Damietta Journal of Agricultural Sciences
http://publication.du.edu.eg/journal/ojs302design/index.php/agr/index
ISSN: 2812-5347(Print)- 2812-5355 (Online)

Physicochemical, Microbiological Properties of Fermented Camel Milk

Mohamed Nour-Eldin Farid Hamad[1]; Sherif Mohamed Lotfi El-Kadi[2]; and Maha Hassan Hassan Zohny[1*]

[1]Food Science Department, Fac. of Agric., Damietta University, Damietta, Egypt
Email address: dr_mnour@du.edu.eg ORCID: http://orcid.org/0000-0003-4423- 0396
[2]Agricaltural Biotechnology Department, Fac. of Agric., Damietta University, Damietta, Egypt
Email address: sherifelkadi@du.edu.eg, *ORCID:* http://orcid.org/0000-0003-0823-7478
Corresponding author*: Maha Hassan Hassan Zohny Email: maha.zohny@students.du.edu.eg

ARTICLE INFO

Key words:
Camel Milk
Fermented Milk
Gahrawy Mango
Strawberry
Guava
Dates

Abstract

The aim of this study was to produce and develop fermented products from CAM, by using two strains and fortified with different types of local fruit's pulp. Production of yoghurt from CAM by the same method as cow's milk is very difficult because it can't coagulate easily. The best method to produce fermented CAM with acceptable texture and appearance was obtained by using 1.5% of stabilizer, 5% of skim milk powder to the milk followed by pasteurization in water bath at 85° C for 30 min., then cooling the mixture to 42°C before adding 1.5ml/L of food grade calcium (40%w/v) and 8 % of starter culture, then incubate the mixture at 42°C for 5 hr. The physicochemical properties of the produced fermented CAM by this method were: 1.36%, 23.63%, 1.4%, 4.1%, and 3.95% for TA, TS, ash, protein and fat, respectively, and when it analyzed microbiological, the average of the TBC was: 5.27× 10^3 CFU/ml and the numeration of *S. thermophilus* and *L. delbrueck*ii subsp. *bulgaricus*, which were: 4.74× 10^3 CFU/ml and 4.84 × 10^3 CFU/ml, respectively, and the average of yeasts count after 5 days incubation was 2× 10^3 CFU/ml. As for the organoleptic properties; product's colour and flavour didn't affected by using various percentages of stabilizers, but the texture improved by increasing the amount of the used stabilizer, Which resulted in reaching an acceptable texture of the fermented CAM. Fermented CAM taste can be improved by adding the fruit's pulp to it after the end of incubation period to be more acceptable to the consumers. The most acceptable flavour which was fortified with 35% (v/w) of date pulp followed by the samples fortified with 50% (v/w) of gahrawy mango pulp. As for the percentages of other types of fruits (strawberry and guava) they needed to be modified, because it turns out that they were not enough to be a sweetener agent to the fermented CAM.

INTRODUCTION

Camels are essential non-ruminant animals that produce nutritive milk for human consumption. Statistical reports indicate, there were 35 million camels all over the world **(Silbermayr *et al*., 2010 and Mihic *et al*., 2016).**

Camel milk (CAM) is rich in many nutrients, including fat, protein, lactose, vitamins, and minerals **(Khalesi *et al*., 2017).** Having low cholesterol, low sugar, high minerals (sodium, potassium, iron, copper, zinc, and magnesium), and high vitamin C makes it distinct from other ruminant milk **(El- Deeb *et al*., 2017).**

Fermented milk products are in high sought after by consumers because of their advantages for health, portability and ease of use. Drinkable yoghurts are fermented milk products that are popular in the Middle East and other parts of the world **(Sobti *et al*., 2023).** CAM yoghurt production suffers significant limitations from weak or no gel formation due to a lot of factors **(Mudgil *et al*., 2018).**

Mango (*Magnifera indica L.)*appears in various shapes and sizes; it contains 15% sugars, 1% protein, major amounts of antioxidants, carotenoids, minerals and vitamins A, C and B complex **(Jahurul *et al.*, 2015).**Strawberries (*Fragaria ananassa)* are a great source of several mineral elements, including K, Mg, and Ca. It has a multitude of health benefits, such as improving cardiovascular health, increasing sensitivity to insulin, reducing the risk of certain cancers and maintaining a healthy immune system **(Ngouana *et al* 2023).** Guava fruit (*Psidium guajava)* is a great source of vitamin C, and antioxidant. The flesh directly below its thick outer rind has much more vitamin C than the creamy inner pulp. It contains many essential vitamins and minerals and antioxidant, but is low in calories and fat as a result of this it play a crucial role in the prevention of cancers, aging, and infections **(Rizk, 2016).**

Dates (*Phoenix dactylifera L.)* may be considered as an almost ideal food, providing a wide range of essential nutrients and potential health benefits (**Al-Shahib and Marshall, 2003).**It is an important source of supplying vitamin elements and minerals in a balanced nutrition regime **(Gad *et al.*, 2010).**

Thus, the aims of this study were to investigate the possibility of making fermented CAM with good quality, and fortifying it with fruit pulps to improve its quality and study their effect on its physicochemical, microbiological and sensory properties.

