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Review Article

The Overview of the Effects of Heat Processing on the Anti-Diabetic Properties of Camel Milk

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Abstract

Camel milk is a superfood with special nutrients and therapeutic values. It contains insulin-like proteins and may be an effective alternative for insulin to treat type 1 and 2 and gestational diabetes. Camel milk may reduce blood sugar and required insulin doses about 30 - 35% in type 1 diabetes patients and prepare about 60% of the insulin in diabetic patients. This milk is a suitable hypoglycemic agent in improving long-term glycemic control in experimental animals and diabetic patients. The preservation of raw milk may be done by heat processing which have direct impacts on the nutritional and functional properties of milk proteins. The biological activity of proteins in processed camel milk at 75°C/30 min is higher than that of cow and buffalo milk. However, limited studies are present on the thermal effect on camel milk casein or whey proteins and anti-diabetes properties. The evidences shows that camel milk is safe without any side effects for long-term hypoglycemic effects in diabetic cases. It appears that more scientific studies are needed to confirm the efficacy of heated camel milk as a superfood on diabetes.

Keywords: *Camel Milk; Heat Processing; Diabetes*

Introduction

The composition of camel milk influenced by age, pregnancy, nutrition, seasonal changes, health, and genetics affect [1]. Camel milk is a superfood with special nutrients. The average fat content of camel milk was 3.82%, protein 3.35%, and lactose 4.12% [2]. The levels of long-chain fatty acids, linoleic acid, and unsaturated fatty acids are high [1]. The unsaturated to saturated fatty acids ratio in camel's milk is more favorable compared to cows and other mammalians [3].

Camel milk has a high amount of immunoglobulin, insulin-like protein, and protective enzymes like lactoferrin and lysozyme [4]. Camel milk contains insulin-like protein and may help to heal. According to the studies, camel milk contains insulin-like proteins that do not form a coagulum in the acidic condition of the stomach, can be absorbed from the intestine, and may be an effective alternative for insulin to treat type 1 and 2 and gestational diabetes. Raw camel milk has immune-modulatory effects on the pancreas beta-cells, increases insulin secretion and reduces insulin resistance in type 1 diabetes patients [5]. It contains small-size immunoglobulins which strengthen the immune system [6]. Daily drinking of camel milk may meet about 60% of the insulin in diabetic patients [7]. Therefore, camel milk is

safe in long-term glycemic control that significantly reduces the required insulin doses in diabetic patients of type 1 and type 2 [5]. The preservation of raw milk can be achieved by heat treatments such as pasteurization, boiling or sterilization processes. These treatments have direct influences on the nutritional, biological and functional properties of milk proteins. However, only limited studies were carried out on the thermal effect on camel milk proteins such as casein, whey proteins and diabetes [8]. This article discuss more information about the effect of heat processing on biological impact of camel milk on the diabetes.

The overview of the heat processing on the anti-diabetic properties of camel milk

In this section, its discussed on the heat processing on the anti-diabetic properties of camel milk. In one experiment, skimmed milk was heated at 65, 75, 85, and 100°C for 10, 20, and 30 minutes. Heating at 65 for 30 minutes had no significant effect on lysozyme and lactoferrin, but immunoglobulin G was significantly affected in three kinds of milk. In contrast, 69% was lost in camel milk [8]. Antimicrobial agents of camel milk were more heat resistant than the cow and buffalo milk [8]. Researchers reported no effect on the whey proteins, alpha-lactalbumin, and beta-lactoglobulin in cow and camel milk at 63 for 30 minutes; Camel milk proteins are even more resistant to 100°C. At 100°C for 30 minutes, total lysozyme activity was eliminated in cow and buffalo milk; But 94% of the lysozyme activity of camel milk was destroyed [8] (Figure 1).

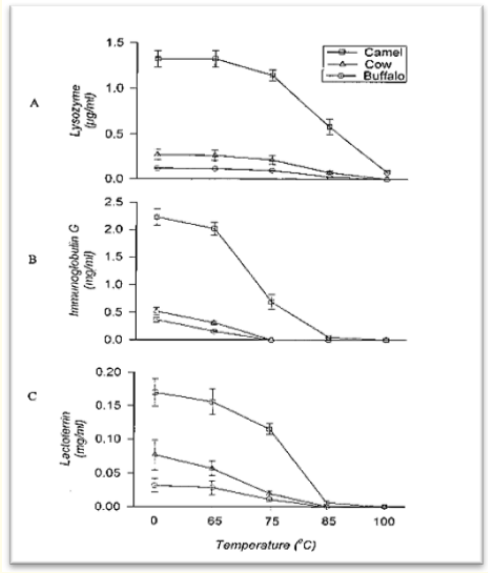

Figure 1: *Effect of heat treatment on lysozyme, immunoglobulin G, and lactoferrin of milk (Adapted from 8).*

