

The Compositional Quality of Raw Milk Produced by Some Dairy Cow's Farms in Khartoum State, Sudan

Mahboba I.A. Ahmed and Ibtisam E.M. El Zubeir

Department of Dairy Production, Faculty of Animal Production,
University of Khartoum, P. O. Box 32, Postal code 13314, Khartoum North, Sudan.

Abstract: This study aimed to evaluate the compositional quality of raw milk produced by the big 60 dairy cow's farms at different locations of Khartoum State (Khartoum, Khartoum North and Omdurman; 20 farms from each town) at both winter and summer season. The means of freezing point of milk samples collected during summer and winter were -518.57 ± 25.65 °C and -532.92 ± 13.48 °C, respectively. The results indicated that there were significant differences in temperature and freezing point ($P < 0.01$ and $P < 0.001$) between seasons. Higher total solids were obtained during winter season than those during summer season ($12.77 \pm 0.919\%$ and $12.47 \pm 1.39\%$, respectively) Total solids content of milk samples revealed significant differences ($P < 0.01$) between cities and non-significant differences ($P > 0.05$) between seasons. However, significant differences ($P < 0.05$) were found in total solids of milk from Omdurman's dairy farms than other two cities. Lactose content during summer and winter were $3.95 \pm 0.561\%$ and $4.06 \pm 0.618\%$, respectively, Lactose was found to be significant ($P < 0.01$) when comparing the interaction between seasons and cities. The fat content was higher during winter ($4.54\% \pm 0.59$) than those during summer ($4.50\% \pm 0.46$), while protein contents were found as 3.77 ± 0.71 and 3.69 ± 0.399 for summer and winter, respectively. Higher ash content were found for the milk samples collected during summer than those collected during winter season ($0.63\% \pm 0.11$ and $0.593 \pm 0.089\%$, respectively). The result of fat, protein and ash content of milk samples revealed non-significant differences ($P > 0.05$) between seasons and between cities. Higher pH was obtained during winter season (6.73 ± 0.10) than those during summer season (6.34 ± 0.211). The higher level of acidity was found during summer season ($0.193 \pm 0.023\%$), while that during winter was $0.164 \pm 0.023\%$. Highly significant variations ($P < 0.01$) were reported for the milk samples collected from dairy farms in Khartoum for means of acidity..

INTRODUCTION

Milk is one of the oldest foods known to man and it is defined as the physiological secretion from the mammary gland of mammals^[17]. Milk and dairy products are part of a healthy diet which, besides cow's milk, also consists of sheep's, goat's and buffalo's milk^[10]. The use of milk products as human food has got a very long history^[22]. In recent years the demand for liquid milk increased tremendously world wide due to the increase of the population growth.

Milk is a complex mixture of fats, proteins, carbohydrates, minerals, vitamins and other miscellaneous constituents dispersed in water^[9]. Synthetic and secretory tissues of the mammary gland, the initiation and establishment of lactation, the milk ejection reflex, the breeds and genetic factors, the nutrition, the environment and the milking management practices, all these factors have important effect on milk composition and quality^[17].

The fat and protein composition of the milk of the

various animal species differs only slightly, but in every case it has a high priority in human nutrition^[10]. Milk composition for a Holstein herd revealed percentages of fat, protein, and lactose averaged 3.5, 3.1, and 4.8, respectively^[18]. The milk proteins are characterized by a high content of essential amino acids beyond that macromolecules, which have various biological functions, are available or may be formed by proteolysis in milk^[10]. White *et al.*^[23] found potentially important differences in fatty acids composition of milk from cows consuming a warm season pasture species compared with milk from cows consuming a total mixed ration, as well as differences between Holstein and Jersey breeds.

In Sudan most of important milk producing areas have no rigid systems of inspection at the farms and are not complying with sanitary standards, subsequently most of the products of these farms are sold through vendors and groceries^[7]. Thus, there is a need for up-to-date sound information based on scientific data on the health, composition and safety measures of

milk. Hence this study was conducted to evaluate raw milk produced by some big dairy cow's farms in Khartoum State to evaluate and compare the effect of season (summer and winter) on the quality (physical and chemical) of raw milk.

MATERIAL AND METHODS

Source of Milk Samples: A total of 120 raw bulk milk samples were collected from 60 dairy farms in Khartoum State, during summer and winter seasons between August 2003- January 2004.

Collection of Milk Samples: Raw bulk milk samples (100 ml each) were collected in the afternoon. They were kept in an ice box, then brought to the laboratory for analysis which was carried out immediately for acidity.

Laboratory Examination of Milk Samples: The raw milk samples were subjected to physical and chemical tests at the laboratory of the Department of Dairy Production, Faculty of Animal Production, University of Khartoum.

The bulk milk samples were stirred, then temperature was taken at the farms using Chem. Thermometer Milch glass Kalla according to Marshall^[12]. The freezing point was determined as described by Harding^[9], using a Fiske Ms Cryoscope, which was manufactured by Fiske Med. Sc. Inc. (USA).

