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Research Article

Effect of Different Packaging Materials on Some Vitamins and Minerals of the Fermented Camel Milk

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Abstract

Objective: This study aimed to investigate the impact of different packaging materials on the preservation of specific vitamins and minerals in fermented camel milk.

Methods: This study investigated the composition of vitamins and minerals in fermented camel milk over a period of 30 days, employing different packing materials. The milk was distributed in containers of 250 ml capacity, employing a range of packaging materials such as polyethylene tetra phthalate bottles, polypropylene cups, polystyrene cups, LDPE bottles, Lightproof polyethylene tetra phthalate bottles, HDPE bottles, aluminum cans, glass (emerald, green), and carton bottles.

Results: The findings of the study revealed statistically significant variations in the levels of vitamins A and C, as well as calcium and phosphorus minerals. Disparity No noticeable disparity was observed in the concentration of selenium.

Conclusion: The nutritional composition of fermented camel milk may vary due to differences in packaging materials and the product's inherent attributes.

Keywords: *Fermented Camel Milk; Retinyl Acetate; Ascorbic Acid; Packaging Materials*

Introduction

Human milk most closely resembles camel milk compared to other milk types. The low levels of sugar and cholesterol in camel milk and the high concentrations of a variety of minerals and vitamin C set it apart from other ruminant milk. These minerals include sodium, potassium, iron, copper, zinc, and magnesium. In recent years, camel milk has seen increased consumer demand as a dietary supplement. Because of its therapeutic qualities, among these properties were antihypertensive, antidiabetic, and anticancer effects [6]. When Sidr fruit pulp was added to fermented camel milk, the result was a fermented product with good physicochemical and sensory properties, a high nutritional value, and a better ability to lower blood sugar levels [3]. This fermented product was found to have an increased ability to lower blood sugar levels. It has been shown that plant sterols and fermented camel milk can be used together to make natural products that improve the oxidative state lower blood lipids, and minimal, dense LDL. This has been linked to a significant drop in atherogenesis,

and cardiovascular disease events [2]. It has been determined that providing diabetic rabbits with fresh and fermented camel milk, and colostrum helps keep the body weight within the normal range while lowering blood glucose. Therefore, camel milk and its derivatives perform the same function as insulin in lowering blood glucose levels [5]. Therapeutic qualities include hypotensive and antihypertensive actions and anti-diabetic and anti-carcinogenic capabilities. It is frequently really straightforward. Lactose-intolerant individuals can absorb it. Camel milk, conversely, can lower elevated levels of bilirubin, globulin, and granulocytes [20].

Camel milk has some distinct advantages over other ruminant milk. Given its high immunoglobulins and insulin concentration, it is ideal for its composition and purpose. It is impressive. Vitamins (A, B-2, C, and E) and minerals (sodium, potassium, and calcium) are abundant [19] and low protein, carbohydrate, and fat levels. Fermented dairy products are included. Fermented dairy products containing *Bifidobacteria* and *Lactobacillus* strains have been developed in many countries worldwide to achieve a dietary therapeutic result capable of overcoming the symptoms associated with elevated cholesterol levels. Several strains of *Bifidobacteria* and *Lactobacilli* have been created in various locations worldwide to obtain a dietetic therapeutic effect that alleviates the symptoms associated with high cholesterol [15].

The camel milk that had been fermented was used to extract and isolate bioactive peptides, which were then identified using HPLC - MS/MS. This bioactive peptide was demonstrated to have immunomodulatory and anti-inflammatory properties in preclinical tests [16]. The composite probiotics made from fermented camel milk exhibit an antidiabetic effect in db/db mice, according to the research findings by [17]. On the other hand, there has been substantial technological improvement in food packaging over the past few decades. This advancement was made in response to client demands for more natural preservation forms and strategies to control packing and storage to guarantee food safety [10]. Because of the possibility of adverse interactions between packaged dairy products and packing material, there are numerous reasons to be concerned about the degree of safety of packaged dairy products. According to [9] several food safety issues have been identified during the last ten to fifteen years that have been linked to the migration of hazardous chemicals from packing material into dairy products. This study examined the influence of various packaging materials on preserving vitamins and minerals in fermented camel milk.