Materials and Methods

Materials

Fresh CAM was obtained from randomly selected camels during summer season throw Animal Production Research Institute, Dokii, Giza,Egypt. Milk samples were kept in the deep freezer of the laboratory at -18° C until the analysis time. Starter culture of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus* was produced by CHR. Hansen Company, Denmark. Stabilizer containing: Mono and Diglycerides of fatty acids, Carrageenan, Arabic gum, Guar gum and Sodium carboxymethyl cellulose, was purchased from Dairy Way Company, Mansoura Governorate, Egypt. . Food grade anhydrous calcium chloride was obtained from Elmasria for chemicals, Egypt. Skim milk powder and natural fruits were purchased from local markets in Damietta Governorate, Egypt. All other chemicals were purchased from El-Gomhoria for chemicals company, Mansoura, Egypt.

Methods

Starter culture preparation:

Three different percentage of starter culture were prepared (4%, 6% and 8%) to examine the best percentage of adding starter culture to manufacture fermented CAM. Each percentage was prepared by adding 100 ml of reconstituted skim milk, which was autoclaved at 121° C for 15 minutes and then cooled to 42°C, followed by inoculation with the culture by pouring the freeze-dried granules directly using slow agitation and taking in consideration mixing them well to distribute the culture evenly, followed by incubation at 42° C for 4:5 hours until milk curdling, then the formed curdle was kept at 4° C to be used in the manufacture process **(Soliman and Shehata, 2019).**

Fruit's preparation

Fruits were peeled off after washing them very well, followed by heat shock at (90°C) for only 3:4 minutes **(El-Raghy, 2017)**, after that each type was mashed separately under aseptic conditions using an electric mixer (Braun, Germany) **(Soliman and Shehata, 2019).** The fruit pulps were stored at 18 °C until using them in the manufacture process.

Determination of the best starter's percentage:

Fifty gm. of skim milk powder and 12gm. of stabilizer were weighted separately and added respectively to the milk (for each 1 Liter of milk) and mixed well.The milk was then pasteurized in water bath at 85° c for 30 minutes followed by cooling to42°C.After that, 1.5ml/L (40%w/v) of food-grade calcium chloride which was added to the milk followed by the addition of 4%, 6% and 8 % previously activated commercial culture, separately to every liter of milk and followed by mixing very well. The inoculated milk samples were then divided in 100 ml sterilized glass bottles and then incubated at 42° C until reach the fermentation of milk with pH 4.6. After reaching the determined pH point, samples were stored at 4° C overnight before testing **(Galeboe *et al.*, 2018).** The optimal percentage of adding starter culture was determined based on the sensory evaluation specifically the flavour of the product.

Determination of the best stabilizer's percentage:

After the determining the best percentage of adding starter culture, two new trials were made to determine the best percentage of stabilizer following the same manufacturing method by adding 1% and 1.5% of stabilizer separately to each liter of milk. The ideal percentage for stabilizer addition was identified through a sensory evaluation that evaluated the product's body and texture especially.

Improving the flavour of fermented CAM with fruits:

After reaching the optimal percentages of adding the starter and the stabilizer, the following step was improving the flavour of the fermented CAM by adding the fruit's pulp, which was added after the end of the incubation and before the analysis directly. Through a sensory evaluation that assessed the product's properties, especially the flavour, the best fruit variety to use was found **(Soliman and Shehata 2019).**

Physicochemical Analysis

Fermented CAM samples from the different treatments were analyzed in duplicate to determine the physical parameters (pH, acidity) and the chemical parameters (total solids, ash, fat and protein content) according to **AOAC (2012)** methods.

Microbiological analysis

Microbiological analysis was done by using pour plate method **(Al-Otaibi and El- Demerdash, 2013)** to count: total bacterial on nutrient agar **(Difco, 2009),** lactic acid bacteria (*S. thermophilus* and *L. delbrueckii* ssp. *bulgaricus*) according to the methods described by **Tharmaraj and Shah (2003)** and detection of yeasts and moulds **(Difco, 2009).**

Sensory Evaluation

The assessment was carried out by 15 panelists at the Faculty of Agriculture, Damietta University, including staff members, assistants and students, from food science department and other departments, the samples of every treatment were rated for colour and appearance, flavour and body and texture. The score points were 15 for colours and appearance, 50 for flavour and 35 for body and texture, which give a total score of 100 points **(Soliman and Shehata 2019).**

Statistical Analysis

The obtained results were statistically analyzed using a software package **(SAS, 1991)** based on analysis of variance. When F-test was significant, least significant difference was calculated according to **Duncan (1955)** for the comparison between means. The data presented, in the tables, are the mean (± standard deviation) of 3 experiments.

