CHEMICAL COMPOSITION AND RENNET COAGULATION PROPERTIES OF CAMEL MILK

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ABSTRACT

The chemical composition and factors affecting the rennet coagulation of camel's milk were studied in comparison to cow's and buffaloe's milk. The total solids of camel milk was slightly higher while its fat and protein content were slightly less than that of cows' milk. Camel's milk had less casein and slightly higher whey proteins than cow's milk. The increase in chymosim concentration, addition of increasing concentration of Ca^{++}, decrease of pH and increase in temperature enhanced the coagulation of camel's milk in a similar way to cow's milk. However in all cases the rennet coagulation time (RCT) of camel's milk was higher than that of cow's and buffaloe's milk.

Keywords*: Rennet coagulation, Camel's milk, Cow's milk, Buffaloe's milk, chemical composition*

INTRODUCTION

Camel milk plays an important role in human nutrition in many arid countries. There is a growing interest in camel's milk due to its chemical therapeutic effects. Wide variations in the composition of camel milk has been reported in several reviews (Farah; 1993; Mohamed 1990, Abu Lehia, 1987). Few studies have been carried an the composition of camel milk in Egypt (El-Bahey 1962, Bayoumi, 1990; Hassan et al., 1987 and Farag and Kebary, 1992).

One of the characteristic properties of camel milk is its weak coagulation by rennet (Farah and Bachman, 1987; Bayoumi, 1990; Mehaia et al. 1988). This has been attributed to the large casein miceller size of camel milk (Gouda et al. 1984; Farah and Ruegg, 1989) and its low content of the colloidal calcium phasphate (Yagil and Etzion, 1980). Several attempts have been made to correct the rennet coagulation and cheese manufacture from camel milk (Farah and Bachmann, 1987; Bayoumi 1990), but more studies are needed along this time.

Therefore, the present study was undertaken to obtain more information about the composition and rennet coagulation of camel's milk produced under the Egyptian conditions .

MATERIALS AND METHODS

Materials :

Cow's and buffaloe's milk were obtained from agriculture college, Cairo university where camel's milk samples were obtained from Assiut Market. The milk samples were kept frozen until analyzed. Calf rennet powder (Hala) was obtained from Ch. Hansen Lab.(Copenhagen, Denmark) calcium chloride was obtained in analytical grade from El-Nasr Company, Egypt, and sodium chloride was obtained from local market.

Methods of analysis

The acidity, pH, fat, total solids and ash content were determined according to methods described by AOAC (1990). The total, non-casein and non protein nitrogen were determined according to IDF, (1993) using kejeldahl method. The rennet coagulation time was measured as described by Berridge (1955).
The procedure was as follows: One gram of powdered calf rennet was dissolved in 100 ml of distilled water. Aliquot(10ml) of the milk sample was pipetted in test tube immersed in a water bath maintained at 40ºC unless stated. After 5 min. 1ml of the rennet solution was added to the milk sample stirred well and left untill the first appearance of clots in milk and clotting time was recorded in sec. With stop watch. The rennet coagulation time (RCT) of each sample was determined in triplicates and the mean value was calculated to the nearest second.

Experiments :

The effect of following factors on the rennet coagulation time (RCT) of camel's, cow's and buffaloe's milk were carried out:

- E**fect of added chymosin:** 0.5, 1.0,1.5,2.0 and 2.5 ml of the prepared rennet solution were used to measure the RCT of different milks.
- **Effect of pH.** The pH of milk was adjusted to 5.5, 5.8, 6.1, 6.4, 6.7 and 7 using 1 N HCl or 1N NaOH before measuring the RCT.
- **Effect of $CaCl_2$.** Exactly 0.0, 20, 40, 50, 60, 80 and 100 mM of $CaCl_2$ were added to milks before measuring the RCT.
- **Effect of NaCl**. Sodium chloride was added at the ratio 0.0, 1.0, 2.0, 3.0, 4.0 and 5% to milks before RCT measurement .
- **Effect of temperature**. The RCT of different milks were measured at 30,40,45and 50 C.

RESULTS AND DISCUSSION

Chemical composition:

Table 1, shows that camel's milk contained slightly higher total solids than cow's milk but much less than buffaloe's milk being in agreement with other reports (Mohamed, 1990, Mehaia et al., 1995). On the other hand, the fat and total protein contents were less than that of cow's and buffaloe's milks. Camel's milk has been reported to contain higher lactose than cow's milk (Bayoumi, 1990) which explain the higher total solids of camel milk compared to that of cow's even it had less fat and protein cantents.

Table (1): Chemical composition* of camel's, cow's and Buffaloe's milk.

