

Research Article

Preliminary Study on the Quality of Pasteurized Milk in Two Factories in Sudan

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Abstract: A total of thirty (n = 30) packaged pasteurized milk samples were collected from two factories in Khartoum (A) and White Nile (B) States, Sudan and investigated to determine their physical, chemical properties and bacterial quality. The results revealed that no significant differences in color, taste, flavor and consistency of the samples. Clot on boiling test revealed that no acidity on day 3 and 6 post production. However, on day 9, 40% (for 6 samples) from factory A and 20% (for 3 samples) from factory B were positive due to ineffective pasteurization. Titratable acidity test met the standards of Sudanese Standard and Metrology Organization (SSMO) in acidity degree for both factories (p>0.05). Phosphatase test revealed that only 6.7% of samples from factory A were positive. Total number of nonpathogenic bacteria test showed high significant differences (p<0.01). The presence of *Escherichia coli* at the rate of 6.7% in factory A and 60% in factory B indicates fecal contamination which demonstrated the hygiene procedures in milk preparation for both factories which should be taken consideration before it was contributed to consumers.

Keywords: Milk pasteurization, milk quality control, Sudan

INTRODUCTION

Sudan is one of the biggest countries in area of 1,886,068 km² of territory. The grazing lands compose 40.4% from total Sudan area. The pastoralists of Sudan own 90% of the nation herds of livestock according to the Ministry of Animal Resource and Fisheries (MARF, 2008). Among the Arab countries, Sudan ranks first and second in Africa with respect to animal production. Recently, the livestock estimation found that there are about 50 million heads of sheep, 40 million heads of cattle, 43 million heads of goat and 4 million heads of camel (MARF, 2008). The consumption of milk in Sudan per capita was estimated in 1999, at 219.7 kg/annum (Ahmed, 2006). It is believed that production of milk increasing in the future.

Milk is good medium for several bacteria to develop and grow. Pasteurized is one of the most famous methods to eliminate and control the bacterial growth (Heeschen, 1994). However, pasteurization may not destroy all microflora due to inadequate or faulty during milk processing production. It also can survive as the medium for heat resistant bacteria which most frequencies involves *Bacillus cereus* and *Clostridium*

sp. Nevertheless, other food pathogen which is also may survive one such as *Salmonella* sp., *Escherichia coli*, (Salo and Wirtanen, 2005).

In Sudan, pasteurization of milk is covered by multiple private firms including Khartoum State and White Nile. However, contamination of microorganisms during milk processing could lead to the reduction of milk quality (Harding, 1999). Milk contamination is major constraint to milk industry in Sudan due to low quality milk supplies for consumers (Mohamed and Ibtisam, 2007). High quality standard of milk is possible by monitoring the quality of end milk products prior before distribution (Smit, 2005). In this study, the quality of pasteurized milk produced by two factories in Khartoum and White Nile States were examined for preliminary test of chemical, physical and bacteriological aspects as in accordance to Sudanese Standards and Metrology Organization (SSMO).

MATERIALS AND METHODS

Samples collection and preparation: A total of thirty pasteurized milk samples (n = 30) were purchased from

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groceries in Khartoum (15) and White Nile States (15). The pasteurized milk from Khartoum was packed in carton. While from White Nile state was packed in plastic container. Both products were stored at refrigerator (4°C) and had validity period of 7 days. All samples were collected during the period from March to April, 2007. The samples were immediately kept into refrigerator (4°C) until used.

Physical tests: Sensory evaluation was performed as described by Campbell and Marshall (1975). Sensory was done to evaluate odor, sight, color and taste. Milk panels were chosen from milk handler, milk management and students who are experienced in milk evaluation.

Phosphatase enzyme test: The phosphatase analysis in milk was evaluated using Lactognost rapid phosphatase test (Heyl, Berlin). The test was done according to the Manufacture's instruction. Five milliliter of milk was poured into 2 test tubes namely, A (sample of pasteurized milk) and B (raw fresh milk as control). One tablet of Lactognost I, a tablet of Lactognost II and spoon full of Lactognost III were added into the labeled test tubes (A and B). Both tubes were incubated at 37°C for 20 min. After incubation, if the blue color appeared it indicates positive result for phosphatase activity. While brown color indicates negative result (no phosphatase activity).

