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ORIGINAL ARTICLE

The effect of moringa flower extract on kidney function in obese rats

Meri[1], Christopher Lawrence[2]*, Wilsen[3]

Abstract

This study aims to measure the effect of moringa flower extract administration on kidney function and histopathological features of the kidneys of obese male Wistar puith galir rats. This research is a type of experimental quantitative research using post-test only group design. This research was conducted at the Department of Pharmacy Pharmacology Laboratory, Faculty of Medicine, University of North Sumatra and Anatomical Pathology Laboratory, University of North Sumatra. Histopathology observation of kidney tissue was done by comparing the control and treatment groups. Changes observed will be the presence of fatty degeneration (vacuolization), necrosis and hydrophic degeneration. To obtain quantitative data, scoring was performed on each change found. The research data were tabulated and then the changes found were analyzed and presented descriptively. The research data were then analyzed with the help of SPSS version 25.0. The data normality test was analyzed with the Kolmogorov-Smirnov test approach ($p > 0.05$). To test the significance between test groups, one-way analysis of variance or One Way ANOVA technique was conducted at 95% confidence level ($p < 0.05$). Further analysis or test was conducted using Post Hoc Test with LSD technique. The results of the analysis showed that the administration of Moringa flower extract at a dose of 600 mg/KgBB was effective in improving kidney function in obese Wistar white rats. This improvement can be seen through the levels of ureum, creatinine, and histological structure of the kidneys that have improved. The results of histopathological observations of kidney tissue in treatment group 3, namely moringa flower extract at a dose of 600 mg/KgBB, experienced the most significant improvement and approached the control group compared to other groups.

Keywords: moringa flower extract, histopathology, kidney, obese rat

Introduction

Obesity is an energy imbalance disorder caused by excessive calorie intake compared to energy expenditure required for survival and physical activity.[1] Obesity is a chronic disease and a growing global concern. Its prevalence has increased across all age groups—children, adolescents, and adults—and is now considered an epidemic.[2] Globally, more than 500 million people are affected by obesity, making it a widespread phenomenon in both developing and developed countries. Excessive consumption of fast food is closely linked to obesity.[3] Fast food is energy-dense, high in fat and sodium, but low in fiber, which contributes to weight gain.[4] National-scale research conducted by the Health Research and Development Agency of the Indonesian Ministry of Health revealed an increase in obesity prevalence in Indonesia. Among children aged 5–12 years, the prevalence of obesity based on the body mass index-for-age (BMI/A) increased from 8.8% to 9.2%.[5] Among adolescents aged 16–18 years, the prevalence rose from 1.6% to 4.0%, and from 5.7% to 9.5%.[6]

Obesity is a significant risk factor for the development of kidney diseases. It causes complex metabolic abnormalities that broadly impact conditions affecting the kidneys. Obesity increases the risk of

Affiliation
[1]Master's Programme in Biomedical Sciences, Universitas Prima Indonesia
[2]Departement of Biomedicine, Universitas Prima Indonesia

Correspondence
christopher.liu09@gmail.com

major chronic kidney disease (CKD) factors, such as diabetes and hypertension, and directly contributes to the progression of CKD and end-stage renal disease (ESRD). In obese individuals, compensatory hyperfiltration mechanisms often occur to meet the increased metabolic demands caused by excess weight. Elevated intraglomerular pressure may damage kidney structures and increase the long-term risk of CKD.[7] Chronic kidney disease (CKD) is a major global public health issue, affecting both young and old populations. Its primary consequences include loss of kidney function, progression to end-stage renal disease, increased cardiovascular disease risk, significant morbidity and mortality, and a decline in health-related quality of life.[8] Oxidative stress serves as a common pathway linking obesity with its related complications. It is defined as an imbalance between antioxidant defenses and free radical production. This oxidative environment triggers mechanisms that cause tissue damage, such as inflammation, excessive extracellular matrix production, endoplasmic reticulum stress activation, and disrupted autophagic flux.[9] The imbalance between reactive oxygen species (ROS) and antioxidants results in oxidative stress. Research has revealed a positive correlation between CKD and oxidative stress.[10] Oxidative stress contributes to the progression of kidney diseases and the decline in renal function. ROS play a critical role in regulating the physiological functions of the kidneys, making them highly vulnerable to redox imbalances and oxidative stress. ROS formation or changes in ROS production can occur in both the renal cortex and medulla, with extensive effects. These effects include altered renal blood flow, sodium/fluid retention, inflammation, fibrotic changes, and proteinuria. This underscores the importance of managing oxidative stress to mitigate kidney-related complications in obesity.[11]