Pasteurization at 71°C for 9s maintained 75% of immunoglobulin. Camel milk had a high loss of immunoglobulin G at 85°C for 30 minutes and was similar to 85 and 100°C. But 75°C in 30 minutes caused a substantial loss in the activity of this enzyme [8]. Camel milk whey proteins were higher and more resistant than the other two kinds of milk [8].

The effect of temperature processing of camel milk on the therapeutic efficacy of diabetic rats was investigated [9]. After eight weeks, the results showed that the highest reduction in blood glucose levels was related to raw camel milk. Also, the therapeutic activity of camel milk was eliminated after heating at 100°C (boiled camel milk). Heat, cold, and freeze-drying treatments have reduced the concentration of insulin in camel milk, reducing camel milk's efficiency in lowering blood glucose levels [9].

The insulin-like protein activity of camel milk is reduced by boiling [10]. Heating camel milk to 100°C, reduced alpha-lactalbumin and immunoglobulin G more than in cow's milk, and lactoferrin was completely denatured [8]. Raw camel milk, pasteurized and refrigerated for 2 to 4 days and freeze-dried decreased triglyceride, LDL, and VLDL levels and increased HDL compared with the diabetic group [9]. Thus, raw, pasteurized, refrigerated, freezer, and freeze-dried milk reduced LDL, VLDL, and increased HDL, reducing the risk of heart diseases [9]. Also, the atherogenic index decreased due to a significant decrease in the LDL to HDL ratio in the groups fed raw, pasteurized, refrigerated, frozen, and freeze-dried camel milk compared to the control [9].

According to the results, a substantial improvement in liver function was followed by feeding raw and pasteurized camel milk [9]. Raw, pasteurized, refrigerated, frozen, and freeze-dried camel milk significantly increased glutathione levels compared to the control group. Raw camel milk had the highest reduction in urea and creatinine, but boiled milk did not affect liver and kidney function [9].

Treatments	Glucose mg/dL	Insulin micro U/mL	HbA1c %	Total cholesterol	LDL c
Negative control	99.62 ± 2.43	15.3 ± 1.28	5.1 ± 2.01	70.32 ± 2.28	16.23 ± 3.16
Diabetic	243.35 ± 2.21	5.51 ± 2.69	11.83 ± 2.31	114.30 ± 3.69	48.71 ± 2.28
Diabetic+raw camel milk	122.16 ± 1.82	10.00 ± 2.61	7.78 ± 2.18	76.12 ± 3.41	16.58 ± 2.98
Diabetic+pasteurized camel milk	153.82 ± 1.51	9.28 ± 1.85	9.18 ± 1.28	91.67 ± 2.61	28.89 ± 2.28
Diabetic+boiled camel milk	240.87 ± 1.41	5.63 ± 2.83	11.21 ± 2.69	112.88 ± 1.31	46.72 ± 2.28
Diabetic+stored camel milk at 4 for two days	147.23 ± 1.26	9.45 ± 2.16	9.01 ± 2.11	90.10 ± 3.41	27.41 ± 2.83
Diabetic+stored camel milk at 4 for four days	161.10 ± 2.28	9.28 ± 1.41	9.75 ± 2.16	93.38 ± 2.28	29.95 ± 2.98
Diabetic+freezed camel milk at 20 for one day	162.56 ± 1.31	9.21 ± 2.61	9.84 ± 1.41	94.18 ± 3.69	31.20 ± 2.00
Diabetic+reconstituted freeze-dried camel milk	174.10 ± 1.21	8.89 ± 1.22	10.41 ± 1.69	95.44 ± 3.41	32.48 ± 3.25

Table 1: *The effect of camel milk processing on blood metabolites of diabetic mice (Adapted from 9).*

