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SHORT COMMUNICATION

COMPOSITIONAL AND BACTERIOLOGICAL QUALITY OF HEAT TREARTED MILK MARKETED IN NAMIBIA

Bille PG*[1] and S Kaposao[1]

Peter Bille

*Corresponding author email: pbille@unam.na

[1]Department of Food Science and Technology, University of Namibia, Neudamm Campus Private Bag 13301, Windhoek, Namibia.

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ABSTRACT

Production of fresh farm milk in Namibia is low due to the arid climate that prevails in the country, low pasture availability and a high milk demand. This scenario has forced Namibia to import dairy products to meet its needs from neighbouring South Africa, South America and Europe. Namibia imports different brands of fresh full cream milk including Parmalat, Clover, Super milk to add on to its own brands such as Namdairies, UNAM milk and others from private and commercial farms in bulk or in plastic sachets and bottles. Generally, milk quality is determined by its safety, shelf life and nutrition. The presence of different brands of milk makes it difficult for milk consumers in Namibia to choose the brand they would prefer including assessing their value for money. The aim of the project was to determine the quality of full cream milk brands marketed in Namibia by assessing their proximate composition, titratable acidity, pH, protein stability, total plate count and Coliform bacteria as indicator bacteria for the presence of pathogens, using standard dairy procedures and AOAC methods. The results of the study indicated that all imported brands of pasteurised full cream milk in Namibia were not significantly different from each other and were safe and stable, and nutritionally of good quality. They were practically the same in composition and bacteriological quality. Butterfat ranged from 3.4 to 3.7%, density from 1.029 to 1.032g/cm^3, total solids from 12.3 to 13.0%, solids-not-fat from 8.6 to 9.7%, moisture content from 87.10 to 87.70%, acidity as lactic acid from 0.15 to 0.17% and pH from 6.4 to 6.7. The total plate count (TPC) ranged from 0 to 40 cfu/cm^3 and there were no Coliform bacteria found in all the brands. The local products were not statistically different in composition from imported brands, with fat ranging from 3.3 to 3.7%, density from 1.029-1.032g/cm^3, TS from 12.3-12.9% and SNF from 8.6-9.4% though they were not standardized but heat treated. The total aerobic counts and Coliforms were the same as those of imported milk brands. The statistical analysis showed that there were no significant differences at $p<0.05$ among the brands and between the brands of the imported and local milk in Namibia as they were all within the South African Standard Specifications. All the brands were, however, regarded as good, stable and safe for consumption.

Key words: Milk, Composition, Bacteriology, Safety, Quality

INTRODUCTION

The human population in Namibia has been increasing over the years and the demand for food is also increasing proportionally, especially for milk products. Milk products provide nutrients that are essential to the human diet, growth and health [1]. As such, a large number of people consume milk or milk products, from new born babies to adults. This makes it vital to keep these products wholesome, safe, fresh, clean and free from contamination with spoilage and pathogenic micro organisms at all times [2, 3, 4, 5, 6, 7].

Raw milk contains hardly any microorganisms as it leaves the udder of a healthy cow but the number increases rapidly in an unhygienic environment related to poor handling, inappropriate milking systems, unclean water and containers and from the uncleaned exterior of the udder [3, 7]. Milk needs to be chilled soon after harvesting in order to preserve it for further treatment [7].

Pasteurization means heating at 72^{o}C/15 sec. by high temperature short-time (HTST) or 65^{o}C/30 min. by long-time low temperature (LTLT) methods, respectively and cooling to 4-5^{o}C. Ultra-High-Temperature (UHT) means heating at higher temperatures for an extremely short time 135-145^{o}C/2 sec. and promptly cooling to room temperature. These processes are applied to liquid foods such as milk to render them safe for human consumption, improve texture and flavour and to prolong shelf life by eliminating microorganisms and enzymes that tend to spoil the foods [8, 9, 10]. Pasteurization causes minimal physical, chemical and organoleptic changes in milk [11]. Such milk, if properly processed and handled, can have a shelf-life exceeding 14 days for pasteurized products stored in a refrigerator and 6-9 months for UHT products stored at room temperature [4, 12]. Namibia imports processed milk from South Africa, Europe and South America such as Parmalat, Clover, Supermilk and Hom'Sek, apart from its own local products from Namdairies milk, Unam milk and milk from private farms.

