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EFFECT OF STORAGE TEMPERATURE ON THE MICROBIOLOGICAL AND PHYSICOCHEMICAL PROPERTIES OF PASTEURIZED MILK

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Abstract
The present study was conducted to examine the effects of storage conditions on some quality measurements of pasteurized milk. Six batches of samples (n=120) that produced by a modern dairy factory were stored at both 5^o C and 10^o C. The analysis was carried out every second day up to 9 days.
The log total bacteria count (TBC) of pasteurized milk were found as 2.534± 0.09 cfu/ml and 2.448± 0.064 cfu/ml, while log coliform bacterial count were 0.235± 0.031 and 0.223± 0.034 cfu/ml for milk samples stored at 5^o C and 10^o C, respectively. The log of thermoduric count of pasteurized milk revealed 1.492± 0.044 and 1.375± 0.047 cfu/ ml and log psychrotrophic count were 0.24± 0.066 and 0.481± 0.071 cfu/ml, respectively and the titratable acidity was found as 0.141 and 0.145% and pH were 7.06± 0.002 and 7.07± 0.002, respectively. Moreover, highly significant differences were found for log/cfu/ml for TBC and coliform bacterial count of pasteurized milk due to variation of temperature and storage period. Similarly the fat, lactose, ash and SNF of the pasteurized milk showed significant (P<0.001) differences due to variation in the storage temperature and the storage period. However the protein content of the pasteurized milk revealed significant (P<0.001) differences during the storage period
The shelf life of pasteurized milk revealed 9 days. Hence it is concluded that the pasteurized milk produced by the selected dairy factory is of high quality.

Keywords: Pasteurized milk, storage conditions, hygienic quality, constituents, shelf life

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1. INTRODUCTION

Pasteurization is a process designed to destroy non-pathogenic microorganisms of raw milk, two-step process consists of rapid heating of the milk followed by immediate cooling. Moreover, this procedure is applied to obtain milk that is fit for human consumption and has longer conservation time (Kameni et al., 2002). Pasteurization as a practice has a positive effect on the bacteriological contents of milk, as it reduces the total bacterial count (TBC), coliform bacterial count and other pathogens (El Zubeir et al., 2007) Simon and Hansen (2001) stated that milk processed at 76.4^o C had the lowest bacterial growth rate. Dumalisile et al. (2005) reported that different pasteurization methods such as Low Temperature Long Time (LTLT), High Temperature Short Time (HTST) and post pasteurization contamination play an important role in the survival/ destruction of different bacterial contaminants in inoculated UHT milk. Processing of milk with pulsed electric fields (PEF) immediately after HTST pasteurization extended the shelf life of milk for more than two weeks over that of HTST pasteurized milk (Sepulveda et al., 2005). However the presence of psychrotrophs in cold raw milk (pre-processing) could be the critical factor in under mining the keeping quality of pasteurized milk and other dairy products (Zall, 1990).
Elmagli and El Zubier (2006a) studied the compositional quality of pasteurized milk in Khartoum State and reported that fat, protein, lactose, ash, titratable acidity and the freezing point ranged between 1 to 2.8%, 2.13 to 3.6%, 2.13 to 4.8%, 0.33 to 0.69%, 0.14 to 0.86% and -0.41 to -0.67, respectively. Elert (2002) mentioned that the mean density (gm/ml) of

various fluid milks was 1.023 at 38.9° C and 1.035 at 4.4° C for producer milk, 1.022 at 38.9° C to 1.033 at 4.4° C for homogenized milk and for skim milk it was 1.026 at 38.9° C and 1.036 at 4.4° C. Elmagli and El Zubeir (2006a) reported that the freezing point of pasteurized milk was -0.41 to – 0.67° C and the mean titratable acidity of pasteurized milk was 0.14 to 0.86%.

The raw milk distributed for the consumer in Sudan never finds the real quality control measures needed to be of a good quality food (Mohamed and El Zubeir, 2007). Dairy industry in Sudan is weak and at an early stage of development, since marketing of raw milk and dairy products made from raw milk are the common features of dairy marketing in Sudan (Elmagli and El Zubeir, 2006b). However currently some new private dairy factories started the processing of dairy products, they faced with so many problems of which the quality control measures constitute an important concern (Abd Elrahman et al., 2009)..Hamed and El Zubeir (2011) reported significant ($P<0.05$) differences between the products of the three companies in fat, solids not fat, density, protein and lactose. Microbiological analysis showed that total bacterial count, coliform count and aerobic spore formers count were significantly ($P<0.05$) affected by the sources of samples and storage period.

