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Full Length Research Paper

Somatic cell count, total bacterial count and acidity properties of milk in Khartoum State, Sudan

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This work was conducted in Khartoum State to study the limits of the somatic cell count (SCC), the total bacteria count (TBC) and the acidity of the raw cow milk produced in the three geographical areas of the Khartoum State.A total of 644 stratified random raw milk samples were collectedduring summer and winter. The different counts and acidity were evaluated in the farm milk and compared to that sold in the market. Total bacterial count was carried out using the pour plate count.The bacterial count of equal or less than 9×10^4cfu/ml in the state was 23.9% with a higher percentage in winter (35.4%) compared to 19.4% in summer. The majority of the samples (55.3%) had a count of less than or equal 9×10^5cfu/ml. The percentage in winter was (71.9%) while in the summer it was (48.1%).Regarding the SCC, it was done using new man stain. The percentage of samples of less than 5×10^5 were (27%) in the state. The percentage was higher in winter (43.3%) than summer (20.8%).The majority of the samples (83.4%) were equal to or less than 7.5×10^5 (93.8%) were in winter and (81.5%) in summer. Regarding acidity which was carried out using the titration method, the percentage of samples of 0.2 titratable acidity were 64.3% in the state. The percentage in winter was 73.6% while in summer it was 60.7%. Statistically significant correlations at 0.01 levels between SCC, acidity and TBC were determined. The differences between the counts of SSC and TBC in winter and summer were statistically significant while the difference between the regions was insignificant.

Keywords: Sudan, milk hygiene, somatic cell count (SCC), total bacteria count (TBC), acidity.

INTRODUCTION

In Sudan milk is produced mostly in non-organized way and usually it is being supplied to the consumers from the urban and rural areas by milk vendors or from the groceries. The distribution of milk to the consumers is completely in poor hygienic conditions. On the other hand, milk is an excellent media for growth of a wide variety of bacteria.One of the requirements of production of the high quality milk is maintaining the bacteria count level of microorganisms in a product and to study the hygienic and sanitary conditions, under which milk was produced, handled, transported and processed (Murphy, 1997; FAO/WHO, 1992). Both temperature and storage time influence the multiplication of the micro-organisms, (Jayarao et al., 2004). Acatincai et al. (2008) stated that the TBC was higher during the summer months it reaches > 7.2×10^4 cfu/ml while it was 6.3×10^4 during winter time. In New York State 50% of the can samples had a count of > 1×10^4 during winter (Boor et al., 1998).Somatic cell count (SCC) is used by milk quality laboratories to determine quality and acceptability of milk (Schallibaum, 2001). At the cow or quarter level the normal SCC is generally below 2×10^5 but, may be below 1×10^5 cells/ml (Muhammad et al., 2009) SCCs are the

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Table 1. Number and percentage of raw milk samples.

Parameter	Summer				Winter			
	Kh (%)	Kh. N (%)	Omd (%)	Total (%)	Kh (%)	Kh. N (%)	Omd (%)	Total (%)
Individual	5(07.9)	12(22.2)	17(27.9)	34(19.1)	33(24.8)	19(09.3)	13(10.1)	65(13.9)
Bulk	13(20.6)	15(23.8)	19(31.1)	47(26.4)	35(26.3)	109(53.4)	53(41.1)	197(42.3)
Market	45(71.4)	27(50)	25(41)	97(54.5)	65(48.9)	76(37.2)	63(48.8)	204(43.8)
Total	63	54	61	178	133	204	129	466

Key to areas: Kh: Khartoum, Kh. N: Khartoum North, Omd. Omdurman.

lowest in a clean dry comfortable environment (Acatincai, 2008) that usually includes adequate shelter against sun and rain, absence and type of bedding, free or closed stalls and dry lots which minimize possible contamination of the teats ends from environmental organisms(Khan et al., 2008; Duane and Gerald, 2003). The seasonal variations of the SCC were studied by Sawa and Pwczynski (2002). They revealed a significant influence of season on the SCC which is higher in summer and lower in winter.