	Camel's milk	Cow's milk	Buffaloe's milk
Total solids %	12.72	12.3	15.54
Fat %	2.9	3.2	6.3
Fat / DM %	22.80	26.02	40.54
pH value	6.42	6.58	6.43
Acidity %	0.18	0.18	0.17
Total Nitrogen	0.446	0.522	0.650
Total protein %	2.85	3.33	4.147
T. protein/DM%	22.41	27.07	26.69
NPN	0.035	0.088	0.091
NCN	0.151	0.198	0.211
CN	0.295	0.324	0.439
PN	0.411	0.434	0.559
WPN	0.116	0.110	0.120
Ash %	0.784	0.615	0.988
Ash/ DM %	6.16	5.00	6.36

Average of 3 replicates

The nitrogen distribution in camel's milk differ slightly from that for cow's and buffaloe's milks. Thus the casein number of camel's milk (Casin N/total N) was less while its whey protein N was higher than that of cow's and buffaloe's milks. There results are in agreement with that reported by Mehaia et al. (1995). However, the NPN content of camel's milk was less than that of cow's and buffaloe's milk, which disagree with other reports (Mehaia et al., 1995, Bayoumi 1990, Farag and Kebary, 1992). However, Farah (1993) stated that the protein and N fractions in camel's milk were generally similar to those in cow's milk.

The acidity and pH values of camel's, and cow's and buffaloe's milkwere generally similar in accordance with previous reports (Mehaia et al., 1995, Farrag and Kebary, 1992). The ash content of camel's milk fall in between cow's milk and buffaloe's milk. Bayaumi (1990) gave similar results with respect to the ash content of the three milks.

Rennet coagulation time (RCT)

Effect of chymosin concentration:

Table 2, shows that the RCT of different milks as affected by the concentration of added chymosin. Camel's milk showed the highest RCT while buffaloe's milk showed the lowest RCT at the different concentrations of added chymosin. In all cases the RCT of milks decreased almost linearly with the increase in chymosin. However, the effect of increased chymosin concentration on RCT was more pronounced in case of camel milk. Similar results were reported by Mohamed et al. (1989). Mehaia (1994) found that the effect of enzyme concentration on RCT to decrease as the protein concentration of milk increased which may explain the differences in the effect of chymosin concentration and RCT of the different types of milks.

Table (2): Effect of chymosin added to milk on RCT (Sec)*:

	Camel's milk		Cow's milk		Buffaloes milk	
	Sec	% of decrease	Sec	% of decrease	Sec	% of decrease
0.5 ml	765	0.0	395	0.0	368	0.0
1.0 ml	555	27.45	312	21.01	342	4.35
1.5 ml	422	44.84	290	26.28	268	27.17
2.0 ml	302	60.52	218	44.81	192	47.83
2.5 ml	193	74.77	136	65.57	124	66.30

Average of 3 replicates

Effect of pH:

Table 3, shows that the effect of changing pH on RCT was more pronounced in case of camel's milk compared with cow's and buffaloe's milks. Thus the increase in pH from 5.8 to 6.1-6.4 increased markedly the RCT of camel's milk. Similar results were reported by Farah
and Bachmann (1987) and Mehaia (1994).

Table (3): Effect of pH on the RCT (Sec.)*.

PH	Camel's milk		Cow's milk		Buffaloe's milk	
	Sec	% of change	Sec	% of change	Sec	% of change
5.5	376	0.0	229	0.0	212	0.0
5.8	423	+ 12.5	276	+20.52	234	+10.38
6.1	509	+35.37	281	+22.71	252	+18.87
6.4	556	+47.87	312	+36.25	268	+26.52
6.7	555	+47.61	344	+50.22	275	+29.72
7.0	589	+65.65	354	+54.59	291	+37.26

Average of 3 replicates

Effect of Ca :++

Addition of an increasing concentration of $CaCl_2$ decreased the RCT of camel's, cow's and buffaloe's milk (Table 4).This can be explained on the basis that the increased Ca++ would enhance the 2^{nd} stage of the rennet coagulation and in turn the RCT would decreased. These results are in agreement with that reported by Farah and Bachmann (1987) and Mehaia (1994)

Table (4): Effect of added $CaCl_2$ on the RCT(Sec.)of camel's cow's, and buffaloe's milk*.