The present was designed with the objectives of evaluating the effect of storage temperature and storage period on the keeping quality of pasteurized milk.

2. MATERIALS AND METHODS

Source and processing of milk samples

This study was carried out during June to September 2005 using pasteurized milk from Blue Nile Dairy Company. Milk fat was standardized to 3-3.2%, and the milk was pasteurized at 72-76° C for 15 second using a HTST plate heat exchanger Wincantor Pasteurizer (Wincanton Engineering LTD South Street Sherborne Dorset, UK). The pasteurized milk was packaged into tetrapack papers (Tetra Pak Technical Services AB, Ruben Rausing gata, 5-221 86 Lund, Sweden) provided by Elabikan Company (Saudi Arabia).

Storage of milk samples

Six batches of pasteurized milk samples (120) were stored at 5° C and 10° C for 9 days and examined every second day ito estimate the shelf life of the pasteurized milk.

Microbiological analysis

Preparation of the serial dilution of milk samples, sterilization of glassware, preparation of culture media and culturing methods were done according to Houghtby et al. (1992). Standard plate count agar was used to determine the total bacterial count (Houghtby et al., 1992). Violet red bile agar (Blomark, B779) was prepared and used to determine the coliforms count Christen et al. (1992). Standard plate count agar was used to determine the psychrotrophic bacterial count. The plates were incubated at 7° C for ten days (Ballou et al., 1995). For aerobic spore count (ASC) determinations, milk samples were heated at 80° C for 12 minutes and rapidly cooled down to 10° C. Then one ml was poured into sterile Petri dish and the standard plate count agar was added. The plates were incubated at 37°C for 48 hours (Ravanis and Lewis, 1995).

Developed colonies were counted using manual colony counter. The plates counting 25-250 colonies were selected as descried by Houghtby et al. (1992). The reciprocal of the dilution factor was recorded as colony forming unit/ml.

Milk constituents and physical characteristics

The milk constituents (fat, protein, lactose, ash and SNF) and physical characteristics (density and freezing point), of the milk samples were determined by milk analyzer using milk analyzer Lactoscan 90 according to the instruction of the manufacturer' instructions (Aple Industries services–La Roche Sur Foron, France).

Milk samples were mixed gently 4-5 times to avoid any air enclosure in the milk. Then 25 ml samples were taken in the sample-holder; one at time and put in the sample- holder with the analyzer in the recess position. Then the starting button inactivated, the analyzer sucks the milk, makes the measurement, returns the milk in the sample- holder and the digital indicator (IED display) shows the specified results.

The acidity of milk samples was determined according to AOAC (1990). The pH of milk samples were measured according to Foley *et al*. (1974) by using a pH meter (3510 pH meter, Jenway).

Statistical analysis

Statistical Packages for Social Sciences (SPSS 10.00) were used to analyze all data using anova test and Duncan Multiple Range Test (DMRT) for mean separation.

3. RESULTS AND DISCUSSION

Milk constituents and physical characteristics of pasteurized milk

Table 1 shows that means and standard errors of fat, protein, lactose and ash contents of pasteurized milk stored at 5° C were 3.33± 0.009 %, 3.20± 0.021 %, 4.02± 0.02 and 0.717± 0.003 %. The samples that were stored at 10° C revealed 3.35± 0.001%, 3.22± 0.020 %, 4.01± 0.027% and 0.718± 0.003 %, respectively. The mean value of SNF content of pasteurized milk stored at 5 and 10° C were 7.91± 0.023 % and 7.91± 0.025 %, respectively. Moreover fat, lactose, ash and SNF of the pasteurized milk showed significant ($P<0.001$) differences due to variation in the storage temperature and the storage period. The protein content of the pasteurized milk revealed significant ($P<0.001$) differences during the storage period (Table 1).

Table 1. Effect of storage temperature on some physicochemical properties of pasteurized milk

Measurement	Mean± std error (%)	
	5˚ C	10˚ C
Fat (%)	3.33±0.009[a]	3.35±0.001[b]
Protein (%)	3.20±0.021[a]	3.22±0.020[a]
Lactose (%)	4.02±0.025[b]	4.01±0.027[a]
Ash (%)	0.717±0.003[a]	0.718±0.003[b]
SNF (%)	7.91±0.023[a]	7.91±0.025[b]
Density (%)	1.028±0.088[a]	1.028±0.094[b]
Freezing point (º C)	-0.448±0.002[a]	-0.447±0.002[b]
Titratable acidity (%)	0.141±0.000[a]	0.145±0.000[b]
pH	7.06±0.002[a]	7.07±0.002[b]

[a,b] Values in the same row with different superscripts letters differ significant ($P < 0.05$).

