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Compositional and microbiological quality of traditional fermented dried milk "Orud/Khurud"

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Abstract

The present study was carried out to analyze the compositional and microbiological quality of Orud/Khurud. A total of thirty locally produced Orud/Khurud samples (~1 kg each), ten samples from each of goat and sheep milk purchased from five districts (Chaghi, Chaman, Kharan, Mastung and Noshki) of Balochistan, were evaluated for moisture, fat, protein, casein, mineral/ash and total viable count (TVC), thermoduric count (TDC), thermophilic spore count (TPSC), Enterobacteraceae count (EBC) and yeasts and moulds count (YMC). Moisture (5.05±0.35%), protein (44.60±1.63%) and casein (37.46±1.19%) contents of sheep milk Orud/Khurud were not significantly different ($p>0.05$) from goat milk Orud/Khurud (5.47±0.31, 41.91±2.02 and 36.56±1.60%, respectively). While fat and mineral/ash contents of sheep milk Orud/Khurud (4.21±0.43%) and (14.34±0.63%) were remarkably different ($P<0.05$) from goat milk Orud/Khurud (2.48±0.19% and 9.88±0.19, respectively). The overall averages of moisture (5.26±0.33), fat (3.35±0.31), protein (43.26±1.83), casein (37.01±1.40) and mineral/ash (12.11±0.41) contents of Orud/Khurud were observed. TVC ($4.2\times10^3 \pm 3.1\times10^2$ cfu g^{-1}), TDC ($4.7\times10^1 \pm 0.60\times10^1$ cfu g^{-1}), TPSC ($4.8\times10^1 \pm 0.71\times10^1$ cfu g^{-1}), EBC ($4.1\times10^1 \pm 0.65\times10^1$ cfu g^{-1}) and YMC ($4.5\times10^1 \pm 0.41\times10^1$ cfu g^{-1}) of sheep milk Orud/Khurud were not significantly different ($p>0.05$) from goat milk Orud/Khurud ($3.7\times10^3 \pm 1.6\times10^2$, $5.0\times10^1 \pm 0.75\times10^1$, $5.1\times10^1 \pm 0.82\times10^1$, $4.3\times10^1 \pm 0.60\times10^1$ and $4.7\times10^1 \pm 0.60\times10^1$ cfu g^{-1}, respectively). The overall average concentration of TVC ($3.9\times10^3 \pm 1.8\times10^2$ cfu g^{-1}) in Orud/Khurud was recovered lower (12.7 folds) compared to Pakistan Standard Institution (PSI) and/or Indian Standard Institution (ISI) (5.0×10^4 cfu/g) and the overall average count of TD, ($4.9\times10^1 \pm 0.50\times10^1$ cfu g^{-1}), TPS ($5.0\times10^1 \pm 0.53\times10^1$ cfu g^{-1}), EBC ($4.2\times10^1 \pm 0.43\times10^1$ cfu g^{-1}) and YM ($4.6\times10^2 \pm 0.35\times10^1$) were also detected lower (-2.04 folds), (-2 folds), (-2.38 folds) and (-2.17 folds) compared to ISI standards, respectively. The results conclude that chemical components in both types of Orud/Khurud were dense with a higher amount and could be a rich source of human nutrition. Moreover, the results of the microbiological examination showed the quality of Orud/Khurud within the acceptable limit.

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Introduction

Fermentation is one of the oldest methods of preservation, which contributes to the flavour, appearance and texture of food. No doubt, the fermentation properties of milk depend upon the chemical composition, the type of fermenting organisms, pretreatment applied to milk and incubation conditions (Cooke *et al.*, 1987). In fact, food products made through the process of fermentation are in general more attractive to the consumer than non-fermented products and play an important role in the diet of many people in the world (Omari *et al.,* 2008).

Traditional dried fermented milk products have been produced for centuries in many countries such as the Balkans, Eastern Mediterranean, Western Asia and Turkistan (Tamime and O'Connor, 1995). The main goal for producing or manufacturing dried fermented milk is to improve the storage life of the product; to reduce bulk packaging and transportation cost (Omari *et al.*, 2008). Most of these products are homemade from whole milk (cow, sheep, goat, or combinations of these) or from buttermilk. Nomads, desert dwellers and people in rural areas tend to preserve surplus summer milk as different products with extended shelf-life, examples of which are (a) concentrated and salted fermented milk preserved in Korga, ah (animal skins); (b) similar to (a) but the product is made into balls and preserved in oil; and (c) numerous dried products (i.e., as powder or cobbles). The drying process is normally carried out by solar energy (Tamime and O'Connor, 1995). Orud/Khurud (names originated from Balochi and Brohi languages of Balochistan, respectively), a dried fermented milk product commonly produced and consumed in the Balochistan region of Pakistan. It is preferably made from sheep and goat milk or a combination of these, but it could also be made from cow milk.

This traditional spontaneous process favours the presence of undesirable microorganisms and may affect the hygienic as well as the compositional quality of the final product. Thus present study has been designed to evaluate the compositional and microbiological quality of Orud/Khurud produced at different areas of Balochistan, Pakistan.

Materials and methods

Collection of Orud/Khurud samples

A total of thirty locally produced Orud/Khurud samples (~1 kg each), 15 from each of sheep and goat milk were collected in sealed plastic bags from five districts (Chaghi, Chaman, Kharan, Mastung and Noshki) of Balochistan, and brought to the Department of Dairy Technology, Faculty of Animal Husbandry & Veterinary Sciences, Sindh Agriculture University Tandojam.

Processing of samples

All the samples were ground into powder form and kept in sterilized sample bottles for the evaluation of compositional and microbial quality characteristics. However, among the thirty samples, nine samples showed either spread colonies and/or heavily contaminated, thus rejected and not included in the present study. Moreover, 10 samples from each category were selected to obtain the analytical differences in both types of Orud/Khurud.