Fifty camel milk samples were divided into different sections and studied in raw, pasteurized forms at 62.3 for 30 minutes and in the microwave at 10, 20, 30, 40, and 50 seconds at 2450 MHz. The results showed that pasteurization with these conditions is insufficient for the microbial count, but 40 seconds in the microwave is enough to reduce the microbial load. Both methods have the opposite effect on the bioactive components of camel milk, such as insulin, immunoglobulin G, vitamin C and glutathione, which lead to an increase in malondialdehyde [10]. In 40 seconds of microwave, the microbiological quality reached the sterile stage and no microbial groups were observed. After microwave, by proper sterilization, milk can be stored for one year without any signs of microbial growth. Degradation of vitamin C and glutathione in the microwave is more minor than regular heat treatment, and fat-soluble vitamins are heat-resistant. Camel milk microwave treatment has promising results in microbiological quality that heating camel milk in the microwave for 10 seconds had a reducing effect on *E. coli*; Microwave heating is more promising and less damaging than conventional heat treatment to preserve camel milk components [10]. This experiment's pasteurized and microwave temperatures did not affect insulin or anti-diabetic effects. Pasteurization, freeze-drying, and storage at 4 degrees for four days and freezing at 20 degrees below zero resulted in a significant reduction in insulin levels [10].

In one experiment, fresh milk was taken from many camels in mid-lactation. Some were kept at 4 degrees, some at 7 degrees, and some at 25 to 30 degrees. The following tables report changes in the chemical composition of camel and cow milk at different temperatures and times [11].

Other researchers reported that camel milk remained unchanged at room temperature for five days and began to sour after seven days, also remained unchanged at 4°C for three months, and had a better storage quality than cow's milk. The best result of this experiment was that camel milk could be stored at 4 degrees for 42 days, at 7 degrees for 15 days, and room temperature for three days without changing the composition and spoiling. In one study, raw camel milk could be stored at 7°C for five days and pasteurized milk at 65°C for 20 minutes, at 7°C for 22 days [12].

The storage of raw camel milk at 37 degrees is about 8 to 9 hours, and at 4 to 6 degrees, it is more than a week. The reaction between casein and beta-lactoglobulin in milk produces allergens not found in camel's milk. The structural changes of proteins are between 15 to 61% at 63°C and between 79 to 98% at 98°C. Heating camel milk at 63, 80, 90, and 100 for 30 minutes caused a loss in vitamin C, about 27, 41, 53 and 67, respectively [13].

Camel milk powder and diabetes

Since fresh camel milk is not available for all people globally, most clinical trials are on fresh camel milk, and information on the antidiabetic effects of camel milk powder is rare. There is only one study on using camel milk powder for diabetes [14] (Table 2).

In one trial, type 2 diabetic patients, 35 - 68 years, without gastrointestinal issues were divided into two groups. They received camel milk powder and cow milk powder two times daily, 10g each for four consecutive weeks. 14 and 13 participants received camel milk powder and cow milk powder after breakfast and dinner [14].

Factors (%)	Camel milk powder	Cow milk powder
Fat	32.6	28.2
Total protein	30.3	25.1
Whey protein	8.0	4.5
Casein	20.8	20.2
Carbohydrates	37.1	42.0
H2O	4.3	2.1

Table 2: *Composition of camel and cow milk powder (Adapted from 14).*

The results showed a significant decrease in fasting blood glucose in patients fed camel milk powder and a nonsignificant reduction in 2-hr postprandial blood glucose [14]. Previous studies confirmed the hypoglycemic effects of camel milk. There was a significant decrease in fasting blood glucose in type I diabetes and type II diabetes [15].

The total cholesterol decreased in the camel milk powder group of patients after 4 weeks, but there were no significant effects on the total triglyceride, LDL-C/HDL-C before and after the consumption of camel milk powder [14]. A decrease in total cholesterol and HDL-C by camel milk indicates decreased vascular risk. After 4 weeks, there was a significant decrease in the inflammatory cytokines IL-6 in the camel milk powder group [14]. Camel milk has more excellent antioxidant and immunomodulatory activities than other whey proteins [16].

Camel milk powder exhibited antidiabetic activity in type 2 diabetic patients. After 4 weeks of applying 10g camel milk powder, two times daily, there was a decrease in fasting blood glucose, 2-hr postprandial blood glucose and total cholesterol [14].

Conclusion

In most studies, the beneficiary impacts of raw camel milk on diabetes proved. The evidences shows that camel milk at dose 10 g/day or 500 mL daily is safe without any side effects and for diabetic cases for long-term hypoglycemic effects. It appears that more scientific studies are needed to confirm the efficacy of heated camel milk and camel milk powder as a superfood on diabetes.

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