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Abstract

The present study was conducted to evaluate physicochemical, rheological, microbiological, antioxidant and sensory properties of probiotic fermented camel milk made from camel milk mixed with Oat milk. Fermented camel milk was made from camel milk served as a control, and the other treatments were made from camel milk after mixing with 25 and 50 % Oat milk. Results revealed that mixing of camel's milk with Oat milk were more effective in increasing the total solids, protein, ash, fiber , acidity , viscosity, phenolic content and antioxidant activity and these increments were proportional to the mixing ratio. Fermented camel milk containing 50 % Oat milk had the highest scores for sensory properties compared to other fermented camel milk treatments. This blend (fermented camel milk containing 50 % Oat milk) was evaluated as hypoglycaemic agent streptozotocin-induced diabetic rats. In this respect, twenty four male adult albino rats of Sprague Dawely strain weighing 150- 185 g were divided into 4 groups as follows: Group (1) non-treated non- diabetic rats (negative control). Group (2) diabetic rats (received Streptozotocin (STZ), 60 mg/Kg BW) (positive control).Group (3) diabetic rats fed on basal diet with fermented camel milk (10g/day) by epi gastric tube. Group (4) diabetic rats fed on basal diet with fermented camel milk containing 50 % Oat milk (10g/day) by epi gastric tube. The treatment of diabetic rats with fermented camel milk containing 50 % Oat milk showed a significant decreases($p<0.001$) in levels of blood glucose, malondialdehyde (MDA), low density lipoprotein (LDL), cholesterol (CL), triglyceride (TG), AST, ALT , ALP, creatinin and urea and increased ($p<0.001$) high density lipoprotein (HDL) and total protein and albumin in comparison to diabetic rats. Consumption of fermented camel milk containing 50 % Oat milk in diabetic rat groups caused significant improvement in all

these factors, compared to the positive control group (untreated diabetic rats). Also in this study, for the first time, we demonstrated that administration of fermented camel milk containing 50 % Oat milk in diabetic rats resulted in enhanced of blood complications compared to the untreated diabetic group, indicating that fermented camel milk containing 50 % Oat milk can play a preventive role in such patients.
Key words: probiotic, Oat milk, camel milk yoghurt, physicochemical, blood glucose, cholesterol, **urea**.

Introduction

Diabetes is one of the most common chronic diseases, and it has shown an increasing rate of occurrence over the past decade (**Bullard et al., 2018**). Diabetes mellitus (DM) is a metabolic disorder that is characterized by an abnormal long-term increase in plasma glucose levels. Diabetes is mainly classified into four types, i.e., type I diabetes (T1DM), type II diabetes (T2DM), gestational diabetes, and specific types of diabetes due to other causes (**American Diabetes Association, 2019**).

Many factors, such as protein, and fat metabolisms, insulin deficiency or resistance as well as altered carbohydrate are usually the reasons for high blood glucose levels leading to diabetes mellitus. Chronic hyperglycemia related to diabetes is often associated with many other complications, such as neurological, renal, retinal, cardiovascular, dermatological and nerve diseases (**Atwaa et al, 2021**).

In type II diabetes mellitus, progressive decline in insulin action referred as insulin resistance and pancreatic β-cell dysfunction leads to increased levels of blood glucose (**Srinivasan *et al*., 2005**). A major risk factor for insulin resistance is obesity, which is generally caused by a western style high fatty diet and physical inactivity (**Zheng et al., 2012**).

The current treatment for type II diabetes includes insulin and oral hypoglycemic drugs such as sulfonylurea derivatives, thiazolidinediones, biguanides, and α-glucosidase inhibitors. These medications have side effects, e. g. osteoporosis and sodium retention, thiazolidinediones induce obesity and sulfonylurea derivatives can lead to incidences of severe hypoglycemia, whereas biguanides like metformin put patients at risk of developing lactic acidosis (**Hamza et al .,2010 and Bandawane et al. ,2020**).

Thus, there is an increasing need to search for effective antidiabetic agents exhibiting fewer side effects. As an alternative, large number of population is trying to rely on plant-based remedies for management of this metabolic disorder. (**Bandawane et al., 2020).**

Antioxidants can reduce markers of oxidative stress in both experimental and clinical models of diabetes (**Hoshyar et al., 2015**).

Camel milk is characterized than cow's milk where it has a high nutritional and health value because it contains immune proteins such as lysozyme, which is an antioxidant and anti-inflammatory, aminoglobulins, with no beta-lactoglobulin which may cause allergic reactions to some people, and contains a large amount of iron, potassium ,vitamin C, E, and A (**Salem *et al*., 2017; Khalesi *et al*., 2017).**

Fermented camel milk is proved to have some health benefits, proved or not, such as antioxidant activity, angiotensin I-converting enzyme (ACE) inhibitory activity, hypocholesterolaemic effect, antimicrobial activity, activity against diarrhea, anticancer activity (**Solanki and Hati, 2018**).

Increased attention has been given to improving fermented dairy products containing probiotic bacteria because of their health benefits **(Atwaa *et al*., 2022**). Dairy products containing probiotics have spread in many countries around the world (**Tharmaraj & Shah, 2003**) to obtain a dietetic therapeutic effect that reduces the symptoms associated with high cholesterol (**Walsh *et al*., 2010).**

Cereals and their components have been accepted as a functional food due to its provision of vitamins , dietary fiber, protein, antioxidants , energy, and minerals required for human health. Also, cereals can be used as fermentable substances for the growth of probiotic bacteria (**Charalampopoulos *et al*, 2002: Atwaa et al, 2020**).

Oat (*Avena sativa* L.) and oat products are a good sources of soluble dietary fiber, β-glucan, vitamin E, polyunsaturated fatty acids and their consumption in the human diet is beneficial to human well-being (**Tiwari and Cummins 2012: Ramzan ,2020**) .

Therefore, the aim of this study was to produce fermented camel milk mixed with Oat milk, and the effect of fermented camel milk mixed with Oat milk on hyperglycemia in streptozotocin-induced diabetic rats.

