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Effect of Different Types of Packaging Materials on the Shelf Life of Pasteurized Camel Milk

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A B S T R A C T

Nine types of packaging materials were tested on this study Included (I) Polyethylenetetraphthalate (PET) Bottle, (ii) Polypropylene (PP) Cup, (iii) polystyrene (PS) Cup, (iv) Low density polyethylene (LDPE) Bottle, (v) Light Proof Polyethyleneterephthalate(LPET) Bottle,(vi) High density Polyethylene(HDPE) Bottle, (vii) Aluminum Cans, (viii) Glass(Emerald Green**)** and (ix) Cartoon bottles (250 ml size) were dispensed in the aseptic condition with Pasteurized camel milk (80 ˚C,16s) for two seasons Summer and Winter and stored immediately inside the chiller at 5 ˚C for 30 days, The camel milk samples were examined for microbial quality, sensory evaluation, also food packaging materials were examined for overall migration test, approximate shelf life of the pasteurized camel milk at temperature 5 ˚C in all types of packaging materials in our study period 30 days, Sensory Evaluation results shown that there is significant differences within best packaging materials, so we can say best packaging materials not same in summer and winter. We see also the best packaging materials is not same in winter of all type of Sensory Evaluation with one ranking (PS, HDPE) respectively, but not difference in summer, so the best in winter is (PP - PS – PET) respectively, lastly the overall migration test analysis for the food packaging materials shown that there are no significant differences within packaging materials. So we can say responds in group equally at all packaging materials and all samples meets the specification limits as per Article 12, EU 10/2011.

Introduction

In the recent decades life style has changed and become more complicated regarding life standard, hygiene, diet, use of antibiotics and other antimicrobial substances, hence a new concept of food need to be introduced. It has long been recognized that some non-

traditional foods, for example camel milk, fortified food and beverages that provide particular health benefits and interestingly, in recent decades they have been modified to provide disease-preventive attributes, in addition to their particular functional health benefits. The concept of functional foods has also been developed and their types have been expanded to become one of the popular foods worldwide. The estimated growth rate of functional food in the global market is 15-20% per year, and the industry is claimed to be worth up to US$168 billion of the annual share (Euromonitor, 2010; Hilliam, 2003). However, there is no internationally accepted definition of functional foods exist, because it is a more of a concept rather than a well-defined group of food products (ILSI, 1999). Camel milk has an important role in human nutrition in the arid regions; however camel milk is generally described as opaque-white, frothy, sweet and sharp but sometimes salty in taste (Al haj and Al Kanhal, 2010). These variations in taste are due to the type of fodder and unavailability of water (Farah, 1996). Nowadays, there is a general need to launch a number of camel milk based functional products to the commercial market due to increasing demand in recent years (Al haj and Al Kanhal, 2010). These products have to be clinically proven and scientifically evident supported (Ghosh, 2009).

On the other hand, Food packaging is an integral part of food processing operations and food preservation. It serves a number of different functions including preservation, containment, convenience and communication; among these, preservation is by far its most important function. Packaging protects the contents against environmental, physical, chemical and mechanical hazards (light, oxygen, moisture, etc.), loss of desirable flavor compounds or pickup of undesirable odors, as well as contamination from microorganisms, insects or rodents during storage and distribution. For the majority of foods and beverages in which quality decreases with time, it follows that there will be a finite length of time before the product becomes unacceptable. This time from production to unacceptability is referred to as shelf life, shelf life refers to the time on the retailer's shelf as well as the consumer's shelf. Although the shelf lives of foods vary, they are routinely determined for each particular product by the manufacturer or processor. Manufacturers generally attempt to provide the longest practicable shelf life consistent with costs and the pattern of handling and use by distributors, retailers, and consumers (Gordon, 2009), So in these study we will focus on the pasteurized camel milk shelf life and it is relation with different types of packaging materials in two season from the year.

Materials and Methods

Area of Study

The Emirates Industry for Camel Milk and Products, the world's first large-scale dairy camel farm located in Dubai, United Arab Emirates (25° N, 55° E) in Dubai Al Ain Road, Exit 26, Um Nahad 3 area.

