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Assessing Compositional and Sanitary Quality of Pasteurized Milk Marketed in Tiaret District, Algeria

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Abstract: This study was carried out to assess the safety and to check for thermo-resistant bacteria of pasteurized cow milk. Physicochemical and bacteriological tests were performed on 100 pasteurized milk samples. The acidity, density, fat, total dry extract (TDE) and the defatted dry extract (DDE) were studied; also, germs were researched according to the national standards. Mesophilic flora count was high; it varied between 10^4 and 1.4×10^6, the total coliforms (TC) and fecal coliforms (FC) content was elevated. 61% of sampled milk was contaminated with *Staphylococcus aureus,* 34% by Sulphite-reducing *Clostridia* (SRC) and 100% by *fecal Streptococci* (FS). The overall results obtained suggested that pasteurized milks were of poor hygienic quality and were not conformed to the Algerian standard; in infringement of the current sanitary regulation. Thus, there is urgent need to test and monitor the milk chain periodically, after pasteurization and packaging.

Key words: Hygienic Quality · Milk Contamination · Pasteurization · Thermo-Resistant Bacteria

INTRODUCTION

Milk is an important component of our daily diet; it is an important source of minerals, carbohydrate, protein, lipid and vitamins. Due to the growing human needs, milk technology has pioneered methods to better preserve the milk for a long time, such pasteurization and sterilization.

However, milk is a nutritious medium that can support growth of a large selection of bacterial contaminants; bacteria are able to use proteins, fats, carbohydrates and vitamins in milk for their growth and metabolism [1]. Hence, milk should not be consumed or used in dairy products without a former pasteurization.

Pasteurization process of milk is a heat treatment intended to reduce the number of any harmful microorganisms to a level at which they do not constitute a significant health hazard; reduce the level of undesirable enzymes and spoilage bacteria and thus increase the keeping quality; achieve the preceding two goals while maintaining the nutritional integrity of the original product [2].

Nevertheless, some agents responsible for zoonosis can be transmitted to the human by milk consumption even if pasteurized [3] so, control of pasteurized milk hygiene proves to be very important. As well, it may be taking into account the conditions in which the milk is produced, including the respect of hygiene mastery of manipulation, to avoid post pasteurization contamination.

In Algeria, a few works were focused on milk quality evaluation [4,5]. The present investigation aimed to spot light on the quality of pasteurized cow milk marketed in Tiaret area (Algeria); determined by physicochemical and bacteriological tests.

MATERIAL AND METHODS

Sources of Milk Samples: Milk samples were collected from GIPLAIT (public milk factory) of Tiaret District in Western Algeria. The study was conducted from December 2013 to May 2014, on 100 samples taken from 100 packets of pasteurized milk. Samples were stored at 6-8 °C till laboratory tests carried out after 4 hours.

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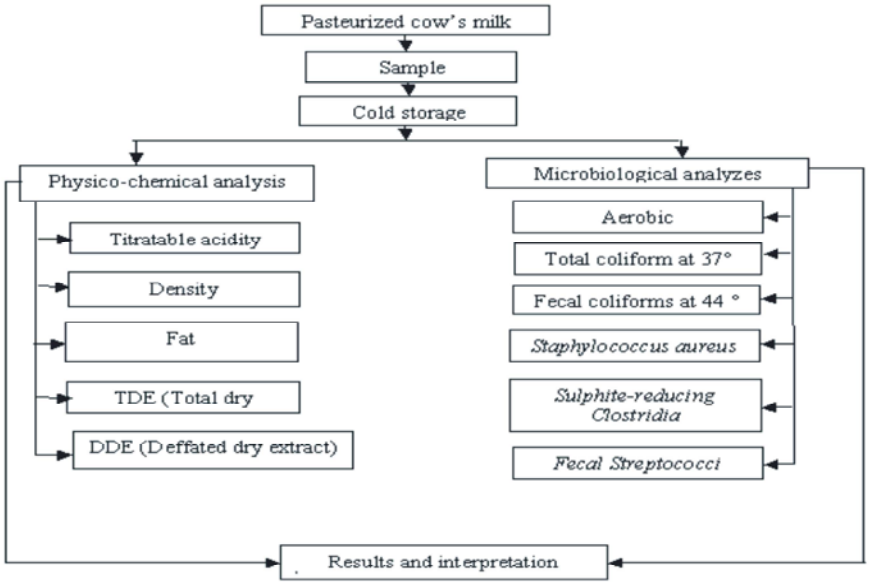
Conducted tests are summarized in the following flow Chart:



Experimental Protocol

Physicochemical Analysis: Acidity was measured by titration with a solution of sodium hydroxide (N/ 9) in the presence of the phenolphthalein at 1 percent, as indicator [6]. Density was calculated by a thermolactodensimeter type Dornic. It is the ratio of masses of a same volume of milk and water at 20°C [7]. Fat was carried out by the butyrometer according to the method described by Abiazar [8]. Total dry extract (TDE) and the defatted dry extract (DDE) expressed as a percentage mass, consist on evaporation method; residue was weighed thereafter [9].