Results and Discussion

Physicochemical properties

Titratable Acidity (TA)

Table1 shows the physicochemical properties of fermented CAM with different percentages of starter culture. It is clear that pH of the three samples increased ($P<0.05$) significantly by increasing the starter culture's percentage, and as a result of this, the TA% of the three samples decreased. The TA% of T2 was higher than the value (1.18%) measured by **Al-Otaibi and El-Demerdash (2013)** after 21 days storage and the value (0.83 %.) measured by **Yousef *et al.* 2013** without using stabilizers during the manufacturing process, and was fairly close to the value (1.255%) indicated by **Galeboe *et al.* (2018).**

TA% didn't differ significantly by increasing the stabilizer content from 1% (T4) to 1.2% (T3), but it decreased significantly ($P<0.05$) by increasing the stabilizer content to 1.5% (T5), so the increasing of stabilizer content decrease the TA% as shown in **Table 2,** and this contradict with the findings of **Mehanna *et al.* (2002) and Ibrahim and Khalifa (2015).**

Table3 illustrates the physicochemical properties of fermented CAM with 8% of starter culture and 1.5% of stabilizer with different concentrations of fruit's pulp.

Table1. The physicochemical properties of fermented CAM with different percentages of starter culture.

TRT	pH	Acidity%	Moisture%	TS%	Ash%	Protein%	Fat%
R	6.60±0.01^{a}	0.18±0.1^{d}	88.86±0.31^{a}	11.14±0.31^{c}	0.55±0.05^{b}	1.59±0.04^{d}	3.15±0.65 ^{d}
T1	4.12±0.01^{d}	2.11±0.1^{a}	74.290.68^{c}	25.70±0.68^{a}	1.65±0.25^{a}	5.01±0.01^{b}	4.65±0.15 ^{a}
T2	4.50±0.01^{c}	1.79±0.1^{b}	74.66±0.38^{c}	25.34±0.38^{a}	1.90±0.01^{a}	5.14±0.03^{a}	4.15±0.05 ^{b}
T3	4.60±0.01^{b}	1.53±0.1^{c}	77.10±0.59^{b}	22.90±0.59^{b}	1.40±0.01^{a}	4.19±0.01^{c}	3.90±0.10 ^{c}
p-value	<.0001	<.0001	<.0001	<.0001	0.0065	<.0001	0.1332

Table2. The physicochemical properties of fermented CAM with different percentages of stabilizer.

^{abcd} Means with unlike superscripts within rows differ ($P<0.05$)

TRT	pH	Acidity%	Moisture%	TS%	Ash%	Protein%	Fat%
T4	4.65±0.01^{c}	1.54±0.01^{a}	77.72±0.41^{b}	22.41±0.55^{a}	1.40±0.01^{a}	4.24±0.08^{b}	4.00±0.01 ^{b}
T5	4.60±0.01^{b}	1.36±0.01^{b}	76.37±0.10^{b}	23.63±0.10^{b}	1.40±0.01^{a}	4.10±0.20^{a}	3.95±0.01 ^{a}
p-value	<.0001	<.0001	0.0002	0.0004	0.0004	0.0011	0.3342

R: Raw CAM- **T1, T2, T3**: Fermented CAM with 4%, 6% and 8% of starter culture.-**T4**: Fermented CAM with 8% of starter culture, 1% of stabilizer.**T5:** Fermented CAM with 8% of starter culture, 1.5% of stabilizer.

Table 3. Physicochemical properties of fermented CAM with different percentages of fruit's pulps.

abcd Means with unlike superscripts within rows differ (P<0.05)

TRT	pH	Acidity%	Moisture%	TS%	Ash%	Protein%	Fat%
Control	4.60±0.01^{b}	1.36±0.01^{b}	78.71±0.10^{b}	21.28±0.10^{a}	1.40±0.01^{a}	4.10±0.20^{a}	3.95±0.01
G.M	4.28±0.01^{d}	1.19±0.01^{c}	78.69±0.06^{c}	21.31±0.05^{b}	1.35±0.15^{ab}	3.40±0.10^{a}	2.85±0.35^{b}
S	4.34±0.01^{c}	1.42±0.01^{b}	80.06±0.23^{b}	19.94±0.23^{c}	1.75±0.25^{ab}	3.82±0.22^{a}	3.90±0.10^{b}
G	4.23±0.01^{d}	1.57±0.01^{a}	80.76±0.02^{b}	19.24±0.02^{c}	3.05±1.25^{a}	3.47±0.28^{a}	5.60±0.40^{a}
D	4.68±0.01^{b}	1.08±0.01^{d}	74.21±0.54^{d}	25.78±0.54^{a}	2.85±0.25^{a}	4.05±0.15^{a}	4.50±0.50^{ab}
p-value	<.0001	<.0001	<.0001	<.0001	0.1175	0.0011	0.0344

Control: Fermented camel milk with 8% of starter culture and 1.5% of stabilizer. **G.M:** Fermented camel milk fortified with 50% Gahrawy mango pulp.**S:** Fermented camel milk fortified with 50% Strawberry pulp. **G:** Fermented camel milk fortified with 50% Guava pulp.**D:** Fermented camel milk fortified with 35% Date pulp.