Chemical Composition: The acidity of the milk samples was determined according to AOAC^[1]. Total protein and fat contents were determined using Kjeldahl method and Gerber method according to Bradley *et al.*^[5]. Determination of total solids were carried out by the IDF gravimetric method described by Foley *et al.*^[6]. Determination of ash was done using the method described by AOAC^[1]. Lactose was determined by anthrone method^[21].

Statistical Analyses: The analysis was carried out using SPSS program (Statistical Package for Social Sciences). All the data of this experiment were analyzed statistically by using complete randomized design and least significant difference test.

RESULTS AND DISCUSSIONS

The means of freezing point of milk samples collected during summer, winter and both seasons were -518.57 ± 25.65 °C, -532.92 ± 13.48 °C and -525.74 ± 21.64 °C, respectively (Table 1). The findings were in agreement with results of Rasmussen *et al.*^[20] and Mohamed and El Zubeir^[16].

Higher pH was obtained during winter season (6.73 ± 0.10) than those during summer season (6.34 ± 0.211). The reductions of pH during summer were disagreed with Payne^[19] who mentioned that acidity is normal in the range of pH 6.5-6.8. The reduction in pH might be due to increased in acidity during summer and so decreased the pH level. The higher level of acidity was found during summer season ($0.193 \pm 0.023\%$), while that during winter was $0.164 \pm 0.023\%$.

The fat content obtained during this study (Table 1) was higher during winter than those during summer ($4.54\% \pm 0.59$ and $4.50\% \pm 0.46$, respectively). The fat content during the present work was higher than those reported by Harding^[9] and Mohamed and El Zubeir^[16]. This might be attributed to genetic, plane of nutrition and yield of cows^[17]. The findings were in accordance with Hamid^[8] and Klungel *et al.*^[11].

Higher protein content was estimated during the present study ($3.73 \pm 0.58\%$). These findings were conflicting with the findings of Ballou *et al.*^[2]. These differences might be due to planning of nutrition^[17].

Ash content obtained during this study was $0.61 \pm 0.103\%$. Also higher ash content were found for the milk samples collected during summer than those collected during winter season ($0.63\% \pm 0.11$ and $0.593 \pm 0.089\%$, respectively) as shown in Table 1. These results differ from those reported by Hamid^[8] who obtained lower ash content. However, the findings were in accordance with Barakat who obtained ash of $0.59 \pm 0.09\%$.

Results of this study revealed that lactose content was found to be $4.01 \pm 0.59\%$ for both seasons, while those during summer and winter were $3.95 \pm 0.561\%$ and $4.06 \pm 0.618\%$, respectively (Table 1). These results were in disagreement with those reported by Harding^[9] and Ballou *et al.*^[2] who obtained higher results. The reduction might be due to breed differences^[4] and health status of the udder^[13,14].

Higher total solids were obtained during winter season than those during summer season ($12.77 \pm 0.919\%$ and $12.47 \pm 1.39\%$, respectively) as shown in Table 1. These were more or less similar to those reported by Mohamed and El Zubeir^[16]. However Hamid^[8] obtained higher total solids (14.3% and $13 \pm 0.99\%$ to $14.02 \pm 1.43\%$).

From Table 2 it was observed that means of fat %, protein %, ash %, and lactose % of milk samples showed non significant differences ($P > 0.05$) for milk samples collected from different cities and during different seasons. However, total solids showed significant differences ($P < 0.01$) due to the different cities from which the milk samples were collected.

Table 1: Frequency analysis of some physical and chemical properties of raw milk of some dairy farms in Khartoum State during summer and winter season

Season	Summer				Winter				Total			
	Mean	SD	Max	Min	Mean	SD	Max	Min	Mean	SD	Max	Min
Temperature °C	35.58	5.15	40	4	33.22	3.71	39	15	34.40	4.62	40	4
Freezing point	-518.57	25.65	-440	-577	-532.92	13.48	-491	-578	-525.74	21.64	-440	-578
pH	6.34	0.211	6.9	6.01	6.73	0.10	6.90	6.50	6.54	0.257	6.90	6.01
Acidity (%)	0.193	0.023	0.26	0.160	0.164	0.023	0.23	0.14	0.179	0.027	0.26	0.14
Fat (%)	4.50	0.46	5.5	3.4	4.54	0.59	5.90	3.10	4.52	0.525	5.90	3.10
Protein (%)	3.77	0.71	5.90	2.50	3.69	0.399	4.9	2.7	3.73	0.58	5.90	2.50
Ash (%)	0.63	0.11	0.82	0.33	0.593	0.089	0.78	0.41	0.61	0.103	0.82	0.33
Lactose (%)	3.95	0.561	4.90	3.00	4.06	0.618	6.60	3.00	4.01	0.59	6.60	3.00
Total solids (%)	12.47	1.39	15.20	8.25	12.77	0.919	14.55	10.30	12.62	1.19	15.20	8.25

SD=Standard deviation

Table 2: The level of significant for physio-chemical and microbial properties of raw milk of some dairy farms at Khartoum State