Titratable acidity plays a fundamental role and represents a very important parameter for the technical evaluation of the technological quality of milk (Harris and Bachman, 1988). The milk components that are acidic and contribute to normal acidity value are carbon dioxide, protein, phosphate and citrates (Harris and Bachman, 1988). High bacterial count which can convert lactose to lactic acid leads to the elevation of the titratable acidity. Simona et al. (2010) showed that the titratable acidity of milk typically varies from 0.15 to 0.19% lactic acid depending on the composition especially on protein content. In Sudan, the acidity values were studied by many workers (Ibrahim, 1973; Idris et al., 1975; El Zubeir and Ahmed, 2007). They reported that the mean titratable acidity was in the range of 0.18 to 020 but acidity of more than 0.22 was found in different milk samples.The main objective of this study is to evaluate the status of milk hygiene in the state of Khartoum from different sources (farms and market). The main measures that are studied are somatic cell count, total bacterial count and titratable acidity. The samples were collected during two seasons, winter and summer.

MATERIALS AND METHODS

In this study,644 raw cow milk samples were collected from the three regions of Khartoum state (Khartoum region, Khartoum North and Omdurman) in winter and summer. Samples were collected from the farm (Individual + bulk tank) and market (vendors or shops) during the period between April 2008 to February 2009 (Table 1). 50 ml of raw milk was collected using clean sterile glass bottles. The samples were put in an ice box and delivered to the laboratory of Veterinary Preventive Medicine at the Faculty of Veterinary Science, Khartoum University for analysis.

Somatic cell count (SCC)

According to IDF, (1984) the milk was mixed thoroughly before a final amount of 0.01 ml of milk was pipetted and spread evenly on the entire area of the special slide, (Special circular slide with an area of 1 cm² circle from Bellco Glass inc. Edrudo Road, Vine Land, U.S.A. (5638 to 01930) stock number) were prepared. Every slide is suitable for 4 samples. After drying the slide was stained with the prepared stain (New Man stain) for two minutes and then the cellswere counted under oil Immersion.

Total bacterial count test (TBC)

Total bacterial count was determined as described by ISO (1991), serial dilution (10^{-1} to 10^{-8}) of the milk samples was made and aliquots of 1ml were added to each duplicate Petri dish. Plate count agar was added to each Petri dish and incubated at 35°C for 48 h ±2, after incubation colonies were counted by colony counter and result was expressed as cfu/ml.

Acidity test

Bacteria that normally develop in raw milk produce lactic acid. In the acidity test the acid is neutralized with 0.1 Nsodium hydroxide and the amount of alkaline is measured. From this the percentage of lactic acid can be calculated (Foley et al., 1974). The number of milliliters of sodium hydroxide solution divided by 10 expresses the percentage of lactic acid.

Statistical analysis

All the data obtained during the study were analyzed statistically to find out the level of significance. The analysis of variance was determined by F-test. The mean differences were evaluated at 1% level of significance and the Pearson Correlation coefficient was calculated using the SPSS and Microsoft Excel programmes.

RESULTS

Total bacterial count (TBC)

The percentage of the total samples with counts of less than 1×10^5 cfu/ml was found to be 23.9% in state in the

Table 2. Seasonal TBC in the three regions of Khartoum State.

Range	Khartoum			Khartoum North			Omdurman		
	Winter {No (%)}	Summer {No (%)}	Total {No (%)}	Winter {No (%)}	Summer {No (%)}	Total {No (%)}	Winter {No (%)}	Summer {No (%)}	Total {No (%)}
1×10^{1} - 9×10^{4}	23(36.5)	28(21.1)	51(26.0)	14(25.9)	41(20.1)	55(21.3)	26(42.6)	22(17.1)	48(25.3)
1×10^{5} - 9×10^{5}	21(33.3)	38(28.6)	59(30.1)	22(40.7)	53(26.0)	75(29.1)	22(36.1)	46(35.7)	68(35.8)
1×10^{6} - 91×0^{6}	18(28.6)	54(40.6)	72(36.7)	09(16.7)	55(26.8)	64(24.8)	12(19.7)	46(35.7)	58(30.5)
1×10^{7} - 9×10^{7}	01(01.6)	10(07.5)	11(05.6)	05(09.3)	31(15.2)	36(13.9)	01(01.6)	11(08.5)	12(06.3
$> 10^{8}$	0(0.00)	04(03.0)	04(02.0)	04(07.4)	22(10.8)	26(10.1)	00(0.00)	05(03.9)	05(02.6)
Total	63	133	196	54	204	258	61	129	190

Table 3. Seasonal total TBC count in Khartoum State at different levels of collection.

