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A Comparative Study of the Use of Cow's Milk and Plant-Based Alternatives Such as Almond Milk and Oat Milk on Diabetic Rats

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Abstract

Purpose: The present study was conducted to evaluate physicochemical, rheological, microbiological, antioxidant and sensory properties of caw, almond and oat milk. Caw milk served as a control (animal source), and the other treatments were made from almond milk and oat milk (plant source).

Methodology: Thirty five male adult albino rats of Sprague Dawely strain weighing 180- 220 g were divided into 5 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 caw milk (10g/day) by epi gastric tube. Group (4) diabetic rats fed on basal diet with almond milk (10g/day) by epi gastric tube. Group (5) diabetic rats fed on basal diet with oat milk (10g/day) by epi gastric tube.

Results: Results revealed that almond milk were more effective in increasing the dry matter, protein, ash, fiber, carbohydrate, energy, acidity, viscosity, phenolic content and antioxidant activity. Almond milk had the highest scores for sensory properties compared to other milk treatments. The Almond milk was evaluated as hypoglycaemic agent streptozotocin-induced diabetic rats. The treatment of diabetic rats with almond 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.

Unique Contribution to Theory, Practice and Policy: This study indicates that the theory used in the study has been validated. Consumption of almond milk in diabetic rat groups caused significant improvement in all these factors, compared to the positive control group (untreated diabetic rats), indicating that almond and oat milk can play a preventive role in such patients. It can be used as an indicator to establish future studies on the importance of consuming plant-based alternatives to milk, such as almond milk and oat milk. Policy makers should recognize the importance of a balanced diet for health in which plant-based alternatives are available and reflect this in public health recommendations.

Keywords: *Almond Milk, Oat Milk, Caw Milk, Physicochemical, Radical Scavenging Activity, Blood Glucose, Cholesterol, Urea and the Phenolic Content*

INTRODUCTION

Cow's milk and plant-based alternatives such as almond milk and oat milk are widely consumed beverages that may have different effects on diabetic rats. Cow's milk contains lactose, a type of sugar that can raise blood glucose levels and insulin secretion in diabetic rats. Plant-based alternatives, on the other hand, are usually lower in sugar and higher in fiber, which may help regulate blood glucose levels and prevent complications in diabetic rats. However, plant-based alternatives also have lower protein and calcium content than cow's milk, which may affect the growth and bone health of diabetic rats. Therefore, a comparative study of the use of cow's milk and plant-based alternatives on diabetic rats is needed to evaluate the benefits and drawbacks of each beverage.

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).

Milk and sugar are excessively consumed in a Western diet. There is increasing epidemiological evidence that the intake of unfermented pasteurized cow´s milk is associated with an increased risk of type 2 diabetes mellitus (T2D). Bodo and Gerd; 2019). T2D is closely related to Western diets providing excessive amounts of sugar and saturated fats. Glucotoxicity and lipotoxicity are thus believed to play a key role inthe pathogenesis of T2D. However, milk is another abundant component of a Western diet, which is the focus of this review. In 2017, aper capita milk consumption in the United States of 65.2 L (16.5 US gal)has been reported(Per capita consumption of milk United States, 2017), which underlines the presence of cowmilk as a substantialfactor of the dietary exposome. Milk exerts high insulinotropic effects . .(Hoyt et al,. 2005)

There are also some people who depend on plant sources for their food, such as vegetarians and those who suffer from digestive disorders as a result of eating cow's milk and its products. Therefore, it was necessary to search for alternatives**.** (Alexandra Alcorta et al.,2021)

Plant-based or non-dairy milk alternative is the fast growing segment in newer food product development category of functional and specialty beverage across the globe. Nowadays, cow milk allergy, lactose intolerance, calorie concern and prevalence of hypercholesterolemia, more preference to vegan diets has influenced consumers towards choosing cow milk alternatives. 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).

Therefore, the aim of this study was to comparison of the use of cow's milk and plant-based alternatives, almond milk and oat milk on kidney and liver functions and hyperglycemia in streptozotocin-induced diabetic rats.

