Comparison Between The Physiochemical Attributes of Yogurt Processed From Camel Milk And That Processed From Cow Milk And The Effect of Storage Period on Ph And Acidity

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A B S T R A C T
The objectives of this study were to compare the physiochemical attributes of yoghurt processed from camel milk to that processed from cow milk and the effect on storage period on pH and acidity. The result has shown significant differences (p≤0.05) in physiochemical characteristics of the mean value of the protein (3.43±0.0650; 3.62±0.2383), SNF (8.41±0.5566; 8.61±0.0928) and density (1.037±0.0080; 1.037±0.0003) of fresh camel and cow milk, respectively. But there were no significant differences (p>0.05) in moisture (86.89±0.0022; 87.02±0.0030), fat (4.69±0.3464; 4.36±0.2683), ash (0.76±0.0183; 0.570±0.0062), lactose (4.22±0.5100; 4.42±0.2100), total solids (TS) (13.10±0.9022; 12.98±0.3601), pH (6.73±0.0066; 7.33±0.1201), acidity (0.226±0.0185; 0.180±0.0086), Ca++ (68.0±0.5737; 87.0±1.547) and phosphorus (66.0±0.5773; 72.33±2.0275) of the camel and cow milk, respectively. The physiochemical characteristics of yoghurt processed from camel milk and that processed from cow milk showed a highly significant difference at (p≤0.05). Pure cow milk yoghurt has higher percentages of protein (4.67±0.088; 3.23±0.0881), fat (5.33±0.145; 4.27±0.203), lactose (4.06±0.0881; 3.34±0.291), SNF (10.03±0.1088; 7.57±0.376), pH (5.83±0.033; 5.20±0.058), calcium (98.0±2.08; 71.67±0.667), and phosphorus (87.6±0.882; 72.0±1.528), while pure camel milk yoghurt has shown high moisture (88.17±0.176; 84.63±0.219), ash (0.84±0.012; 0.74±0.009) and acidity (0.78±0.007; 0.71±0.009) percentages. The storage period for camel and cow milk yoghurt had a significant effect at (p≤0.05) on pH and acidity. The high value of pH was observed after incubation for 24 hr then after 10 days while the acidity is higher after 10 days of storage compared to after 24 hr incubation.

INTRODUCTION
Camel milk plays an important role in the nutrition of camel herders in the arid and semi arid regions. The nutritional value of camel milk is basically related to its chemical composition (Mohamed and Larsson-Raznikiewicz, 1990). Feed and water availability can affect the chemical composition and taste of camel milk, which contains 2.9 to 5.5% fat, 2.5 to 4.5% protein, 2.9 to 5.8% lactose, 0.35 to 0.90% ash, 86.3 to 88.5% water, and 8.9 to 14.3% Solid None Fat (SNF) (Khan and Igbal, 2001). The mean composition of protein and nitrogen fraction of camel milk is generally similar to those of cow’s milk; the average values for the casein and whey protein content varies from 1.9 to 2.3 percent and 0.7 to 1.0%, respectively. The fat content of camel milk varies greatly from 1.10-5.50% depending on the breed and feeding condition (Farah and Ruegg, 1991). With relation to cattle, camel milk is rich in vitamin C (Kheraskov, 1961). Insulin, niacin and some unsaturated fatty acids are higher in camel than cattle, and lactose intolerance against camel milk does not exist (Wernery, 2007). The pH of camel milk ranges between 6.5–6.7 (Shalash, 1979) and the min. titratable acidity, expressed as %lactic acid (%m/m) is 0.6% (CODEX, 2003).
Fermented camel milk has a high biological value due to its high content of antimicrobial factors such as lysozyme, lactose and immunoglobulins (Elagamy, 1994). Fermented camel milk products in Sudan e.g. “Garis” (a special kind of fermented camel milk) (Elagab and Elfaki, 2002) and yoghurt are popular among the nomads, prepared and consumed by camel herders commonly in some parts of the country. Yoghurt is a product of the lactic acid fermentation of milk by addition of a starter culture. It provides milk proteins with a higher biological

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value and provides almost all the essential amino acids necessary to maintain good health (Weerathilake, 2014) and it can provide the body with significant amounts of calcium in a bioavailable form.

