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NUTRITIONAL QUALITY, PHYSICOCHEMICAL AND MICROBIOLOGICAL PROPERTIES OF CAMEL MILK IN NORTH SINAI GOVERNORATE

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ABSTRACT

This study was aimed to evaluate the nutritional quality and compare the general physic-chemical characteristics and microbial properties of camel milk in North Sinai Governorate. The samples were collected from camel grazed on open and close pastures. Also compare the concentration of some elements, amino and fatty acids of the milk samples for both systems. The biological and caloric values were evaluated in both systems. A section of this study was intended to study some technological properties such as coagulation time and curd tension. The analytical result indicated a wide variation between the major components of the samples for both gazing systems. There were high significant differences of some physical properties i.e. specific gravity, viscosity, flow index, consistency index and density and there was insignificant difference of freezing point of milk samples of close and open pasture ($P< 0.0001$). The average of titratable acidity and pH value were 0.175 %, 6.62 and 0.16 %, 6.66 of close and open system respectively. All elements content expect P show high significant differences between milk of close and open pastures ($P< 0.0001$). All minerals concentration except Fe were higher of camel milk of open than close system. Sum of amino and fatty acids, cholesterol, biological and caloric values were higher of open than those of close system. The results of technological properties indicated that coagulation time decreased when added the rennet to camel milk which incubated with yoghurt starter at 12-15 min., the range of curd tension was 28-42 g. All samples of open were higher of aerobic count, lactic acid bacteria and moulds & yeasts than those of close system, while coliform numbers was higher in the samples of close than that of open system samples. 60 % of the examined samples were positive for *Staphylococcus* of both systems. All samples were tested for pathogenic bacteria which were negative for *Salmonella spp., Listeria* and *Escherichia coli* 0157:H7.

INTRODUCTION

According to the recent statistics by the food and Agriculture Organization (FAO), the total population of camels in the world is estimated to be about 20 million, with Somalia having the largest herd worldwide (FAO, 2008). Camels are considered to be a good source of milk and meat, and are used for other purposes such as transportation and sport racing. Camel milk has an important role in human nutrition in the hot regions and arid countries. The milk contains all the essential nutrients found in bovine milk (El-Agamy, et al., 1998; Karue 1998).

Camel's milk is a major source of protein and energy for desert inhabitants especially for those in the Middle East. Protein of camel milk contains all essential amino acids and in its fat there are unsaturated aliphatic acids. Although camel milk production in Egypt is still essentially following the old un- organized nomadic style, efforts are now focused on applying modern techniques in the production, transformation and marketing of camel milk in our country.

Recently, camel milk was also reported to have other potential therapeutic properties, such as anti-carcinogenic (Magjeed, 2005), anti-diabetic (Agrawal, et al., 2007a), and anti-hypertensive (Quan, et al., 2008), and has been recommended to be consumed by children who are allergic to bovine milk (El-Agamy, et al., 2009).

Camel milk is important to the human diet in many parts of the world. Fresh and fermented camel milks have been used in different regions in the world including India, Russia and Sudan as a treatment for a series of diseases such as dropsy, jaundice, tuberculosis, asthma and leishmaniasis or Kala- azar (Abdelgadir, et al., 1998; Shalash, 1984). Camel milk is an ideal habitat for the growth and multiplication of microorganisms due to its nutritional constitution which contain protein, carbohydrate, minerals and vitamins. All these components support the growth of many forms of bacteria. Raw milk aseptically drawn from a healthy animal usually contains a few bacteria (Omer and Eltinay 2008). On the other hand camel milk has the ability to inhibit the growth of pathogenic microorganisms because it contains number of enzymes with anti-bacterial and anti-viral properties. The activity of protective proteins was assayed against *Lactococcus lactis sub-sp., Cremoruis, Escherichia coli, staphylococcus aureus, Salmonella typhimurium and rotavirus* (Barbour et al., 1984).