Chemical analysis

Moisture content

The moisture content of Orud/Khurud was observed according to the method of the Association of Official Analytical Chemists (AOAC, 2000). The sample (2gm) was transferred in the pre-weighed flat bottom dish. The dish was placed in a hot air oven at 101 ±1°C for 3 - 4 h. The dried sample was transferred to a desiccator having a silica gel as a desiccant. After 1h, the dish was weighed. The process was repeated till constant weight was achieved. Moisture content was calculated by the following formula.

$$\text{Moisture (\%)} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where,

W_1 = weight of empty dish.

W_2 = weight of dish + sample.

W_3 = weight of dish + dried sample.

Fat content

The fat content was determined by Gerber method as described by Sorevsen *et al.* (1978). The Orud/Khurud sample (2.5g) diluted with distilled water (8 ml) was mixed with 91 % sulfuric acid (10 ml) and amyl alcohol (1ml) in a butyrometer and closed with rubber cork. The mixture was mixed and centrifuged in a Gerber centrifuge machine for 15 minutes at 65°C, at 1200 r.p.m. Then it was shaken for further 5 minutes and again centrifuged for 15 min at 65°C. The fat percentage was noted on the butyrometer scale.

Total protein content

Protein content was determined according to the method of AOAC (2000). Sample (1g) was digested using micro-kjeldhal digester in the presence of a catalyst (0.2g copper sulfate and 2g sodium sulfate/potassium sulfate) where sulfuric acid (20-30ml) was used as an oxidizing agent.

The digested sample was diluted with distilled water (250 ml). Then 5 ml portion from the diluted sample was distilled with NaOH (40%) using a Micro-Kjeldhal distillation unit where steam was distilled over 2% boric acid (5 ml) containing an indicator for 3 minutes. The ammonia trapped in boric acid was determined by titrating with 0.1N HCl. The nitrogen percentage was calculated using the following formula.

$$N\ (\%) = \frac{1.4\ (V_2 - V_1) \times \text{normality of HCL}}{\text{Weight of sample taken} \times \text{sample used for distillation}} \times 250$$

Where,

V_1= titrated value

V_2= blank sample

While protein percentage was determined by conversion of nitrogen percentage to protein, assuming that all the nitrogen in milk was present as protein, i.e., Protein percentage = N% × Conversion factor. Where conversion factor = 100/N% in the protein of milk dairy products (i.e., 15.66) (James, 1995).

Casein content

Casein content was determined according to the method of AOAC (2000). Orud/Khurud sample (1g) was taken in the beaker with distilled water (90ml) at 40-42°C and immediately, 1.5ml of glacial acetic acid (1+9) was added. The sample was stirred and left to stand for 3-5 min. The sample was then decanted on the acid-washed filter and washed by decanting 2-3 times with cold water. Precipitation was transferred to filter and washed till it became clear N% in washed ppt and paper was determined as described in section 3.9.3. The result of N% was multiplied by 6.38 to obtain the casein content.

Minerals /Ash percentage

Ash content was determined by Gravimetric method as described by AOAC (2000). Orud/Khurud (2g) was taken in the pre-weighed crucible and evaporated to dryness on the steam bath. It was ignited in a muffle furnace (550 °C) for 3-5hours and transferred to a desiccator having an effective desiccant. After one hour of cooling, it was re-weighed and ash percentage was calculated using the following formula.

$$\text{Ash content } (\%) = \frac{\text{Weight of ashed sample}}{\text{Weight of sample take}} \times 100$$

Microbiological analysis

Preparation of test sample

Primary dilution was prepared by diluting Orud/Khurud (10g) in trisodium citrate (90 ml), and then serial dilution (1:9ml) up to 10^{-6} was prepared by using sterile quarter strength Ringer's solution.

Enumeration of total viable count (Colony count technique at 30°C)

Total viable counts were enumerated according to the method of International Dairy Federation (IDF, 1991). Pre-prepared test samples (1ml) of 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5} and /or 10^{6} dilutions were transferred into sterile Petri dishes in duplicate through a sterile graduate pipette and/or automatic pipette (1000µl) with sterile plastic tips and warm (45±1°C) sterile plate count agar medium (15ml) was mixed with inoculum. The mixture was allowed to solidify and incubated (30°C) for 72 ± 2 h. Parallel to that, control plates were also prepared using a similar medium (15ml) to check the sterility. The dishes containing more than 30 and/or fewer than 300 colonies were selected and counted using colony counter. The result was calculated by using following formula.

$$N = \frac{\sum c}{(n_1 + 0.1 \times n_2)\, d}$$

Where,

$\sum c$=Sum of colonies counted on all the dishes retained.

n_1 = Number of dishes retained in the first dilution.

n_2 = Number of dishes retained in the second dilution.

d = Dilution factor corresponding to the first dilution.

Enumeration of thermoduric and thermophilic spore counts at 55 °C

Thermoduric and thermophilic spore counts were enumerated according to the method of Marshall (1993). Orud/Khurud (10g) was reconstituted in trisodium citrate diluents (90ml) and heated (80°C or 100°C) for 10 or 30 mint to eliminate the vegetative cells. Heat-treated sample (1ml) of 10^{-1}, 10^{-2}, 10^{-3} and/or 10^{-4} dilution was transferred into Petri dishes (in duplicate) through automatic pipette (1000µl) with sterile plastic tips and warm (45±1°C) sterile nutrient or milk starch agar medium (15ml) was mixed with inoculum. The mixture was allowed to solidify and incubated (55°C) for 48 h. Parallel to that, control plates were also prepared using a medium (15ml) to check the sterility. The dishes containing more than 10 and/or fewer than 200 colonies were selected and counted using a colony counter.

Enumeration of enterobacteriaceae counts (Colony count technique at 37 °C)

Enterobacteraceae counts were enumerated according to the method of the British Standard Institute (BSI, 1993). Pre-prepared test sample (1ml) of 10^{-1}, 10^{-2}, 10^{-3} and/or 10^{-4} dilution was transferred into sterile Petri dishes through automatic pipette (1000µl) with sterile plastic tips and warm (45±1 °C) violet red bile agar medium (15ml) was mixed with inoculum. The mixture was allowed to solidify and incubated (37°C) for 24±2 h. Parallel to that, control plates were also prepared using a similar medium (15ml) to check their sterility. The dishes containing more than 10 and/or fewer than 200 colonies were selected and counted using a colony counter.

