CAMEL MILK – NEW OBSERVATIONS

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ABSTRACT

The camel is a multi-purpose animal with a huge productive potential. To western societies and even scientists it is unfortunately an alien animal. Only a few people have realised that the camel is the most suitable domestic animal for use in climatic extremes. In time of global warming, growing deserts and increasing scarcity of food and water, the camel can be part of a solution to these problems.

Small-scale enterprises have demonstrated that living condition of the nomadic herdsman and his family can be improved by selling surplus camel milk. The Dubai example has also clearly proven that dromedaries can be milked in high-tech dairy farms. Some compositions of camel milk are different from cow milk and their values also differ from cow milk and also between different researchers. Insulin, vitamin C, niacin and some unsaturated fatty acids are higher in camel milk. The absence of beta-lactoglobulin and the different compositions of proteins in camel milk may prevent allergic reactions. Therefore, camel milk could be an interesting alternative for infant milk products. Although the amount of lactose in camel milk is as high as in cow milk, lactose intolerance against camel milk does not exist. The reason is unknown. Raw camel milk is highly contaminated with bacteria when camels are milked under nomadic conditions lacking proper hygiene. However, there is no doubt that microbiological parameters of camel milk can meet international standards of cow milk when proper hygienic conditions are in place. No microbiological standards for camel milk exist. Camel milk must be heat-inactivated for human consumption. Our investigations showed that the shelf life of pasteurised camel milk kept at 4°C is more than 10 days. Heat-inactivation of 72°C for 5 minutes on different camel milk parameters, including insulin and vitamin C reduces their amount by only 5% to 8%. Gammaglutamyl transferase (GGT) is a potential indicator for the question of whether camel milk has been properly pasteurised or not.

Key words: Camel milk, compositions, heat inactivation, hygiene, shelf life

General Aspects

The camel possesses a huge productive potential. It is a multi purpose animal and, unlike any other domesticated animal, has been utilised by humans for centuries for transport, traction power, milk, meat, skin and fuel. In the countries of East and North Africa, as well as in some Asian countries, camel milk is still the main food source for the nomadic peoples, as it was for the Bedouins of Arabia before the oil boom. The camel is universally highly valued and provides a social standing for its owner. To date, the productive potential has been neglected by governments and scientists. The camel is an alien animal to western societies and is loaded with negative prejudices and misconceptions. In time of global warming, growing deserts and increasing scarcity of water and food, the camel can be part of a solution to these problems. Nowadays, even some Masais and Samburus, who are real cattle breeders, have given up cattle rearing in Kenya and Tanzania for camels (Albrecht, 2006). Only recently, the camel family has become the focus of interest, and even the FAO has stepped in promoting camel milk. Some governments and people are slowly realising that the camel is the most suitable domestic animal for uses in climatic extremes.

However, large and modern camel dairy enterprises like the one in Dubai (Fig 1, Wernery and Wernery, 2006) will be the exception because only rich, oil producing camel countries can afford to fulfill all requirements needed for such projects. Elsewhere, the camel is not suitable for projects that are designed for quick success with high income. However, the Mauritanian and Kenyan examples clearly demonstrate that living conditions for the nomadic herdsman and his family can be greatly improved by selling surplus camel milk to small scale enterprises without any negative effect on resources (Abdeirrahmane, 1997). It is common knowledge that millions of litres of nutritious camel milk are daily lost due to the unavailability of markets (Yagil, 1995). Nomadism does not present a problem for selling camel milk or products because the camel owners would bring their products to any prearranged point. According to EU regulations, no camel milk or its products are allowed to enter the European market.

Table 1. Compositional differences of camel and cow milk from the UAE

Parameters	Camel milk values	Cow milk values	Units
Water	90	87	%
Total solids	10	13	%
Fat	2	4	%
Insulin	40.5	16.3	µU/ml
Iron	0.05	0.27	mg/100g
Calcium	132	120	mg/100g
Potassium	152	140	mg/100g
Zinc	0.50	0.4	mg/100g
Vit C	35	10	mg/l
Niacin	4.6	0.6	mg/l
Pantothenic acid	0.9	3.8	mg/l
β-lacto-globulin	0	3500	mg/l
Whey acidic protein	157	0	mg/l
Peptidoglycan Recognition protein	107	0	mg/l
β-lactalbumen	3500	1200	mg/l
Kappa casein	5	14	%
Casein micelles	320	160	µm
Whey protein	1.0	0.8	%
Omega-6	3.5	5.2	%
Omega 7	11.6	2.3	%