The addition of different types of fruits with different percentages had a significant effect on the TA (% lactic acid) of the fermented CAM which varied between 1.08% and 1.57% , addition of guava (50%) and strawberry pulp (50%) caused a significant (P<0.05) increase in the TA and made its flavour sour, on the other hand adding dates (35%) and grahrawy mango pulp (50%) decreased it significantly (p<0.05), which made them more acceptable than the other flavours.

Total Solids (TS)

As for the TS content of the raw CAM increased significantly (P<0.05) during the manufacturing process, as for the samples T1 and T2 didn't differ significantly (P<0.05) compared to T3 which decreased significantly. Results of TA% in **Table 1** are in conflict with the findings of **Al-Otaibi and El-Demerdash (2013) and Yousef *et al.* (2013),** and in agreemengt with the findings of **Mahdian and Tehrani (2007).**

It is clear that, increasing the added stabilizer from 1% to 1.2% didn't differ the TS% significantly as shown in **Table 1,** but there was a significant (P<0.05) increase by adding it with1.5% as shown in **Table 2.**

The addition of gahrawy mango pulp didn't differ the TS content significantly , but adding date pulp to the fermented CAM occurred a significant (P<0.05) increase in the TS% as shown in **Table 3,** and this is in accordance with **Ismail 2015** who declared that rutub date addition raised the TS%, despite of the addition of strawberry and guava pulps which decreased the TS content significantly(p<0.05), this is due to the high content of TS in dates and gahrawy mango and the high content of water in strawberry and guava.

Ash

Table 1 show that there was a significant (P<0.05) increase in the ash content of T1, T2 and T3 as a result of producing fermented CAM with different percentages of starter culture, and it's clear that in **Table 2** sample T4 and T5 didn't differ significantly. **Galeboe *et al.* (2019)** mentioned that the ash content of CAM yoghurt with 6% of starter culture was 1.13% which was lower than the ash content of T2, as shown in **Table 1.** The observations of **Soliman and Shehata (2019), Bhagiel *et al,* (2015), Eissa *et al.* (2011)** and **Ibrahim and ElZubier (2016)** contradicted the findings of this study, because it was proposed that variations in ash content were caused by breed, feeding, and water intake differences **(Haddadin *et al.*, 2008).** The ash content significantly (P<0.05) differs due to the different fruits added. Adding guava pulp to the fermented CAM recoded the highest ash content due to it is high content of minerals content followed by the addition of date pulp as shown in **Table 3.** Addition of G.M pulp decreased the ash content.

Protein

The protein content of the raw CAM increased (P<0.05) significantly by manufacturing fermented CAM, but the content of it in the three samples (T1, T2 and T3) of fresh CAM decreased (P<0.05) significantly by increasing the amount of added starter culture as shown in **Table 1.** Adding different amounts of stabilizer differ significantly protein content and this result contradict with the results of **Ibrahim and Khalifa (2015)** who mentioned increasing in the protein content by increasing the stabilizer's percentage. Adding different types of fruit's pulps with different percentages decreased (P<0.05) significantly the protein content of the fermented CAM as shown in **Table 3,** and this is in the line with the findings of **Soliman and Shehata (2019).**

Fat

The fat content of the first three treatments (T1, T2 and T3) which ranges between (3.90 and 4.65 %) as a result of the addition of starter culture with different percentages as shown in **Table 1,** it decreased significantly (P<0.05) by increasing the starter culture content. This result is consistent with the average fat content of the findings of **Bhagiel *et al.* (2015)**, **Isamil (2015)**, **Al-Otaibi and El-Demerdash (2013)** and **Yousef *et al.*, 2013.** As shown in **Table2**, by increasing the stabilizer's content, the fat content decreased (P<0.05) significantly, and this is in agreement with the findings of **Mudgil *et al.* (2018)** and contradict with the findings of **Jasim *et al.* (2018). Table 3** illustrates the effect of adding fruit's pulp on the fat content of the fermented CAM. It increased significantly (P<0.05) by adding 35% of date and 50% of guava pulps to the fermented CAM. On the other hand, adding 50% of G.M pulp decreased the fat content significantly (P<0.05) and 50% of strawberry pulp didn't affect fat content significantly.

Microbiological properties

Number of TBC, *S. thermophilus* and *L.delbrueckii* subsp. *bulgaricus*, yeasts and moulds of fresh samples of different treatments of fermented CAM are shown in **Table 4, 5 and 6.** It is clear that the significant (P<0.05) increasing in the TBC between the three samples (T1, T2 and T3) of fermented CAM with three different percentages of starter culture in **Table 4.**T3 indicated the highest TBC and the highest enumeration of S. *thermophilus* and *L.delbrueckii* subsp. *bulgaricus* which was 4.78 × 10^3 CFU/ml, 4.40 × 10^3 CFU/ml and 4.43 × 10^3 CFU/ml, respectively.