Enumeration of yeasts and moulds counts (Colony count technique at 25°C)

Yeasts and moulds count were enumerated according to the method of IDF (1990). Pre-prepared test sample (1ml) of 10^{-1}, 10^{-2}, $10^{-3}$and /or 10^{-4} dilution was transferred into sterile Petri dishes through automatic pipette (1000µl) and using sterile plastic tips warm (45±1°C) sterile potato dextrose agar medium (15ml) was mixed with inoculum. The mixture was allowed to solidify and incubated (25°C) for 5 days. Parallel to that, control plates were also prepared using a medium (15ml) to check the sterility. The dishes containing more than 10 and/or fewer than 150 colonies were selected and counted using a colony counter.

Statistical analysis

Statistical analysis was performed using the computer programme, i.e., Student Edition of Statistics (Sxw), version 8.1 (Copyright 2005, Analytical Software, USA).

Results

Moisture content

Orud/Khurud was analyzed for moisture content, and results are presented in Fig. 1. It was observed that moisture content in sheep milk Orud/Khurud varied between 3.70 and 6.40%. Whilst moisture content in goat milk Orud/Khurud was in a range between 4.40% and 6.70%. Further, the result showed that there was a very slight difference between the average moisture content of sheep milk Orud/Khurud (5.05± 0.35%) and goat milk Orud/Khurud (5.47±0.31%). The overall mean in both types of Orud/Khurud was ranged between 4.05 to 6.55 and averaged 5.26±0.33 One-way analysis of variance (ANOVA) revealed the non-significant differences (P>0.05) between the moisture content of sheep milk Orud/Khurud and goat milk Orud/Khurud.

Table 1. Total viable count (cfu g^{-1}) in Orud/Khurud samples compared to ISI and PSI standards for milk powder.

Orud/Khurud sample	Total viable count (TVC) cfu g^{-1}	
	Observed (a)	Deviation in folds from ISI/ PSI Standard for milk powder (b) = (x) ÷ (a)
Sheep milk	4200	-11. 9
Goat milk	3700	-13. 5
Mean	3900	-12.7

a = Observed Values

x = Standard Value of ISI/ PSI for milk powder = (≤ 50000 cfu/g)

ISI = Indian Standards Institution

PSI = Pakistan Standards Institution

Fat content

Orud/Khurud was analyzed for fat content, and results are shown in Fig. 2. The minimum fat content in sheep milk Orud/Khurud was recorded as 2.85% and the maximum was 5.90%, while goat milk Orud/Khurud revealed a range of fat content between 1.70 and 3.30%. Further, the average fat content in sheep milk Orud/Khurud was analyzed as 4.21±0.43% and in goat milk, Orud/Khurud was 2.48±0.19%. The overall mean was ranged between 2.28 to 4.60 and averaged 3.35±0.31.

Statistical analysis (ANOVA) performed on the data of fat content revealed the significant differences ($P<0.01$) among the sheep milk Orud/Khurud and goat milk Orud/Khurud. Whilst computing the LSD (0.05) between the means, the results showed that the fat content was significantly higher ($P<0.05$) in sheep milk Orud/Khurud compared to goat milk Orud/Khurud.

Protein content

Orud/Khurud was analyzed for protein content, and results are presented in Fig. 3. A wide variation was observed in the protein content of sheep milk Orud/Khurud and/or goat milk. Protein content was in a range between 35.70 and 53.50% in sheep milk Orud/Khurud and in between 31.20 and 53.50% in goat milk Orud/Khurud. Whereas the average protein content in sheep milk Orud/Khurud and goat milk Orud/Khurud was 44.60±1.63% and 41.91±2.02%, respectively.

Table 2. Thermoduric count (cfu g^{-1}) in Orud/Khurud samples compared to ISI standards for milk powder.

Orud/Khurud sample	Thermoduric count (TDC) cfu g^{-1}	
	Observed (a)	Deviation in folds from ISI standard for milk powder (b) = (x) ÷ (a)
Sheep milk	47	-2.12
Goat milk	50	-2.5
Mean	49	-2.04

a = Observed Values

x = Standard Value of ISI for milk powder, (1975) = ($\leq 1.0\times10^{2}$ cfu g^{-1})

ISI = Indian Standards Institution.

The overall range of Orud/Khurud was between 33.45 to 53.50 and averaged 43.26±1.83. Even though protein content was higher in sheep milk, Orud/Khurud but One-way ANOVA revealed the non-significant differences ($P>0.05$) among sheep milk Orud/Khurud and goat milk Orud/Khurud.

Table 3. Thermophilic spore count (cfu g^{-1}) in Orud/Khurud samples compared to ISI standards for milk powder**.**

Orud/Khurud sample	Thermophilic spore count (TPSC) cfu g^{-1}	
	Observed (a)	Deviation in folds from ISI standard for milk powder (x) ÷ (a)
Sheep milk	48	-2.08
Goat milk	51	-1.96
Mean	50	-2

a = Observed Values

x = Standard Value of ISI for milk powder, (1975) = ($\leq 1.0 \times 10^2$ cfu g^{-1})

ISI = Indian Standards Institution.

Casein content

Orud/Khurud was analyzed for casein content, and results are shown in Fig. 4. It was observed that casein content sheep of milk Orud/Khurud varied between 31.20 and 44.60%. While casein content in goat milk Orud/Khurud was in a range between 26.70 and 44.60%. Further, the results showed that there were wide differences among the average casein content of sheep milk Orud/Khurud (37.46±1.19%) and goat milk Orud/Khurud (36.56±1.60%).

The overall mean was between 28.95 to 44.60 and averaged 37.01±1.40. While One-way ANOVA revealed the non-significant differences ($P>0.05$) between sheep milk Orud/Khurud and goat milk Orud/Khurud.

Table 4. Enterobacteriaceae count (cfu g^{-1}) in Orud/Khurud samples compared to ISI standards for milk powder.

