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Research Article

The Impact of Various Packaging Materials on the Physical and Chemical Characteristics of Pasteurized Camel Milk

Ahmed Elghali Mohamed Khalil[1]*, Ahmed Eltigani Almansoori[2], Mohamed Abdelsalam Abdalla[1] and Abdel Moneim Elhadi Sulieman[3]

[1]Department of Preventive Medicine and Public Health, College of Veterinary Medicine, Sudan University of Science and Technology, Sudan

[2]Al Rawabi Dairy Company, Dubai, United Arab of Emirates

[3]Department of Food Engineering, Faculty of Engineering and Technology, University of Gezira, Wad-Medani, Sudan

***Corresponding Author:** Ahmed Elghali Mohamed Khalil, Department of Preventive Medicine and Public Health, College of Veterinary Medicine, Sudan University of Science and Technology, Sudan.

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Abstract

Objective: This research was done to examine the impact of various packaging materials on the physiochemical characteristics of pasteurized camel milk.

Methods: In the current study, a variety of packaging materials were used, including (i) PET bottles, (ii) PP cups, (iii) PS cups, (iv) LDPE bottles, (v) LPET bottles, (vi) HDPE bottles, (vii) aluminum cans, (viii) emerald green glass, and (ix) cartoon bottles (250 ml size). During the summer and winter, pasteurized camel milk samples were aseptically packed in a variety of packaging materials under aseptic conditions (80°C, 16s). They were put in the refrigerator and kept there for 30 days at 5°C. The study investigated the physiochemical parameters including density, pH, acidity, protein, fat, lactose, (TS), (S-N-F), and lactose. The overall migration of the food product from the packaging was also calculated for each package.

Results: The results indicated variations in almost all physicochemical properties of pasteurized camel milk packed in various packaging materials. On the other hand, the season did not affect the values of the tested physicochemical properties. Furthermore, all packaging materials showed chemical migration from the packaging to the food product in the range of 1.25 to 2.05 (mg/dm^2) according to the overall migration test of the food packaging materials. Still, the migration limit was less than the limit of 10 (mg/dm^2 of the European Union Standards and complying with the UAE regulations.

Conclusion: In conclusion, we should consider the significance of packaging barrier physicochemical qualities and make our choice in accordance with the nature of the product when selecting the right packing materials for camel milk.

Keywords: *Polypropylene (PP); Polystyrene; Protein; Density; Total Solids; Acidity; Overall Migration*

Introduction

A new food idea needs to be established because life standards, hygiene, diet, and the usage of antibiotics and other antimicrobial chemicals have changed and complicated over the past ten years. It has long been understood that some unusual foods, such camel milk and foods and beverages with added vitamins, provide specific health advantages. It's interesting to note that they have lately been changed to include characteristics that prevent disease in addition to their unique functional health advantages. Functional meals have also been conceptualized and their varieties have grown to become some of the most well-liked foods worldwide.

In dry areas, camel milk is crucial for human sustenance; nonetheless, it is typically described as opaque-white, frothy, sweet, and sharp, but occasionally salty [4]. Due to rising demand in recent years, there is a general need to introduce various functional items made with camel milk on the market [4]. These products must have clear scientific backing and clinical validation. Many experts believe that some of camel milk's health benefits for consumers can be attributed in part to its vitamin makeup [8]. In addition, Camel milk is well known for its mineral richness [11]. Camel milk has higher potassium, magnesium, iron, copper, manganese, sodium, and zinc concentrations than cow milk [33].

Food processing and food preservation processes depend heavily on food packaging. It performs a variety of tasks, the most crucial of which is preservation. Other tasks it does include containment, convenience, and communication. Packaging safeguards the contents against environmental, physical, chemical, and mechanical risks (light, oxygen, moisture, etc.), the loss of taste components that contribute to attractive flavors or the acquisition of unpleasant aromas, and contamination from germs, insects, or rodents during storage and delivery. By comparing the impact of several types of packing materials on the physiochemical qualities of the milk, this study seeks to identify the ideal packaging materials for pasteurized camel milk to reach the final consumer with excellent nutritional values.