Camels, Management of the Farm, and Milking of the Animals

The animals belonging to different breeds or ecotypes were between 5 to 19 years of age and had variable parity. Camels were kept in groups of 12 or 24 animals in open paddocks. Calves were weaned partially and were kept in adjacent paddocks next to their dams throughout lactation.

They were allowed to suckle after each milking. The normal daily ration consisted of 5 to 6 kg of wheat bran and 6 to 7 kg of alfalfa hay (~15% CP) distributed with feeding

wagons as TMR in 2 portions per day throughout the year. Further details of farm management have been described elsewhere (Nagy *et al.*, 2013a, b). Dromedaries were milked twice a day with an automatic system in a 2 × 12 herringbone milking parlor.

Milk yield (kg) of individual dromedaries was measured during each milking with a milk meter approved by the International Committee for Animal Recording (ICAR).

Camel Milk samples

Pasteurized camel milk samples were obtained from the Emirates Industry of Camel Milk and products Company plant in Umm Nahad 1 area at 6 O'clock in the morning in sterilized steel containers and were kept in ice boxes then transferred to Al Rawabi Dairy Company Laboratory in Al Khawaneej area both area in Dubai, United Arab of Emirates. The study was conducted Between August and September (Summer Season 2017, 2018 through January to February 2018, 2019 (Winter Season) Respectively.

Sample preparation and handling

Pasteurized camel milk (80 ˚C, 16 s) was obtained from the Emirates Industry of Camel Milk and products Company plant in Umm Nahad 1 area at 6 O'clock in the morning in Sterilized Steel Containers and were transferred in Ice boxes to Al Rawabi Dairy Company quality control plant, the milk was aseptically dispensed into clean bottles, cups, cans and coated paperboard cartons in the plant laboratory.

Bottles were sealed using polyethylene twist caps (plastic bottles), glass bottles with crown caps, cups with pail lid, while coated paperboard cartons were sealed on the production line sealer, all packaging materials size 250 ml. The filled packaging materials were stored inside the fridge at 5 ˚C for a period up to 30 days, Pasteurized camel Milk samples (250 mL) were sampled from sealed packaging materials every day till day 30 after initial packaging for physicochemical, microbiological and sensory testing. Testing at day 0 was carried out on milk samples immediately after packaging.

Packaging Materials

The plastic Packaging materials, Poly ethylene tetra phthalate (PET), Polypropylene (PP), polystyrene (PS) Low density polyethylene (LDPE), Light Proof Polyethylene tetra phthalate (LPET), High density Polyethylene (HDPE) were supplied from Precision Plastic Products CO. LLC-Dubai, Glass (Emerald Green**)** from Al tajir Glass Industries –Dubai, Aluminum Cans from Can Pack Middle East LLC -Dubai and the cartoon from Parksons Packaging Ltd- India.

Taste Panel

Taste panels were performed on pasteurized camel milk stored at 5 ˚C, the trained panelists from Al Rawabi Dairy Company quality control department were asked to compare and score the samples against a reference sample (R) in a difference from control test (Meilgaard *et al.*, 1991) and to rate the degree of acceptability compared with a reference using a multiple comparisons test (Lyster, 1965).

Microbiological Analysis

Detection of Coliforms

Detection of Coliforms, Total Bacterial Count (TBC), Aerobic plate count (ABC), Enterobacteriaceae, *Salmonella* and *Escherichia coli* by mini VIDAS automated solutions for rapid pathogen detection method (Law *et al.*, 2015).

Species Identification

Based on the results of Aerobic Plate Count colonies were isolated and further process for species identification test to identify the predominant bacteria environmental and pathogenic microorganism produce a characteristic pattern or metabolic finger print these patterns are then analyzed with sophisticated interpretation software and compared to the extensive organism and pathogen databases to deliver results of a demonstrated level of accuracy by mini VIDAS automated solutions for rapid pathogen detection method (Law *et al.*, 2015).

Overall migration test for packaging materials

To select appropriate conditions and test methods for the determination of overall migration into food simulants from plastics which are intended to come into contact with food stuffs. Food Simulants, test media and reagents (EU Commission. (2002). The overall migration of non-volatile substance from a sample of the plastic is determined as the mass of non-volatile residue after evaporation of the food simulants following filling the test specimen. The test conditions are selected by conditions of use as per BS EN1186-1:2002 clauses 4, 5 and 6.