Material and Methods

Materials:

Camel milk was obtained from Desert Research Center, Dokki, Egypt. Oat flakes purchased from local market. Food grade "-amylase from *Bacillus subtilis* was purchased from Sigma Aldrich which had an activity of 2000IU in a powder form , other chemicals and reagents were purchased form Sigma-Aldrich .ABT-5 culture containing *Streptococcus thermophilus*, *Lactobacillus acidophilus* and *Bifidobacterium bifidum* were obtained from the Microbiological Resources Center (MIRCEN), Faculty of Agric. Aim Shams Univ., Egypt.

Methods:

Preparation of oat milk sample:

Oat milk was prepared according to enzymatic method described by **Deswal *et al*,(2014)** About 1 kg of rolled oats was ground into a laboratory food processor to produce finely granulated oat flour and then mixed with 2.7 kg of water. Calcium chloride at a concentration of 0.04% (w/w) was added as a catalyst for the enzyme. Oat slurry was treated with "-amylase (77.78 mg kg^{G1} of Rolled oats) for liquefaction for 49 min at 75 ˚C. The liquefied oat solids were then filtered through muslin cloth to get the Oat milk. At the end of the treatment, the enzyme was inactivated by heating at 100 ˚C for 5 min.

Fermented camel milk manufacture:

Probiotic fermented camel's milk was manufactured according to the method reported by **Tamime and Robinson, (1999)** and modified with **Atwaa *et al*,(2020).**

Treatments were carried out as follows:

Whole camel milk as a control C)

Whole camel milk mixed with 25 % Oat milk (T1)

Whole camel milk mixed with 50 % Oat milk (T2)

Milk of all treatments homogenized at 55–60°C for 2 min using a high speed mixer (22,000 rpm/min), heat-treated in a thermostatically controlled water bath at 85 °C for 30 min ,cooled to 42°C in an ice bath, ,inoculated with 5 % (w/v) ABT5 culture, incubated at 42ºC for 6–8 h until a firm curd was obtained, the curd was refrigerated at 4°C overnight, stirred using the mixer , stored at 4 ± 1 °C, then analyzed after 1 day from manufacture for physicochemical, rheological , microbiological, and sensory properties.

Chemical Composition:

The dry matter, protein, fat, ash contents and titratable acidity (expressed as lactic acid %) were determined as described in **AOAC (2007).** The pH values were measured by digital laboratory pH meter (HANNA Digital). Viscosity of fermented camel milk was determined according to **Aryana(2003).**

Determination of total phenolic content:

The total phenolic content (TPC) of the extract was determined by Folin-Ciocalteu assay using Gallic acid as the standard according to **Kaur and Kapoor (2002)** .The total phenolic content was expressed as gallic acid equivalents (mg GAE/100g dry weight basis) through the calibration curve of Gallic acid.

Radical scavenging activity (Scavenging DPPH):

The antioxidant activity was evaluated by the DPPH (2, 2-diphenyl-1-picrylhydrazyl) assay according to **Brand Williams *et al*,(1995).** The scavenging activity percentage (AOA%) was determined according to **Mensor *et al*,(2001)** as follows:

$AOA(\%) = 1- Abs_{sample} - Abs_{blank} / Abs_{control} \times 100$ (1)

Sensory evaluation:

The sensory properties of yoghurt samples were assessed by 10 panel members of the Dairy Sci., Dep., Fac. Agric., Zagazig, Univ. for flavour (60) body and texture (30) and appearance (10) as reported according to **Nelson and Trout (1981).**

Experimental design of biological study

Thirty-two male adult Wistar rats weighing 200-250 g will be collected from Agricultural Reached Center, Giza, Egypt. All animals kept under controlled conditions of light (12 h of light and 12 h of darkness) with the ambient temperature of 22±2°C and relative humidity of 40 - 60% and free access to water and food in the Animals' Room. All animals will be allowed free access to standard diet. The normal diet composition will be as follows: Casein (20%), sucrose (50%), Corn Starch (15%), powdered cellulose (5%), corn oil (5%), mineral mix (3.5%), vitamin mix (1%), DL- Methionine (0.3%), Choline bitartrate (0.2%) according to AIN-93 guidelines (**Reeves et al., 1993**). After acclimation on a basal diet for seven days Albino rats were classified into two main sections, where the first one (n= 8) received only the standard diet and served as the normal control group while the second one (hyperglycemia rats, n= 24) will be subjected to 60 mg/Kg BW Streptozotocin (STZ) intraperitoneally injection. After 24-48h, rats that showing fasting blood glucose more than 200 mg dl-1 will be considered diabetic rats. Diabetic rats will be divided into three groups (n = 8 each) .The first did not receive any treatment and served as the hyperglycemia positive control. The second and third ones received 10g/day probiotic camel milk yoghurt and 10g/day probiotic camel milk yoghurt containing 50 % Oat milk respectively. The body weight of rats will be measured at the beginning of experimental period and after 7 days intervals. At the end of the experiment and after an overnight fasting (10 hr), rats will be killed, blood samples will be collected and centrifuged at 3000 rpm to obtain the blood serum which will store at (–20ºC) for biochemical analysis.

Biochemical analysis:

Insulin was determined in human blood samples according to the method of (**Thomas, et al., 2014).** Blood glucose level was determined according to the method of Clinical Methods **(Trinder, 1969).**The method of **Caraway (1955)** was used to determine serum uric acid, while serum creatinine level was measured by the method of **Bohmer (1971)** and serum urea was determined according to **Marsch et al., (1965).** Total antioxidant capacity (TAC) and malondialdehyde (MDA) were determined in serum according to **Koracevic et al. (2001)** and **Satoh (1979).** Alanine amino transferase (ALT), aspartate amino transferase (AST) enzymes were measured according to the methods described by **Bergmeyer and Harder, (1986) .** Total cholesterol, will be determined according to the method of Enzymatic Colorimeter, **Deweerdt and Later (2009).** Total lipids and triglycerides will be determined according to the method of **Devi and Sharma, (2004).** The LDL will be calculated using Friedewald formula **(Friedewald et al., 1972)** as following:

LDL-cholesterol= Total cholesterol - (HDL-cholesterol) - (Triglycerides/5).

Statistical analysis:

The obtained results were evaluated statistically using analysis of variance as reported by **McClave & Benson (1991).** In addition the other reported values were expressed as mean ±SD and ±SE, two – tailed Student's t test was used to compare between different groups. . P value less than 0.05 was considered statistically significant. SPSS (Chicago, IL, USA) software window Version 16 was used.

