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(Original Article)

Production of Fermented Camel Milk Beverage Flavoured with Some Plant Extracts

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Abstract

This study was conducted to study the use of different ratios of Lemongrass (2 & 4%) and Rosemary (1 & 2%) extracts in manufacture of fermented camel milk beverage. The chemical composition and nutritional values of camel milk, Lemongrass and Rosemary extracts were performed. All fermented camel milk beverage samples were analyzed for chemical, phenolic compounds, antioxidant activity, total volatile free fatty acids (TVFFA), microbiological and sensory properties when fresh and during storage (21 days) at 4±1°C. Our results indicated that, there were increases of total solids, fat, protein, ash and TVFFA contents in the flavoured samples with two plant extracts than that of control samples. Moreover, all the pH values significant decreased with the prolonging the storage period in all treatments. In addition, there were decreases in antioxidant activity and phenolic compounds of all treatments during storage period in all treatments. Microbiologically, the counts of *Str. thermophilus*, *Lb. delbrueckii* subsp. *bulgaricus* and total count increased at the 14 days of storage then decreased up to the end of storage period in all treatments. Generally, the data concluded that using of 4% Lemongrass and 1% Rosemary extract were gained higher scores for organoleptic properties than other treatments.

Keywords: *Camel milk, Fermented milk, Lemongrass, Rosemary.*

Introduction

Camel milk (CM) is the most similar to human milk of any milk. The composition of CM varies according to geographical region, physiological stage, milk production, feeding conditions, and health status or genetics. The gross composition of camel milk differs from that of other ruminants (Elkot *et al*., 2021). They differ from other ruminant milk in that it has low cholesterol, low sugar and high minerals (sodium, potassium, iron, copper, zinc & magnesium) and high amount of vitamin C, as well as a composition and health claims. CM has been used as medicines for diverse ailments science ancient time (Gader *et al*., 2016). Also, CM has become more popular among customers in recent years as a result of its therapeutic properties; these properties included antihypertensive, anti-diabetic, and anti-cancer (Elkot *et al*., 2022). Lactose-

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intolerant people often find it easy to digest. CM has the ability to lower increased levels of bilirubin, globulin and granulocytes (Yadav *et al*., 2015). It is a key part of human diet in many arid and semi-arid regions of the world. CM either fresh or fermented has been used to treat a variety of ailments in several parts of the world, including Africa and the Middle East. Its proteins have anticarcinogenic, anti-diabetic, and anti-inflammatory properties (Agrawal *et al.,* 2007). The natural flora became a very useful source for health improvement and to cure many diseases across various human communities and a variety of plants species are offered which are still in use in many parts of the world such as Asia South America and Africa for remedies against several diseases (Khalid *et al*., 2012).

Lemongrass (*Cymbopogon citratus*) contains many biological active compounds found in the leaves that play significant role in various health problems. Its aqueous infusion is mostly used for making aromatic beverage like tea and the whole plant is used into traditionally food, because of its lemony flavour as well as in folklore medicines (Figueirinha *et al.,* 2008). Lemongrass possesses cleansing properties and is regarded as efficient detoxifier that detoxifies gastrointestinal tract, liver, bladder, pancrease and kidney; as well as it regulates the levels of uric acid and cholesterol, reduces extra fat, body mass and different body toxins. However, it stimulates the lactation, food digestion and circulation but gastroenteritis and heartburn are reported by its severe use. Aqueous infusion of lemongrass is considered helpful in curing skin problems and reducing blood pressure. In addition, lemongrass has strong antitumor properties (Mirghani *et al.,* 2012). Rosemary is a member of the Rosmarinus genus (*Rosmarinus officialism* L.**)** (Valgimigli, 2012). It is mainly grown in Mediterranean countries such as Italy, Spain, Turkey, Egypt, Portugal, Greece, France, and North Africa as well as it is cultivated in other countries like Argentina, Brazil, and Uruguay **(**Miguel, 2007). Moreover, Kamel *et al*. (2022) used Rosemary essential oil as a potential natural preservative during Stirred like yogurt making.

The present study was to develop a new type of flavoured fermented beverage from CM (FFBCM) with high nutritive and healthy benefits using two extracts from leaves from Lemongrass and Rosemary (2 & 4%) and (1 & 2 %), respectively.

