JOURNAL OF SCIENCE & DISEASES

Evaluation of the quality of concentrated milk consumed in the city of Yaoundé

Evaluation des laits concentrés consommés dans la ville de Yaoundé

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Original Article

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ABSTRACT

Introduction: Condensed milk is widely consumed in Cameroonian cities due to its accessibility. This research assesses the safety and quality of condensed milk available in Yaoundé to address these public health concerns.

Methodology: The study was cross-sectional and analytical. A census of different brands of sweetened condensed milk was made with the aim of collecting samples in supermarkets and local markets in the city of Yaoundé in Cameroon. To do this, we were interested in sanitary quality control through a series of physico-chemical analyses, microbiological analyses and sensory analyses using CODEX and ISO standards.

Results: A total of nine separate brands were collected from the city's markets. Most of the physico-chemical parameters complied with the standards. Labelling compliance was 88.9% (8/9), with one brand having no information on the manufacturer. We observed that the milks had an acceptable creamy-white colour (55.6%); brown (22.2%) indicating thermal alteration/degradation; non-dairy odours (77.8%) and excessive sweetness (44.4%). Most pH values (55.6%) were within the standard range (6.5-6.7). Microbiological tests revealed the presence of Staphylococcus aureus in all the samples studied, while total coliforms, E. coli, Salmonella, yeasts and moulds were absent in all samples.

Conclusion: While these results indicate effective pasteurization, the universal presence of Staphylococcus aureus and significant sensory deviations from Codex Alimentarius standards highlight critical gaps in hygiene and storage. Ultimately, systemic improvements in the cold chain and sanitary protocols are essential to rectify quality inconsistencies and mitigate public health risks.

RESUME

Introduction : Le lait concentré constitue une denrée largement consommée dans les centres urbains du Cameroun du fait de son accessibilité. Cette étude vise à évaluer la qualité et la sécurité sanitaire du lait concentré commercialisé à Yaoundé pour répondre à ces enjeux de santé publique.

Méthodologie : Une étude transversale a porté sur neuf marques de lait concentré. Des analyses physico-chimiques, microbiologiques et organoleptiques ont été réalisées conformément aux normes du Codex Alimentarius et de l'ISO.

Résultats : Au total Neuf marques distinctes ont été collectées dans les marchés de la ville. La plupart des paramètres physico-chimiques sont conformes aux normes. La conformité de l'étiquetage était de 88,9 % (8/9) avec une marque qui présentait l'absence d'informations sur le fabricant. Nous avons observé que les laits présentaient une couleur blanc-crème acceptable (55,6 %), brunes (22,2 %) indiquant une altération/dégradation thermique ; odeurs non laitières (77,8 %) ; une sucrerie excessive (44,4 %). La plupart des valeurs (55,6 %) de pH étaient dans la plage standard (6,5–6,7). Par ailleurs, les tests microbiologiques ont mis en évidence la présence Staphylococcus aureus dans tous les échantillons étudiés, contrairement aux Coliformes totaux, E. coli Salmonella Levures et moisissures qui étaient Absents dans tous les échantillons

Conclusion : Les résultats témoignent d'une pasteurisation efficace. La présence universelle de Staphylococcus aureus et les écarts sensoriels importants par rapport aux normes du Codex Alimentarius soulignent des lacunes en matière d'hygiène et de stockage.

Introduction

Milk is a globally recognized source of essential nutrients, including proteins, fats, vitamins, and minerals, playing a critical role in meeting the dietary requirements of diverse populations [1]. In Cameroon, condensed milk has emerged as a dietary staple in urban centers like Yaoundé, favored for its affordability, convenience, and extended shelf life [2]. Furthermore, rapid urbanization and evolving consumer preferences have fueled the demand for processed dairy products, particularly in resource-limited settings [3].

However, the quality of these products is often compromised by unregulated production practices, inadequate storage conditions, and inconsistent adherence to food safety protocols [2]. Substandard quality control poses significant public health risks, primarily due to microbial contamination and the presence of hazardous substances common in informal dairy markets [4]. Research across Sub-Saharan Africa highlights persistent risks in informally processed dairy, including pathogenic bacteria (such as Salmonella and Escherichia coli) and antibiotic residues resulting from poor hygiene and the non-therapeutic use of antibiotics in livestock [5].

On a global scale, major food safety crises such as the 2008 melamine contamination incident and reports from the U.S. Food and Drug Administration (FDA) regarding the misuse of antibiotics underscore the critical public health implications of substandard dairy safety regulations [6]. In Cameroon, inadequate infrastructure and traditional processing methods amplify these risks, particularly for urban consumers who rely on condensed milk . Given these concerns this study therefore aims to evaluate the quality of concentrated milk consumed in Yaoundé by assessing its physicochemical and microbiological composition, as well as identifying risk factors associated with milk quality .