The coagulation time of camel milk is important factors when it is used for produce some of dairy products. With the same amount of calf rennet, the coagulation time of camel's milk is twice or three times longer than that of cow's milk. The action of rennet on camel's milk leads to coagulation in the form of flocks, with no firm coagulum (Mohamed, 1990). Due to technical difficulties of camels milk coagulation, several researchers are now focusing on the functional and coagulation properties of camel's milk (El-Agamy, 2000a; El-Agamy, 2000b; Laleye, et al., 2008).

The main objectives of this study were to (1) evaluate of nutrient and biological values of camel milk (2) investigate the microbial quality of camel milk (3) enumerate the bacteria that may cause changes in camel milk and the distribution of those bacteria (4) measurement of coagulation time and curd tension of camel milk. .

MATERIALS AND METHODS

Starter Cultures: Yoghurt starter culture containing *Streptococcus salivarius* sub spp *thermophilus* and *Lactobacillus delbruickii* sub spp *bulgaricus*, were obtained from Chr. Hansen's Lab., Copenhagen, Denmark.

Rennet: Animal rennet powder (HA- LA) was obtained from Chr. Hansen's Lab., Copenhagen, Denmark.

Milk samples: Camel milk samples were collected from 20 lactating camels, from two different private camel herds, one herd from Central region (Al-Areesh) of close and open pastures and the other from the Northern region of Sinai (Rafah) of close and open pastures too. The milk was collected in sterile bottles, transported to the laboratory in a cool box and stored at 4-6°C before analysis.

Microbiological analysis : The milk samples were analyzed with 12 h of collection for microbiological evaluation. All the microbiological analysis was carried according to FAO, (1992). The samples were analyzed for total aerobic plate count (TC), lactic acid bacteria count (LAB), total coliforms, *E. coli* 0157: H7, *staphylococcus aureus* and yeasts and molds. For total count, plate count agar was used; plates were incubated for 48 hrs at 37 °C. For yeasts and molds, potato dextrose agar (PDA) was used; plates were incubated at 25 °C for 1 to 3 – 7 days. Counts of LAB were determined using nutrient agar incubated at 37 °C for 48 h. Coliform numbers were determined using Mackonky agar plates were incubated at 37 °C for 24 h. *Staphylococcus aureus* was detecting by using Baird-Parker medium Oxoid, plates incubated at 37 °C for 24 h. *Salmonella spp*, was detected as described by FAO (1992).

Determination some of physical properties: The curd of enzymatic coagulation of camel milk was stirred for 5 min. to achieve visually homogeneous slurry (Lankes et al. 1998). The viscosity, consistency index and flow index were measured using a Brookfield viscometer (Brookfield Engineering Labs, Inc., MA, USA), equipped with a SC4-21 spindle (Model, RV) running at 25 rpm. Measurements were made at the temperature of 24°C and shear rate ranging from 23.3 to 232.5s $^{-1}$. Specific gravity, density and freezing point measured by Milkotronicltd, Lactoscans, Milk Analyzer 8900 Nova Zagora, Bulgaria.

Determination of chemical composition: Total solids, fat, protein, ash and lactose contents were measured by Milkotronicltd, Lactoscans, Milk Analyzer 8900 Nova Zagora, Bulgaria. The titratable acidity determined according to **(AOAC, 1990).** pH values were measured using JENWAY Digital pH meter Model 3310.

Determination of minerals:

Wet digestion of a 2 ml milk sample was carried out utilizing a mixture of concentrated sulfuric and nitric acids (4 ml and 8 ml respectively). The final volume was made up to 50 ml with distilled water. Na and K were determined with a flamephatometer (Epperdorf Geratebau, F.R. Germany). Ca, Mg, Fe and Zn were determined with an atomic absorption spectrophotometer (Instrumentation Lab., Inc., USA). For the determination Ca, Mg, lanthanum chloride was added to give a lanthanum concentration of 1 % (w/v), in order to overcome interference, especially by phosphates. Phosphorus was determined spectrophotometrically with a spectronic 21 (Bousch-Lomb, USA) according to the method of Watanabe and Olson (1965).

Determination of Amino acids content: The amino acids content was determined according to the procedure of **Amado et al. (1983).** The sample analyzed by using an amino acid analyzer LC 3000 Epoendrof, Germany. The instrument condition was: flow rate, 0.2 ml/min, pressure of buffer from 0.0 to 50.0 bars, pressure of reagent from 0.0 to 150.0, reaction temperature, 123 ^{0}C.

