



**The possibility of converting  
camel (*Camelus dromedaries*)  
milk into milk products  
(cheese – yogurt )**

**By**

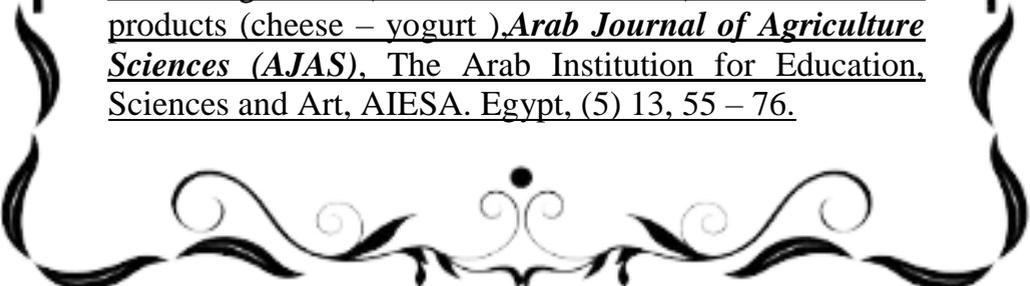
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**The possibility of converting camel (*Camelus dromedaries*)  
milk into milk products (cheese – yogurt )****Abstract:**

This study is carried out to investigate the possibility of converting camel milk into milk products (cheese – yogurt ), An experiment was conducted on converting camel milk to yogurt and soft white cheese, where 20 kilos of camel milk was used. The experiment was divided into two experimental groups, the first for 100% camel milk (CM) and the second experiment for 50 percent camel milk into 50 percent buffalo milk (CMB). Rennet was added in all samples, Then curd start to be formed. The results showed that adding 1 g of liquid animal rennet to 10 kg of milk led to the formation of milk curd. There were significant differences between the two experiments in terms of curd formation time and temperature in cheese formation 12 hours (CMB) and 24 hours (CM), respectively, while the temperature was from 80-85 degrees Celsius in (CMB), and 70-75 degrees Celsius in (CM). Milk pH and curd pH were measured during all cheese processing. the chemical composition of camel milk, There were significant differences between the two experiments in terms of curd formation time and temperature in yogurt formation 6 hours (CMB) and 8 hours (CM), respectively, while the temperature was from 45-48 degrees Celsius in (CMB), and 40 -45 degrees Celsius in (CM). Milk pH and curd pH were measured during all cheese processing average camel milk contains 81.4-87 % water, 10.4 % dry matter, 1.2-6.4 % milk fat, 2.15-4.90 % protein, 1.63-2.76 % casein, 0.65-0.80 % whey protein, 2.90-5.80 % lactose and 0.60-0.90 % ash. yogurt was produced using camel milk (CM) and (CMB). The pH (4.59-4.63) and titratable acidity (0.71-0.87 %) of the camel milk yogurt. yogurt contained 10.6 mg/mL of lactic acid based on HPLC. Camel milk cheese modified represents a

special feature as this cheese is traditionally made of whey and cream. the highly valuable whey proteins which contain a higher amount of the amino acids lysine, methionine in general, the greater soft cheese yields are accompanied by higher recovery of solids. However, more than 50% of the milk total solids were retained in the whey, which was white. Sensory evaluation by a taste panel was conducted to determine acceptability of cheeses and yogurt. The result showed that the transfer of cheese preparation technology from camel milk and yogurt, help camel keepers in the dry areas to improve their economic condition by finding a proper market of camel milk cheese..