Test specimens are filled with the food simulant for 10 Days at 5 ˚C temperature and including 70°C at the end of the test period each specimen is emptied. The food simulant from each test specimen is evaporated to dryness the mass of the non-volatile residue is determined and reported as mg/md^2 of surface area exposed to food simulant.

Aqueous Food Simulants

Distilled water or water of equivalent quality - Simulant A. (Pasteurized Milk)

3% Acetic acid (w/v) in aqueous solution - Simulant B. (Fermented Milk).

Statistical Analysis

Analysis of variance was obtained using Statistical Package for the Social Science (SPSS V. 25). The P value for significance was stated in P< 0.05.

Results and Discussion

Microbiological Analysis

Pasteurized Camel Milk in Summer

Coliform

From the table above there is no significant differences within packaging materials responds of experts about (Coliform) because the sig = (0.965) more than 0.05 and 0.01. So we can say responds in group equally at all packaging materials in (Coliform).

Total Bacterial Count

From the table above there is no significant differences within packaging materials responds of experts about (TBC) because the sig = (0.987) more than 0.05 and 0.01. so we can say responds in group equally at all packaging materials in (TBC).

Pasteurized Camel milk in winter

Coliform

From the table above there is no significant differences within packaging materials responds of experts about (Coliform) because the sig = (0.945) more than 0.05 and 0.01. so we can say responds in group equally at all packaging materials in (Coliform).

Total Bacterial Count

From the table above there is no significant differences within packaging materials responds of experts about (TBC) because the sig = (0.735) more than 0.05 and 0.01. so we can say responds in group equally at all packaging materials in (TBC).

After the end of experiments (Day 31) for more accuracy Milk samples were submitted to External lab for testing the Aerobic plate Count, Enterobacteriaceae, *Salmonella* and *Escherichia coli*, So the results in all seasons (Summer and Winter) Negative results coming for the Enterobacteriaceae, *Salmonella* and *Escherichia coli*, for the Aerobic plate Count A few colonies were detected and it were comply with standards of the Gulf Countries Council (GCC), colonies of same morphology were identified and further processed for species identification test, to identify the pre-dominant bacteria. Environmental and pathogenic microorganisms produce a characteristic pattern or "metabolic ginger print". These patterns are then analyzed with sophisticated interpretation software and compared to extensive organism and pathogen databases to deliver results and for more confirmation species identification test was did for this colonies, *Enterococcus* species (Non Pathogenic Bacteria) were identified in both season summer and winter.

Criteria of technical conformity

The sample is found to be of satisfactory quality and within the specified limits.

Sensory Evaluation

From the table above there is significant differences within best packaging materials responds of Type of Sensory Evaluation so we can say best packaging materials not same in summer and winter. We see also the best packaging materials is not same in winter of all type of Sensory Evaluation with one ranking (PS, HDPE), but not difference in summer, so the best in winter is (PP - PS – PET).

Overall Migration Test Analysis of the Food Packaging Materials

From the table above there is no significant differences within packaging materials responds of experts about (overall migration test analysis for the food packaging materials) because the sig = (0.000) Less than 0.05 and 0.01. so we can say responds in group t equally at all packaging materials in overall migration test analysis for the food packaging materials, Al these results of the food packaging materials overall migration test meets the specification limits of European Union as per Article 12, EU 10/2011.

Results and Discussion

Microbial and shelf life

The present results are in agreement with earlier reports in the literature, (Kappeler *et al.,* 1999; Wernery *et al.,* 2005; Benkerroum 2008) the shelf life of camels' milk is longer compared to other milk animals since it contains antibacterial agent such as lysozyme, lactoferrin and immunoglobulin than do bovine or buffalo milk, (Wernery, 2008). Hassan *et al.,* (2006) Pasteurized camel milk can last for more than 10 days at 4°C found that pasteurization of camel milk before its fermentation improved the microbial content and increasing the shelf life of the product, similarly Mohamed and El Zubeir (2007) recommended the immediate cooling for milk after milk and application of heat treatment to improve its bacteriological quality. Hassan *et al.,* (2007) reported that camel milk has special properties that it can be looked upon as one of the promising industry in the future by