Table 4. Microbiological properties of fermented CAM with different percentages of starter culture.

TRT	Total bacterial count (Log_{10})	*Streptococcus thermophilus* on M17 media (Log_{10})	*Lactobacillus delbrueckii* subsp. *bulgaricus* on MRS media (Log_{10})	Yeasts and Moulds count (Log_{10})
R	5.46±0.05^a	5.06±0.06^a	4.85±0.07^a	4.3 ^{a}
T1	4.31±0.21^c	3.93±0.20^c	3.91±0.23^c	3^b
T2	4.63±0.06^{bc}	4.28±0.04^{bc}	4.23±0.07^{bc}	2.3 ^{c}
T3	4.78±0.07^b	4.40±0.09^b	4.43±0.09^{ab}	2.3 ^{c}

^{abcd} Means with unlike superscripts within rows differ (P<0.05)
R: Raw CAM- **T1, T2, T3**: Fermented CAM with 4%, 6% and 8% of starter culture

Samples with 1.5% stabilizer (T5) has the highest count of TBC which was 5.27 × 10^3 CFU/ml as shown in **Table 5**, due to the increasing of *S. thermophilus* and *L. delbrueckii* subsp. *bulgaricus* than the other samples which was : 4.74 × 10^3 CFU/ml and 4.84 × 10^3 CFU/ml, respectively , and this is in agreement with the findings of **Mahdian and Tehrani (2007) who reported that** improving the growth and the acidity of the starter culture are due to the increasing of TS%.

Table 5. Microbiological properties of fermented CAM with different percentages of stabilizer.

TRT	Total bacterial count (Log_{10})	Streptococcus thermophilus on M17 media (Log_{10})	Lactobacillus delbrueckii subsp. bulgaricus on MRS media (Log_{10})	Yeasts and Moulds count (Log_{10})
T4	4.92±0.23	4.68±0.22	4.48±0.28	1
T5	5.27±0.12	4.74±0.16	4.84±0.04	2

^{abcd} Means with unlike superscripts within rows differ (P<0.05)**T4**: Fermented CAM with 8% of starter culture, 1% of stabilizer.**T5:** Fermented CAM with 8% of starter culture, 1.5% of stabilizer.

It turns out that; the TBC of the samples decreased (P<0.05) significantly by adding fruit's pulps as shown in **Table 6.** As for the count of *S. thermophilus* and *L. delbrueckii* subsp. *bulgaricus,* the fruits declined the growth of both of them as shown in **Table 6** than the control, so it can be concluded that adding fruit's pulp with different percentages to the fermented CAM with 8% of starter culture and 1.5% of stabilizer decreased the growth of the starter culture. By comparing the effect of the four types of fruit's pulp with each other on the growth of the starter culture; it's clear that adding gahrawy mango pulp with 50% to the fermented CAM enhanced the growth of *Str. thermophilus* to 4.64 × 10^3 CFU/ml, but improving the growth of L. *delbrueckii* subsp. *bulgaricus* was a result of adding date's pulp with 35% to the samples than other fruit's which was: 4.59 × 10^3 CFU/ml , and this is in agreement with the results of **Al-Otaibi and El-Demerdash (2013), Ismail (2015)** and **El-raghy (2017).**

Table 6. Microbiological properties of fermented CAM with different percentages of fruit's pulp.

TRT	Total bacterial count (Log_{10})	*Streptococcus thermophilus* on M17 media (Log_{10})	*Lactobacillus delbrueckii* subsp. *bulgaricus* on MRS media (Log_{10})	Yeasts and Moulds count (Log_{10})
Control	5.27±0.12	4.74±0.16	4.84±0.04	2
G.M	4.97±0.15	4.64±0.09	4.57±0.24	1
S	4.87±0.05	4.57±0.09	4.49±0.02	0.3
D	4.93±0.13	4.54±0.14	4.59±0.14	1.3
G	4.77±0.06	4.38±0.07	4.44±0.04	0.6

^{abcd} Means with unlike superscripts within rows differ ($P<0.05$).
Control: Fermented camel milk with 8% of starter culture and 1.5% of stabilizer. **G.M:** Fermented camel milk fortified with 50% Gahrawy mango pulp.**S:** Fermented camel milk fortified with 50% Strawberry pulp. **G:** Fermented camel milk fortified with 50% Guava pulp.**D:** Fermented camel milk fortified with 35% Date pulp.

As shown in **Table 5,** the yeasts and moulds count decreased significantly ($P<0.05$) during the manufacturing of fermented CAM. There is no significant difference between T2 and T3 counts but there is a significant difference between them and the counts of T1.