Oxidative stress damages tissues, including the kidneys, through various mechanisms, particularly by disrupting cell membranes, causing DNA damage, and modifying proteins. Lipid peroxidation, a process of oxidative degradation of lipids, is a key mechanism wherein free radicals bind to electrons in lipids within cell membranes, leading to direct cellular damage. The kidneys are highly susceptible to damage from reactive oxygen species (ROS), likely due to their high content of long-chain polyunsaturated fatty acids (PUFAs) in their lipid composition. The allylic hydrogen in PUFAs is particularly sensitive to free radical attacks.[12] Oxidative stress arises from an imbalance between free radical production and antioxidant defenses. This imbalance results in the oxidation of certain biomolecules, leading to structural and functional modifications. [13] This process is primarily driven by mitochondrial oxidant production with the involvement of mitochondrial cytochrome oxidase enzymes, such as cytochrome P450. The ROS generated from these processes contribute to kidney damage and the pathogenesis of atherosclerotic diseases associated with chronic kidney disease (CKD).[11] Oxidative stress, representing a disruption of the complex balance between pro-oxidants and antioxidants, is widely recognized as a critical factor in the pathogenesis and progression of CKD. By targeting this imbalance, strategies to reduce oxidative stress may help mitigate kidney damage and slow CKD progression.

The human body has an innate defense mechanism against oxidative stress: antioxidants. Antioxidants inhibit harmful oxidative reactions by oxidizing themselves. This defense system functions through a cascade that blocks the initial production of free radicals and scavenges oxidants, converting them into less toxic compounds while preventing the secondary production of toxic metabolites. Additionally, it aims to repair molecular damage or enhance the endogenous antioxidant defense system, which consists of enzymatic and non-enzymatic antioxidants.[11] Currently, there is significant research on plant-derived antioxidants. One medicinal plant with potent antioxidant properties is Moringa oleifera. Moringa contains proteins, fatty acids, minerals, and polyphenolic compounds, and its high antioxidant activity is attributed to its significant total phenolic content.[14] *Moringa oleifera* is often referred to as the "miracle tree" because all parts of the plant, including its roots, bark, sap, leaves, fruit, flowers, and seeds, can be utilized for various purposes.[15]

Moringa oleifera has multisystem effects on the human body and is a well-known herbal remedy in various communities. It contains free radical inhibitors such as phenolics (phenolic acids, flavonoids, coumarins, quinones, tannins, and stilbenes), nitrogen compounds (alkaloids, amines, β-alanine), vitamins, terpenoids (carotenoids), and other endogenous metabolites.[16] Specifically, the pods and seeds of Moringa oleifera are useful for water purification due to their cationic polyelectrolyte content, which has proven effective in treating water for human consumption by removing turbidity. These compounds cause colloidal

particles to coagulate, facilitating their removal through sedimentation or filtration. Additionally, the chemical composition of Moringa pods, seeds, and leaves makes it a significant source of nutrients and micronutrients, essential for a balanced daily diet.[17] Various studies report that Moringa leaves have a higher protein content compared to other plants.[15] The secondary metabolites of Moringa include alkaloids, saponins, phenolics, tannins, flavonoids, and steroids. Ethanolic extracts of Moringa leaves contain total phenols of 62.56 ± 0.72 mg GAE/g extract and total flavonoids of 10.477 ± 0.222 mg QE/g extract. The leaf extract demonstrates moderate antioxidant capacity with an IC50 value of 118.615 mg/L[18]. Based on this background, the researcher aims to examine the effects of Moringa flower extract on kidney function and the histopathological features of the kidneys in male Wistar rats suffering from obesity.