Range	Winter				Summer			
	Individual {No (%)}	Bulk {No (%)}	Market {No (%)}	Total {No (%)}	Individual {No (%)}	Bulk {No (%)}	Market {No (%)}	Total {No (%)}
1×10^{1} - 9×10^{4}	21(61.8)	22(46.8)	20 (20.8)	63(35.4)	25(38.5)	32(16.2)	34(16.7)	91(19.5)
1×10^{5} - 9×10^{5}	09(26.5)	18(38.3)	38 (39.6)	65(36.5)	15(23.0)	60(30.5)	62(30.4)	137(29.4)
1×10^{6} - 9×10^{6}	04(11.7)	07(14.9)	28 (29.2)	39(21.9)	25(38.5)	60(30.5)	70(34.3)	155(33.3)
1×10^{7} - 9×10^{7}	00(0.00)	00(0.00)	7 (7.2)	07(3.9)	00(0.00)	26(13.2)	26(12.7)	52(11.1)
$>10^{8}$	00(0.00)	00(0.00)	4 (4.2)	04(2.3)	00(0.00)	19(09.6)	12(5.9)	31(06.7)
Total	034	047	96	178	065	197	204	466

two seasons (Table 2). In winter it was found to be 35.4% and in the summer it was 19.5%. The total count of less than or equal to 9×10^{5}cfu/ml was found to be 55.3% in the state during the two seasons. During winter 71.9% of the samples were within the limits of this count and 44.6% during summer (Table 2). In Khartoum state during the two seasons the percentage of samples with count of more than 10^{5} was 44.7%, in the state, with 28.1% in winter and 45.4% during summer (Table 2).The difference in the TBC between winter and summer was found to be statistically significant at 0.05, but the differences in the TBC between the three regions of the state were insignificant at 0.05 level of significance (Table 2).The percentages of counts of less than 10^{5} in individual cows' milk, farm bulk tank milk, and market milk during winter season were 61.8, 46.8 and 20.8%, respectively; during summer season the percentages were 38.5, 16.2, and 16.7%, respectively (Table 3). The percentage of counts of less than 9×10^{5} in individual cow's milk, bulk tank milk and market milk during winter season were 88.3, 85.1, and 60.4% respectively, during summer season the percentages were 61.5, 46.7 and 47.1%, respectively (Table 3). The percentage of counts of more than 10^{6} in individual cow's milk, bulk tank milk, and market milk during winter season was 11.7, 14.9 and 40.6% respectively (Table 3), during summer season the percentages were 38.5, 53.3 and 52.9%, respectively (Table 3). The correlations between individual cow's milk and farm bulk tank milk and between bulk tank milk and vendor milk were significant at 0.05 level (Table 4). At 0.05 level of significance there was no difference between the three regions. At 0.05 level of significance there is a significant difference between the two seasons.

The somatic cell count

As shown in Table 5, the percentages of samples with count less than 5×10^{5} Khartoum State were 27.0%. The percentages in winter and in summer were 43.3 and 20.8%, respectively. The percentage of samples of cells less than 7.5×10^{5} were 55.9% in Khartoum State. The percentages in winter and in summer were 69.7 and 47.7% during the two seasons, respectively. The percentage of sample, which has a count of over 1×10^{6} were 15.1% in Khartoum State. The percentages in winter and in summer were 6.2 and 18.5% in two seasons respectively. Statistically at 0.05 level the differences in count were significant between the three regions of the state and also between the two seasons.

Table 4. Correlations of TBC between individual, bulk, vendor and market milk.

