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Original Article

Effect of Raw Camel Milk on Type 2 Diabetic Patients

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Abstract

This study was designed to investigate the potential effect of raw camel milk (*Camellus dromedaries*) as an adjunct to insulin therapy in treating patients with type 2 diabetes mellitus (DM) treated by insulin. A total of 43 type 2 diabetic male patients aged (40- 65 years) were randomly selected from volunteers in a local Hospital at Al-Ajeilat city west of Tripoli, Libya. The patients were divided into two groups. Group 1 (n=22) received usual care i.e. diet, exercise and insulin dose ranged from 45 to 60 IU / day and group 2 patients (n= 21) received 500 ml of fresh camel milk daily in addition to the same usual care (i.e. diet , exercise and insulin doses) . The study lasted for 3 months during which fasting blood sugar levels and insulin doses were continuously monitored on biweekly basis for members of both groups. In addition, several other clinical parameters were measured at the beginning and end of the study including: Cholesterol, Triglycerides (TG), Glycosylated haemoglobin (HBA1C), Bilirubin, Glutamate Pyruvate Transaminase (GPT), Glutamate Oxaloacetate Tansaminase (GOT), Urea, Creatinine, and Alkaline – phosphatase (ALK).

Results have shown that group 2 patients with the exception of cholesterol experienced a highly significant reduction ($p<0.01$) in almost all monitored parameters .This was true for HbA1c: (8.1±0.1 to % 7.0±0.6), TG: (163.6 ± 4.3 to 160.5 ± 3.9 mg/dl), GPT: (18.3±0.8 to 16.1±0.7), Bilirubin: (0.6±0.03 to 0.50±0.03 mg /dl), Urea: (31.1±1.5 to 27.2±1. 2 mg/dl), Creatinine: (0.9±0.1 to 0.7±0.1 mg/dl) and Alkaline- phosphatase (187.8±6.2 to 182.5±6). Comparing the differences between the two groups at the beginning of the trial, most of these parameters were not significantly different except for GOT (12.91±2.39 vs. 15.90±3.62) and Bilirubin (0.55±0.2 vs. 0.6±0.2 mg/dl). On the other hand, at the end of the study the two groups showed significant differences in several parameters. Group 2 patients being lower in blood sugar (168.5± 3.9 vs.

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193.2 ±3.1 mg/dl). This is equivalent to approximately 13.1% reduction. In addition, it was found that treated patients experienced a gradual decline in their daily insulin dose requirement which reached as an overall average approximately 25.01% reduction by the end of the study.

It could be concluded from the present study that consuming camel milk (500 ml/day) would be a useful therapeutic tool adjunct to insulin for type 2 diabetic patients due to its significant effect in reducing blood sugar and insulin daily doses in such patients. Further research however is needed to demonstrate the ability of camel milk to cure and/or protect from other diseases and elucidate the exact mechanism in such regard.

Key words: Camel milk, Diabetic mellitus, Therapeutic effect.

Introduction

Diabetic Mellitus is a common endocrinal disorder, characterized by chronic hyperglycemia and disturbance of carbohydrate, fat and protein metabolism associated with insulin deficiency. According to recent estimates, approximately 370 million people suffer from this chronic disease worldwide and this most likely will reach 500 million within the next 20 years. Seventy-five percent of people with diabetes live in low- and middle-income countries in Asia and Africa. Even though the largest populations of diabetics are in China and India, the highest incidence of this disease is in the Arabic Middle East especially oil producing countries including Libya (American Diabetes Association, 2008 and Malik *et al.*, 2012).

Type 2 diabetes mellitus is a heterogeneous disease, often associated with obesity and develops when chronic over nutrition conspires with genetic susceptibility to cause impaired insulin signalling-insulin resistance, as well as a relative insulin deficiency of non-autoimmune aetiology. Recently the number of people diagnosed with type 2 diabetes has risen steeply exhausting the ability of health care systems to deal with the epidemic (Singh, 2008). It is well established that insulin therapy is still the best treatment for DM, of both types, but most people complain from needle phobia and high cost of insulin. These concerns force many patients to adopt alternative traditional treatments.

