Quality Attributes of Soy-yoghurt During Storage Period

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Abstract: The utilization of soybean milk in manufacturing yoghurt in Sudan was investigated. Soybean milk was prepared from grinded soybean seeds. Four samples of soy yogurt product were used, namely sample A) 100% soymilk (sample B) 1:1 soymilk: cow milk, sample C (2:1 soymilk: cow milk) and sample D (1:2 soymilk: cow milk). The prepared soy yoghurt samples were stored at refrigerator temperature (10±2°C) followed by analyses at 0, 5, 10, 15 and 20 days intervals. The chemical compositions of soybean milk used were the total solids (13.15%), protein (7.64%), fat (2.75%), pH-value (6.70) and titratable acidity (0.20%). The type of milk significantly (p≤0.05) affected the pH-value of the soy yoghurt. Sample A was the highest (4.50), sample D the lowest (3.30) while sample B and sample C were at an intermediate position (3.50 and 3.70 respectively). Storage period significantly (p≤0.05) affected the pH-value of soy yoghurt, the highest value (4.30) was obtained at the beginning of the storage period, while the lowest value (3.00) at the end. The type of milk significantly (p≤0.05) affected the titratable acidity of the soymilk yoghurt. Sample A was the lowest (1.12%), Sample D was the highest (2.50%), while samples B and C were in an intermediate position. Storage period significantly (p≤0.05) affected the titratable acidity of soy yoghurt. The lowest titratable acidity (1.21%) was obtained at the beginning of storage period and the highest (2.60%) at the end. The type of milk significantly (p≤0.05) affected the wheying off of the soy yoghurt. Sample A was the highest (2.70 ml), sample D was the lowest (1.70 ml), while samples B and C were at an intermediate position. Storage period significantly (p≤0.05) affected the wheying off of soy yoghurt. The lowest wheying off (0.00 ml) was obtained at the beginning of storage period and the highest (4.00 ml) at the end. The chemical analyses of soy yoghurt samples at zero time processing, sample A) 100% soymilk (was the highest (31.20%) for total solids and protein content (16.70%), while sample D (1:2 soymilk: cow milk) was the lowest (15.70%) for total solids and protein content) 11.25%. Sample B and C were at an intermediate position. Sample A was the lowest (2.20%) for fat content, sample D was the highest (3.25%) while samples Band C occupy an intermediate position. The sensory evaluation significantly (p≤0.05) affected by the type of milk and storage period revealed that, the best score (p≤0.05) in appearance (4.38), flavour (4.10), texture (4.22) and overall acceptability (4.28) in sample D (1:2 soymilk: cow milk), the worst was recorded by sample A (Soymilk 100%) for appearance (2.68), flavour (3.48), texture (3.36) and overall acceptability (3.44). The other samples were at an intermediate position. It was found that 10 days storage period at refrigerator temperature (10±2°C) was quite satisfactory to attain good quality soymilk yoghurt.

Key words: Soy milk, yoghurt, storage, cow milk

INTRODUCTION
Vegetable milk is prepared from food grains such as soya bean, sesame and groundnut. Soybean (Glycine max), a plant protein which is cheaper could serve as an alternative to cow milk. Soybean milk is richer in protein than most animal milk. It contains up to 40% protein compared with 1.0% to 5.6% protein content of most animal milk (Burton, 1985). Soymilk is processed from soybean. Intake of fermented soymilk improves the ecosystem in the intestinal tract by increasing the amount of probiotics (Chang et al., 2005). Soybean and its derivatives represent an excellent source of high quality protein, with low content of saturated fat and a great amount of dietary fiber and bioactive components like the isoflavones. Soymilk and its fermented products constitute an alternative for lactose intolerant people. In this way, soy yoghurt could be a suitable vehicle for iron fortification, since it has high nutritional value and low-cost. However, calcium content of soymilk is lower than that found in cow's milk, being necessary the addition of this mineral to improve its nutritional properties. The objective of this work is to prepare the milk from soybean seeds and to study their effects on quality of Sudanese soy yoghurt during storage period.

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MATERIALS AND METHODS
The seeds were obtained from the local market. The starter culture Lactobacillus bulgaricus and Streptococcus thermophilus were obtained from Khartoum Dairy Products Company Ltd. Plastic cups (250 ml volume) were purchased from retailers in the local market. Fresh cow milk was obtained from the University of Sudan Dairy Farm (Shambat).

Preparation of soymilk: Soymilk was prepared by soaking kernels in 0.5% sodium bicarbonate solution for 16-18 h, drained, washed with tap water, ground, steeped for 4-5 h in tap water (100 g soybean mixed with 100 ml tap water) and filtrated through cheese cloth to obtain the soymilk.

