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Physicochemical Characteristics of *Roub*; Traditional Fermented Dairy Product of the Sudan

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Authors' contributions

This work was carried out in collaboration between both authors. Author MOMA designed the study, wrote the protocol and performed the statistical analysis. Author SASEKO managed the analyses of the study, managed the literature searches and wrote the first draft of the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: This study was conducted to determine the physicochemical characteristics of fermented milk "*roub*" during the storage period.

Methodology: Thirty *roub* samples were collected (10 samples from each of Khartoum, Khartoum North and Omdurman areas) in sterile polyethylene bags, preserved in sample containers in ice (4°C) and transported to the laboratory for analysis. Physicochemical characteristics [fat, protein, total solids (TS), solids-non-fat (SNF), ash, acidity] were determined at 1, 7, 14 and 20-day intervals.

Results: The results showed that area from which samples were collected had a significant effect on all physicochemical characteristics of *roub* except solids-non-fat and acidity. During the storage period, there was no significant variation in all physicochemical characteristics of samples collected from Khartoum except the protein content, while in samples collected from Khartoum North there was a significant effect of the storage period on the protein and total solids contents only, and in samples collected from Omdurman the storage period significantly affected the protein and ash contents and acidity of *roub*. *Roub* samples were good up to the end of the storage period.

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Conclusion: The significant variation in physicochemical characteristics of the product indicates the differences in the source of milk rather than and/or the processing methods. Therefore, the authorities are encouraged to control this process by implementing legislations or prohibit the manufacture of this product in such prevailing conditions.

Keywords: Area; physicochemical; roub; storage period.

1. INTRODUCTION

Traditional fermented milk is a dairy product obtained by the spontaneous fermentation of milk through an appropriate process that results in lowering the pH [1]. Traditional fermentation is a food processing technique where lactic acid bacteria are utilized, and over the years, this process became part of the cultural and traditional criterion among the indigenous communities in most developing countries, especially in Africa [2]. A wide range of fermented milk products have been produced in different parts of the world for the purpose of preserving and extending the shelf life of milk. The majority of fermented milks of Africa are obtained from cow's milk, moreover, camel, goat, buffalo, sheep and horse milks are also used [3]. Fermented food products have a significant socio-economic role in the developing world contributing to the protein requirements of the indigenous consumers. In these foods food preservation takes place by lowering the pH. Fermentation has also other benefits such as improvement of food quality through food digestibility to increase essential amino acids, minerals, vitamins and protein [3].

The people living in remote areas prefer fermented milk products over non-fermented ones, due to improved flavour and texture accompanying fermentation, in addition to being important supplement to the local diet providing vital elements for growth and good health [2]. Milk fermentation assists in the preservation of milk by lactic acid and other antimicrobials, production of flavour compounds as well as prolonging the shelf life of food [4]; improves the nutritional value of milk by releasing free amino acids and promoting synthesis of vitamins; contains special therapeutic or prophylactic properties against cancer and lactose intolerance [5,6,7]; improves food safety through inhibition of pathogens [8]; and leads to removal of toxic compounds in food [2]. Some of the major fermentation processes are based on the use of lactic acid bacteria which produce organic acids, and the presence of lactic acid bacteria is crucial to the intrinsic properties of fermented food products [9,10]. Abdalla and Hussain [11] isolated coliform bacteria, *Staphylococcus aureus*, *Salmonella* spp., lactic acid bacteria and yeasts and moulds from *roub* samples collected from different regions of the Sudan.

The surplus milk produced during the rainy season by cattle owned by nomadic people in the Sudan is fermented by souring into one or other certain dairy products some of which are spread wide in the country whereas others are confined to certain geographical areas [12]. *Roub*'a traditional fermented dairy product' is made from surplus unheated milk by inoculating with starter culture, natural microflora of milk which is mainly mesophilic lactic acid bacteria, from the fermentation of the previous day [12]. The aim of this study is to determine the physicochemical characteristics of traditionally fermented milk of the Sudan '*roub'* collected from different areas in Khartoum State during the storage period.