Microbiological Analysis: Germs were examined by total aerobic mesophilic flora (TAMF) at 30°C; enumeration was carried out on agar PCA (Pasteur Institute Algeria) [7]. VRBL agar (Difco) was used to detect TC (Total coliforms) at 37°C and FC (Fecal coliforms) at 44°C [10]. Research of *S. aureus* was made according to Giraud [11] and count using Baird-parker agar (Difco) [12]. Determination of SRC (Sulphite-reducing *Clostridia*) was carried out according to Catsaras and Bourgeois [13]. Whereas, VF agar was used for detecting FS (Fecal streptococci) and counting was done on Roth and Litsky medium [14].

RESULTS AND DISCUSSION

Physicochemical Characteristics of Milks: The results of analyses are summarized in Table 1; they were discussed following the national standard [15].

Table 1: Physicochemical parameters in checked samples of pasteurized milk

Parameter								Total No. of samples	Mean	Standard [15]
TA (°D)	17°		18°		20°		--		17.8°	16° - 19°
	(n=40)		(n=50)		(n=10)		--	n=100		
Density	1.029	1.030	1.031	1.031	1.031	1.031	--		1.030	1.027-1.035
	(n=10)	(n=20)	(n=20)	(n=30)	(n=10)	(n=10)	--	n=100		
Fat g/l	24	27	28	30	--	--	--		27.3	30 - 45
	(n=20)	(n=30)	(n=30)	(n=20)	--	--	--	n=100		
TDE g/l	109.5	115	116.5	118	118.5	119.5	120		117.2	125 - 130
	(n=10)	(n=10)	(n=10)	(n=20)	(n=30)	(n=10)	(n=10)	n=100		
DDE g/l	89.5	90	90.5	91	91.5	92	109.5		92.5	90 - 95
	(n=20)	(n=10)	(n=20)	(n=10)	(n=10)	(n=20)	(n=10)	n=100		

TA= Titratable acidity; °= Dornic degree; TDE= Total dry extract; DDE= Defatted dry extract;

n = number of samples

The large proportion of checking milk (90%) had a titratable acidity (TA) close to standard [15] except for 10 samples; showing a slight elevation. Acidity increase might be due to a high microorganism's number of milk and/or to microorganism's proliferation; that metabolism caused a high production of lactic acid, on one hand and hygienic conditions during milking, on other [7]. According to Schmidt *et al*. [16] as raw milk increased in age TA increased to the upper level; also, augmentation of milk protein content has the same effect.

Concerning milk density, it was in compliance with the national standard. About the fat content of milks, 80% of samples results ranged between 24 and 28g/l; which are below the reference value (Table 1). This is the most variable component of milk [17], its less level might be due to an excessive extraction of fat from raw milk in processing for producing butter. TDE rate of all results are substandard; the dray matter represents all the components of milk except for water and dissolved grasses. The less level of TDE can be explained by milk dilution. For the DDE, according to Veisseyre [18] one liter of milk contains 90 to 95 g; 90% of our results accord with these values which are within the regulatory limit, except ten samples; with high level (109.5g/l). This increase might be due to environmental and dietary factors.

Total Mesophilic Flora and Hygienic Quality: The results of bacteriological analyses are presented in Table 2; they were discussed following the regulatory limit [12].

The microbiological quality control of pasteurized cow milk samples is determined by the count of mesophilic aerobic bacteria, indicators who provide an assessment on the overall level of milk contamination [14]. TAMF permit to appreciating microbial pollution and general quality of food product [18, 19]. The fact that TAMF charges were highest, in 55% of samples, proved that milk pasteurization is not efficient. In practice, an efficient pasteurization process should kill most of pathogen bacteria; however, some bacteria can survive pasteurization and are called thermodurics [20]. Or a possible contamination of the product has been occurred during packaging processes.

Coliform in milk is one of the best indications for judging its sanitary quality [20], thus when in high numbers, coliforms can cause food poisoning [14]. In our study, 63% of samples showed the presence of high level of total coliforms, in disagreement with the Algerian regulation, the rest of milk are considered satisfactory. In Tiaret district, Aggad *et al*. [5] also found a high incidence (31%) of TC in pasteurized cow milk; as well, Shaltout *et al*. [21] and Kunda *et al*. [22] reported an elevated range (22 and 57%, in Jordan and Zambia, respectively). In contrast, Kunda *et al.* [23] revealed a very low count of coliforms (4.8%) in raw milk, because of good hygienic practice. A possible explanation of the high level of TC is the milk contamination after processing; during packaging, or the use of poor quality packaging material. In addition, a probable contamination by polluted added water, after butter extraction, can occur. In fact, the presence of fecal coliforms reflects a recent fecal contamination, because these bacteria live primarily in the external environment [5,24]. Nevertheless, according to Afif *et al.* [25], the existence of coliforms may not necessarily indicate a direct fecal contamination of milk, but more precisely as an indicator of poor hygiene and sanitary practices during milking and further handling.