encouraging the investment of camel milk and products. Camel milk possesses superior keeping quality to cows' milk due to its high contents of proteins that have inhibitory properties against bacteria (Younan, 2004). Also the results of absent of pathogenic bacteria (bacreiacae, *Salmonella* and *E. coli*) it is agreement with literature review of Omer and Eltinay (2008), all 68 samples of raw camel milk tested for the occurrence of pathogenic bacteria were negative for *Listeria monocytogens*, *Salmonella* spp., and *Clostridium perfringens*. On the basis of this result, the authors attempted to explain the negative result as a possible outcome of the activities of protective proteins (Lysozyme, lactoferrin, lactoperoxldase, immunoglobulm G and A) in raw camel milk and El-Agamy *et al.,* (1992), was also assayed the activity of protective proteins that extracted from camel milk against Lactococcus lactis subsp. cremoris, *Escherichia coli*, *Staphylococcus aureus*, Salmonella typhimurium and rotavirus and lysozyme extracted from camel milk was effective against Salmonella. A similar result was also reported by Barbour *et al.*,(1984) on the other hand, contrary to this finding, Matofari *et al.*, (2007) reported that from 196 samples tested, 84 were found to contain *Salmonella* spp. (Lund,2020) found that the camel milk was expired on 76 hrs and 42 days (at ambient and refrigerator temperature, respectively). At the ambient temperature, keeping quality of raw and heat treated came milk was 76, 64, 56 and 24 hrs (100.5°C for 10 minutes, 63°C for 30 minutes, 72°C for 15 seconds and control, respectively).

However, when kept under refrigeration temperature, the keeping quality of raw and heat treated camel milk was 42, 39, 27 and 18 days (at 100.5°C for 10 minutes, 63°C for 30 minutes, 72°C for 15 seconds and control, respectively). On the same line results of (Said *et al.*, 2013) who observed that the keeping quality of pasteurized milk (36 days) is higher compared to the raw camel milk.

Sensory Evaluation

The present results of the sensory evaluation shown significant differences within Best packaging materials responds of Type of Sensory Evaluation so we can say best packaging materials not same in summer and winter. We see also the best packaging materials is not same in winter of all type of Sensory Evaluation with one ranking (PS, HDPE) respectively, but not difference in summer, so the best in winter is (PP - PS – PET) respectively, these result agreements with literature review from (Duncan and Marcy, 2014). All volatile flavor compounds studied (acetaldehyde, pentanal, dimethyl disulfide, and hexanal) were increased in light-exposed milk samples. Amber PETE showed the least amount of oxidation off-flavor, while clear PETE with UV block showed significantly less oxidation off-flavor than glass, clear PETE or HDPE on day 7 and 18. Acetaldehyde was not detected by sensory analysis in either light-exposed or light-protected samples. Also Cladman *et al.*, (1998) compared the effectiveness of clear PETE, green PETE, clear PETE with UV block, HDPE jugs, and low-density polyethylene pouches for chemical changes in milk over a period of 18 days. Green PETE showed best protection of milk against lipid oxidation, with clear PETE showing the worst results. Clear PETE containers with UV block showed little protection against lipid oxidation. (Nijssen *et al.*, 1996) assayed the migration of compounds may influence the sensory quality and acceptability of the foodstuff. In particular, the odor of mineral water stored in PETE bottles compared to that of soft drinks, can be detected at very low levels, due to the absence of masking flavor compounds.

Table.1 Source of variation in Coliform in packaging materials

S.O.V	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.435	8	.054	.317	0.965
Within Groups	45	265	.170		
Total	14.125	273			

Table.2 Source of variation in TBC in packaging materials

S.O.V	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.180	8	.022	.0.119	0.987
Within Groups	49	265	.185		
Total	17.156	273			

Table.3 Source of variation in Coliform in packaging materials

S.O.V	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.675	8	.084	.333	0.945
Within Groups	67	265	.252		
Total	26.225	273			

Table.4 Source of variation in TBC in packaging materials

S.O.V	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.422	8	.0528	.359	0.735
Within Groups	39	265	. 147		
Total	17.156	273			

Table.5 Microbiological Analysis for Pasteurized Camel Milk

Parameters	Units		Methods	Results	1016/2015(E) Specification
Aerobic Plate Count	CFU/		BAM Jan 2001 cha ter3	< 100	$3x10^4$ - 10^5
Enterobacteriaceae	CFU/		CCFRA 2.3.1: 2007	< 10	3 - 5
Salmonella	In 25		VIDAS	Not detected	Absent
Escherichia coli	MPN/		CMMEF 8.91 92		Absent