Orud/Khurud sample	Enterobacteriaceae count (EBC) cfu g-1	
	Observed (a)	Deviation in folds from ISI standards for milk powder (b)=(x) ÷ (a)
Sheep milk	41	-2.43
Goat milk	43	-2.32
Mean	42	-2.38

a = Observed Values

x = Standard Value of ISI for milk powder, (1975) = ($\leq 1.0 \times 10^2$ cfu g^{-1})

ISI = Indian Standards Institution.

Minerals/Ash content

Orud/Khurud was analyzed for minerals/ash content, and results are shown in Fig. 5. It was observed that the minimum minerals/ash content in sheep milk Orud/Khurud was 12.15% and the maximum was 17.75%. While goat milk Orud/Khurud revealed a range of minerals/ash content in between 9.0 and 10.75%. Further, the average minerals/ash content in sheep milk Orud/Khurud was analyzed as 14.34±0.63% and in goat milk, Orud/Khurud was 9.8±0.2%. The overall mean ranged between 10.58 to 14.25 and averaged 12.11± 0.41.

Statistical analysis (ANOVA) revealed the significant differences ($P<0.01$) among sheep milk Orud/Khurud and goat milk Orud/Khurud. While computing the LSD (0.05) between the means, the results showed that the minerals/ash content was significantly higher ($P<0.05$) in sheep milk Orud/Khurud compared to goat milk Orud/Khurud.

Table 5. Yeasts and moulds count (cfu g^{-1}) in Orud/Khurud samples compared to ISI standards for milk powder.

Orud/Khurud sample	Yeasts and moulds count (YMC) cfug^{-1}	
	Observed (a)	Deviation in folds from ISI standard for milk powder (b) = (x) ÷ (a)
Sheep milk	45	-2.22
Goat milk	47	-2.12
Mean	46	-2.17

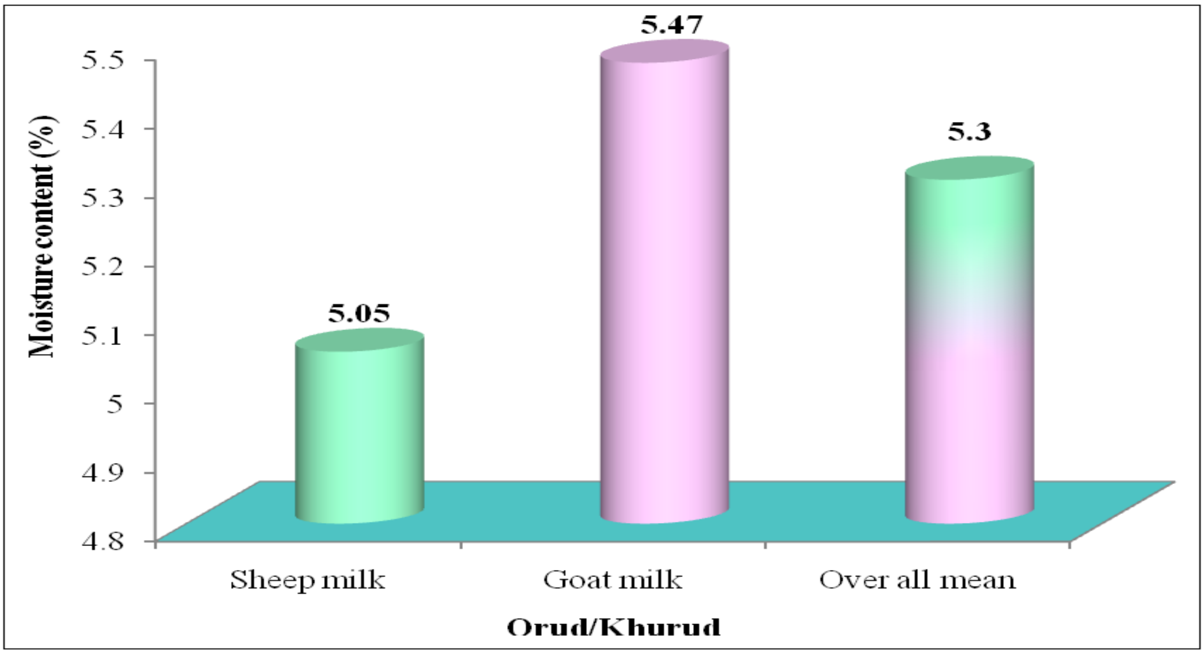
A = Observed Values

x = Standard Value of ISI, for milk power (1993) = (≤1.0×10² cfu/g)

ISI = Indian Standards Institution.

Total viable (TV) count

The total viable count of Orud/Khurud samples of sheep and goat milk are evaluated, and the results are presented in Table 1. The concentration of TV count in sheep milk Orud/Khurud ranged between 3.0×10^3 to 6.0×10^3 cfu g^{-1} and averaged $4.2\times10^3 \pm 3.1\times10^2$ cfu g^{-1}. While in case of goat milk Orud/Khurud, the TV count were observed in between 2.9×10^3 and 4.4×10^3 cfu g^{-1} and averaged $3.7\times10^3\pm1.6\times10^2$ cfu g^{-1}). The overall mean in both types of Orud/Khurud ranged between 2.9 ×10 to 6.0×10^3 cfu g^{-1} and averaged $3.9\times10^3 \pm 1.8\times10^2$ cfu g^{-1}.