2. MATERIALS AND METHODS

2.1 Sample Collection

A total of 30 *roub* samples (10 samples from each of Khartoum, Khartoum North and Omdurman) were collected in sterile polyethylene bags, preserved in sample containers in ice (4℃) and transported to the laboratory for analysis. The analysis was carried out immediately on arrival, otherwise the samples were stored at 4℃ and analysis was started within a period of not more than 24 hr. Physicochemical characteristics were determined at 1, 7, 14 and 20-day intervals.

2.2 Determination of Physicochemical Characteristics of *Roub*

Fat content was determined by Gerber method [13]. Total nitrogen (N) was measured by micro-Kjeldahl method, and the protein content was calculated as N×6.38 [13]. Total solids content was determined by gravimetric method by drying the samples in an oven at 105℃ for 24 h [13]. Ash content was determined by dry ashing of the samples for 24 h at 550℃ [13]. Titratable acidity was determined after mixing *roub* samples with 10 mL of hot distilled water (90℃) and titrating with 0.1 N NaOH containing 0.5% phenolphthalein as an indicator to an end point of faint pink colour [13]. Solids-non-fat content was determined by subtraction. The analyses were performed in triplicate.

2.3 Statistical Analysis

The statistical analysis was carried out using Statistical Analysis Systems (SAS, ver.9). General linear model (GLM) procedure was used to determine the effect of area from which samples were collected and the storage period on the physicochemical characteristics of *roub*. Mean separation was carried out by Duncan multiple range test (P≤0.05).

3. RESULTS AND DISCUSSION

3.1 Physicochemical Characteristics of *Roub* Samples Collected from Khartoum, Khartoum North and Omdurman

The physicochemical characteristics of *roub* collected from three areas under study are presented in Table 1. The fat content of samples collected from Khartoum area was significantly (P<0.001) higher (1.98±0.93) than samples collected from Khartoum North (1.91±0.65) and Omdurman (1.46±0.80) areas. These findings are in disagreement with Hassan et al. [14] who reported that the fat content of collected *gariss* 'a fermented camel milk product' samples was 2.8-3.6%, Biratu and Seifu [15] for fat content of 4.04 – 4.11% in camel fermented milk of Ethiopia, Johri and Chauhan [16] who reported fat content of 4.01±0.01 in Misthi Doi, an Indian fermented milk product from cow, and Noori et al. [17] who reported fat content of 2.46 – 3.35% in Traditional Kashak (fermented dairy product), and 1.63 – 3.50 in Traditional Doogh (fermented dairy product). However, the results in this study are higher those reported by Samet-Bali et al. [18] who reported a value of 1.35±0.10 in Industrial Laben produced with traditional starters, and Brasileiro et al. [19] who reported a fat content of 1.19±0.14 in Brazilian fermented dairy drink.

The protein content of samples collected from Omdurman area was significantly (P<0.001) higher (2.97±0.61) than samples collected from Khartoum (2.59±0.57) and Khartoum North (2.06±0.59). This might be attributed to the proteolytic activity of bacteria in samples collected from Khartoum North that resulted in the degradation of protein. The results in this study are in agreement with those of Biratu and Seifu [15] who reported a protein content of 2.50±0.60% and 2.39±0.56% in traditional Ethiopian camel milk made traditionally and in the laboratory, respectively, and Brasileiro et al. [19] who reported a value of 1.90±0.07% in Brazilian Traditionally fermented dairy drink.

There was statistically significant (P<0.01) variation in total solids content of samples collected from the areas under study, with the value being high (7.19±1.78) in samples collected from Khartoum, while the lower value of 6.47±0.94 was in samples collected from Omdurman. These results are not in accord with those of Biratu and Seifu [15] who reported the total solids content of Dhanaan: traditional fermented camel milk produced in Eastern Ethiopia to be 11.08±2.47% and 11.83±1.24% for traditional and laboratory made samples, respectively, and Johri and Chauhan [16] who reported a value of 13.38±1.34% for Misthi Doi, a traditional fermented milk.