Results and discussion

Chemical composition of fresh camel milk and Oat milk:

The chemical composition of fresh camel milk, Oat milk and dried whey protein concentrate are illustrated in Table (1). Total solids, protein, fat, ash carbohydrate and fiber contents of camel milk were (12.58, 3.18, 4.12, 0.82, 4, 46 and 0.0 g/100g) respectively. These results are in agreement with the data obtained by **Rahli *et al* ,(2013) and Omar *et al*., (2019).**Total solids, protein, fat, ash carbohydrate and fiber contents of Oat milk were (21.70, 2.30, 1.74, 0.354, 17, 30 and 2.04 g/100g) respectively. These results are in agreement with the data obtained by **Atwaa *et al*., (2020).** While, total solids, protein, fat, ash carbohydrate and fiber contents of dried whey protein concentrate were (95.40, 87.36, 0.10, 2.62, 5, 32 and 0.0 g/100g) respectively. These results are in agreement with the data obtained by **El-Batawy *et al*., (2019).**

Table 1. Chemical composition of fresh camel milk and Oat milk

Components (%)	Camel milk	Oat milk
Total Solids	12.22±0.20	20.85±1.60
Protein	3.12±0.06	2.44±0.14
Fat	4.02±0.08	1.70±0.09
Ash	0.85±0.04	0.40±0.02
Fiber	----	2.12±0.10

Chemical composition of fermented camel milk made from camel milk mixed with Oat milk:

Table (2) shows the chemical composition of fermented camel milk made from camel milk mixed with Oat milk ,it can be seem that control fermented camel milk had the lowest total solids (TS), protein, ash and fiber contents it was significantly ($P \leq 0.05$) compared with fermented camel milk containing Oat milk treatments. The TS, protein, ash and contents of fermented camel milk containing Oat milk increased gradually by increasing the mixing ratio ,this may be due to a high TS, protein, ash and fiber contents of Oat milk (**El-Batawy *et al*., 2019)** . Concerning fat content, mixing of camel milk with Oat milk did not affect on fat content of resultant fermented camel milk. These results are in agreement with those reported by **Atwaa *et al*., (2020)**, who found that partial replacement of camel milk with Oat milk increased the TS, protein, ash and carbohydrate contents of resultant yoghurt compared with camel milk yoghurt.

Table 2: Chemical composition probiotic fermented camel milk made from camel milk mixed with Oat milk

Components (%)	Treatments		
	C	T_1	T_2
Total Solids %	12.24±0.46[a]	16.72±0.60[a]	21.34±0.42[a]
Protein %	3.18±0.16[c]	3.12±0. 22[c]	3.09±0.28[c]
Fat %	4.08±0.18[c]	3.50±0.16[c]	2.96±0.14[c]
Ash	0.88±0.07[c]	1.34±0.12[c]	2.14±0.06[c]
Fiber %	---	1.14±0.02[c]	1.72±0.03[c]

*** Values (means ±SD) with different superscript letters are statistically significantly different ($P \leq 0.05$).**

C: fermented camel milk made from camel milk as a control (C) .

T_1: fermented camel milk made from camel milk mixed with 25 % Oat milk

T_2: : fermented camel milk made from camel milk mixed with 50 % Oat milk

Titratable acidity, pH values viscosity, total phenolic content and radical scavenging activity of fermented camel milk made from camel milk mixed with Oat milk:

Data illustrated in Table, (3) indicated that titratable acidity (TA) of the control fermented camel milk had the lowest value, this may be due to a high antimicrobial components such as lactoferrin , lysozyme and immunoglobulin's in camel milk which decreased viability of starter culture (**Galeboe *et al* ,2018**). The acidity of y fermented camel milk made from camel milk mixed with Oat milk increased gradually by increasing the mixing ratio; this may be due to contains Oat milk fermentable substance which improved viability of starter culture (**El-Batawy *et al*., 2019).** pH values of all treatments behaved reverse trend to TA .Similar results were obtained by **Atwaa *et al*, (2020)** who found that partial replacement of camel milk with Oat milk increased the TA and decreased pH values of resultant camel milk yoghurt .

Viscosity of the control fermented camel milk (C), was the lowest value, while mixing of camel milk with Oat milk greatly increased of viscosity. Similar results were reported by **Omar et al, (2019)** they observed that increasing the total solid in milk caused an increase in the viscosity of the yoghurt gel.

Total phenolic content fermented camel milk made from camel milk mixed with Oat milk were increased by increasing the mixing ratio compared to control fermented camel milk ,this may be due to a higher total phenolic content of Oat milk (**Ibrahim *et al* ,2020**) than camel milk (**Soliman and Shehata,2019**). These results are in agreement with those reported by **Ibrahim *et al*, (2020)** who found that total phenolic content and radical scavenging activity of fermented camel's milk increased when fortified camel milk with different ratios of kiwi and avocado. Also, **Atwaa et al (2020)** found that addition of Oat milk to camel milk increased the total phenolic content and radical scavenging activity of fermented camel milk.

Table 3: Titratable acidity, pH values, viscosity, total phenolic content and radical scavenging activity of fermented camel milk made from camel milk mixed with Oat milk

Parameters	Treatments		
	C	T_1	T_2
Acidity%	0.78±0.03	0.85±0.06	0.94±0.08
pH values	4.80 ±0.08	4.74±0.14	4.66 ±0.06
Viscosity (C.P.S.)	2120±88	2310±94	2430±98
Total phenolic content (mg / g)	1.42. ±0.04	2.48±0.25	3.18±0.22
Radical scavenging activity RSA %	8.35±0.54	11.14±1.05	14.06±162

* Values (means ±SD) with different superscript letters are statistically significantly different ($P \leq 0.05$).

Sensory properties of fermented camel milk made from camel milk mixed with Oat milk:

Data presented in Table (4) showed that the mixing of camel milk with Oat milk increased greatly the sensory attributes of the resultant fermented camel milk, especially its flavor and body & texture as compared with the control fermented camel milk and this improvement was proportional to mixing ratio. Control fermented camel milk had the lowest score for sensory properties this may be due to a very weak body & texture and inferior flavor of curd produced from camel milk (**Soliman *and* Shehata,2019:Atwaa et al,2020**). On the other hand, the use of Oat milk improved all sensory attributes of the resultant fermented camel milk. This finding is consistent with the observation of **Atwaa et al, (2020)** who reported that fortification of camel milk with Oat milk increased the sensory attributes scores of the resultant fermented camel milk.

