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A COMPARATIVE STUDY ON THE EFFECT OF COLD STORAGE ON SOME PROPERTIES OF GOAT'S AND COW'S MILK

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ABSTRACT

The attained results showed slight changes in the acidity, pH and stability to ethanol during the cold storage of goat's milk, whereas the corresponding values in cow's milk were more pronounced. Rennet clotting time significantly decreased during storage of goat's milk, whereas the changes were insignificant in cow's milk.

The proteolysis expressed as NPN/TN was insignificant and significant during storage of goat's and cow's milk, respectively.

The values of curd tension gradually decreased during storage of goat's milk and increased in case of cow's milk. Advancing of storage period had insignificant effect in this respect and on curd syneresis of both types of milk.

Cold storage of milk had a significant effect on decreasing water and oil absorption capacities of goats casein, whereas the differences in case of cow's casein were insignificant. Casein solubility gradually increased during storage of both types of milk.

INTRODUCTION

Owing to the limited production of goat's milk in the Egyptian farms, it is quite important to apply the cold storage of milk. This gives an opportunity to collect a reasonable quantity of milk to be suitable for processing. However, storage of milk at lower temperature favours growth of psychrotrophs. Although most of them are heat sensitive, they produce heat-resistant proteinases and lipases which may cause defects in the stored milk and its products (Adams *et al.*, 1975 and Law *et al.*, 1976). Such effects, defects and ways of preventing them were comprehensively given by Shah (1994) and Sorhaug and Stepaniak (1997).

On the other hand, differences in composition and properties of milk from different mammals were reported in the literature (Woodward, 1976 ; Jenness, 1979 and Abd El-Salam *et al.*, 1992). Goat's milk differs from cow's milk in several physico-chemical characteristics. This can explain to a large extent the differences in the technological properties of the two milks. Thus, poor cheesemaking ability of goat's milk is due essentially to its lower casein content and to specific properties of casein micelles as composition, size and hydration (Remeuf and Lokeshwar, 1992).

Proportion of the four caseins (i.e. α_{S1}-, α_{S2}-, β- and K-) are not the same. Goat's casein was reported to contain lower proportion of α_{s1}-CN and higher proportion of β-CN (Jenness, 1979 ; Juarez and Ramos, 1986 ; and Abd El-Salam *et al.*, 1992). However, richness of goat's milk with β-CN which dissociates to some extent at low temperature from the micelles (O'Conner

and Fox, 1973 and Jenness, 1979) may cause differences in behaviour of goat's milk during cold storage.

The main target of the present study was to follow the changes in some properties of goat's milk and its prepared casein during the cold storage of milk. Comparison with cow's milk was taken in to consideration.

MATERIALS AND METHODS

Herd bulk goat's and cow's milk samples were collected from the herd of Sakha Animal Production Research Station, Kafr El-Sheikh. The milk samples were stored in refrigerator at 4±2°C for 72 h. The samples were analysed directly when collected and at 24 h intervals for pH and acidity as described by Ling (1963). Alcohol test was carried out as given by White and Davies (1958). Rennet coagulation time (RCT) was measured according to Berridge (1952) using the same amounts of rennin units. Curd tension was measured at room temperature (25-30°C) according to Chandrasekhar *et al.* (1957), whereas whey syneresis was measured according to Mehanna and Mehanna (1989). Total N, non-protein N soluble in 12% TCA were measured by semi-micro Kjeldahl procedure as given by Ling (1963).

Milk samples was skimmed by centrifugation and rennet casein was obtained by adding suitable amount of rennet to skim milk at room temperature. The collected casein samples were dried by ethanol. Water and oil absorption were measured according to the methods given by Beuchat (1977), whereas the method of Morr (1985) was used for determining the protein solubility.

The attained data were statistically analysed according to Steel and Torrie (1984).

RESULTS AND DISCUSSION

The pH values, acidity, stability to ethanol and rennet clotting time (RCT) of both goat's and cow's milks are shown in table (1). The attained results showed that the pH values of goat's milk slightly decreased during the storage time and minimum value of 6.70 was recorded at the end of storage period. The decrease of pH values was more pronounced in cow's milk. Thus the recorded values were 6.73 and 6.58 at the beginning and the end of storage period, respectively. However, statistical analysis, (Table 5) showed that the differences in pH values due to storage period were insignificant for both goat's and cow's milk and between them. The opposite trend of these results was observed with respect to acidity values of cow's milk (Table 1), whereas, those of goat's milk were nearly the same. Statistical analysis showed that the differences in acidity of cow's milk were significant ($P<0.05$), but were insignificant for goat's milk and between them. The gradual increase of acidity and the decrease of pH during cold storage of cow's milk agree with those given in the literature (Moussa *et al.*, 2000 and Saleh, 2001). Stability of milk to ethanol was changed during the storage period. The highest

stability was recorded for both goat's and cow's milks before cooling and then insignificantly decreased. However, goat's milk was less stable than cow's milk at any given storage time. The differences between the mentioned milks were insignificant (Table 5).