Table 1. Physicochemical characteristics of *roub* samples collected from Khartoum Khartoum North and Omdurman (mean ±SD)

Physicochemical characteristics (%)	Area from which samples were collected			*p*
	Khartoum	Khartoum North	Omdurman	
Fat	1.98±0.93[a]	1.91±0.65[b]	1.46±0.80[a]	<0.0001
Protein	2.59±0.56[b]	2.06±0.58[c]	2.97±0.61[a]	<0.0001
Total solids	7.19±1.78[a]	6.73±1.33[b]	6.47±0.94[c]	0.0055
Solids-non-fat	5.22±1.48[a]	4.84±1.09[c]	5.02±0.96[b]	0.1945
Ash	2.63±0.68[b]	2.48±1.09[c]	2.96±0.56[a]	0.0008
Titratable acidity	0.58±0.19[a]	0.57±0.16[a]	0.53±0.13[b]	0.0798

Means in each row bearing similar superscripts are not significantly different (P>0.05)
SD ≡ Standard deviation

The solids-non-fat content was not significantly affected by the area from which samples were collected, although higher values were in samples collected from Khartoum (5.22±1.48) and lower values were in samples collected from Khartoum North (4.84±1.09). The variation in solids-non-fat content of *roub* might be due to variation in the milk collected from different sources. The values in this study are far lower than those reported by Johri and Chauhan [16] who reported that the solids-non-fat content of Misthi Doi is 9.64±1.19.

Significantly (P<0.001) higher ash content was obtained in samples collected from Omdurman area (2.96±0.56). The ash content in this study is higher than the results of Biratu and Seifu [15] for Dhanaan: traditional fermented camel milk produced in Eastern Ethiopia (0.96±0.03 - 0.99±0.09), Johri and Chauhan [16] for Misthi Doi: traditional fermented milk product (0.74±0.08), Noori et al. [17] for traditional Doogh (yogurt drinking) and Kashk fermented dairy product (0.56±0.07 - 1.59±1.20) and ElZubeir et al. [20] for traditional roub of Sudan (0.71 ± 0.35). Samet-Bali et al. [18] reported higher values of ash content in Industrial Laben produced with traditional starters (8.58 ± 0.06).

Although the acidity was not significantly affected by the area from which samples were collected, slightly higher (0.58±0.19) value was obtained in samples collected from Khartoum. The results in this study are higher than those of Biratu and Seifu [15] for traditional fermented camel milk (1.54- 1.75%), Johri and Chauhan [16] for Misthi Doi (1.16%), Noori et al. [17] for traditional Kashak, a traditional fermented dairy product (0.23 – 0.48) and Brasileiro et al. [19] for Brazilian fermented dairy drink (0.55±0.00), and lower than those of Swapna and Charannavar [21] for Shrikand, a traditional dairy product (1.21and. ElZubeir et al. [20] reported fat, total protein, total solids and ash contents and acidity of 2.43±1.08%, 3.48±0.16, 9.28±1.68, 0.71 ± 0.35 and 1.250 ± 0.35, respectively in processed *roub* of Sudan.

3.2 Effect of Storage Period on the Physicochemical Characteristics of *Roub*

The effect of the storage period on the physicochemical characteristics of *roub* collected from Khartoum, Khartoum North and Omdurman areas is presented in Tables 2, 3 and 4. There was no significant variation in the fat content of samples collected from the three areas. The fat content of samples collected from Khartoum are slightly increased at day 7 (2.50±1.03%) probably due to decrease in moisture content of *roub*, followed by a decrease at day 14 before slightly increasing again at the end of the storage period, while the fat content of samples collected from Khartoum North and Omdurman areas gradually increased till day 14 (2.05±0.69% and 1.34±0.80%, respectively)possibly due to depletion of water from the product, then decreased at day 20 (1.98±0.49%) for samples collected from Khartoum North area, and slightly increased to 1.37±0.71% for samples collected from Omdurman area. These results are in disagreement with Al. Otaibiand El. Demerdash [22] who reported that fat in dry matter content of labneh increased from 32.29 at day 1 to 32.50 at day 21. The fat content did not show any change before and after storage of fermented goat milk product (Oggtt) [23]. Hamad et al. [24] reported that fat increased from 4.40% in fresh Jameed to 10.7% at day 180. However, Irigoyen et al. [25] reported that fat content decreased by the end of the storage period in the kefir batches made using the 1% and 5% inoculates, owing this decrease to the growth of moulds which are the principal lipolytic agents in fermented milks