Table 4: Sensory properties of fermented camel milk made from camel milk mixed with Oat milk

Attributes	Treatments		
	C	T_1	T_2
Flavor (60)	39.6±2.50	43.2±2.20	45.8±3.24
Body & Texture (30)	21.4±1.14	24.3±1.84	27.5±1.44
Appearance (10)	7.6±0.55	8.2±0.86	9.3±0.52
Total Scores (100)	69.5±3.12	76.8±3.64	85.2±3.36

* Values (means ±SD) with different superscript letters are statistically significantly different ($P \leq 0.05$).

Effect of fermented camel milk containing Oat milk on Final weight and body weight gain of diabetic rats:

Data presented in Table (5) showed that FW and BWG were significantly (P<0.05) affected by the treatments. The use of 10 g/day fermented camel milk containing 50% Oat milk in diabetic rats gave the best values of FW (296.4 g) and BWG (18.98 %), respectively compared to positive control group which showed FW (282.6 g) and BWG (13.22 %), respectively. This improvement may be ascribed to the Oat milk high vitamins, minerals, and antioxidants contents, which may prevent/avoid the body's cells damage by free radicals (**Ramzan, 2020**). Accordingly**, Gohari et al (2019)** found that unfermented and fermented Oat milk addition in rat diets promoted a significant increment ($P < 0.01$) of the body weight gain and enhanced nutritional status in comparison to group 2 (negative control group).

Table 5: Final weight and body weight gain of diabetic rats treated with lemon grass leaves extract

Group	**Parameters**		
	Initial weight (g)	**Final weight (g)**	**B W G %**
Group (1)	248.2±4.6[a]	302.3±5.2[a]	21.79±1.2[a]
Group (2)	249.6±2.8[a]	282.6±3.7[d]	13.22±1.8[d]
Group (3)	248.3±4.5[a]	290.5±5.2[c]	16.99±1.3[c]
Group (4):	249.1±4.5[a]	296.4±4.8[b]	18.98±1.6[b]

Mean values of six rat's ± SD. A, b, c….of the small letters in the same column are significantly different at ($p \leq 0.05$).

Group (1) non-treated non-diabetic rats (negative control).

Group (2) non-treated diabetic rats (positive control).

Group (3) diabetic rats treated with fermented camel milk.

Group (4) diabetic rats treated with fermented camel milk containing 50 % Oat milk.

Effect of fermented camel milk containing Oat milk on blood glucose and insulin of diabetic rats:

Data presented in Table 6, shows that administration fermented camel milk containing Oat milk in diabetic treated groups lead to significant decrease ($p \leq 0.05$) in serum glucose level and increase in insulin levels as compared with untreated STZ-induced diabetic rats .The way of oat lowering the blood glucose level is multiway mechanism by converting glucose into glycogen and increase the glucose uptake by body for its breakdown as energy source **(Varma *et al*., 2016)**. Another way to lowering the blood glucose in the body is resultant short chain fatty acids formed by the fermentation of beta-glucan, which increased insulin responsive glucose transporter type 4 that affects the glucose-insulin homeostasis **(Khoury *et al*., 2012).**

Also, some factors may contribute to the observed hypoglycemic effect of camel milk such as, camel milk contains a high concentration of insulin(52 units/liter), camel milk does not form coagulum in the stomach or the acidic media, thereby it prevents degradation of insulin in the stomach , amino acid sequences of some camel milk proteins are rich in half- cystine, which has superficial similarity with insulin family of peptides **(Beg et al, 1986, Wangoh,1993 : Singh,2001 and Mailam et al,2017).** In line with our results, **Varma et al., (2016) and Ashraf et al, (2020)** who found that diabetic rats treated with Oat or camel milk showed increasing in the blood insulin levels and decreasing in the blood sugar levels compared to the untreated diabetic rats group.

Table 6: Effect of fermented camel milk containing 50 % Oat milk on blood glucose and insulin of rate groups

Groups	**Parameters**	
	Blood glucose concentration (mg/dL)	**Insulin (µU/ml)**
Group (1)	98.40±3.60[c]	19. 14±0.62[a]
Group (2)	245.60±5.40[a]	8.46 ± 0.48[d]
Group (3)	122. 50±4.90[b]	12.20 ± 0.55[c]
Group (4)	102.40±3.70[c]	14.26 ± 0.60[b]

Mean values of six rat's ± SD. A, b, c….of the small letters in the same column are significantly different at ($p \leq 0.05$)..

Group (1) non-treated non-diabetic rats (negative control).
Group (2) non-treated diabetic rats (positive control).
Group (3) diabetic rats treated with fermented camel milk.
Group (4) diabetic rats treated with fermented camel milk containing 50 % Oat milk.

Effect of fermented camel milk containing Oat milk on the serum lipid profile of diabetic rats.

From the results presented in Table 7, it can be noticed that, among diabetic rats groups, group 4 treated with fermented camel milk containing Oat milk had the lowest total cholesterol (72.8 mg/dl) compared to positive control which had the highest total cholesterol (91.2 mg/dl).

Concerning triacylglyceride and LDL positive control group had the highest content of triacylglyceride and LDL (101.2 and 43.56 mg/dl, respectively) compared with rat's treated with fermented camel milk containing Oat milk which recorded significant decrease in triacylglyceride and LDL contents with (77.6 and 22.08 mg/dl, respectively) .

As for HDL content, (+ve) control group had the lowest HDL content (27.40 mg/dl) compared to others group, while rat's administration of diet supplemented with fermented camel milk containing Oat milk recorded significant increase in HDL level (35.20 mg/dl) .

There was significant increase ($P<0.05$) in the levels of serum cholesterol, triacylglyceride and LDL-c and a decrease in level of HDL-c in the positive control when compared to normal fed and fermented camel milk containing Oat milk treated rats. Treatment fermented camel milk containing Oat milk significantly decreased the levels of total cholesterol, triglycerides and LDL-c as compare to the positive control.