Method

Study Design and Sampling

This study is quantitative experimental research utilizing a post-test only group design. The sample consisted of male Wistar rats (Rattus norvegicus) weighing 200–300 grams and aged 2–3 months. Male Wistar rats were chosen as test subjects due to their physiological and characteristic similarities to humans and because they are among the most commonly used animals in biomedical research. The sample size was calculated using the Federer formula, resulting in a minimum of six animals per group. This study included 24 Wistar rats in total, divided into four experimental groups, with six rats per group. The test subjects were randomly assigned to the experimental groups.The study was conducted at the Laboratory of the Department of Pharmacology, Faculty of Medicine, Universitas Sumatera Utara, and the Laboratory of Anatomical Pathology, Universitas Sumatera Utara, from October to December 2023.

Tools and Material

The tools used in this research include a maceration set, filter, rotary evaporator, evaporating dish, and water bath. For in vitro testing, the tools include 10 mL, 25 mL, and 100 mL volumetric flasks; test tubes; test tube racks; BioHit 1000 µL micropipettes; graduated pipettes; spatulas; vials; incubators; pH meters; cuvettes; centrifuges; centrifuge tubes; UV-Vis spectrophotometers; beakers; and microtomes. The materials used include Moringa flowers, 96% ethanol, 70% alcohol, 80% alcohol, 90% alcohol, 96% alcohol, paraffin, embedding sets, and 10% Neutral Buffered Formalin (NBF).

Preparation of Moringa Flower Extract

The preparation of Moringa flower extract began with cleaning and drying the flowers. The dried flowers were stored in airtight plastic bags for further use. Simplisia was prepared through maceration using 96% ethanol as the solvent. Fresh Moringa flowers were macerated for two days at a temperature of 30–35°C. After drying, the flowers were ground into a powder using a blender to produce Moringa flower powder. For the maceration process, 100 grams of this powder was mixed with 100 mL of 96% ethanol. The mixture was placed in a jar, and an additional 1 liter of 96% ethanol was added. The jar was sealed and left for 48 hours, protected from sunlight. The mixture was then filtered to obtain the macerate. The residue from the initial filtration was re-macerated using the same procedure with 96% ethanol. This process continued until a clear macerate was obtained, aided by a digital shaker operating at a speed of 50 rpm. Finally, the liquid extract was evaporated using a rotary evaporator for 2 hours, resulting in a concentrated extract. This high-quality Moringa flower extract was prepared for use in subsequent experimental procedures.

Test Animal Preparation

The test animals were prepared by feeding them a high-fat diet to induce weight gain. The diet consisted of standard rat pellets mixed with quail egg yolk. The high-fat feed was prepared by mixing standard feed with quail egg yolk at a dosage of 10 mL/kg body weight, administered once daily using a gastric gavage. This dosage was based on a study by Prakoso et al. [19]This exogenous diet effectively increased body weight. The high-fat diet was given for 14 days prior to starting the treatment with Moringa flower extract. Parameters used to confirm obesity in the rats included body weight and abdominal circumference measurements. Rats were classified as obese if their Lee index exceeded 0.300 (14). The Lee

index is a parameter used to assess obesity in rats, analogous to the Body Mass Index (BMI) in humans. This approach ensured the effective induction of obesity in the test animals before the experimental treatments. [20]