Preparation of soy-yoghurt: Four samples (A, B, C and D) were selected in which soymilk was kept in equal volumes after being filtered from impurities. Sample (A) 100% soymilk, sample (C) 1:1 soymilk: cow milk, sample (D) 1:2 soymilk: cow milk. The volumes were pasteurized at 85°C for 10 min and then cooled to 45°C. Starter culture 3% of the milk volume was added in the form of (Streptococcus thermophilus and Lactobacillus bulgaricus). The milk mixture was placed in 250 ml cups and kept in an incubator at 45°C for 3-6 h. The cups were transferred to refrigerator and stored in a temperature of 10±2°C for 0, 5, 10, 15 and 20 days intervals. The Analyses were carried for physicochemical, rheological and sensory evaluation.

Chemical analyses: The pH-values of samples were determined according to Newlander and Atherton (1984), while the titratable acidity, total solids, protein and fat content were determined according to AOAC (1995).

Rheological properties: Wheying-off was measured by sucking off the water from the surface of the curd and poured in a graduated cylinder.

Sensory evaluation: The sensory evaluation was performed by 10 untrained panelists using procedure according to Ihekoronye and Nogddy (1985).

Statistical analyses: Data was subjected to statistical analyses using Statistical Analysis System program (SAS, 1988).

RESULTS AND DISCUSSION
Soybean milk: The results of chemical properties of soy milk were of total solids (13.15%), pH-value (6.70), titratable acidity (0.20%), protein content (7.64%) and fat content (2.75%).

Tuitemwong et al. (1993) found that, the soymilk has desirable characteristics as an ingredient for making soy yoghurt because of its high solid content (Moriguchi et al., 1961). Angeles and Marth (1971) found a titratable acidity of 0.23-0.25% or a pH of 5.7. Wolf, (1979) concluded 60-70% of the total protein in the soybean is stored in the protein bodies. Deshpande et al. (2008) found that, the soymilk contains total solids (9.8%), fat (2.8%), protein (5.8%), pH value (6.0) and ash (0.8%). Lee et al. (1990) stated the variation in the results to the origin of soybean and to the processing condition.

Chemical properties of soy yoghurt
pH-value: The type of milk was significantly (p<0.05) affected pH-values of the soy yoghurt (Table 1). Samples D (1:2 soymilk: cow milk) was the lowest (3.30) and sample A) 100% soymilk (the highest (4.50), while samples B (1:1 soymilk: cow milk) and C (2:1 soymilk: cow milk) were at an intermediate position (3.50 and 3.70) respectively.

Storage period significantly (p<0.05) affected the pH-values, where they decreased gradually till the end of storage (Table 2 and Fig. 1). The highest pH-value (4.30) was obtained at the beginning of the storage period, whereas the lowest (3.00) at the end. Sugimoto and Van Buren (1970) and Buono (1988) found that, the pH-value of soy yoghurt to be 5.0. Moriguchi et al. (1981) stated high optimum pH-values of soy yoghurt varied form 5.0-6.0.

Table 1: Effect of type of milk on pH-value*, titratable acidity* and wheying off* of soy-yoghurt

<table>
<thead>
<tr>
<th>Parameters</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>LSDmin</th>
<th>SE#</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH-value</td>
<td>4.50±0.08*</td>
<td>3.50±0.04*</td>
<td>3.70±0.06*</td>
<td>3.30±0.02*</td>
<td>0.027*</td>
<td>0.083*</td>
</tr>
<tr>
<td>Titratable acidity (lactic acid)</td>
<td>1.12±0.01*</td>
<td>1.76±0.04*</td>
<td>1.41±0.03*</td>
<td>2.50±0.05*</td>
<td>0.151*</td>
<td>0.03651</td>
</tr>
<tr>
<td>Wheying-off (ml)</td>
<td>2.70±0.06*</td>
<td>2.40±0.04*</td>
<td>1.40±0.05*</td>
<td>1.70±0.02*</td>
<td>0.189*</td>
<td>0.05774</td>
</tr>
</tbody>
</table>

*Means±SD. Values having different superscript letter in rows are significantly different (p<0.05). A = Soymilk 100%; B = Soymilk: cow milk 1:1; C = Soymilk: cow milk 1:2; D = Soymilk: cow milk 1:2

Table 2: Effect of storage period on pH-value*, titratable acidity* and wheying off* of soy-yoghurt

