ELSEVIER

Food Chemistry **50** (1994) 153–155

0308-8146/94/$7.00

Vitamin C and riboflavin content in camels milk: effects of heat treatments

Mohamed A. Mehaia

Dairy Technology Laboratory, College of Agriculture and Veterinary Medicine, King Saud University-Qassim Buriedah, PO Box 1482, Saudi Arabia

(Received 15 July 1993; revised version received and accepted 16 September 1993)

Vitamin C and riboflavin content in dromedary camels milk and in milk heated at 63, 80, 90 and 100°C for 30 min, 73°C for 15 s and 90°C for 10 min were studied. Results showed that the levels of vitamin C and riboflavin in raw camels milk were 24·9 ± 2·75 and 0·56 ± 0·11 mg/kg and in cows milk were 14·3 ± 1·12 and 1·84 ± 0·16 mg/kg, respectively. Heating of camel milk at 63, 80, 90 and 100°C for 30 min results in a loss of vitamin C content of about 27, 41, 53 and 67%, respectively. The corresponding figures for cows milk were 18, 26, 36 and 48%. However, the heat treatments caused a negligible amount of destruction (0–7%) of the riboflavin content in camels and cows milk.

INTRODUCTION

There are about 19 million camels in the world. Most of them are found in African and Asian countries (Chapman, 1991). The vast majority are dromedaries (*Camelus dromedarius*; the one-humped camel) and are found particularly in desert (arid) areas, whereas bactrians (*Camelus bactrianus*; the two-humped camel) are more prevalent in the cooler areas. The population of camels in Saudi Arabia is estimated to be 600 000 and they are all dromedaries (Chapman, 1991). Camels in Saudi Arabia play a major role in supplying the desert dwellers with milk of high nutritional quality and meat under extremely hostile conditions of temperature, drought and lack of pasture (Yagil & Etzion, 1980). Moreover, camels milk has been suggested to have a relatively high content of vitamin C (Rao *et al.*, 1970; Knoess, 1977).

Most camels milk produced in Saudi Arabia was traditionally consumed fresh, as raw milk, or when soured, Recently, however camels milk is gaining more popularity, and several commercial farms are being established to supply fresh pasteurised milk to consumers.

Although the composition of camels milk has been studied in various parts of the world (Ohri & Joshi, 1961; El-Bahay, 1962; Rao *et al.*, 1970; Knoess, 1977; Yagil & Etzion, 1980; Sohail, 1983; Yagil, 1987) including Saudi Arabia (Sawaya *et al.*, 1984*a*; Abu-Lehia, 1987; Mehaia & Al-Kanhal, 1989; Elamin & Wilcox, 1992) there is limited information on the vitamin content of camels milk especially that of the Majaheem breed of Saudi Arabia. Moreover, no data are available in the literature on the effect of heat treatments on vitamin content (e.g. vitamin C and riboflavin) of camels milk.

The present investigation was undertaken to study the vitamin C and riboflavin content, as well as the effect of different heat treatments on the content of the two vitamins, in Majaheem camels milk of Saudi Arabia. The information complements existing data and provides background information about the nutritional quality of heat-treated camels milk.

MATERIALS AND METHODS

Milk samples

Twelve milk samples of dromedary Majaheem camels were collected from 12 healthy female camels from private farms near Buriedah City in the central region of Saudi Arabia. Samples collected were immediately pooled, refrigerated and transferred to the laboratory. For comparison, bulk cows milk of the Friesian breed, obtained form the University Farm, was used.

Heat treatments

Each batch of milk was divided into 250-ml portions. One portions was kept as a control (raw milk) and the rest was individually heated at 63, 80, 90 and 100°C for 30 min, 73°C for 15 s and 90°C for 10 min in 500 ml round bottomed flasks equipped with a condenser and thermometer. After heating, the flasks were cooled to room temperature and analysed. The experiments were repeated four times and the mean and standard deviations were calculated. In order to protect the vitamins from light, milk samples were collected in plastic containers and the flasks, used during heat treatments, were wrapped with aluminium foil.