Treatment Procedures

Male Wistar rats that had undergone an acclimatization period and consumed a high-fat diet were randomly divided into four groups. A total of 24 obese male Wistar rats were used as samples and were randomly assigned into four groups, each consisting of six rats. The rats were treated for 14 days. This study adapted the findings of Farhan[21], which reported microscopic changes in the kidneys of Wistar rats exposed to lead acetate at a dose of 50 mg/kg BW/day, and modified the dosage as follows: a) Control Group (K0): Rats were fed a standard pellet diet and given distilled water (aquades) daily for 14 days; b) Treatment Group 1 (K1): Rats were fed a high-fat diet and given Moringa flower extract at a dose of 200 mg/kg BW/day per orally using a gastric gavage for 14 days; c) Treatment Group 2 (K2): Rats were fed a high-fat diet and given Moringa flower extract at a dose of 400 mg/kg BW/day per orally using a gastric gavage for 14 days; and d) Treatment Group 3 (K3): Rats were fed a high-fat diet and given Moringa flower extract at a dose of 600 mg/kg BW/day per orally using a gastric gavage for 14 days.

The Moringa flower extract was administered orally every day. On the 14th day, the administration of the extract was stopped. The rats were then euthanized using ketamine, followed by necropsy. Once the abdominal cavity was opened, the kidney organs were removed and placed in pots containing 10% Neutral Buffer Formalin (NBF) for preservation and further histological analysis.

Kidney Function Examination

Histopathological observations of kidney tissue were conducted by comparing the control and treatment groups. The changes examined included fatty degeneration (vacuolization), necrosis, and hydropic degeneration. To obtain quantitative data, scoring was performed for each observed alteration.

Preparation of Histopathological Slides

The preparation of histopathological slides involved fixing the kidney organs in 10% Neutral Buffer Formalin (NBF) for 18–24 hours. After fixation, the dehydration process was conducted sequentially using alcohol solutions of 70%, 80%, 90%, 96%, and absolute alcohol, each for two hours. Clearing was performed with toluene, followed by paraffin infiltration. The kidney samples were then embedded in paraffin using an embedding set, poured with liquid paraffin, and cooled to form blocks. These processes were completed within one day. The cooled paraffin blocks were sectioned into slices approximately 4–5 microns thick using a microtome. The sections were stained using Harris Hematoxylin–Eosin (H&E) staining. The stained specimens were mounted onto glass slides, adhered with mounting media, and covered with cover slips.

Histopathological Observation Process

The histopathological observation of kidney tissues was conducted by comparing the control and treatment groups to identify alterations such as fatty degeneration (vacuolization), congestion, necrosis, and inflammatory cell infiltration. Quantitative data were obtained by scoring changes observed under a light microscope at 400x magnification, with observations taken across five fields of view per sample. The scoring system used for assessment included four categories: Score 0, indicating no histopathological damage; Score 1, representing focal (mild) damage; Score 2, indicating multifocal (moderate) damage; and Score 3, representing diffuse (severe) damage. This system provided a comprehensive evaluation of the histopathological changes in kidney tissues across the experimental groups, enabling an in-depth comparison of the effects of the treatments.

Data Analysis

Data from histopathological observations through microscopic examination were collected and then scored. The data from the research results are tabulated, then the changes found are analyzed and presented descriptively. The data from the research results were then analyzed with the help of SPSS

version 25.0. The data normality test was analyzed using *the Kolmogorov-Smirnov test* approach ($p > 0.05$). To test the significance between the test groups, the test was carried out with a one-way variance analysis technique or *One Way ANOVA* at a confidence level of 95% ($p < 0.05$). Further analysis or tests are carried out using *Post Hoc Test* with LSD technique.

Results

In general, the mice were in a healthy condition during this study, namely before and after the treatment. A total of 24 test animals were able to take part in this study until the end without any drop out. Based on the data obtained, before the high-fat diet, the value of Lee's index in the treatment group was 0.28. This value is less than 0.3 so it has not been included in the obesity category according to the Lee index. After consuming a high-fat diet in the form of quail egg yolk for 14 days, the weight and nasoanal length of the rats were again calculated to determine the value of Lee's index. In treatment group 1, Lee's index value changed to 0.31, and treatment groups 2 and 3 became 0.32. Based on this data, it can be concluded that the test animals in the treatment group were in a condition of obesity before testing in the form of giving moringa flower extract to improve kidney function in white rats.