occurs globally in 1 to 7% of all infants. Restani *et al* (1999) tested IgEs from children allergic to cow milk. They observed that none of the children's sera reacted with camel milk proteins, whereas IgEs recognised most of the milk proteins from mammals bred in European countries. Camel milk was also not recognised by circulating IgEs from a child specifically allergic to ewe milk. The authors believe that the phylogenetic difference could be responsible for the failed recognition of camel protein by circulating IgEs and monoclonal antibodies. Lactose intolerance is a completely different entity and occurs in people above 5 years. The amount of lactose varies according to the lactation stage of the camel, but, in general, is around 4.5% as in cow milk. Lactose intolerance is the result of a decrease or absence (alactasia) of the enzyme lactase in the gastrointestinal tract. Lactase metabolises the milk sugar, lactose. Approximately 90-95% of black individuals and 20-25% of white individuals throughout the world have partial or complete lactose intolerance associated with nausea, vomiting, abdominal distention and stomach cramps. To our knowledge, camel milk lactose intolerance does not exist. The reason is unknown.

Insulin in camel milk is higher than in cow milk. It has been proven by Indian scientists (Agrawal *et al*, 2005) that the consumption of raw camel milk significantly reduces the doses of insulin in diabetes patients to maintain long-term glycaemic control. It is so far not known if the positive effect on diabetes patients is caused by the higher amount of insulin in camel milk or by other pathways.

One of the most remarkable features of dehydrated camels is the ability to continue lactation and to secrete milk that is highly diluted with over 90% water content (Table 2). In true ruminants the reservoir for milk-water is lost for cooling and via faecal and urinary excretion. In cattle, sheep and goats the lack of water leads to cessation of lactation or to a very concentrated high fat and low water content in the milk. A 600 kg camel has about 200 kg of fluid in the alimentary tract, which is available for milk production, giving 20 litres per day for 10 days (Yagil, 2000; Schmidt-Nielsen, 1998). This is only possible due to the camel's exceptional adaptation to desert conditions. Not only the milk water content is affected when a camel is dehydrated or hydrated, but also other parameters like protein, fat and lactose (Table 2).

Table 2. Comparison between some milk parameters in hydrated and dehydrated dromedaries (Mohammed, 2006)

Parameters	Hydrated	Dehydrated	Units
Water	88.5	93	%
Total Solids	11.5	7	%
Protein	3.0	1.7	%
Fat	3.0	1.8	%
Lactose	4.2	3.7	%

Hygienic condition of camel milk

Few reports deal with the microbiological status of raw camel milk, and there is virtually no report on the microflora of pasteurised camel milk or its products. *Investigations show that raw camel milk* is highly contaminated when camels are milked under nomadic conditions lacking proper hygiene. The EU standard for total bacterial count (TBC) of raw cow milk is $< 1.0 \times 10^5$ colony forming units (CFU) per ml (Anonymous, 2004), but many raw camel milk samples have TBC between 10^6 to 10^9 CFU/ml (Lhoste, 2004). Not only is the TBC too high, but in Saudi Arabia for example, 24% of 33 raw bulk milk samples were even contaminated with salmonella bacteria, resulting in a significant health risk for the consumer (EL-Ziney and Al Turki, 2006). Other researchers also cultivated different fungal species from raw camel milk and detected high values of aflatoxins. However, there is

Table 3. Total bacterial count results of raw, hand and machine milked camel milk from Dubai for human consumption after pasteurisation

Machine milking					
Year	Total	Suitable	Percentage	Not suitable*	Percentage
2003	2.719	2.650	98	69	2
2004	2.908	2.874	99	34	1
2005	4.184	4.143	99	41	1
Total	**9.811**	**9.667**	**99**	**144**	**1.5**
Hand milking					
2003	1.405	1.388	99	17	1
2004	1.594	1.582	99	12	1
2005	1.735	1.726	99.5	9	0.5
Total	**4.734**	**4.696**	**99**	**38**	**0.8**

* = Outside the EU range of < 1.0 x 10^5 CFU/ml

no doubt that microbiological parameters of camel milk can meet international standards of cow milk when proper hygienic conditions are implemented and followed for both automatic and manual milking (Wernery *et al*, 2006; Eberlein, 2007–in press). There are currently no microbiological standards for camel milk but results should be interpreted according to cow milk standards which demand testing of tank milk for TBC and somatic cells (SCC).