<table>
<thead>
<tr>
<th>Parameters</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>LSDmin</th>
<th>SE#</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH-value</td>
<td>4.30±0.09*</td>
<td>3.90±0.08*</td>
<td>3.70±0.06*</td>
<td>3.30±0.04*</td>
<td>3.00±0.02*</td>
<td>0.151*</td>
<td>0.05774</td>
</tr>
<tr>
<td>Titratable acidity (lactic acid)</td>
<td>1.2±0.01*</td>
<td>1.5±0.02*</td>
<td>2.0±0.04*</td>
<td>2.34±0.06*</td>
<td>2.60±0.08*</td>
<td>0.1151</td>
<td>0.03651</td>
</tr>
<tr>
<td>Wheying-off (ml)</td>
<td>0.0±0.00*</td>
<td>1.5±0.01*</td>
<td>2.40±0.03*</td>
<td>3.00±0.05*</td>
<td>4.00±0.07*</td>
<td>1.156*</td>
<td>0.3670</td>
</tr>
</tbody>
</table>

*Means±SD. Values having different superscript letter in rows are significantly different (p<0.05)
Titratable acidity: The type of milk was significantly (p<0.05) affected titratable acidity (Table 1). Sample A (100% soy milk) was the lowest (1.12%), Samples D (1:2 soymilk:cow milk) the highest (2.50), while sample B and C were at an intermediate position (1.70% and 1.41, respectively).

Storage period significantly (p<0.05) affected titratable acidity of Sudanese soy yoghurt samples (Table 2 and Fig. 2). Titratable acidity increased gradually till the end of storage. The highest value (2.60%) was obtained at the end, while the lowest (1.21%) at the beginning of the storage.

Methods for the reduction of the flatulent sugars, raffinose and stachyose in soymilk and soybean products have been extensively investigated (Mital et al., 1973; Pinthong et al., 1980a,b; Buono, 1988; Buono et al., 1990a,b). Mital et al. (1973) stated the activity of the enzyme alpha-galactosidase (EC 3.2.1.22) in some lactic acid bacteria. The soy yoghurt contains oligosaccharides such as raffinose, stachyose produced during the fermentation process.

Wheying off: The type of milk was significantly (p<0.05) affected the wheying off (Table 1). Sample A was the highest (2.70 ml), sample D the lowest (1.70%), while sample B and C were at an intermediate position (2.40 ml and 2.50 ml respectively).

Storage period significantly (p<0.05) affected wheying off of Sudanese soy yoghurt samples (Table 2 and Fig. 3). The wheying off increased gradually till the end of storage. The highest value (4.00 ml) was obtained at the end, while the lowest (0.00 ml) at the beginning of the storage period. Lucey et al. (2000) found that, stabilizers are commonly used in cultured products to reduce whey separation.

Chemical composition of soy yoghurt samples
Total solids: The type of milk significantly (p<0.05) affected the total solids of the soy yoghurt. Sample A (100% soymilk) recorded the highest content of total solids (31.20%) compared with sample D (1:2 soymilk cow milk), that gave the lowest (15.70%). Samples B (21.80%) and C (20.40%) showed an intermediate position (Table 3).

Tuilernwong et al. (1993) found high total solid content of processed soy yoghurt ranged from 56.02-61.12%. The soymilk has desirable characteristics as an ingredient for making soy yoghurt because of its high solid content. Tamime and Robinson (1999) found the total solids of processed soy yoghurt ranged from 34.2-44.4%.

Protein content: The type of milk was significantly (p<0.05) affected the protein content of soy yoghurt (Table 3). Sample A was the highest (16.70%), Sample D the lowest (11.25%), while sample B and Sample C, occupied an intermediate position (13.00% and 14.80%, respectively). Burrington (2000) noticed that, soy proteins are high in the amino acids glycine and arginine.

Fat content: The type of milk was significantly (p<0.05) affected fat content of soy yoghurt. Sample D (Soymilk cow milk 1:2) was the highest (3.25%) whereas sample A (Soymilk 100%) was the lowest (2.20%). While sample B and C showed an intermediate position (3.00% and 3.20, respectively). Tamime and Robinson (1999) reported that, the fat content of processed soy yoghurt varied from 1.2-2.2%. Friedman and Brandon (2001) found that, soy or soy product containing soy protein that meets requirements including low saturated fat and low cholesterol with a minimum of 4.25% of soy protein. Burrington (2000) noticed that, soy proteins are high in the amino acids glycine and arginine, which decrease cholesterol and lower fat levels. Dashnell et al. (1990) stated low cholesterol soy milk yoghurt.
Table 3: Chemical composition* (% of soy-yoghurt