Measurements	Level of significant		
	Season	Cities	Interaction between seasons and cities
Temperature	0.01**	(P > 0.05)	0.01**
Freezing point	0.001***	(P > 0.05)	0.001***
PH	0.001***	0.001***	(P > 0.05)
Acidity	0.001***	0.001***	0.01**
Fat	(P > 0.05)	(P > 0.05)	(P > 0.05)
Protein	(P > 0.05)	(P > 0.05)	(P > 0.05)
Ash	(P > 0.05)	(P > 0.05)	(P > 0.05)
Lactose	(P > 0.05)	(P > 0.05)	0.01**
Total solids	(P > 0.05)	0.01**	(P > 0.05)
Standard plate count	0.001***	0.001***	0.001***
Laboratory pasteurization count	0.001***	0.001***	0.001***
Staphylococcus count	0.001***	0.001***	0.001***
Entrobacteriaceae count	0.001***	0.001***	0.001***
Coliforms counts	0.001***	0.001***	0.001***

Also Table 3 indicated that total solids of milk samples collected from Omdurman were significantly differences (P< 0.05) from those which collected from Khartoum and Khartoum North. This might be due to effect of breed, feeding and management as stated by Nickerson^[17]. He also reported that synthetic secretory tissue of the mammary gland, the initiation and establishment of lactation, the milk ejection reflex, the breeds and genetics factors, the nutrition, the environment and the milking management practice,

mightl have important effects on milk composition and quality. So higher total solids of milk samples collected from Omdurman might be due to one or other factors included above. Omdurman dairy farms have local breed and most crossed with low percentage of foreign blood. Further work is needed to established this.

Table 2 clearly presents the effect of season on milk properties, which showed highly significant different (P< 0.01) for temperature degree. Similarly higher significant variations (P< 0.001) were obtained

Table 3: Frequency analysis of some physical and chemical properties of raw milk of the dairy farms of the three cities of Khartoum State

Cities	Khartoum				Khartoum North				Omdurman			
	Mean	SD	Max	Min	Mean	SD	Max	Min	Mean	SD	Max	Min
Temperature °C	34.85	6.56	39	4	35.15	3.64	40	26	33.20	2.57	38	26
Freezing point	-526.22	18.28	-450	-568	-524.38	22.65	-448	-578	-526.63	24.04	-440	-577
pH	6.544	0.232	6.8	6.15	6.441	0.2289	6.8	6.04	6.627	0.279	6.9	6.01
Acidity (%)	0.193	0.026	0.25	0.14	0.173	0.018	0.22	0.14	0.171	0.031	0.26	0.14
Fat (%)	4.56	0.5904	5.9	3.10	4.45	0.476	5.35	3.5	4.569	0.507	5.5	3.10
Protein (%)	3.76	0.559	5.90	2.90	3.75	0.612	5.7	3.0	3.67	0.563	5.9	2.5
Ash (%)	0.586	0.115	0.78	0.33	0.608	0.092	0.78	0.41	0.635	0.097	0.82	0.46
Lactose (%)	3.876	0.647	6.60	3.00	4.038	0.536	4.90	3.00	4.103	0.575	4.9	3.0
Total solids (%)	12.42	1.081	14.25	8.250	12.399	1.012	14.55	10.10	13.04	1.35	15.20	9.55
pH				6.54 ^{ab}				6.44 ^b			6.62 ^a	
Acidity			0.193 ^a					0.173 ^b			0.171 ^b	
Total solids			12.42 ^b					12.39 ^b			13.04 ^a	

SD=Standard deviation

a and b: means in the same raw with different superscript letters are significantly different (P < 0.05)

for freezing point, pH and acidity. However non significant differences (P> 0.05) were observed for fat, protein, ash, lactose and total solids. This indicated that season had highly significant effect on quality of raw milk produced by different farms, especially during summer season where the temperature was high combined with the absence of cooling facilities as was reported earlier by Mohamed and El Zubeir^[15]. It was also observed that the milk samples collected from Khartoum had high significant differences (P< 0.05) than those collected from Khartoum North and Omdurman for acidity. It was also observed from Table 3 that means of temperature were 34.85± 6.56° C for the milk samples collected from Khartoum, 35.15± 3.64° C for the milk samples collected from Khartoum North and 33.2± 2.57° C for the milk samples collected from Omdurman. Also from Table 2 it was observed that temperature showed significant differences between seasons (P< 0.01) and non-significant differences (P> 0.05) between cities. These might be due to higher temperature of the milk samples collected from Khartoum dairy farms (34.85± 6.56° C) except Arab dairy farm, which has cooling facilities (4 and 15° C during summer and winter, respectively). So standard deviation was clearly higher than those of Khartoum North and Omdurman. So the absence of cooling combined with higher temperature might activate and enhance the growth and multiplication of bacteria and therefore increase the acidity of milk. Also the poor management practices (not shown data) found in Khartoum dairy farms might be another reasons. Furthermore the educational level of the farm's owners was low.

Enforcement of legislations and laws for milk production and dairy products, adoption of standard methods for production and establishment of procedures to control milk grading and marketing are of high priority. In addition to set milk pricing structure in order to stimulate the awareness of the quality for milk production.

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