Original Article

Effect of *Moringa* on Biochemical and Immunological Changes in Hyperglycemic Rats

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Abstract

Phytotherapy is the treatment and prevention of diseases using plants, plants part such as herbal, flowers, leaves, peels, and roots or mixtures of them. This study seeks to determine the impact of moringa on biochemical and immunological alterations in hyperglycemic rats. Moringa is one of the most herbal plants with remarkable medicinal effects, including treating high blood sugar and enhancing immune functions. Twenty-four (24) male albino Sprague-Dawley strain rats were separated into four groups, with one serving as the negative control group (normal); the other groups were used to induce diabetes with alloxan. The rats were ten weeks old and weighed 15010g. Two of the diabetes groups received 5% 10% Moringa for 28 days, while the positive control group of one was given a conventional diet. After the experiment, a blood sample was obtained, and the organs were taken out and biochemically analyzed. Therefore, when compared to the control (+) group, all experimental groups exhibited significantly different glucose levels. In addition, when compared to the control (+) group, group 4 (10% Moringa) had the best effects on the triglycerides, HDL, and LDL of the diabetic rats. In diabetic rats, ALP, AST, ALT, and uric acid were best measured in Group 3 (5% Moringa), while urea and creatinine were best measured in Group 4 (10% Moringa). Even when measured against the reference (+) group. This study suggested giving diabetics varying doses of moringa, as well as perhaps giving them varied doses of moringa to lower LDL and atherogenic index readings.

Keywords: Moringa, Diabetes, Biochemical, Immunological changes

Introduction

For thousands of years, people have hailed the plant Moringa oleifera for its therapeutic properties. It contains a lot of beneficial antioxidants and bioactive plant substances. Only a small portion of its numerous credible health advantages have so far been studied by scientists [1]. Saudi Arabia and northern India's Himalayan mountains are the tree's native habitats. It is widely grown in many tropical regions, including Sudan, Ethiopia, and the Philippines, as well as in Pakistan, Bangladesh, and Afghanistan [2]. Moringa plants are accustomed to tropical and semi-tropical climates in South Asia and grow in hot and arid lands where they tolerate drought and are distinguished by their rapid growth, and they are considered one of the fastest-growing trees [3]. It stimulates the pancreas to produce insulin in the body and lowers and balances the blood sugar level. Moringa also contains vitamins A, C, and D that support the health of all types of diabetes patients [4]. Moringa seeds support the efficiency of the immune system in the body to resist diabetes patients' lot of diseases and moringa oil and its roots protect against the risk of clogging arteries and maintain heart health. Moringa seeds prevent nerve damage and protect the seeds from circulatory diseases and maintain the health of blood circulation [5]. One of the harms of Moringa is that it may contribute to lowering blood sugar, so blood sugar should be carefully monitored, especially when any signs of low blood sugar appear for fear of a sudden drop in diabetic patients and lead to coma [6]. Moringa is safe for children and has some important benefits for maintaining children's health, as it helps absorb essential nutrients important for the growth of the child's body. It is also important for children suffering from malnutrition, as it helps them improve weight, especially for children who suffer from a low-weight problem. Diabetes is a condition marked by elevated blood sugar or blood sugar levels.

You consume foods that contain glucose. A hormone called insulin facilitates the delivery of glucose to your cells, providing them with energy. When you have type 1 diabetes, your body cannot make insulin. The most typical form of diabetes, type 2, is marked by poor insulin production and

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utilization by the body. Insufficient insulin causes glucose to remain in circulation. Also possible is prediabetes. This indicates that while your blood sugar is higher than normal, it is not yet diabetes. Type 2 diabetes is more likely to develop if you have prediabetes, [7].

Aim of Study

This study aims to know the effect of *Moringa* on biochemical and immunological changes in hyperglycemic rats.

Materials and Methods

Materials

Moringa

Moringa was obtained from the nature of the environment in Tihama, Al Baha region - Kingdom of Saudi Arabia.