Materials and Methods

Materials

Fresh camels' milk was collected from areas around Aswan governorate. Rosemary (*Rosmarinus officinalis* L.) and Lemongrass (*Cymbopogon citratus*) were obtained from the local market at Aswan Governorate. Milk samples were immediately stored under refrigerated conditions until the transferring it to the laboratory. Skim milk powder (97% TS) produced in Poland by Varimex Company and commercial grade sugar (sucrose) was obtained from a local

market. Palsgaard 156 (used as a stabilizer) produced by Danisco Ingredients (Juelsminde, Denmark) by Misr Food Additives Company (MIFAD), Egypt.

Yoghurt culture, which consists of *Str. thermophilus* & *Lb. delbrueckii* subsp. *bulgaricus* were obtained from Chr. Hansen Laboratories, Copenhagen, Denmark. The working culture was prepared by adding few milligrams from the freeze-dried culture to 100 ml of sterile reconstituted skim milk. The mixture was then incubated at 42°C until the onset of gelation. Two milliliters of the mother culture from this passage were transferred into 100 ml of sterile skim milk at 42°C and incubated until a gel had just formed.

Methods

Preparation of Rosemary and Lemongrass concentrated extract

Rosemary (*Rosmarinus officinalis* L.) and Lemongrass (*Cymbopogon citratus*) powder was mixed each one alone with sterile water at the ratio of 1: 10 in a 250 ml bottle. The final volume of both plant extracts was 0.1 g/ml. The mixture was left for 12 h in water bath (70°C), followed by centrifugation (2000 rpm, 15 min at 4°C). The supernatant was collected and concentrated in a rotary evaporator, then used as an herbal concentrated extract in making of herbal-fermented beverage (Shori and Baba, 2014).

Preparation of FFBCM

The traditional method for making fermented CM was described by Tamime and Robinson (1999) with some modifications as follows:

Fresh camel milk, 3% cow skim milk powder and 0.5% (w/v) Palsgaard 156 were mixed and homogenized at 55-60°C for 2 min, using high speed mixer (2400 rpm/min) (T25B, IKA, Labortechnik, Germany), heated in a water bath at 85±1°C for 5 min. After cooled to 45°C, inoculated with 3% (v/v) of mother culture, followed by incubation at 42±1°C until pH reached to 4.5-4.6, then immediately cooled to 5±1°C for 4 h. Sucrose solution was added at the level of 6% and heated at 85±1°C for 5 min, then cooled and blended well with fermented CM. Mixture was divided into equal portions, the first one was used to prepare control (C), while other portions were used to prepare FFBCM with addition 2% (L1), 4% (L2) of Lemongrass extracted and 1% (R1), 2% (R2) of Rosemary extracted. Samples were mixed well individually, and then packed in 100 ml sterilized glass bottles and stored at 4±1°C. All treatments were analyzed at fresh and after 7, 14 and 21 days of storage periods at 4±1°C.

Chemical analysis

Total solids (TS), total nitrogen (TN), fat, titratable acidity percentages and pH values were measured according to the method described in AOAC (2010); total volatile free fatty acids (TVFFA) were estimated according to the method described by Kosikowski (1982). Total phenolic compounds (PCS) were determined by the Folin-Ciocalteau method following a published procedure (Roy *et al*., 2014). Antioxidant activity (AOA) was determined using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) method as described by Li *et al.* (2009).

Microbiological analysis

Total bacterial colony forming units (CFU): It was determined by using the standard plate count technique as described by Marshall (2004).

Lactobacillus spp. count: It was estimated on the selective medium for *lactobacilli* (MRS) as suggested by IDF (1997). The plates were incubated at 37°C for 48 h.

Streptococci count: It was determined by M17 agar medium (IDF, 1997).

Sensory evaluation

Sensory analysis was performed by the staff members of the Dairy Science Department and others according to according to El-Etriby *et al.* (1997) and Mehanna *et al*. (2000).

Statistical analysis

All data are presented as the mean ± SE. One-way analysis of variance (ANOVA) was performed using SAS (1999) $P<0.05$ was the level of significance.

Results and Discussion

Chemical composition of Lemongrass and Rosemary extracts

The chemical composition of Lemongrass and Rosemary concentrated extracts is shown in Table 1. The data presented that, the composition of Lemongrass extracted was 4.54, 0.32%, 13.16%, 2.31%, 88.12% and 18.83 mg/100 g for pH, acidity, TS, ash, AOA and PCS, respectively.