Biological evaluation: Protein efficiency ratio (PER) was estimated using equation reported by (Alsmeyer et al., 1974).

PER = 0.684 + 0.456 (Leucine)- 0.647 (proline)

Biological value (BV) was estimated using the equation reported by Mitchell and Block, (1946).

BV = 49.9 + 10.53 PER

Caloric value: The caloric value was calculated according to the following equation of **FAO/WHO, 1985**.

Caloric value = 4 (Protein% + Carbohydrate %) + 9 (Fat %)

Determination of fatty acids:

Standard methods of the AOAC (1990) were used to determine the fatty acids content (Method 989.05). The esters were analyzed using a gas chromatograph (GC) system Model HP 6890 series (USA). The capillary column: Model number, Agilent 1909 1 N- 116; Hp-INNOWax Polyethylene Glycol; Nominal length, 60.0 m; Nominal diameter, 320.0 µm; Nominal film thickness, 0.25 µm; Initial flow, 0.2 ml/min under the following conditions:

- Column head pressure 200 KPa
- Split flow rate 34 ml/min
- Oven temperature
  - Initial temperature 70 ^{0}C
  - Initial time 2 min.
  - Program rate 5 ^{0}C/ min.
- Final temperature 240 ^{0}C
- Final time 5 min.
- Injector temperature 260 ^{0}C
- Detector temperature 280 ^{0}C

Determination of total cholesterol content: The total cholesterol content was determined according to Pantalu et al. (1975).

Coagulation time of camel milk: Whole camel milk was heated to 72°C for 15 Sec. in a water bath and cooled immediately to 5 ± 1°C in on ice bath. Milk divided into three portions; first one was heated into 37°C, rennet was added at the rate of 3% of camel milk. The second portion was heated into 42°C and then yoghurt starter culture was added at the rate of 3 %. The third portion was heated to 42°C and then yoghurt starter culture was added at the rate of 3% of camel milk. After about one and half hour, rennet was added at the rate of 3% of camel milk. The milk was allowed to coagulate to measure the coagulation time. All the treatments were incorporate $CaCl_2$ at 0.02 % after pasteurization process.

Statistical Analysis: The general liner models procedure of SAS was used to analyze the data. Analysis of variance for all camel milk was performed to determine differences between samples. One-way randomized

complete block design and least significant differences (L.S.D) were adopted in camel milk.

RESULTS AND DISCUSSION

Physical properties:-

Results presented in Table (1) showed the physical properties of camel milk. Statistically, specific gravity, viscosity, flow index, consistency index and density of camel milk samples of open and close pasture indicates that there were significant differences ($P < 0.0001$), with L.S.D = 0.0025, 0.3105, 0.0124, 0.0124 and 12.967 respectively. While there was insignificant differences of freezing point between open and close pasture ($P < 0.0001$), with L.S.D = 0.1615. These results are not in agreement with result reported by Ahmed (1990), while it was in agreement with Khaskheli, et al., (2005) and Shamsia, (2009).

Table (1). Physical quality of camel milk in North Sinai

Attribute	Close pasture			Open pasture			LSD
	Min	Max	Average	Min	Max	Average	
Specific gravity	1.012	1.014	1.013^{b}	1.014	1.018	1.016^{a}	0.0025
Viscosity (m pas)	2.06	2.23	2.145^{b}	2.42	2.84	2.63^{a}	0.3105
Flow Index	1.12	1.17	1.145^{b}	1.04	1.08	1.06^{a}	0.0124
Consistency Index (m pas)	0.13	0.16	0.145^{b}	0.10	0.14	0.12^{a}	0.0124
Density (g/cm^3)	34.61	51.17	42.89^{b}	24.34	30.46	27.40^{a}	12.967
Freezing Point	0.41	0.50	0.455^{a}	0.46	0.68	0.57^{a}	0.1615

- **Data are the average of camel milk samples and each in duplicate.**
- **Any two averages with different letters in the same raw are highly significant differed.**
- **L.S.D = Least significant differences**

Chemical composition:

Table (2) shows the chemical composition of camel milk of close and open pastures. From statistical analysis of total solids, fat, protein, lactose and acidity, it was clear that, there were significant differences between camel milk samples of close and open pasture ($P < 0.0001$), with L.S.D = 0.6728, 0.2484, 0.4471, 0.2981 and 0.0124 respectively. On the other hand there were no significant differences of ash and pH value ($P < 0.0001$), with L.S.D = 0.1118 and 0.0497 respectively Table (2).