At present, entire physiological insulin replacement cannot be achieved in clinical practice and metabolic disturbances cannot be normalized. For centuries camel milk consumption was the most common alternative in traditional medicine. Camel milk is unique in its composition compared with bovine and other ruminant milk; having low cholesterol, low sugar, high minerals (sodium, potassium, iron, copper, zinc and magnesium), high vitamin C, low protein and large concentrations of insulin. There are no allergens, and it can be consumed by lactase deficient persons and those with weak immune systems (Omer and Eltinay, 2008). In addition, it is claimed that the value of camel milk is to be found in the high concentrations of volatile fatty acids especially, linoleic acid and polyunsaturated fatty acids, which

are essential for human nutrition (Agrawal, 2004). The traditional belief in many Middle Eastern countries is that regular consumption of camel milk helps in prevention and control of diabetes. However, over the years the new generations of the Arab population has drastically changed their life style (especially diet) by increasing their intake of animal protein, saturated fat, simple sugars accompanied with a drastic reduction in the daily exercise and in a lower consumption of fibers and camel milk. Net result of such changes led to a significant rise in the incidence of diabetes (Malik *et al.*, 2012). Yet, literature cited refer to numerous studies indicating that regular consumption of camel milk for few months significantly improved the condition of diabetic patients and experimental animals including rats (Mahamad, 2011; Alabdaziz *et al.*, 2008; Agrawal *et al.*, 2004). It is worth mentioning that such therapeutic effect of camel milk were not altered by pasteurization (an industrial treatment for raw milk by most dairy plants (Sboui *et al.*, 2012). Agrawal and co-workers (2003, 2005, 2007) conducted several studies with human patients in India and concluded that camel milk proved to be an effective supplementation tool in the management of type 1 diabetes based on the significant reduction in doses of insulin along with a decrease in BMI, quality of life. It was observed that the daily insulin dose/kg before treatment of camel milk was 93.50 unit/kg and after camel milk supplementation decreased to 60.64 unit/kg. It was postulated that one of the camel milk proteins could have characteristics similar to insulin and does not form coagulum in acidic environment. Radioimmunoassay of camel milk has revealed high concentration of insulin i.e. 52 units/lt (Agrawal *et al.*, 2011). Thus, they postulated that, lack of coagulum formation by camel milk allows its protein like insulin factor to remain un altered by the acidic environment of the human stomach and remains available for absorption in the intestine as lipid vesicles. In a recent study in Poland, Malik *et al.*, (2012), reported a controlled clinical experiment with camel insulin using diabetic patients. Their study showed that regular consumption of camel milk lowered blood glucose level, besides additional insulin requirement was reduced in 25% of patients which was contrary to the results of insulin therapy on the diabetic patients.

Thus, zero prevalence of diabetes in camel milk drinking population and the results of use of camel milk in controlled clinical trials on diabetic humans and animals are highly encouraging to use it as natural therapy for the prevention and treatment of diabetes. Despite the wide spread consumption of camel milk among Libyan population, and its well known use in traditional medicine, there were negligible scientific data supporting its role in preventing and /or curing diabetes of both types. Thus, lack of data in this field on the local level dictated the need for conducting such type of work. The main objective of this study was to evaluate the efficacy of camel milk as an adjunct to insulin therapy in patients with type 2 diabetes in Ajielat General Hospital, Libya.

Materials and Methods

A total of 43 type 2 diabetic Mellitus male patients were randomly chosen from Al-Ajielat General Hospital west of Tripoli, Libya. The patients ages ranged from 40 to 65 years and are medically diagnosed of being diabetic. They were randomly divided into two groups. Group 1 patients (n=22) received usual care i.e diet and dose of insulin injection ranged from 45 to 60 IU/day and group 2 patients (n=21) received 500 ml of fresh camel milk daily for three months in addition to the same usual care of diet exercise and insulin doses. Patients with any acute metabolic complications like hypoglycaemia, ketoacidosis, cardiovascular event, renal or acute infections were excluded. Blood samples were drawn from all patients at the beginning and twice a week for three months. Fasting Blood sugar was measured biweekly and insulin doses were monitored on a weekly basis up to the end of the study according to the blood sugar levels. In addition, other parameters such as Glycosylated haemoglobin (HBA1C), Cholesterol, Triglycerides, Glutamate Pyruvate Transaminase (GPT), Glutamate Oxaleacetate Transaminase (GOT), Bilirubin, Urea, Creatinine and Alkaline - phosphatase (ALK) were measured at the beginning and the end of the study. Safety evaluations included vital signs, Liver function and other clinical parameters.