Table 1. Test Animal Characteristics

Components	Groups			
	Control	P1	P2	P3
Types of Rats	White rat wistar strain			
Gender	Male			
General Circumstances	White, healthy and active skin color			
Average Starting Weight	245 gr	246 gr	238 gr	241 gr
Average Final Weight	248 gr	332 gr	342 gr	348 gr

Table 2. Test Animal Weights

Parameter	Group	Average	
		Before high fat diet	After high fat diet
Weight (gr)	Control	245 gr	248 gr
	P1	246 gr	332 gr
	P2	238 gr	342 gr
	P3	241 gr	348 gr
Naso-anal Length(mm)	Control	216 mm	217 mm
	P1	219 mm	222 mm
	P2	215 mm	217 mm
	P3	217 mm	219 mm
Lee Index	Control	0.28	0.28
	P1	0.28	0.31
	P2	0.28	0.32
	P3	0.28	0.32

The results of observations conducted in all groups showed that there was a change in urea levels in the treatment group. Based on the average value of urea levels, the control group got a result of 16.08 mg/dl before the treatment and after 14 days to 16.73 mg/dl. The value of urea levels in the control group was the normal level or reference for high and low urea levels in the treatment group given a high-fat diet and moringa flower extract. Treatment group 1 after being given a high-fat diet had urea levels of 29.18mg/dl. and after being given moringa flower extract at a dose of 200 mg/KgBW decreased to 21.11 mg/dl. Treatment group 2 after a high-fat diet of 29.4 mg/dl and after being given moringa flower extract with a dose of 400 mg/KgBW became 18.98 mg/dl. Finally, treatment group 3 after a high-fat diet of 29.55 mg/dl and after being given moringa flower extract with a dose of 600 mg/KgBW to 17.3mg/dl.

Based on this difference in the average value of urea levels, the researcher concluded that treatment group 3, namely mice that were obese and given moringa flower extract at a dose of 600 mg/KgBW, had the largest decrease in urea levels and was close to the control group. Meanwhile, treatment group 1, namely rats who were obese and given moringa flower extract at a dose of 200 mg/KgBW, experienced the lowest decrease or improvement in urea levels compared to treatment groups 2 and 3.

The results of observations made in all groups showed that there was a change in creatinine levels in the Treatment group. Based on the average value of creatinine levels, it can be seen that the control group has an average value of 3.55 mg/dl before treatment and 4.03 after 14 days. The value obtained in the Control group is a normal level as well as a reference for high and low creatinine levels in the Treatment group. Treatment group 1 after being given a high-fat diet had creatinine levels of 9.91 mg/dl and after being given moringa flower extract with a dose of 200 mg/KgBW to 8.36 mg/dl. Treatment Group 2 after a high-fat diet of 10.2 mg/dl and after being given moringa flower extract at a dose of 400 mg/KgBW to 5.93 mg/dl. Finally, the Treatment 3 group after a high-fat diet of 10.23 mg/dl and after being given moringa flower extract with a dose of 600 mg/KgBW became 4.71 mg/dl.

Based on the differences in average creatinine levels, the study concluded that Treatment Group 3, consisting of obese rats administered Moringa flower extract at a dose of 600 mg/kg BW, showed the most significant reduction in serum creatinine levels, approaching those of the Control Group. Conversely, Treatment Group 1, which received 200 mg/kg BW of Moringa flower extract, exhibited the smallest

improvement in creatinine levels. The phytochemical analysis revealed that Moringa flower extract contains secondary metabolites such as flavonoids, saponins, tannins, alkaloids, and steroids. These findings align with previous research by Isyraqi et al[22]which reviewed studies on the phytochemical contents of Moringa and identified similar compounds, including alkaloids, flavonoids, saponins, triterpenoids, tannins, and steroids.