The mechanism behind bringing down the serum cholesterol by oat β-glucan is that it helps in the lowering of bile acid reabsorption that ultimately ends in the increment of Bile acid excretion in feces. That promotes more bile acid production by the liver utilizing cholesterol in the serum **(Yao *et al*., 2006 and Khoury et al., 2012)**.

Also, a high insulin concentration of camel milk can cause the activation of lipoprotein lipase enzyme (**Hull, 2004 and Agrawal et al., 2007**). **Farah, (1993)** reported that a high mineral content of camel milk (sodium, potassium, zinc, copper and magnesium) as well as a high vitamin C intake may act as antioxidant thereby removing free radicals .Similar results were obtained by **Varma et al., (2016) and Mailam et al, (2017)** who found that Oat or camel milk had Hypocholesterolaemic effect.

Table 7: Effect of fermented camel milk containing 50 % Oat milk on lipid profile of oxidative stress rats

Groups	Parameters			
	Total cholesterol (TC) (mg/dl)	Triglycerides (TG) (mg/dl)	HDL (mg/dl)	LDL (mg/dl)
Group (1)	69.4±2.2[d]	79.5±2.3[c]	38.2±2.1[a]	15.3±1.2[d]
Group (2)	91.2±3.6[a]	101.2±5.4[a]	27.4±1.8[d]	43.56±1.5[a]
Group (3)	84.6±2.4[b]	84.5±4.6[b]	30.2±1.4[c]	37.5±1.4[b]

Group (4)	72.8±2.7^{c}	77.6±3.4^{c}	35.2±1.2^{b}	22.08±1.6^{c}

Mean values of six rat's ± SD. A, b, c….of the small letters in the same column are significantly different at ($p \leq 0.05$).

Effect of fermented camel milk containing Oat milk on liver function parameters in diabetic rats:

Data illustrated in Table (8) showed that the untreated group (positive control) showed significant increase in AST, ALT and ALP and decrease in total protein and albumin at ($p \leq 0.05$) in comparing with normal control group. On the other hand the group treated with fermented camel milk containing Oat milk showed significant increase in total protein and albumin and decrease in AST, ALT and ALP comparing with positive control group. This decrease in the values of aminotransferase enzymes and the restoration of some vital functions by the hepatocytes can be attributed to the high content of Oat from phenolic and bioactive components such as avenanthramides, phenolic acids and flavonoids as phenolic compounds which work to preserve the plasma membrane in hepatocytes and protect it from rupture and the exit of the cytosol loaded with these enzymes.(**Xu et al., 2009: Ramzan,2020**) .Also, a high vitamin C and mineral content of camel milk may act as antioxidant ,which decrease in the values of aminotransferase enzymes (**Mailam et al, 2017**). These results were collaborated by **Yang et al., (2019)** and **Dikhanbayeva et al, (2021)** who found that Oat or fermented camel milk significant reduction in the levels of ALT, AST, and ALP; increase in TP and albumin levels in serum.

Table 8: Effect of fermented camel milk containing 50 % Oat milk on liver function parameters in oxidative stress rats

Group	Aspartate aminotransferase (AST U/L)	Alanine aminotransferase (ALT U/L)	Total protein (g/dl)	Total albumin (g/dl)
Group	35.6±1.2^{d}	43.8±2.1^{d}	6.34±0.3^{a}	3.82±0.2^{a}
Group	81.6±2.5^{a}	88.2±3.5^{a}	5.61±0.2^{c}	2.94±0.7^{b}
Group (3)	42.2±1.4^{b}	54.6±2.4^{b}	5.94±0.5^{b}	3.08±0.3^{b}
Group (4)	38.2±1.6^{c}	47.6±3.1^{c}	6.08±0.3^{ab}	3.78±0.3^{a}

Mean values of six rat's ± SD. A, b, c….of the small letters in the same column are significantly different at (p ≤0.05).

Effect of fermented camel milk containing Oat milk on kidney function parameters in diabetic rats:

Data presented in Table (9) showed that the positive control showed significant increase in creatinin and urea at ($p < 0.05$) in comparing with normal control group. While group treated with fermented camel milk containing Oat milk showed significant decrease in creatinin and urea comparing with positive control group. Creatinin and urea of different rat groups were reduced respectively as follows negative control, rat group treated with fermented camel milk containing Oat milk, rat group treated with fermented camel milk in comparison to positive control.

Concerning MDA, it can noticed that positive control was 69.20 µmol/L which considered the highest mean value of MDA compared to negative control which recorded the lowest value (44.30µmol/L). There is a significant decrease in rat treated with rat group treated with fermented camel milk containing Oat milk with 47.68 µmol/L .Malondialdehyde has a very devastating process altering the structure and function of cell membranes (**Nair and Nair, 2015**). The formation and increase of MDA level can lead to oxidative mechanisms, high cytotoxicity and inhibitory actions. MDA acts as a tumor promoter and co-carcinogenic agent (**Koc 2003**).These results were collaborated by **Aly et al,(2021)** and **El-Zahar et al,(2021)** who found that Oat or fermented camel milk supplementation effectiveness in decrease in creatinin urea and malondialdehyde comparing with positive control group.

Table 9: Effect of fermented camel milk containing 50 % Oat milk on kidney function parameters in oxidative stress rats

Group	Creatinin (mg/dl)	Urea (mg/dl)	Malondialdehyde (MDA) (µmol/L)
Group (1)	0.43±0.02^{d}	15.6±0.2^{d}	44.30±1.3^{d}
Group (2)	0.86±0.05^{a}	25.2±0.5^{a}	69.20±2.5^{a}
Group (3)	0.65±0.04^{b}	20.4±0.4^{b}	52.46±1.4^{b}
Group (3)	0.48±0.03^{c}	17.5±0.5^{c}	47.68±1.8^{c}

Mean values of six rat's ± SD. A, b, c….of the small letters in the same column are significantly different at ($p \leq 0.05$).

Conclusion

The mixing of camel milk with Oat milk improved the chemical, antioxidant, rheological and sensory properties of stirred probiotic camel milk yoghurt, and these improvements were proportional to mixing up to 50 % which added nutritive and healthy benefits to resultant probiotic camel milk yoghurt. Consumption of probiotic camel milk yoghurt containing 50 % Oat milk in diabetic rat groups caused significant decreased in levels of blood glucose, malondialdehyde (MDA), low density lipoprotein (LDL), cholesterol (CL), triglyceride (TG), AST, ALT , ALP, creatinin and urea and increased high density lipoprotein (HDL) and total protein and albumin in comparison to diabetic rats.