Table 1. Chemical composition of concentrated Lemongrass and Rosemary extracts

Ingredients	Lemongrass	Rosemary
pH	4.54 ± 0.31^{b}	4.94 ± 0.02^{a}
Acidity (%)	0.32 ± 0.01^{a}	0.30 ± 0.01^{b}
TS (%)	13.16 ± 0.02^{b}	26.12 ± 0.03^{a}
Ash (%)	2.31 ± 0.01^{b}	3.70 ± 0.02^{a}
AOA (%)	88.12 ± 0.01^{b}	92.10 ± 0.43^{a}
PCS (mg /100 g)	18.83 ± 0.24^{b}	23.75 ± 1.07^{a}

a, b: variables with different superscript within the same row are significantly different at $P \leq 0.05$.

Moreover, from the same Table, the composition of Rosemary extracted water was recorded at 4.94, 0.30%, 26.12%, 3.70%, 92.10% and 23.75 mg/100 g for pH, acidity, TS, ash, AOA and PCS, respectively. These results indicated that, water extracted of Lemongrass and Rosemary concentrated extracted show high an antioxidant activity; this is due to the substantial amount of their water-soluble phenolic contents.

Table 2. Chemical composition of FFBCM by using different levels of Lemongrass and Rosemary extracts during storage at 4±1°C for 21 days

Treatments	Fresh	7 days	14 days	21 days
		Total solids %		
C	13.65±0.03^{cB}	13.76±0.01^{cB}	13.91±0.03^{dB}	14.39±0.03^{dA}
L1	13.73±0.04^{bC}	13.95±0.12^{bC}	14.08±0.03^{cB}	14.83±0.03^{cA}
L2	13.82±0.07^{bC}	14.01±0.13^{bB}	14.37±0.71^{cB}	16.06±0.92^{aA}
R1	14.63±0.06^{aB}	14.73±0.07^{aB}	15.62±0.07^{aA}	15.92±0.05^{aA}
R2	14.66±0.97^{aD}	14.92±0.12^{aC}	15.19±0.06^{bB}	15.57±0.10^{bA}
		Fat %		
C	3.40±0.04^{cC}	3.56±0.04^{bB}	3.70±0.04^{bB}	4.03±0.07^{aA}
L1	3.96±0.03^{aC}	4.23±0.31^{aB}	4.24±0.03^{aB}	4.38±0.66^{aA}
L2	3.86±0.03^{bC}	4.13±0.33^{aB}	4.20±0.06^{aB}	4.23±0.03^{aA}
R1	3.90±0.60^{aC}	4.06±0.03^{aB}	4.31±0.03^{aA}	4.27±0.07^{aA}
R2	3.94±0.03^{aC}	4.03±0.04^{aB}	4.32±0.04^{aA}	4.30±0.06^{aA}
		Protein %		
C	3.83±0.02^{aA}	3.46±0.02^{bC}	3.60±0.02^{cB}	3.71±0.12^{dAB}
L1	3.26±0.04^{cB}	4.00±0.08^{aA}	4.01±0.09^{aA}	4.13±0.04^{aA}
L2	3.37±0.02^{bC}	3.57±0.24^{bB}	3.69±0.30^{bA}	3.87±0.04^{bA}
R1	3.13±0.03^{cA}	3.48±0.01^{bC}	3.58±0.07^{bB}	3.78±0.06^{cA}
R2	3.37±0.03^{bC}	3.49±0.08^{bC}	3.77±0.01^{aB}	3.88±0.03^{bA}
		Ash %		
C	0.85±0.05^{bC}	0.88±0.05^{bB}	0.88±0.05^{dB}	1.04±0.02^{cA}
L1	0.96±0.03^{bC}	0.99±0.08^{aB}	1.15±0.03^{aA}	1.15±0.11^{bA}
L2	0.96±0.03^{bB}	0.99±0.08^{aB}	1.08±0.04^{cA}	1.16±0.01^{bA}
R1	1.15±0.03^{aA}	0.93±0.03^{aB}	1.13±0.02^{bA}	1.03±0.02^{cA}
R2	1.16±0.03^{aA}	0.99±0.08^{aB}	1.20±0.01^{aA}	1.26±0.29^{aA}

a, b, c, d: means with the same column with different superscripts differed significantly between the treatments. A, B, C, D means with the same row with different superscripts differed significantly among the storage period. C (control): no addition, L1: FFBCM + 2% extracted Lemongrass, L2: FFBCM + 4% extracted Lemongrass, R1: FFBCM + 1% extracted Rosemary and R2: FFBCM + 2% extracted Rosemary.

Chemical composition of FFBCM

Data presented in Table 2 observed that, the TS, fat, protein and ash percentages of FFBCM is affected by addition of different levels of Lemongrass and Rosemary water extracts during storage at 4±1°C for 21 days.