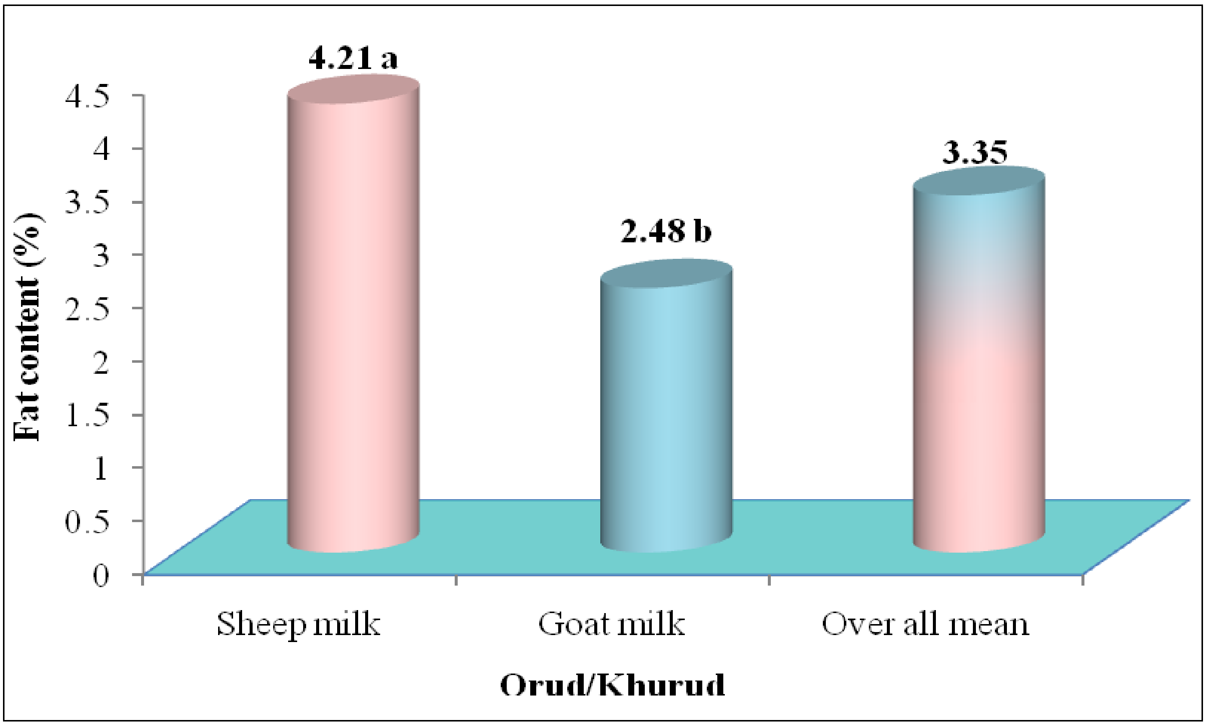
Data are the average of each of 10 sheep milk and/or goat milk Orud/Khurud and each in duplicate.

Fig. 1. Moisture content of sheep milk and/or goat milk Orud/Khurud.

Moreover, the results of statistical analysis (ANOVA) showed non-significant difference ($P>0.05$) in TV count between sheep milk Orud/Khurud and goat milk Orud/Khurud. It was further observed that the concentration of TV count in sheep milk Orud/Khurud (4.2×10^3 cfu g^{-1}) and goat milk Orud/Khurud (3.7×10^3 cfu g^{-1}) was comparatively lower (-11.9 and -13.6 folds, respectively) than the Standard TV count of milk powder (5.0×10^4 cfu g^{-1}) as specified by Pakistan Standard Institution (PSI) or Indian Standards Institution (ISI).

Thermoduric (TD) count

Thermoduric count of sheep milk Orud/Khurud and goat milk Orud/Khurud was evaluated and the results were shown in Table 2.



LSD (0.05) = 0.987

SE ± = 0.47

Data are the average of each of 10 sheep milk and/or goat milk Orud/Khurud and each in duplicate.

Fig. 2. Fat content of sheep milk and/or goat milk Orud/Khurud.

The concentration of TD count in sheep milk Orud/Khurud ranged between 2.2×10^1 to 7.3×10^1 cfu g^{-1} and averaged $4.7\times10^1 \pm 0.60\times10^1$ cfu g^{-1}.

While in case of goat milk Orud/Khurud, the TD counts were observed in between 1.8×10^1 and 9.5×10^1 cfu g^{-1} with mean value of ($5.0\times10^1 \pm 0.75\times10^1$ cfu g^{-1}). The overall mean ranged between 1.8×10^1 to 9.5×10^1 cfu g^{-1} and averaged $4.9\times10^1 \pm 0.50\times10^1$ cfu g^{-1}.

Moreover, the results of statistical analysis (ANOVA) showed non-significant difference ($p > 0.05$) in TD count in sheep milk Orud/Khurud and goat milk Orud/Khurud. It was further observed that the concentration of TD counts in sheep milk Orud/Khurud (-2.12 folds) and in goat milk, Orud/Khurud (-2 folds) were lower than the standard concentration ($\leq 1.0\times10^2$ cfu g^{-1}) of milk Powder (ISI, 1975).

