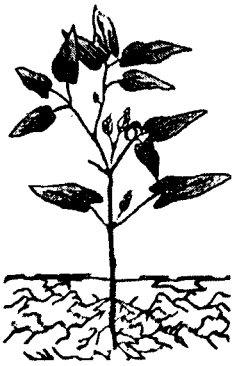

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# EFFECT OF COLD STORAGE AND HEATING OF CAMEL'S MILK ON FUNCTIONAL PROPERTIES AND MICROSTRUCTURE IN COMPARISON WITH COW'S AND BUFFALO'S MILK

[11]

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## ABSTRACT

The effect of cold storage (4°C/48h.) and heating (85°C/5min.) on some properties of camel's, cow's and buffalo's milks were studied. These included acidity, pH, nitrogen distribution, rennet coagulation time (RCT), surface tension (ST), foam expansion (FE), foam volume stability (FVS), buffer intensity , the electrophoretic properties and microstructure. Cold storage of all milk samples increased acidity, and decreased pH, ST, RCT (except camel's milk) and FE (except cow's milk). No significant effect on CN, NCN and WPN was found. Heating all milk samples increased acidity, casein nitrogen (CN) and RCT (except camel's milk), decreased non-casein nitrogen (NCN), whey protein nitrogen (WPN) and non significant effect on ST. Also, heating decreased only FE of buffalo's milk and increased the others, while FVS of camel's milk was not recorded (after 15 min.). In all cases, buffer intensity curves showed same peaks and were the highest at pH( 7-8 ) and (6.5-7.5) in buffalo's and cow's milk respectively. However, camel's milk had less buffering capacity compared with either buffalo's or cow's milk. Concerning, the electrophoretic patterns, some whey proteins especially β-lactoglobulin (β-Lg) disappeared on heating, whereas cold storage slightly decreased β-casein. In general, camel's milk showed different protein patterns. There was little microstructure difference between raw and cooled (4°C/48h.) camel's, cow's and buffalo's milk; while heat treatment increased the size of casein micelles in all samples.

## INTRODUCTION

Milk is heated to improve its keeping quality by deactivation microorganisms and to achieve desirable properties in the final products (**Vasbinder and Kruif, 2003**). In addition, heat treatment of milk is widely used to alter the functional properties of milk and milk products for a variety of applications (**Oldfield *et al* 2000**) as well as such treatment is one of the most important processing parameters affecting the texture and consistency of some dairy products like yoghurt( **Lucey *et al* 1998**). However, it is well known that milk is a heat - labile material in which all the major components may be altered physically and/or chemically by heat. This depends on severity of heat treatment. It has been long recognized that heat treatment of milk above 70°C causes denaturation of whey proteins and some of which complex with the casein micelles (**Singh & Creamer, 1992** and **Singh, 1995**).

Denaturation of whey proteins has been previously described as a two-step process, protein unfolding flowed by aggregation (**Roefs** and **de Kruif, 1994**). The main heat-induced complex is formed between β-lactoglobulin and K-casein at

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the micelle surface *via* sulphahydrl-disulphide interchange reactions and hydrophobic interaction (**Haque** and **Kinsella, 1988**). On the other hand, it is common practice in the developed countries-also in Egypt- to store milk on the farm up to 2 days at low temperature (4-6°C) in order to reduce collecting costs. Such treatments of heating and cold storage improve the bacteriological quality of milk but modify several of milk properties. Composition and type of milk is quite important in this respect. For example, camel's milk was characterized by high proportion of α-lactalbumin and immunoglobulin, whilst,β-lactoglobulin was the major whey protein in cow's and buffalo's milks (**Abd El-Salam *et al* 1992**). **Farah** and **Farah (1985)** reported that no protein bands homologues for bovine K-casein could be clearly detected in the electrophoretic pattern of camel's milk protein. Also, the whey proteins of camel's milk were generally more heat-stable than cow's milk (**Farah, 1986**). Such importance of milk proteins especially for some functional properties in dairy products as well as the nutritive value of the liquid milk give more attention for studying impact of heating and cold storage on properties of the treated milk of different species.

Therefore ,the aim of this study was to apply some functional properties, nitrogen distribution, surface tension, electrophoresis and microstructure for distinguishes the changing in proteins of heat treatment or cold storage of camel's milk in comparison with cow's and buffalo's milk. This is reflected the facility of using milk to improve the quality properties of final products.

## MATERIALS AND METHODS

### Materials

Camel's milk of Dromedary was obtained from Maryout Research Station Desert Research Center. Whereas,Buffalo's milk was obtained from the herd of the Fac. Agric., Ain Shams Univ., Cairo, Egypt; cow's milk was obtained from Dina farm at the 80$^{th}$ Km of Alex. desert high way. Chemicals for analysis were obtained from Sigma, USA.

### Methods

### Preparation of milk samples

Each type of milk (camel, cow and Buffalo) was divided, into three parts. The first part was raw (control); the second one was kept at 4°C for 48h. and the third part was heated at 85°C for 5 min. then cooling. Three replicates were carried out for each treatment.