Table 1. Chemical composition of camel and cow milks (mean ± SD)

Components	Camel	Cow
Total solids (%)	11·69 ± 0·25	12·23 ± 0·31
Protein (N × 6·38) (%)	2·80 ± 0·12	3·31 ± 0·09
Fat (%)	3·50 ± 0·30	3·40 ± 0·20
Lactose (%)	4·60 ± 0·11	4·85 ± 0·10
Ash (%)	0·79 ± 0·01	0·72 ± 0·01
Titratable acidity (%)	0·14 ± 0·01	0·16 ± 0·01
pH	6·61 ± 0·02	6·60 ± 0·01

Chemical analysis

Proximate analysis (total solids, fat, protein and ash), pH and titratable acidity were determined according to procedures outlined in AOAC (1980). Lactose was determined by difference. Standard methods of the AOAC (1980) were used to determined the vitamin C and riboflavin content of the milk.

RESULTS AND DISCUSSION

Vitamin C and riboflavin in camels milk

The chemical composition of dromedary Majaheem camels and Friesian cows milk, used in this study, is shown in Table 1. Table 2 lists the vitamin C content of Majaheem camels and cows milks. Vitamin C content of various milks, as taken from the literature, are also given in Table 2. The level of vitamin C in Majaheem camels milk was close to that reported by Sawaya *et al.* (1984*a*), Kon (1972), Knoess (1977) and Khanna (1986), but was relatively lower than that reported by Rao *et al.* (1970), Hartman and Dryden (1978) and Sohail (1983). Moreover, vitamin C content of dromedary camels milk was about two times higher than that of cows, goats or ewes milk but was almost half of that in human milk. The amount of vitamin C in camels milk is of relevance to the human diet in areas where green vegetables and fruits are hard to find (Sawaya *et al.*, 1984*a*).

Table 2. Vitamin C content (mg/kg) in milk or camel, cow, goat, ewe and human

Reference	Camel	Cow	Goat	Ewe	Human
This work	24·9	14·3			
Rao *et al.* (1970)	57–98				
Kon (1972)	23–98				
Knoess (1977)	23·8				
Sohail (1983)	58·2				
Khanna (1986)	25·0				
Yagil (1987)	23–100				
Sawaya + (1984*a*)	23·7				
Hartman & Dryden (1978)	64·0	2·4–20·5	15·0		43·0
Posati & Orr (1976)		14·7	12·9		50·0
Knoess (1976)		14·5	19·7	14·3	
Saad (1980)		13·8			
Deeth & Tamine (1981)		1·0–20·0			
Sawaya *et al.* (1984*b*)			9·0		
Sawaya *et al.* (1985)				6·0	

Table 3. Riboflavin content (mg/kg) in milk of camel, cow, goat, ewe and human

Reference	Camel	Cow	Goat	Ewe	Human
This work	0·56	1·84			
Knoess (1977)	0·80				
Sawaya *et al.* (1984*a*)	0·42				
Khanna (1986)	0·30				
Posati & Orr (1976)		1·61	1·38	3·55	0·36
Hartman & Dryden (1978)		1·74	1·48	3·82	0·36
Saad (1980)		2·48			
Deeth & Tamine (1981)		1·5–2·0			
Sawaya *et al.* (1984*b*)			1·2–1·7		
Sawaya *et al.* (1985)				2·38	

Riboflavin contents of Majaheem camels and cows milks, as well as those of various milks reported in the literature are given in Table 3. Our results are comparable to those reported by Sawaya *et al.* (1984*a*), but substantially lower than those reported by Knoess (1977) and higher than those reported by Khanna (1986). However, riboflavin content of dromedary camels milk was relatively higher than that reported for human milk, and was substantially lower than that reported for cows, goats or ewes milk.

According to the Recommended Dietary Council/ National Academy of Science (Anonymous, 1980) 1 kg of Majaheem camels milk furnishes approximately 42% of vitamin C and 32% of riboflavin.