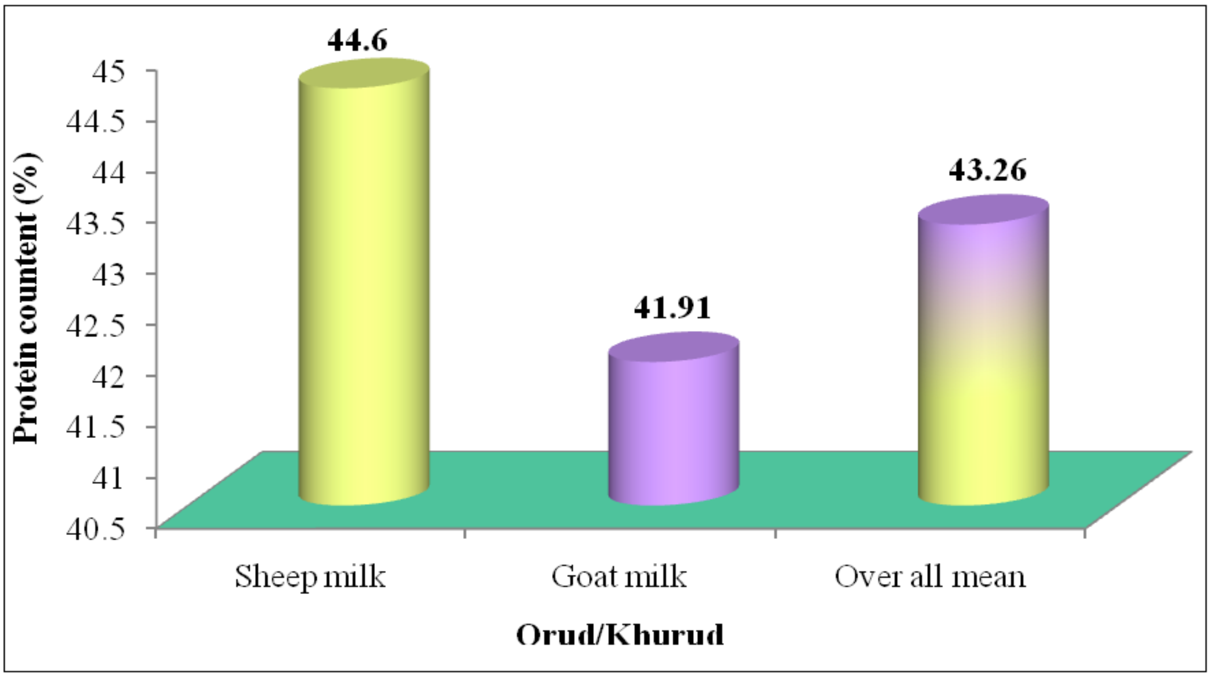
Thermophilic spore (TPS) count

Orud/Khurud samples of sheep milk and goat milk were evaluated for thermophilic spore count, and the results are presented in Table 3. The concentration of TPS count in sheep milk Orud/Khurud ranged between 1.8×10^1 to 8.2×10^1 cfu g^{-1} and averaged $4.8\times10^1 \pm 0.71\times10^1$ cfu g^{-1}. While in case of goat milk Orud/Khurud the TPS counts were observed in between 1.4×10^1 and 9.0×10^1 cfu g^{-1} and averaged $5.1\times10^1 \pm 0.82\times 10^1$ cfu g^{-1}. The overall mean were between 1.4×10^1 to 9.0×10^1 cfu g^{-1} and averaged ($5.0\times10^1 \pm 0.53\times10^1$ cfu g^{-1}). Moreover, the results of statistical analysis (ANOVA) showed no significant difference ($p > 0.05$), in TPS counts observed among sheep and goat milk Orud/Khurud.

It was further observed that the concentration of TPS count in sheep milk Orud/Khurud (-2.08 folds) and in goat milk Orud/Khurud (-1.96 folds) were lower than the Standard concentration ($\leq 1.0\times10^2$ cfu g^{-1}) of milk powder (ISI, 1975).

Enterobacteriaceae (EB) count

Orud/Khurud samples of sheep milk and goat milk were evaluated for enterobacteriaceae count and the results are depicted in Table 4.



Data are the average of each of 10 sheep milk and/or goat milk Orud/Khurud and each in duplicate.

Fig. 3. Protein content of sheep milk and/or goat milk Orud/Khurud.

The Ebc count within the same sample of Orud/Khurud of sheep milk and/or goat milk examined in the present study. The concentration of enterobacteriaceae count in sheep milk Orud/Khurud ranged between 1.4×10^1 to 7.7×10^1 cfu g^{-1} and averaged $4.1\times10^1 \pm 0.65\times10^1$ cfu g^{-1}. While in case of goat milk Orud/Khurud, the enterobacteriaceae counts were observed in between 2.2×10^1 and 7.3×10^1 cfu g^{-1} and averaged $4.3\times10^1 \pm 0.60\times10^1$ cfu g^{-1}.

Moreover, the results of statistical analysis (ANOVA) showed non-significant difference ($P>0.05$) in enterobacteriaceae counts in sheep and milk goat milk Orud/Khurud. The concentration of enterobacteriaceae count in sheep milk Orud/Khurud (-2.19 folds) and in goat milk Orud/Khurud (-2.14 folds) were lower when compared to that of ISI, (1975), i.e, $\leq 9.0\times10^1$ cfu g^{-1}.