References

Agrawal, R. P.; Saran, S. and Sharma, P. (2007). Effect of camel milk on residual β-cell function in recent onset type 1 diabetes. Diabetes Research and Clinical Practice, 77: 494-495.

Aly, A. A., Zaky, E. A., Mahmoud, H. A., Alrefaei, A. F., Hameed, A. M., Alessa, H., ... & Kadasah, S. (2021). The Impact of Addition Oats (Avena sativa) and Cinnamon on Cookies and their Biological Effects on Rats Treated with Cirrhosis by CCL4. *Saudi journal of biological sciences*, *28*(12), 7142-7151.

American Diabetes Association. (2019). 2. Classification and diagnosis of diabetes: standards of medical care in diabetes. Diabetes Care 42, 513–528.

AOAC. (2007). Association of Official Analytical Chemists, Official Methods of Analysis, Vol.118 th ed. Washington, D.C.

Arkkila, P. E.; Koskinen, P. J. and Kantola, I. M. (2001). Diabetic complications are associated with liver enzyme activitiesin people with type I diabetes. Diabetes Res. Clin. Pract, 52:113-118.

Aryana, K.J. (2003). Folic acid fortified fat free plain set yoghurts. Int. J. Dairy Technol., 56(4) : 219-222.

Ashraf, A., Mudgil, P., Palakkott, A., Iratni, R., Gan, C. Y., Maqsood, S., & Ayoub, M. A. (2021). Molecular basis of the anti-diabetic properties of camel milk through profiling of its bioactive peptides on dipeptidyl peptidase IV (DPP-IV) and insulin receptor activity. *Journal of dairy science*, *104*(1), 61-77.

Atwaa E.H. , Hanan A. Radwan, Hanan S. Shalaby and Ghada M. El-Araby.(2021). Therapeutic potential of low-fat yogurt supplemented with Dried Nabaq fruit (*Zizyphus spina-christi* L) on hyperglycemia in streptozotocin-induced diabetic rats. Egyptian J. of Nutrition,2:149-201.

Atwaa, E. H., Hassan, M. A. A., & Ramadan, M. F. (2020). Production of probiotic stirred yoghurt from camel milk and oat milk. *Journal of Food and Dairy Sciences*, *11*(9), 259-264.

Atwaa, E. S. H., Shahein, M. R., El-Sattar, E. S. A., Hijazy, H. H. A., Albrakati, A., & Elmahallawy, E. K. (2022). Bioactivity, Physicochemical and Sensory Properties of Probiotic Yoghurt Made from Whole Milk Powder Reconstituted in Aqueous Fennel Extract. *Fermentation*, *8*(2), 52.

Bandawane, D.D., Mooliya, S.B., and Jadhav, S.B.(2020). Protective role of berberine in ameliorating diabetic complications in streptozotocin-high fat diet model in experimental animals. *Int J Pharm Pharm Sci, Vol 12, Issue 8, 41-48*.

Beg, O.U.; von Bahr-Lindström, H.; Zaidi, Z.H. and Jörnvall, H. (1986). Characterization of a camel milk protein rich in proline identifies a new beta-casein fragment. RegulPept 15: 55-61.

Bergmeyer HU, Harder M (1986). A colorimetric method of the determination of serum glutamic oxaloacetic and glutamic pyruvic transaminase, Clin. Biochem., 24: 481-486.

Bohmer, H.B. (1971): Micro- determination of creatinine. Clin. Chem.Acta. 32: 81-85.

Brand-Williams, W.; Cuvelier, M. E.; and Berset, C.(1995). Use of a Free Radical Method to Evaluate Antioxidant Activity. Lebenson Wiss Technol., 28, 25–30.

Bullard, K. M., Cowie, C. C., Lessem, S. E., Saydah, S. H., Menke, A., Geiss, L. S., et al. (2018). Prevalence of diagnosed diabetes in adults by diabetes type — United States 2016. Morb. Mortal. Wkly. Rep. 67, 359–361.

Caraway, W. (1955): Determination of serum urate. Am. J. Clin. Path.25: 840.

Charalampopoulos, D., R. Wang, S.S. Pandiella and C. Webb, (2002). Application of cereals and cereal components in functional foods: A review. Int. J. Food Microbiol., 79: 131-141.

Deswal, A., N.S. Deroa and H.N. Mishra, (2014). Optimization of enzymatic production process of oat milk using response surface methodology. Food Bioprocess Technol., 7: 610-618.

Devi R. and Sharma DK. 2004. Hypolipidemic effect of different extracts of Clerodendron colebrookianum Walp in normal and high-fat diet fed rats. J Ethnopharmacol. 90: 63–68.

Deweerdt L. and Later R. 2009. Mise en place d’un laboratoire de biologie médicale autonome dans un pays en développement.

Dikhanbayeva, F., Zhaxybayeva, E., Smailova, Z., Issimov, A., Dimitrov, Z., Kapysheva, U., & Bansal, N. (2021). The effect of camel milk curd masses on rats blood serum biochemical parameters: Preliminary study. *Plos one*, *16*(9), e0256661.

El-Batawy, O.I., Samar Mohamed Mahdy And Safaa Talaat Gohari,(2019). Development of Functional Fermented Oat Milk by Using Probiotic Strains and Whey Protein. Int.J.Dairy Sci.,14(1):21-28.

El-Zahar, K. M., Hassan, M. F., & Al-Qaba, S. F. (2021). Protective Effect of Fermented Camel Milk Containing Bifidobacterium longum BB536 on Blood Lipid Profile in Hypercholesterolemic Rats. *Journal of Nutrition and Metabolism*, *2021*.

Farah, Z. (1993). Composition and characteristics of camel milk. J. Dairy Res, 60: 603-626.

Friedewald WT., Levi RI. and Fredrickson DS. 1972. Estimation of the concentration of low-density lipoproteins cholesterol in plasma without use of the ultracentrifuge. Clin. Chem. 18: 499-502.

Galeboe, O.; Seifu, E., and Sekwati-Monang, B. (2018). Production of Camel Milk Yoghurt: Physicochemical and Microbiological Quality and Consumer Acceptability. International Journal of Food Studies. 7: 51-63.