**Key Word:** camel milk, Camelus dromedaries, cheese and yogurt.

#### المستخلص:

اجريت هذه الدراسة للتحقق من إمكانية تحويل لبن النوق إلى منتجات ألبان (جبين - زبادي) ، وأجريت تجربة على تحويل لبن الإبل إلى لبن زبادي وجبين أبيض طري ، حيث تم استخدام ٢٠ كيلو من حليب الإبل. تم تقسيم التجربة إلى مجموعتين تجريبية الأولى لحليب الإبل ١٠٠٪ والتجربة الثانية ٥٠٪ لبن الإبل إلى ٥٠٪ حليب جاموس. تمت إضافة المنفحة في جميع العينات ، ثم تبدأ في تكوين الخثارة. أظهرت النتائج أن إضافة ١ جرام من المنفحة الحيوانية السائلة إلى ١٠ كجم من الحليب أدى إلى تكوين اللبن الرائب. كانت هناك فروق معنوية بين التجريبتين من حيث زمن تكوين الخثارة ودرجة الحرارة في تكوين الجبن ١٢ ساعة (CMB) و ٢٤ ساعة على التوالي ، بينما كانت درجة الحرارة من ٨٥-٨٠ درجة مئوية في (CMB) ، و ٧٥- ٧٠ درجة مئوية في وتم قياس درجة حموضة الحليب ودرجة حموضة اللبن الرائب أثناء معالجة الجبن بالكامل. التركيب الكيميائي لحليب الإبل ، كانت هناك فروق معنوية بين التجريبتين من حيث زمن تكوين اللبن الرائب ودرجة الحرارة في تكوين الزبادي لمدة ٦ ساعات (CMB) و ٨ ساعات على التوالي ، بينما كانت درجة الحرارة من ٤٨-٤٥ درجة مئوية. في (CMB) ، و ٤٥-٤٠ درجة مئوية في . تم قياس درجة حموضة الحليب ودرجة حموضة اللبن الرائب أثناء معالجة جميع الجبن ، حيث يحتوي متوسط حليب الإبل على ٨١،٤-٨٧٪ ماء ، ١٠،٤٪ مادة جافة ، ١،٢-٦،٤٪ دهن حليب ، ٢،١٥-٤،٩٠٪ بروتين ، ١،٦٣-٢،٧٦٪ كازين ، ٠،٦٥-٠،٨٠٪ مصل بروتين اللبن ، ٢،٩٠-٥،٨٠٪ لاكتوز ، ٠،٦٠-٠،٩٠٪ رماد.

تم إنتاج الزبادي باستخدام حليب الإبل (CM) و (CMB). الأس الهيدروجيني (٤,٥٩-٤,٦٣) والحموضة القابلة للمعايرة (٠,٧١-٠,٨٧٪) من لبن الإبل. يحتوي الزبادي على ١٠,٦ مجم / مل من حمض اللاكتيك على أساس HPLC. يمثل جبن حليب الإبل المعدل ميزة خاصة حيث أن هذا الجبن مصنوع تقليدياً من مصل اللبن والقشدة. بروتينات مصل اللبن عالية القيمة التي تحتوي على كمية أعلى من الأحماض الأمينية ليسين ، ميثيونين بشكل عام ، كلما زادت إنتاجية الجبن الطري مصحوباً باسترداد أعلى للمواد الصلبة. ومع ذلك ، تم الاحتفاظ بأكثر من ٥٠٪ من إجمالي المواد الصلبة للحليب في مصل اللبن ، والذي كان أبيض. تم إجراء تقييم حسي من قبل لجنة التذوق لتحديد مدى مقبولية الجبن والزبادي. وأظهرت النتائج أن نقل تقنية تحضير الجبن من لبن النوق والزبادي يساعد مربّي الإبل في المناطق الجافة على تحسين حالتهم الاقتصادية من خلال إيجاد سوق مناسب لجبن لبن النوق.

## INTRODUCTION

Camel milk is very important source of nutrient for human in several arid and semi-arid zones [1]. camel milk considers the most important product obtained from camel being a complete food, helps to provide a nutritious and balanced diet to nomadic desert people under harsh conditions. Both milk yields and the nutritional composition of camel milk are affected by many factors, including forage quantity and quality, watering frequency, climate, breeding age, parity, milking frequency, calf nursing, milking method (hand or machine milking), health, and reproductive status".[2] it is on paper technically impossible to turn into cheese. Regular (calf/kid) rennet and traditional methods of using rennet do not work in coagulating camel milk; you must use Camel chymosin. Camel milk is becoming an increasingly interesting product in the world, not only for its good nutritive properties, but also for its interesting and tasteful products. rennet agent coming from vegetal sources for camel cheese making [3]. Regarding bovine rennet, a lot of parameters (rennet quantity, time of coagulation, curd description, pH value) for technological production of cheese from camel milk were studied [4].