$CaCl_2$ added (mM)	Camel's milk		Cow's milk		Buffaloes milk	
	Sec	% of decrease	Sec	% of decrease	Sec	% of decrease
0.0	555	0.0	312	0.0	268	0.0
20	498	10.27	281	9.94	232	13.43
40	488	12.07	262	16.03	200	25.37
50	474	14.60	248	25.81	182	32.09
60	453	18.38	240	23.08	174	35.08
80	438	21.08	229	26.60	151	43.66
100	364	34.41	191	38.78	139	48.13

Average of 3 replicates

Effect of NaCl:

Table 5, shows that the addition of NaCl to camel's,cow's and buffaloe's milks retarded the coagulation time. The increase in rennet coagulation time (RCT) ran parallel to the percentage of NaCl added. This can be attributed to partial soluluization of colloidal calcium phosphate and decrease in the rate of k-casein hydrolysis (El.Zeny ,1991)

Effect of Temperature:

Increasing the coagulation temperature from 30 to 50°C enhanced the rennet coagulation of different milks (Table 6). However, the effect of temperature was more pronounced in case of camel's milk. Farah and Bachmann (1987) reported that the effect of temperature on cow's and camel's milks was nearly the same.

Table (5): Effect of added NaCl on the RCT(Sec) of camel's cow's and buffaloe's milk*.

NaCl %	Camel's milk		Cow's milk		Buffaloe's milk	
	Sec	% of increase	Sec	% of increase	Sec	% of increase
0.0	555	0.0	312	0.0	304	0.0
1.0	568	2.34	334	7.05	312	2.63
2.0	605	9.01	352	12.82	323	6.25
3.0	625	12.61	362	16.03	346	13.82
4.0	672	21.08	400	28.21	362	19.08
5.0	784	41.26	431	38.14	390	28.29

Average of 3 replicates

Table (6): Effect of coagulation temperature on RCT (Sec.) on camel's,cow's, buffaloe's milk*.

Temperature °C	Camel's milk		Cow's milk		Buffaloes milk	
	Sec	% of change	Sec	% of change	Sec	% of change
30 °C	873	0.0	373	0.0	342	0.0
40 °C	593	-32.07	352	-5.63	280	-18.13
45 °C	555	-36.43	344	-7.77	268	-15.79
50 °C	478	-45.25	378	+1.34	341	-0.29

Average of 3 replicates

The foregoing results suggest that the RCT of camel's was affected by changing the temperature, pH, Ca++, enzyme concentration and NaCl in a similar way to cow's and buffaloe's milk, However, the effect of these factors on RCT was more pronounced in case of camel's milk.

This may be attributed to difference in casein micellar-size distribution, and the low Ca++ content of camel's milk. Camel's milk showed broader distribution curve of casein micells with a maximum between 260 and 300 nm compared to the smaller micellar size of cow's milk ie. 100-140 nm (Farah and Ruegg 1989). Yagil and Ezion (1980) showed that the colloidal calcium bond to the micellar in camel's milk to be much lower than in cow's milk.

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التركيب الكيميائى وخواص التجبن بالمنفحة للبن الابل (النوق)

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تم تجميع عينات لبن الابل (الجمال) من السوق المحلى ولبن الابقار و الجاموس من كلية الزراعة,جامعة القاهرة. وقد تم تجميد العينات وحفظها عند درجة حرارة –18°م لحين تحليلها لمكوناتها من الجوامد الكلية، الدهن، البروتين الكلي، النيتروجين الكازينى والنيتروجين غير البروتينى وكذلك محتواها من الرماد وتم تقدير الحموضة وقياس رقم ال pH .

وقد خلصت نتائج الدراسة إلى أن الجوامد الكلية فى لبن الابل أعلى قليلا عن نسبتها فى لبن الابقار.كما احتوى لبن الابل على نسبة أقل من النتروجين الكازينى عن لبن الابقار والجاموسى بينما احتوى على نسبة أعلى من من بروتينات الشرش عن لبن الابقار.

و قد شمل البحث دراسة خاصية التجبن بالمنفحة وتأثير بعض العوامل عليها ويمكن تلخيص النتائج المتحصل عليها فيما يلى:

1- أن زيادة كمية أنزيم الكيموسين تقلل من زمن التجبن فى الألبان الثلاثة.
2- أن اضافة كلوريد الكالسيوم يقلل من زمن التجبن فى الألبان الثلاثة , وأن العلاقة بين نسبة كلوريد الكالسيوم المضاف و زمن التجبن عكسية.
3- بزيادة درجة حرارة التجبن من (30°م الى50°م) تؤدى إلى تقليل زمن التجبن فى الألبان الثلاثة.
4- زيادة رقم الـ pH (5.5 – 7) وجد أنه يؤدى إلى زيادة زمن التجبن فى الألبان الثلاثة.
5- أن اضافة كلوريد الصوديوم تزيد من زمن التجبن فى الألبان الثلاثة.
6- فى جميع الحالات كان زمن تجبن لبن الابل أعلى من زمن تجبن لبن الابقار و أقلهم فى زمن التجبن لبن الجاموس.