Table 2. Effect of storage period on physicochemical characteristics of *roub* samples collected from Khartoum (mean±SD)

Physicochemical characteristics (%)	Storage period (days)				*p*
	1	7	14	20	
Fat	1.96±0.94 ^{a}	2.05±1.03 ^{a}	1.93±0.86 ^{a}	1.98±0.95 ^{a}	0.9571
Protein	2.52±0.72 ^{b}	2.83±0.48 ^{a}	2.59±0.43 ^{ab}	2.44±0.59 ^{b}	0.0113
Total solids	7.29±2.16 ^{a}	7.40±2.19 ^{a}	7.04±1.47 ^{a}	7.03±1.21 ^{a}	0.7327
Solids-non-fat	5.33±1.89 ^{a}	5.36±1.72 ^{a}	5.11±1.29 ^{a}	5.06±0.92 ^{a}	0.7372
Ash	2.56±0.58 ^{a}	2.68±0.61 ^{a}	2.59±0.80 ^{a}	2.68±0.75 ^{a}	0.8045
Titratable acidity	0.59±0.19 ^{a}	0.59±0.19 ^{a}	0.56±0.22 ^{a}	0.58±0.18 ^{a}	0.6120

Means in each row bearing similar superscripts are not significantly different (P>0.05)
SD ≡ Standard deviation

Table 3. Effect of storage period on physicochemical characteristics of *roub* samples collected from Khartoum North (mean±SD)

Physicochemical characteristics (%)	Storage period (days)				*p*
	1	7	14	20	
Fat	1.76 ± 0.66^{a}	1.84 ± 0.76^{a}	2.05 ± 0.69^{a}	1.98 ± 0.49^{a}	0.1931
Protein	1.79 ± 0.44^{b}	1.92 ± 0.54^{b}	2.19 ± 0.65^{a}	2.34 ± 0.56^{a}	<0.0001
Total solids	6.36 ± 1.28^{b}	6.64 ± 1.43^{ab}	7.00 ± 1.51^{a}	6.92 ± 1.08^{ab}	0.0282
Solids-non-fat	4.59 ± 0.99^{a}	4.89 ± 1.22^{a}	4.96 ± 1.14^{a}	4.91 ± 1.03^{a}	0.4406
Ash	2.16 ± 1.16^{a}	2.59 ± 0.002^{a}	2.63 ± 1.03^{a}	2.56 ± 1.18^{a}	0.1739
Titratable acidity	0.57 ± 0.17^{a}	0.59 ± 0.17^{a}	0.57 ± 0.16^{a}	0.58 ± 0.17^{a}	0.9451

Means in each row bearing similar superscripts are not significantly different (P>0.05)
SD ≡ Standard deviation

Table 4. Effect of storage period physicochemical characteristics of *roub* samples collected from Omdurman (mean±SD)

Physicochemical characteristics (%)	Storage period (days)				*p*
	1	7	14	20	
Fat	1.62 ± 0.80^{a}	1.50 ± 0.86^{a}	1.34 ± 0.80^{a}	1.37 ± 0.78^{a}	0.3663
Protein	2.78 ± 0.56^{b}	2.96 ± 0.59^{ab}	3.07 ± 0.66^{a}	3.06 ± 0.61^{a}	0.0123
Total solids	6.53 ± 1.02^{a}	6.55 ± 1.06^{a}	6.42 ± 0.98^{a}	6.39 ± 0.71^{a}	0.8533
Solids-non-fat	4.93 ± 1.03^{a}	5.05 ± 1.03^{a}	5.08 ± 1.01^{a}	5.02 ± 0.82^{a}	0.9099
Ash	2.56 ± 0.49^{c}	2.82 ± 0.46^{b}	3.02 ± 0.52^{b}	3.42 ± 0.39^{a}	<0.0001
Titratable acidity	0.39 ± 0.10^{d}	0.49 ± 0.09^{c}	0.59 ± 0.08^{b}	0.65 ± 0.06^{a}	<0.0001