Data presented in the same Table observed that, the TS percentages of FFBCM with Lemongrass and Rosemary water extracts in fresh samples were 13.73 & 13.82% and 14.63 & 14.66% in fresh samples and increased to 14.83 & 16.06% and 15.92 & 15.57% after 21 days of storage, respectively. The control samples had lower TS contents than that of FFBCM with Lemongrass or Rosemary concentrated extracts. These results were significant differences between the treatments ($P \leq 0.05$). Furthermore, TS percentages of different FFBCM samples increased gradually with increasing storage periods up to 21 days as a result of further evaporation of water or loss of moisture content. These results were in agreement with those reported by Hassan and Ismran (2010), and

higher than the obtained data by Bayoumi (1990), who found that the TS percent was around 13.40%.

Data presented in the same Table observed that, the fat percentages of different FFBCM samples regularly increased with increasing the cold storage period as a result of further evaporation of water or loss of moisture content. These results are in agreement with those reported by Shori (2013) and nearly similar to 4.6% reported by Mohamed and Larsson (1990). Moreover, Farah and Ruegg (1991) found the fat content were in the range of 1.1-5.5%. The control samples had lower TS contents than that of FFBCM with Lemongrass or Rosemary concentrated extracts. These results were significant differences between the treatments ($P \leq 0.05$).

Data presented in the same Table observed that, the protein percentages of different FFBCM samples regularly increases significantly with increasing the cold storage period as a result of further evaporation of water or loss of moisture content. The protein percentages of FFBCM with Lemongrass and Rosemary water extracts in fresh samples were 3.26 & 3.37% and 3.013 & 3.37% in fresh samples and increased to 4.13 & 3.87% and 3.78 & 3.88% after 21 days of storage; respectively. The control samples had lower protein contents than that of FFBCM with Lemongrass or Rosemary concentrated extracts. These results were in agreement with those reported by Elamin and Wilcox (1992) and Weerathilake *et al*. (2014); and they are higher than those reported by Bayoumi (1990). The differences may be due to breed, season, nutrition, and the addition of skim milk powder.

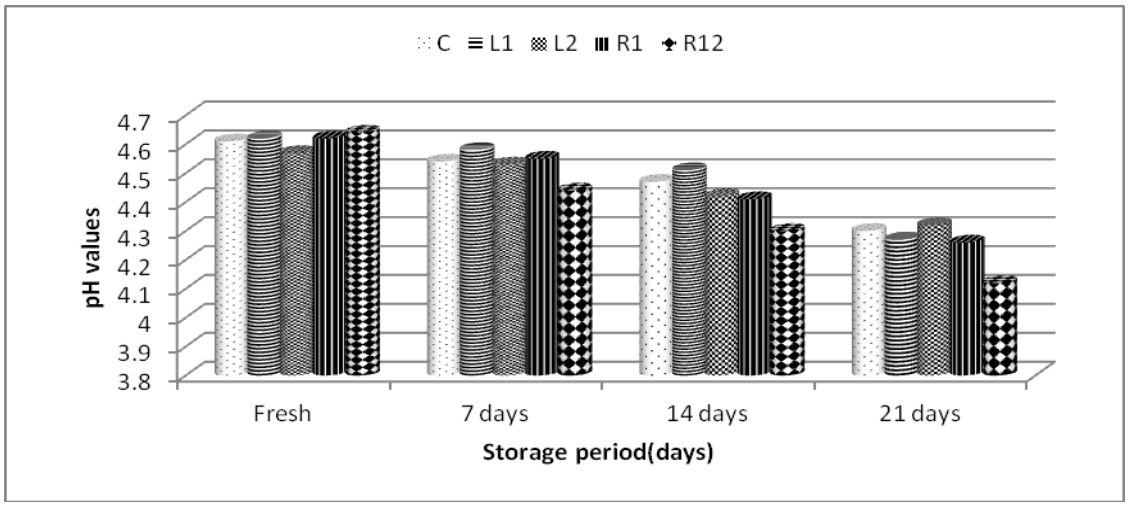

Fig 1. Changes in pH values of FFBCM by using different levels of Lemongrass and Rosemary extracts during storage at 4±1°C for 21 days. C (control): no addition, L1: FFBCM + 2% extracted Lemongrass, L2: FFBCM + 4% extracted Lemongrass, R1: FFBCM + 1% extracted Rosemary and R2: FFBCM + 2% extracted Rosemary.