However, Hansen<sup>TM</sup> (Denmark) delivered recently new coagulant agent named "Chy-Max M" containing camel chymosin [5]. In the traditional pastoral communities, camel milk is consumed fresh or fermented [6] Although camel milk has been consumed for centuries, camel milk products are not common. Recently, however, the manufacture of camel milk products, such as ice cream (4), butter (10), and fermented camel milk (11), has been reported. Reports of possible methods for making cheese from camel milk are rare and often contradictory. Some authors (9, 15, 16, 18, 19, 25, 26) reported that the addition of calcium chloride and rennet to camel milk caused a clotting reaction and the formation of a soft light coagulum, but others (14) stated that camel milk alone cannot be coagulated with rennet. However, (20) and only after it is mixed with the milk of other species (goats, sheep, or buffalo). However, a recent study (17) in Somalia on hard cheese manufacture from camel milk showed that hard cheese could be made from camel milk if whey culture is included.

#### **MATERIALS AND METHODS**

Milk used for making good cheese must meet certain critical physical, chemical and microbial standards. These standards, which should be rigorously imposed when the milk is intended for human consumption, Fresh whole camel milk was obtained from the herd of Camel studies and development center in Matrouh were collected. Milk was immediately cooled to 5 C, transported to the pilot plant, and maintained cold until use. Camel skim milk was obtained by separation of raw camel milk at 45 C, using an Electrem 1 Separator (Electro Eremeuse Constructeur, Paris, France)

Rennet powder, calcium chloride, yogurt B-6 starter (a mixed strain of *Streptococcus salivarius* ssp. *thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*), and lactic

fermentation CH-normal 01 starter (a mixed strain of *Lactococcus lactis* ssp. *cremoris*, *Lactococcus lactis* ssp. *lactis*, and *Lactococcus lactis* ssp. *diacetylactis*) were obtained from Chr. Hansen's Lab. A1S (Copenhagen, Denmark). Salt was obtained from a local market. methods were used to manufacture soft white cheese from camel milk and yogurt. One method utilized 10 L of whole milk in cheese, the second method utilized 10 L of milk containing , yogurt starter culture, and rennet. Rennet (.004%, wtlwt) was added to coagulate each milk sample within 2 to 3 h. The coagulum of each milk was ladled and left to drain for 20 to 24 h. The resultant cheeses were weighed, cut into blocks, packed in plastic bags, and stored at refrigerated temperature (5 C) for 1 d until analysis.

Milk, whey, and cheese samples were analyzed for moisture, fat, salt, and total nitrogen, as described by Ling (25). Ash was determined by use of a muffle furnace at 550·C (8).

Natural acidification of camel cheese curd The pH value was measured at 20°C and 36°C during 10 hours with Ph-meter Hanna Instruments HI221 pH/mV/ORP

### **Cheese Yields and Component Recovery**

Cheese yields were calculated as a weight of cheese divided by weight of milk expressed as a percentage. Recovery of components (protein, fat, and milk total solids) was calculated as the weight of the component in the cheese divided by the original weight of the component in the milk expressed as a percentage. Sensory Evaluation Sensory evaluation of cheeses was performed after 1 d of storage at 5 ± I·C. The cheeses were evaluated by a panel of staff members, and students who were familiar with soft white cheese and yogurt

### **Make yogurt**

The process of making yogurt goes through several steps, during which the ingredients for yogurt are added, and these steps are as follows: the milk, which is one of the main

components of yogurt, is heated, and the milk is left until its temperature reaches 85 for CMB and 75 for CM degrees Celsius, and this may take approximately 10-30 minutes, and the longer the heating time of the milk, the denser the yogurt. After that, the temperature is reduced to 44 degrees Celsius. Good or beneficial bacteria are added, Probiotic fermented camel's milk was manufactured according to the method reported by(13) (28) usually *Lactobacillus bulgaricus*, these bacteria consume the sugar in milk, producing a substance called lactic acid, which in turn coagulates proteins Milk, thus the milk becomes a thick yoghurt.



### Camel Yogurt box

#### **Cheese making ingredients**

ten liters of milk, preferably full fat. Half a cup of white vinegar. 2 teaspoons salt. Half a tablespoon of the pond.