It's clear from **Table 6** that the increasing of stabilizer addition increased the yeasts count; however it was still in the allowed range as mentioned before by **Ledenbach and Marshall (2009).**Fruits addition decreased the growth of yeasts. Samples with strawberry pulp recorded the lowest count as shown **Table 6**, followed by the addition of guava pulp.

Organoleptic properties

Table 7 illustrates the sensory evaluation of all the samples. Sample T3 with 8% starter's culture was preferred from the evaluators due to the high acidity in samples T1 and T2, but still there is a low acceptability for the taste of fermented CAM for some evaluators due to the different taste of this type of milk. Most of the panelists were noticed a salty taste in the samples, so there was a need to improve the taste of the fermented CAM with natural fruits, to be more acceptable to the consumers and maintain its nutritive value. So, this is what was followed in the manufacturing method later.

By studying the results of the organoleptic properties of samples T4 and T5, it turns out that increasing the stabilizer's percentage affected the body and the texture positively and obtained customer's satisfaction. samples fortified with 35% of date's pulp obtained the highest average for flavour and texture compared with other samples with other fruits, due to the sweet taste of date which is desirable for many consumers, although it obtained the lowest average for color and appearance due to the dark color of dates which in order affected the milk color, so it affected the consumer's acceptability. Samples fortified with 50% of gahrawy mango's pulp come in the second level for color, flavour and body and texture, because it improved the color and flavour significantly, but the texture was undesirable for most of the panelists because it was thicker than the texture of the common fermented milk. As for the samples with strawberry pulp, it gained the highest average of color and appearance for the majority of the panelists, but it gained the lowest average of body and texture as a result of high percentage of adding strawberry which negatively affected the texture. The flavour was not perfect as expected because it needed more sugary taste to be acceptable to consumers. Adding guava pulp to the fermented camel milk was not a good choice because it needed to be added with a high percentage (50%) to make the flavour more apparent and rich with the taste of guava, which resulting in affecting the flavour negatively due to increasing the acidity of the fermented milk, which made it undesirable to most of the consumers. Although the color was pretty good and the texture was fairly good. So, it is concluded that the best treatment was by adding 35% of date's pulp to the fermented CAM, because it was the best texture and flavour with scores 32.2 and 46, respectively, but percentages of adding other types of fruits needed to be modified, and it turns out that they were not enough to be a sweetener agent to the fermented CAM.

Table 7. Sensory evaluation of the different treatments

Treatments	Color and Appearance (15) Points	Flavour (50) Points	Body and Texture (35) Points	Total (100) Points
Samples with different starter culture percentages				
T1	11	20	19	50
T2	10.5	22	23.5	56
T3	11.25	42.75	30	84
Samples with different stabilizer percentages				
T4	11	42.5	27	80.5
T5	11	43	33	87
Samples with different concentrations of different types of fruits				
G.M	13.2	44.5	25.2	82.9
S	13.69	40.82	27.05	81.56
D	12.2	46	32.2	90.4
G	3.2	35	29	77.2

T1, T2, and **T3**: Fermented CAM with 4%, 6% and 8% of starter culture. T4 and T5: fermented CAM with 1% and 1.5% of stabilizer, respectively. **G.M:** Fermented camel milk fortified with 50% Gahrawy mango pulp.**S:** Fermented camel milk fortified with 50% Strawberry pulp. **G:** Fermented camel milk fortified with 50% Guava pulp.**D:** Fermented camel milk fortified with 35% Date pulp.

CONCLUSION

After trying several trials, it turns out that, the best procedure to manufacture fermented CAM is by adding: 5% of skim milk powder and 1.5% of stabilizer to CAM followed by mixing well and pasteurization at 85°C for 30 min. in water bath, before adding 1.5ml/L of food grade calcium(40% w/v) and 8% of starter culture.

FUNDING
This research did not receive any funding.

CONFLICT OF INTEREST
The authors declare that they have no conflict of interest.

AUTHORS CONTRIBUTION
Hamad, M. N. F.; El-Kadi, Sh. M. L. and Zohny, M.H.H. developed the concept of the manuscript. Zohny wrote the manuscript. All authors checked and confirmed the final revised manuscript.

REFRENCES
Al-Otaibi, H.H and El-Demerdash H. (2013). Nutritive Value and Characterization properties of fermented camel milk fortified with some date palm products chemical, bacteriological and sensory properties. *International Journal of Nutrition and Food Sciences*. 2(4): 174-180.

Al-Shahib, W. and Marshall R.J. (2003). The fruit of the date; it's possible as the best food for the future? *Int. J. Food Nutr*. 54:47-259.

AOAC (2012). Association of official analytical chemists, Official methods of analysis, 19th Ed (2), Arlington VA. USA.

Bhagiel, I.; Musatafa E.A.; Tabidi M.M. and Ahmed M.E.M. (2015). Comparison between the physiochemical attributes of yogurt processed from camel milk and that processed from cow milk and the effect of storage. *World Journal of Pharmacy and Pharmaceutical Sciences*. 4(8):1530-1540.

