Original Article

Effect of camel milk in comparison with cow milk on blood glucose and lipid profile in patients with type 2 diabetes: A randomized clinical trial

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Abstract

Context: Type 2 diabetes mellitus (T2DM) is a common metabolic disorder. In traditional medicine, camel milk has been used in the treatment of some of diseases such as diabetes. The studies on effect of camel milk on glycemic control are limited and contradictory.

Aims: The effect of camel milk on blood glucose and lipids in T2DM patients and compare it with the control group.

Setting and Design: This case-controlled clinical trial study was performed in the endocrinology clinic in Iran.

Materials and Methods: 50 patients with T2DM were allocated into two groups. 25 participants in the intervention group consumed 500 ml camel milk and 25 participants in the control group consumed 500 ml cow milk daily for 8 weeks. Weight, fasting blood sugar (FBS), total cholesterol (TC), and triglyceride (TG) were measured at the baseline and end of intervention.

Statistical Analysis Used: Data were analyzed using SPSS v.16, independent t-test and analysis of covariance.

Results: Mean of glycosylated hemoglobin (HbA1c) and TG concentration was significantly decreased in the camel milk group at the end of the study ($P < 0.05$). There was an increase in HbA1c in the cow's milk group, while the TG was not changed in this group. No significant differences were shown in weight, FBS, and TC at the end of the study in comparison with baseline values in any of the two groups.

Conclusion: Camel milk can improve glycemic control according to HbA1c index. It might contribute to decreasing TG level in patients with T2DM.

Keywords: Camel milk, Clinical trial, Glycosylated hemoglobin, Triglycerides, Type II diabetes

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INTRODUCTION

Diabetes mellitus type 2 is a metabolic disorder characterized by chronic increase of blood sugar and impairment in metabolism of carbohydrates, fats, and proteins. The patients have a trouble in the production of insulin or response to it. As a result, blood sugar is increased and leads to short-term and long-term complications for the diabetic person.[1] It is predicted that the worldwide prevalence of diabetes mellitus in 2030 increased to 4.4%, and the total number of people with diabetes will reach 366 million.[2,3] Increasing prevalence of obesity and overweight in developed and developing countries, population growth, aging population, urbanization and industrialization, and lack of exercise are the main factors increasing its epidemic growth.[4] Prevention of diabetes complications requires accurate and consistent control over the years. The level of glycosylated hemoglobin (HbA1C), from all indicators, is the best indicator to show the level of long-term blood sugar control.[5] The usage of traditional treatments along with pharmacological interventions in controls and treatment of diseases, particularly about diabetes, has always been considered. Camel milk contains significant amounts of mineral salts of iron, zinc, copper, potassium, sodium, calcium, phosphorus, and Vitamin C which can be used as a good nutrient source for humans. Moreover, there are unsaturated fatty acids in it that can also be beneficial for cardiovascular disease.[6,7] In traditional medicine of India, camel milk has been used in the treatment of diseases of the spleen, jaundice, tuberculosis, asthma, anemia, and diabetes.[8] In a study, it was observed that in the population of the north of West India that consume camel milk regularly and continuously, the prevalence of diabetes is very low and zero.[2] A possible mechanism of hypoglycemic effect of camel milk is attributed to the peptides with the same amino acid sequences of insulin family of peptides that bind to insulin receptors and mimic its effects.[9] The results of studies on its effect on blood sugar are limited and contradictory. North East of Iran (Turkmen Sahra, Gonbad-e Kavus, Aq qala, and Maraveh Tappeh) is one of the areas where Turkmen camels are bred, but despite this, camel milk consumption is not common. In the present study, we investigated the effects of camel milk on type II diabetic patients referred to Sayyad Shirazi Teaching Hospital and compared its results with the control group.

MATERIALS AND METHODS

This study was a randomized controlled clinical trial. The study population included patients with type 2 diabetes referred to the Shahid Sayyad Shirazi Teaching Hospital in Gorgan in 2014. According to the Mohamad *et al.* study,[6] sample size was calculated considering the decrease in insulin levels in the intervention group in contrast to the control group with values of 40.83 ± 6.95 versus 29.66 ± 5.64, 90% exponent, and 1% error using the following formula, and 25 samples for each group was determined:

The research proposal was approved by the Ethics Committee of Golestan University of Medical Sciences (No: 261013929196) and was registered in the Iranian Clinical Trial Center, and the RCT code was received (IRCT 201308265866N15). After a complete explanation of the plan, written informed consent was obtained from the volunteers and sampling was carried out.

Eligible participants in the study attended a meeting, and the research method was explained to the volunteers. Then, people were divided into two groups according to their interests: camel milk or cow milk.