Materials and Methods

Study area

Emirates industry for camel milk and products is the world's first large-scale dairy camel farm. It is located in the Um Nahad 3 neighborhood off the Dubai Al Ain Road at Exit 26 in Dubai, United Arab Emirates (25 degrees North, 55 degrees East).

The farm's management, the camels, and the milking of the animals

The animals' ages ranged from 5 to 19 years and belonged to various breeds or ecotypes. There were a varying number of pairs. The animals were housed in groups of 12 to 24 dromedaries in open paddocks. The calves were only partially weaned and spent the length of their mothers' nursing in nearby paddocks. They were allowed to breastfeed after each round of milking. Total Mixed Ration (T.M.R.) feeding carts provided a typical daily diet of five to six kilograms of wheat bran and six to seven kilograms of alfalfa hay, each providing fifteen percent crude protein. Additional information on farm management has been described elsewhere (Nagy., *et al.* 2013a, b). Using an automatic system, a herringbone-shaped milking parlor measuring 2 meters by 12 meters milked dromedaries twice daily. Each milking involved measuring the amount of milk (in kilos) produced by each dromedary using a milk meter that had received approval from the International Committee for Animal Recording (ICAR).

Materials for packaging

Precision plastic products CO. L.L.C., Dubai, provides polyethylene tetra phthalate (P.E.T.), polypropylene (P.P.), polystyrene (P.S.), low-density polyethylene (LDPE), lightproof polyethylene tetra phthalate (LPET), and high-density polyethylene (HDPE) plastic packaging

materials. Al Tajir Glass Industries in Dubai provided the glass (Emerald Green). Can Pack Middle East L.L.C. of Dubai provide the aluminum cans and the cartoon from Parksons Packaging Ltd - India.

Collection and preparation of samples

At six a.m., fermented camel milk was collected in sterile steel containers (90 degrees for twenty minutes, with the CH-1 culture introduced at 42 degrees and the medium maintained for a maximum of five hours). from the emirates industry of camel milk and products company's factory in the Umm Nahad 1 area. These containers were subsequently delivered in iceboxes to the Al Rawabi dairy company's quality control plant. The fermented camel milk was distributed aseptically into sterile bottles, cups, cans, and protected paperboard boxes in the plant laboratory. Cups were sealed with pail lids, glass bottles with crown caps, and plastic bottles with polyethylene twist tops. Coated paperboard boxes were sealed using a production line sealer. Polyethylene twist caps were used to close the bottles. Each piece of packaging has a capacity of 250 milliliters. The filled packaging materials were kept in the refrigerator for up to one month at a temperature of five degrees Celsius.

Chemical analysis

On day zero, calcium, phosphorus, selenium, vitamin A (Retinyl acetate), and vitamin C (ascorbic acid) levels were determined at seven, fourteen, twenty-one, and thirty.

Determination of vitamins A and C

For vitamin A, initially, the samples were subjected to methanol, a solvent known for its ability to induce protein precipitation and micelle disruption, thereby facilitating the extraction of lipids. After that, the samples were extracted by using isooctane, and then they were spun in a centrifuge to separate the isooctane layer from the alcohol and water layers. The HPLC system was injected with a 20-femtoliter aliquot of the upper isooctane layer. The chemical was detected via U.V. analysis at a wavelength of 32 nm (Acetate). Ascorbic acid was taken out of the sample with the help of trichloroacetic acid (T.C.A.) and Tris [2-carboxyethyl] phosphine (TCEP), which acted as a reducing agent. Subsequently, the ascorbic acid concentration was determined using ultra-performance liquid chromatography with ultraviolet detection at a wavelength of 265 nm. We used a C18 column, sodium acetate with a pH of 5.4 as the eluent, and TCEP and decyl amine as ion-pairing agents to separate. The official methods of analysis are recognized by AOAC [4]. International for 2012 - 2012.

Analysis of calcium, phosphorus, and selenium content

A mixture of H.N.O. and $HCI0_4$ was used to break down the test sample, and I.C.P. emission spectroscopy was used to determine the elements in the sample. The sample containers were subjected to vigorous shaking to achieve thorough mixing. 15.0 mL of Lofrcady solution was carefully dispensed to introduce a 0.0 mL sample into a Kjeldahl flask with a capacity of 100 mL. The flask was filled with 30 mL of a 2:1 mixture of $HN0_3$ and $HCl0_4$, and 3 to 4 glass-boiling beads were added. The test specimens were immersed in acid for an extended period. Two reagent blanks were utilized throughout the operation with the test parts. The ice bath was employed to facilitate the cooling process of Kjeldahl flasks.