Total Bacterial Count (TBC): The Total Bacterial Count (TBC) was carried out according to Andrewes (1997). Milk samples was diluted from 10⁻¹ to 10⁻⁴ and spread onto Plate count agar medium in duplicate (5 g/L casein enzymatic hydrolysate, 2.5 g/L yeast extract, 1 g/L dextrose and 9 g/L agar; CDH, USA). The plates were incubated at 37°C for 24 h. The colonies were counted and recorded as an according to ISO (1991).

Isolation of *Escherichia coli*: Sample was streaked onto Eosin Methylene Blue (EMB) (Oxoid) plate medium and incubated at 37°C for 18-24 h. Visualization was performed for *E. coli* colonies on EMB plate by metallic sheen.

Clots On boiling (CO): The coagulation tests were performed as described by LPC (1999). A total of 5 mL of milk was boiled in a test tube and if coagulation was shown the milk contain high acid.

Acidity test: Acidity test was conducted according to Richardson (1985). Nine ml of milk was placed into the conical flask, five drops phenolphthalein were added and titrated with 0.1 N NaOH until faint pink color appeared. The volume of sodium hydroxide solution was then divided by 10 and expressed as percent of lactic acid production.

Statistical analysis: ANOVA and t-test (Gomez and Gomez, 1984) at significance level of p<0.05 and the Statistical Package for Social Sciences (SPSS) program were used.

RESULTS AND DISCUSSION

A total of thirty packaged pasteurized milk samples from factory A and B were collected randomly from different sources during this study to investigate the color, taste, flavor and consistency evaluation, degree of acidity, adequate efficiency pasteurization and bacterial quality. The results also showed that no significant difference between the pasteurized milk of the two factories. Panel test revealed acceptable to less acceptable taste. Similarly, the consistency was neither affected by the source nor by the storage period. Nonetheless, it varied from watery to thick.

The pasteurized milk of both factories (A and B) showed similar white-creamy color. No significant change in color or in taste was observed due to storage on days 3, 6 and 9, respectively as shown in (Table 1).

In phosphatase test, it showed that all samples tested in factory B were free of phosphatase as indicated by brown color. While, 6.7% of the samples obtained from factory A revealed blue color, indicating the presence of phosphatase. This indicated that the pasteurized milk of factory A did not meet the standards of SSMO (2007), while factory B followed with food standard which given by SSMO (2007). Smit (2005) and Richardson (1985) reported that a negative result for phosphatase test showed the proper pasteurization processed was applied on the milk product (Table 2).

Table 1: The sensory evaluation (color, taste, consistency and flavor) of the two factories at day 3, 6 and 9, respectively post pasteurization

Factory	Color			Taste		
	3 day	6 day	9 day	3 day	6 day	9 day
*A	2.68±0.48	2.92±0.57	2.80±0.41	3.1±0.60	3.50±0.50	2.75±0.50
*B	2.84±0.62	2.64±0.48	2.70±0.47	3.5±0.57	3.21±0.44	3.00±0.84
Factory	Consistency			Flavor		
	3 day	6 day	9 day	3 day	6 day	9 day
*A	3.12±0.44	3.28±0.61	3.13±0.52	3.00±0.00	2.8±0.45	2.92±0.29
*B	3.20±0.71	3.28±0.61	3.35±0.67	3.00±0.82	3.7±0.50	3.31±0.75

Table 2: Phosphate test in two milk factories in Sudan

Factory	Phosphate test (%)	
	-ve	+ve
A	93.3	6.7
B	100	0.0

-ve: Negative; +v: Positive; 15 samples for each factories (A and B)

The total bacterial counts results of the current study (Table 3) showed a significant effect of storage time (3, 6 and 9 days, respectively) on total bacterial counts. It can also be seen that the pasteurized milk of factory B contain higher total bacterial count than that of factory A.

The results obtained for the total bacteria counts represent high significance ($p < 0.05$) at level of concentration (10^4) between the milk produced by the two factories A and B (Table 2). The results disagrees with the health condition of pasteurized milk for the total bacteria counts (nonpathogenic organisms shall be less than 50,000 cells/mL) as given by SSMO (2007). The high bacterial counts were expected under tropical conditions like in Sudan due to the fact that high temperature enhances growth and multiplication of bacteria.