Rats

At the Doki, Cairo-based clinical Bugs Exploration Organization, 24 (24) grown-up male pale-skinned person rodents weighing 15010 g were collected. The rodents were kept in a controlled climate of mugginess (25-2°C), temperature, and light (12h light/12h dark). The Rodents were secured from the Menoufia College Staff of Home Financial matters creature house and kept in standard ventilated confines with free admittance to food and water as long as necessary. ***Alloxan Instruments, Cairo, Egypt, and used as a dose of 150 mg/kg body weight.***

Methods

Analytical Methods

Preparation of Material

Normal Moringa has washed appropriately with water to eliminate the mud or residue on the off chance that at first it was dried in the sun for 60 minutes, and was concealed and dried totally. The dried leaves were then powdered through a wood processor and afterward put away in hermetically sealed holders [8].

Basal Diet Composition of Rats

The basil diet contained 10% casein, 0.25% choline chloride, vitamin mixture (1%), 5% cellulose, 10% maize oil, 4% salt mixture, 0.35% methionine, and corn starch (69.5%) [9].

The basal diet in the test contained $CaCO_3$ (600 mg), $MgSO_4.2H_2O$ (20_4 mg), K_2HPO_4 (645 mg), $CaHPO_4.2H_2O$(150 mg), $Fe(C_6H_5O_7)$ $26H_2O$ (55 mg), $ZnCl_2$ (0.5 mg), $MnSO_4.4H_2O$ (10 mg), NaCl(334 mg), $CuSO_4.5H_2O$ (0.06 mg) and K_l (1.6 mg), [10].

The basal diet in the test contained Vitamin A (200 Iu), Vitamin K (0.50 Iu), Vitamin E (10 Iu), Calcium panthothenic acid (0.40 mg), Thiamin (0.50 mg), Pyridoxine (1.00mg), Vitamin D (100 Iu), Folic acid (0.02 mg), Niacin (4.00 mg), Para-amino – benzoic acid (0.02 mg), Choline chloride (200 mg), Inositol (24 mg), Vitamin B12 (2.00 g) [11].

Source: [10]
Source: [11]

The Induction of Experimental Diabetes

Diabetes was prompted in rodents by the single intraperitoneal (i.p.) infusion of a newly pre-arranged arrangement of alloxan monohydrate at a portion of 150 mg/kg b.w. broken down in refined water (1 ml/kg b.w.). Seven days after the infusion, the blood glucose levels were estimated. Every creature with a blood glucose fixation level over 200 g/dl was viewed as diabetic and utilized in the examinations to forestall the hypoglycemia, which happened during the initial 24 h following the alloxan organization, 5% glucose arrangement was orally given to the diabetic rodent.

Rats were kept in controlled environments with controlled humidity, temperature (25–2°C), and light (12h light/12h dark).

Two major groups of rats were separated as follows:

The first main group (n=6) received the baseline diet as the negative control.

The second main group: (n=18) diabetic rats were given 150 mg/kg of alloxan injections before being split into 3 subgroups as follows:

- Basal diet plus diabetic rats (positive control).
- Diabetic rats + basal diet containing 5% Common (*Moringa*).
- Diabetic rats + basal diet containing 10% Common *(Moringa)*

Biochemical Analysis

Determination of Serum Glucose

Utilizing compound units, serum glucose was estimated, according to [12].

Determination of Serum Lipids

Fatty Substances

Fatty oils were estimated by enzymatic calorimetry as per [13].

All Out Cholesterol

As indicated by Allain, the essential use of complete cholesterol assurance (1974) [14].

HDL-Cholesterol

A similar strategy used to gauge complete cholesterol can be utilized to evaluate the particular precipitation of all lipoproteins except for the HDL portion cholesterol in the supernatant by phosphotungstic corrosive and magnesium particles, as per [15].

V-LDL and LDL-Cholesterol

As indicated by the Lee and Nieman technique, VLDL (exceptionally low thickness lipoproteins) and not entirely set in stone (1996).

Absolute Lipids

Colorimetric examination was utilized to decide the complete lipids [16].

Assurance of Liver Capabilities

Assurance of Alanine Transferase (ALT).

The Tietz technique was utilized to decide the worth of (ALT) (1976) [17].

When ALT catalyzes the conversion of the amino group from L-alanine to a-Ketoglutarate, pyruvate and L-glutamate are produced.

Assurance of Asartate Transferase (AST)

The plan for Henry accomplished (AST) assurance (1974) [18].

Assurance of All Out Protein

Henry's total protein concentration was calculated using a colorimetric method (1974).

Confirmation of Kidney Function Creatinine Assurance

Not fully resolved by the active procedure for Henry (1974).