Regarding ash percentages, the data observed that ash percentages of different FFBCM samples regularly increased significantly with increasing the cold storage period as a result of further evaporation of water or loss of moisture content. The ash percentages of FFBCM with Lemongrass and Rosemary water

extracts in fresh samples were 0.96 & 0.96% and 1.015 & 1.16% in fresh samples and increased to 1.15 & 1.16% and 1.03 & 1.26% after 21 days of storage; respectively. The control samples had lower ash contents than that of FFBCM with Lemongrass or Rosemary concentrated extracts. These results were in agreement with those reported by Elamin and Wilcox (1992), and it is higher than that reported by Osman (2013).

Changes in pH values of FFBCM with Lemongrass and Rosemary extracts are shown in Fig 1. It is clear from obtained data that, pH values are affected by addition of different levels of Lemongrass and Rosemary water extracts during storage at 4±1°C for 21 days.

The pH values of different FFBCM samples decreased gradually with increasing storage periods up to 21. This decrease as a result of fermentation of lactose to lactic acid. Similar results were obtained by El-Deeb *et al*. (2017).

Total volatile free fatty acids (TVFFA)

Data presented in Table 3 observed that, the TVFFA of FFBCM is affected by addition of different levels of Lemongrass and Rosemary water extracts during storage at 4±1°C for 21 days. Data presented in the same Table observed that, the TVFFA of different FFBCM samples regularly increased significantly with increasing the cold storage period in all treatments. It was found that, using Lemongrass extracts of FFBCM samples have lower in TVFFA compared to samples Rosemary extracts. The control samples had lower TVFFA than that of FFBCM with Lemongrass or Rosemary concentrated extracts, with wide variations between treatments ($P \leq 0.05$). A similar finding was reported by Omar *et al.* (2019). According to the results obtained by Slocum *et al*. (1988) showed that, the changes in the fat globule membrane structure resulted during storage and after heating by increasing the composition of protein lipid complex. These changes in the structure may change the susceptibility of fat globule membrane to lipolysis. This protein lipid complex may decrease the amount fat, which are available to lipolysis.

Table 3. Changes in TVFFA content of FFBCM by using different levels of Lemongrass and Rosemary extracts during storage at 4±1°C for 21 days

TVFFA (ml 0.1 N Na OH/100 g)				
Treatments	**Storage period (days)**			
	Fresh	**7**	**14**	**21**
C	7.20 ± 0.42^{bD}	7.90 ± 0.36^{cC}	8.40 ± 0.24^{dB}	8.90 ± 0.19^{dA}
L1	7.40 ± 0.14^{bC}	8.20 ± 0.28^{cB}	8.80 ± 0.11^{cA}	9.00 ± 0.26^{dA}
L2	7.50 ± 0.04^{bC}	8.70 ± 0.01^{bB}	9.10 ± 0.08^{cA}	9.40 ± 0.26^{cA}
R1	8.20 ± 0.44^{aC}	8.30 ± 0.18^{bB}	9.80 ± 0.16^{bA}	10.20 ± 0.26^{bA}
R2	8.40 ± 0.12^{aC}	9.30 ± 0.32^{aB}	10.20 ± 0.24^{aA}	10.80 ± 0.41^{aA}

a, b, c: means with the same column with different superscripts differed significantly between the treatments. A, B, C, : means with the same row with different superscripts differed significantly among the storage period. C (control): no addition, L1: FFBCM + 2% extracted Lemongrass, L2: FFBCM + 4% extracted Lemongrass, R1: FFBCM + 1% extracted Rosemary and R2: FFBCM + 2% extracted Rosemary.

Antioxidant activity (AOA) and Phenolic compounds (PCS)

Data presented in Tables 4 & 5 observed that, both AOA and PCS of FFBCM is affected by addition of different levels of Lemongrass and Rosemary water extracts during storage at 4±1°C for 21 days.

Data presented in the Table 4 observed that, Lemongrass or Rosemary concentrated water extracts to fermented camel milk showed a significant increase in AOA content proportional directly to increasing the flavouring level. Data in the same Table showed a significant decrease in antioxidant activity up to the end of the storage period in all treatments. These results are in agreement with Murakami *et al*. (2004) and Buchner *et al*. (2006).

Table 4. Changes in AOA of FFBCM by using different levels of Lemongrass and Rosemary extracts during storage at 4±1°C for 21 days.