Effect of heat treatments

Heat treatments can decrease the nutritive value of milk through loss of vitamins and loss of protein value. It is well known that vitamin C is quite thermolabile and it is rapidly destroyed when milk is heated. The effects of various treatments on the content and the loss of vitamin C are given in Table 4. Pasteurisation of camels milk by the low-temperature long-time method (LTLT) caused loss at 27% of vitamin C, whereas the loss by the high-temperature short-time method (HTST) was only 15%. This is due to formation of sulfhydryl compounds; as these are reducing substances, there was a lowered oxidation–reduction potentional and apparently a protection of vitamin C against oxidation (Hartman & Dryman, 1978). However, by increasing the temperature from 63 to 100°C for 30 min the loss of vitamin C was increased

Table 4. Effect of heat treatments on the content and loss of vitamin C in camel and cow milks

Heat treatment	Camel		Cow	
	mg/kg	% loss	mg/kg	% loss
Raw milk	24·9 ± 2·75	0	14·3 ± 1·12	0
63°C/30 min (LTLT)	18·2 ± 2·15	27	11·7 ± 1·51	18
73°C/15 s (HTST)	21·2 ± 1·61	15	12·9 ± 1·71	10
80°C/30 min	14·6 ± 1·62	41	10·6 ± 1·05	26
90°C/10 min	13·8 ± 1·20	45	10·4 ± 1·21	27
90°C/30 min	11·7 ± 2·20	53	9·1 ± 1·60	36
100°C/30 min	8·3 ± 1·69	67	7·5 ± 1·21	48

Table 5. Effect of heat treatments on the content and loss of riboflavin in camel and cow milks

Heat treatment	Camel		Cow	
	mg/kg	% loss	mg/kg	% loss
Raw milk	0·56 ± 0·11	0	1·84 ± 0·16	0
63°C/30 min (LTLT)	0·54 ± 0·02	4	1·84 ± 0·14	0
73°C/15 s (HTST)	0·54 ± 0·12	4	1·82 ± 0·17	1
80°C/30 min	0·53 ± 0·08	5	1·80 ± 0·08	2
90°C/10 min	0·52 ± 0·12	7	1·78 ± 0·10	3
90°C/30 min	0·52 ± 0·08	7	1·77 ± 0·11	4
100°C/30 min	0·52 ± 0·12	7	1·75 ± 0·09	5

from 27 to 67%. Generally, vitamin C in camels milk showed a higher heat sensitivity than cows milk. This may be because the sensitivity of whey proteins to heat denaturation in camels milk is considerably lower than in cows milk (Farah, 1986), resulting a less formation of sulfhydryl compounds. However, this remains to be confirmed.

In the absence of light, the riboflavin in milk is quite stable to heat (Hartman & Dryden, 1978). The effects of various heat treatments on riboflavin contents of camels and cows milk are listed in Table 5. The losses of riboflavin due to various heat treatments of camels and cows milk were 4–7 and 0–5%, respectively. Holmes and Jones (1945) reported no effect of the HTST pasteurisation method on riboflavin content of cows milk, whereas, Saad (1980) found that pasteurisation of cows milk caused a 12% loss of riboflavin content. Reports of large losses of riboflavin due to heating, which have occasionally been made, are undoubtedly complicated by the effect of light (Hartman & Dryden, 1978).

CONCLUSIONS

From the foregoing results it could be concluded that dromedary camels milk contains more vitamin C (24·9 ± 2·75 mg/kg) and less riboflavin (0·56 ± 0·11 mg/kg) than cows milk. Heating camels milk at 63, 80, 90 and 100°C for 30 min resulted in losses of vitamin C and riboflavin of about 27 and 4, 41 and 5, 53 and 7 and 67 and 7%, respectively. Pasteurisation of camels milk by the LTLT method results in a decrease in vitamin C of about 27%, whereas destruction by the HTST method was much less (15%). However, vitamin C in camels milk was more heat-sensitive than in cows milk, whereas heat-treatments of camels and cows milk caused negligible destruction of riboflavin.

ACKNOWLEDGEMENT

The author acknowledges the support and the assistance provided by the Department of Food Science, King Saud University and Food Science and Nutrition Section, Regional Agriculture and Water Research Centre, Ministry of Agriculture and Water, Riyadh, Saudi Arabia. The author is very grateful to Mr Mohamed A. Hablas for his skilful technical assistance.