Tabel 3. Creatinine from Ureum Up

Group	Cycles	After High Fat Diet (U/L)		After Treatments (U/L)	
		Ureum	Creatinine	Ureum	Creatinine
Control	1	16.3	3.3	16.9	4.1
	2	16.7	3.9	17.2	4.5
	3	15.9	3.1	16.7	3.2
	4	17.1	4.2	17.5	4.7
	5	15.6	3.6	16.4	3.9
	6	14.9	3.2	15.7	3.8
	Average	16.08	3.55	16.73	4.03
Treatment I	1	30.3	9.9	21.2	8.6
	2	29.5	10.1	20.6	9.1
	3	28.4	10.8	22.1	8.4
	4	28.9	11.1	20.7	7.8
	5	27.2	8.2	21.8	7.4
	6	30.8	9.4	20.3	8.9
	Average	29.18	9.91	21.11	8.36
Treatment II	1	28.9	11.2	19.1	5.5
	2	27.8	11.4	18.8	6.1
	3	30.4	9.7	18.2	6.8
	4	31.7	8.9	19.5	5.9
	5	28.5	9.9	19.8	4.9
	6	29.1	10.1	18.5	6.4
	Average	29.4	10.2	18.98	5.93
Treatment III	1	30.1	10.8	17.2	4.9
	2	28.9	11.6	16.2	5.1
	3	29.2	11.1	16.8	4.3
	4	31.1	8.5	18.1	3.8
	5	29.8	9.2	17.6	4.7
	6	28.2	10.2	17.9	5.5
	Average	29.55	10.23	17.3	4.71

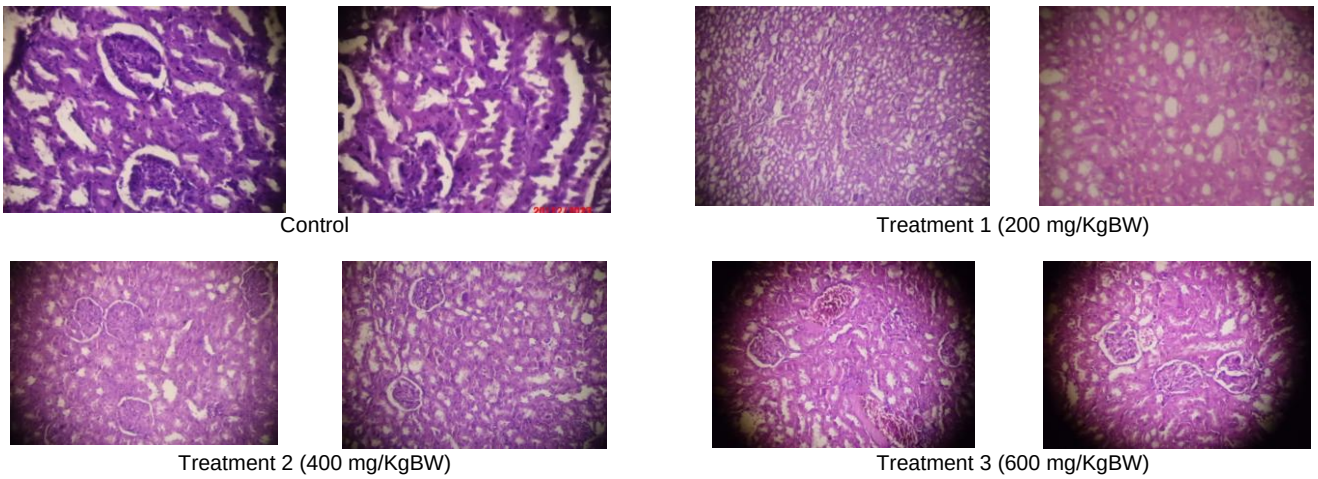

Figure 1. Histopathological picture of liver tissue

Histopathological observations indicated distinct cellular appearances across groups. The Control Group, fed a standard pellet diet and aquades, showed normal kidney histology, classified as Score 0 (no histopathological damage). The normal histology observed in the Control Group, which was not subjected to a high-fat diet, served as a baseline for comparison with the Treatment Groups. These results demonstrated that the combination of a high-fat diet and Moringa flower extract had varying degrees of

impact on kidney histology, with the extract showing potential for mitigating obesity-induced kidney damage.