Determination of Urea

Not entirely settled by the enzymatic strategy for Patton and Hunch (1977) [19].

Assurance of Uric Corrosive

Uric is not entirely settled by the strategy portrayed by Patton and Squat (1977), Barham and Trinde (1972), and Faulkner and Ruler (1976), separately [20, 21].

Assurance of IgM and IgG

As per Kamiya biomedical Retention utilized was 450 nm and, Fixation was communicated as mg/dl, in 37°c.

Determination of IgA and IgE

According to Alpco diagnostic procedure, the absorption used was 450nm and, Concentration was expressed as ul/dl.

Statistical Analysis

One-way grouping was utilized to work out the factual examination. The most un-massive distinction (LSD) and investigation of fluctuation (ANOVA) [22].

Results and Discussion

This work planned to know the impact of Moringa on biochemical and immunological changes in hyperglycemic rodents.

Biological Results

Effect of different doses of (*Moringa)* on relative organs weight of change on diabetic rats.

- ### Liver Weight(g)

The impacts of different Moringa doses on liver weight (g) in diabetic rodents are displayed in **Table 1**. It was clear that the control (+) gathering's mean worth was more noteworthy than the control (-) gathering's, coming in at 7 1.5 g and 5.7 1.6 g, separately, which shows a tremendous contrast with a percent drop of - 18.57% between the two gatherings. Each gathering altogether varies from the control (+) bunch. For Moringa, the numbers were 6.3 1.4 g and 4.9 1.3 g, separately. For bunches 3, and 4, the rate diminishes were - 10 and - 30%, separately. In any event, when contrasted with the control (-) bunch, the best liver load for bunch 410%) Moringa (of diabetic rodents) was recorded.

- ### Kidneys Weight(g)

The effects of various dosages of Moringa officinalis on kidney weight (g) in diabetic rats are shown in **Table 1**. It was apparent that the control (-) group's mean value was greater than the control (-) group's, coming in at 1.5 0.7 g and 1.3 0.8 g, respectively. This difference was substantial, with the control (-) group's percent drop from +the control (+) being 13.33%. Each group significantly differs from the control (+) group. For 5% and 10% Moringa, the results were 1.4 0.6 g and 1.2 0.5 g, respectively. For groups 3 and 4, the percent decreases were -6.67 & -20%, respectively. Groups 1 and 3 don't differ significantly from one another. Even when compared to the control (-) group, group 4 of diabetic rats' kidney weight was the best.

- ### Heart Weight(g)

The **Table 1** displays how different doses of Moringa officinalis affected the heart weight (g) of diabetic rats (4)The mean values for the control (+) and control (-) groups, 0.7 0.04 g and 0.6 0.05 g, respectively, were found to be higher. This difference was significant, with the control (-) group's percent reduction from control (+) being -14.29%. Each group distinguished itself significantly from the control (+) group. For 5% and 10% Moringa a, the results were 0.60.03 g and 0.5,0.02 g, respectively. For groups 3 and 4, the percent decreases were -14.29 & -28.57%, respectively. Groups 1 and 3 don't differ significantly from one another. Even when compared to the control (-) group, group 4 of diabetic rats' best heart weight was recorded.

Table 1. Effect of different doses of *(Moringa)* on relative organs weight of change in diabetic rats.

	Mean (±SE)			
Parameters	**Control (-)**	**Control (+)**	**5% *Moringa***	**10 % *Moringa***
Liver(g)	5.7 ^{c}± 1.6	7^{a}± 1.5	6.3 ^{b}± 1.4	4.9 ^{d}± 1.3
Kidney(g)	1.3^{ab}± 0.8	1.5 ^{a}± 0.7	1.4 ^{ab}± 0.6	1.2 ^{b}± 0.5
Heart(g)	0.6 ^{b}± .05	0.7 ^{a}± 0.04	0.6 ^{b}± .03	0.5 ^{c}± 0.02

Arithmetic means and standard deviation are indicated by values. Those with similar letters are non-significant in the one-way ANOVA test.