Materials and Methods

Study area

The Emirates Industry for Camel Milk and Products is the first large-scale dairy camel farm in the world. It is located in the Um Nahad 3 neighborhood of Dubai, United Arab Emirates (25° N, 55° E). The farm's animals, which were of various breeds or ecotypes, ranged in age from five to nineteen and varied in parity. In open paddocks, camels were housed in herds of 12 to 24 animals. Partially weaned calves were kept in nearby paddocks with their mothers for the duration of lactation. After every milking, they were permitted to breastfeed. The typical daily ration was provided via feeding carts and included 5 to 6 kg of wheat bran and 6 to 7 kg of alfalfa hay (15% CP).

Sample preparation and handling

At 6 a.m., sterile steel containers containing pasteurized camel milk (80°C, 16s) were picked up at the Emirates Industry of Camel Milk and Products Company factory in Umm Nahad 1. It was delivered to the Al Rawabi Dairy Company's quality control facility in ice boxes. In the plant laboratory, the milk was aseptically distributed into pristine bottles, cups, cans, and coated paperboard cartons. Plastic bottles with polyethylene twist closures, glass bottles with crown caps, and cups with pail lids were used to close the bottles. The production line sealer was used to close coated paperboard boxes, and all packing materials were 250 ml in size. For a duration of u, the filled packaging materials were kept in the refrigerator at 5°C; pasteurized samples of camel milk 250 ml.

Packaging materials

The plastic packaging components, including polyethylene terephthalate (PET), polypropylene (PP), polystyrene (PS), low-density polyethylene (LDPE), and light-proof polyethylene terephthalate (LPET), as well as glass (emerald green) and aluminum cans, were provided by Precision Plastic Products CO. LLC in Dubai, Al Tajor Glass Industries in Dubai, Can Pack Middle East LLC in Dubai, and Parksons Packaging Ltd. in India.

Physiochemical analysis

For the purpose of determining the values of density, fat, protein, and lactose in the various milk samples, a calibrated Milkoscan FT 120 (Foss Brand) was employed.

The modified AOAC (1990) method was used to determine the amount of TS and S-N-F. Using a pH meter (Model L. pusl müchen 15-1260/7, Germany), pH was determined in a 10% solution of the material as Newlander and Atherton (1964) specified.

According to the AOAC (1990), milk's titratable acidity (TA) was calculated.

Overall migration test for packaging materials

The laboratory (Alhoty Stanger Laboratory) received the plastic packaging materials so that it could decide on the best conditions and testing procedures for determining the overall migration of plastics meant to come into contact with food into food simulants. Reagents, test medium, and food simulators (EU Commission, 2002). The amount of non-volatile residue left behind after the evaporation of the food simulants after filling the test specimen is used to calculate the overall migration of non-volatile substances from a plastic sample. The test circumstances were chosen based on the BS EN1186-1:2002 clauses 4, 5, and 6. Each test sample was emptied at the conclusion of the 10-day test period, which took place at a temperature of 5°C with an increase to 70°C. The simulated food used in each test specimen.

Statistical analysis

SPSS V. 25's statistical package for the social sciences was used to produce the analysis of variance. The significance P value was given as P 0.05.

Results

The summer season revealed considerable variances in protein, fat, and lactose percentages among packaging materials; the impacted group is not equal in all packaging materials.

Figure 1-3 demonstrate the strong interaction between the packing materials and the protein, fat, and lactose percentages during the summer.