Difco (2009). Manual of Microbiological Culture Media Second Edition. Becton, Dickinson and Company parks, Maryland 21152. U.S A.

Duncan, D. B. (1955). Multiple Range and Multiple F-test. Biometrics, 11:1–42.

Eissa, E.A.; Yagoub A.E.A.; Babiker E.E. and Ahmed I.A.M.(2011). Physicochemical, microbiological and sensory characteristics of yoghurt produced from camel milk during storage. *Electronic Journal of Environ- mental, Agricultural and Food Chemistry*. 10 (6): 2305-2313.

El-Deeb , A.M.; Dyab A.S. and Elkot W.F. (2017). Production of flavoured fermented camel milk. *Ismailia Journal of Dairy Science & Technology; Suez Canal University*. (1): 9-20.

El-Raghy, E.(2017). Studies on functional fermented dairy products. PhD thesis, Food science department, Faculty of Agriculture, Damietta University.

Gad, A.S.; Kholif A.M. and Sayed A.F. (2010). Evaluation of the nutritional value of functional yoghurt resulting from combination of date palm syrup and skim milk. *American journal of food technology* 5(4): 250-259.

Galeboea, O.; Seifua E. and Monanga B.S. (2018). Production of camel milk yoghurt: physicochemical and microbiological quality and consumer acceptability. *International Journal of Food Studies*. (7):51-63.

Haddadin, M.S.Y.; Gammoh S.I and Robinson R.K. (2008). Seasonal variations in the chemical composition of camel milk in Jordan, *Journal Dairy Research*. 75: 8-12.

Ibrahem, S.A. and El Zubeir I.E.M. (2016). Processing, composition and sensory characteristic of yoghurt made from camel milk and camel–sheep milk mixtures. *Small Ruminant Research*. 136:109-112.

Ibrahim, A.H. and Khalifa S.A. (2015). The effects of various stabilizers on physiochemical properties of camel's milk yoghurt. *Journal of American Science*. 11 (1): 15-24.

Ismail, M. M. (2015). Improvement of nutritional and healthy values of yoghurt by fortification with rutub date. *Journal of Microbiology, Biotechnology and Food Science*. 4(5):398-406.

Jahurul, M.H.A; Zaidul I.S.M; Ghafoor K.; Al-Juhaimi F.; Nyam K.; Norulainj N.A.N.; Sahena F. and Omar A.K.M. (2015). Mango (*Mangifera indica* L.) by-products and their valuable components: A review. Food Chem. 183:173-180.

Jasim, M.A.; Salih G.M. and Hamk M.L. (2018). The Effect of Arabic Gum on Physicochemical and Sensory Properties of Camel Milk, Yogurt. *Journal of Zankoy Sulaimani* **.** *2nd Int. Conference of Agricultural Sciences*.

Khalesi, M.; Salami M.; Moslehishad M.; Winterburn J. and Movahedi A.M. (2017). Bio molecular content of camel milk: a traditional super food towards future healthcare industry. *Trends in Food Science & Technology*. 62: 49–58.

Ledenbach, L.H. and Marshall R.T. (2009). Compendium of the Microbiological Spoilage of Foods and Beverages. Food Microbiology and Food Safety. Springer, New York, NY. 41-67.

Mahdian, E. and Tehrani M.M. (2007). Evaluation the effect of milk total solids on the relationship between growth and activity of starter cultures and quality of concentrated yoghurt. *American-*

Eurasian Journal of Agriculture & Environmental Science, 2 (5):587.

Mehanna, N.S.; Sharaf O.M.; Ibrahim G.A. and Tawfik N.F. (2002). Incorporation and viability of some probiotic bacteria in functional dairy food (1) soft cheese. Egypt. *J. Dairy Sci.*, 30(2):30-217.

Mihic, T; Rainkie D; Wilby K.J. and Pawluk S.A. (2016). The therapeutic effects of camel milk: a systematic review of animal and human trials. *J. Evid Based Complement Altern Med*. 21(4): 110-126.

Mudgil, P.; Jumaha B.; Ahmada M.; Hamed F. and Maqsooda S. (2018). Rheological, micro-structural and sensorial properties of camel milk yogurt as influenced by gelatin. *LWT - Food Science and Technology*. (98):646-653.

Ngouana , L.S.T.; Tonfack L.B.; Temegne C.N.; Agendia A.P. and Youmbi E. (2023). Current status of strawberry (*Fragaria* spp.) cultivation and marketing in Cameroon. *Journal of Agriculture and Food Research* 14.

Rizk, A.E. (2016). Study of production functional beverages of milk permeate fortified with fruit and herbs. *Middle East Journal of Applied Science*. 155-161.

SAS (1991). SAS User's guide: statistics. SAS Inst, Inc, Cary, NC**.**

Silbermayr, K; Terwengel P.O. and Charruau P. (2010) High mitochondrial diferentiation levels between wild and domestic Bactrian camels: a basis for rapid detection of maternal hybridization. *Anim Genet.* 41(3): 315-318.