Camel milk was obtained from a camel flock reared in a semi dry area 50 km south -east of Al -Ajielat city. Twenty lactating female camels were milked daily after washing the udder and hands with a detergent. Samples were filtered by a medical cloth in a 20 litter sterilized container, then delivered within 30 minutes to the patients (500 ml/patient/day) before breakfast. Meanwhile, samples of 100 ml milk were taken every 2-3 weeks period interval for chemical and bacteriological analysis.

Chemical analysis included total solids, fat, protein, lactose and ash contents. Chemical analysis were conducted according to the methods of Association of Official Analytical Chemists (AOAC, 1990). In addition, pH was determined using a pH meter (Model HI, Hanna Instruments, Italy). Microbiological analysis included Total Viable Count (TVP), Total Coliform (TCF) count and detection and enumeration of *Staphylococcus aureus as* an index of quality and safety respectively. Such tests were performed according to the official methods described in the standard methods for the examination of dairy products (APHA, 2001).

Statistical Analysis:

The data were analyzed using T test in pair or in groups. Least Significant Differences (LSD) test was used to examine the differences among means (SAS, 2006).

Results and Discussion

The camel milk used in this study was analysed before given to the patients. The results indicated that total solids (TS) was 11.6 ± 2 g/100g. This result was lower than that (13.1 ± 2.5) obtained by Gnan and Shareha (1986).

On the other hand, moisture content (%) , protein, fat, lactose, and ash were 88.1 ±2 , 3.3 ± o.5 , 3.3 ± 0.3 , 4.6 ± o.5 , and 0.9 ± o.1 respectively . The values were in line with those of Gnan and shareha (1986) and. The acidity (as lactic acid equivalent) ranged between 0.2 - 0.25 g/100g. This result was in agreement with that of Abu-Lehia, (1998). Camel milk had high caloric value (676.2 ± 5.1 K cal/L) this may be due to an increase in fat and protein content. These values were lower than those (759 Kcal /L) reported by Shamsia (2009). In the current study the blood sample parameters were measured in relation with diabetes type 2 , the results of clinical parameter (means ± SE) of group 1 patients (control) at the start and the end of study (Table,1) indicated that with few exceptions experienced no significant change in parameters throughout the study period. This is obvious since this group depended entirely on insulin daily doses.

Data for group 2 patients that were given 500 ml/day camel milk beside insulin are shown in Table (2). In contrary to the first group almost all parameters were significantly reduced by the end of 3rd month period (171.8 to 168.2) but such reduction was not significant. Comparing clinical parameters of both groups at the beginning of the study (Table, 3), it could be clearly seen that there was no significance difference between the two groups in almost all parameters except for Bilirubin and GOT.

A comparison of data of the two groups at the end of the study was shown in (Table 4). The results indicated that in exception for blood glucose, GOT and HBAIC, no significance difference could be seen for rest of the parameters. Yet there was slight reduction in the values of the other parameters of group -2 patients compared to group1. Taking into consideration the fact that the two groups were not significantly different in all measurements at the start of the study (Table 3), it could be safe to conclude therefore, that camel milk had a positive effect on blood sugar and slight effect on most of the clinical parameters of the treated diabetic patients.

Table 5 presents a summary of data comparing the two groups in terms of glucose level at the start and end of the study. Data clearly indicate that group 2 patients experienced a reduction in glucose level (25.01 %) vs slight changes in case of group -1 patients (9.0 %). This could be attributed to camel milk given to group 2 patients. Differences in mean insulin daily doses for group 1 and group 2 patients are shown in Table (6).

Insulin daily doses for Group 1 patients remained almost constant throughout the study period that is 45 or 60 µU / ml. On the other hand, group 2 patients experienced a gradual decrease in their insulin daily intake, such effect started to be noticeable by the end of the 1st month and reached its minimum level of about 30 µU /ml by the end of the study. The overall reduction was estimated to be approximately 25.01% (Table 6). These results are nearly similar to those reported by Agrawal *et al.* (2005) who used camel milk as a treatment for diabetes mellitus type I.

Table 1. Clinical parameters (means ± SE) of the control patients (group I) at the start and the end of the study.