Table 2. Effect of storage temperature on some microbiological quality of pasteurized milk

Measurement	Mean± std error	
	5˚ C	10˚ C
Log total bacterial count (cfu/ml)	2.448±0.064[a]	2.534±0.059[b]
Log coliform (cfu/ml)	0.223±0.034[a]	0.235±0.031[b]
Log thermoduric bacterial count (cfu/ml)	1.375±0.047[a]	1.492±0.044[b]
Log psychotropicbacterial count (cfu/ml)	0.481±0.071[b]	0.249±0.066[a]

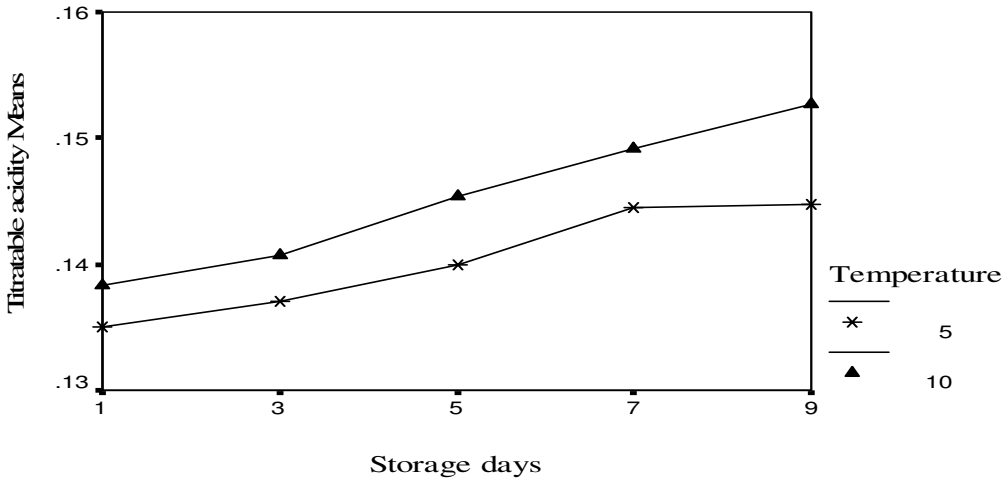

Fig.1: Effect of storage period and temperature on acidity (%) of pasteurized milk

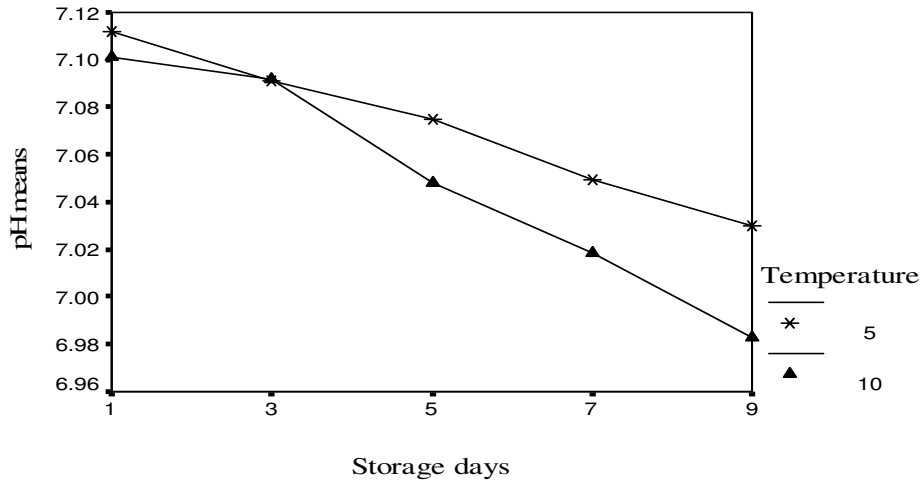

Fig.2: Effect of storage period and temperature on pH of pasteurized milk

The present data revealed high compositional content compared to Elmagli and El Zubeir (2006a). Similarly lower values for these measurements were reported previously for the pasteurized milk from South Africa (El Zubeir et al., 2007; El Zubeir et al., 2008). These variations in milk composition might be due to the initial raw milk used and the procedure of processing (Abd Elrahman et al., 2009). Also the data found lower mean values for the lactose content than that reported by the factory (4.7%). However they were higher than that reported by El Zubeir et al. (2007); El Zubeir et al. (2008) who reported means of 3.195± 0.835 and 3.897± 0.908 respectively, for South African pasteurized milk. The lower lactose may be due to the effect of psychotrophic bacteria (Ballou et al., 1995).