Effect of Different Doses of (Moringa) on Serum Glucose of Diabetic Albino Rats

Table 2 shows the effect of different dosages of moringa on the glucose levels of diabetic rodents. The control (+) gathering's mean worth was more noteworthy than the control (-) gathering's, coming in at 130.7 1.2 versus 87 0.9 mg/dl, separately. This distinction is significant because the control (-) gathering's percent of a drop from the control (+) bunch was 33.44%. In contrast with the control (+) bunch, all gatherings display significant contrasts. For 5% and 10% Moringa, the outcomes were 102 0.07 and 118 0.06 mg/dl, individually. For the previously mentioned gatherings, the rate diminishes were - 21.96 % and - 9.72% individually. In any event, when contrasted with the control (-) bunch, Gathering 3 (5% Moringa) accomplished the best outcomes for the glucose of diabetic rats, This result concurs with Adewale Bakrea *et al*. (2013), It animates the pancreas to create insulin in the body and brings down and balances the glucose level. Moringa likewise contains nutrients A, C, and D that help the well-being of a wide range of diabetes patients.

Table 2. Effect of different doses of (*Moringa*) on serum glucose of diabetic albino rats.

Parameters	Mean (±SE) Control (-)	Control (+)	5% *Moringa*	10% *Moringa*
Serum glucose (mg/dl)	87 ^{d}± 0. 9	130.7 ^{a}± 1.2	102^{c}± 0.7	118 ^{b}±0.6

Values denote arithmetic means ± Standard error of the mean. one-way ANOVA test, while those with similar letters are non-significant

Effect on Cholesterol, Triglyceride, and VLDL-c in Diabetic Rats

Table 3 represents the effect of different doses of *Moringa* on total cholesterol, triglyceride, and VLDL-c in both normal and alloxan-induced diabetic rats.

- *Total Cholesterol (mg/dl)*

Table 3 displays the impact of various Moringa dosages on total cholesterol in diabetic rats.

It was clear that the control (+) group's value was greater than the control (-) group's with mean values of 67 0.8 and 45 0.9 mg/dl, respectively. It was statistically significant that the control (-) group's percent drop from the control (+) group was 32.84%. Every group differs greatly from the control (+) group. The values were 53.7 0.7 and 54.2 0.6 mg/dl for 5% and 10% Moringa, respectively. Both of the aforementioned groups saw declines of -19.85% and -19.10%. Group 4 (10% Moringa) showed the best outcomes for total cholesterol in diabetic rats, even when compared to the control (-) group.

- *Triglycerides mg/dl*

The **Table 3** shows the impacts of different Moringa measurements on fatty substance levels in diabetic rodents (6) With mean upsides of 125 0.8 and 40 0.9 mg/dl, separately, it was apparent that the control (+) gathering's worth was higher than the control (-) group's. The control (-) gathering's mean worth dropped by 68% in contrast with the control (+) bunch, having this effect significant. Each bunch altogether varies from the control (+) group. For 5% and 10% Moringa, the outcomes were 48 0.7 and 41 0.6 mg/dl, respectively. The previously mentioned bunches experienced diminishes of 61.6% and 67.2%, respectively. Even when contrasted with the control (-) bunch, Gathering 4 (10% Moringa) showed the best outcomes for the fatty oils of diabetic rodents. This outcome concurs with Lauren's (2019) [23]. Moringa oil and its foundations safeguard against the gamble of coronary supply route blockage and keep a solid heart. Moringa seeds forestall nerve harm and it was additionally found that the seeds safeguard against circulatory illnesses and keep up with the soundness of the circulatory framework.

- *Very Low-density Lipoprotein Cholesterol V LDL-c (mg/dl)*

Table 3 displays the impact of various Moringa dosages on VLDL in diabetic rats. It was clear that the control (+) group's mean value was greater than the control (-) group's, coming in at 25 1.05 and 8 1.06mg/dl, respectively. This difference was noteworthy because it showed a -68% decrease in the control (-) group's value when compared to the control (+) group. Each group significantly differs from the control (+) group. For (5% and 10% Moringa), the results were 9.6 1.04 & 8.2 1.03 mg/dl, respectively. The above-mentioned groups experienced decreases of 61.6% and 67.2%, respectively. Even as compared to the control (-) group, Group 4 (10% Moringa) recorded the best VLDL levels in diabetic rats.

Table 3. Effect of different doses of (*Moringa*) on cholesterol, triglyceride, and VLDL-c in diabetic rats.