The antioxidant activity (AOA)				
Treatments	**Storage period (days)**			
	Fresh	**7**	**14**	**21**
C	77.72 ± 0.16^{dA}	77.82 ± 0.14^{dA}	77.56 ± 0.29^{dB}	77.26 ± 0.15^{dC}
L1	89.02 ± 0.01^{cA}	86.12 ± 0.02^{cB}	80.79 ± 0.25^{cC}	77.86 ± 0.47^{cD}
L2	90.25 ± 0.03^{bA}	88.38 ± 0.04^{bAB}	81.33 ± 0.88^{cB}	78.29 ± 0.96^{bC}
R1	89.15 ± 0.03^{cA}	88.98 ± 0.01^{bA}	84.80 ± 0.29^{bB}	78.04 ± 6.50^{bC}
R2	91.08 ± 0.07^{aA}	90.29 ± 0.35^{aB}	86.50 ± 0.15^{aC}	79.92 ± 0.45^{aD}

a, b, c: means with the same column with different superscripts differed significantly between the treatments. A, B, C, : means with the same row with different superscripts differed significantly among the storage period. C (control): no addition, L1: FFBCM + 2% extracted Lemongrass, L2: FFBCM + 4% extracted Lemongrass, R1: FFBCM + 1% extracted Rosemary and R2: FFBCM + 2% extracted Rosemary.

It is clear that using flavoured Rosemary extract significantly increased the AOA than that of Lemongrass extract of the resultant samples. Moreover, the control samples had lower AOA contents than that of FFBCM with Lemongrass or Rosemary concentrated extracts. These results were significant differences between the treatments ($P\leq 0.05$).

Table 5. Changes in PCS of FFBCM by using different levels of Lemongrass and Rosemary extracts during storage at 4±1°C for 21 days

Phenolic compound content				
Treatments	**Storage period (days)**			
	Fresh	**7**	**14**	**21**
C	3.31 ± 0.05^{dB}	3.34 ± 0.05^{dB}	3.44 ± 0.05^{dA}	3.31 ± 0.05^{eB}
L1	7.85 ± 0.03^{cA}	7.63 ± 0.01^{cAB}	7.18 ± 0.12^{cB}	5.57 ± 0.19^{dC}
L2	8.12 ± 0.07^{bA}	8.03 ± 0.15^{bA}	7.43 ± 0.02^{bB}	6.05 ± 0.32^{cC}
R1	7.91 ± 0.03^{cA}	7.79 ± 0.01^{bA}	7.50 ± 0.25^{aB}	6.31 ± 0.15^{bC}
R2	8.32 ± 0.04^{aA}	8.29 ± 0.04^{aB}	7.62 ± 0.01^{aC}	6.38 ± 0.22^{aD}

a, b, c: means with the same column with different superscripts differed significantly between the treatments. A, B, C, : means with the same row with different superscripts differed significantly among the storage period. C (control): no addition, L1: FFBCM + 2% extracted Lemongrass, L2: FFBCM + 4% extracted Lemongrass, R1: FFBCM + 1% extracted Rosemary and R2: FFBCM + 2% extracted Rosemary.

Data presented in the Table 5 observed that Lemongrass or Rosemary concentrated water extracts to fermented camel milk showed a significant increase in PCS content proportional directly to increasing the flavouring level.

Data in the same Table showed a significant decrease in phenolic compounds up to the end of the storage period in all treatments. These results are in agreement with the results obtained by El-Deeb *et al*. (2017), who mentioned that the aqueous extract contains high levels of phenolic and possesses significant phenolic compounds, antioxidants and anticancer activities. This is due to the substantial amounts of their water-soluble phenolic compounds. It is clear that using flavoured Rosemary extract significantly increased the PCS than that of Lemongrass extract of the resultant samples. Moreover, the control samples had lower PCS contents than that of FFBCM with Lemongrass or Rosemary concentrated extracts. These results were significant differences between the treatments ($P \leq 0.05$).

Microbiological properties

Table 6. Growth of *Str. thermophilus, Lb. delbruecki* subsp. *bulgaricus* and T.C. (Log cfu/g) of FFBCM by using different levels of Lemongrass and Rosemary extracts during storage at 4±1°C for 21 days

Treatments	Storage period (day)	*Str. thermophilus*	*Lb. delbruecki* subsp. *bulgaricus*	T.C.
C	**Fresh**	7.45	7.97	6.44
	7	7.49	8.12	6.53
	14	7.39	8.21	6.75
	21	6.47	8.09	6.71
L1	**Fresh**	8.33	7.95	6.73
	7	8.58	7.85	6.85
	14	8.77	7.86	7.05
	21	8.68	7.67	6.92
L2	**Fresh**	8.64	7.83	6.80
	7	8.73	7.85	6.94
	14	8.81	7.89	7.12
	21	8.57	7.31	6.84
R1	**Fresh**	7.85	7.88	6.75
	7	7.94	7.94	6.88
	14	7.91	8.08	6.94
	21	7.79	7.92	6.68
R2	**Fresh**	7.82	7.89	6.69
	7	7.89	8.14	6.73
	14	8.01	8.12	6.64
	21	7.69	7.85	6.61

C (control): no addition, L1: FFBCM + 2% extracted Lemongrass, L2: FFBCM + 4% extracted Lemongrass, R1: FFBCM + 1% extracted Rosemary and R2: FFBCM + 2% extracted Rosemary.