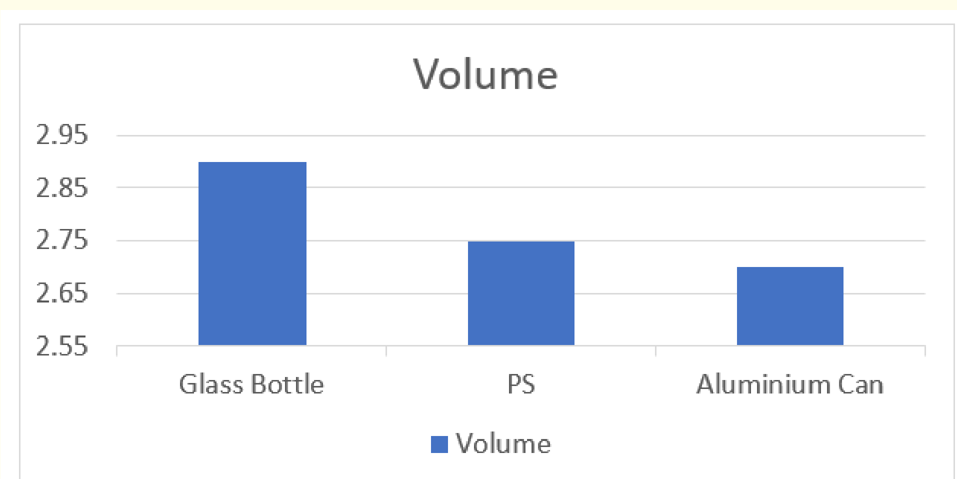

Figure 1: *Protein % of the pasteurized camel milk in summer.*

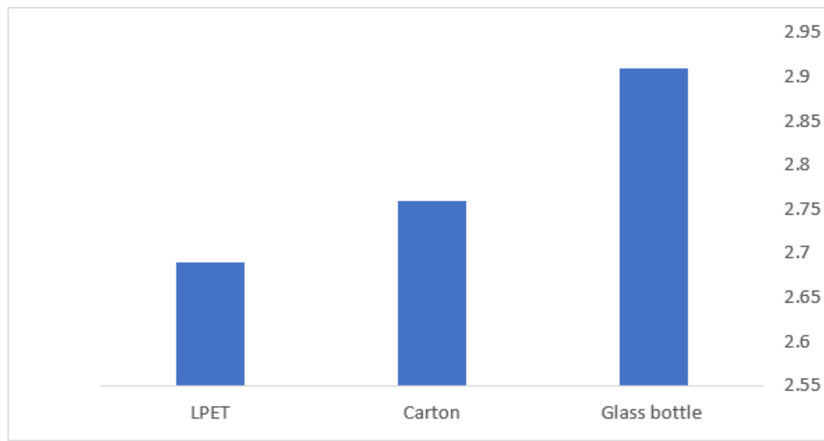

Figure 2: *Fat % of the pasteurized camel milk in summer.*

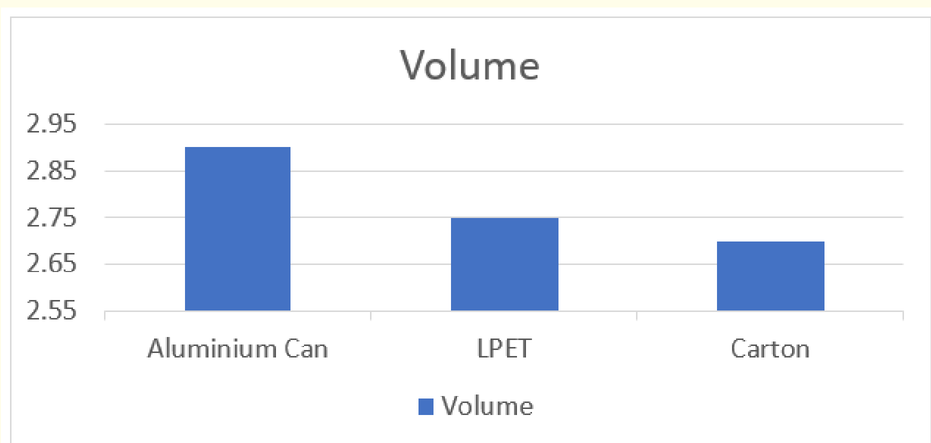

Figure 3: *Lactose % of the pasteurized camel milk in summer.*

There were no appreciable changes in the total solid percentage, solid non-fatty acid percentage, density, acidity, or pH among the packaging materials; the influenced group is equal in all packaging materials during the summer.