Gohari ; S.T., O. I. El-Batawyand Samar M. Mahdy.(2019). Biological Attributes of Unfermented and Fermented Oat Milk Compared to

Cow Milk in Alloxan-Induced Diabetic Rats. J. Food and Dairy Sci.,. 10 (3):61 – 69.

Hamza N, Berke B, Cheze C, Agli AN, Robinson P, Gin H, et al. Prevention of type 2 diabetes induced by high fat diet in the C-57BL/6J mouse by two medicinal plants used in traditional treatment of diabetes in the East of Algeria. J Ethnopharmacol 2010;128:513–8.

Hoshyar R, Mahboob Z, Zarban A. The antioxidant and chemical properties of Berberis vulgaris and its cytotoxic effect on human breast carcinoma cells. Cytotechnology. 2015; 1–7. Epub ahead of print].

Hull, S. J. (2004). Camel's milk to treat diabetes. Nature. 363:446-448.

Ibrahim, M.S., Ahmad , A., Asma Sohail , and Asad,M.J.(2020). Nutritional and functional characterization of different oat (*Avena sativa* L.) cultivars. International Journal of Food Properties, 23, 1, 1373–1385.

Kaur, C.; and Kapoor, H. C.(2002). Antioxidant Activity and Total Phenolic Content of Some Asian Vegetables. Int. J. Food Sci. Tech., 37, 153–161.

Khalesi, M.; Salami, M.; Moslehishad, M.; Winterburn, J., and Moosavi-Movahedi, A.A. (2017). Biomolecular content of camel milk: A traditional superfood towards future healthcare industry. Trends in Food Science & Technology. 62: 49-58.

Khoury, D.E., Cuda, C., Luhovyy, B.L., Anderson, G.H. (2012). Beta glucan: health benefits in obesity and metabolic syndrome. *Journal of Nutrition and Metabolism*. 2012: 1-28.

Koc, M., Taysi, S., Buyukokuroglu, M.E., and Bakan, N. (2003). Melatonin protects rat liver against irradiation-induced oxidative injury. J. Radiat. Res., 44:211-215.

Koracevic, D., Koracevic, G., Djorjevic ,V.,Anderjevic, S., and Cosic, V. (2001).Methods for measurement of antioxidant activity in human fluids. J.Clinpathol; 54:356-361

Mailam, A.(2017). A comparative study on antidiabetic effect of buffalo and camel fermented milk in induced diabetic rats. Advances in food science,39(4):124-132.

Marsch, W.H.; Fingerhut, B. and Miller, H. (1965): Automated and manual direct methods for the determination of blood urea. Clin. Chem.11: 624-27.

McClave, J.T., and Benson, P. G.(1991). Statistical for business and economics. Max Well Macmillan International editions. Dellen Publishing Co. USA. 1991:272-295.

Mensor, L. L.; Menezes, F. S.; Leitao, G. G.; Reis, A. S.; Santos, T. C. d.; Coube, C. S.; Leit~ao, and S. G.(2001).Screening of Brazilian Plant Extracts for Antioxidant Activity by the Use of DPPH Free Radical Method. Phytother. Res.,15, 127–130.

Nair, G.G., and Nair, C.K. (2013). Radioprotective effects of Gallic acid in mice. Bio. Med. Res. Int., 953079.

Nelson J.A. and Trout G. M. (1981). Judging of Dairy Products.4 th ED. AVI Publishing Company, INC. Westport Connection, PP. 295-313.

Omar, H. H.; Amal M.M. El-Nimer; Ahmed, M.A. ., and Hassaan, H.M.H.(2019). Production of functional bio - yoghurt made from camel milk, skim milk retentate and fortified with sweet potato powder. *Egypt. J. Agric. Res., 97 (1)*,441-458.

Rahli, F., Saidi, N., Kihal, M., (2013). Evaluation of the factors affecting the variation of the physicochemical composition of Algerian Camel's raw milk during different seasons. Adv. Environ. Biol. 7 (14), 4879–4884.

Ramzan, S.(2020). Oat: a novel therapeutic ingredient for food applications. J Microbiol Biotech Food Sci:, 9 (4) 756-760.

Reeves, P.G., Nielsen, F.H., and Fahey, G.C. (1993). AIN-93 purified diets for laboratory rodents: final report of the American Institute of Nutrition ad hoc writing committee on the reformulation of the AIN-76A rodent diet. J. Nutrition, 123(11):1939–1951.

Salem, S.A.; Meead, G.H.; EL-Rashody & Fardous, M.M. (2017). Physicochemical and sensory properties of ice cream made from camel milk and fortified with dates products. International Journal of Humanities, Arts, Medicine and Sciences. 5: 29-40.

Satoh, K. (1978).Serum lipid peroxide in cerebrovascular disorders determined by a new colorimetric method, Clinchim Acta Nov 15; 900(1):37-43.

Singh, R. (2001). Annual Report of National Research Center on Camel. 1st Edn. Bikaner, India, pp: 50.

Solanki, D., and Hati ,S.(2018). Fermented camel milk: A Review on its bio-functional properties. Emirates Journal of Food and Agriculture. 2018. 30(4): 268-274.

Soliman , T.N and Samera H. Shehata.(2019). Characteristics of fermented camel's milk fortified with kiwi or avocado fruits. Acta Sci. Pol. Technol. Aliment. 18(1) : 53–63.

Srinivasan K, Viswanad B, Asrat L, Kaul CL, Ramarao P. Combination of high-fat diet-fed and low-dose streptozotocintreated rat: a model for type 2 diabetes and pharmacological screening. Pharmacol Res 2005;52:313-20.

Tamime, A.Y. and Robinson, R.K. (1999). Yoghurt. Science and Technology.Cambridge, UK:Woodhead Publishing Limited England.

Tharmaraj, N. and Shah, N.P.M. (2003). Selective Enumeration of *Lactobacillus delbrueckii ssp. bulgaricus*, *Streptococcus thermophilus*, *Lactobacillus acidophilus*, *Bifidobacteria*, *Lactobacillus casei*, *Lactobacillus rhamnosus*, and Propionic bacteria. Journal of dairy science. 86: 2288- 2296.