Table (1): Some properties of goat's and cow's milk as affected by cold storage for 72 h (average of 3 replicates).

Property	Goat's milk				Cow's milk			
	Storage time (h)				Storage time (h)			
	zero	24	48	72	zero	24	48	72
PH	6.77	6.77	6.73	6.70	6.73	6.73	6.68	6.58
Acidity, %	0.18	0.18	0.17	0.17	0.17	0.17	0.18	0.19
Stability to ethanol*	72	68	68	68	88	84	80	72
Rennet clotting time (sec)	1020	842	673	667	851	721	666	724

* Expressed as the weakest ethanol concentration when added to an equal volume of milk caused clotting.

RCT had wide range of variation during storage of both milks. The maximum RCT value was 1020 sec. with fresh goat's milk and significantly decreased during the storage, reaching the minimum of 667 sec after 72 h. In cow's milk the RCT values gradually decreased up to 48 h and then slightly increased. The differences in this respect were insignificant and also between RCT of both milks. The foregoing results suggest that RCT of goat's milk was almost longer than that of cow's milk. This finding agrees with the results of Remeuf and Lenoir (1985). Such differences in the results might due to differences in composition and physico-chemical properties of both types of milk and between different breeds of goats.

The decrease in RCT during the cold storage might be attributed to the corresponding increase in acidity values. This agrees with the results given by Abdel-Kader (1999) and Ammar (1999).

Table (2) shows that the protein content slightly change during storage of both milks, the highest value was recorded in fresh goat's and cow's milk being 3.63 and 2.88%, respectively., This was followed by the values of 3.43, 3.04 and 3.11% for goat's milk after 24, 48 and 72 h. of storage and corresponding values of 2.83, 2.64 and 2.62% for cow's milk, respectively. Statistical analysis showed that the differences in protein during storage of goat's milk were significant ($P<0.05$), but were insignificant for cow's milk (Table 5). Such differences were accompanied by a corresponding increase in NPN during storage of cow's milk while those of goat's milk were nearly the same. However, NPN/TN (%) showed a gradual increase for both types of milk and the maximum values were recorded at the end of storage period. Such changes were insignificant in goat's milk and significant in cow's milk (Table 5). The recorded proteolysis agrees with the findings given in the literature (Adams *et al.*, 1975 and Moussa *et al.*, 2000) and could be due to the proteolytic action of some proteases of psychrotrophic bacteria.

Table (2): The changes in protein content (%) and proteolysis expressed as non-protein N/total N (NPN/TN, %) in goat's and cow's milk as affected by cold storage for 72 h (average of 3 replicates).

Property	Goat's milk				Cow's milk			
	Storage time (h)				Storage time (h)			
	zero	24	48	72	zero	24	48	72
Protein, %*	3.63	3.43	3.04	3.11	2.88	2.83	2.64	2.62
NPN, %	0.049	0.050	0.046	0.047	0.029	0.040	0.040	0.044
NPN/TN, %	8.63	9.29	9.66	9.66	6.42	9.01	9.66	10.73

* Protein = TN x 6.38

Table (3) reveals that the trend of curd tension was quite different in both milks. A gradual decrease was recorded in case of goat's milk, whereas corresponding increase was observed for cow's milk during the storage. The differences in curd tension, curd firmness and bahaviour of the milks towards the cold storage could be explained on the basis of the known differences in the physical properties of casein micelles, mean diameter and degree of hydration (Remeuf *et al.*, 1989 ; Remeuf and Lokeshwar, 1992).

Table (3): Curd tension (g) and curd syneresis (g/15 g curd) of goat's and cow's milk as affected by cold storage for 72 h (average of 9 determination from 3 replicates).

Property	Goat's milk				Cow's milk			
	Storage time (h)				Storage time (h)			
	zero	24	48	72	zero	24	48	72
Curd tension	16.50	15.42	14.55	14.17	17.90	19.37	21.70	22.20
Curd syneresis after:								
10 min.	6.39	5.93	6.02	7.02	6.71	5.47	6.49	7.53
30 min.	7.45	6.77	7.78	7.72	8.20	7.25	8.05	8.99
60 min.	8.49	7.84	8.54	8.62	9.25	8.27	9.16	9.77
120 min.	8.98	8.44	9.25	9.42	9.55	8.97	9.71	10.02

Curd syneresis was also insignificantly affected by the storage period but the maximum amounts of exudate were recorded for goat's milk (9.42 g) and for cow's milk (10.02 g) after 72 h of storage. Fluctuant figures were noticed during the storage period up to 48 h.