Parameter	Start	End	Sig. Dif.
HbA1c (%)	8.05 ±(0.12)	7.72 ± (0.10)	*
Cholesterol (mg/dl)	180.32 ± (3.48)	179.32 ± (3.50)	NS
Triglycerides(mg/dl)	174.36 ±(4.40)	170.27 ± (4.40)	*
GPT (μ /dl)	17.05 ±(0.65)	18.05 ± (3.18)	NS
GOT (μ /dl)	12.91 ±(0.51)	12.95 ± (0.70)	NS
Bilirubin (mg/dl)	0.55 ±(0.03)	0.55 ± (0.04)	NS
Urea (mg/dl)	31.74 ±(1.63)	30.30 ± (1.28)	NS
Creatinine (mg/dl)	0.85 ± (0.06)	0.70 ± (0.03)	**
Alk-phosphatase (μ /dl)	184.18±(4.02)	182.18 ± (4.10)	NS

* significance diff. at (p<0.05), ** highly sig. at (p<0.01), NS: no sig. diff.

Table 2. Clinical parameters (means ± SE) of group II patients treated with 500 ml camel milk daily for three months at the start and the end of the study.

Parameter	Study Period		Sig.Dif.
	Start	End	
HBA1C (%)	8.11 ± (0.10)	7.03 ± (0.06)	**
Cholesterol (mg/dl)	171.76 ± (7.65)	168.24 ± (6.31)	NS
Triglycerides (mg/dl)	163.57 ± (4.30)	160.48 ± (3.97)	**
GPT (μ/dl)	18.33 ± (0.82)	16.14 ± (0.73)	**
GOT (μ/dl)	15.90 ± (0.79)	13.43 ± (0.72)	**
Bilirubin (mg/dl)	0.65 ± (0.03)	0.50 ± (0.03)	**
Urea (mg/dl)	31.06 ± (1.53)	27.23 ± (1.19)	**
Creatinine (mg/dl)	0.93 ± (0.07)	0.70 ±(0.06)	**
Alk-phosphatase (μ/dl)	187.75 ± (6.20)	182.52 ± (5.96)	**

* significance diff. at p<0.05), ** highly sig. at p<0.01), NS: no sig. diff.

Table 3. Comparing various blood parameters (Mean ± SE) of the control patients (group I) and the treated patients (group II) at the start of study.

Parameter	Group I	Group II	Sig. Dif.
Blood sugar (mg/dl)	202.18 ± (3.67)	193.86 ± (5.29)	NS
HBA1C (%)	08.05 ± (0.57)	8.11 ± (0.50)	NS
Cholesterol (mg/dl)	180.32 ± (16.35)	171.76 ± (35.04)	NS
Triglycerides (mg/dl)	174.36 ± (20.65)	163.57 ± (19.71)	NS
GPT (µ/dl)	17.04 ± (3.04)	18.33 ± (3.75)	NS
GOT (µ/dl)	12.91 ± (2.39)	15.90 ± (3.62)	**
Bilirubin (mg/dl)	0.55 ± (0.16)	0.64 ± (0.15)	*
Urea (mg/dl)	31.74 ± (7.62)	31.06 ± (7.01)	NS
Creatinine (mg/dl)	0.85 ± (0.29)	0.93 ± (0.33)	NS
Alk-phosphatase (µ/dl)	184.18 ± (18.85)	187.57 ± (28.39)	NS

* significance diff. at ($p<0.05$), ** highly sig. at ($p<0.01$), NS: no sig. diff.

Table 4. Comparing various blood parameters (Mean ± SE) of the control patients (group I) and the treated patients (group II) at the end of the study.

Parameter	Group I	Group II	Sig.Dif.
Blood sugar (1 Mo.) mg / dl	198.86 ± (3.32)	187.05 ± (5.29)	*
Blood sugar (2 Mo.) mg / dl	195.00 ± (3.14)	180.14 ± (4.75)	**
Blood sugar (3 Mo.) mg / dl	193.18 ± (3.12)	168.52 ± (3.88)	**
HBA1C (%)	7.73 ± (0.10)	7.04 ± (0.07)	**
Cholesterol (mg/dl)	179.32 ± (3.50)	168.24 ± (6.31)	NS
Triglycerides (mg/dl)	170.28 ± (4.40)	160.48 ± (3.97)	NS
GPT (µ/dl)	18.05 ± (0.68)	16.14 ± (0.73)	NS
GOT (µ/dl)	12.95 ± (0.70)	13.43 ± (0.72)	**
Bilirubin (mg/dl)	0.55 ± (0.04)	0.50 ± (0.03)	NS
Urea (mg/dl)	30.30 ± (1.28)	27.23 ± (1.19)	NS
Creatinine (mg/dl)	0.70 ± (0.03)	0.70 ± (0.06)	NS
Alk-phosphatase (µ/dl)	184.18 ± (4.02)	187.57 ± (6.20)	NS