Theoretical Framework

The study follows the application of the following theories

The Glycemic Index Theory

This theory states that foods with a low glycemic index (GI) cause less rise in blood glucose levels than foods with a high GI. This theory can be used to compare the effects of different types of milk on the blood glucose levels and insulin sensitivity of diabetic rats, as different types of milk may have different GI values depending on their carbohydrate content and composition. (Augustin et al., 2015)

The Anti-Inflammatory Theory

This theory states that foods with anti-inflammatory properties can reduce the inflammation and oxidative stress associated with diabetes and its complications. This theory can be used to compare the effects of different types of milk on the inflammatory markers and oxidative stress indicators of diabetic rats, as different types of milk may have different anti-inflammatory properties depending on their fatty acid profile and antioxidant content.(Heng-Chang et al ., 2022)

METHODOLOGY

Preparation of Almond Milk Sample

Raw sliced almonds (500 g) were soaked overnight in 2 L of deionized water at room temperature. The almonds in water were then mixed in a wet disintegrator (Jeffress Bros Ltd, Brisbane, Australia) for 8 min at room temperature and the slurry was filtered twice through a 50 µm mesh bag (Filtercorp International Ltd, Auckland, New Zealand) to remove any residual almond particles and to obtain full-fat whole almond milk. AOAC (1995).

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 kgG1 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.

Preparation of Caw Milk Sample

Raw cow’s milk was collected from a dairy farm . After collection, the milk was heated for 15 s at 78 °C, cooled to 4 °C and then stored at −20 °C until further use (pasteurized milk) until further use (Waser et al.,2007).

Treatments were carried out 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 caw milk (10g/day) by epi gastric tube. Group (4) diabetic rats fed on basal diet with almond milk (10g/day) by epi gastric tube. Group (5) diabetic rats fed on basal diet with oat milk (10g/day) by epi gastric tube.

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 caw milk was determined according to Lu et al., 2020).Viscosity was determined using the Brookfield viscometer DV-E. Viscosity was expressed in terms of centipoises (cP) (Weaver and Daniel, 2005)

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 ×100 (1)

Sensory Evaluation

The sensory properties of milk samples were assessed by 10 panel members for flavour (60) body and texture (30) and appearance (10) as reported according to Eman Saad Ragab et al., 2023

Experimental Design of Biological Study

Thirty five albino male adult rats weighing 180-220 g . 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= 7) received only the standard diet and served as the normal control group while the second one (hyperglycemia rats, n= 28) 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 four groups (n = 7 each) .The first did not receive any treatment and served as the hyperglycemia positive control. The second, third and fourth group received 10g/day caw milk , almond milk and 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 hours), 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

The chemical composition of fresh cow milk, almond milk and oat milk are illustrated in Table (1).Protein, fat, dry matter, ash, fiber, carbohydrate and energy contents of caw milk were (13.38, 7.13, 28.9, 0.76, ND, 11.6 and 161.1 g/100g) respectively. These results are in agreement with the data obtained by Rahli et al ,(2013) and Omar *et al*., (2019). Protein, fat, dry matter, ash, fiber, carbohydrate and energy contents of almond milk were (22.24, 5.20, 28.7, 2.43, 0.27, 21.8 and 211.6 g/100g) respectively. While, Protein, fat, dry matter, ash, fiber, carbohydrate and energy contents of Oat milk were (3.31, 3.14, 28.7, 0.57, 0.49, 21.6 and 133.9 g/100g) respectively. These results are in agreement with the data obtained by El-Batawy *et al*., (2019) and Atwaa *et al*., (2020).

Table 1: Chemical Composition of Caw Milk, Almond Milk and Oat Milk (g/100G)

Milk	Caw	Almond	Oat
Protein	13.38 ± 0.02	22.24 ± 0.09	3.31 ± 0.00
Fat	7.13 ± 0.04	5.20 ± 0.04	3.14 ± 0.02
Dry Matter	28.9 ± 0.17	28.7 ± 0.36	28.7 ± 0.14
Ashe	0.76 ± 0.01	2.43 ± 0.04	0.57 ± 0.03
Fiber	ND	0.27 ± 0.05	0.49 ± 0.02
Carbohydrates	11.6 ± 0.19	21.8 ± 0.23	21.6 ± 0.17
Energy	161.1 ± 0.38	211.6 ± 1.11	133.9 ± 0.77