Every Kjeldahl flask was carefully placed on a heating mantle that had been set to a low temperature to begin the digestion process. After boiling, the expulsion of red-orange vapors consisting of N_2 occurred. Mild heating resulted in the complete evaporation of $IN0_3$ and H_20. The release of gas bubbles signaled the start of a chemical reaction between organic matter and HC_10_4. The flask was positioned on a cooling mantle and subjected to intermittent heating from the blanket for digestion. A solution of hydroxylamine nitrate ($HN0_3$) was introduced and subsequently subjected to mild heating; the sample was subjected to elevated temperatures for approximately two minutes to facilitate its drying. The flask was extracted from the heating mantle and then subjected to a cooling process. Subsequently, a volumetric flask was used to transport each 50 mL digest, diluted to its designated volume using distilled water. Inductively coupled

plasma (I.C.P.) emission spectroscopy facilitated the analysis and quantification of elemental composition. The instrument was calibrated using established calibration standards. Calcium, phosphorus, and selenium determination using AOAC official method 984.27.

Statistical evaluation

An analysis of variance was performed using the statistical package for social science (SPSS V. 25). The significance level for the P value was found to be 0.05.

Results

Vitamin A

S.O.V.	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.000	8	.000	13.705	0.000
Within Groups	.000	18	.000		
Total	.000	26			

Table 1: *Source of variation in the influence of Vitamin A in packaging materials.*

Table 1 illustrates substantial changes in the packaging materials that were used and their influence on the amount of vitamin A that was extracted from fermented camel milk. Vitamin A was most reliably preserved when packaged in one of the three containers: glass, aluminum, or carton. Because the sig = (0.000) less than 0.05 and 0.01, there were significant differences between packaging materials.

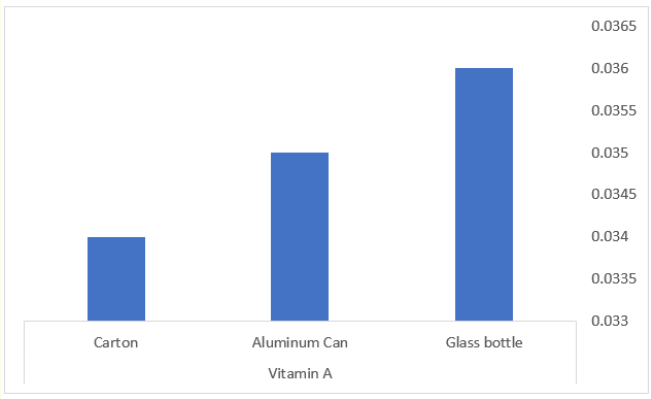

Figure 1: *Vitamin A level in fermented camel milk.*

Vitamin C

S.O.V.	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.001	8	.000	25.284	0.000
Within Groups	.000	18	.000		
Total	.001	26			

Table 2: *Source of variation in influences of Vitamin C in packaging materials.*

Table 2 reveals significant differences in the impact of packing materials on the vitamin C content of fermented camel milk. Because the Sig = (0.000) less than 0.05 and 0.01, aluminum cans, cardboard cartons, and glass bottles were the most suitable packaging for preserving vitamin C content.

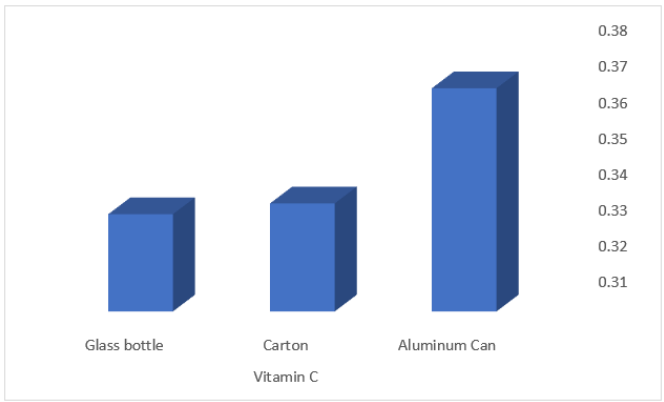

Figure 2: *Vitamin C level in fermented camel milk.*

Calcium (Ca)

S.O.V.	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	31213.333	8	3901.667	1.285E3	0.000
Within Groups	54.667	18	3.037		
Total	31268.000	26			

Table 3: *Source of variation in the influence of Calcium (Ca) level in packaging materials.*

Table 3 shows significant variations in packing materials' influence on calcium (Ca) in fermented camel milk. HDPE, LDPE, and P.S. were the most suitable plastics for packing calcium (Ca) in fermented camel milk. The influence was not uniform across all materials. Because the Sig = (0.000) was less than 0.05 and 0.01.