The means of the density of pasteurized milk (1.028± 0.088 and 1.028± 0.094 at 5 and 10^{o} C, respectively) as shown in Table 1 was higher than that reported by Elert (2002) who found the mean density of various fluid milks was 1.023 at 38.9^{o} C. The freezing points (^{o} C) were -0.448 ± 0.002 and -0.447 ± 0.002, respectively (Table 1). This study agreed with that reported by Elmagli and El Zubeir (2006a) who found freezing point of -0.4734± 0.05032^{o} C. This study revealed significant effects of storage condition and storage period on density and freezing point of pasteurized milk (Table 1).

Microbial quality of pasteurized milk

The microbiological quality of the pasteurized milk showed lower bacterial loads with TBC of log 2.448± 0.064 and 2.534± 0.059 cfu\ml and coliform of log 0.223± 0.034 and 0.235± 0.031 cfu/ml respectively, at 5° C and 10° C (Table 2, Figure 3 and Figure 4). Results showed that pasteurization process was efficient in reducing the microorganism, which agreed with Simon and Hansen (2001); Dumalisile et al. (2005). Moreover, highly significant differences were found for log/cfu/ml for TBC and coliform bacterial count of pasteurized milk due to variation of temperature and storage period (Table 2).

The obtained data showed lower values than that reported by Elmagli and El Zubeir (2006b); El Zubeir et al. (2007); Hamed and El Zubeir (2011). PMO (2001) stated that the bacteria standards for grade A pasteurized milk should be less than 20,000 total bacterial count /ml and be < 10 coliform count/ ml. Result of total bacterial count for pasteurized milk obtained during this study showed low count, which might be due to quality of raw milk, proper heat treatment and efficient storage conditions (Abd Elrahman et al., 2009). Also the lower count of bacteria may be due to good cleaning system and good handling from farms to factory which supported).

Thermoduric bacterial count revealed log 1.375± 0.047 and 1.492± 0.044 cfu/ml at 5° C and 10° C, respectively (Table 2 and Figure 5). These differences were significantly (P<0.05) affected by storage periods and temperature. The obtained values were lower than that reported by Elmagli and El Zubeir (2006b); Hamed and El Zubeir (2011) Milking equipment provides excellent locations in which thermoduric bacteria can thrive and contaminate milk (Zall, 1990).

The mean value of psychrotrophic bacteria for pasteurized milk were log 0.481± 0.071 and 0.249± 0.066 cfu/ml at 5° C and 10° C, respectively (Table 2 and Figure 6). These differences were significantly (P<0.05) affected by storage periods and temperature. This result showed lower count compared with that reported by Elmagli and El Zubeir (2006b). The present study revealed high count of psychrotrophic at day 7 and day 5 in 5° C and 10° C, respectively (Figure 4). This supported Karatapanis et al. (2006) who reported significant (P<0.05) differences among packages during day 5 and day 7 of storage. Zygoura et al. (2004) reported no significant differences (P>0.05) in psychrotrophic count for milk samples during the entire 7 days storage period.

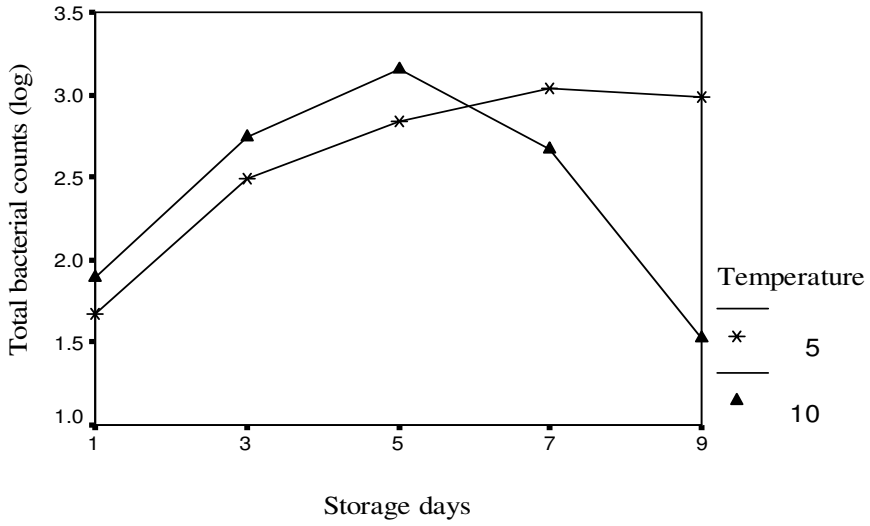

Fig. 3: Effect of storage period and temperature on total bacterial counts of pasteurized milk