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

Data illustrated in Table, (2) indicated that titratable acidity (TA) of the control caw milk had the highest value, this may be due to a high antimicrobial components . (Galeboe et al, 2018)& (Magdy et al., 2022)

Table 2: Treatable Acidity, pH Values, Viscosity, Total Phenolic Content and Radical Scavenging Activity of Caw Milk, Almond Milk and Oat Milk

Parameter	Caw	Almond	Oat
Acidity	0.24±0.08	0.78±0.03	0.75±0.06
PH Values	6.63 ±0.08	7.02 ±0.06	5.09±0.14
Viscosity (C.P.S.)	2.02±94	5.92±98	3.5±88
Total phenolic content (mg / g)	1.31 ±0.05	3.08±0.17	2.76±0.21
Radical scavenging activity RSA %	7.76±0.43	13.03±1.01	12.21±1.02

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

Data presented in Table (3) showed that almond milk increased greatly the sensory attributes of the resultant milk, especially its flavor and body & texture as compared with the caw milk. While, the caw milk had the lowest score for sensory properties this may be due to a very weak body & texture and inferior flavor (Soliman *and* Shehata, 2019:Atwaa *et al*,2020). On the other hand this finding is consistent with the observation of Atallah et al., 2020

Table 3: Sensory Properties of Caw Milk, Almond Milk and Oat Milk

Parameter	Caw	Almond	Oat
Flavor (60)	42.2±2.07	51.3±2.42	46.1±2.1
Body & Texture (30)	18.3±1.11	26.2±1.31	23.7±1.61
Appearance (10)	7.2±0.43	8.9±0.65	8.1±0.72
Total Scores (100)	**67.7±2.82**	**86.4±2.79**	**77.9±2.93**

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

Data presented in Table (4) showed that FW and BWG were significantly (P<0.05) affected by the treatments. The use of 10 g/day oat milk in diabetic rats gave the best values of FW (319.3 g) and BWG (13.58 %), respectively compared to positive control group which showed FW (279.2 g) and BWG (8.70 %), respectively, this is due to the fact that oat is high in carbohydrates **(Xu et al., 2009).** This improvement may be ascribed to the almond and 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 and 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 4: Final Weight and Body Weight Gain of Diabetic Rats Treated With Caw Milk, Almond Milk and Oat Milk

Groups	Initial weight (g)	Final weight (g)	B W G %
Negative control	271.3±3.7 a	321.1±4.3a	18.35±1.4a
Positive control	273.5±2.6b	279.2±4.1b	8.70±1.7b
Cow milk	277.7±3.9c	317.7±4.5c	14.46±1.5c
Almond milk	269.2±3.7c	302.8±4.9d	12.25±1.4c
Oat milk	281.6±3.4cd	319.3±4.7c	13.58±1.4c

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

Data presented in Table 5, shows that administration of caw milk , almond milk and 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 almond milk and oat milk lowering the blood glucose level is multi-way 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 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 caw milk such as, caw milk contains a high concentration of insulin(52 units/liter), caw milk does not form coagulum in the stomach or the acidic media, thereby it prevents degradation of insulin inthe stomach , amino acid sequences of some caw 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) who found that diabetic rats treated with almond or oat milk showed increasing in the blood insulin levels and decreasing in the blood sugar levels compared to the caw milk group and untreated diabetic rats group.

Table 5: Effect of Caw Milk, Almond Milk and Oat Milk on Blood Glucose and Insulin in Rate Groups

Groups	Blood glucose concentration (mg/dL)	Insulin (µU/ml)
Negative control	88.37±2.91a	19. 08±0.59a
Positive control	251.23±3.33b	7.91 ± 0.36b
Cow milk	131. 73±3.62c	13.81 ± 0.42c
Almond milk	104.33±3.69d	13.13 ± 0.71c
Oat milk	107.58±3.74d	13.73 ± 0.66c

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

From the results presented in Table 6, it can be noticed that, among diabetic rats groups, groups treated with a caw milk , almond milk and oat milk had the lowest total cholesterol (81.5,76.3 and 78.5 mg/dl) respectively compared to positive control which had the highest total cholesterol (98.7 mg/dl).