* significance diff. at ($p<0.05$), ** highly sig. at ($p<0.01$), NS: no sig. diff.

Table 5. Comparing the mean ± SE of glucose levels at the start and the end of the study for the control patients (Group I) and the treated patients (Group II).

Study Period	Glucose level (mg/ dl)		
	Group 1	Group 2	Dereference (+/-)
Start of study	202.18± 3.676	193.86 (±5.29)	- 8.32 units
End of experiment	193.18±3.115	168.52 (±3.88)	-24.66 units
Over all mean reduction	9.00	25.34	16.34 units
Reduction (%)	4.45	13.07	8.62

Table 6. Comparing the mean ± S.E. of insulin doses at the start and the end of the study for the Control patients (Group I) and the treated patients (Group II) .

Study Period	Insulin dose (µU / ml) Mean± Std error	
	Group 1	Group 2
Start of study	45 - 60	51.43 (±1.66)
End of study	45 - 60	38.57 (±2.44)
Overall mean reduction	- -	12.86
Reduction (%)	- -	25.01%

This study indicate that there was a positive effect on reduction of blood sugar and insulin doses of diabetes patients type 2 using 500 ml camel milk/day. Several authors reported that there were reduction in some clinical parameters besides blood sugar in type 1 diabetes mellitus patients as well as some animals consuming raw camel milk (Agrawal *et al.*, 2003, Mahamad *et al.*, 2005, and Wang *et al.*, 2009). Moreover, they postulated that "camel insulin differs from human insulin by four amino acids and from bovine and buffalo by just one amino acid". None of these amino acids however, affect specificity toward digestive enzymes. Therefore, camel insulin should be identical to human, bovine, buffalo, goat, sheep and pig insulin in terms of susceptibility toward proteolysis. Thus, when camel insulin comes in contact with the proteases of digestive tract it should be digested like other mammalian insulin. In addition, they stated that "it is possible that insulin in camel milk is present in the nano-particles form capable of transporting this hormone into the blood stream. Although, much more probable is that camel milk contains 'insulin-like' small molecular substances that mimic insulin interaction with its receptor and being able to

modulate glucose level. On the other hand, Malik *et al.*, (2012) commented on such hypothesis and stated that in order that camel milk be effective it would have to be absorbed directly in the mucosal cavity or completely proteolytically protected during passage through stomach and absorbed in the intestine, the fact which is not yet proven".

Regardless of the un resolved issue of the mechanism of the therapeutic effect of camel milk, it could be concluded however, that camel milk does posses a significant reduction in insulin dose for patients with type 2 diabetes mellitus by about 25%, in addition to glucose blood level by approximately 12.8%. Yet, further research is needed to demonstrate the ability of camel milk to cure and/or protect from other diseases and elucidate the exact mechanism in such regard.

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تأثير حليب الإبل الخام على مرضى السكري نوع 2