Parameter	Correlation	Individual	Bulk	Vendor	Market
Individual	Pearson correlation	1	0.931(*)	0.470	0.395
	Correlations	0.0	0.021	0.424	0.511
	N	5	5	5	5
Bulk	Pearson correlation	0.931(*)	1	0.956*	0.677
	Correlations	0.021	0.0	0.160	0.209
	N	5	5	5	5
Vendor	Pearson correlation	0.470	0.956(*)	1	0.987(**)
	Correlations	0.424	0.160	0.0	0.002
	N	5	5	5	5
Market	Pearson correlation	0.395	0.677	0.987(**)	1
	Correlations	0.511	0.209	0.002	0.0
	N	5	5	5	5

* Correlation is significant at the 0.05 level (2 - tailed), ** Correlation is significant at the 0.01 level (2 - tailed).

Table 5. Seasonal SCC count in the different three geographical areas of Khartoum State.

× 10^3	Khartoum			Khartoum N.			Omdurman		
	Winter {No (%)}	Summer {No (%)}	Total {No (%)}	Winter {No (%)}	Summer {No (%)}	Total {No (%)}	Winter {No (%)}	Summer {No (%)}	Total {No (%)}
100 to < 200	12(19)	06(04.5)	18(9.2)	04(7.4)	07(3.4)	11(4.2)	01(01.6)	01(0.7)	02(01.1)
200 to < 500	18(28.6)	29(21.8)	47(24)	16(29.6)	40(19.6)	56(21.7)	26(42.6)	14(10.9)	40(21.1)
500 to < 750	14(22.2)	36(27.1)	50(25.5)	17(31.5)	70(34.3)	87(33.7)	16(26.3)	33(25.6)	49(25.8)
750 to <1000	17(26.9)	41(30.8)	58(29.6)	12(22.2)	47(23.0)	59(22.9)	14(22.9)	56(43.4)	70(36.8)
> 1000	02(03.3)	21(15.8)	23(11.7)	5(09.3)	40(19.6)	45(17.4)	04(06.0)	25(19.3)	29(15.3)
Total	63	133	196	54	204	258	61	129	190

Table 6. The averages of seasonal SCC in the three regions of Khartoum State.

Region	Winter × 10^5			Summer × 10^5		
	Market	Bulk	Individual	Market	Bulk	Individual
Khartoum	6.2	5.3	5.2	7.4	6.0	5.6
Omdurman	6.8	5.6	5.6	7.8	6.8	6.0
Khartoum N.	7.8	7.6	6.4	7.8	8.0	6.4

The average counts in Khartoum region for the individual, bulk and market milk were 5.2 × 10^5, 5.3 × 10^5, 6.2 × 10^5 during winter and 5.6 × 10^5, 6.0 × 10^5, 7.4 × 10^5during summer (Table 6).The average counts in Omdurmanregion for the individual, bulk and market milk were 5.6 × 10^5, 5.6 × 10^5, 6.8 × 10^5 during winter and 6.0 × 10^5, 6.8 × 10^5, 7.8 × 10^5 during summer, respectively (Table 6). The average counts in Khartoum North region for the individual, bulk and market milk were 6.4 × 10^5, 7.6 × 10^5, 7.8 × 10^5 during winter and 6.4 × 10^5, 8 ×10^5,

Table 7. Seasonal acidity values in the three regions of Khartoum State.

Range	Khartoum			Khartoum N.			Omdurman		
	Winter {No (%)}	Summer {No (%)}	Total {No (%)}	Winter {No (%)}	Summer {No (%)}	Total {No (%)}	Winter {No (%)}	Summer {No (%)}	Total {No (%)}
≤ 0.20	47 (74.6)	81 (60.9)	128	38 (70.4)	122 (59.9)	160 (62)	46 (75.4)	80 (62)	126 (66.3)
0.21- 0.22	06 (9.5)	28 (21)	34 (17.3)	08 (14.8)	37 (18.1)	45 (17.4)	06 (9.8)	21 (17.3)	27 (14.2)
> 0.22	10 (15.9)	24 (18.1)	34 (17.3)	08 (14.8)	45 (22)	53 (20.5)	09 (14.8)	28 (21.7)	37 (19.5)
Total	63	133	196	54	204	258	61	129	190

Table 8. Seasonal acidity values in Khartoum State at different levels of collection.

