Chemical Composition of Raw Milk Produced and Distributed In Khartoum State, Sudan

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ABSTRACT---- ***This study was conducted to evaluate the physicochemical properties of raw milk from different marketing channels in Omdurman and Khartoum North towns, Sudan. A total of 150 samples of raw milk were collected from distribution channels (pick-up trucks, venders on donkeys cart farms) in each town, and subjected to physicochemical analysis (fat, protein, total solids (TS), solids-non fat (SNF), lactose, density, acidity and added water). The highest contents of fat and added water were found in Omdurman, while the highest acidity was recorded in samples from Khartoum North. Among the distribution channels, the highest fat and TS contents and acidity were in pick-up trucks, and the lowest in venders on donkeys' cart and farms. The highest added water was obtained in venders on donkey cart. In Omdurman, the highest fat and TS contents were in samples collected from pickup- trucks, while the lowest fat and TS contents were in farm's milk. Furthermore, the acidity was higher in milk samples collected from venders on donkeys' cart compared to farm's milk. In Khartoum North, the highest fat content was in milk from pick-up trucks, whereas the lowest was in venders on donkeys. The highest contents of protein and acidity were obtained in farms' milk and venders' on donkey cart, respectively.***

Keywords— Physicochemical, milk, marketing channels, Sudan

1. INTRODUCTION

Fresh milk is considered as a complete diet because it contains the essential nutrients such as lactose, fat, protein, minerals and vitamins in balanced ratio rather than the other foods (Hossain and Dev, 2013). Moreover, milk can be considered as a source of macro and micro-nutrients, and contains a number of active compounds that play a significant role in both nutrition and health protection (Ceballos *et al*., 2009). The solid components of milk mainly fat and protein make milk an economically and nutritionally important asset (Negash *et al*., 2012). Milk is more widely influenced by environmental and genetic factors than any other biological fluid (Mohamed and Elzubeir, 2007). Negash *et al*. (2012) reported that the factors responsible for variations in milk composition include breed and individuality of cow, strain, interval between milking, stage of lactation, age and health of the cow, feeding regime and completeness of milking.

Adulteration of milk can cause the deterioration of dairy products, therefore milk quality requires the necessity and greater emphasis on regulatory aspects with advanced methods of analysis and monitoring milk production and processing (Fox and McSweeney, 1995).

In Khartoum State, milk is distributed through irregular marketing channels such as venders on donkeys or by cars in addition to collection centers and some consumers buy milk directly from the farms. These informal channels make milk uncontrollable and could influence the nutritional value of milk in case of adulteration. The present study is carried out to evaluate the physicochemical properties of raw milk produced and consumed in Khartoum State.

2. MATERIALS AND METHODS

2.1 Milk samples

Raw milk samples were collected from Omdurman and Khartoum North towns of Khartoum State, Sudan. A total of 150 samples were randomly collected, of which 75 samples were collected from Omdurman and 75 samples from Khartoum North. In each town, 25 samples were collected from each of traditional farms (locally known as *zariba*), pick-up trucks and venders on donkey carts. The samples were collected in dry clean glass bottles (25 ml), preserved in ice box at ≤4°C and transported to the laboratory for chemical analysis.

2.2 Physicochemical analyses of milk

Chemical analyses (fat, protein, TS, SNF, lactose, density and added water) of milk samples were determined using Lactoscan 90 milk analyzer (Aple Industries Service-La Roche Sur Foron, France). Milk samples were mixed gently 4-5 times to avoid any air enclosure in the milk, then 5 ml of the sample were taken in the sample-holder, one at a time and put in the sample holder with the analyzer in the recess position. The starting button was activated, the analyzer sucked the milk, the measurements were taken and the result was shown on the digital display. The titratable acidity was determined according to AOAC (2000).

2.3 Statistical analysis

The statistical analysis was performed using Statistical Analysis Systems (SAS, ver. 9). GLM procedures were used to determine the effect of location and marketing channel on physicochemical properties of milk. Means were separated by Duncan multiple range test at P≤0.05.