Materials and Methods

This study employs an analytical research design. Samples were collected from various retail points, including supermarkets, local markets, and informal street-food stalls, locally known as 'tourne-dos'. The experimental part of our work was done at the Multidisciplinary Laboratory of the Department of Galenic Pharmacy and Pharmaceutical Legislation of the Faculty of Medicine and Biomedical Sciences of the University of Yaoundé I. Our study was conducted over a period of eight-month, from October 2024 to June 2025. The target population is made up of consumers of concentrated milk, milk vendors, and the consumers in Yaoundé and All the milk selled in Yaoundé. The study included condensed milk products sold across the identified retail outlets in Yaoundé. Exclusion was applied to any samples past their expiration date or those exhibiting physical

damage to the container. To evaluate the quality of concentrated milk consumed in Yaoundé, a comprehensive research study was conducted. The study employed a comprehensive analytical approach, utilizing structured scorecards for sensory evaluation and adhering to Codex Alimentarius and Pharmacopoeia standards for laboratory testing. The physicochemical assessment was categorized into four primary analyses: labeling compliance, pH measurement, total solids determination, and milk fat content. These are the different materials used in the physicochemical analysis.

Labelling compliance based on compliance with the criteria of the CODEX STAN 1-1985 [7] and CODEX STAN 206-1999 standards [8]. Measuring pH using an electronic pH meter and buffer solutions. Based on the ISO-2917:1999 standard [9]; compliant samples are those with a pH between (6.5-6.7). pH below 6.5 indicates acidity, while a pH above 6.7 indicates basicity. For the organoleptic criteria, the operating mode for conducting evaluations involves systematic sensory testing by trained panels or consumers by predefined attributes (appearance, odour, taste, texture, colour) using a standardized scoring system (e.g. a scale from 1 to 5 or 1 to 10). The evaluations were conducts in a controlled environment with neutral lighting and minimal distractions. Samples should be presented in identical containers to avoid bias.

The microbiological quality of the samples was evaluated through the enumeration of Staphylococcus aureus, coliforms, Escherichia coli, yeasts, and moulds, as well as the detection of Salmonella spp. These analyses adhered to international standards, including Codex Alimentarius and specific ISO protocols (ISO 6888-1, ISO 6579, ISO 4831, ISO 16649-2, and ISO 21527-1). For statistical validity, colony counts were performed on plates containing a minimum of 15 colonies. The final microbial load, expressed in Colony-Forming Units per gram (CFU/g), was calculated based on the number of colonies observed, the sample mass (25g), and the respective dilution factors.

$$CFU/g = \frac{Number\ of\ colonies}{Mass \times dilution\ factor}$$

The data was recorded in Excel (Microsoft Excel 2016), we analysed our data using Excel 2019 software, the graphs and tables were made on Excel 2019. To complete our studies, we obtained ethical clearance from the institutional ethics and research committee of the Faculty of Medicine and Biomedical Sciences of the University of Yaoundé I and a research authorization from the Multidisciplinary Laboratory of Galenic Pharmacy and Pharmaceutical Legislation.

Results

I.   The samples collected

The study evaluated nine distinct brands: Latteo, Djatou, O'la, Pavani, Top Saho, Broli, Nestlé, Omit, and Belle France. Samples were procured from various retail outlets, including Acacia Market, Santa Lucia, Carrefour Market, Dovv, and local shops. Distribution of purchases showed that 33.33% of the brands were sourced from Acacia Market, followed by 22.22% each from Carrefour Market and Santa Lucia. The remaining 11.11% were obtained from Dovv and smaller retail stores, respectively.

II.   Physico-chemical characteristics

1.   Labeling compliance control

The labeling compliance results indicate that 88.9% of the concentrated milk samples collected in our study adhered to labeling regulations.