The main processing steps in the manufacture of yoghurt include milk standardization, heat treatment, homogenization, addition of starter culture and fermentation, then cooling and finally storage of end product. The fat content should be standardized to the level preferred by the market (Smith and Hui, 2004). Homogenization prevents fat separation (Tammie and Robinson, 1999) and pasteurization is used for improving the keeping quality of yoghurt manufactured from camel milk by using heat shock treatment (60°C for 2.5 minutes) El-Hofi and El-Tanboy (2006). Yoghurt products are often blast chilled to 5°C in the refrigerated cold store to reduce further acid development (Rehab, 2013). Mortada et al. (2013) reported that yoghurt made from camel’s milk revealed a longer shelf life than any other milk. This might be due to the natural antimicrobial agents in the camel’s milk.

**MATERIALS AND METHODS**

**Materials:**

Fresh camel milk was obtained from the Camel Research Center, University of Khartoum (Shambat) and fresh cow milk was obtained from Animal Production Department dairy farm, College of Agriculture Studies, Sudan University of Science and Technology (Shambat). Fresh milk samples were taken by clean plastic containers to National Food Research Center Laboratory (NFRCL) in Khartoum (Shambat) for determination of physiochemical components. Skim powder milk was obtained from local market.

**The procedure of yoghurt production:**

Yoghurt was prepared according to (Lee and Lucey, 2010) and (Dirar, 1993) procedures. Raw camel and cow milk were filtered and the total solids were increased to 15% by adding skimmed powder milk. The milk was pasteurized at 85°C for 30 min as described by Dirar (1993), and rapidly cooled to 43°C. Then the starter culture of *Streptococcus salivarius* subspecies *thermophilus* and *Lactobacillus delbrueckii* subspecies *bulgaricus* was added at the rate of 3% and blended thoroughly.

**Physiochemical analysis of milk and yoghurt:**

Chemical composition of milk and yoghurt (fat, protein, lactose, TS, SNF, Ash, Ca, P and moisture) and physical characteristics (pH, Acidity and density) were analyzed at NFRCL. Then samples were stored in a refrigerator for subsequent processing. All chemicals and media used in this study were of reagent grade.

Fat was determined by Gerber method described by AOAC (1995). Total nitrogen was measured by Kjeldahl method according to AOAC (1995) and protein % was calculated as N% × 6.38. Lactose was determined by Anthrone Method (Richard, 1959). Total solids content was determined according to AOAC (1995) using a forced draft oven at 100°C for 3hrs. The total solids (T.S.) content was calculated as follows: T.S.% = W1/W2 X 100. Where: W1=Weight of sample after drying; W2=Weight of sample before drying. Solids non-fat (S.N.F) content was determined from the following equation SNF (%) = % T.S.% - Fat%. Ash content was determined by gravimetric method AOAC (1995) using a muffle furnace at 550-600°C for 3 hrs until ash was carbon free. Moisture content was determined according to AOAC (1995) by drying samples overnight at 105°C. For calcium and phosphorus determination samples were ashed in the furnace at 550°C for 16 hrs and Calcium was determined using an atomic absorption spectrometer and phosphorus was measured at 400 nm by spectrophotometer.

**Density, total titratable acidity and pH determination:**

Density of the milk samples were determined by milk analyzer using (Lacto scan Milkotronic LTD, Supply 230 VAC) (University of Khartoum). Total titratable acidity was determined according to AOAC (1990) method and the pH was determined by electric pH meter (HANNA-pH, 209, Germany).

**Statistical analyses:**

Data generated was subjected to statistical analysis with Statistical Package of Social Science version 11.5(SPSS), using analysis of variance (Independent T test for fresh milk and (CRD) completely randomized design for yoghurt and means separated by Duncan’ Multiple Range Test(DMRT).