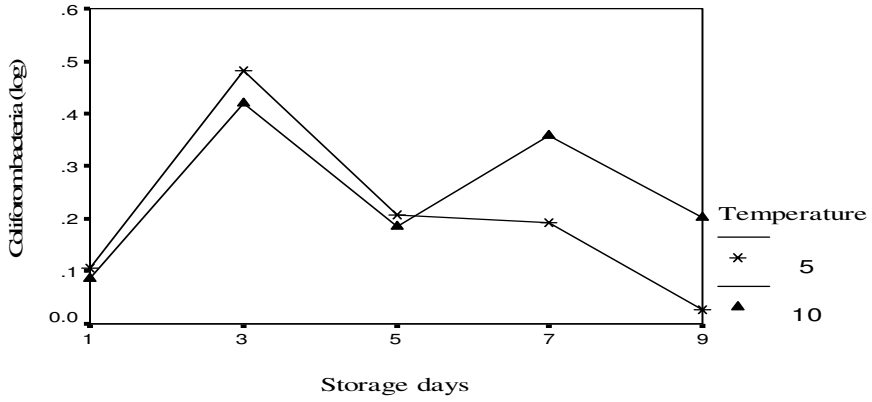

Fig.4: Effect of storage period and temperature on coliform bacteria of pasteurized milk

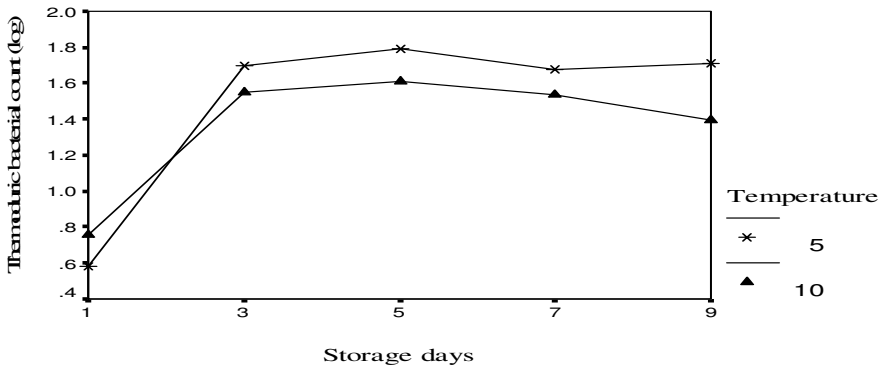

Fig.5: Effect of storage period and temperature on thermoduric bacteria of pasteurized milk

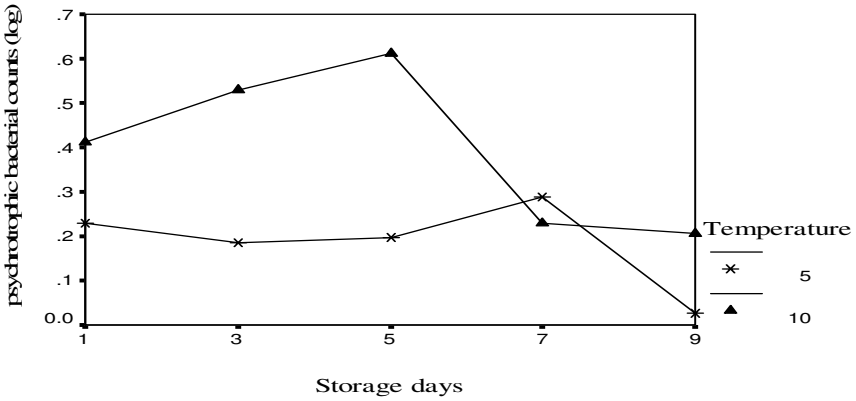

Fig.6: Effect of storage period and temperature on psychotropic bacteria of pasteurized milk

4. CONCLUSIONS

The data revealed an extended shelf life of pasteurized milk up to nine days than that reported by the factory (six days). This finding might be due to proper pasteurization, hygienic process and good storage condition, which was favorable with that reported by Sepulveda (2005). The results also illustrated that high quality pasteurized milk is produced by the

selected dairy factory as the values of chemical contents and microbiological values are within standard limits. Hence the present study recommends the use of pasteurized milk instead of raw milk to ensure good health for the consumers and to extend the shelf life of dairy products.

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