Parameters	Mean (±SE) Control (-)	Control (+)	5 % *Moringa*	10 % *Moringa*
Total Cholesterol (mg/dl)	45 ^{c} ± 0.9	67 ^{a}± 0.8	53.7 ^{c}± 0.7	54.2 ^{b}± 0.6
Triglyceride (mg/dl)	40 ^{d}± 0.9	125 ^{a}± 0.8	48 ^{b}± 0.7	41 ^{c}± 0.6
VLDL-c (mg/dl)	8 ^{d}± 1.06	25 ^{a}± 1.05	9.6 ^{b}± 1.04	8.2 ^{c}± 1.03

Values denote arithmetic means ± Standard error of the mean. one-way ANOVA test, while those with similar letters are non-significant.

Effect of Different Doses of (Moringa) on Very Low-density Lipoprotein Cholesterol V LDL-c (mg/dl) in Diabetic Rats.

- *High-Density Lipoprotein Cholesterol HDL-c (mg/dl):*

The impact of various dosages of moringa on HDL in diabetic rats is seen in **Table 4**. It was clear that the mean value for the control (+) group was lower than the mean value for the control (-) group, coming in at 23.23 and 25.12 mg/dl, respectively. This difference was noteworthy because it showed an increase of +8.69% in the control (-) group as opposed to the control (+) group. Each group significantly differs from the control (+) group. For (5% and 10%

Moringa), the results were 27 1.33 & 28 1.44 mg/dl, respectively. The above-mentioned groups experienced increases of +17.39 % and +21.74%, respectively. Even when compared to the control (+) group, Group 4 (10% Moringa) had the best results for HDL in diabetic rats.

- *Low-Density Lipoprotein Cholesterol LDL-c (mg/dl)*

Table displays how different doses of moringa affected LDL in diabetic rats (4).

With mean values of 19 0.8 and 12 0.9 mg/dl, respectively, it was clear that the control (+) group's value was higher than the control (-) group's. The control (-) group's percent decline of -36.84% when compared to the control (+) group shows how significant this difference was. Differentiating each group significantly from the control (+) group.

- 17.1 and 18 mg/dl (5% and 10% Moringa) were the results, respectively. The above-mentioned groups experienced decreases of -10 and -5.26% respectively. Even when measured against the control (+) group, group 3 (5% Moringa) showed the best results for LDL in diabetic rats. This outcome supports Armando's theory (2020) [24]. By enhancing blood circulation, moringa supports heart health and lowers the risk of heart attacks and strokes.

- *Atherogenic Index AI (mg/dl)*

The effects of various Moringa dosages on Al in diabetic rats are shown in **Table 4**.

It was clear that the control (+) group's mean value was greater than the control (-) group's, coming in at 1.91 0.003 and 0.8 0.004 mg/dl, respectively. This difference was substantial, as shown by the control (-) group's percent drop of -58.12% when compared to the control (+) group. Each group significantly differs from the control (+) group. For (5% and 10% Moringa), the results were 0.99 0.002 & 0.94 0.011 mg/dl, respectively. The above-mentioned groups had decreases of -48.17 % and -50.78% respectively. Despite being compared to the control (-) group, Group 4 (10% Moringa) recorded the greatest results for the diabetic rats.

Table 4. Effect of different doses of (Moringa) on serum HDL-c, LDL-c, and Al of Diabetic rats.

	Mean (±SE)			
Parameters	**Control (-)**	**Control (+)**	**5% *Moringa***	**10% *Moringa***
HDL-c (mg/dl)	25 ^{c}± 1.12	23 ^{d}± 1.23	27 ^{b}± 1.33	28 ^{a}± 1.44
LDL-c (mg/dl)	12^{d}±3.9	19^{a}± 0.8	17.1 ^{e}± 0.7	18 ^{b}±0.6
A I (mg/dl)	0.8 ^{d}_± 0.004	1.91 ^{a}± 0.003	0.99 ^{b}± 0.002	0.94 ^{c}±0.011

Values denote arithmetic means ± Standard error of the mean. one-way ANOVA test, while those with similar letters are non-significant

Effect on liver function (AST, ALT, and ALP)

- *Serum AST (U/L)*

The impact of various dosages of Moringa on AST in diabetic rats is shown in **Table 5**. It was apparent that the control (+) group's mean value was higher than the control (-) group's, coming in at 353 U/L and 118 U/L, respectively. This difference showed a significant difference with a percent drop of -66.57% between the control (-) and control (+) groups. Each group significantly differs from the control (+) group. For (5% and 10% Moringa), the values were 1521.33 & 1701.66 U/L, respectively. The above-mentioned groups experienced decreases of -56.94 % and -51.84%, respectively. Even when compared to the control (+) group, Group 3 (5% Moringa) obtained the best results for AST in diabetic rats.