As can be observed from Table 3, proper hand milking produced the same results as automatic milking. Implementation of hygienic measurements for both hand and machine milking can produce high quality camel milk with few samples above 1.0 x 10^5, the EU TBC level. Besides the monthly testing of tank milk samples for TBC, EU hygiene regulations also demand monthly somatic cell counting (SCC). So far no reference values of SCC have been established for camel milk, but a thesis on this subject is currently being prepared (Halbrock, 2007–in press). The EU reference value for SCC is <4.0 x 10^5 SCC/ml. It is worthwhile mentioning that, according to EU milk hygiene legislations, microbiological standards are more modest for other milk producing animal species than cows, such as buffaloes, sheep and goats. For these animals, values for TBC is 1.5 x 10^6 CFU/ml, and there is even no SCC needed.

Shelf life of pasteurised camel milk

In the United Arab Emirates (UAE) pasteurised camel milk which is produced at the Emirates Industry for Camel Milk & Products (EICMP) is now regularly sold in the UAE supermarkets. This commercially available camel milk is pasteurised at 74°C for 15 seconds. Dubai Municipality regulations do not permit keeping pasteurised camel milk longer than 5 days on supermarket shelves. However, laboratory investigations have shown that pasteurised milk can easily be kept for at least 15 days under refrigeration (Fig 2).

Effect of heat treatment on camel milk constituents

Wernery *et al* (2003) demonstrated that many camel milk components were more heat resistant than those in cow milk. Especially vitamin C, the most heat sensitive vitamin, and insulin were only affected by 5 to 8% reduction of the values found in raw milk when heated at 72°C for 5 minutes. This is a tremendous advantage when it comes to the commercial production of camel milk.

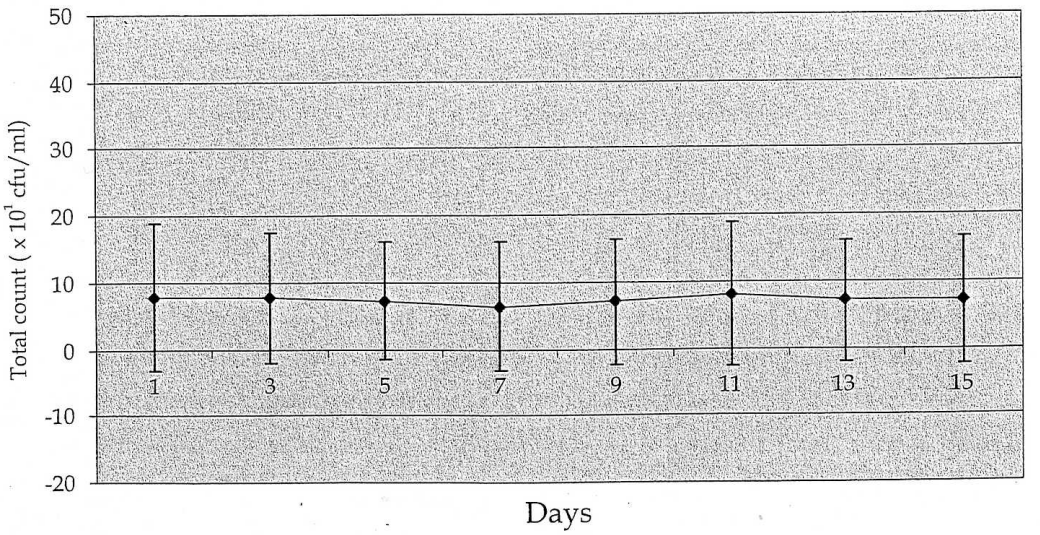

Fig 2. Shelf life of pasteurised camel milk kept at 4°, mean of 50 samples with SD

If one day camel milk and its products are allowed into foreign markets, a milk enzyme must be found that clearly confirms proper heat inactivation. In cow milk this enzyme is alkaline phosphatase (ALP) which is destroyed at 72°C but not in camel milk. Gamma-glutamyl transferase (GGT) seems to be a good componant for the proper heat inactivation of camel milk (Wernery *et al*, 2007) because it is destroyed between 10 and 20 minutes at 72°C.

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