MPN method <3 is considered as "not detected".
<IO is considered as "not detected".
*GS 1016/2015 (E), Microbiological criteria for food stuffs, ICS: 67.040, Clause

Table.6 Pasteurized Camel Milk in summer and winter

Type of Sensory Evaluation	In summer		Rank of packaging materials	In winter		Rank of packaging materials
	Packaging materials	Average packaging materials		Packaging materials	Average packaging materials	
Appearance/Color	PP	4.54	1	PS	4.62	1
	PS	4.42	2	PP	4.60	2
	PET	4.32	3	Aluminum Can	4.57	3
. Texture	PP	4.61	1	LDPE	4.82	1
	PS	4.58	2	HDPE	4.78	2
	PET	4.51	3	PS	4.75	3
Smell / flavor	PP	4.63	1	LDPE	4.81	1
	PS	4.58	2	HDPE	4.76	2
	PET	4.55	3	PS	4.71	3
Taste/ Mouth feel	PP	4.61	1	PP	4.81	1
	PS	4.57	2	HDPE	4.72	2
	PET	4.54	3	PS	4.68	3

Table.7 Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Simulant A(Distilled water)	1.5920	10	.17862	.05649
	Simulant B(3 % Acetic Acid)	1.8660	10	.14879	.04705

Table.8 Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	A & B	10	.972	.000

Table.9 Paired Samples Test

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	A - B	-.27400-	.04858	.01536	-.30875-	-.23925-	-1.784E1	9	.000

Table.10 Overall migration test for packaging materials

Simulants (Temp/Time)	Concentration of Extractives, m /dm^2	Limit as per Article 12, EU 10/2011, m dm^2
Simulant A(Distilled water) @ 5^0 C for 10 Days	<	10
Simulant B(3^0/o Acetic Acid) @ 5^{0}C for 10 Days.	<	10