Thomas A., Schänzer W., and Thevis M. 2014. Determination of human insulin and its analogues in human blood using liquid chromatography coupled to ion mobility mass spectrometry (LC-IM-MS). Drug Testing and Analysis. 6: 1125–1132.

Tiwari, U., & Cummins, E. (2012). Dietary exposure assessment of β-glucan in a barley and oat based bread. LWT - Food Science and Technology, 47(2), 413–420.

Trinder P. 1969. Determination of Glucose in Blood Using Glucose Oxidase with an Alternative Oxygen Acceptor.Ann.Clin. Biochem. 6(1):24-33.

Varma, P., Bhankharia H., Bhatia, S. (2016). Oats: A multi-functional grain. *Journal of Clinical and Preventive Cardiology*. 5: 9-17.

Walsh, H.; Ross, J.; Hendricks, G., and Gum Mingruo, (2010). Physico-chemical properties, probiotic survivability, microstructure, and acceptability of a yogurt-like symbiotic oats-based product using pre-polymerized whey protein as a gelation agent. Journal of Food Science. 75: 327-337.

Wangoh, J. (1993). What steps towards camel milk technology? Int. J. Anim. Sci, 8: 9-11.

Xu, J.G., Tian, C.R., Hu, Q.P., Luo, J.Y., Wang, X.D., Tian, X.D. (2009). Dynamic changes in phenolic compounds and antioxidant activity in oats (Avena nuda L.) during steeping and germination. *Journal of Agricultural and Food Chemistry*. 57: 10392-10398.

Yang, R., Wang, C., Ye, H., Gao, F., Cheng, J., Zhang, T., & Guo, M. (2019). Effects of feeding hyperlipidemia rats with symbiotic oat-based frozen yogurt on serum triglycerides and cholesterol. *Food Science & Nutrition*, *7*(3), 1096-1103.

Yao, N., Jannink, J.L., Alavi, S., White, P.J. (2006). Physical and sensory characteristics of extruded products made from two oat lines with different β-glucan concentrations. *Cereal Chemistry*. 83: 692-699.

Zheng T, Shu G, Yang Z, Mo S, Zhao Y, Mei Z. Antidiabetic effect of total saponins from Entadaphaseoloides (L.) Merr. in type 2 diabetic rats. J Ethnopharmacol 2012;139:814-21.

تأثير لبن الإبل المتخمر الحيوي المحتوي على لبن الشوفان على ارتفاع السكر في الدم في الفئران المصابة بداء السكري المستحث بفعل الاستربتوزوتوسين

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أجريت الدراسة الحالية لتقييم الخصائص الفيزوكيميائية والمضادات للأكسدة والحسية للبن الإبل المتخمر الحيوي المصنوع من لبن الإبل الممزوج بلبن الشوفان. تم صنع لبن الإبل المتخمر من لبن الإبل واستخدم كلبن ابل متخمر للمقارنة ، بينما كانت المعاملات الأخرى مصنوعة من لبن الإبل بعد مزجها مع لبن الشوفان بنسبة ٢٥٪ و ٥٠٪ عل التوالي . أظهرت النتائج أن خلط لبن الإبل مع لبن الشوفان كان أكثر فاعلية في زيادة المواد الصلبة الكلية والبروتين والرماد والألياف والحموضة واللزوجة والمحتوى الفينولي ونشاط مضادات الأكسدة وكانت هذه الزيادات متناسبة مع نسبة الخلط. كما أظهر لبن الإبل المتخمر المحتوي على ٥٠٪ من لبن الشوفان أعلى الدرجات في الخصائص الحسية مقارنة بغيره من معاملات لبن الإبل

المتخمر. تم تقييم هذا المزيج (لبن الإبل المخمر المحتوي على ٥٠٪ من لبن الشوفان) كعامل خافض لسكر الدم الناجم عن الاستربتوزوتوسين في الفئران المصابة بداء السكري. في هذا الصدد ، تم تقسيم أربعة وعشرين من ذكور الفئران البالغة من سلالة Sprague Dawely التي يتراوح وزنها بين ٢٠٠ الي ٢٥٠ جرامًا إلى ٤ مجموعات على النحو التالي: المجموعة (١) الفئران غير المعاملة وغير المصابة بداء السكري (التحكم السلبي). المجموعة (٢) الجرذان المصابة بداء السكري (تناولت ستربتوزوتوسين (STZ) ، ٦٠مجم / كجم من وزن الجسم) (التحكم الإيجابي) المجموعة (٣) فئران مصابة بداء السكري تتغذى على النظام الغذائي الأساسي مع لبن الإبل المخمر (١٠ جم / يوم) .المجموعة الرابعة: فئران مصابة بداء السكري تم تغذيتها على النظام الغذائي الأساسي مع لبن الإبل المتخمر المحتوي على ٥٠٪ لبن الشوفان (١٠ جم / يوم) .أظهرت معاملة الفئران المصابة بداء السكري بلبن الإبل المخمر المحتوي على ٥٠٪ من لبن الشوفان انخفاضًا كبيرًا ($p \leq 0.05$) في مستويات السكر في الدم ، malondialdehyde (MDA)، البروتين الدهني منخفض الكثافة (LDL) ، الكوليسترول (CL)، الدهون الثلاثية (TG) ، AST، ALT، ALP، الكرياتينين واليوريا وزيادة ($p \leq 0.05$)البروتين الدهني عالي الكثافة (HDL) والبروتين الكلي والألبومين مقارنة بالفئران المصابة بداء السكري. أدى استهلاك لبن الإبل المتخمر المحتوي على ٥٠٪ من لبن الشوفان في مجموعات الفئران المصابة بداء السكري إلى تحسن معنوي في كل هذه العوامل ، مقارنة بالمجموعة الضابطة الإيجابية (الفئران المصابة بداء السكري). في هذه الدراسة أيضًا ، ولأول مرة ، أظهرنا أن إعطاء لبن الإبل المتخمر المحتوي على ٥٠٪ من لبن الشوفان في الجرذان المصابة بداء السكري أدى إلى زيادة المؤشرات الحيوية للدم مقارنة بمجموعة مرضى السكر غير المعاملة ، مما يشير إلى أن لبن الإبل المتخمر المحتوي على ٥٠٪ من لبن الشوفان يمكن يلعب دورًا وقائيًا لمرضي السكري.