Range	Winter				Summer			
	Individual {No (%)}	Bulk {No (%)}	Market {No (%)}	Total {No (%)}	Individual {No (%)}	Bulk {No (%)}	Market {No (%)}	Total {No (%)}
≤ 0.20	29 (85.3)	35 (74.6)	67 (69.1)	131 (73.6)	50 (76.9)	127 (64.5)	126 (61.8)	303 (65)
0.21 - 0.22	02 (5.9)	05 (10.6)	11 (11.3)	18 (10.1)	08 (12.3)	31 (15.7)	32 (15.7)	71 (15.2)
> 0.22	03 (8.8)	07 (14.9)	19 (19.6)	29 (16.3)	07 (10.8)	39 (19.8)	46 (22.5)	92 (19.7)
Total	34	47	97	178	65	197	204	466

7.8×10^5 during summer, respectively (Table 6). At 0.05 level of significance there were significant differences between the three regions. At 0.05 level of significance there is a significant difference between the two seasons.

Acidity of milk

The percentages of samples with titratable acidity of less than or equal to 0.20 in Khartoum State were 64.3% .In winter it was 73.6%and in summer it was 60.7%. The percentages of samples with titratable acidity of more than 0.22 were 15.2% in winter, 20.8% in summer and 19.3% during the two seasons in Khartoum State (Table 7).The percentages of samples with titratable acidity of less than or equal to0.20 in Khartoum region were 74.6% in winter, 60.9% in summer and 65.3% during the two seasons. The percentages of samples with titratable acidity of less than or equal 0.20 in Khartoum North were 70.4% in winter, 59.9% in summer and 62% during the two seasons (Table 7). The percentages of samples with titratable acidity of less than or equal 0.20 in Omdurman were 75.4% in winter, 62% in summer and 66% during the two seasons (Table 7).

Statistically (at 0.05 level) the differences in acidity were of no significance between the three regions, but the difference was significant between the two seasons.The percentages of samples with acidity of less than or equal to 0.20 in individual, bulk, and market milk in Khartoum State were 79.8, 66.4and 63.7% in the two seasons. In winter these percentages were 85.3, 74.6 and 69.1% and in summer, 76.9,64.5 and 61.8% in individual, bulk and market milk,respectively (Table 8). At 0.05 level there was a correlation between individual and farm bulk tank milk and between bulk and market milk, there was a correlation in the acidity values between individual cow milk and bulk tank milk (Table 9).Statistically at 0.05 level there were significant correlations between acidity, SCC, and TBC and at 0.01 there was correlation between TBC and SCC (Table10).Statistically (at 0.05 level) the differences in titratable acidity were of no significance between the three regions, but the difference was significant between the two seasons.

DISCUSSION

The major observations is the wet poor hygienic practices in the farm and during marketing which contributes a lot to the quality of raw milk before it reaches the consumers. The milk was collected from the milking bucket into a plastic or aluminum containers which were not well washed, no cooling system was applied at any level of the milk chain which may last for five hours till milk reaches the consumer. Accordingly it was expected that milk would have a moderate to poor hygienic quality. Smiddy et al. (2007) stated that TBC count greater than 1 recommended that Grade A milk should not exceed 1×10^5 and Grade two milk should be less than 3×10^5.

Table 9. Correlations of titratable acidity values between different sample sources.

Parameter	Correlation	Individual	Bulk	Market
Individual	Pearson correlation	1	0.889**	0. 791*
	Sig. (2 - tailed)	0.0	0.018	0.500
	N	6	6	6
Bulk	Pearson correlation	0.889**	1	0.821*
	Sig. (2 - tailed)	0.018	0.0	0.019
	N	6	6	6
Market	Pearson correlation	0. 791*	0.821*	1
	Sig. (2 - tailed)	0.500	0.019	0.0
	N	6	6	6

*Correlation is significant at the 0.05 level (2-tailed), ** correlation is significant at the 0.01 level (2-tailed).

Table 10. Correlations between acidity, SCC and TBC in Khartoum State.