Table I: Label compliance

No.	Brands	Nutritional declaration	Country of origin	Special storage instructions	Net content	Sales name	address of manufacturer	Date of manufacture	Expiry date	Lot No.	Obs.
1	Latteo	P	P	P	P	P	P	P	P	P	C
2	Djatou	P	A	P	P	P	A	P	P	P	NC
3	O'la	P	P	P	P	P	P	P	P	P	C
4	Pavani	P	P	P	P	P	P	P	P	P	C
5	Top Saho	P	P	P	P	P	P	P	P	P	C
6	Broli	P	P	P	P	P	P	P	P	P	C
7	Nestle	P	P	P	P	P	P	P	P	P	C
8	Omit	P	P	P	P	P	P	P	P	P	C
9	Belle france	P	P	P	P	P	P	P	P	P	C

Legend: P: present; A: absent; NC: non-compliant; C: compliant

2.   Organoleptic criteria

The sweetened condensed milk samples exhibited varying organoleptic characteristics. Specially, in terms of color, 55.6% were creamy white, while 22.2% were brown and another 22.2% were white. Moreover, the odour profile showed a dominance of non-milky notes in 77.8% of samples, whereas 22.2% had a milky odour suggesting possible contamination or spoilage. Furthermore, the taste was predominantly sweet and milky in 55.6% of samples, whereas 44.4% were perceived as too sweet. Sensory evaluation identified a bitter aftertaste in 11.1% of the products. Furthermore, the physical consistency of the samples was heterogeneous, predominantly fluid (44.4%), followed by thick (33.3%) and semi-fluid (22.2%) textures.
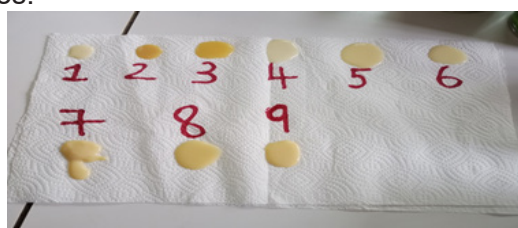

Figure 1 : Colors of differents condensed milk samples

3.   pH measurement

The analysis of our nine milk samples reveals that 55.6% (5/9) of samples fall within the acceptable range, indicating proper processing and storage conditions.

III.   Microbiological analysis

1.   Total coliforms

These results show 100% of satisfactory samples for Escherichia coli and coliforms. Indicating a strong level of microbiological safety in the products available in Yaoundé.

2.   Salmonella

All samples were with satisfactory results suggesting that there is no significant contamination with this pathogen in the products available in Yaoundé.

3.   Yeast and Molds

Table II: Yeast and Molds counts in concentrated milk

Samples ID	Enumeration (CFU/g)	Observations
Latteo	Negative	Absent
Djatou	Negative	Absent
O'la	Negative	Absent
Pavani	Negative	Absent
Top Saho	Negative	Absent
Broli	Negative	Absent
Nestle	Negative	Absent
Omit	Negative	Absent
Belle France	Positive	Present

According to the results of Table out of 9 samples, 11.1% tested positive for mold contamination, while 88.9% showing no growth.

4.   Staphylococcus aureus

Table III: Staphylococcus aureus in sweetened condensed milk

Samples ID	Observation	Results
Latteo	Positive	Present
Djatou	Positive	Present
O'la	Positive	Present
Pavani	Positive	Present
Top Saho	Positive	Present
Broli	Positive	Present
Nestle	Positive	Present
Omit	Positive	Present
Belle France	Positive	Present

According to the results of this table, all samples showed unsatisfactory results indicating a pervasive contamination issue within the products available.

Discussion

The identification of only nine distinct condensed milk brands across Yaoundé's diverse commercial landscape highlights a significant trend in market structure and product availability. These results differ

from those presented by ACDIC [12], which had identified six condensed milk brands in Cameroon. Despite extensive sampling across various retail formats, including supermarkets (Carrefour, Santa Lucia, Dovv) and traditional markets (Acacia), the limited diversity suggests a highly concentrated market and an organized distribution circuit as cited by ACDIC [12]. This concentration may be attributed to import regulations, logistical distribution challenges, or established consumer preferences. Acacia Market served as the primary procurement site (33.3% of samples), followed by Carrefour Market and Santa Lucia (22.2% each), while Dovv and neighborhood shops offered more restricted selections (11.1% each). Notably, this comprehensive survey conducted across different socioeconomic zones revealed a remarkable consistency in brand availability, regardless of the retail location.

The high compliance rate (88.9%) with labeling requirements among condensed milk brands in Yaoundé indicates generally effective regulatory oversight and manufacturer adherence to international standards. These results may be explained by the requirement that the importation of dairy products is subject to compliance with the labeling standard for prepackaged food products, which came into force in December 2001 [12]. However, the identification of one non-compliant product, lacking essential traceability information, reveals some gaps in market surveillance mechanisms that could pose public health risks.

The finding that only 55.6% of samples exhibited the standard creamy white color mandated by Codex Alimentarius [10] indicates significant quality inconsistencies in the market. The presence of brown discoloration in 22.2% of samples is particularly concerning, as it suggests advanced Maillard reactions or caramelization processes that typically occur during improper processing or storage, especially relevant in Cameroon's tropical climate where high temperatures could accelerate such reactions. These color deviations are not merely aesthetic concerns but are often correlated with nutritional deterioration through lysine blockage and the potential formation of undesirable compounds.