Fig.1 Appearance /Color of the pasteurized camel milk in summer

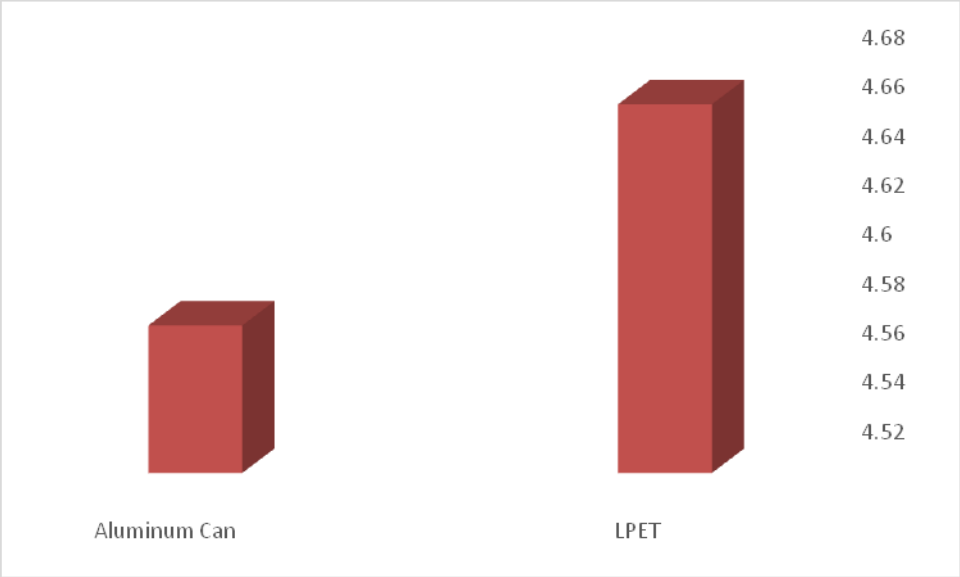

Fig.2 Texture of the pasteurized camel milk in summer

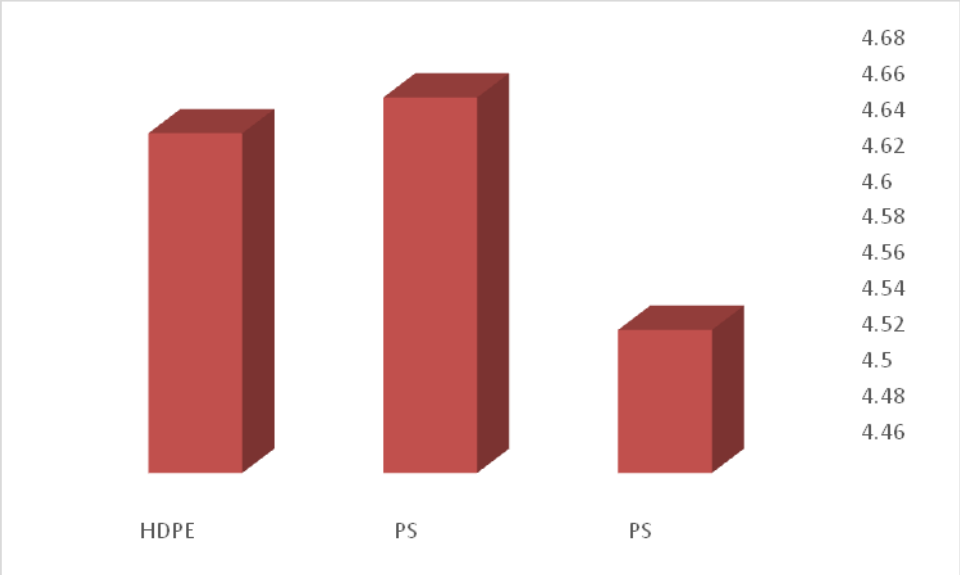

Fig.3 Smell /Flavor of the pasteurized camel milk in summer

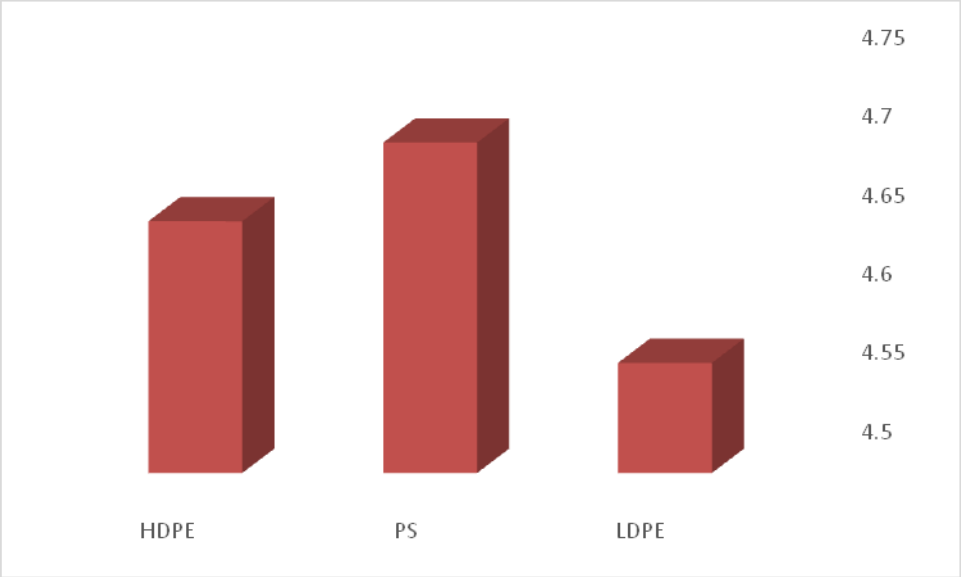

Fig.4 Taste /Mouth feel of the pasteurized camel milk in summer

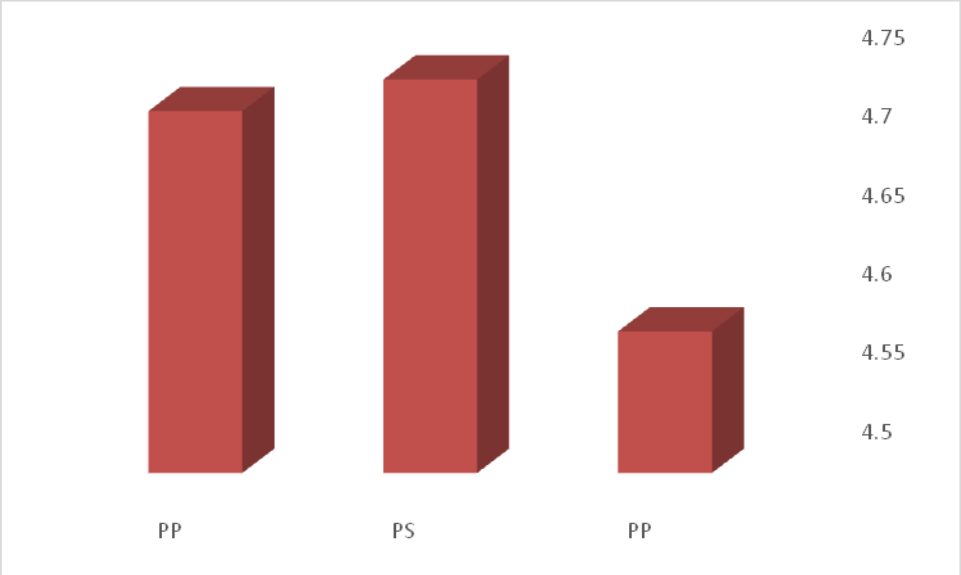

Fig.5 Appearance /Color of the pasteurized camel milk in winter

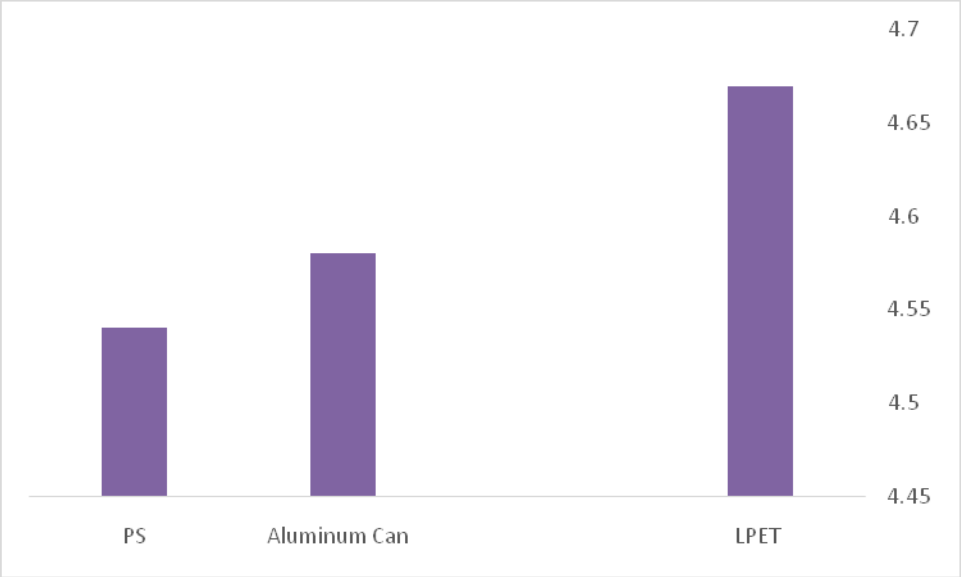

Fig.6 Texture of the pasteurized camel milk in winter

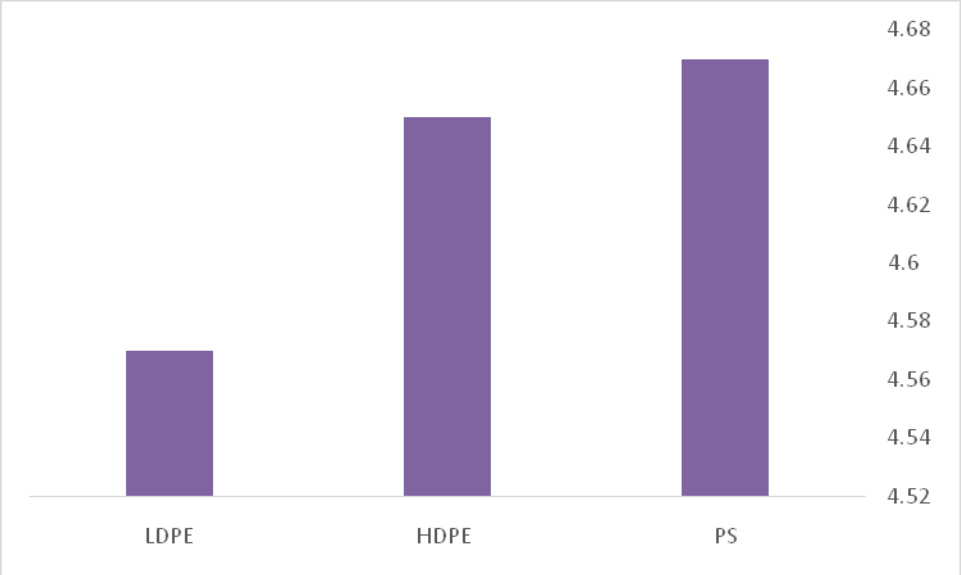

Fig.7 Smell /Flavor of the pasteurized camel milk in winter

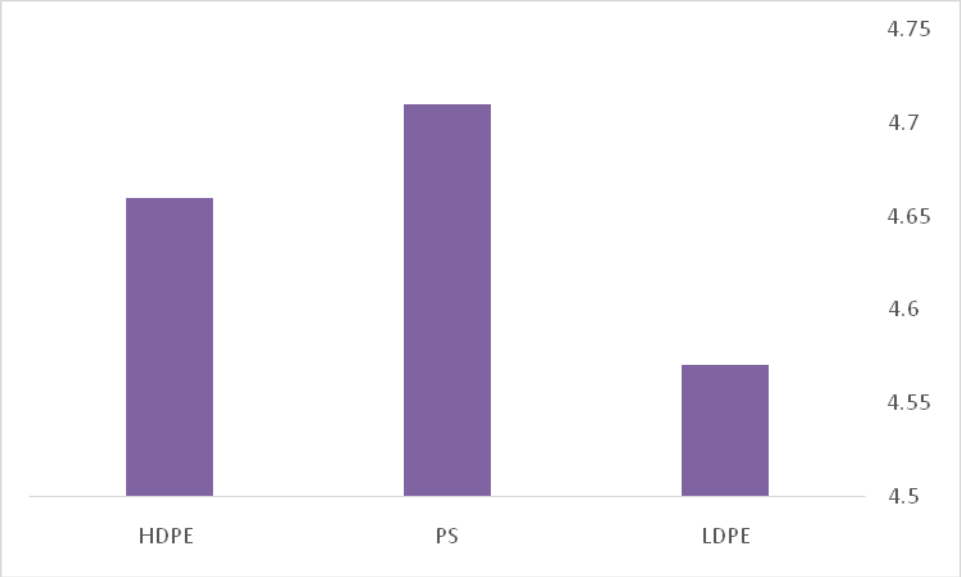

Fig.8 Taste /Mouth feel of the pasteurized camel milk in winter

Chemical Migration