Pasteurized camel milk in winter season

Most importantly, the winter season revealed considerable discrepancies in packaging materials in the values of protein%, fat%, lactose%, total solid%, solid non-fatty acid%, density, acidity, and pH; the impacted group is not equal in all packaging materials.

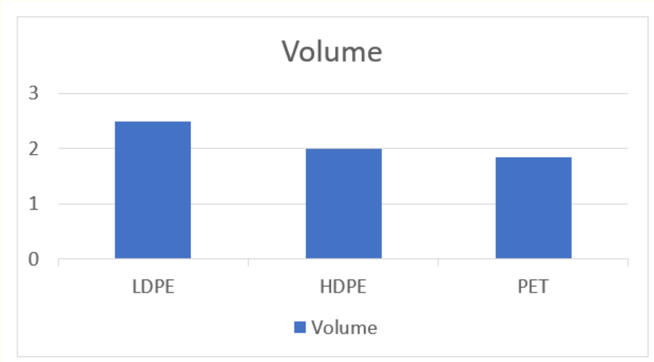

Figure 4: *Protein % of the pasteurized camel milk in winter.*

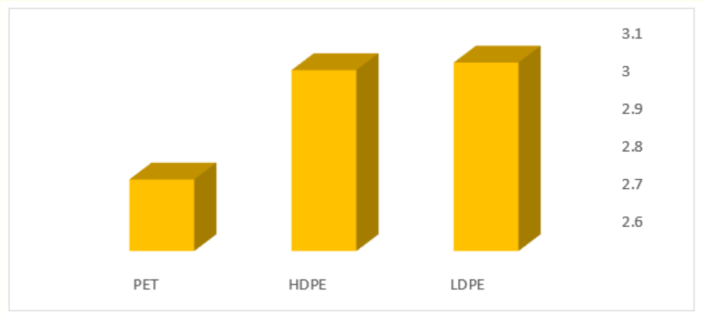

Figure 5: *Fat % of the pasteurized camel milk in winter.*

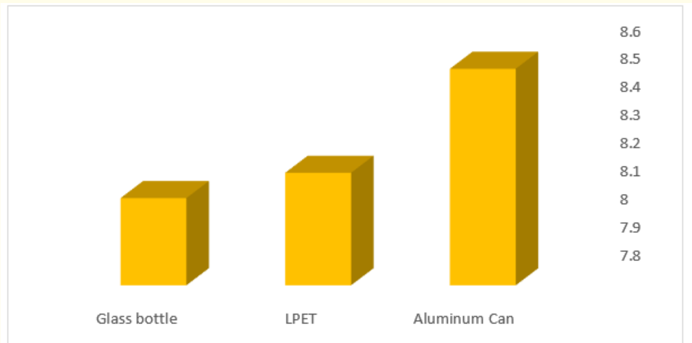

Figure 6: *Lactose % of the pasteurized camel milk in winter.*

Table 1 demonstrates that there were no statistically significant differences in the total migration values among the different packaging materials. The group's influence was practically uniform across all packaging components. According to Article 12 of EU 10/2011, this test's results are within the European Union's permissible specifications. The Directive 2002/72/EC's maximum is 10 mg of plastic compounds released per square decimeter of plastic surface area (mg/dm^2) or 60 mg of plastic substances transferred to 1 kg of food (mg/kg).

	Mean	N	Std. Deviation	Std. Error Mean
Simulant A (Distilled water)	1.5920	10	.17862	.05649
Simulant B (3 % Acetic Acid)	1.8660	10	.14879	.04705

Table 1: *The overall migration (mg/dm^2) of plastic packaging materials.*

Discussion

This study's main finding is the difference in physiochemical composition between the summer and winter seasons, and the findings are consistent with those of many other authors who have reviewed the literature. The highest variability was found for milk fat, protein, and lactose, which are all influenced by the season [6]. According to Shuiep and Elzubeir [30], camel milk had a minimum fat content in the hot season and a maximum protein and lactose content in the autumn. With a maximum level (3.46%) in January and a low in the summer (2.29% in July, the hottest month), the fat content consistently fell throughout the year. The fat content increased once more in the autumn, coinciding with colder weather and the end of lactation, to reach a similar level in February.