These results were in line with the values reported by different workers (Al-Kanhal, 1993; Shahien, 2006), while they were higher than that reported by Khaskheli, et al., (2005). The fat contents were found to be in proportion with the total solids content. It could be stressed that protein content of the feed as well as water intake had directly affected the protein quality of milk (FAO, 1982). However, relatively similar range (2.0 to 4.2 %) of protein was observed by Shahien, (2006). These results were higher than that reported by Neimat and Salwa (2011); Khaskheli, et al., (2005). Ash content of camel milk (Table 2) was observed to vary in between 0.93 to 1.005 %. The results relatively in line with those reported by Shahien, (2006), (0.89- 0.99 %); Khaskheli, et al., (2005), (0.85-1.0 %). The results were

higher than those reported by different workers i.e. in between 0.75 to 0.83 % Khaskheli et al. (2005), but lower than those reported by Meiloud et al. (2011), 1.3%. The reason for higher ash content observed could be due to free grazing of camel on bushes or plants grown at saline soil.

Lactose content of camel milk (Table 2) varied between 4.345 to 5.095 %. The highest lactose content observed in present study was quite similar to that of reported by Shahien, (2006). This variation could be due to the fact that camel usually grazed on halophillic plants for example A triplex, Acacia etc. (FAO, 1982). This result was higher than reported by Neimat and Salwa (2011); Khaskheli, et al., (2005). pH values of fresh these camel milk was observed in between 6.62 and 6.66 of close and open pasture respectively. These results were relatively similar to that of reported values (6.5-6.7) by FAO (1982), while higher than those reported by Shahien, (2006) (i.e. 6.53, 6.49 and 6.60 respectively). It was observed that this variation was greater in between herds as compared to within a herd. The averages of titratable acidity in terms of lactic acid content were 0.175 and 0.16% of camel milk samples of close and open pasture respectively. These results were higher than those reported by Shahien, (2006) (i.e. 0.13, 0.15 and 0.16 respectively). It was further observed that when camel milk was left to stand the lactic acid content did not show any noticeable increase until approximately 8-10 h. This observation was similar to as Hafiz and Hamzawi (1991), but differ from FAO (1982) who reported that when the milk is left to stand for 2-6 h.

Table (2). Chemical composition of camel milk in North Sinai.

Component %	Close pasture			Open pasture			LSD
	Min	Max	Average	Min	Max	Average	
Total Solids	11.17	12.87	12.02 [b]	13.39	15.58	14.285 [a]	0.6728
Fat	3.00	3.60	3.30 [b]	3.60	4.40	4.00 [a]	0.2484
Protein	3.11	3.70	3.405 [b]	3.91	4.86	4.385 [a]	0.4471
Ash	0.90	0.96	0.93 [a]	0.93	1.08	1.005 [a]	0.1118
Lactose	4.08	4.61	4.345 [b]	4.95	5.24	5.095 [a]	0.2981
Acidity %	0.13	0.22	0.175 [a]	0.12	0.20	0.16 [b]	0.0124
pH value	6.60	6.64	6.62 [a]	6.62	6.70	6.66 [a]	0.0497

- **Data are the average of camel milk samples and each in duplicate.**
- **Any two averages with different letters in the same raw are highly significant differed.**
- **L.S.D = Least significant differences**

Minerals content:

Table (3) shows the minerals composition of camel milk of close and open pastures. Statistically, there were significant differences in Fe, Na, K, Ca, Mg and Zn contents between camel milk samples of close and open pasture ($P < 0.0001$), with L.S.D = 0.0001, 6.2103, 9.9366, 12.421, 1.2421 and 0.0124 respectively, and there was insignificant difference of P ($P < 0.0001$), with L.S.D = 6.2103.