### Analytical methods

All milk samples were tested for total solids (T.S), fat, protein, lactose, ash, acidity and pH using Metter Toledo pH meter as reported by **AOAC (2007)**.

The concentrations of total nitrogen (TN), soluble nitrogen at pH 4.6 (NCN), non-protein nitrogen (NPN) and proteose-peptone (PP) were quantified in all milk samples by the micro-kjeldahl method (**AOAC, 2007**). The whey proteins nitrogen (WPN) and the casein nitrogen (CN) contents were calculated respectively as follows:

$$WPN = NCN - (NPN+PP).$$
$$CN = TN - NCN.$$

### Measurement of rennet coagulation time (RCT)

Rennet coagulation time (RCT) was carried out as given by **Berridge (1945)**.

### Surface tension determination

Surface tension was measured as reported by **Salaün *et al* (2005)**. This was done by placing 100 ml of milk sample in 150 ml plastic cup,then warmed to 25°C in a controlled water bath and stirred for 1/2 min. just before measurement. A ring tensiometer (DuNouy ring Tensiometer, Krüss-Instrument, No. 8158, Germany) was used to measure the interfacial surface tension. The DuNouy ring used for determination was cleaned prior to each measurement by dipping the ring in dilute nitric acid then flaming until the ring was "red" hot in the oxidizing portion of Bunsen burner flame to remove organic materials. After cooling, the ring was then hung from the load cell and lowered to the base of sample container. The ring was pulled from the surface of sample and the force required to do so was recorded as surface tension values which read directly from the instrument scale as $N/m^{-1}$. Duplicate samples were prepared for measurements of each treatment.

### Measurement of foaming properties

Foam ability and foam stability were measured (at 5 ± 2°C) as described by **Closs *et al* (1990)**. Samples of raw, heated or cold stored milks

(200 ml) were whipped at maximum speed for 5 min. using blender (Brun, Germany). Foams were carefully transferred to a 1 L graduated glass measuring cylinder. The foaming capacity was measured according to **Poole *et al* (1984)** and expressed as:

$$\text{Volume increase \%} = \frac{\text{Final volume} - \text{Initial volume}}{\text{Initial volume (200 ml)}} \times 100$$

The foam stability was expressed as time (in min.) required for the foam to breakdown (time required for return to initial sample volume (200 ml).

### Buffer capacity

Buffer intensity curves were determined according to **Morr *et al* (1973)**. Buffering indices (dB/dpH) were calculated for each addition of acid and buffering curves prepared by plotting these indices as a function of pH. Areas under buffering curves were integrated to estimate the intensity of buffering capacity.

### Polyacrylamide-gel electrophoresis

A method described by **Laemmli (1970)** was adapted for the qualitative study. The obtained SDS-PAGE patterns were identified as described by **Basch *et al* (1985)** and **Farrell *et al* (2004)**.

### Microstructure examination of milk samples

Transmission Electron Microscopy (TEM-ZEISS, West Germany) (National Research Center, Dokki, Giza, Egypt) milk samples were examined by TEM microscope at 80 Kv and magnification (63.000X) using the method described by **McMahon *et al* (1993)**.

### Statistical analysis

The experimental data was analyzed using the general linear models procedure of the Statistical Analysis System (**SAS, 1996**). Significant differences were defined at $p<0.05$.

## RESULTS AND DISCUSSION

Chemical composition of the camel's, cow's and buffalo's milk are shown in **Table (1)**. The results show buffalo's, cow's milks had lower ash and lactose contents but higher fat and protein, compared with the camel's milk. These results agree with those reported by **Shahein (2006)**.

Data in **Table (2)** indicate the acidity as lactic acid (%), pH values and rennet coagulation time (RCT, min.) of raw, cold storage, and heated camel's, cow's and buffalo's milk. Cold storage and heating of each type of milk samples resulted in a significant increase in acidity and decrease of pH values, as compared with raw milk samples. The changing in the acidity and pH values were more pronounced in buffalo's and cow's milk than the camel's milk i.e.no coagulum was found. Significant differences ($p < 0.05$) could be detected between raw, cold storage, heated cow's and buffalo's milk for RCT. On the other hand, no time could be recorded for RCT of camel's milk. The increase in the acidity and decrease in the pH values of heated milk could be due to the transference of calcium phosphate from the soluble phase to the colloidal phase, which would result from the liberation of hydrogen ions (**Jennes and Patton, 1959**). The obtained results for camel's milk were similar to the findings of **Bayoumi (1990)** who reported that the raw camel's milk characterized with poor rennet ability and even with the addition of $CaCl_2$. The changes of acidity and pH values of all cold storage milk could be due to growth of psychotropic bacteria (**Cousin *et al* 1992**). The surface tension (ST) was not significantly affected by the applied treatments in camel's milk. However, cold storage treatment had a significant effect in cow's and buffalo's milk. This may be due to the impact of cold storage on solublization of some casein into milk serum (**Ali *et al* 1980; Dzurec & Zall, 1985** and **Lucey *et al* 1998**).