October had the lowest protein content (2.76%), while February had the highest (3.32%). The maximum mean value for lactose was 4.38% in February, while the lowest value was 3.83% in September. The ash content fluctuated in January (with a very high standard deviation) and remained largely constant throughout the year, with a small decline in the fall. According to Musaad., *et al*. [24] this variation in milk components causes the packing materials to have various impacts. We have a wide range of findings, as was described in our study. The results were different in the summer and the winter because some of the pasteurized camel milk content was altered by the various packing types, while some of them were not. There is not enough.

The degree of proteolysis in the milk samples was unaffected by the opacity and oxygen barrier levels. Tyrosine readings following a 6-day storage period ranged from 0.011 to 0.023 mg/ml, according to Cadman., *et al*. [10], who also noted difficulty drawing conclusions about the specific pattern of proteolysis. The degree of lipid degradation varied very little between samples held in the four types of packaging, and the range of free fatty acid levels was between 1.24 and 4.39 equiv/ml. In general, as storage time rose, FFA formation showed a marginally increasing tendency. After 13 days of storage, milk in clear PET showed a faster rate of lipolysis, which may be due to this milk's higher psychrotrophic levels.

The pigmented HDPE bottles' much thicker thickness (300 - 350 vs. 550 - 600 mm) and superior light protection for the product may be the cause of the tinted PET bottles' higher degree of lipid oxidation than that of the coloured HDPE bottles. The observed influence of light is greater the longer the storage duration. The degree of lipid oxidation in the product did not appear to be influenced by oxygen permeability during the storage time evaluated or for the packaging materials used. The relatively substantial headspace (containing air), which was similar in all packages (25 - 40 mL), including the "control," may help to explain this. Oxygen values were measured after being dissolved in the milk (7.5, 6.6, 1.3, and 0 mg L1).

Additionally, Al-Saadi and Deeth [5] explained that the lysis of lactose, proteolysis, calcium precipitation, and dephosphorylation of casein micelles were responsible for the increase in Titratable acidity over the course of the storage period (12 weeks) of UHT milk stored at various temperatures (5, 20, 37, and 45°C). In addition, the UHT milk that was put into the pouch had a higher rate of acidity escalation than Tetra Brik. Additionally, Ranvir., *et al*.'s [27] findings are supported by the fact that UHT milk's TA% growth rate was larger at 25°C than it was at 5°C. According to Rodionov., *et al*.'s research, [28] markers including the amount of fat, protein, lactose, and dry components are constant within the experimental error for fresh milk and milk that has been aged for 24 hours.

The current findings of the overall migration test of the materials used in food packaging It has been established that there was some chemical migration from the packaging to the food product, but that amount was below the threshold set by European Union guidelines. These findings are consistent with those of Schmid and Welle [29]. There is no proof that important compounds have migrated from packaging into beverages, according to the review. Testing the migration in actual drinks both during and after their shelf lives demonstrates conformity with the established migration limitations. According to Nijssen., *et al*.'s research [25], leftover monomers from PETE, such as ethylene glycol, terephthalic acid, and isophthalic acid, oligomers, breakdown products including acetaldehyde, and catalyst residues may migrate to the finished product. Khalil [21] discovered plastic parts.

Conclusion

One last significant point is that chemical oxidation through O_2 permeation and light-induced oxidation are the two main mechanisms of pasteurized camel milk quality deterioration. Add to that the degree of chemical migration from the packaging materials, and we have a recipe for disaster. Therefore, when choosing the appropriate packaging materials for camel milk, we should keep the importance of packaging barrier properties in mind and make our choice in accordance with the product's nature.

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