3. RESULTS AND DISCUSSION

3.1 Physicochemical properties of raw milk collected from Omdurman and Khartoum North

Physicochemical properties of milk samples collected from Omdurman and Khartoum North are summarized in Table 1. The mean values of fat content in milk collected from Omdurman (5.02±0.60%) was significantly (P<0.01) higher than milk samples collected from Khartoum North (4.72±0.67%). Results in this study are higher than those reported by Shojaei and Yadollahi (2008), Hossain *et al.* (2011), Barlowshka *et al.* (2012) and Hattem *et al.* (2012). Mohamed and Elzubeir (2007) reported that the mean fat content of milk in Omdurman and Khartoum North was 3.75±1.07 and 3.46±1.17%.

The average protein content in milk samples collected from Omdurman (3.58±0.33%) was higher than Khartoum North (3.57±0.17%), although there was no significant difference (P>0.05) between the two locations. These results are in line with Shojaei and Yadollahi (2008) and Hossain *et al*. (2011). Hattem *et al*. (2012) and Mohamed and Elzubeir (2007) found that the mean value of protein content in milk collected from Khartoum North (3.08±0.59%) was higher than that of Omdurman (2.93±0.47%). This might be due to the effect of adulteration of milk or breed and feeding on the protein content of milk. Barlowshka *et al*. (2012) stated that nutrition is an essential factor influencing the chemical composition in particular fat and protein contents. The mean SNF content of milk collected from Khartoum North and Omdurman was 9.13±0.39% and 9.12±0.65%, respectively. These values showed no significant variation (P>0.05) between locations. These values are higher than those of Shojaei and Yadollahi, (2008) and Hossain *et al*. (2011). The current results for fat, SNF and protein are similar to those reported by Negash (2012) who reported 5.48±0.19% fat, 9.10± 0.09% SNF and 3.46±0.04% protein.

Lactose content in milk samples collected from Omdurman and Khartoum North was 4.77±0.40% and 4.86±0.24%, respectively. This value is higher than that reported by Abd Elrahman *et al*. (2009).

The density of milk collected from Khartoum North (1.031±0.0%) was slightly lower than that of milk samples collected from Omdurman (1.035±0.03%), although no significant variations (P>0.05) were obtained between the two locations.

The acidity of milk samples collected from Khartoum North (0.23±0.03%) was higher than that collected from Omdurman (0.21±0.03%), and these values showed higher significant variation (P<0.001) between the two locations. These results are higher than the findings of Shojaei and Yadollahi (2008) and Tasci (2011). Mohamed and Elzubier (2007) found that the mean titratable acidity in Khartoum North and Omdurman was 0.18±0.03% and 0.17±0.03%, respectively, and concluded that the high acidity in milk might be due to the high temperature and growth and multiplication of bacteria.

Adulteration of milk in different marketing channels in Omdurman and Khartoum North was evaluated. The mean values of added water in milk samples collected from Omdurman was significantly (P<0.01) higher (Table 1). Addition

of water is the simplest way to increase milk quantity, in addition to the economic part of the problem, watering milk may also cause public health hazard since the available water added may be grossly contaminated (Tasci, 2011).

Generally, the composition and quality of milk might be affected by important factors such as synthetic and secretory tissues of the mammary gland, initiation and establishment of lactation, milk ejection reflex, breed and genetic factors, nutrition, environment and milking management practices (Nickerson, 1999).

3.2 Physicochemical properties of raw milk collected from different marketing channels

In the Omdurman and Khartoum North, raw milk is distributed through unregulated marketing channels including pick-up trucks, venders on donkey cart and traditional farms. Physicochemical properties of milk collected from different marketing channels were determined.

The composition of milk samples collected from different marketing channels is presented in Table 2. The mean value of fat content in milk samples collected from pick-up trucks was 5.08±0.64% followed by farms and venders on donkey cart (4.78±0.59% and 4.74±0.66%, respectively). Statistically, fat content was significantly ($P<0.05$) affected by source of samples. This result is slightly higher than that of Soomro *et al.* (2014) who reported that the fat content of milk obtained from milk producer was remarkably higher ($p<0.05$) in fat content (4.88±0.16%) than that of milk produced from milk vendor (3.34±0.22%). Difference in environmental, feeding and management conditions affect the fat content (Javaid *et al*., 2009).