Milk is a complex biological fluid consisting of fats, proteins, minerals, vitamins, enzymes and sugars and these are the reasons for spoilage as microorganisms feed on them [1, 13]. However, raw milk composition can vary quite considerably depending on the number of factors such as the breed of the animal, stage of lactation, the nutritional quality of feeds, frequency of milking, diseases, their activities and general environment. The average milk composition figures are thus given as follows; fat 3.5%, protein 3.2%, lactose 4.7%, ash 0.72%, casein 2.8%, whey proteins 0.6% and water 87.50% [8, 9, 10].

The predominant spoilage microorganisms found in pasteurized and chilled milk are gram negative psychrotrophic or psychrophilic bacteria. The common species belong to the genus *Pseudomonas, Flavobacterium* and *Alcaligenes*, as well as some members of the Coliform groups [4, 12]. When heat-treated chilled milk becomes spoiled, it can be detected organoleptically as it curdles with sweet or bitter taste, low acidic flavour and rancid taste and has bad smell due to the activities of psychrotrophic bacteria. The rate of microbial growth and quality deterioration of the

products are influenced by the number and types of bacteria in the freshly pasteurized products and the storage temperatures [4, 10, 12]. The common pathogenic bacteria that are passed through milk are Mycobacterium, which are responsible for spreading Tuberculosis [14, 15, 16, 17, 18, 19]. This occurs mostly in poor countries due to the poor health status of animals, hygiene and sanitation [15, 17]. However, this bacterium can easily be destroyed by the right pasteurization temperatures [17, 18, 19]. Other countries have a problem with *Listeria monocytogenes* that tends to multiply and cause milk spoilage [20, 21]. The objectives of this study were therefore to determine the compositional and bacteriological quality of full cream heat treated milk brands marketed in Namibia in order to compare their stability, nutritional value, safety and shelf life for consumer quality assurance.

MATERIALS AND METHODS

Raw materials

The seven brands of heat treated milk mentioned earlier were purchased randomly in triplicates in 500 mL cartons, plastic bottles and sachets from groceries, supermarkets and from the local farms in Windhoek, Namibia and delivered to the laboratory in a cool box for analysis according to IDF [22]. The chemical analysis and bacteriological counts were carried out within 3 h of sample collection at the University of Namibia, Neudamm campus, in the Department of Food Science and Technology.

Chemical characteristics of milk brands

The common brands of heat treated full cream milk bought in Windhoek, Namibia and the local products were analysed for proximate composition using the standard dairy analytical procedures [2, 23, 24, 25, 26] for butter fat contents (BF), density (D), total solids (TS), solids-not-fat, (SNF), moisture contents, titratable acidity expressed as lactic acid, pH and protein stability tests. Fat content was determined by the Gerber technique and density by a lactometer calibrated at 20^{o}C. Total solids (TS) were determined by the dairy formula: TS=D/4 (BF x 1.22) + 0.72. The SNF values were obtained by subtracting the BF contents from the TS values. The pH of the samples was measured using a calibrated pH meter with a standard glass electrode. Acidity was determined by titration using the method of Case *et al.* [23]. Protein stability was determined by Alcohol (68%) and Clot-On-Boiling tests.

Enumeration of total plate counts and Coliform

Only total aerobic plate counts (TPC) and Coliform counts were determined in each brand of local and imported full cream milk. Ten ml of each sample was diluted in 90 ml of sterile Ringer's solution and mixed thoroughly. One ml of each sample was serially diluted using sterile quarter-strength Ringer's solution and appropriate dilutions were then plated using pour-plate method, as described by Vanderzant and Splittstoesser [12] and Harrigan and McCance [27]. Total aerobic counts were determined on Eugon's Agar (Oxoid, Unipath Ltd, Hampshire, England) while Coliform counts were carried out on Red Bile Agar, incubated at 37±1^{o}C for 48 h. Confirmation of the presence of Coliform was carried out in 2% Brilliant Green Bile

Broth with inverted Durham tubes incubated at 45°C. Evolution of gas and production of acid were considered as positive results for Coliform.