Table (3). Minerals concentration of camel milk in North Sinai

Minerals	Concentration (mg/100g)						
	Close pasture			Open pasture			LSD
	Min	Max	Average	Min	Max	Average	
Fe	0.27	0.30	0.285[a]	0.20	0.23	0.215[b]	0.0001
Na	63.0	72.0	67.5[b]	71.0	85.0	78.0[a]	6.2103
K	140.0	168.0	154.0[b]	162.0	182.0	172.0[a]	9.9366
Ca	98.0	106.0	102.0[b]	120.0	138.0	129.0[a]	12.421
Mg	12.0	13.2	12.6[b]	14.8	15.0	14.9[a]	1.2421
Zn	0.38	0.40	0.39[b]	0.45	0.48	0.465[a]	0.0124
P	78.0	81.0	79.5[a]	80.0	88.0	84.0[a]	6.2103

- **Data are the average of camel milk samples and each in duplicate.**
- **Any two averages with different letters in the same raw are highly significant differed.**
- **L.S.D = Least significant differences**

inerals content are higher than most of data reported by Konuspayeva, (2007). The reason of this increase is still unclear to us but on cause could be a traditional practice in the country, which is giving natural solid salt.

Amino acids content:

Amino acid composition is the principal effect. All proteins are made up of combinations of the biological amino acids. Some of these can be synthesized or converted in the body, whereas others cannot and must be ingested in the diet. These are known as essential amino acids (EAA_s), of which there are 9 in human. EAA_s missing from the diet prevent the synthesis of proteins that require them. If a protein source is missing critical EAA_s, then its biological value will be low as the missing EAA_s. Amino acids composition of protein plays an important role in determining the biological and nutritive value of protein (Karade, 1974). Results presented in Table (4) showed a wide variation in the amino acids content of camel milk of close and open pasture. From statistical analysis there was high significant difference of total amino acids of camel milk of close and open pasture ($P < 0.0001$), with L.S.D = 5.9868. The results indicated that total amino acids contents were higher of open than close pasture. The results were relatively similar with those obtained by Shahien, (2006).

Biological (BV) and Caloric values:

The biological value (BV) of a food is the percentage of absorbed protein from the food that is retained in the body and is therefore available for incorporation into the proteins within the body of the organism that consumed it.

Results presented in Table (4) showed that the biological and the caloric values of camel milk of close and open pasture. The average of biological value was 70.85 and 73.27 of camel milk samples of close and open pasture. The averages of caloric values were 60.70 and 62.32 ki/g in the same order. Analytical result indicated that there was significant high difference of biological and caloric values of camel milk of close and open pasture ($P < 0.0001$), with L.S.D = 1.1924 and 0.0994, respectively.

Table (4):Amino acids composition, Biological and Caloric values of camel milk in North Sinai:

Amino acids	Concentration (mg/ml)						
	Close pasture			Open pasture			LSD
	Min	Max	Average	Min	Max	Average	
Aspartic	6.93	7.55	7.24	7.10	7.85	7.475	-
Glutamic	19.39	21.15	20.27	18.10	18.13	18.115	-
Serine	4.25	4.26	4.255	4.31	5.19	4.75	-
Glycine	2.05	2.07	2.06	0.95	1.32	1.135	-
Histidine	2.06	2.31	2.18	2.09	2.51	2.295	-
Arginine	1.97	2.02	1.995	4.00	4.71	4.355	-
Threonine	4.07	4.21	4.14	4.22	4.91	4.565	-
Alanine	2.05	2.10	2.075	2.00	2.27	2.135	-
Proline	6.10	6.18	6.14	6.28	7.15	6.715	-
Tyrosine	3.12	3.22	3.17	4.20	4.39	4.295	-
Valine	4.13	4.27	4.20	5.60	6.93	6.265	-
Methionine	1.98	2.15	2.065	2.50	3.03	2.765	-
Cysteine	1.93	2.03	1.98	0.96	1.32	1.14	-
Lysine	3.96	4.04	4.00	6.68	6.83	6.755	-
Isoleucine	4.87	5.09	4.98	2.98	3.05	3.015	-
Leucine	11.17	11.98	11.575	11.83	13.96	12.895	-
Phenylalanine	3.95	4.01	3.98	4.68	4.86	4.77	-
Total amino acids	83.98	88.64	86.31^{b}	88.48	97.96	93.22^{a}	5.9868
PER	1.83	2.15	1.99^{b}	2.02	2.42	2.22^{a}	0.0994
Biological value (BV)	69.18	72.52	70.85^{b}	71.12	75.42	73.27^{a}	1.1924
Caloric value (kj/g)	55.76	65.64	60.70^{b}	57.34	67.30	62.32^{a}	0.0994