Means in each row bearing similar superscripts are not significantly different (P>0.05)
SD ≡ Standard deviation

The protein content of samples collected from Khartoum area significantly (P<0.05) increased to 2.83±0.48% at day 7, then gradually decreased towards the end of storage period (2.44±0.59%). The protein content of samples collected from Khartoum North and Omdurman areas significantly increased from 1.71±0.44% and 2.78±0.56%, respectively at day 1 to 2.34±0.56% and 3.06±0.61%, respectively at day 20, probably due to inactivation of proteolytic bacteria in the product that led to inability of these bacteria to degrade the protein into simpler products. Bukhari et al. [26] reported a decreasing pattern of crude protein content from 23.5±0.15% at day 1 to 22.6±0.15% at the end of the storage period of 28 days, while Al-Abdulkarim et al. [23] did not find any change in crude protein content of fermented goat milk product before and after storage.

The total solids content was not significantly affected by the storage period. The maximum total solids content was obtained at day 7 (7.04±1.47% and 6.55±1.06%, respectively) for samples collected from Khartoum and Omdurman, while the maximum total solids content for samples collected from Khartoum North was at day 14 (7.00±1.51%). These results are in disagreement with Al. Otaibi and El.Demerdash [22] who reported that total solids content of control sample of Labneh increased from 22.95% at day 0 to 23.31% at day 21. de Souza et al. [27] reported that total solids content decreased from 15.40a ± 1.20 at day 0 to 15.05a ± 0.03 at day 70.

The solids-non-fat content of samples collected from Khartoum insignificantly decreased from 5.33±1.89% at day 1 to 5.06±0.92% at day 20, while for samples collected from Khartoum North and Omdurman areas there was an insignificantly (P>0.05) increase from 4.59±0.99% and 4.93±1.03%, respectively at day 1 to 4.91±1.03% and 5.02±0.82%, respectively at the end of the storage period.

The ash content of samples collected from Khartoum insignificantly fluctuated during the storage period being high at days 7 and 20 (2.68±0.61% and 2.68±0.75%, respectively), while the ash of samples collected from Khartoum North insignificantly increased at days 14 and 21 (2.63±1.03% and 2.56±1.18%, respectively), and the ash content of samples collected from Omdurman area significantly (P<0.001) increased from 2.56±0.49% at day 1 to 3.42±0.39% at the end of the storage period. The results in this study are in agreement with Hamad et al. [24] who reported that ash increased from 10.73% in fresh Jameed to

14.58% at day 180, and not in accordance with de Souza et al. [27] who reported that ash content slightly decreased from 0.58±0.01 at day 0 to 0.57±0.01 at day 70. However, Bukhari et al. [26] reported that the ash content did not significantly change during the storage period as the value kept constant at 2.4±0.2%.

The titratable acidity content of samples collected from Khartoum and Khartoum North was not significantly affected by the storage period showing no increase in the acidity with the advancement of the storage period, while the acidity of samples collected from Omdurman area significantly ($P<0.001$) increased from 0.39±0.10% at the beginning to 0.65±0.06% at the end of the storage period. The results of the effect of the storage period on the acidity of samples from Omdurman area are similar to the results of Al.Otaibi and El.Demerdash [22], Bukhari et al. [26], Pawlos et al. [28] and Patel et al. [29] who reported an increasing trend of acidity in labneh during the storage period, while the results of samples collected from Khartoum and Khartoum North are in agreement with Al-Abdulkarim et al. [23] who reported no significant effect of the storage period on the acidity of dried fermented goat milk product (Oggtt) before and after storage.de Souza et al. [27] and Cais-Sokolinska et al. [30] reported a decreasing pattern of acidity of fermented dairy products during the storage period.

4. CONCLUSION

The traditional fermented milk '*roub'* is manufactured in traditional plants using milk collected from different sources and different animal species, therefore, the area from which the product is collected significantly affected all physicochemical characteristics. The manufacturing method needs to be improved by pasteurization of milk and then cooling and inoculating with starters as it makes *roub* safe for consumption.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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