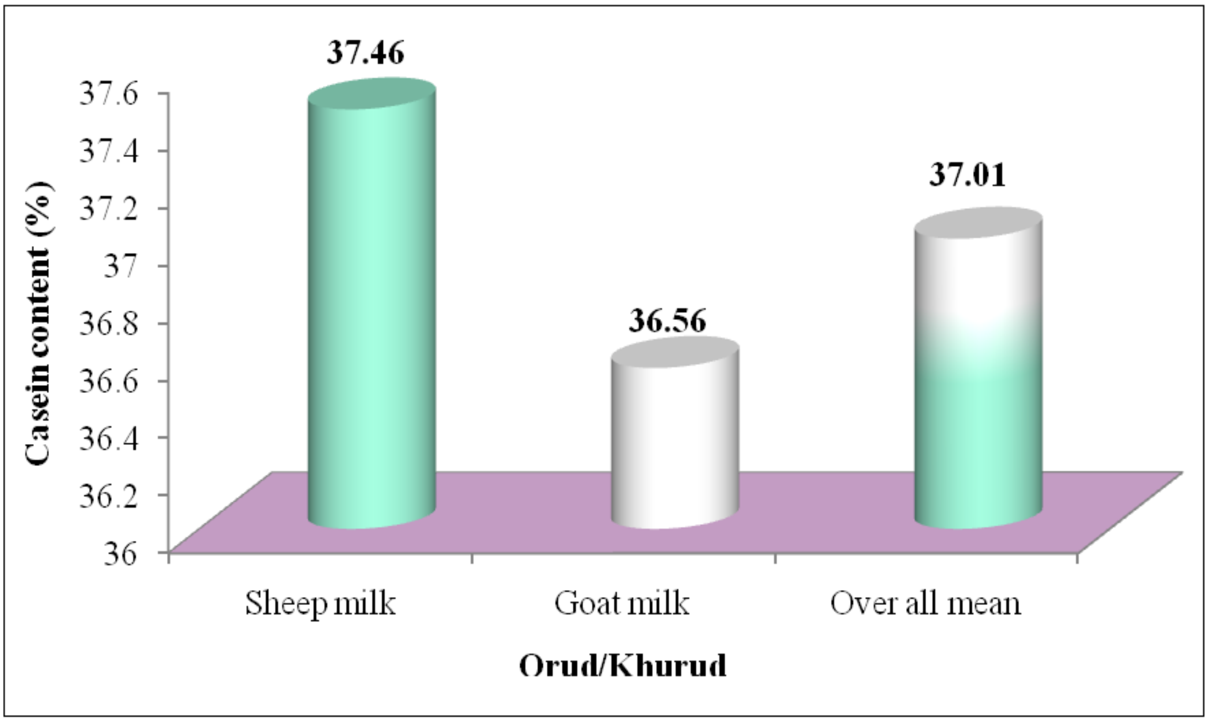
Yeasts and moulds (YM) count

Yeasts and moulds count of Orud/Khurud of sheep milk and goat milk was examined and the results are shown in Table 5. It was observed that YM counts within both types of Orud/Khurud varied greatly. However, the concentration of yeasts and moulds count in sheep milk Orud/Khurud ranged between 2.7×10^1 to 6.8×10^1 cfu g^{-1} and averaged $4.5\times10^1 \pm 0.41\times10^1$ cfu g^{-1}. While in case of goat milk Orud/Khurud the yeasts and moulds counts were observed in between 3.1×10^1 and 9.0×10^1 cfu g^{-1} and averaged $4.7\times10^1 \pm 0.60\times10^1$ cfu g^{-1}.The overall range of Orud/Khurud was in between 2.7×10^1 and 9.0×10^1 cfu g^{-1} and the mean $4.6\times10^1 \pm 0.35\times10^1$ cfu g^{-1}.

Moreover, the results of statistical analysis (ANOVA) revealed non-significant difference ($P>0.05$) in yeasts and moulds counts among sheep milk and goat milk Orud/Khurud (Appendix-X). The concentration of Y and M counts in sheep milk Orud/Khurud (-2.22 folds) and in goat milk, Orud/Khurud (-2.12 folds) was lower compared to that of Indian Standards Institution (ISI, 1975) i-e $\leq 1.0\times10^2$ cfu g^{-1}.

Discussion

In the current study, the moisture content of Orud/Khurud of sheep milk (5.05±0.35%) and of goat milk (5.47±0.31%) was not significantly different ($P>0.05$) from one another. This indicates that there is much similarity in traditional drying techniques under which both types of Orud/Khurud are made. Furthermore, the moisture content observed in Orud/Khurud is higher than reported by Salji, (1986), i.e., 3.9%, but lower than Mazahreh *et al.* (2008) and Kamber, (2008), i.e., 13.61% and 12.10%, respectively. However, the present results were very close to the findings of Al-Ruqaie *et al.* (1987), i.e., 5.4%. In contrast, the moisture content of Orud/Khurud within the same type varied greatly, which could have been attributed to the preparation method of Orud/Khurud that may differ from one place to another place because these processes are based on the traditional system.

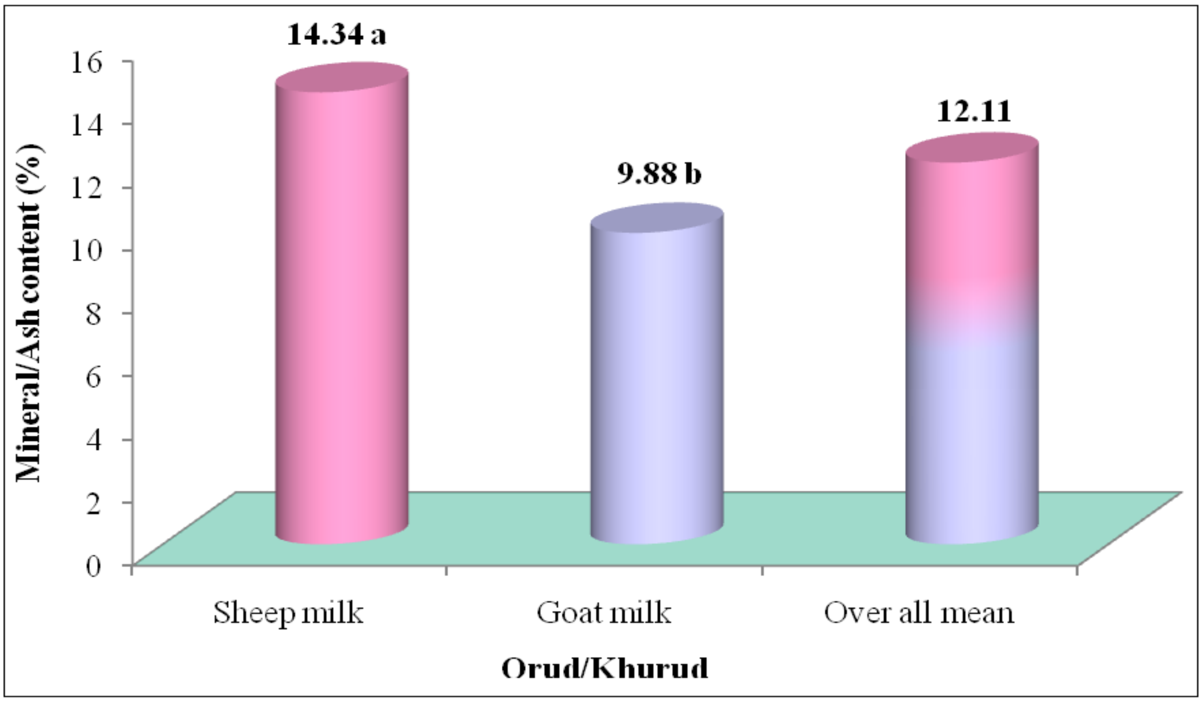


Data are the average of each of 10 sheep milk and/or goat milk Orud/Khurud and each in duplicate.

Fig. 4. Casein content of sheep milk and/or goat milk Orud/Khurud.

There is a significant difference ($P<0.05$) in fat content of Orud/Khurud of sheep milk (4.21±0.43%) and goat milk (2.48±0.19%). Moreover, these values of the fat content of Orud/Khurud in the present study are not in line with the results of Abou-Donia *et al.* (1991), who reported the fat content in a range of 0.7 to 1.8%, while Atia and Khattab, (1985); Kamber (2008); Mazahreh *et al.,* (2008) observed the fat content in between 7.4, 45.88±3.28 and 10.60%, respectively.