#### **How to prepare**

Place the milk in a deep saucepan with a thick base, and leave on medium heat, until the milk boils vigorously. Remove the pot from the heat, add vinegar, and stir for a minute with a large wooden spoon. Set the milk aside for a few minutes, and

we will form a layer on the face of the milk, as well as lumps in the milk. Drain the milk with a soft strainer, and place in a large piece of clean cloth or in a gauze envelope. Add the pond grain and salt to the milk [27],(24) stirring gently, until the salt is mixed with milk. Press the milk mixture by hand, until it gathers under the envelope. We put the envelope in a large plastic strainer, preferably with wide holes. Place a heavy object over the envelope, according to glass. Leave the cheese aside in a cool place, for at least four hours, and it's worth noting that the longer it lasts, the better. We get rid of the water in the dish from time to time. Remove the cheese from the envelope after the passage of time, cut it into squares or slices as desired, and serve with green olives, and municipal bread.



Camel  
milk in  
deep  
saucepan  
with a  
thick  
base on  
medium  
heat



Camel cheese in a gauze envelope



Camel cheese with Nigella sativa and olive oil

### Statistical Analysis

Data from the cheese-making trials were statistically analyzed using analysis of variance of the SAS package (22)

### Sensory Evaluation

Sensory evaluation of cheeses was performed after 1 d of storage at  $5 \pm 1$ °C. The

cheeses were evaluated by a panel of staff members, and students who were familiar with soft white cheese, Sensory

attributes of appearance, texture, flavor, and overall acceptability were considered by the panelists. A nine-point hedonic scale (23) was utilized in this study (9 = like extremely, 5 = neither like nor dislike, and 1 =dislike extremely). Panelists were also asked to list any defects. The cheeses and yogurt were randomly coded with three-digit numbers. Cheeses manufactured on the same day were evaluated together. Each attribute was separately scaled and analyzed. Sensory attributes were analyzed for significance along with the other measurements as described in the

## **RESULTS AND DISCUSSION**

### **Experimental Camel cheese**

Coagulation properties Before testing the milk, its gross physicochemical composition was analyzed (tab.1) and its microbiological status was assessed (total flora and coliforms).

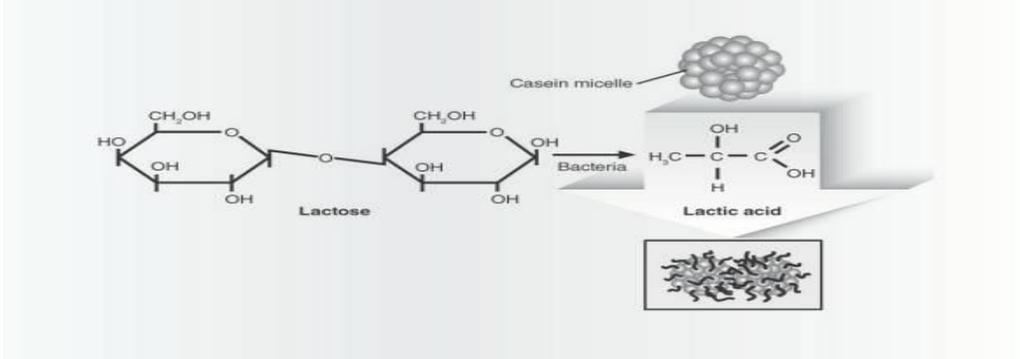
**Table 1. Global composition of camel milk (g/100g).**

<b>Parameter</b>	<b>Mean and SD</b>
Fat	3.02 ± 0.15
Protein	2.52 ± 0.03
Solid non-fat	8.03 ± 0.13
Water	86 ± 0.16
ash	0.6 ± 0.12
Lactose	3.5 ± 0.17

<sup>ns</sup>: Not significant <sup>\*\*</sup>: significant ( $p \leq 0.05$ )