Protein content of milk obtained from farms, pick-up trucks and venders on donkey cart was 3.62±0.34%, 3.59±0.19% and 3.51±0.24% respectively. These results are in line with Javaid *et al*. (2009) who stated that higher percentage of protein content is in dairy farm milk due to managerial practices.

The mean TS and SNF contents in milk samples from pick-up trucks were14.04±0.87% and 9.18±0.43%, followed by milk samples collected from farms and venders on donkeys' cart. The present study is in line with Javaid *et al*. (2009) who found that SNF content of milk in the farms and vendors were 8.06±0.19% and 9.79±0.10%, respectively. This result is higher than that of Tasci (2011) who reported that SNF in cow's milk cannot be legally lowered by the adulteration of water and the resultant product sold as fluid. The high value of lactose content is in milk samples collected from pick-up trucks (4.88±0.23%) followed by farms and venders on donkeys cart (4.79±0.43% and 4.77±0.27% respectively), although there is no significant variation ($P>0.05$) between different sources of milk. These results do not match with the findings of Javaid *et al*. (2009) who found the lactose content in milk obtained from farms (4.35±0.08%) to be higher than milk obtained from vendors (3.91±0.19%).

The highest density was shown in milk collected from pick-up trucks (1.037±0.04%), while the density of milk collected from farms and venders on donkeys cart was 1.03±0.00%. Javaid *et al*. (2009) reported that water adulteration might decrease the specific gravity of milk.

The high mean value of acidity was obtained from milk collected from pick-up trucks (0.23±0.04%), followed by milk collected from venders on donkeys cart and farms (0.22±0.03% and 0.20±0.03%, respectively). The acidity showed high significant variation ($P<0.001$) between different sources of milk. The high acidity in this study is affected by high ambient temperature and venders transporting milk for long distance without cooling. These results are in agreement with Elamin (2004) who found that the acidity of milk sold in Khartoum state was 0.19-0.22%. Acidity in this study was higher than that found by Tasci (2011) and Abdalla and El Hagaz (2011) who reported that the acidity of milk collected from farms in Khartoum state ranged between 0.14 and 0.18%.

The high mean value of added water was obtained in samples collected from venders on donkeys cart (0.41±2.7%, respectively), followed by milk collected from farms and pick-up trucks (0.23±0.27% and 0.29±0.27%). The results showed high significant variation ($P<0.001$). The same results were reported by Tasci (2011) who stated that addition of water and ice affect the physical and chemical quality of milk by altering the proportions of different constituents.

The quality of milk is hardly maintained at consumer level due to unrecognized and non regulated marketing systems (Javaid *et al*., 2009). Hossain and Dev (2013) stated that the mean of fat, protein, lactose, TS, SNF and acidity was 3±0.11, 3.96±0.16, 4.59±0.12, 8.53±0.02, 12.24±0.54 and 0.14% respectively.

The physicochemical properties of milk samples collected from different distribution channels in Omdurman and Khartoum North are presented in Table 3. In Omdurman, the highest fat content was obtained in milk samples collected from pickup trucks (5.24±0.48%), while the highest protein content was obtained in milk collected from farms (3.62±0.49), followed by pickup trucks and venders on donkeys cart (3.59±0.18 and 3.51±0.31 respectively). The SNF, lactose and density were higher in milk sold in pickup trucks (9.17±0.45%, 4.88±0.22% and 1.042±0.05% respectively). Venders' milk sold on donkeys cart was slightly acidic (0.21±0.03).

In Khartoum North, milk from farms was better than that from other sources in protein, TS, SNF and lactose (3.62±0.18%, 14.19±0.81%, 9.25±0.39%, 4.90±0.21, respectively). Fat content was slightly higher (4.91±0.74) in milk

collected from vender's milk sold in pickup trucks, while the lowest fat content was in milk collected from venders on donkeys' cart (4.43±0.55).