**Table (3)** indicates the effect of the applied treatments on the nitrogen distribution (mg/100 ml) of the camel's, cow's and buffalo's milk. The significant changes due to heat treatment was an increase in the casein nitrogen (CN) with a corresponding decrease in whey protein nitrogen (WPN). The significant decrease in non-casein nitrogen (NCN) may be attributed mainly to the effect of such heat treatment on denaturation of whey protein. Increasing in the CN theraby causing denatured WPN associate with casein precipitate by the casein precipitating agents. Also, it could be noticed that, heat treatment induced no changes in non-protein nitrogen (NPN) and proteose-peptone nitrogen. These results are in agreement with the finding of **Stephan and Gangull (1974)**. The camel's milk was generally more heat-stable than buffalo's and cow's milk, the degree of whey

**Table 1. Gross composition of fresh milk samples (of the camel's, cow's and Buffalo's) milk**

| Content | Type of milk | | |
|---|---|---|---|
| | Camel's | Cow's | Buffalo's |
| Total Solids (T.S %) | 11.94 | 11.83 | 15.68 |
| Fat % | 3.10 | 3.65 | 6.14 |
| Total Protein % | 2.81 | 2.98 | 3.84 |
| Lactose % | 5.13 | 4.48 | 4.86 |
| Ash % | 0.90 | 0.72 | 0.80 |

**Table 2. Effect of cold storage (4°C/48h.) or heating (85°C/5min.) treatments on the acidity, pH values, rennet coagulation time (RCT) and surface tension of the camel's, cow's and buffalo's milk**

| Treatments | Acidity (%) | pH values | RCT (min.) | Surface Tension ($N/m^{-1}$) |
|---|---|---|---|---|
| **Camel:** | | | | |
| Raw | $0.211^{b}$ | $6.44^{a}$ | N.C | $53.62^{a}$ |
| Cold stored | $0.232^{a}$ | $6.10^{b}$ | N.C | $52.10^{a}$ |
| Heated | $0.215^{b}$ | $6.45^{a}$ | N.C | $52.50^{a}$ |
| **Cow:** | | | | |
| Raw | $0.166^{c}$ | $6.64^{a}$ | $2.50^{b}$ | $57.00^{a}$ |
| Cold stored | $0.196^{a}$ | $6.46^{c}$ | $2.00^{c}$ | $51.75^{b}$ |
| Heated | $0.185^{b}$ | $6.56^{b}$ | $3.52^{a}$ | $55.80^{ab}$ |
| **Buffalo:** | | | | |
| Raw | $0.173^{c}$ | $6.61^{a}$ | $1.35^{b}$ | $58.75^{a}$ |
| Cold stored | $0.218^{a}$ | $6.40^{c}$ | $1.10^{c}$ | $50.50^{b}$ |
| Heated | $0.194^{b}$ | $6.52^{b}$ | $2.21^{a}$ | $58.60^{a}$ |

a, b, c...: Means with the different letters within the same column and kind of milk are significantly different ($p < 0.05$).
N.C = No coagulation.

**Table 3. Effect of cold storage (4°C/48h.) and heat (85°C/5 min.) treatments on the nitrogen distribution (mg/100 ml) of the camel's, cow's and buffalo's milk**

| Treatments | Casein nitrogen | Non-casein nitrogen | Whey Protein nitrogen | Proteose-peptone nitrogen | Non-protein nitrogen |
|---|---|---|---|---|---|
| **Camel:** | | | | | |
| Raw | 348 [b] | 147 [a] | 102 [a] | 16 [a] | 29 [a] |
| Cold stored | 350 [b] | 150 [a] | 105 [a] | 16 [a] | 29 [a] |
| Heated | 391 [a] | 104 [b] | 59 [b] | 16 [a] | 29 [a] |
| **Cow:** | | | | | |
| Raw | 431 [b] | 140 [a] | 70 [a] | 40 [a] | 30 [a] |
| Cold stored | 433 [b] | 145 [a] | 75 [a] | 40 [a] | 30 [a] |
| Heated | 501 [a] | 70 [b] | 00 | 40 [a] | 30 [a] |
| **Buffalo:** | | | | | |
| Raw | 579 [b] | 162 [a] | 78 [a] | 51 [a] | 33 [a] |
| Cold stored | 582 [b] | 164 [a] | 80 [a] | 51 [a] | 33 [a] |
| Heated | 658 [a] | 84 [b] | 00 | 51 [a] | 33 [a] |

a, b...: Means with the different letters within the same column and kind of milk are significantly different ($p < 0.05$).

proteins denaturation due to heat treatment was about 43 %. These may be due to absence or deficiency of K-casein and β-lactoglobulin in camel's milk might be a cause of its higher heat stability at high temperature **(Farah and Atkins, 1992)**. There were no major differences ($p < 0.05$) in nitrogen profile between raw and cold storage milk samples.

Results in **Table (4)** indicate that the raw cow's milk had the lowest foam expansion compared with the other milks, while camel's milk had the excellent one. This also was true with heated milks. However, cow's milk characterized with higher foam stability compared with the other types of milk. Such results may be due to the distribution of casein micelles in camel milk which is significantly broader than that of buffalo's milk with greater number of larger micelles of 350-500 nm. **(Farah 1993)** and higher in molecular weight of casein micelles **(El Agamy** and **Kamal, 1998)**.