The predominance of non-milky odors (77.8%) represents another significant deviation from expected quality parameters, as condensed milk should retain characteristic dairy notes according to ISO 22935-2:2009 sensory evaluation standards. This observation suggests possible protein denaturation, lipid oxidation, or contamination issues that warrant further investigation. This finding is consistent with previous studies by Schiano et al. [11]. Texture variations across samples (44.4% fluid, 22.2% semi-fluid, and 33.3% thick) indicate potential standardization issues in manufacturing processes or

age-related changes in product structure. According to IDF guidelines, condensed milk should maintain consistent viscosity parameters; the observed variations suggest inadequate quality control during production or potentially different formulations despite similar product categorization.

According to the standard CODEX [10], concentrated milk should maintain a pH range between 6.5 and 6.7. The analysis of our milk samples reveals that 55.6% of the samples fall within the acceptable range, while the remaining 44.4% show pH levels below the acceptable interval, thus indicating high acidity. This may be due to bacterial fermentation, early spoilage, or an increase in storage temperature, as indicated by Webb et al [15].

The detection of *Staphylococcus aureus* in all nine condensed milk samples raises serious concerns about food safety. These results differ slightly from those presented by MAÏWORÉ et al. [13], who found 70% of raw milk samples contaminated with staphylococci. This pathogen is known for its ability to cause foodborne illnesses, often linked to improper handling or insufficient hygiene practices during production and processing. The presence of Staphylococcus aureus indicates that there may be significant gaps in quality control measures, particularly in hygiene and sanitation [13], which could expose consumers to health risks. This bacterium can multiply at pH values ranging from 4.2 to 9.3, with an optimal growth between 7 and 7.5 and under temperatures ranging from 6–46°C according to PUJOL-DUPUY et al [16]. Staphylococcus aureus is a commensal bacterium of the skin of animals and humans. Healthy carriage exists in both humans and animals. In humans, the nasal cavities are considered the most frequent site of carriage, but the bacterium can also be found on the skin, scalp, throat, and intestine. Contamination of human skin therefore occurs mainly through the nose and the intestine. These results can thus be explained by poor hygiene conditions, inadequate preservation or contamination of the working environment. This finding underscores the need for improved training of dairy handlers and strict adherence to sanitary protocols to reduce contamination risks.

The absence of Salmonella spp. in all analyzed samples is a positive indicator of the microbiological safety of condensed milk in Yaoundé. As a critical enteric pathogen associated with severe foodborne illness, the non-detection of Salmonella spp. suggests that producers are likely adhering to effective pasteurization protocols and hygiene standards. These results differ from those of MAÏWORÉ et al. [13], who found 20% of their samples contaminated with salmonella under ordinary conditions. Nevertheless, continuous surveillance remains imperative, given the serious public health risks associated with sporadic

contamination.

The results show an absence of total coliforms and Escherichia coli in all samples. These results differ from those of MAÏWORÉ et al. [13], who found 30% of their samples contaminated with total coliforms under ordinary conditions. Total coliforms serve as primary indicators of sanitary quality and fecal contamination; their absence suggests that the manufacturing environment and processing chain maintain high sanitation levels. More specifically, the absence of Escherichia coli (a significant pathogen linked to gastrointestinal disease) underscores the effectiveness of current quality control measures within the industry.

Regarding fungal contamination, 11.1% of samples tested positive for yeasts and molds. These results are very low compared to those presented by MAÏWORÉ et al. [13], who found 80% of their samples contaminated. This may be explained by post-processing contamination or inadequate storage and handling practices. Mold proliferation not only leads to organoleptic spoilage but also poses a potential risk of mycotoxin production [14]. This localized incident highlights the need for rigorous monitoring of storage conditions and the implementation of robust distribution practices to prevent spoilage.

Conclusion

This study assessed the physicochemical and microbiological quality of condensed milk in Yaoundé. The findings reveal high labeling compliance and a total absence of enteric pathogens, indicating effective pasteurization. However, the universal presence of Staphylococcus aureus and significant deviations from Codex Alimentarius sensory standards highlight critical gaps in handler hygiene and storage conditions.

Ultimately, while the milk is free from fecal contamination, systemic improvements in the cold chain and sanitary protocols are essential to rectify sensory inconsistencies and mitigate the public health risks associated with staphylococcal contamination. These findings highlight the need for improved quality control measures in the production and handling of concentrated milk to ensure consumer safety and compliance with regulatory standards.

Conflicts of interest: No conflict of interest exists between the authors and the research concerned.

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