The method was modified. At first, one person entered each group, but some people did not want to eat camel milk, so after explaining how to do the work, people interested in eating camel milk entered the intervention group and the rest entered the control group.

All participants were over 18 years old. Diabetic patients who had diabetic complications such as diabetic ketoacidosis, hypoglycemic attacks, nephropathy, neuropathy, or heart disease and people who did not want to consume milk for any reason were excluded. At baseline, patients in both the groups received routine treatment for 2 weeks involving medication and dietary recommendations. The control group received 500 ml of cow milk daily with the previous diet and the intervention group received 500 ml (2 cups) of camel milk daily for 8 weeks. During the intervention, we asked the participants do not change their routine diet and physical activity. After eight to ten hours of fasting, venous blood samples were takenat at 8–9 am as baseline (before intervention), and in day 43 of intervention (at the end of six week). After centrifugation, blood samples serum was separated and saved for testing glucose, triglyceride (TG), cholesterol, and HbA1C. The milk used in this study was prepared in camel milk procurement center of Aq Qala city. The veterinary organization confirmed the health of camels. The samples were analyzed regarding microbial status in the Food Quality Control Laboratory so that any contamination outside the standard chart occurs. The data collection instrument included a checklist contained two parts: demographic information and clinical characteristics of patients that involved age, height, weight, body mass

index, duration of diabetes, diabetes type, amount of consuming drugs, and result recording table for laboratory tests before and after the intervention which was recorded by the investigators. After collecting the results and data entry, data analysis was done by (version 16- SPSS 16.0 Student Version for Windows Inc. SPSS©2009). Data distribution normality checked by Kolmogorov–Smirnov test. A comparison between two the groups was done using independent *t*-test, and data were analyzed using covariance.

Ethical considerations

The research was approved by the Medical Ethics Committee of Golestan University of Medical Sciences and was registered in the Clinical Trial Center in Iran and received the code: IRCT201308265866N15. After complete explanation of the project for patients, informed written consent was given from them. Helsinki ethical principles were observed in all stages of this study. Patients had the right to stop their participation in any time of the study. All patients' information was recorded confidentially by code.

RESULTS

Fifty patients with diabetes were included in this study, and in each group, 25 patients were placed. Of these, one person in the intervention group did not return for testing after intervention. Then data of 24 people in the intervention group and 25 people in the control group were analyzed. The intervention group had no complaints about the taste of camel milk, and no specific gastrointestinal symptoms were reported, such as nausea, diarrhea, vomiting, or intolerance of camel milk consumption. The average age of study participants in the intervention and control groups was 56.7 ± 9.9 and 54.9 ± 8.7 years, respectively. The number of males in the intervention group was 9 persons, and in the control group, it was 13 persons.

Body mass index (BMI) mean at the baseline in the intervention group was 29.06 ± 3.26 and in the control group was 29.15 ± 4.62, and this difference was not statistically significant. Furthermore, fasting blood sugar (FBS), cholesterol, and HbA1c means at the baseline of this study in the two groups did not differ significantly. The TG level mean in the intervention group was lower than the control group at the baseline, and this difference was statistically significant ($P = 0.01$). Normal distribution of data was evaluated using Kolmogorov–Smirnov test.

The results of variables comparison, before and after the intervention are shown in Table 1. As shown in the table, weight, body mass index, and FBS means were decreased in the intervention group and increased in the control group, but these changes were not statistically significant. Furthermore, the blood cholesterol mean was not significantly changed in both the groups after the end of the study. TG levels in the intervention group decreased from 134.04 ± 94.98 to 121.58 ± 46.86 mg/dl after 6 weeks, while there were no significant changes in the control group. Regarding HbA1c, after 6 weeks of camel milk consumption, it was decreased from 7.56 ± 1.6% to 5.82 ± 0.94% ($P < 0.000$), while it was increased in the control group from 7.48 ± 1.61% to 8.06 ± 1.79% that was not statistically significant.