- *Serum ALT(U/L)*

Table 5 displays the impact of various Moringa dosages on ALT in diabetic mice. It was apparent that the control (+) group's mean value was greater than the control (-) group's, coming in at 95 0.8 and 30 0.9 U/L, respectively. This difference was substantial, with the control (-) group's percent drop from the control (+) being 68.42%. Each group significantly differs from the control (+) group. For (5% and 10% Moringa), the results were 33 0.7 & 45 0.6 U/L, respectively. The above-mentioned groups experienced decreases of 65.26 and 52.63% respectively. Even when compared to the control (+) group, Group 3 (5% Moringa) obtained the best results for ALT in diabetic rats.

- *Serum ALP(U/L)*

The effects of various dosages of moringa on ALP in diabetic rats are shown in **Table 5**. It was clear that the control (+) group's value was higher than the control (-) group's with mean values of 242 0.8 and 139 0.9U/L, respectively. The mean value of the control (-) group decreased by -42.56% in comparison to the control (+) group as a result of this significant difference. Every group differs greatly from the control (+) group. The findings were 232 0.7 & 239 0.6 U/L for 5% and 10% Moringa, respectively. The percentage drops for the aforementioned groups were -4.13% and -1.24%, respectively. The best ALP levels for diabetic rats were obtained by Group 3 (5% Moringa), even when compared to the control (+) group. This result agrees with Shalini, *et al*. (2014) Both liver damage and the signs of liver fibrosis were reduced with moringa [25]. The administration of Moringa seed extract decreased the increase in globulin levels and blood aminotransferase activity brought on by CCl(4).

Table 5. Effect of different doses of (*Moringa*) on liver enzymes in serum diabetic albino rats.

	Mean (±SE)			
Parameters	**Control (-)**	**Control (+)**	**5% *Moringa***	**10% *Moringa***
AST (u/l)	118 ^{d}± 1.22	353 ^{a}± 1.55	152 ^{c}± 1.33	170 ^{b}± 1.66
ALT (u/l)	30 ^{d}± 0.9	95 ^{a}± 0.8	33 ^{c}± 0.7	45 ^{b}±0.6
ALP (u/l)	139^{d}± 0.9	242 ^{a}± 0.8	232 ^{c}± 0.7	239 ^{b}± 0.6

Arithmetic means and standard deviation are indicated by values. Those with similar letters are non-significant in the one-way ANOVA test.

Effect on Kidney Functions

- *Uric Acid (mg/dl)*

The effects of various Moringa dosages on uric acid in diabetic rats are shown in **Table 6**. It was clear that the control (+) group's value was higher than the control (-) group's with mean values of 2.3 0.8 and 1 0.9 mg/dl, respectively. This difference was statistically significant, with the control group's difference from control (+) falling by 56.52%. Each group is significantly different from the control (+) group. The results were 1.1 0.7 mg/dl (5% Moringa) and 1.2 0.6 mg/dl (10% Moringa), respectively. The decreases were -52.17% and -47.83%, respectively, for the aforementioned groups. The distinctions between Groups 1, 3, and 4 are minimal. Even though compared to the control (+) group, Group 3 (5% Moringa) produced the best results for uric acid in diabetic rats.

- *Urea Nitrogen (mg/dl)*

The effects of various Moringa doses on urea nitrogen in diabetic rats are shown in **Table 6**. It was clear that the control (+) group's value was higher than the control (-) group's with mean values of 18 0.8 and 11 0.9 mg/dl, respectively. How big this difference may be seen by the control (-) group's percent fall, which was -38.89% when compared to the control (+) group. When compared to the other groups, each group differs significantly from the control (-) group. For (5% & 10% Moringa), the results were 14 0.7 & 13 0.6 mg/dl, respectively. The aforementioned groups saw reductions of -22.22 and -27.78%. Even when compared to the control (-) group, Group 4 (10% Moringa) produced the best results for urea nitrogen in diabetic rats.