Data presented in Table 6 observed that, the *Str. thermophilus, Lb. delbrueckii* subsp. *bulgaricus* and T.C. of FFBCM is affected by addition of different levels of Lemongrass and Rosemary water extracts during storage at 4±1°C for 21 days.

Data presented in the same Table observed that, the count of *Str. thermophilus* of FFBCM with Lemongrass water extracts (L1 & L2) in fresh

samples are ranged from 8.33 to 8.64 log cfu/g in fresh samples and ranged from 8.68 to 8.57 log cfu/g after 21 days of storage; whilst, the count of *Str. thermophilus* with Rosemary extracts (R1 & R2) ranged from 7.85 and 7.82 log cfu/g in fresh samples and ranged from 7.79 to 8.01 log cfu/g after 21 days of storage. These results are in agreement with Shihata and Shah (2002).

The counts at fresh, 7, 14 and 21 days were significantly different from each other. The increase in the count of *Str. thermophilus* at 7 and 14 days compared to fresh, while the counts decrease after 21 days of storage in most treatments but was higher than the initial bacterial count. The decrease in the count of *Str. thermophilus* between the 14 and 21 days of storage due to an increase in pH and the accumulation of organic acids (Shori, 2013). The decrease in *Str. thermophilus* count on the 21st day compared to the 14th day was possible, they due to the continuous pH decrease (Birollo *et al*., 2000). Cultures of *Str. thermophilus* show a high level of survival in the presence of different concentrations of total sugars. Moreover, *Str. thermophilus* strains are sensitive to the presence of acetaldehyde and diacetyl. These compounds are produced during the lactic acid fermentation and may be the reason for the reduction in the bacterial count (Vinderola *et al*., 2002).

Data presented in the same Table observed that, the count of *Lb. delbrueckii* subsp. *bulgaricus* of FFBCM with Lemongrass water extracts (L1 & L2) in fresh samples are ranged from 7.95 to 7.83 log cfu/g in fresh samples and ranged from 7.67 to 7.31 log cfu/g after 21 days of storage; whilst, the count of *Lb. delbrueckii* subsp. *bulgaricus* with Rosemary extracts (R1 & R2) ranged from 7.88 and 7.89 log cfu/g in fresh samples and ranged from 7.92 to 7.85 log cfu/g after 21 days of storage. These results are in agreement with those reported by Mani-López *et al*. (2014). The counts at fresh, 7, 14 and 21 days were significantly different from each other. There were increases in the count of *Lb. delbrueckii* subsp. *bulgaricus* at 14 and 21 days of storage in all treatments. The control samples had higher counts than that of other treatments. The count of *Lb. delbrueckii* subsp. *bulgaricus* between 14 and 21 days was attributed to the decrease in pH and accumulation of organic acids (Attia *et al*., 2001). The decrease in the number of viable cells during storage is explained by the post-acidification, increase in the amount of hydrogen peroxide and the presence of active antibacterial compounds in camel milk (Shori, 2013). The decrease in *Lb. delbrueckii* subsp. *bulgaricus* count on the 21-day compared to the 14 day was possibly due to the continuous pH decrease. Moreover, *Lb. delbrueckii* subsp. *bulgaricus* strains are sensitive to the presence of acetaldehyde and diacetyl. These compounds are produced during the lactic acid fermentation and may be the reason for the reduction in the bacterial count (Buchilina, 2020).

Data presented in the same Table observed that, the T.C. of FFBCM with Lemongrass water extracts (L1 & L2) in fresh samples are ranged from 6.73 to 6.80 log cfu/g in fresh samples and ranged from 6.92 to 6.84 log cfu/g after 21 days of storage; whilst, the T.C. with Rosemary extracts (R1 & R2) ranged from 6.75 and 6.69 log cfu/g in fresh samples and ranged from 6.68 to 6.61 log cfu/g

after 21 days of storage. It was found that, using amounts of Lemongrass and Rosemary extracts caused an increase of T.C. in FFBCM in fresh, 7- and 14-days storage; after that these counts decreased up to the end of storage, but the counts of FFBCM were higher than that of control samples. This may be due to the antibacterial effect, which was found in camel milk (Gran *et al*., 1991). These results are in line with those reported by Bozanic *et al*. (2000).