Parameter	Correlation	Acidity	SCC	TBC
Acidity	Pearson correlation	1	0.121*	0.009*
	Sig. (1 - tailed)	0.0	0.064	0.000
	N	643	643	643
SCC	Pearson correlation	0.121*	1	0.142**
	Sig. (1 - tailed)	0.064	0.0	0.000
	N	641	642	642
TBC	Pearson correlation	0.009*	0.142**	1
	Sig. (1 - tailed)	0.000	0.000	0.0
	N	643	644	644

* Correlation is significant at the 0.05 level (1-tailed), ** correlation is significant at the 0.01 level (1-tailed).

Raw milk ready for pasteurization must be within the count rate of 1×10^5 to 3×10^5 (Coast et al., 2004 and Jayarao et al., 2001). During this study only 23.9% were within this limit, (equal to or less than 9×10^4), 35.4% in winter compared to 19.5% in summer, it was the highest in Khartoum region (26.0%), followed by Omdurman (25.3%) then Khartoum North (21.3%) during the two seasons. Elevated bacterial counts in summer months are generally due to warm moist environment that increases pathogen exposure and number (Duane and Gerald, 2003).

During this study the majority of samples 55.3% were with a count of less than or equal 9×10^5, higher in winter 71.9% compared to 48.1% in summer this finding is almost in line with Duane and Gerald (2003).In Poland, Marian (2001) reported that raw milk is acceptable if it contains 4×10^5 cell/ml. The acceptable bacterial counts in Pakistan as reported by Muhammadet al.(2009) was 1×10^6,he also stated that most of the milk had a count of more than 1×10^7.Higher counts of more than 1×10^6reported by many researchers in many countries such as Mali (Bonfoh et al., 2003), Sudan (Elmagli et al., 2006), Malaysia (Chye et al., 2004), and India (Chatterjee et al., 2006). The percentage of samples of count of less than or equal 9×10^5 were highest in Omdurman (61.1%) followed by Khartoum region (56.1%) then Khartoum North (50.4%) during the two seasons, at winter time the percentage were higher than summer. In summer the count of less than 9×10^5 in Omdurman was the best (52.8%) followed by Khartoum (49.7%) then Khartoum North (46.1%), but when comparing the higher counts of more than or equal to 1×10^8 Khartoum North was the worst (10.1%); followed by Omdurman (2.6%) then Khartoum (2%). These differences between the regions

were statistically insignificant but the differences were significant between the seasons, this was in agreement with Ahmed and Elzubier (2007) who compared the count between winter and summer in Khartoum State and found higher counts during summer compared to winter season (5.3×10^{10} and 7.5×10^{7}cfuml, respectively).In this study the average counts of individual, bulk, vendor and market milk in summer were also higher than those in winter, the highest count was found among vendor and market milk at the range of 1.5×10^{7} in Khartoum region and 9.4×10^{8} in Khartoum North. This was almost in agreement with Beniwal et al. (1998) who found the change in TBC at the beginning to the end of the channel to be 1×10^{5} to 8.1×10^{7}.