The present results of overall migration test of the food packaging materials it is shown there is a chemical migration from the packaging to the food product, but it less than the limit of European union standards and this results agreement with the result of (Schmid and Welle, 2020). The review shows no evidence of critical substances migrating from packaging into beverages.

Testing the migration in real beverages during and at the end of the shelf life shows compliance with the specific migration limits. (Nijssen *et al.*, 1995) It has been found that residual monomers, such as ethylene glycol or terephthalic acid and isophthalic acid,

oligomers and degradation products, such as acetaldehyde, and catalyst residues may migrate from PETE to the product. (Khalil, 2016) he found plastic components migrate from the three types of the HDPE in the both simulants, distilled water and 3% of Acetic acid, at 70°C and 100°C of temperature even agreement with this study because in both migration level meets with the authorities' regulations.

The Present findings lead to conclusion there is no significant difference between the packaging materials on the microbial quality of the pasteurized camel milk and overall migration test, both are meet with specific regulations, but there is significant difference on the sensory evaluation of pasteurized camel milk between the different types of the packaging materials and also between the summer and winter season and may be due to the different composition of packaging materials and the effect of light transmission and oxygen permeability.

Based on, microbial quality, sensory evaluation and overall migration test for the packaging materials the shelf life of pasteurized camel milk (80 ˚C, 16 s) in this study was approximately 30 days.

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