**Results:**

**The physical and chemical composition of camel milk compared to cow milk:**

The result of this study has shown significant differences (p≤0.05) in physiochemical characteristics of protein (3.430± 0.0650; 3.623± 0.2383), SNF (8.413± 0.5566; 8.616± 0.0928) and density (1.039±0.0000; 1.037±0.0003) of fresh camel and cow milk, respectively. But there were no significant differences (p≤0.05) in moisture (86.896± 0.9022; 87.020±0.3601), fat (4.690±0.3464; 4.363± 0.2683), ash (0.763± 0.0185;
0.570±0.0602, lactose (4.220±0.5100; 4.420±0.2100), total solids (TS) (13.103 ± 0.9022; 12.980± 0.3601), pH (6.733± 0.2666; 6.733 ±0.1201), acidity (0.226 ± 0.0185; 0.180 ± 0.0057), Ca++ (68.0± 0.5773; 87.0±1.1547) and phosphorus (66.0±0.5773; 72.333± 2.0275) of the camel and cow milk, respectively (Table 1). Protein and SNF in cow milk (3.62a±0.24, 8.62±0.093) were higher than that in camel milk (3.4a±0.065, 8.4±0.557), respectively. The density of camel milk (1.039±0.00) was higher than that of cow milk (1.037±0.0003) (Table1). Numerically, moisture, lactose, Ca and P were higher in cow milk but fat, ash, total solid and acidity were higher in camel milk.

Table 1: Physical and chemical analysis of cow and camel milk

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Treatments (Mean ± SE)</th>
<th>Level of Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>Cow Milk</td>
<td>Camel Milk</td>
</tr>
<tr>
<td>Fat (%</td>
<td>4.36±0.2683</td>
<td>4.69±0.3464</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>3.623±0.2383</td>
<td>3.430±0.0650</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>0.570±0.0602</td>
<td>0.763±0.0185</td>
</tr>
<tr>
<td>Lactose (%)</td>
<td>4.420±0.2100</td>
<td>4.220±0.5100</td>
</tr>
<tr>
<td>T.S (%)</td>
<td>12.980±0.3601</td>
<td>13.103±0.9022</td>
</tr>
<tr>
<td>S.N.F (%)</td>
<td>8.616±0.0928</td>
<td>8.413±0.5566</td>
</tr>
<tr>
<td>pH</td>
<td>6.733±0.1201</td>
<td>6.733±0.2666</td>
</tr>
<tr>
<td>Acidity (%)</td>
<td>0.180±0.0057</td>
<td>0.226±0.0185</td>
</tr>
<tr>
<td>Calcium (%)</td>
<td>87.0±1.1547</td>
<td>68.0±0.5773</td>
</tr>
<tr>
<td>Phosphorus (%)</td>
<td>72.333±2.0275</td>
<td>66.0±0.5773</td>
</tr>
<tr>
<td>Density (%)</td>
<td>1.037±0.0003</td>
<td>1.039±0.0000</td>
</tr>
</tbody>
</table>

For each mean parameters a>b, (p<0.05)

The chemical and physical analysis of camel and cow yoghurt:

Pure cow milk yoghurt has higher percentages of protein (4.67 ± 0.088; 3.23±0.881), fat (5.33 ±0.145; 4.27±0.203), lactose (4.06 ±0.881; 3.43±0.291), SNF (10.03 ±0.088; 7.57±0.376), pH (5.83 ±0.033; 5.20±0.058), calcium (98.0±2.0; 71.67±0.667) and phosphorus (87.67±0.882; 72.0±1.528), while pure camel milk yoghurt showed high moisture (88.17±0.176; 84.63±0.219), ash (0.84±0.012; 0.74 ±0.009) and acidity (0.78±0.007; 0.71±0.009) percentages (Table 2).