The correlation between the individual TBC and farm bulk tank TBC milk were significant at 0.05, for the bacteria found in milk will be significantly affected by the holding time of the milk and the storage temperature of the milk (Khan,2008). Ombui et al. (1995) compared TBC from farmer cans and distributors cans, he found that 44% of samples with count of more than 10^{5} were from farmers cans compared to 86% from distributors cans,this was in direct agreement with Shojaei and Yadollahi (2008) who reported a count of more than 13×10^{7}in market milk. Mariana (2001) showed that in Poland milk should not exceed the count of 4×10^{5}. In this study the percentage of samples with count less than or equal to 5×10^{5} were 31.7% higher in winter (43.6%) compared to 20.9% in summer in Khartoum state. But in the USA a count of $7.5\times10^{5}$is acceptable the majority of samples (60.0%) during this study were within this limit. The percentages of samples with count less than 7.5×10^{5} was also higher in winter (69.7%) compared to 47.7% in summer, this was in line with Duane and Gerald (2003). Since extreme heat and humidity were among the most important factors which affect the count of somatic cell, the count in summer were expected to be higher, the elevated SCC of raw milk raise the suspicion that the raw milk is produced under poorer standard of hygienic condition and from unhealthy cows. The percentage of samples with a count over 1×10^{6} was lower in winter (6.2%) compared to 18.4% in summer, this was lower than what found by Nada (2000) who reported 26% of the samples were of SCC of about 1×10^{6} while 32% were between 2×10^{5} to1×10^{6}. Assgad (2002) reported that 51% of samples in Kordofan State (western Sudan) were with SCC of more than 5×10^{7} which is lower than the percentage calculated in this study (68.3%). The seasonal variation of SCC was studied by Sawa and Pwczynski (2002) and revealed a significant influence of season on SCC; higher in summer and lower in winter.Khartoum region was the best in the cell count during the two seasons and also has a lower unacceptable count during the two seasons followed by Omdurman then Khartoum North. These differences were statistically significant at both the season and area levels at 0.05. This was in agreement with Marian (2001) who found a significant difference between seasons of the year on the SCC. The maximum count of more than1×10^{6} was found among summer milk in Khartoum North but generally market milk has almost higher counts compared to individual and farm bulk milk. This may be due to mixing of milk from different farms for probability of getting herd with sub clinical mastitis which was known to elevate SCC. The lowest minimum counts were within Khartoum region milk in winter time this was similar to the TBC result in Khartoum region which suggest the better hygienic condition and relatively better mastitis control programs followed in Khartoum region compared to Khartoum North and Omdurman.

The titratable acidity of milk is very important parameter for the evaluation of milk quality Harris and Beach man (1988) they accepted milk with 0.19% acidity. In the present study, the percentage of samples with titratable acidity of less than or equal 0.20 in Khartoum State were 64.3% during the year, higher in winter (73.6%) compared to 60.7% in summer (Acatincai et al., 2008) reported average acidity ranging between 0.18 and 0.185 during both seasonsbut if the range reported by Idris et al. (1975) of not more than 0.22 was adopted we find that in this study 80.7% of the samples satisfy this rangein the State higher in winter compared to summer. Idris et al. (1975) found the upper limit of titratable acidity to be 0.22% (Mohamed and El Zubeir, 2007) reported acidity ranging between 0.17 to 0.26. In this study 15.9% of the samples in the state were in agreement with this upper limit. Normal range of acidity is affected by total solid content of milk, so Harris and Bachman (1988) suggested that each supplier or area should establish its own limits which when exceeded might indicate high bacterial count. Asaminew and Eyassu (2010) in Ethiopia reported an acidity values ranging between 0.22 to 0.23 in bulk while Ismail et al. (2010) reported acidity ranging between 0.14 to 0.16 in raw cow milk in Egypt.In this study the percentage of samples with acidity more than 0.20 were higher in market milk (29.1%) compared to farm bulk milk (27.0%) during the two seasons, this difference might indicate high bacterial count in marketmilk as shown in this study compared to farm bulk milk; this was in agreement with Ibrahim (1973) who reported an average of 0.18 titratable acidity among farm bulk milk and 0.20 in marketraw milk and also in agreement with Ammar et al. (2008) whofound an average acidity of raw milk in KhartoumState to be about 0.19 in the farm while it was0.22 at the sale points. The maximum limit of titratable acidity was found among samples from Omdurman market (0.26) during summer,this is again in agreement with Ahmed and El Zubeir (2007). This may be due to high bacterial count, for most of the milk sold in Omdurman markets was brought from Khartoum North

(the time between milking and distribution ranges from 3 to 5 h) without proper cooling to the milk and the effect of direct sunlight.The correlation between individual and farm bulk milk was significant at 0.05 but that between farm bulk milk and market milk was significant at 0.01 levels. This is in agreement with Ammaretal.(2008) who found this difference to be of significance. This may be due to long time spent by the vendor distributing milk house to house.Statistically there is correlation between the acidity, SCC and total bacterial count (TBC). This correlation shows the direct effect of TBC on SCC and the effect of both TBC and SCC on the acidity.

Conclusion

Most of the raw milk sold in Khartoum State is of poor hygienic quality. So, the Ministry of Agriculture and Animal Resources of Khartoum State should enforce all the regulations needed for producing and purchasing raw milk with acceptable hygienic, chemical land physical quality.

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