- *Creatinine (mg/dl)*

The table displays the effects of various doses of moringa on creatinine in diabetic rats (6)With mean values of 0.36 0.003 mg/dl and 0.2 0.001 mg/dl, respectively, it was clear that the control (+) group's value was higher than the control (-) group's. Between the control (-) and control (+) groups, there was a percent drop of -44.44%, demonstrating a significant difference. Every group differs greatly from the control (+) group. Salvia officinalis concentrations of 5% and 10% were 0.3 0.004 mg/dl and 0.28 0.002 mg/dl, respectively. Each of the aforementioned groups saw losses of -16.67% and -22.22%. Group 4 (10% Moringa) achieved the greatest results for Creatinine of diabetic rats, even when compared to the control (-) group.

Table 6. Effect of different doses of (*Moringa*) on some parameters for kidney function of serum diabetic albino rats.

Parameters	Mean (±SE) Control (-)	Control (+)	5% *Moringa*	10% *Moringa*
Uric acid (mg/100ml)	1^{b} ± 0.9	2.3^{a} ±0.8	1.1^{b} ±0.7	1.2^{b} ±0.6
Urea (mg/100ml)	11^{d} ±0.9	18^{a} ±0.8	14±0.7	13^{c} ±0.6
Criatinine (mg/100ml)	0.2^{b} ±0.001	0.36^{a} ±.003	0.3^{b} ±0.004	0.28^{c} ±0.002

Arithmetic means and standard deviation are indicated by values. Those with similar letters are non-significant in the one-way ANOVA test.

Immunological Results

After 4 weeks of feeding, the effects of various dosages of moringa on serum IgG, serum IgM, and total immunoglobulin in normal and diabetic rats are shown in **Table 7**.

In the gathering of ordinary rodents, the serum IgG level was (2850.5350.10) U/ml. While gatherings of diabetic rodents took care of a base eating regimen and food enhanced with changing measures of moringa (5%, 10%, and positive control) showed serum IgG upsides of 2400.5, 160.40, 3300.9, and 2500.6, 200.90 U/ml, individually. When contrasted with the negative control, the outcomes showed significant changes somewhere in the range of 5% and 10% Moringa. This finding is reliable with Lauren's (2019) discoveries that moringa seeds assist diabetics' insusceptible frameworks with working great so they can fight off different illnesses. Serum IgM esteem in ordinary rodents bunch was (380.92±15.12) U/ml. While in diabetic rodents bunches benefited from basal and enhanced eats fewer carbs with various dosages of Moringa (positive control, 5%, and 10% Moringa) were (330.25±25.3, 445.50±45.55, and 365.45±30.20) U/ml separately. The outcomes exhibited huge contrasts between 5% and 10% when contrasted and negative control.

All out Immunoglobulin esteem in ordinary rodents bunch was (3650.25±200.5) U/ml. While in diabetic rodents bunches benefited from basal and enhanced slims down with various portions of Moringa (positive control, 15%, 10%, and 5% Moringa) were (3550.35±25.3, 4150.2±90.10, and 3650.40±30.8) U/ml, for (positive control, 5%, and 10% Moringa), separately. The outcome showed huge contrasts somewhere in the range of 5% and 10% Moringa) when contrasted and negative control.

Table 7. Effect of different doses of (*Moringa*) on immunity indices of serum diabetic albino rats.

Parameters	Mean(±SE) Control (-)	Control (+)	5% *Moringa*	10% *Moringa*
IgG (U/ml)	2850.5 ± 350.10^{b}	2400.5 ± 160.40^{c}	3300.9 ± 80.25^{a}	2500.6 ± 200.90^{c}
IgM (U/ml)	380.92 ± 15.12^{b}	330.25 ± 25.3^{C}	445.50 ± 45.55^{a}	365.45 ± 30.20^{b}
Total Immunoglobulin (U/ml)	3650.25 ± 200.5^{C}	3550.35±55.8°	4150.2 ± 90.10^{a}	3650.40 ± 30.8^{C}

Arithmetic means and standard deviation are indicated by values. Those with similar letters are non-significant in the one-way ANOVA test.

Conclusion

1. For diabetic patients, various doses of moringa are advised.
2. Various Moringa doses may be recommended for reducing LDL and atherogenic index readings.

The results showed that the moringa plant had an effective effect on improving immunity and improving general health of diabetic rats and the improvement rate increased in the group containing 5% moringa, because it contains Phytochemicals and antioxidants that are abundant.

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