Organoleptic properties

Data presented in Table 7 observed that, the organoleptic properties of FFBCM is affected by addition of different levels of Lemongrass and Rosemary water extracts during storage at 4±1°C for 21 days.

Table 7. Organoleptic properties of FFBCM by using different levels of Lemongrass and Rosemary extracts during storage at 4±1°C for 21 days

Treatments	Storage period (day)	Flavour (45)	Body & texture (35)	Appearance (10)	Acidity (10)	Overall acceptability (100)
C	**Fresh**	38.66	29.00	8.00	8.00	83.67
	7	38.00	30.00	8.00	7.66	83.66
	14	37.33	29.00	7.33	7.33	81.00
	21	35.00	31.00	7.00	7.66	80.66
L1	**Fresh**	39.66	34.66	6.67	6.67	88.67
	7	41.33	31.00	7.66	8.16	87.16
	14	37.67	29.66	7.66	7.00	73.00
	21	39.33	30.63	8.33	8.33	85.66
L2	**Fresh**	43.33	31.00	9.00	8.00	91.33
	7	43.66	32.00	8.66	9.50	93.83
	14	42.66	32.66	7.66	8.33	91.33
	21	43.33	32.33	8.33	8.33	92.00
R1	**Fresh**	41.67	32.33	8.00	8.33	90.33
	7	42.33	32.66	8.67	8.33	92.00
	14	43.00	32.33	8.33	8.00	91.67
	21	37.00	30.00	7.33	6.66	81.00
R2	**Fresh**	36.33	29.67	6.33	6.33	78.66
	7	32.33	25.66	6.00	7.00	71.00
	14	34.00	32.33	6.67	6.67	75.67
	21	38.33	31.00	7.33	7.66	84.33

The data showed that, increasing the levels of Lemongrass and Rosemary extracts positively influenced the sensory scores of some properties of FFBCM. The maximum attainable score was given for the appearance of 7 days for L2 and R1 samples. There were significant differences ($p \leq 0.05$) in the overall scores for FFBCM with different levels of concentrated Lemongrass and Rosemary extracts during storage. Generally, the obtained results concluded that the addition of 4% of concentrated Lemongrass water extracted and 1% of concentrated Rosemary extracted gained higher scores for organoleptic properties than other treatments. This may be due to the acidic taste and deepest colour noticed in those samples.

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إنتاج مشروب لبن الإبل المتخمر بنكهة بعض المستخلصات النباتية

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الملخص

أجري هذا البحث لدراسة استخدام نسب مختلفة من مستخلصات عشبة الليمون (2 و4%) وإكليل الجبل (1 و2%) في صناعة مشروب لبن الإبل المتخمر. تم تقدير التركيب الكيميائي والقيم الغذائية للبن الإبل وخلاصة عشبة الليمون وإكليل الجبل، وقد تم تحليل جميع العينات من حيث التركيب الكيميائي والمركبات الفينولية والنشاط المضاد للأكسدة والأحماض الدهنية الطيارة الحرة والخصائص الميكروبيولوجية والحسية وهي طازجة وأثناء التخزين (21 يومًا) عند 4±1 درجة مئوية، وقد أشارت النتائج إلى وجود زيادة في محتوى المادة الصلبة الكلية والدهن والبروتين والرماد والأحماض الدهنية الطيارة الحرة في عينات مشروب لبن الأبل مع المستخلصين النباتيين، كما أن جميع قيم الأس الهيدروجيني انخفضت معنوياً مع إطالة فترة التخزين في جميع المعاملات، بينما كانت الحموضة عكس ذلك، بالإضافة إلى ذلك كان هناك انخفاض معنوي في نشاط مضادات الأكسدة والمركبات الفينولية لجميع المعاملات خلال فترة التخزين، كما أوضحت النتائج أن اعداد كل من الـــ *Str. thermophilus, Lb. delbrueckii* subsp. *bulgaricus* وإجمالي العدد الكلي للميكروبات زاد في فترة التخزين لمدة 14 يومًا ثم انخفض حتى نهاية فترة التخزين، وخلصت الدراسة إلى أن استخدام 4% من عشب الليمون و1% مستخلص إكليل الجبل قد حصل علي اعلي الدرجات في تقييم الخواص الحسية مقارنة بباقي المعاملات .