Under tropical condition many factors such as high temperature, absence of sanitary condition for production of milk in the dairy farms and unavailability of cooling during handling and transportation of milk affect the quality of milk. Also, absence of application of principles of Hazard Analysis Critical Control Point (HACCP) system, which includes all concepts of sanitary regulation and hygienic practices contribute a lot to the production of Unhealthy pasteurized milk as stated by Harrigan and Park (1991).

E. coli was isolated from the samples using EMB medium as mentioned in materials and methods. The colonies of *E. coli* appeared as green metallic color on EMB medium. Test of *E. coli* showed higher values (60%) from factory B were positive to *E. coli* compared to (6.7%) from factory A. Presence of *E. coli* in high values as the results showed indicating high contamination. Concerning the presence of *E. coli* in

pasteurized milk, 6.7% of the milk samples of factory A gave positive result for *E. coli*, while those of factory B gave 60% (Table 4). This can be attributed to poor hygienic production or ineffective pasteurization of milk (Harding, 1999). This result agreed with Dasilva *et al.* (2001) who isolated *E. coli* from pasteurized milk and this represents a potential risk for children. Also agree with Sayed (2006) but disagree with the health condition of SSMO (2007). In developing countries there is no doubt that the Entero Toxigenic *E. coli* (ETEC) are important organism responsible for causing of diarrhea in all age groups in areas of poor hygiene, particularly in tropics where isolation rate of ETEC ranged between 10 and 70%. These records are collected from children and adults suffering from diarrhea (Gross and Row, 1985).

The presence of *E. coli* indicates faecal contamination and specifically in enteric pathogen. The high percentage of *E. coli* 60% obtained in this study might be due to improper handling, poor cleaning of equipments as stated by Hayes *et al.* (2001) (Table 4).

Concerning the clot on boiling test the samples of the pasteurized milk of factory A and B were negative at the third and six days after production and this is in accordance with standards given by SSMO (2007). On day 9, 40 and 20%, of milk samples of factory A and B clotted, respectively. It is well-known that the shelf life of pasteurized milk is 7 days as reported by SSMO (2007).

The clot on boiling test was negative to all samples collected from both factories on day 3 and 6 post pasteurization. Results also showed that no significance in all samples of both factories. However, 40 and 20% of samples were significant on day 9 post pasteurization in factory A and B, respectively.

The titratable acidity showed no significant differences on day 3 and 6 for both factories in the obtained values compared to the SSMO. However, it was significantly ($p < 0.05$) higher than that of the SSMO on day 9.

The results obtained for acidity degree showed no significant difference between the milk of the two

Table 3: Total bacterial count (10^4) and titratable acidity test of the pasteurized milk of factories: A and B at day 3, 6 and 9, respectively post pasteurization

Factory	Total bacterial count (10^4)			Titratable acidity		
	3 day	6 day	9 day	3 day	6 day	9 day
*A	1040.6±1617.6	349.9±495.6	10.0±14.10	0.21±0.02	0.21±0.02	0.27±0.09
*B	161.1±197.4	963.4±1703.0	1009.9±1685.62	0.21±0.02	0.21±0.02	0.23±0.02

Table 4: *E. coli* test in two milk factories in Sudan

Factory	<i>E. coli</i> (%)	
	-ve	+ve
A	93.3	6.7
B	40	60

-ve: Negative; +v: Positive; 15 samples for each factories (A and B)

factories A and B and this comes in agreement with SSMO which gives a rate of 0.18 lactic acid %. Previously, it was reported that that the mean of titratable acidity for Sudanese cattle milk was in the range of 0.16-0.22 with a mean of 0.19 lactic acid % which is agree with our study (Idris *et al.*, 1975).

CONCLUSION

From the present study it can be concluded that; the general and health conditions for the production of pasteurized milk given by Sudanese Standards and Metrology Organization are applied partially by some factories. Low quality pasteurized milk were distributed in Khartoum in terms of high total counts of bacteria and presence of *E. coli*.

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