powder milk, 0 gm/100 mL (A), 5 gm/100 mL (B), 10 gm/100 mL (C), and 15 gm/100ml (D). Sensory characteristics of peanut-based yoghurt

The sensory characteristics of fresh and mature (10 days) yoghurt made using peanut milk fortified with different levels of skim milk powder are shown in Table 2. The fresh yoghurt prepared by adding different levels of skimmed milk powder was significantly \( (P \leq 0.05) \) higher than that of pure peanut milk with respect to flavor, taste , and overall acceptability. Whereas the texture and color of the fresh yoghurt made from pure peanuts milk is slightly better than that of 5% substitution. However, during maturation all the sensory attributes of the skimmed milk fortified yoghurt was significantly enhanced by the addition of skinned milk powder compared to that of pure peanuts milk. Among all types of yoghurts, peanuts milk-based yoghurt fortified with 10 g/100 ml skimmed milk represented highest \( (P \leq 0.05) \) scores of all sensory attributes and remains superior in this regards in both fresh and mature yoghurt. Mature yoghurt prepared from peanut milk fortified with powdered skimmed milk and stored for 10 days at 4°C showed improved sensory attributes compared to fresh yoghurt. It is worth to note that all the sensory characteristics peanuts milk-based yoghurt fortified with various concentrations of skimmed milk powder were significantly improved during maturation compared to that of pure peanuts milk.
Table 2. Sensory evaluation of fresh (day 0) and mature (day 10) yoghurt manufactured from peanut milk fortified with different levels of skim powder milk.

<table>
<thead>
<tr>
<th>Quality attribute</th>
<th>Fresh yoghurt (day 0)</th>
<th>Mature yoghurt (day 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Flavor</td>
<td>5.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.6&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Texture</td>
<td>5.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.6&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Taste</td>
<td>5.4&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.8&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Color</td>
<td>6.6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.6&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Overall acceptability</td>
<td>6.4&lt;sup&gt;d&lt;/sup&gt;</td>
<td>6.6&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Mean values in the same column with different letters in the superscript are significantly different (p<0.05), yoghurt produced using peanut milk fortified with different concentrations (0, 5, 10, 15%) of skim powder milk, 0 gm/100 mL (A), 5 gm/100 mL (B), 10 gm/100 mL (C), and 15 gm/100ml (D).

Discussion and Conclusion

The prevalence of under nutrition and micronutrient deficiencies are high among peoples in most developing countries. The high cost of animal protein, poverty, and unavailability of nutritious foods, adds more to the difficulty of providing good nutrition to peoples in these countries. To overcome these limitation research on the preparation of nutritious foods from the local and cheap plant materials gained the highest priority and accordingly many research on fortified foods has been reported (Isanga & Zhang, 2009; Kpodo et al., 2014a; Zanhi & Jideani, 2012) and is still on raise. In the current study we prepared yoghurt from peanuts milk fortified with various concentrations of skimmed milk powder and evaluated the product for its nutritional and sensory quality.

The results pointed out that the nutritional quality (especially protein content) of peanuts based yoghurt was greatly improved by the addition of skimmed milk powder. This may be due to the fact that skimmed milk powder has generally high protein (32.7 g/100 g) content compared to that of peanuts milk (5.6 g/100g). The concomitant increase of fat, protein, and total solids of both fresh and mature yoghurt with increasing the fortification level of skimmed milk powder could be attributed to the fact that drying of the milk to prepare skimmed milk is well known to concentrate the biochemical constituents of the powdered milk. Thus, the addition of small amounts of this powdered skimmed milk may contribute significantly in the elevation of the chemical composition of the final products. Similarly, increasing of the total solids content of soy and milk solids fortified yoghurt was occurred with the concentration of both soy milk powder and non-fat dried milk (Zanhi & Jideani, 2012). As expected with increasing the fortification level of skimmed milk, the acidity of fresh yoghurt was increased concomitantly with the reduction of the pH. This could be attributed to that fact that addition of skimmed milk increases the concentration of lactose that could be degraded by the starter culture enzymes to produce lactic acid (Elsamani et al., 2014; Kpodo et al., 2014b). This acid in turn increases the acidity and automatically reduces the pH. The acidity depends primarily on type and quantity of starter added, pre-acidification applied, temperature and duration of acid development (Elsamani et al., 2014). It has recently been reported that increasing the concentration of cow milk in yoghurt prepared form blends of soy, peanuts and cow milk was found to increase the acidity and in turn reduce the pH of the final product (Kpodo et al., 2014b). Although, nutritionally balanced yoghurt could be prepared from peanuts milk without skimmed milk powder, however, addition of small amount (up to 10%) of skimmed milk powder could significantly enhance the nutritional quality of this important food.

Since the sensory quality of the product is the most determining factor of its usefulness and consumption, the sensory attributes of peanuts milk based yoghurt was evaluated in the current study. Generally, the results showed that incorporation of skimmed milk powder in peanuts milk yoghurt significantly (P ≤ 0.05) improved the overall sensorial quality of both fresh and mature yoghurt. All mean scores for the different sensory attributes of peanuts yoghurt with and without skimmed milk powder were similar than those reported previously for various yoghurts (Isanga & Zhang, 2009; Zanhi & Jideani, 2012). The scores were also within the commercially acceptable range (4–9 scores) recommended for yoghurt by the Karl Ruther nine points scheme (Tamime & Robinson, 1999). Overall, the peanuts based yoghurt in the current study was approved to have acceptable sensorial quality, and thus its potentiality as nutritious food for people in developing countries.

In conclusion, this research proves that there are serious confirmations those supporting develop of new peanut yoghurt formulation. The addition of skimmed milk powder and application of growing culture have important role in design of various
functional products including peanut yoghurt. Stability during storage is important characteristics that are proved observing physicochemical characteristics of produced samples of peanut yoghurt. Therefore, production of peanut beverages which are highly consumed by Sudanese because of the availability of peanut in commercial quantity is another way of increasing the food value of this crop. Moreover, incorporation of peanuts milk in yoghurt manufacturing resulted in cost saving and improvement of the nutritional value and sensory quality.

References