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المستخلص

صممت هذه الدراسة لغرض التأكد من التأثير الإيجابي المحتمل لحليب الإبل الخام على مرضى السكري نوع 2 كعامل مرافق لجرعات الأنسولين. شملت الدراسة عدد 43 متطوعا من مرضى السكري جميعهم من الذكور تراوحت أعمارهم من 40-65 سنة. تم اختيار عينة الدراسة عشوائيا من المرضى المترددين على مستشفى مدينة العجيلات غرب طرابلس ليبيا. تم تقسيم المرضى إلى مجموعتين: الأولى (ن= 22) أعطيت وجبات غذائية معتادة بالإضافة إلى جرعات يومية من الأنسولين (45-60 وحدة دولية) مع نشاط رياضي متوسط. أما المجموعة الثانية (ن= 21) فقد أعطيت 500 مل/ يومياً حليب إبل خام مع وجبة الإفطار بالإضافة الى المعاملة السابق ذكرها للمجموعة الأولى فيما يتعلق بالنمط الغذائي والنشاط الرياضي وجرعة الأنسولين. استغرقت الدراسة 3 أشهر تم خلالها أخذ القياسات المعهودة لمرضى السكري والتي شملت مستوى السكر بالدم (قبل الأكل) ونسبة الأنسولين والسكر التراكمي وذلك بمعدل مرتين في الأسبوع. هذا بالإضافة إلى تقدير بعض المؤشرات السريرية مع بداية الدراسة وفي نهايتها وشملت كل من: الكوليسترول و الجليسريدات الثلاثية والبليروبين و اليوريا و الكرياتينين و هيموجلوبين الدم السكري Glycosylated haemoglobin (HBA1C) ، إضافة إلى بعض إنزيمات الكبد: (GPT وGOT وإنزيم الفوسفاتيز القاعدي (ALK).

أشارت النتائج أن المجموعة الثانية التي تناولت حليب الإبل قد حدث لديها انخفاض معنوي عند مستوى ($p<0.01$) بمعظم المؤشرات باستثناء الكوليسترول مقارنة بالمجموعة الأولى (مجموعة المراقبة). فقد انخفض مستوى الجليسريدات الثلاثية من 163.57 ± 4.30 مع/د.ل إلى 160.48 ± 3.97 مع/ د.ل والبليروبين من 0.65±0.03 مغ/ د.ل إلى 0.50 ± 0.03 مع/د.ل واليوريا من 31.06 ± 1.53 مع/ د.ل إلى 27.23±. مغ/ د.ل 3.97 والكرياتينين من 0.93 ± 0.07 مع/ د.ل إلى 0.70 ± 0.06 مع/ د.ل، و إنزيم الفوسفاتيز القاعدي من 187.75 ± 6.20 ميكروغ/د.ل إلى 182.52 ± 5.96 ميكروغ/د.ل. أما انزيمات الكبد GPT وGOT فقد انخفضت بدورها من 18.33± 0.82 إلى 16.14 ± 0.73 ميكروغ/ د.ل، ومن 15.90 ± 0.79 ميكروغ/ د.ل إلى 13.43 ± 0.72 ميكروغ/ د.ل على التوالي.

وبمقارنة الفرق في المؤشرات المذكورة بين المجموعتين عند بداية الدراسة تبين أنه لم تكن هناك أية فروق معنوية عدا مستوى كل من GOT 12.91 ± 2.39 مقارنة بـ 15.90 ± 3.62 و البيليروبين 0.55 ± 0.16 مقارنة بـ 0.64 ± 0.15 ، بينما لوحظ فرق معنوي واضح بين المجموعتين بمعظم المؤشرات في نهاية الدراسة - (بعد 3 أشهر) حيث سجل أفراد المجموعة الثانية أعلى انخفاض في مستوى جلوكوز الدم وذلك من: 193.18 ± 3.12 مقارنة بـ 168.52 ± 3.88 في نهاية الدراسة. وهذا يعادل

معدل انخفاض قدره حوالي 13.07% . بالإضافة إلى ذلك فإن النتائج أفادت بأن المجموعة المعاملة قد سجلت انخفاضا تدريجيا ملحوظا في مستوى جرعات الأنسولين اليومية وذلك بما يقارب 25.01% مقارنة بالمجموعة الأولى.

على ضوء نتائج هذه الدراسة فإنه بالإمكان التأكيد على أن استهلاك حليب الإبل الخام بمعدل 500 مل/ يومياً يعتبر معزز جيد للأنسولين في علاج مرضى السكري نوع 2، وذلك بناء على تأثيره المعنوي الواضح في خفض مستوى جلوكوز الدم إضافة إلى خفض الاحتياج اليومي من جرعات الأنسولين لهؤلاء المرضى.

ختاما, فإن هناك حاجة ماسة لإجراء مزيد من الدراسات خاصة في مجال التأثير الإيجابي المحتمل لحليب الإبل على العديد من الأمراض الأخرى و التفسير العلمي للآلية التي تتم بها .

كلمات دالة : حليب الإبل, مرض السكري نوع 2, التأثير العلاجي.

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