Sobti, B.; Alhefeiti R.M.S.; Alahdali F.A.S.; Al Samri M.A.M. and Kamal-Eldin A. (2023). Supplementation of drinkable yogurt (Laban) from Camel milk with fruit purees improves its quality and sensory properties. *NFS Journal 32*.

Soliman, T.N. and Shehata S.H. (2019). Characteristics of fermented camel's milk fortified with kiwi or avocado fruits. *Acta Sci. Pol. Technol. Aliment.* 18(1): 53–6.

Tharmaraj, N and Shah N.P. (2003). Selective Enumeration of *Lactobacillus delbrueckii* ssp. *bulgaricus*, *Streptococcus thermophilus*, *Lactobacillus acidophilus*, Bifidobacteria, *Lactobacillus casei*, *Lactobacillus rhamnosus*, and Propionibacteria**.** *J. Dairy Sci.* 86:2288–2296.

Yousef, M.; Nateghi L. and Azadi E. (2013). Effect of different concentration of fruit additives on some physicochemical properties of yoghurt during storage. Annals of Biological Research, 4 (4):244-249.

الملخص العربى

الصفات الفيزيوكيميائية و الميكروبية للبن الإبل المتخمر

محمد نور الدين فريد حماد [1] , شريف محمد لطفي القاضي [2] , مها حسن حسن ذهني [1]
[1]قسم علوم الأغذية, كلية الزراعة ,جامعة دمياط
[2]قسم البيوتكنولوجيا الزراعية ,كلية الزراعة ,جامعة دمياط

تهدف هذه الدراسه إلى إنتاج منتجات ألبان متخمرة ذات قيمة غذائية عالية من لبن الإبل و ذلك بإستخدام نوعين من السلالات الميكروبية مع تدعيمها بأنواع مختلفة من لب الفاكهة المحلية حتى تصبح مقبوله أكثر بالنسبة للمستهلكين, وذلك نظرا لأهمية هذا النوع من الحليب كأحد الأغذية الصحيه والوظيفية هامة الأمر كما أبرزت الدراسات العلمية الحديثة , **و كانت النتائج المتحصل عليها كالتالي:**

من الصعب تصنيع زبادي من لبن الإبل بنفس طريقة تصنيعها من اللبن البقري, وذلك لأنه لا يكون خثره بسهولة.
لإنتاج لبن إبل متخمر ذو قوام ومظهر مقبولين, يوصى بإستخدام 1.5%من المثبت مع ٥ % من لبن بقري منزوع الدسم وبسترة الخليط في حمام مائي على درجة حرارة ٨٥° م لمدة ٣٠ دقيقة , ثم التبريد إلى ٤٢° م قبل إضافة ١,٥ مل/ اللتر من محلول كلوريد الكالسيوم و ٨% من البادئ ثم التحضين على ٤٢°م لمدة ٥ ساعات.
كانت الخصائص الفيزيوكيميائية للبن الإبل المتخمرالمنتج بهذه الطريقه كالتالي: ١,٣٦% , ٧٦,٣٧% , ٢٣,٦٣% , ١,٠٤% , ٤,١% و ٣,٩٥% بالنسبة للتالي : الحموضة, الرطوبة, المواد الصلبة الكلية, الرماد, البروتين, والدهن على التوالي, و عند تحليله ميكروبيولوجيا كانت متوسط قيمة العد البكتيري الكلي (5.27×10^3 CFU/ml) وكانت قيمة عد *S. thermophilus* و *L. delbrueckii* subsp. *bulgaricus* كالتالي(4.74×10^3 CFU/ml) و(4.84×10^3 CFU/ml) على التوالي , أما بالنسبه لمتوسط عدد الفطريات المتحصل عليها بعد ٥ أيام من التحضين كانت(2×10^3 CFU/ml).
أما بالنسبه للصفات الحسيه : لم تتأثر خواص اللون والنكهة بتغير نسبة المثبت المضافة إلى اللبن المتخمر, ولكن تحسن القوام بشكل كبير بزيادة المثبت المضاف , مما ترتب عليه الوصول إلى قوام مقبول من لبن الإبل المتخمر.
يمكن تحسين مذاق لبن الإبل المتخمر ليصبح مقبولا بشكل أفضل للمستهلك وذلك بإستخدام لب الفاكهة الطبيعية بعد إنتهاء فترة التحضين. فقد كانت النكهة الأكثر قبولا كانت التي تم تدعيمها ب ٣٥ % من لب البلح الأسود , يليها العينات التي تم إضافة ٥٠ % من لب المانجو الجحراوي لها, و يوصى بتعديل نسب إضافة لب الأنواع الأخرى من الفاكهه المستخدمة (الفراولة والجوافة) عند إستخدامها مع لبن الإبل المتخمر, نظرا لعدم كفائتها في تحسين نكهة لبن الإبل المتخمر بالنسب المستخدمه في هذه الدراسة .