REFERENCES

Abu-Lehia, I. H. (1987). Composition of camel milk. *Milchwissenschaft*, **42**, 368–71.

Anonymous (1980). *Recommended Dietary Allowances*, (9th edn). National Research Council/National Academy of Science, Washington, DC, USA.

AOAC (1980). *Official Methods of Analysis* (13th edn). Association of Official Agricultural Chemists, Washington, DC, USA.

Chapman, M. J. (1991). Camels. *Biologists*, **38**, 41–4.

Deeth, H. C. & Tamine, A. Y. (1981). Yogurt: nutritive and therapeutic aspects. *J. Food Sci.*, **44**, 78–85.

Elamin, F. M. & Wilcox, C. J. (1992). Milk composition of Majaheim camels. *J. Dairy Sci.*, **75**, 3155–7.

El-Bahay, G. M. (1962). Normal contents of Egyptian camel milk. *Vet. Med. J. (Egypt)*, **8**, 7–10.

Farah, Z. (1986). Effect of heat treatment on whey proteins in camel milk. *Milchwissenschaft*, **41**, 763–5.

Hartman, A. M. & Dryden, L. P. (1978). The vitamins in milk and milk products. *In Fundamentals of Dairy Chemistry* (2nd edn) ed. B. H. Webb, A. H. Johnson & J. A. Alford. The AVI Publ. Company, Inc., Westport, CT, USA, pp. 325–401.

Holmes, A. D. & Jones, C. P. (1945). Effect of sun shine upon the ascorbic acid and riboflavin content of milk. *J. Nutr.*, **39**, 201–9.

Khanna, N. D. (1986). Camel as a milch animal. *Indian Farming*, **36**, 37–40.

Knoess, K. H. (1976). *Assignment Report on Animal Production in the Middle Awash Valley* (Project ETH/75/001. Class W/K 3651). FAO, Rome, Italy.

Knoess, K. H. (1977). The camel as a meat and milk animal. *World Anim. Rev.*, **22**, 39–44.

Kon, S. K. (1972). *Milk and Milk Products in Human Nutrition* (FAO Nutrition Studies, No. 27). FAO, Rome, Italy.

Mehaia, M. A. & Al-Kanhal, M. A. (1989). Studies on camel and goat milk proteins: Nitrogen distribution and amino acid composition. *Nutr. Reports Int.*, **39**, 351–7.

Ohri, S. P. & Joshi, B. K. (1961). Composition of camel milk. *Indian Vet. J.*, **38**, 514–7.

Posati, L. & Orr, M. L. (1976). *Composition of Foods, Dairy and Egg Products—Raw, Processed, Prepared* (Agriculture Handbook No. 8–1). USDA, Agriculture Research Science, Washington, DC, USA.

RAO, M. B., Gupta, R. C. & Dastur, N. N. (1970). Camels' milk and milk products. *Indian J. Dairy Sci.*, **23**, 71–8.

Saad, M. H. (1980). Vitamin C and riboflavin in milk and some of its products. MSc thesis, Alexandria University, Alexandria, Egypt.

Sawaya, W. N., Khalil, J. K., Al-Shalhat, A. F. & Al-Mohammad, H. (1984*a*). Chemical composition and nutritional quality of camel milk. *J. Food Sci.*, **49**, 744–7.

Sawaya, W. N., Khalil, J. K. & Al-Shalhat, A. F. (1984*b*). Mineral and vitamin content of goat's milk. *J. Am. Dietet. Assoc.*, **84**, 433–5.

Sawaya, W. N., Khalil, J. K., Al-Shalhat, A. F. & Al-Mohammad, M. M. (1985). Mineral and vitamin contents of sheep milk. *Milchwissenschaff*, **40**, 81–3.

Sohail, M. A. (1983). The role of the Arabian camel (*Camelus dromedarius*) in animal production. *World Rev. Animal Prod.*, **19**, 37–40.

Yagil, R. (1987). Camel milk-a review. *Int. J. Anim. Sci.*, **2**, 81–99.

Yagil, R. & Etzion, Z. (1980). Effect of drought condition on the quality of camel milk. *J. Dairy Res.*, **47**, 159–62.