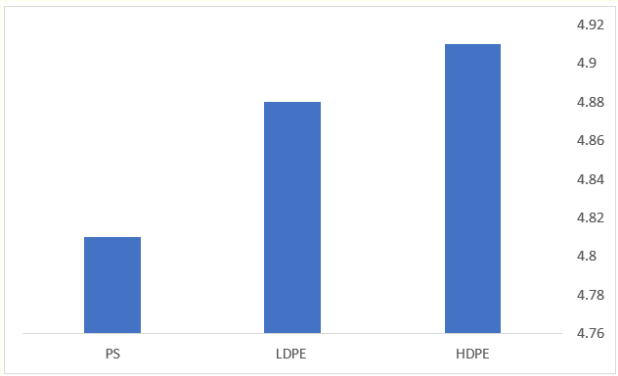

Figure 3: *The calcium level in fermented camel milk.*

Selenium (Se)

S.O.V.	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.000	8	.000	< 1	0.989
Within Groups	.000	18	.000		
Total	.000	26			

Table 4: *Source of variation in the influence of Selenium (Se) level in packaging materials.*

Table 4 shows variations in packing materials' influence on Selenium (Se), with sig = (0.989) higher than 0.05 and 0.01. Each type received equal attention and consideration.

Phosphorous (P)

S.O.V.	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	772.074	8	96.509	32.984	0.000
Within Groups	52.667	18	2.926		
Total	824.741	26			

Table 5: *Sources of variation and influence of Phosphorous (P) levels in packaging materials.*

Table 5 shows significant variations in packing materials' impact on phosphorous (P) in fermented camel milk. LDPE, HDPE, and P.E.T. were the best packaging materials for phosphorous (P) in fermented camel milk because the sig = (0.000) less than 0.05 and 0.01.

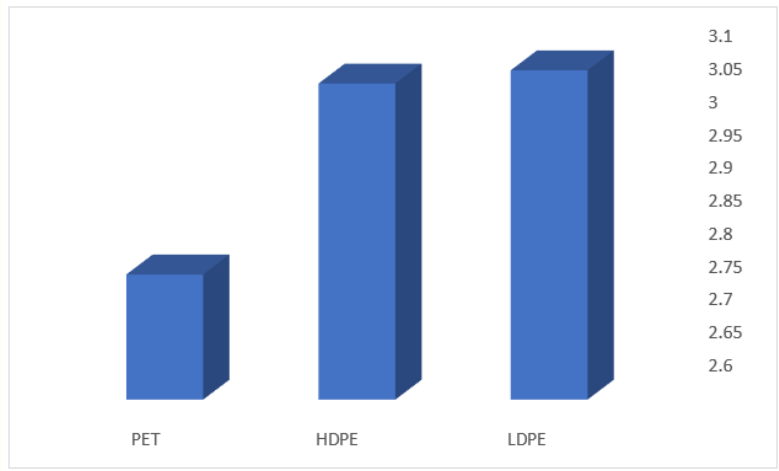

Figure 4: *The phosphorous (P) level in the fermented camel milk.*

Discussion

According to the findings, there were discernible differences between the various types of packaging materials for vitamins A and C and the minerals calcium and phosphorus; conversely, there is no distinguishable difference for Selenium. Concerning vitamins, A and

C, the utilization of packaging materials such as amber glass, aluminum cans, and cardboard, as opposed to plastics, serves as a shared characteristic in safeguarding fermented camel milk from light-induced degradation. This observation aligns with the findings [23] who examined the effect of light transmittance on the vitamin content of UHT whole milk. It found that the highest light intensity led to significant degradation of vitamins A and B2, with total decomposition delayed from 4 to 8 weeks.