Soft cheeses, such as cream cheese, coagulate slowly. As bacteria produce lactic acid, the other layer of the casein micelle becomes less and less polar. The micelles begin sticking together at around pH 5.3,[31](12) with full coagulation after 24 hours, at pH 4.6. After the bacteria replicate and culture the milk at the optimal temperature, the milk coagulates and changes from a liquid into a firm, rubbery material. This change takes an hour or two and is possible because of the casein proteins in milk. Casein molecules aggregate into spheres called micelles. The outer layer is negatively charged, which allows the micelles to remain

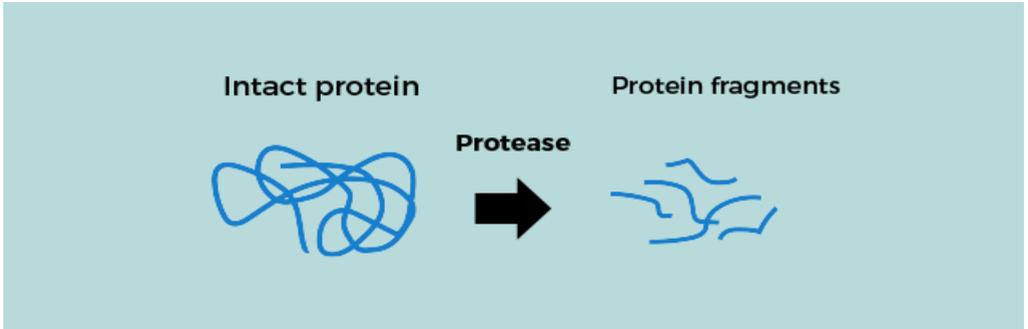
dispersed in liquid milk. To form cheese, the proteins must coagulate, or stick together (Fig.1).



**Fig 1. Casein comprises 80% of the protein in milk. The casein molecules are normally wrapped into compact spheres that are packed together with calcium and phosphate ions to form microscopic micelles. Acid causes the casein molecules to partially unfold and link with each other.**

Cheese curds are transferred into molds to drain completely and to give the cheese its final shape.

**Fig 2. The breakdown of protein, proteolysis, can lead to a softer/weaker cheese**



**Table 2: Manufacturing parameters for soft white cheese from camel milk:**

ITEM	CMC	CMBC
Initial pH of milk	6.55± 0.15	6.32± 0.15
Titrateable acidity, %	0.15± 0.15	0.15± 0.15
pH at rennet addition	6.43± 0.15	6.36± 0.15
clot formation time	24± 0.15	12± 0.15

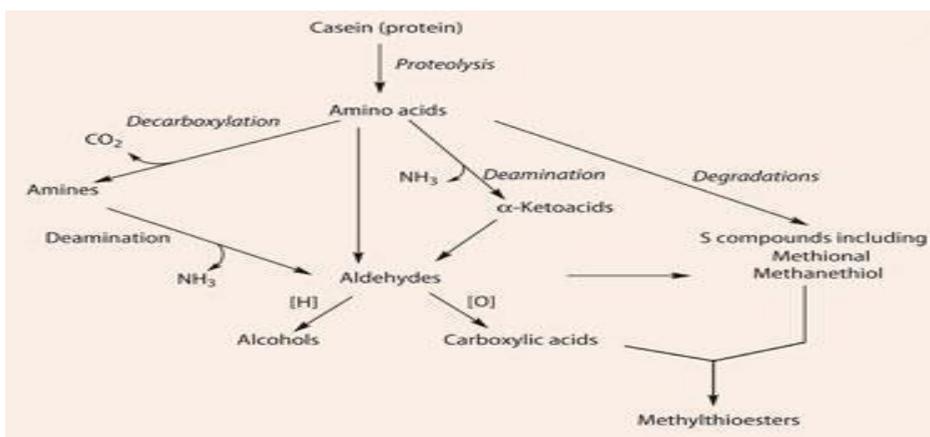
**CMC:** cheese camel milk **CMBC:** cheese of camel milk mix with buffalo milk 1:1

<sup>ns</sup>: Not significant <sup>\*\*</sup>: significant ( $p \leq 0.05$ )