Statistical analysis

All determinations were carried out in triplicates. Mean values and standard deviations were calculated. Analysis of Variance (ANOVA) was performed and separation of the mean values was carried out by Duncan's Multiple Range Test at $p<0.05$, using statistical package for social sciences (SPSS) software, version 10.0 (SPSS Inc; Chicago, Illinois, USA).

RESULTS

Proximate composition of milk brands in Namibia

Proximate composition and bacteriological quality of both imported and local full cream heat treated milk brands bought from supermarkets and shops in Namibia are summarized in Tables 1 to 3.

The BF content of imported full cream heat treated milk ranged from 3.3 to 3.4% fat (3.5-3.7%) with local in brackets (Table1). The results of the densities of all the brands were similar and also within the required range of 1.029 to 1.032 g/cm^3 (1.029-1.032g/cm^3). Total solids contents ranged from 12.5 to 12.9% (12.3-12.4%) and SNF from 8.6-9.0%. The moisture contents of all milk brands of full cream milk were 87.1%-87.5% (87.6-87.7%) and they were determined by difference (100-TS). The results indicated that the moisture contents of all brands were within the normal range, and therefore, results were satisfactory. The SNF of the brands samples were determined by subtracting TS from BF (TS-BF).

The titratable acidity ranged from 0.15%-0.16% (0.15-0.18%) and pH from 6.5-6.6 (6.4-6.5), respectively, while clot-on-boiling and alcohol tests were negative in both the imported and local brands with no flocculation, indicating that proteins were stable (Table 2). The above results indicated that the proximate composition of all the brands were not significantly different ($p<0.05$), they were practically the same, within the normal range and were therefore considered satisfactory.

Bacteriological characteristics

The total aerobic counts (TPC) and Coliform counts on all the samples of full cream heat treated milk brands are summarised in Table 3. According to the South African Bureau of Standards [28], heat-treated milk should not contain colonies exceeding 50 cfu/cm^3 and should be free of Coliform. Ultra-High-Temperature (UHT) milk should have none of these bacteria. The results indicated in the current study were obtained from dilution 10^{-1} plates. There was no growth of Coliform or total aerobic counts on the TPC dilutions 10^{-2} and 10^{-3}. The dilution 10^{-1} of TPC showed colonies below 50 cfu/cm^3. A few of the local brands had an average of 4 x10^1 bacteria while others were 2 x10^1 cfu/cm^3. The results from all the total plates counted were less than 50

cfu/cm^3 and with no Coliform. Therefore, all the brands were not significantly different ($p<0.05$) and they complied with the South African Standard Specifications [28].

DISCUSSION

Consumers of fresh full cream milk brands in Namibia requested to know the quality of the imported and local brands in order to be assured of what they were purchasing in terms of nutrition, safety and shelf life. This was brought to the attention of the University of Namibia, Food Science Department, Neudamm Campus. The Department embarked on quality assessment on behalf of the consumers. The proximate composition, pH, acidity and density results of all full cream heat- treated milk imported and local products in Namibia were determined. The quality of the imported brands was quite good, they were not significantly different ($p<0.05$) and fell within the required ranges as confirmed by the analyses carried out and compared to the South Africa Standard Specifications [28]. Surprisingly, the local milk brands were within the specifications, though they were not standardized, as most of them originate from Friesians cows, which are known to produce milk with low butterfat content [3,8,9]. Butterfat of imported milk brands ranged from 3.4 to 3.5 %, which is normal for standardized milk. Densities ranged from 1.029 to 1.032g/cm^3, total solids content ranged from 12.3 to 12.9%, solids-not-fat ranged from 8.6-9.5% and moisture content ranged from 87.1 to 87.7%, indicating that all the imported brands were normal and were within the specifications. The local milk, however, had variable results but within the specifications due to non-fat standardization and probably due to some adulteration (Fig.1). Un-standardized milk should have higher butterfat content than milk of imported brands and should range from 4-6% [3,8.9]. Since the butterfat content of milk from the local producers appeared not to be significantly different from the imported milk brands, the obvious and speculated reasons could be that some of the local milk brands were obtained from cows with low butter fat contents such as Friesians cows, as in the case with UNAM milk. Titratable acidity of imported and local milk ranged from 0.15 to 0.17% while pH ranged from 6.4 to 6.6, which were normal (Table 2). Clot-on-boiling and alcohol tests were negative in all the brands, including the local milk, indicating that proteins were stable in all the brands and they were all fresh.