**Figure (1)** shows the buffer index (BI) [dB/dpH] *versus* pH values of raw, cold stored (4°C/48h.) and heated (85°C/ 5 min.) milk samples as titrated with 0.1N HCl from pH 10.0 to 3.0. The maximum buffering capacity of buffalo's milk was attained at pH range about 6-7 for heated or cold stored samples compared with raw one (7-8). The corresponding values for cow's milk were about 6.0, 6.5 and 7.5 in order. However , camel's milk had lower values i.e. less buffering capacity compared with either buffalo's or cow's milk .The little variations in the buffer capacity among raw, heated and cold stored milk may be due to the effect of such treatments on the salt distribution. In this respect, **Alsaleh and Hammad (1992)** reported that the shapes and positions of maximum peaks in the buffering curves for cow and camel milk are different and pasteurization had slight effect on the buffering capacity of them. Generally, the obtained results revealed that, the buffering capacity of milk from the various species studied increased in order: buffalo's > cow's >camel's milk. The different behaviour of these milks in the buffer index could be due to the descending order of their protein content as well as the form and nature of protein fractions which confirmed by electrophoresis **(Fig. 2)**.These results are in accordance with **Immam *et al* (1974)**; **Hassan *et al* (1987)** and **Abd El lateef (2001)** for milk from different mammals.

Table 4. Effect of cold storage (4°C/48h.) and heat (85°C /5 min.) treatments on Foam expansion (FE%) and Foam volume Stability (FVS% after 5,10,15 and 20 min.) of the camel's, cow's and buffalo's milk

| Treatments | Final Vol.( ml.) | FE% | FVS % | | | |
|---|---|---|---|---|---|---|
| | | | 5 | 10 | 15 | 20 |
| **Camel:** | | | | | | |
| Raw | 725 | 262.5 | 72.4 | 17.2 | 0.0 | |
| Cold stored | 460 | 130 | 56.5 | 51.0 | 0.0 | |
| Heated | 750 | 275 | 73.3 | 13.5 | 0.0 | |
| **Cow:** | | | | | | |
| Raw | 365 | 82.5 | 45.2 | 31.5 | 20.5 | 0.0 |
| Cold stored | 500 | 150 | 60.0 | 45.0 | 13.0 | 0.0 |
| Heated | 415 | 107.5 | 51.8 | 42.1 | 36.1 | 0.0 |
| **Buffalo:** | | | | | | |
| Raw | 500 | 150 | 60 | 20 | 0.0 | 0.0 |
| Cold stored | 435 | 117.5 | 54 | 42.5 | 0.0 | 0.0 |
| Heated | 385 | 92.5 | 48 | 35 | 22 | 0.0 |

**Fig. (2)** shows the electrophoretic patterns of all milk samples. In general, the proteins of raw milk fractionated into 6 main fractions namely κ-casein, β- casein, $\alpha_s$-casein, α-Lactalbumin, (α-La), β- Lactoglobulin (β-Lg) and bovine serum albumin (BSA). This agrees with the well-known information given in the literature. It may be of interest to note that the mobility and intensity of the different fractions were greatly affected by milk type and the camel's milk showed the pronounced differences in this respect. This agrees with findings of **El-Agamy and Kamal (1998).**

Concerning, effect of heat treatments (columns 1, 2 and 3, **Fig. 2),** it is clear that such treatment decreased intensity of whey proteins bands including α-La and β-Lg with corresponding increase in k-casein region. This was expected since heat treatments of milk at >70°C cause denaturation of whey proteins. Some of the denatured whey proteins complex with casein micelles involving k-casein *via* hydrophobic interactions and formation of intermolecular disulphide bonds **(Lucey *et al* 1998).** The presence of disulphide bonds among whey proteins and between whey proteins and casein was suggested as a disulphide- bond-blocking agent prevented the complete decrease of α-La and β-Lg electrophoretogram bands **(Dzurec** and **Zall, 1985).** However, the degree of interaction between β-l.g and κ-casein depends on the time and temperature of heating, concentration of proteins, pH and presence of salts **(Singh, 1995).** This may give explanation for the different behaviour of the different milks towards the applied heat treatment. Also, the increase of molecular size of the formed complex due to heating may cause less migration *via* the small pore size of the gel **(Dalgleish, 1990** and **Singh & Creamer, 1991)** causing more intensity bands in κ-casein region or slightly before that region.