- **Data are the average of camel milk samples and each in duplicate.**
- **Any two averages with different letters in the same raw are highly significant differed.**
- **L.S.D = Least significant differences**

Fatty acids content:

Data presented in Table (5) showed that short-chain fatty acids (C4:0 – C8:0) of camel milk lipid constituted a very small amount with average 1.03 and 2.09 % of close and open system respectively. Our findings are similar to those reported by Farah, (1993) reported that short- chain fatty acids of camel milk amounted to 1.2 %. The different results could be due to differences in the type of feed, breed and/ or stage of lactation among animals. Palmquist et al. (1993) reviewed others factors which affect fatty acid composition like animal genetic, feed, grain, amount and composition of dietary fat, dietary protein, seasonal and regional effects. Even- numbered long-chain saturated fatty acids 14:0- 18:0 in camel milk lipid accounted for of total fatty acids. Analysis of variance showed that there were high significant between saturated, unsaturated and total fatty acids of close and open pasture ($P < 0.0001$), with L.S.D = 3.751, 0.9067 and 2.8443 respectively. Data presented in Table (5) shows that the averages of total saturated fatty acids were 62.995 and 71.865 % of camel milk samples of close and open pasture, respectively, while unsaturated fatty acids were 28.76 and 31.855 % in the same order. These results are similar to those reported by Abu-Lehia, (1989). Total cholesterol of camel milk was higher content of open than close pasture. There was high significant difference of cholesterol content of close

and open pasture (P < 0.0001), with L.S.D =28.568. The averages were 312.9 and 345.6 mg/100g fat of camel milk samples of close and open pasture respectively. Our findings are similar with those reported by (Shahien, 2006**)**, (300.20- 350.2 mg/ 100 g fat).

Table (5). Fatty acid composition and cholesterol concentration of camel milk in North Sinai:

Fatty acids %	Close pasture			Open pasture			LSD
	Min	Max	Average	Min	Max	Average	
C4. 0 Butyric	0.12	0.14	0.13	0.08	0.12	0.10	-
C6. 0 Caproic	0.13	0.14	0.135	0.19	1.16	0.675	-
C8.0 Caprylic	0.10	1.43	0.765	0.93	1.70	1.315	-
C10.0 Capric	4.22	7.30	5.76	4.29	8.02	6.155	-
C12.0 Lauric	1.21	1.35	1.28	1.80	1.81	1.805	-
C14.0 Myristic	7.06	8.50	7.78	9.74	12.00	10.87	-
C15.0 Pentadecanoic	0.50	0.84	0.67	0.65	1.50	1.075	-
C16.0 Palmitic	22.76	25.71	24.235	23.75	27.10	25.425	-
C16:1 Palnitoleic	6.01	7.64	6.825	7.03	8.00	7.515	-
C18.0 Stearic	14.62	16.21	15.415	15.63	18.23	16.93	-
Total Saturated acids	56.73	69.26	62.995 ^{b}	64.09	79.64	71.865 ^{a}	3.751
C18:1 Oleic	18.77	21.15	19.96	20.61	23.28	21.945	-
C18:2 Linoleic	3.30	4.95	4.125	4.90	5.01	4.955	-
C18:3 α Linolenic	3.84	4.11	3.975	3.91	4.75	4.33	-
C20.0 Arachidic	0.60	0.80	0.70	0.55	0.70	0.625	-
Total Unsaturated acids	26.51	31.01	28.76^{b}	29.97	33.74	31.855^{a}	0.9067
Total fatty acids	83.24	100.27	91.755^{b}	94.06	113.38	103.72^{a}	2.8443
Total cholesterol (mg/100g)	301.2	324.6	312.9^{b}	322.4	368.8	345.6^{a}	28.568