The lower fat content of Orud/Khurud indicates that the product has either been made from buttermilk or from milk to which fat has been removed.Orud/Khurud of sheep milk (44.60±1.63%) and goat milk (41.91±2.02%) did not show any significant differences ($P>0.05$) in Protein content. However, the values observed under the present study are lower than reported by El-Erian, (1979); Mazahreh *et al.* (2008) (i.e., 45.8 and 52.70%, respectively) but higher than (Salji, 1986; Al-Mashhadi *et al.,* 1987; Abou-Donia *et al.,* 1991; Salama *et al.,* 1992; Kamber, 2008) (i.e., 35.5, 36.4, 17.5-19.3,16.8-17.9 and 25.53±2.20 %, respectively). It was further observed that Orud/Khurud produced from sheep and goat milk was rich in casein content (37.46±1.19% and 36.56±1.60%, respectively). This indicates that Orud/Khurud may provide a good source of protein content.In the present study, the mineral/ash content of Orud/Khurud of sheep milk (14.34±0.63%) and goat milk (9.88±0.19%) are very high and significantly different ($P<0.05$) from each other. Moreover, these values are lower than reported by Mazahreh *et al.* (2008) (i.e.17.87%), but higher than observed by Atia and Khattab, (1985); Abou-Donia *et al.,* (1991); Salama *et al.,* (1992); Kamber, (2008) (i.e., 11.1, 4.3-4.7, 8.7-8.9, and 9.98±1.7%, respectively).



SE± = 0.69

LSD (0.05) =1.38

Data are the average of each of 10 sheep milk and/or goat milk Orud/Khurud and each in duplicate.

Fig. 5. Minerals/Ash content of sheep milk and/or goat milk Orud/Khurud**.**

The microbiological quality of Orud/Khurud is assumed to be safe due to low water activity (aw), high salt content, high acidic condition and the specific metabolite excreted by lactic acid bacteria. However, the presence of microbes in it is not surprising as these reflect the sanitary conditions during manufacturing stages or post-production contamination. In the present study, the total viable count in sheep milk Orud/Khurud averaged 4.2×10^3 $\pm3.1\times10^2$ cfu g^{-1}, which was not significantly different ($P>0.05$) from goat milk Orud/Khurud, (3.7×10^3 $\pm1.6\times10^2$ cfu g^{-1}).

This indicates that both types of Orud/Khurud are processed under similar manufacturing conditions. Furthermore, the total viable count observed in Orud/Khurud was within the acceptable limit of dried powders (ISI, 1975 and PSI, 2007) i.e 5.0×10^4 cfu g^{-1}. However, the result of the present study was not in line with the results of (Tamime and McNulty, 1999; Omari *et al.,* 2008), who reported the higher TV count in kishk and freeze-dried Jameed (i.e 1.1×10^6 and 2.0×10^4 cfu g^{-1}, respectively). While Omari *et al.* (2008) reported the lower TV counts in solar dried Jameed than Orud/Khurud of the present study.

There is no significant difference in thermoduric counts detected from sheep milk Orud/Khurud (4.7×10^1 $\pm0.6\times10^1$ cfu g^{-1}) and it was not significantly different from the goat milk Orud/Khurud (5.0×10^1 $\pm0.75\times10^1$ cfu g^{-1}). Moreover, the mean counts observed in the present study were lower than the reported values of Kamber (2008) for kurut (i.e., 10^2-10^5).

It could be agreed that the lower thermoduric count in Orud/Khurud is not surprising because it is a fermented product that might have produced an antagonistic effect against pathogenic as well as spoilage organisms (Yadev *et al.*, 1993). While drying process during its manufacturing might have caused the instant death of microbes. However, the presence of these types of microbes in Orud/Khurud is of great concern since thermoduric bacteria are heat resistant and may tolerate high drying temperature and/or might be the result of post contamination. The thermophilic spore count observed from Orud/Khurud of sheep milk ($4.8\times10^1 \pm0.71\times10^1$ cfu g^{-1}) and goat milk ($5.1\times10^1 \pm0.82\times10^1$ cfu g^{-1}) was not significantly different from each other. However, the average TPS counts ($5.0\times10^1\pm0.53\times10^1$ cfu g^{-1}) detected in the present study was lower than counts reported for kishk by Tamime and McNulty, (1999); Kamber, (2008) i.e., 6.1×10^2 to 1.43×10^6 cfu g^{-1} and 1.0×10^2 to 1.0×10^4 cfu g^{-1}, respectively.

Enterobacteriaceae counts between sheep milk ($4.1\times10^1 \pm0.65\times10^1$ cfu g^{-1}) and goat milk ($4.3\times10^1 \pm0.6\times10^1$ cfu g^{-1}) Orud/Khurud was not significantly different (P>0.05).

The mean count ($4.2\times10^1 \pm0.43\times10^1$ cfu g^{-1}) observed in the present study is higher than reported by Omari *et al.,* (2008), i.e., < 10, but lower than reported by Atia and Khattab (1985) and Kamber (2008), i.e., 3.4×10^2 and 2.13×10^2, respectively.

The presence of Enterobacteriaceae suggests the contamination in the Orud/Khurud during their manufacture or drying processes.

The yeasts and moulds counts between sheep milk ($4.5\times10^1 \pm0.41\times10^1$cfu g^{-1}) and goat milk ($4.7\times10^1 \pm0.60\times10^1$ cfu g^{-1}) Orud/Khurud was not significantly different (P>0.05). However, the mean value ($4.6\times10^1 \pm0.35\times10^1$ cfu g^{-1}) observed in the present study is lower than the results reported by Kamber, (2008) for kurut (3.94×10^2) and Tamime and McNulty, (1999) for kishk (a fermented yoghurt and cereal mixture) (8.5×10^5 cfu g^{-1}). In contrast, the result of the present study is not inconsistent with the reported concentration of yeasts and moulds (i.e., < 10 cfu g^{-1} (Omari *et al.,* 2008).

Conclusion

It is concluded that the chemical components in both types of Orud/Khurud were dense with a higher amount and could be a rich source of human nutrition. Moreover, the results of the microbiological examination showed the quality of Orud/Khurud within the acceptable limit.

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