**Fig. (2)** Shows also differences in β-casein region, its band was more intense in case of buffalo's milk. However, in all cases cold storage of milk (columns 4, 5 and 6 of **Fig. 2)** caused dissociation of β-casein from micelles and its subsequent solubilization in milk serum. This agrees with **Dzurec** and **Zall, (1985).**

During the study of Microphotographs of all treatments by Transmission Electron Microscopy (TEM), it was observed that the casein micelles had spherical shapes with a wide range of diameters. Also, there were more small micelles in cow's milk than in camel's and buffalo's milk. Moreover, casein micelles of buffalo's milk showed discrete, clearly defined particles. Also, casein micelles of cow's and camel's milks appeared adhered to each other and consisted of more numerous branches. After heating buffalo's cow's and camel's milk increased the formation of protein were observed. This may be due to the denaturation of whey proteins precipitated on the surface of the casein micelles, which gradually became linked through whey protein bridging. The polypeptide

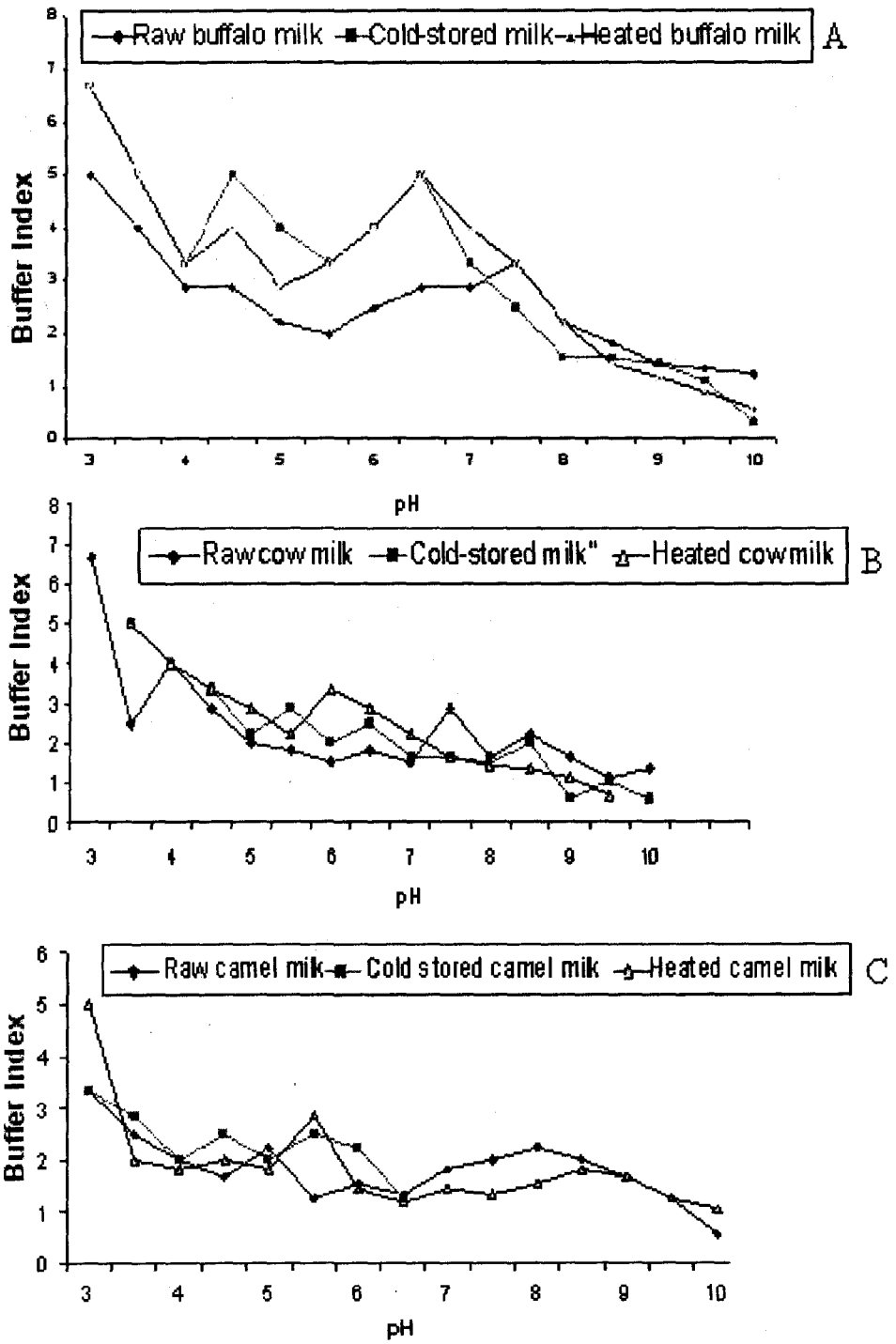


**Fig. 1. Buffer intensity curves of raw, cold storage (4°C/48h.) and heat treatment (85°C/5min.) of buffalo's (A), cow's, (B) and camel's (C) milk.**

| | Treatments | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Heated milk | | | Cold stored milk | | | Raw milk | | | | |
| | Camel | Buffalo | Cow | Camel | Buffalo | Cow | Camel | Buffalo | Cow | Orig. CN | Marker |
| Nr | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |

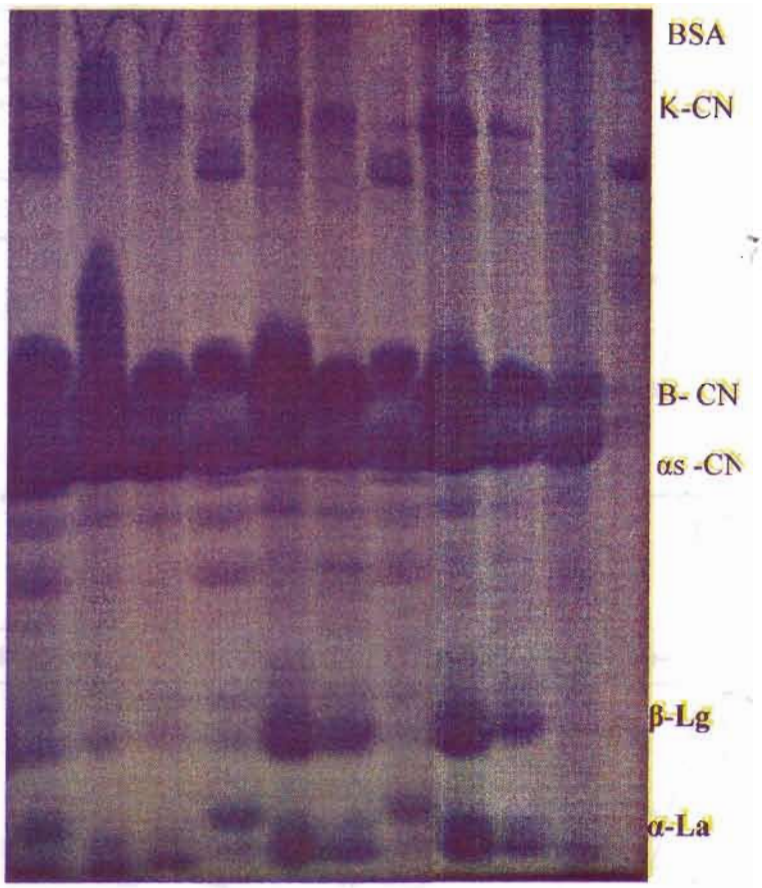


**Fig. 2. The electrophoretic patterns of heated (85°C/5 min) and cold stored (4°C/48h) and raw camel's, buffalo's and cow's milks. The lanes were (1, 2, 3) heated samples, (4, 5, 6) cold samples, (7, 8, 9) raw samples, (10) casein standard, (11) molecular weight markers**

chains may also be linked through disulphide bond, especially between K-casein and β-lactoglobulin as the result of the electrophoretic patterns . This indicated that the cross-linking capacity of denatured whey protein plays a key role in milk structure after heating; it contributes to an increase in the degree of bridging between protein particles. Buffalo's milk appeared spherical in shape with smooth surface and to be composed of a large number of small subunits. This could be explained by the reported by **Omar, (1985)** who observed that heating of milk caused an increase in the number of free submicelles from disintegrated casein micelles.

There was little microstructure difference between raw and cooled (4°C/48h.) buffalo's cow's and camel's milk. These results are in agreement with those reported by **Omar, (1985)** and **McMahon *et al* (1993).**

## REFERENCES

**Abd El-lateef, (2001). Comparative Study on Milk Properties of some Ruminants in Egyptian Desert, pp.105-108.** M.Sc. Thesis, Fac. of Agric., Ain Shams Univ. Cairo, Egypt.

**Abd El-Salam, M.H.; S.I. Farage; H.F. El-Dein; M.B. Mahfouz and H.M. El-Etriby, (1992).** A comparative study on milk proteins of some mammals. **Proc. 5th Egyptian Conf. Dairy Science & Tech., p. 281, Ismailia, Egypt.**

**Al-Saleh,** A.A. **and Y.A. Hammad, (1992).** Buffering capacity camel. **Egypt. J. Food** Sci., **20: 85-97.**

**Ali, A.E.;** A.T. **Andrews and G.C. Cheesman, (1980).** Influence of storage of milk on casein distribution between the micellar and soluble phase and its relationship to cheese-making parameters. **J. Dairy Res., 47: 371-382.**

**A.O.A.C., (2007).** Association of Official Analytical Chemists. **Official Method of Analysis. (18th Ed.), Chapter 33, pp. 7, 10-14,** Benjamin Franklin Station Washington, D.C., USA.

**Basch,** J.J.; **F.W. Douglas; L.G. Procino; V.H. Holsinger and H.M.Jr. Farrell, (1985).** Quantitation of caseins and whey proteins of processed milks and whey protein concentrates, application of gel electrophoresis, and comparison with Harland-Ashworth procedure. **J. Dairy Sci., 68: 23-31.**

**Bayoumi,** S. **(1990).** Studies on composition and rennet coagulation of camel milk. **Kieler-Milchwirtschafliche Forschungsberichte 42: 3-8.**

**Berridge,** N.J. **(1945).** Some observations on the determination of the activity of rennet. **The Analyst 77: 57 -72.**

**Closs, B.;** J-L. **Courthaudon and D. Lorient, (1990).** Effect of chemical glycosylation on the surface properties of the soluble fraction of casein. **J. Food Sci., 55: 437- 461.**

**Cousin, M.A.; J.M. Jay and P.C. Vasavada, (1992).** Psychrotrophic microorganisms. In: **Compendium of Methods for the Microbiological Examination of Foods.** Vanderzant, C. and D.F. Splittstoesser, (Eds.), **(3rd Ed.). pp. 153-155.** American Public Health Association, Washington, DC.