- **Data are the average of camel milk samples and each in duplicate.**
- **Any two averages with different letters in the same raw are highly significant differed.**
- **L.S.D = Least significant differences**

Technological properties:-

Coagulation time and curd tension of camel milk are summarized in Table (6). It is clear from the results that there is decrease in coagulation time when added the rennet to the camel milk which incubated with yoghurt starter. The decreasing of coagulation time approximately between 12-15 min. It may be due to the activity of yoghurt starter to produce lactic acid. Concerning the curd tension of camel milk the average was 28-42 g. This variation may be due to the effect of fat, protein, pH value and heat treatment of camel milk. Our findings in line with those reported by Ahmed and Kanwal (2004) who reported that camel milk took (4hr) at which milk completely curdled.

Table(6).Coagulation time of camel milk by Rennet, Yoghurt starter and mixture of them and curd tension.

Time	Rennet		Yoghurt starter		Rennet & Yoghurt starter		Curd tension (g)
	h	min.	h	min.	h	min.	
Minimum	3	32	4	15	3	20	28
Maximum	4	15	5	10	4	00	42

- **Data are the average of camel milk samples and each in duplicate.**

Microbial properties:

Table (7) shows the average of bacterial counts of raw camel milk of close and open pasture. Analysis of variance showed that there were high significant of aerobic plate count, lactic acid bacteria, coliform and yeast and mould ($P < 0.0001$), with L.S.D = 3.2294, 1.7389, 9.4397 and 0.7452 respectively. On the other hand there was insignificant of *Staphylococcus* ($P < 0.0001$), with L.S.D = 1.7637 of camel milk of close and open pasture. The aerobic plate count average was 2.3 $x10^5$ and 7.6$x10^5$cfu/ml in close and open system respectively. These results were in agreement with those reported by Omer and Eltinay (2008), and lower than that of those reported by El-Demerdash and Al-Otaibi (2012). The average of lactic acid bacteria (LAB) were 0.9 $x10^5$ and 5.2 $x10^5$ cfu/ml of raw camel milk of close and open pasture respectively. These results lower than that those reported by El-Demerdash and Al-Otaibi (2012), (4.8 x 10^7 cfu/ml). The average of total coliform in camel milk was 5.0 $x10^1$ and 2.2 x 10^1 cfu/ml in close and open system respectively. These results is lower than that reported by El-Demerdash and Al-Otaibi (2012), this generally provides an index of the sanitation used during collection. The average of mould and yeasts were 1.1 $x10^2$ and 3.2 x 10^2cfu/ml of close and open system respectively. Our findings are higher than of those reported by Omer and Eltinay (2008), (4.1 $x10^1$) and lower than of those reported by El-Demerdash and Al-Otaibi (2012), (6.5 $x10^3$). *Staphylococcus* was isolated from 60 % of the examined camel milk samples of both systems. These results agreed with those reported by Neimat and Salwa (2011), and lower than that reported by Omer and Eltinay (2008); El-Demerdash and Al-Otaibi (2012). All the samples tested were found negative for *Salmomella ssp, Listeria* and *E.coli* 0157:H7. The negative results of most pathogenic bacteria may be due to the activity of protective proteins (Lysozme, Lactoferrin, lactoperoxidase and immunoglobulin of camel milk, as reported by Barbour, et al. (1984).

Table (7). Enumeration of different microbiological and pathogenic bacteria in raw camel milk in North Sinai.