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Total solids content</td>
<td>31.20±0.09a</td>
</tr>
<tr>
<td>Fat content</td>
<td>2.20±0.01a</td>
</tr>
<tr>
<td>Protein content</td>
<td>16.70±0.48a</td>
</tr>
</tbody>
</table>

*Means±SD. Values having different superscript letter in rows are significantly different (p≤0.05). A = Soymilk 1:1; B = Soymilk: cow milk 2:1; D = Soymilk: cow milk 1:2

Table 4: Effect of type of milk on quality attributes* of soy-yoghurt

<table>
<thead>
<tr>
<th>Quality attribute</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Appearance</td>
<td>2.68±0.01a</td>
</tr>
<tr>
<td>Flavour</td>
<td>3.48±0.02a</td>
</tr>
<tr>
<td>Texture</td>
<td>3.36±0.01a</td>
</tr>
<tr>
<td>Overall acceptability</td>
<td>3.44±0.03a</td>
</tr>
</tbody>
</table>

*Means±SD. Values having different superscript letter in rows are significantly different (p≤0.05). A = Soymilk 1:1; B = Soymilk: cow milk 2:1; D = Soymilk: cow milk 1:2

Table 5: Effect of storage period on quality attributes* of soy-yoghurt

<table>
<thead>
<tr>
<th>Quality attribute</th>
<th>Storage period (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Appearance</td>
<td>3.26±0.01a</td>
</tr>
<tr>
<td>Flavour</td>
<td>3.58±0.03a</td>
</tr>
<tr>
<td>Texture</td>
<td>3.64±0.02a</td>
</tr>
<tr>
<td>Overall acceptability</td>
<td>3.76±0.03a</td>
</tr>
</tbody>
</table>

*Means±SD. Values having different superscript letter in rows are significantly different (p≤0.05)

**Fig. 4: Effect of storage period on appearance of soy-yoghurt**

Organoleptic quality of Sudanese soy yoghurt samples

- **Appearance**: The type of milk was significantly (p≤0.05) affected the appearance of yoghurt. Table 4 shows the appearance score of Sudanese soy yoghurt. Sample D (soy milk: cow milk 1:2) significantly (p≤0.05) secured the best appearance (4.38). Sample B and C in an intermediate position (3.37 and 2.86, respectively). The worst (2.68) recorded by sample A (soy milk 100%).

- **Storage period**: Significantly (p≤0.05) affected the appearance of the soy yoghurt samples (Table 5 and Fig. 4). The best scores (3.86) were obtained at day 10 and the worst (2.28) at the end of the storage period. Pinthong et al. (1980a); Nielsen (1985) reported that the fermented soybean milk was more acceptable than others and was preferred in terms of colour. Cuenca et al. (2005) found that, the soy yoghurt fermented with starter culture improve colour can be fortified with especially natural fruit juices to meet the requirement of consumers.

- **Flavour**: Table 5 illustrated the flavour score of the Sudanese soy yoghurt. Sample D made with (Soy milk: cow milk 1:2) significantly (p≤0.05) secured the best flavour (4.10), followed by sample B and C. The worst flavour (3.48) was recorded by sample A (Soy milk 100%). Storage period significantly (p≤0.05) affected the flavour of the soy yoghurt samples (Fig. 5). The best score (4.50) was obtained at day 10 and the worst (3.58) at the beginning of the storage period. Lactic acid fermentation reduced beany flavours in soybean products (Pinthong et al., 1980a; b; Buono, 1988; Buono et al., 1990a). Liu (1997b) found that, fermentation of soymilk offers not only a means of preserving soymilk but also a possibility for modifying or improving flavour. Cuenca et al. (2005) mentioned that, the soy yoghurt fermented with starter culture improve taste can be fortified with especially natural fruit juices to meet the requirement of consumers.
D made with (soymilk:cow milk 1:2) significantly secured the best acceptability (4.28), followed by sample B (3.85) and C (3.68). The worst (3.44) was recorded in sample A made with 100% soymilk.

Storage period significantly (p<0.05) affected the overall acceptability of the soy yogurt samples (Fig. 7). The best score (4.30) was obtained at day 10 and the worst (3.68) at the end of the storage period.

Osmoelastic quality of fermented products is directly related to levels of n-pentanal and n-hexanal, the form being produced by S. thermophilus and the latter being naturally present in soy milk (Pinthong et al., 1980a). Pinthong et al. (1980b) found that, fermented soymilk contained less n-hexanal than the unfermented soymilk. Beany flavours, chalkiness and astringent characteristics have been reported as the major sensory attributes found by sensory evaluation of soy yoghurt samples by trained panels (Tuitemwong et al., 1993).

REFERENCES