Concerning triacylglyceride and LDL positive control group had the highest content of triacylglyceride and LDL (103.3 and 45.81 mg/dl, respectively) in the rat's treated with caw milk compared with treated with almond and oat milk which recorded significant decrease in triacylglyceride and LDL contents. As for HDL content, (+ve) control group had the lowest HDL content (28.7 mg/dl) compared to others group, while rat's administration of diet supplemented with almond milk recorded significant increase in HDL level (36.6 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 fed containing caw, almond and oat milk treated rats. Treatment with almond and oat milk significantly decreased the levels of total cholesterol, triglycerides and LDL-c as compare to the positive control. (Charalampopoulos et al., 2002).

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 caw 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 caw milk (sodium, potassium, zinc, copper and magnesium) as well as a 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 almond and oat or caw milk had Hypocholesterolaemic effect.

Table 6: Effect of Caw Milk, Almond Milk and Oat Milk on Lipid Profile

Groups	**Total cholesterol (TC) (mg/dl)**	**Triglycerides (TG) (mg/dl)**	**HDL (mg/dl)**	**LDL (mg/dl)**
Negative control	70.2±3.1b	78.33±3.06b	37.4±2.7a	17.6±1.5a
Positive control	98.7±2.93a	103.3±4.3a	28.7±2.3b	45.81±1.7b
Cow milk	81.5±2.7c	87.6±3.9c	31.8±1.5c	38.3±1.8c
Almond milk	76.3±2.4d	79.7±3.5c	36.6±1.4a	31.5±1.2d
Oat milk	78.5±2.5d	81.31±3.4c	34.8±1.2c	34.3±1.4d

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

Data illustrated in Table (7) 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 caw, almond and 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 almond and 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 mineral content of caw 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 almond and oat milk significant reduction in the levels of ALT, AST, and ALP; increase in TP and albumin levels in serum.

Table 7: Effect of Caw Milk, Almond Milk and Oat Milk on Liver Function

Groups	Aspartate aminotransferase (AST U/L)	Alanine aminotransferase (ALT U/L)	Total protein (TP g/dl)	Total albumin (g/dl)
Negative control	37.2±1.7b	44.2±3.1b	7.22±0.5a	4.27±0.3a
Positive control	83.5±2.3a	91.3±3.2a	5.73±0.3b	2.66±0.6b
Cow milk	54.7±1.5d	61.7±2.2d	5.83±0.4c	2.88±0.5d
Almond milk	49.4±1.6c	53.3±2.7c	6.11±0.3d	3.03±0.3c
Oat milk	51.8±1.4d	58.6±2.9d	5.91±0.3d	2.83±0.4d

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

Data presented in Table (8) 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 caw, almond and 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 almond and oat milk, rat group treated with caw milk in comparison to positive control. (Wang and Singh, 2020)

Concerning MDA, it can noticed that positive control was 71.3 µmol/L which considered the highest mean value of MDA compared to negative control which recorded the lowest value (62.7 & 63.4 µmol/L). There is a significant decrease in rat treated with almond and oat milk were 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 almond and oat milk supplementation effectiveness in decrease in creatinin urea and malondialdehyde comparing with positive control group.

Table 8: Effect of Caw Milk, Almond Milk and Oat Milk on Kidney Function Parameters in Oxidative Stress Rats

Groups	Creatinin (mg/dl)	Urea (mg/dl)	Malondialdehyde (MDA) (mol/L)
Negative control	0.46±0.07b	17.2±0.3b	45.4±2.1b
Positive control	0.91±0.04a	28.4±0.4a	71.3±2.3a
Cow milk	0.77±0.05c	21.7±0.4c	66.5±1.6c
Almond milk	0.61±0.04d	18.3±0.3d	62.7±1.3c
Oat milk	0.67±0.04cd	19.5±0.3d	63.4±1.7c

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

CONCLUSION

The consumption of caw, almond and oat milk improved the chemical, antioxidant, rheological, sensory propertiesand these improvements were added nutritive and healthy benefits. Furthermore the consumption of caw, almond and 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.

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