Microorganism	Close pastures				Open pastures				LSD
	No. of Samples	Range & Average	No. of positive samples	Positive samples %	No. of samples	Range & Average	No. of positive samples	Positive samples %	
	cfu				cfu				
Total aerobic (Average)	10	1.8-2.8 $x10^5$ ($2.3 x10^5$)^b	10	100	10	5.8-9.4 $x10^5$ ($7.6 x10^5$)^a	10	100	3.2294
Lactic acid (Average)	10	0.1-1.7 $x10^5$ ($0.9 x 10^5$)^b	10	100	10	3.7-6.7 $x10^5$ ($5.2 x10^5$)^a	10	100	1.7389
Total coliform (Average)	10	1.0-9.0 $x10^1$ ($5.0 x 10^1$)^a	10	100	10	2.0-2.4 $x10^1$ ($2.2 x 10^1$)^b	8	80	9.4397
Mould & yeasts (Average)	10	0.3-1.9 $x10^2$ ($1.1 x 10^2$)^b	8	80	10	2.1-4.3 $x10^2$ ($3.2 x 10^2$)^a	6	60	0.7452
Total Staph. (Average)	10	0.02-0.4 $x10^3$ ($0.21 x10^3$)^a	6	60	10	0.2-2.0 $x10^3$ ($1.1 x 10^3$)^a	6	60	1.7637
Salmonella	10	ND	0	0	10	ND	0	0	-
Listeria	10	ND	0	0	10	ND	0	0	-
E.coli 0157:H7	10	ND	0	0	10	ND	0	0	-

- **Data are the average of camel milk samples and each in duplicate.**
- **Any two averages with different letters in the same raw are highly significant differed.**
- **L.S.D = Least significant differences**
- **ND: Not detected**

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القيمة الغذائية والخواص الفيزيوكيميائية والميكروبيولوجية للبن الابل فى محافظة شمال سيناء

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يهدف هذا البحث إلى دراسة القيمة الغذائية والخواص الطبيعية والكيماوية والبكتريولوجية للبن الابل فى محافظة شمال سيناء. فقد تم تجميع العينات تحت ظروف الرعى الحر والرعى المغلق. وأشارت النتائج الى وجود بعض الفروق المعنوية فى معظم الخواص الطبيعية والكيماوية والبكتيريولوجية بين عينات لبن الابل من الرعى الحر والرعى المغلق. كما أشارت النتائج الى أن متوسط قيم الحموضة ورقم الـ pH بلغ ٠.١٧٥ % ، ٦.٦٢ & ٠.١٦ % ، ٦.٦٦ فى نظام الرعى المغلق والمفتوح على الترتيب. وسجلت نسبة كل من الجوامد الكلية- الدهن- البروتين- اللاكتوز قيم أعلى فى الرعى الحر عنه فى الرعى المغلق. كذلك وجود فروق معنوية بين جميع العناصر فيما عدا عنصر الفوسفور. وتشير النتائج الى زيادة محتوى معظم العناصر المعدنية فى الرعى المفتوح عنه فى الرعى المغلق فيما عدا مستوى الحديد حيث كان محتواه أعلى فى نظام الرعى المغلق عنه فى الرعى المفتوح. وكان مجموع كل من الاحماض الأمينية والدهنية ومحتوى الكوليسترول والقيمة الحيوية (BV) والطاقة أعلى فى نظام الرعى المفتوح عنه فى الرعى المغلق. كما أشارت النتائج الى انخفاض زمن التجبن عند إضافة المنفحة الى اللبن المحمض ببادئ الزبادى (المضاف بنسبة ٣ %) بمقدار ١٢-١٥ دقيقة عن التجبن بالمنفحة فقط ، ٥٥-٧٠ دقيقة عن التجبن الحامضى بواسطة بادئ الزبادى وتراوحت قوة الخثرة بين ٢٨- ٤٢ جرام. كما أشارت النتائج الى وجود فروق معنوية بالنسبة للعد الكلى للبكتيريا وبكتيريا حامض اللاكتيك والفطر والخميرة بين نظام الرعى المغلق والحر وكان أعلى فى نظام الرعى الحر عنه فى نظام الرعى المغلق. أما مجموعة بكتيريا القولون كان أعلى فى نظام الرعى المغلق عنه فى نظام الرعى الحر. ولم تسجل أى من العينات وجود معظم أى من البكتيريا المرضية *مثل* *Salmonella, Listeria, Escherichia coli* 0157:H7 فيما عدا *Staphylococcus* حيث وجدت فى عينات كلا النظامين من الرعى.

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