In the same findings of [8] the packaging material used significantly influences the number of vitamins and minerals included in pasteurized camel milk. They found that milk treated with vitamin A could be stored successfully in glass bottles, aluminum cans, and cartons. In contrast, milk that had been treated with vitamin C could be stored successfully in aluminum cans, cartons, and glass bottles. The minerals selenium, calcium, and phosphorous were investigated, but the results did not reveal any significant differences between the groups. According to [14] study, milk is adequately protected against potential microbiological and chemical dangers when packaged in any of the evaluated containers, independent of the container's content. Chemical alterations occur in the components of UHT milk when stored for extended durations, particularly in environments exposed to light, such as warehouses or retail establishments. These modifications have the potential to significantly decrease the duration for which the product remains viable on store shelves. Specifically, the alterations in chemical composition resulting from the process of oxidation triggered by light exposure have the potential to result in the depletion of essential nutrients in milk and an elevation in undesirable taste and aroma. The presence of undesirable flavors [21,22].

The evaluation lasted for a total of seven days. According to the research results, the type of packaging used substantially affected the rate at which vitamin C degraded over time. After one month of storage, there was a correlation between using an opaque bottle with three layers and the overall oxidation of vitamin C. On the other hand, the storage of vitamin C in an opaque bottle with six layers that contain an oxygen barrier resulted in a progressive reduction in the content of vitamin C until it reached 25 percent of the initial concentration after four months of storage. This was the case even though the bottle contained an oxygen barrier. However, regarding the Maillard process, it was not feasible to notice any significant effects of vitamin C degrading while it was being stored [12]. The researchers' conclusion was this. The reduction in ascorbic acid concentration in the product after being kept in the refrigerator for sixty days was interpreted as proof of the chemical stability of milk packaged in P.E.T. bottles [11]. This storage study shows that vitamins in HPP milk undergo a slow and constant depletion over 60 days of storage. The majority of the vitamins in HPP milk, such as vitamins A (25%), B3 (91%), B5 (35%), B6 (80%), and C (85%), dropped below their initial level by the time storage was complete, except for vitamins B7 (25%), B9 (100%), and B12 (20%), which grew. The majority of the vitamins in HPP milk dropped below their initial levels, including vitamins A (25%), B3 (91%), B5 (35%), B6 (80%), and C (85%). No other work had been done to compare the deterioration of vitamins in HPP-treated milk while it was being stored. On the other hand, records of the decline of vitamins in fresh milk during six days of refrigerator storage have been detected by [7]. No other work had been done to compare the deterioration of vitamins in HPP-treated milk while it was being kept. These findings pertain to the vitamins A, B6, and B12, as well as vitamin C.

After storage, the calcium content grew by 1.6%, the phosphorus content climbed by 1.1%, and the magnesium content increased by 13.1% when compared to the fresh milk that was originally produced. In the study, significant losses (p 0.05) were seen in potassium (5.3% loss) and zinc (18.4% loss), although an increase in the levels of calcium, phosphorus, and magnesium was observed after storage. Even at concentrations as high as 0.2 mg/kg, the researchers did not uncover traces of Selenium throughout their investigation [7]. [1] discovered that after 45 days of storage at 4 degrees Celsius, the mineral profiles of potassium, calcium, magnesium, and zinc in milk treated with HPP (450 - 650 MPa, 3 minutes, 20 degrees Celsius) did not alter significantly ($p > 0.05$). The HPP treatment included 3 minutes of 450 - 650 MPa and 20 degrees Celsius. Except for Selenium, which likewise stayed undetectable, the conflicting changes were more evident in the fresh milk that had been refrigerated for six days. There was more significant degradation of potassium (4.3%), calcium (7.2%), and phosphorus (14.8%) in the milk that had been refrigerated for this length of time.

The research conducted on the relevant literature [13] made a claim. Furthermore, the deterioration of micronutrients and bioactive constituents is subject to various circumstances, including the type of packaging material employed, the temperature at which storage occurs, and the duration of storage.

Conclusion

The nutritional composition of fermented camel milk, namely the levels of vitamins A and C, is influenced by the selection of packing materials. The packaging barrier serves as a protective measure against light exposure, while it was observed that light transmission did not have a significant impact on the concentrations of Phosphorus and Calcium, as well as Selenium. Additional research is required in order to comprehensively comprehend the effects of packaging on fermented camel milk.

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