The physico-chemical composition of camel milk was analyzed before starting the experimentation. The fat and protein contents of our camel milk were in the range of the normal values reported in the literature(29)(30). To transform milk into cheese, the gel obtained after coagulation play important role. calcium ions help to attend this gel stable in all types of milk. Usually calcium phosphate or calcium chloride is used, mainly on milk after heat treatment [21]. It is stated that to get firmness curd of camel milk, 10-15 g of calcium chloride per 100 kg of milk have to be added when bovine rennet is used (30)Indeed, in our trial, camel milk was not heated. In such conditions, camel milk showed no effect of adding of calcium ions, whatever the form, phosphate or chloride on clotting time and yield. In all published data, the described trials used heat treated camel milk. In the case of preparation of different types of cheese from camel milk, it is necessary to know the acidification patterns, how many times it takes before attend determined pH value. For coagulation of milk, These technological parameters of camel milk processing into cheese by camel rennet represent

informative steps for further trials and could be useful for industrial scale cheese processing of camel milk.

**Fig3. Proteins in milk are broken down first into peptides, then amino acids, then finally converted into a range of other molecules contributing to the taste and smell of cheese (8)**



yield of fresh cheese was increased by direct acidification of milk before renneting, which indicates that curd firmness plays an important role in determination of fat recovery because acidification normally improves curd. The yield was lowest ( $P < .05$ ), 10.10%, with whole milk and Table 3. This low yield may have been caused by the lower moisture content in the cheese and by less recovery of protein, fat, and solids of cheeses. However, the average fresh cheese yield ( $12.29 \pm 1.63\%$ ) obtained from camel milk was lower than that reported from buffalo.

**Table 3. Means of yield and recovery of protein, fat, and milk total solids of fresh soft white cheeses made from camel milk.**

Item	Yield	Total solids	fat	protein
CMC	10.10± 0.13	39± 0.02	68± 0.14	60± 0.13
CMBC	13.3± 0.02	45± 0.12	75± 0.12	79 <sup>a</sup> ± 0.15

**CMC:** cheese camel milk **CMBC:** cheese of camel milk mix with buffalo milk 1:1

<sup>ns</sup>: Not significant <sup>\*\*</sup>: significant ( $p \leq 0.05$ )

### Experimental Camel yoghurt

Camel milk produced a thin, flowing, and very soft yogurt. Then, CM was boiled for 30 min in a water bath to inactivate the antimicrobial agents. [4] heating CM at 100°C for 30 min resulted in complete loss of antimicrobial agents. The boiled CM did not produce a firm yogurt, indicating that antimicrobial agents present in CM had no effect on firmness of the yogurt. The body and texture of yogurt should be firm, smooth, uniform, and free of lumps. Textural defects of cultured dairy products include weak body, wheying-off, and lumpiness).

pH ranged from 4.3 to 4.5 and titratable acidity ranged from 0.98 to 1.16% as percentage of lactic acid. Previous reports indicated that lactose content was responsible for the coagulum formation. [6] dia-filtered milk containing less than 2% lactose produced yogurt with soft coagulum, whereas milk containing at least 2% lactose formed a coagulum. Although the acidification rate of lactic acid bacteria may vary with the type of milk, similar results were reported for mixtures of cow and goat milk) and in garris, a Sudanese traditionally fermented camel milk).

**Table 4. Some parameter of experimental yoghurt**

Item	ph.	Fat %	Protein%	Ash %	Total solids%
CMY	5.65± 0.23	2.4± 0.96	2.97± 0.15	0.71± 0.15	11.6± 0.15
CMBY	5.42± 0.22	4.21± 0.15 <sup>a</sup>	3.5± 0.15	0.75± 0.15	12.82± 0.15

**CMY:** yogurt camel milk **CMBY:** yogurt of camel milk mix with buffalo milk 1:1

<sup>ns</sup>: Not significant <sup>\*\*</sup>: significant ( $p \leq 0.05$ )

CMBY yoghurt revealed significantly higher ( $P \leq 0.01$ ) fat, ash and total solids content in comparison to that made from CMY

**Table 5. Some parameter of experimental yoghurt**

Item	CMY	CMBY
Temperature of manufacture	40 - 45°	45 - 48°
Curd duration .h	8	6
Aadditives	Starter + local yoghur + Full Cream Milk Powder	Starter +local yoghurt

**CMY:** yogurt camel milk **CMBY:** yogurt of camel milk mix with buffalo milk 1:1

<sup>ns</sup>: Not significant <sup>\*\*</sup>: significant ( $p \leq 0.05$ )

### Sensory analysis

there were significant ( $P < 0.05$ ) differences in the intensity of attributes such as colour, salty taste, bitter taste aftertaste, hardness, chewiness, rubbery, dryness, and grainy caused by difference between experiments. In table 6 some definition of a attributes for profiling of the cheese and yoghurt.