4. CONCLUSION

It was concluded that, the chemical composition of milk from Omdurman and Khartoum North varied slightly. The fat content was higher in Omdurman, while the acidity was higher in milk samples collected from Khartoum North. Adulteration of milk with the addition of water was obvious in milk samples obtained from Omdurman. In regard to the distribution channel, milk samples distributed through pick-up trucks contained high fat and total solids compared to other marketing channels. The adulteration of milk by water was recorded in milk samples distributed by venders on donkey. The consumer to be aware about the kind of milk he consumes, and the authorities should realize the importance of frequent inspection of the market to check whether this milk meets the minimum legal standards.

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Table 1: Physico-Chemical properties of raw milk samples collected from Omdurman and Khartoum North

Physico-chemical composition	Omdurman	Khartoum North	SL
Fat (%)	5.02 ^{a} ±0.60	4.72^{b}±0.60	**
Protein (%)	3.58 ±0.33	3.57±0.17	NS
Total solids	14.13± 1.04	13.89±0.90	NS
Solid non fat (%)	8.12±.05	9.13±0.43	NS
Lactose (%)	4.72±0.36	4.76±0.24	NS
Density (%)	1.033±2.07	1.031±1.65	NS
Acidity (%)	0.21^{b}±0.03	0.23^{a}±0.05	***
Added water (%)	0.62^{a}±2.28	0^{b}	*

Mean with the different superscripts in the same row are significant different (P<0.05)
SL = Significance level
*** = P<0.001
** = P<0.01
* = P<0.05
NS = Not Significant

Table 2: Physico-chemical properties of raw milk samples obtained from different marketing channels

Physico-chemical composition	Marketing channels			SL
	Farms	Pick-up trucks	Venders on donkey cart	
Fat (%)	4.78^{b}±0.62	5.08^{a}±0.64	4.74^{b}±0.66	*
Protein (%)	3.62±0.34	3.59±0.19	3.51±0.24	NS
TS (%)	14.01^{b}±1.05	14.04^{a}±0.87	13.78^{c}±0.97	*
SNF (%)	9.17±0.65	9.18±0.43	9.05±0.51	NS
Lactose (%)	4.79±0.43	4.88±0.22	4.77±0.27	NS
Density (%)	1.031±0.00	1.037±.04	1.031±0.00	NS
Acidity (%)	0.20^{c}±0.03	0.23^{a}±0.04	0.22^{b}±0.03	***
Added Water (%)	0.23^{b}±0.27	0.29±0.27^{b}	0.41^{a}±0.27	**

Means in a row bearing the same superscript are not significantly different at (P>0.05)
SL = Significant Level
*** = P<0.001
** = P<0.01
* = P<0.05
NS = Not Significant

Table 3: Chemical composition of raw milk samples from different location and different marketing channels

Parameter	Omdurman			Khartoum North			SL
	Farm	Pick-up trucks	Venders on donkey cart	Farm	Pick-up trucks	Venders on donkey cart	
Fat (%)	4.76±0.61	5.24±0.48	5.05±0.62	4.79± 0.64	4.91±0.74	4.43±0.55	*
Protein (%)	3.62±0.49	3.59±0.18	3.50±0.32	3.62±0.18	3.59±0.16	3.50±0.13	NS
TS (%)	13.82±1.23	14.39±0.83	14.16±0.98	14.19±0.81	14.08±0.90	13.40±0.80	**
SNF (%)	9.07±0.83	9.17±0.45	9.11±0.65	9.25±0.39	9.20±0.41	8.99±0.31	NS
Lactose (%)	4.67±0.54	4.87±0.23	4.76±0.35	4.90±0.21	4.88±0.22	4.78±0.15	NS
Density (%)	1.031±0.00	1.042±0.00	1.030±0.00	1.031±0.00	1.031±0.00	1.03±00	NS
Acidity (%)	0.19±0.02	0.20±0.03	0.21±0.03	0.20±0.02	0.20±0.04	0.22±0.03	***
Added water (%)	0.45±1.63	0.57±0.27	0.81±3.18	0	0	0	NS

SL = Significant Level
*** = P<0.001
** = P<0.01
* = P<0.05
NS = Not Significant