In the Treatment 1 group that was given a high-fat diet and moringa flower extract at a dose of 200 mg/KgBW, there was a difference in the shape of the kidney structure, because the organs were already exposed to the consumption of a high-fat diet and obesity. In the histological picture of the Treatment 1 group which was given moringa flower extract at a dose of 200 mg/KgBW, there was damage to kidney cells, so it was included in the score category of 4 (there was diffusion/severe damage). The Treatment 2 group, which was given moringa flower extract at a dose of 400 mg/KgBW, showed improvements in the structure of kidney histology but there was still multifocal / moderate damage, so it was included in the score category 2. The Treatment 3 group, which was given a high-fat diet and moringa flower extract with a dose of 600 mg/KgBW, showed a renal histological structure that was close to that of the Control group, so it was included in the 0 score category.

The results of this study showed that the administration of moringa flower extract at doses of 400 mg/KgBW and 600 mg/KgBW could improve the histological structure of the kidneys in male white rats of the Wistar strain who were obese. However, the dose of 600 mg/KgBW is more effective because it is closer to the normal group. This can be seen from the results of the observation of renal histopathology in the Control group and the Treatment 3 group which have a shape that is not much different. The improvement of the histological structure of the kidney organs of male white rats of the Wistar strain who were obese was inseparable from the content of compounds possessed by moringa flower extract.

Table 4. Normality Test

Groups	df	Sig
Control	6	.200
P1	6	.200
P2	6	.200
P3	6	.200

Table 5. Homogeneity Test

Levene static	df1	df2	Sig
0.181	3	20	.908

From the results of the normality test, it can be seen that all data are normally distributed ($p > 0.05$), therefore it is continued with a homogeneity test using the Levene test to find out whether each variant of the population group of this study is the same or homogeneous. The results of the homogeneity test using the Levene test can be seen in the table above. The probability value in the significance column is 0.908. The significance probability value obtained is greater than 0.05, so it can be concluded that the Control group, Treatment 1 group, Treatment 2 group, and Treatment 3 group come from populations that have the same variance, or are homogeneous.

The results of the One-Way Anova test show that the resulting significance value is 0.000 or < 0.05. Based on these data, it can be concluded that there is a significant difference between the Control group and the Treatment group. The results of the analysis showed a significant difference between the Control group and the Treatment 1 group (p= 0.000) and the Treatment 2 group (p= 0.000). Meanwhile, the Control group and the Treatment 3 group did not have a significant difference (p= 0.158).

Table 6. One Way Anova *Test Results* on Urea Levels

	Sum	df	Mean square	F	Sig
Between Groups	69.823	3	23.274	52.010	.000
In Groups	8.950	20	.447		
Total	78.773	23			

Table 7. Post-Hoc LSD Test Results on ALT Levels

Groups		Mean difference	Sig
Control	Treatment 1	-4.38333*	.000
	Treatment 2	-2.25000*	.000
	Treatment 3	-.56667	.158
P1	Control	4.38333*	.000
	Treatment 2	2.13333*	.000
	Treatment 3	3.81667*	.000
P2	Control	2.25000*	.000
	Treatment 1	-2.13333*	.000
	Treatment 3	1.68333*	.000
P3	Control	.56667	.158
	Treatment 1	-3.81667*	.000
	Treatment 2	-1.68333*	.000

The results of the One-Way Anova test showed that there was a significant difference between the Control group and the Treatment group. Post-hoc LSD follow-up tests were conducted to analyze the difference in the average creatinine levels between groups. The results of the analysis showed that there was a significant difference between the Control group and the Treatment 1 (p= 0.000) and 2 (p= 0.000) groups and there was no significant difference with the Treatment 3 group (p= 0.070).