In terms of total aerobic counts and the Coliform, there was no indication from the results to doubt the safety and shelf life of the products as they were all within the legal standards. There were no Coliform counts in all the plates of the imported and local brands. This indicated that there were no pathogens or spoilage microorganisms in all the brands tested.

These results were not significantly different (0.05), they were satisfactory and safe for consumption. All the brands complied with the South African Standard Specifications [28]. The UNAM milk and other local brands were pasteurized in sealed plastic bottles and in sachets and were free from micro-organisms but were not standardized for fat. This showed that all the heat treated full cream milk brands sold

in Namibia, whether UHT or Pasteurized milks coming from different plants and countries, were processed according to the standard procedures, rules and regulations according to South African Bureau of Standards [28]. These results confirm that the products were of acceptable quality in all aspects. Consumers should, therefore, not be worried about the quality of the brands or the type of milk to buy, as they were all nutritionally sound, safe and stable.

CONCLUSION

The quality of imported heat treated full cream milk brands marketed in Namibia were within the standard rules and regulations of South African Bureau of Standard [28]. There were, however, some small variations in the quality of local brands as they were not standardized, but statistically they were not different. Composition and bacteriological qualities of both local and imported full cream heat-treated milk analysed were statistically the same. They were safe, stable and of high nutritional quality. Thus, the Ministry of Health and Social Services as well as the health inspectors are commended for their good work of ensuring safety and quality of both local and imported dairy products in Namibia.

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Table 1: Mean proximate composition & SD

Milk brands	BF%	Sp Gr	TS%	SNF%	Moisture%
Parmalat	3.4±0.1	1.032±0.02	12.9±0.03	9.5±0.01	87.1±0.04
Clover	3.4±0.1	1.032±0.02	12.9±0.03	9.5±0.02	87.1±0.04
Super Milk	3.5±0.2	1.032±0.02	12.5±0.04	9.0±0.02	87.5±0.01
Hom'Sek	3.7±0.4	1.029±0.03	12.3±0.03	8.6±0.04	87.7±0.02
Namdairies	3.5±0.1	1.032±0.01	12.9±0.03	9.4±0.03	87.1±0.04
Unam milk	3.6±0.3	1.032±0.02	12.4±0.03	9.0±0.03	87.6±0.01
Private Farms	3.7±0.4	1.029±0.03	12.3±0.03	9.0±0.03	87.7±0.01

Note that: All the brands were not significantly different and were within SA Standards. Unam and Private farm milk were not standardized but were from Friesian cows.

Table 2: Mean pH, Acidity, Clot-On-Boiling and Alcohol Tests

Milk brands	pH	Acidity%	COB/Alcohol
Parmalat	6.5±0.1	0.15±0.02	-Ve
Clover	6.6±0.2	0.16±0.01	-Ve
Super milk	6.5±0.1	0.16±0.01	-Ve
Hom'Sek	6.4±0.3	0.17±0.02	-Ve
Namdairies	6.5±0.1	0.16±0.01	-Ve
Unam milk	6.5±0.1	0.15±0.02	-Ve
Private Farms	6.4±0.1	0.18±0.02	-Ve

Note that: All the above were within normal range and not significantly different

Table 3: Range SPC and Coliforms counts (log cfu/cm^3)

Milk brands	TPC	Coliforms
Parmalat	$0.0x10^1$-$1.0x10^1$	Absent
Clover	$0.0x10^1$-$1.0x10^1$	Absent
Supper milk	$0.0x10^1$-$1.0x10^1$	Absent
Hom'Sek	$2.0x10^1$-$4.0x10^1$	Absent
Namdairies	$2.0x10^1$-$4.0x10^1$	Absent
Unam milk	$2.0x10^1$-4.0x1	Absent
Private farms	$2.0x10^1$-$4.0x10^1$	Absent

Note that: Parmalat, Super milk and Clover milk were UHT milk & the rest were Pasteurized milk in cartons, plastic bottles & sachets

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