**Dalgleish, D.G. (1990).** The effect of denaturation of β–lactoglobulin on renneting. A quantitative study. **Milchwissenschaft 45: 491-496.**

**Dzurec,** D.J.Jr. **and R.R. Zall (1985).** Effect of heating, cooling and storing milk on casein and whey proteins. **J. Dairy Sci., 68: 273-280.**

**El-Agamy, E.I. and N.M. Kamal, (1998).** Polyacrylamide gel electrophoresis is a reliable technique for detection of camel milk mixtures with cow, buffalo, sheep and goat milk. **J. Agric. Res. 43: 23-36.**

**Farah, Z. (1986).** Effect of heat treatment on the whey protein of camel milk. **Milchwissenschaft 41: 763-765.**

**Farah, Z. (1993).** Composition and characteristics of camel milk. **J. Dairy Res., 60: 603-625.**

**Farah, Z. and D. Atkins, (1992).** Heat coagulation of camel milk. **J. Dairy Res. 59: 229-231.**

**Farah, Z. and M. Farah-Riesen,** (1985). Separation and characterization of major components of camel milk casein. **Milchwissenschaft, 40: 669 - 671.**

**Farrell, H.M.Jr.; R. Jimenez-Flores; G.T. Bleck; E.M. Brown; J.E. Butler; L.K. Creamer; C.L. Hicks; C.M. Hollar; K.F. Ng-Kwai-Hang and H.E. Swaisgood, (2004).** Nomenclature of the proteins of cows' milk-sixth Revision. **J. Dairy Sci., 87: 1641-1674.**

**Haque, Z. and J.E. Kinsella,** (1988). Interaction between heated K-casein and β -lactoglobulin: predominance of hydrophobic interactions in the initial stages of complex formation J. **Dairy Res., 55: 67-80.**

**Hassan, A.A.; A.E. Hagrass; K.A. Soryal and S.A. El-Shabrawy, (1987).** Physico –chemical properties of camel milk during lactation period of Egypt. **Egypt. J. Food Sci.,15: 1-14.**

**Immam,** A.; **A.E. Shazly and S.** Abdou, **(1974).** Buffer intensity curves of buffaloes,cows,ewes and goats milk. **Milchwissenschaft, 29: 597-598.**

**Jennes,** R. **and D. Patton, (1959). Principle of Dairy Chemistry. pp. 322-359.** Wiley Eastern Private Limited, New Delhi.

**Laemmli, U.K. (1970).** Cleavage of structural proteins during the assembly of the head of bacteriophage T4. **Nature, 227: 680-685.**

**Lucey, J.A.; M. Tamehana; H. Singh and P.A. Munro, (1998).** Effect of interaction between denaturated whey proteins and casein micelles on the formation and rheological properties of acid skim milk gels. **J. Dairy Res. 65: 555- 567.**

**McMahon, D.J.; B.H. Yousif and M. Kalab (1993).** Effect of whey protein denaturation on structure of casein micelles and their rennetability

after Ultra-high temperature processing of milk with or without Ultrafiltration. **Int. Dairy J., 3: 239-256.**

**Morr, C.V.; E.P. Swenson and L.R. Richter, (1973).** Functional characteristics of whey protein concentrate. **J. Food Sci., 38: 324-330.**

**Oldfield, D.J.; H. Singh; M.W. Taylor and K.N. Pearce, (2000).** Heat-induced interactions of β-lactoglobulin and α-lactalbumin with the casein micelle in pH-adjusted skim milk. **Inter. Dairy J. 10: 509 -518.**

**Omar, M.M. (1985).** Size distribution of casein micelles during milk coagulation .**Die Nahrung, 29: 119-124.**

**Poole, S.; I.W. Stuart and C.L. Walters, (1984).** Protein-protein interactions: their importance in the foaming of heterogeneous protein systems. **J. Sci. Food Agric., 35: 701-704.**

**Roefs, S.P.F. and C.G. de Kruif, (1994).** A model for denaturation and aggregation of β-lactoglobulin. **European J. Biochem., 226: 883-889.**

**SAS (1996).** Statistical Analysis System. **SAS User's Guide: Statistics, Release 6.12 Education.** SAS Inst. Inc. Cary NC., USA.

**Salaün, F.; B. Mietton and F. Gaucheron, (2005).** Buffering capacity of dairy products. **Inter. Dairy J.,15: 95-109.**

**Shahein, M.R. (2006). Chemical and Bacteriological Studies on Camel Milk in North Sinai Governorate, pp. 58-115.** Ph.D. Thesis, Fac. of Enviromental Agricultural Sciences., Suez Canal Univ. Ismalia, Egypt.

**Singh, H. (1995).** Heat-induced changes in casein, including interactions with whey proteins: In: **Heat-induced Changes in Milk. Fox, P.F. (ed.), (2nd Ed.), pp. 86-104.** Inter. Dairy Federation, Brussels.