Water absorption capacity (WAC) and oil absorption capacity (OAC) of caseins obtained from goat's and cow's milk are shown in Table (4). The mentioned properties were significantly decreased during storage of goat's milk, whereas fluctuant figures were observed in case of cow's casein. Although goat's casein had always lower values for WAC and OAC as compared to cow's casein, the differences in this respect were insignificant (Table 5) and might be attributed to the differences in the protein compcsition and conformation (Barbut, 1996). The well known effect of cold storage on β-CN might explain such impact on WAC and OAC of the obtained caseins which greatly had different quantity of β-CN.

Table (4): Water absorption capacity (WAC)*, oil absorption capacity (OAC) and protein solubility (PS, %) of goat's and cow's casein as affected by cold storage of milk for 72 h (average of 3 replicates).**

Property	Goat's milk				Cow's milk			
	Storage time (h)				Storage time (h)			
	zero	24	48	72	zero	24	48	72
WAC	1.60	1.30	1.18	1.00	1.60	1.65	1.55	1.47
OAC	1.35	1.26	1.26	0.90	1.80	1.53	1.32	1.44
PS, %	6.36	7.96	8.03	9.15	1.64	4.76	5.36	6.74

* WAC expressed as g water /g protein powder.
** OAC expressed as g oil/g protein powder.

Solubility of goat's casein (Table 4) was higher at any given storage time than that of cow's casein, and in all cases the solubility gradually increased during storage. Such differences might be explained on the basis of the known differences in composition of the mentioned caseins and their different behaviour towards cooling.

Table (5): Analysis of variance (F-values) for the effect of cold storage on properties of goat's and cow's milk.

Property	F-value		
	Storage period		Type of milk
	Goat's milk	Cow's milk	
PH	1.046	4.084	3.530
Acidity	2.793	6.22*	0.089
Stability to ethanol	2.451	0.098	3.174
RCT	27.411**	0.522	0.360
Protein	7.349*	0.266	7.510
NPN	0.277	1.530	1.659
NPN/TN	2.670	5.950*	0.046
Curd tension	0.182	2.048	4.559
Curd syneresis	3.293	0.985	0.478
Water absorption	8.286**	1.136	1.132
Oil absorption	6.950*	1.050	1.35
Solubility	6.010	10.535**	0.019

* Significant at 0.05 level
** Significant at 0.01 level

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دراسة مقارنة عن تأثير التخزين المبرد على بعض خواص لبن الماعز ولبن الابقار

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أوضحت نتائج الدراسة التى اهتمت بتتبع التغيرات فى بعض خواص لبن الماعز ولبن الابقار خلال الحفظ مبردا لمدة ٧٢ ساعة حدوث تغيرات بسيطة فى الحموضة والرقم الهيدروجينى والثبات ضد الايثانول فى حالة لبن الماعز بينما كانت الزيادة معنوية فى حموضة اللبن البقرى مع تناقص الرقم الهيدروجينى والثبات ضد الايثانول بتقدم فترة التخزين وواكب ذلك حدوث تناقصا معنويا فى وقت تجبن لبن الماعز بالمنفحة ، بينما كانت التغيرات غير معنوية احصائيا فى حالة اللبن البقرى.

حدث تحلل بروتينى معبرا عنه بالنتروجين غير البروتينى منسوبا للنتروجين الكلى عند تخزين اللبن مبردا وكانت التغيرات غير معنوية فى حالة لبن الماعز ومعنوية فى حالة لبن الابقار.

اما عن الجذب الخثرى فقد تناقصت القيم تدريجيا بتقدم فترة تخزين لبن الماعز وزادت تدريجيا فى حالة اللبن البقرى ولم تكن التغيرات معنوية احصائيا فى كلتا الحالتين وايضا لم تكن معنوية عند تقدير معدل طرد الشرش من الخثرة.

ادى تخزين اللبن مبردا الى الانخفاض المعنوى فى مقدرة كازين لبن الماعز على امتصاص الماء والزيت بينما كانت التغيرات غير معنوية فى حالة الكازين المحضر من اللبن البقرى وزادت ذائبية الكازين فى كلتا الحالتين بتقدم فترة تخزين اللبن.