Fecal coliforms were present in 41% of total samples; while, Aggad *et al.* [5] by checking pasteurized milk in Tiaret district found only 2% of contamination. The presence of these pathogens with a high level seems to be linked to several factors; like failure of

Table 2: Microbiological parameters in checked samples of pasteurized milk

Total samples (N=100)	TAMF	Total coliforms	Fecal coliforms	*Staphylococcus aureus*	*Sulphite-reducing Clostridia*	*Fecal Streptococci*
	Number of colonies (CFU/ml)					
12	$1.4\times1\ 0^{6}$	10^{5}	1.4×10^{4}	Present	Present	150
12	1.2×10^{5}	2.1×10^{4}	1.6×10^{3}	Present	Present	120
10	1.5×10^{5}	10^{4}	Absent	Present	Present	120
12	2.1×10^{5}	1.8×10^{4}	Absent	Absent	Absent	210
08	1.6×10^{4}	3.1×10^{3}	4.1×10^{2}	Absent	Absent	1100
09	1.9×10^{5}	1.8×10^{4}	10^{3}	Present	Absent	460
09	1.7×10^{4}	200	Absent	Present	Absent	1100
09	2.6×10^{4}	1.6×10^{2}	Absent	Present	Absent	240
13	1.3×10^{4}	1.3×10^{2}	Absent	Absent	Absent	1100
06	10^{4}	Absent	Absent	Absent	Absent	460
Standards	10^{5}	10^{3}	10^{2}	Absent	Absent	Absent/0.1ml

pasteurization, the personnel hygiene default, the failure of decontamination protocol of equipment and premises and poor conditions of storage or milk protection. Furthermore, germs' ability to withstand pasteurization, the thermoduric bacteria can limit the shelf life of pasteurized milk [26]. According to Guiraud [11] their presence at an abnormal rate indicates a poor general hygiene.

S. aureus was present in 61% of the checked milks; which is very considerable. Unlike, Leite *et al.* [27] did not detect *S. aureus* in the pasteurized milk in Salvador. Nevertheless, Srairi *et al*. [28] found 30% of contaminated raw milk, in Morocco. The presence of *S. aureus* in milk causes food poisoning; it is one of the most common causes of reported foodborne diseases, which is a major risk to public health [29]. This sanitary problem can occur under certain conditions of heat-stable enterotoxin that can withstand heat treatments [30] or when heat treatment process is ineffective; faulty pasteurization will not destroy all foodborne pathogens [31-33]. Thus, according to Oliver *et al*. [33] the increasing number of reports on detection of foodborne pathogens in pasteurized fluid milk and ready-to-eat dairy products clearly indicates that pasteurization alone is not the final solution for the control of milk-borne pathogens.

The SRC are reported in 34% checked samples. These germs are used as hygiene controls in the microbiological analysis of a number of food products. Their presence in pasteurized milk reflects a failure of pasteurization or contamination after pasteurization. Most of thermoduric bacteria grow slowly in refrigerated milk and are generally outgrown by Gram-negative psychrotrophic species that gain entry primarily as post-pasteurization contaminants [34]. However, in the absence of psychrotrophic bacteria or if large numbers of thermoduric bacteria survive pasteurization; certain thermodurics particularly psychrotrophic spore forming *Bacillus spp.* can grow and cause milk spoilage [35].

The fecal streptococci are potential fecal contamination agents; they are the most commonly used alternative or adjunct to coliform bacteria as faecal pollution indicators [36]. We found these pathogens in all checked samples; which means that contamination occurred, on a large scale, before and / or during milk processing. Fecal streptococci may play a role in food poisoning [20].

At last, with regard to its poor hygienic quality, it appears clearly that checked pasteurized and marketed milk in Tiaret district is strongly similar to the raw milk collected in bad hygienic condition around world [25,31,37-39].

CONCLUSIONS

Pasteurization of milk assures safety for human consumption by reducing the number of live pathogenic bacteria present; thus, the public health benefits of pasteurization are well established. But, our study revealed that checked samples of pasteurized milks were not in compliance with sanitary regulation and its abundance with potential harmful germs constitute a serious health hazard. It is difficult to know if contamination has occurred after an effective pasteurization or it is due to failure of the process.

Consequently, urgent measures are required from the side of the responsible authorities to ensure pasteurization process effectiveness and to survey chain milk production.

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