**Singh, H. and L.K. Creamer, (1991).** Aggregation and dissociation of milk protein complexes in heated reconstituted concentrated skim milks. **J. Food Sci., 56: 238- 246.**

**Singh, H. and L.K. Creamer, (1992).** Heat stability of milk. In: Advanced Dairy Chemistry. 1. Proteins. **Fox, P.F. (ed.), (2nd Ed.). pp. 621-656.** Elsevier Science Publishers Ltd., England.

**Stephan, J. and N.C. Ganguli, (1974).** Distribution of nitrogen in buffalo milk and ultracentrifugal whey as affected by heat treatments. **Milchwissenschaft , 29: 589-594.**

**Van Slyke, D.D. (1922).** On the measurement of buffer values and on the relationship of buffer value to the dissociation constant of the buffer and the concentration and reaction of the buffer solution. **J. of Biological Chem., 52: 525–571.**

**Vasbinder, A.J. and C.G. de Kruif, (2003).** Casein- whey protein interactions in heated milk: The influence of pH. **Inter. Dairy J., 13: 669-677.**

حوليـــات العلـــوم الزراعية
جامعة عين شمس ، القاهرة
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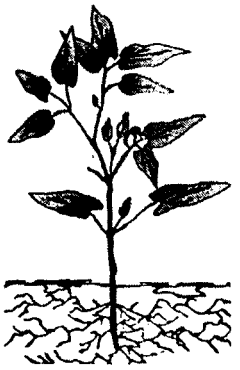

# تأثير حفظ اللبن مبردا والتسخين على الخواص الوظيفية والتركيب البنائي للبن النوق مقارنة باللبن البقرى والجاموسى

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## الموجـــز

يهدف هذا البحث إلي دراسة تأثير حفظ اللبن مبـرد (٤ °م/٤٨ ساعة) والمعاملة الحراريه (٨٥ °م/٥ دقـائق) علـى بعض خواص لبن النوق و اللبن الجاموسى والبقرى حيـث اشتملت التحليلات على اللبن تقدير النسبة المئوية للحموضة ورقم الأس الهيدروجيني ، ووقت التجبن بـأنزيم الـرنين والتوزيع النيتروجينى والتوتر السطحى وخـواص القابليـة للخفق وثبات الرغوة والسعة التنظيمية والفـصل الكهربـى على جيل الاكريلاميد والتركيب البنائى الدقيق للبن.

أوضحت نتائج الدراسة أن معاملة اللبن حراريـا زادت من قيم النسبة المئوية للحموضة والنيتـروجين الكـازينى ، ووقت التجبن بأنزيم الرنين فيما عدا لبن النوق، فى حـين وجد انخفاض فى كل مـن النيتـروجين غيـر الكـازينى ، نيتروجين بروتينات الشرش ولا يوجد تأثير معنـوى علـى التوتر السطحى. كمـا أن المعاملـة الحراريـة أدت الـى انخفاض فى القابلية للخفق للبن الجاموسى بينما زادت فـى الالبان الاخرى. بينما كانت ثبـات الرغـوة للـبن النـوق منخفضة.

كان لحفظ اللبن مبردا تأثير على خواصة حيـث زادت قيم النسبة المئوية للحموضة ولم يتأثر بصورة معنوية كـل من النيتروجين الكـازينى والنيتـروجين غيـر الكـازينى ونيتروجين بروتينات الشرش وحدث انخفاض فى رقم الأس الهيدروجيني ووقت التجبن بأنزيم الرنين ماعدا لبن النـوق والتوتر السطحى والقابلية للخفق ماعدا اللبن البقرى. فى كل الحالات فان منحنيات السعة التنظيمية لهـا نفـس الاتجـاه ولكنها كانت مرتفعة عند رقم الأس الهيـدروجيني (٧-٨) فى اللبن الجاموسى و(٦,٥-٧,٥) فى اللبن البقـرى بينمـا أظهر لبن النوق سعة تنظيمية منخفضة .

هذا وعند فصل بروتينات اللبن فـى مجـال كهربـائى على جل البولى اكريلاميد كانت للمعاملة الحراريـة تـأثير واضحا على اختفاء معظم البيتا لاكتوجلوبيـولين فـى كـل عينات اللبن المسخن. فى حين نقـصت كميـه البيتاكـازين نتيجه حفظ اللبن مبردا. مع ملاحظه أن لبن النـوق أظهـر فصلا متباينا عن باقى الالبان من ناحيه عدد وقـوه مناطق الفصل . اوضحت نتائج التركيب البنائى وجود فروق طفيفة بين اللبن المبرد (٤ °م/٤٨ ساعة ) واللبن الخام لكـل مـن اللبن الجاموسى والبقرى والنوق. فى حين اظهرت النتـائج وجود فروق كبيرة بالمعاملة الحراريـه (٨٥ °م/٥ دقـائق) نتيجة لحدوث دنترة بروتينات الشرش على سطح جـسيمات الكازين مماادى الى زيادة حجم الجسيمات.

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