Discussion

This study was conducted to test and analyze the effectiveness of moringa flower extract on the kidney function of male Wistar strain white rats in the obesity model based on urea and creatinine levels and how the histopathological picture. The condition of the kidney histology of mice that had gone through the trial process was then analyzed. The control group had a typical picture of renal histology. The results of renal histopathology observations in the control group were used as a reference to describe other groups and become a comparison. In the Treatment 1 group that was given a high-fat diet and moringa flower extract at a dose of 200 mg/Kg BW, there was a difference in the shape of the kidney structure because the organ were already exposed to a high-fat diet and obesity. In the histological picture of the Treatment 1 group, which was given moringa flower extract at a dose of 200 mg/Kg BW, there was damage to kidney cells, so it was included in the score category of 4 (there was diffusion/severe damage). The Treatment 2 group, which was given moringa flower extract at a dose of 400 mg/Kg BW, showed improvements in the structure of kidney histology. However, there was still multifocal/moderate damage, which was included in the score category 2. The Treatment 3 group, given a high-fat diet and moringa flower extract with a dose of 600 mg/Kg BW, showed a renal histological structure close to that of the Control group, which was included in the zero score category.

Table 8. One Way Anova *Test Results* at AST Levels

	Sum	df	Mean square	F	Sig
Between Groups	65.368	3	21.789	57.127	.000
In Groups	7.628	20	.381		
Total	72.996	23			

Table 9. Post-Hoc LSD Test Results on AST Levels

Groups		Mean difference	Sig
Control	Treatment 1	-4.33333*	.000
	Treatment 2	-1.90000*	.000
	Treatment 3	-.68333	.070
P1	Control	4.33333*	.000
	Treatment 2	2.43333*	.000
	Treatment 3	3.65000*	.000
P2	Control	1.90000*	.000
	Treatment 1	-2.43333*	.000
	Treatment 3	1.21667*	.003
P3	Control	.68333	.070
	Treatment 1	-3.65000*	.000
	Treatment 2	-1.21667*	.003

The observation results showed that administering moringa flower extract at a dose of 600 mg/KgBB could improve the structure of renal histology in male white rats of the Wistar strain who were obese. This can be seen from the results of renal histopathological observations in the Control group and the Treatment 3 group, which are not very different. The improvement of the histological structure of the kidney organs of male white rats of the Wistar strain who were obese was inseparable from the content of compounds possessed by moringa flower extract. The secondary metabolite content in moringa flower extract can repair cell tissue damaged by a high-fat diet and obesity conditions experienced by white rats of the Wistar strain.

The results of phytochemical tests that have been carried out show that moringa flower extract contains secondary metabolites in the form of flavonoids, saponins, tannins, and triterpenoids. The content of moringa flower extract obtained in this study is in line with the results of previous research.[22] The study conducted a literature study of research that tested the phytochemical content in moringa plants and found phytochemical compounds in the form of alkaloids, flavonoids, saponins, triterpenoids, tannins, and steroids. The flavonoid content in moringa flower extract can help improve kidney function that is damaged due to obesity. This is in line with research conducted by Cao *et al.*[23] which found that flavonoids play an essential role in preventing and managing chronic kidney disease and renal fibrosis. Flavonoid compounds can avoid dysfunctional kidneys and improve kidney function by blocking or suppressing harmful pathways like oxidative stress and inflammation.

Conclusion

Moringa flower extract contains secondary metabolites in saponins, tannins, flavonoids, alkaloids, and steroids that help repair kidney cells that experience fattening and decreased kidney function due to obesity. The administration of moringa flower extract at 600 mg/Kg BW effectively improved kidney function in white rats of the obese wistar strain. This improvement can be seen through improved urea, creatinine, and renal histological structure levels. The results of histopathological observation of kidney tissue in the Treatment 3 group, namely moringa flower extract with a dose of 600 mg/Kg BW, experienced the most significant improvement and were close to the control group compared to other groups.

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