Table 2: Physiochemical analysis of cow and camel milk yoghurt

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Treatments (Means ± SE)</th>
<th>L.Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>Cow milk yoghurt</td>
<td>88.17±0.176</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>Cow milk yoghurt</td>
<td>3.23±0.0881</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>Cow milk yoghurt</td>
<td>4.27±0.203</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>Cow milk yoghurt</td>
<td>0.84±0.012</td>
</tr>
<tr>
<td>Lactose (%)</td>
<td>Cow milk yoghurt</td>
<td>3.43±0.291</td>
</tr>
<tr>
<td>T.S (%)</td>
<td>Cow milk yoghurt</td>
<td>11.83±0.176</td>
</tr>
<tr>
<td>S.N.F (%)</td>
<td>Cow milk yoghurt</td>
<td>7.57±0.376</td>
</tr>
<tr>
<td>pH</td>
<td>Cow milk yoghurt</td>
<td>5.20±0.058</td>
</tr>
<tr>
<td>Acidity as lactic acid (%)</td>
<td>Cow milk yoghurt</td>
<td>0.78±0.007</td>
</tr>
<tr>
<td>Ca²⁺(mg/100g)</td>
<td>Cow milk yoghurt</td>
<td>71.67±0.667</td>
</tr>
<tr>
<td>P (mg/100g)</td>
<td>Cow milk yoghurt</td>
<td>72.0±1.528</td>
</tr>
</tbody>
</table>

Different superscript letters (a to d) within the same raw showed significant differences among the groups (P<0.05). L.Sig= Level of significant.

The effect of storage period on yoghurt:

The effect of storage period for camel and cow milk yoghurt was highly significant (P<0.05) on pH and acidity (Table 3). The high value of pH was observed after incubation (6.26±0.041) followed by after 24hr storage (5.33±0.07) then after 10 days storage (4.35±0.065), while the acidity was higher after 10 days of storage (0.84±0.008) followed by after 24 hr storage (0.75±0.005) and after incubation (0.74±0.007) (Table 3).

Table 3: Effect of storage period on pH and acidity from different samples of camel and cow yoghurt

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Treatments Means ±SE</th>
<th>Level of sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>Storage after incubation</td>
<td>6.26±0.041</td>
</tr>
<tr>
<td></td>
<td>Storage after 24 hr</td>
<td>5.33±0.070</td>
</tr>
<tr>
<td></td>
<td>Storage after 10 days</td>
<td>4.35±0.065</td>
</tr>
<tr>
<td>Acidity</td>
<td>Storage after incubation</td>
<td>0.74±0.007</td>
</tr>
<tr>
<td></td>
<td>Storage after 24 hr</td>
<td>0.75±0.005</td>
</tr>
<tr>
<td></td>
<td>Storage after 10 days</td>
<td>0.84±0.008</td>
</tr>
</tbody>
</table>

Different superscript letters (a to c) within the same raw showed significant differences among the groups (P<0.05).
Discussion:

In the present study the average moisture content was 86.9%. It was lower than that reported by Aisha (2009) (88.7%), and Rehab (2013) (87.7 %). However, it was in the range which was reported by Mahamoud (2009) (84 to 90%). The difference can be attributed to seasonal variations and availability of drinking water. The average protein content in this study was 3.4% which was higher than that reported by Byoumi (1990) (3.3%), but similar to that estimated by Wilson (1984) (3.4%). The average fat content, in this study was 4.7%. It was higher than that estimated by Aisha (2009) (3.7%) and nearly similar to that reported by Mohamed and Larsson-Raznikiewicz (1990) (4.6%), and it was in the range estimated by Farah and Ruegg (1991) (1.1-5.5%). This variation can be due to breed and feeding conditions. The average of lactose in the present study was 4.2%. It was higher than that estimated by Aisha (2009) (3.28%) and similar to that reported by Elamin and Wilcox (1992) (4.2%). This variation might be attributed to the stage of lactation, as it was noticed that lactose % increased gradually at parturition until it reached 5.58% at the 10th day (Abu-Lehia, 1989). Generally, lactose content of camel milk varies greatly depending on feeding and watering conditions (Yagil, 1994). The average of T.S. in the present study was estimated at 13.1%. It was higher than that reported by Aisha (2009) (11.3%) and lower than that estimated by Byoumi (1990) (13.4%). In general, the T.S.tends to be lower in hot season, as camel looses a considerable amount of its water to milk for the nourishment of young calves. The average ash content in this study was found to be 0.76% which was higher than that reported by Rehab (2013) (0.73%) and lower than that reported by Elamin and Wilcox (1992) (0.80%). However, all approximate chemical camel milk constituents were in the range reported by Hashim et al. (2009). The mean of calcium in this study in camel milk was 68mg/100 ml, which was lower than that estimated by Aisha (2009) (116 mg) and higher than that reported by Elamin and Wilcox (1992) (30 mg/100). The variation might be due to seasons. The mean of phosphorus in this study in camel milk was 66mg/100ml which was higher than that reported by Aisha (2009) (24mg/100) and lower than that reported by Gorbán and Izzeldin (1997) (76mg).

The acidity in this study was 0.2% which was higher than that reported by Aisha (2009) (0.18%) and similar to that reported by Karim and Gook Lani (1987) (0.2%). The variation may be due to breed, lactation period and analytical procedure. In the present study the pH value in the camel milk was 6.7 which was similar to that reported by Mahamoud (2009) and higher than that reported by Rehab (2013) (6.40). The variation may be due to breed and analytical procedure. In the present study the mean specific gravity of camel milk was 1.039 which was higher than that reported by (Shalash, 1982) (1.0305). The variation may be due to breed and analytical procedure.

In this study the average of pure camel milk yoghurt fat was 4.27% which was higher than the minimum level reported by Price Weston (2008) (2.5%) and nearly similar to that estimated by Mortada et al. (2013) (4.1%), but lower than that reported by Rehab (2013) (4.53%). The average of protein in this study was 3.23% which was higher than that reported by Price Weston (2008) (3%) and lower than that reported by Mortada et al. (2013) (3.63%). The average of lactose in this study was 3.43% which was lower than that reported by PriceWeston(2008) (4.8%) and Mortada et al. (2013) (6.9%). The total solid was 11.83% which was lower than that reported by Mortada et al. (2013) (13.77%). The variation may be due to the availability of drinking water and breed. The pH in the present study was 5.2 which was nearly similar to that reported by Mortada et al. (2013) (5.3) and higher than that found by Rehab (2013) (4.13). These findings were in agreement with Dankow et al. (1999) and Eissa et al. (2011) who indicated that there were increases in acidity and decreases in pH with the storage period in camel milk yoghurt; also similar changes were observed by Vargas et al. (2008) and Güler (2007) in some yoghurt products. The changes in pH and acidity during the preservation may be due to the effect of yoghurt microflora on its nutrient composition (Eissa et al., 2011). In the present study the slower acidification in camel milk yoghurt that started immediately after incubation and increased gradually up to 10 days of storage may be ascribed to the presence of the antimicrobial agent in the camel milk (Elagamy et al., 1992) and (Gran et al., 1991).

Conclusion and Recommendation:

It could be concluded that pure cow milk yoghurt has higher percentages of protein, fat, lactose, SNF, pH, calcium and phosphorus, while pure camel milk yoghurt showed high moisture, ash and acidity percentages. The acidity and pH were affected by the storage period; the high value of pH was observed after incubation for 24 hours then after 10 days, while the acidity was higher after 10 days of storage followed by after 24hrs incubation.

It is recommended that production of dairy products from camel milk is to be encouraged. Research in camel dairy production, processing and introduction of new bio-technologies need to be strengthened. Further investigation is needed to detect manufacturing of camel milk yoghurt mixing with milk of other species such as cows.
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