[7]

**Table 6. Definitions of attributes for profiling of the cheese and yoghurt**

Descriptor	Definition
color	visual estimation of intensity
Creamy odour	smell of market cream (30%)
Acid odour	typical note of fermented milk products such as yoghurt
Salty	taste, basic taste typical of sodium chloride as diluted in water (0.2%)
sweet	fundamental taste sensation of which sucrose is typical
Acid	taste of fermented milk products
Aftertaste	aftertaste which continued after the removal of the sample
Hardness*	the force needed by the jaws to bite the sample into two pieces
Chewiness	time and multiplicity of chewing the product to prepare it to swallow
Rubbery	the ability of the sample to regain shape after pulling
Dryness (moisture)	moisture that exists in the sample, mouthfeel after 4, 5 chews
Grainy	the ability of the sample to break into pieces

**Table 7. Overall liking attribute means from consumer acceptance testing of cheese and yogurt**

Item	CMC	CMBC	CMY	CMBY
Appearance liking	2.6± 0.2	4.5± 0.2	3.1 ± 0.2	4.7± 0.22
Color liking	3.1± 0.2	4.2± 0.2	2.5± 0.22	3.8 ± 0.12
Flavor liking	3.4± 0.2	4.6± 0.2	1.2± 0.22	4.9 <sup>a</sup> ± 0.22
Thickness liking	4.2± 0.2	4.7 <sup>a</sup> ± 0.2	1.3± 0.22	2.4± 0.22
Smoothness liking	2.6± 0.22	2.8 ± 0.2	2.5± 0.22	2.7± 0.22

Texture liking	4.1± 0.12	4.7 ± 0.2	3.2± 0.22	3.4± 0.22
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means signify significant differences ( $P < 0.05$ ). Data represent 150 consumers. Liking attributes were scored on a 0-point hedonic scale, where dislike extremely = 1 and like extremely = 5

yogurts and cheeses had small but distinct flavor and texture differences by descriptive sensory analysis. Consumers were aware of the increased protein content of yogurts and cheese but generally unaware of differences between yogurts. Both yogurts received high overall liking scores in blinded acceptance testing. These results indicate that successful fortified yogurts can be manufactured using addition of dried dairy ingredients or by traditional straining and centrifugation. External preference mapping demonstrated consumer preferences for CMBY yogurt and cheese having a moderate amount of sweet and sour taste, high milk fat flavor, and high firm and dense texture. Burnt/beefy flavor was a consistent driver of dislike across all 3 consumer clusters; this particular flavor was detected only in fortified CMBY yogurts and cheese with added dried dairy ingredients, suggesting that careful selection of dried ingredients and processing parameters play an important role in manufacture of CMBY,CMBC style with consumer appeal.

### Conclusion

Manufacture of fresh soft white cheese from camel milk appears to be feasible. Composition of cheeses and yoghurt obtained from this study compared favorably with different cheese composition reported from buffalo milks (1). The average cheese yield ( $12.29 \pm 1.63\%$ ) obtained from camel milks was lower than that reported for mix camel milk and buffalo milks (6, 7, 21). Fresh soft white cheeses made from camel milk and yogurt were

the most acceptable. Based on these , the composition of the best cheeses, as selected by the panelists, treatments combinations resulted in soft camel milk cheese with good flavor, texture, and overall acceptability. CMC ,CMBC,CMBY,CMY, However, more research is needed to study the mechanism of enzymatic coagulation of camel milk, to improve the quality and the yield of camel milk cheeses, and to utilize the nutritious whey that is produced from cheese making with camel milk. Moreover, These technological parameters of camel milk processing into cheese and yoghurt by camel rennet represent informative steps for further trials and could be useful for industrial scale cheese processing of camel milk.

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**The possibility of converting camel..**

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