DISCUSSION

This study was done aiming determination of the effect of camel milk on glycemic status and serum lipids in patients with type 2 diabetes compared with the control group who consumed camel milk instead of cow milk for 6 weeks. After treatment, HbA1C and TG levels were significantly lower in the group consuming camel milk, while there were no significant changes in the control group. In this study, fasting blood glucose mean decreased in the intervention group and the control group who drank cow's milk, but this increase was not statistically significant. These results are similar to the results obtained in the Ejtahed *et al*. study that indicated by giving camel milk 500 ml/day in 2 months, patients with type 2 diabetes mellitus (T2DM) did not show significant changes in FBS levels.[10] In some of studies, the effect of camel milk on reducing blood glucose and better control of glycemic status in animal models and humans were studied. In a study by Sahani *et al* the mice were fed for three weeks with camel milk and compared with mice that were fed with cow milk or water. A significant reduce in blood glucose was observed in mice that were fed with camel milk.[11] Furthermore, some studies

Table 1: The study variables means in intervention and control groups

Parameter	Intervention group			Control group		
	Before	After	*P*	Before	After	*P*
BMI (kg/m^2)	29.06±3.26	28.84±4.45	NS	29.15±4.62	29.83±5.29	NS
Triglyceride (mg/day)	134.04±94.98	121.58±46.86	0.01	163.72±68.03	169.16±73.47	NS
Fasting blood sugar (mg/dl)	163.08±73.81	155.25±51.95	NS	135.84±54.49	152.28±53.31	NS
Cholesterol (mg/dl)	158.21±37.07	157.04±31.83	NS	169.8±32.66	168.6±37.18	NS
HbA1c (%)	7.56±1.6	5.82±0.94	0.0001	7.48±1.61	8.06±1.79	NS

BMI: Body mass index, HbA1c: Glycosylated hemoglobin, NS: Not significant

of Agrawal *et al*. on people with type 1 diabetes showed that the consumption of camel milk for 3 months significantly reduces blood sugar levels.[1,12-14] In Mohamad *et al*. study, camel milk consumption of 500 ml/day in patients with type 1 diabetes for 16 weeks resulted in a significant reduction in FBS compared to the control group.[6] Furthermore, Agrawal *et al*. study on patients with type II diabetes indicated that the consumption of camel milk for 3 months caused to reduce FBS and increase insulin levels after meals.[15] In the present study, HbA1c as an indicator of glycemic status in the last few weeks was also evaluated. The results showed that in the intervention and control groups, HbA1c was significantly lower after consumption of camel milk and it was significantly higher after cow milk consumption. In other studies, HbA1C levels after consumption of camel milk have been reported.[1,12-15] Declining in this index despite no change in FBS mean in our study may be due to changes in drug doses or lack of strict consideration to the diet by patients in the final days of study and 2nd sampling time.

The effect of camel milk on serum lipids, total cholesterol (TC), and TGs was studied in this study. Serum cholesterol level average did not change in both the study groups after the intervention, but in the intervention group, TG levels showed a significant decrease than the control group that was similar to Agrawal *et al*. study that indicated after 6 months of treatment by camel milk in patients with type 1 diabetes, TC levels did not change significantly, but the amount of TG was reduced.[1] In the results of the Ejtahed *et al*. study, no changes in serum lipids in T2DM patients after 2 months of treatment were reported.[10] Furthermore, Agrawal *et al*. study on type 1 diabetic patients who consumed camel milk for 3 months illustrated that there were no significant changes in serum lipid levels in these patients.[14] Kotb-El-Sayed *et al*. in a study on patients with type 1 diabetes showed a significant reduction in the amount of TGs, TC, LDL, and increase in HDL levels after 3 months in both the camel milk treatment group and the control group.[16] A similar effect of camel milk on reducing lipid levels in patients with T2DM was reported by Wang *et al*.[17]

In this study, changes in BMI in the intervention and control groups were not statistically significant that was similar to some previous studies, such as Ejtahed *et al*. study.[10] Furthermore, Agrawal *et al*. work aiming the investigation of the effect of camel milk on diabetic nephropathy and microalbuminuria in type 1 diabetes patients showed a significant change in BMI mean after 6 months of treatment with camel milk,[1] while some studies found a significant weight gain in the BMI index after camel milk consumption after 16 weeks and 1 year.[6,18] These differences could be due to differences between our study and the other studies in terms of the duration of study execution, the average weight of patients at baseline, and the amount of their energy intake from dietary. The differences in the effect of camel milk on weight and BMI, blood glucose, and lipids in different studies may be due to different intervention period, the number of samples, and clinical differences between patients. Furthermore, the composition of camel milk could be different based on race, geographic region, season, stage of lactation, and diet. Anyway, an explanation of these contradictory results requires further investigation in the future.

CONCLUSION

The results of this study showed that 6- week consumption of camel milk compared to cow milk could improve glycemic status in patients with type 2 diabetes based on HbA1c index improvement and could reduce the amount of TGs in them. Some limits of this study include not monitoring changes in drug intake, diet, and physical activity of patients during the study. It is suggested that future studies on a larger sample size and longer and more intense case monitoring would be performed.

Conflicts of interest

There are no conflicts of interest.

Authors' contribution

All authors had enough contribution in different aspects of this work.

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