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The Effect of Administering Kelor Flower (*Moringa Oleifera*) Extract on Reducing Cholesterol Levels and Histopathological Features of The Testis of White Rats (*Rattus norvegicus*) Male Wistar Strain Obesity

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ABSTRACT

Obesity and high cholesterol levels have garnered clinical attention for male infertility. The numerous compounds in Kelor flowers or Moringa make it a potential cholesterol medication. The research data were analyzed using SPSS, and the study was conducted as a true experiment using test animal samples of twenty-four male Wistar rats (*Rattus norvegicus*). The purpose of this study was to examine the histopathological features of obese male Wistar rats (*Rattus norvegicus*) and to determine whether or not the administration of Kelor flower extract (*Moringa ternatea*) reduced cholesterol levels and improved testicular function. Obese white Wistar rats had their total cholesterol levels decreased by 400 mg/kgBW and 600 mg/kgBW of Kelor flower extract, respectively, according to the study's results. The group that received 600 mg/kgBW of Kelor flower extract showed the most improvement and was the most similar to the control group in testicular histopathology studies. The substances found in Kelor or Moringa flowers have been found to improve testicular function and lower total cholesterol levels in people who suffer from obesity, according to the research.

Keywords:

Kelor Flower, Cholesterol Level, Testicular Function, Obesity

1. INTRODUCTION

Our health is greatly affected by the food that we eat. Your resting energy expenditure and degree of physical activity determine the number of calories you burn and store. Obesity occurs when caloric intake exceeds energy expenditure [1].

The illness known as obesity develops when an abnormally high amount of fat is stored in the body. Adults, adolescents, and children of all ages in both developed and developing nations are impacted by this condition, which leads to various health issues. As a result of its worrying global prevalence, obesity has emerged as a critical public health issue in the modern era [2].

Obesity is a disease that has increased rapidly over the last decades and is caused by environmental, human, and genetic factors, most likely working in combination. Environmental factors contributing to the increase in obesity include but are not limited to decreased physical activity, increased television viewing time, and a sedentary lifestyle; increased food consumption, especially energy-dense, high-calorie, palatable foods served in increased portion sizes; and use of medications with weight gain as a side effect. However, although most individuals are exposed to these environmental factors, not everyone becomes obese, suggesting that different genetic mechanisms predispose specific individuals to develop obesity [3].

The body mass index (BMI) can be used to determine if a person is obese or not. One common way to categorize obesity is by body mass index (BMI). Levels of obesity are associated with an increase in mortality, morbidity, and comorbidities [3]. Adults are often classified as overweight or obese based on their body mass index (BMI), which is a straightforward measure of weight relative to height. A person's body mass index (BMI) is calculated by dividing their height in meters squared by their weight in kilograms. A body mass index (BMI) of 30

kg/m2 or above is considered obese, according to the World Health Organization (WHO), whereas a BMI of 25 kg/m2 or lower is considered overweight [4].

At this point, obesity is a significant risk factor for chronic disease. Obesity increases insulin resistance, glucose tolerance, cholesterol, and glucose triglycerides. The jaw's self-functioning causes the tightness of the jaw in the body as an endocrine organ. Insulin resistance and type 2 diabetes are caused by hormone resistance, which the liver attempts to eliminate [5]. Then, they go on to inject another hormone, leptin, which is toxic to the cardiovascular system. The pancreas can potentially increase the risk of many cancers by lowering insulin resistance by producing more insulin [6]. Infertility in women is another negative effect of obesity [7].

Recent decades have seen an uptick in clinical and academic interest in male infertility. The reason for this is because the prevalence level is rising. Among the known causes of infertility, men account for almost 20% to 30% [8]. Approximately 90% of male infertility cases are caused by poor spermatogenesis and quantity, making sperm quality and quantity deficiencies the most prevalent reasons [9]. About half of the couples who seek help for infertility also have male infertility. When men are unable to conceive, fundamental sperm analysis might help pinpoint the cause. Tests using sperm allow for the evaluation of a variety of parameters, such as ejaculate volume, sperm concentration (density), motility, and morphology. We determined the total and motile count by analyzing the volume, concentration, and percentage of motile sperm in the ejaculate. The researchers also checked the sperm agglutination level, white blood cell concentration, viscosity, and semen pH [10]).

Physical (old age, weight, body composition, etc.), pathological (metabolic syndrome, infection, inflammation, etc.), psychological (anxiety, trauma, stress, etc.), lifestyle (exercise, smoking, alcohol consumption, drug abuse, etc.), and environmental (exposure to heavy metals, radiation, etc.) variables can all impact a man's ability to conceive [11]. One prevalent mechanism in the prediction of male infertility is oxidative stress, which can be induced by all the conditions described above and more. The end outcome is chronic illnesses characterized by excessive cell damage, which includes problems with male reproductive tissue that impact fertility [10].

An imbalance between the formation of reactive oxygen species (ROS) and the antioxidant defense system is known as oxidative stress [12]-[13]. It is being discussed as a potential role in male infertility. Due to the high rates of cell division and mitochondrial oxygen consumption in testicular tissue and the similar quantities of unsaturated fatty acids compared to other tissues, oxidative stress is an essential component in the development of male infertility. The testicular arteries are weak, so oxygen tension levels are also low, leading to intense competition for oxygen among cells. The male reproductive system and testicular tissue are particularly susceptible to oxidative stress due to this situation [14].

Because plasma cholesterol levels are associated with an increased risk of several ailments, the public's interest in cholesterol diets is rising. Awareness of the cholesterol content in food consumption is crucial, as animal products (e.g., eggs, meat, dairy, etc.) contribute about 20–25% of total body cholesterol. Because nutrition food labels should educate consumers about nutritious meals and the right food choices to decrease nutrition-related illnesses, laboratories must supply producers with food nutrition information for accurate food labeling. Accordingly, it is highly recommended that technology for quantifying cholesterol be developed to accurately evaluate the cholesterol level of meals [15].

Participating in athletic activities is another tactic that could be used. According to a plethora of research, exercise can keep brain cells from dying. However, many people cannot stick to an exercise routine for various reasons, including lack of time or physical ability. As a result, we need to find alternatives to exercise that have the same or better health benefits, including using plant-based medications with fewer adverse side effects [15]. *Moringa Oleifera* is one of the plants.

One member of the Moringaceae family, the Moringa tree (*Moringa Oleifera*), can grow to a height of 5–10 meters. A nutritious plant, moringa is grown throughout Asia, Africa, and Arabia due to its high vitamin and protein content [16]. Many of this plant's numerous actions and health advantages have been linked to its phytochemical components, which exhibit a broad spectrum of pharmacological effects [17]. Potassium, calcium, phosphorus, iron, vitamins A and D, vital amino acids, carbs, and powerful antioxidant chemicals like ß-carotene, vitamin C, and flavonoids are abundant in this plant, according to phytochemical research [18].

Moringa, scientifically known as *Moringa Oleifera*, is a very hardy plant. As a result, this plant may thrive in hot and cool climates, even when planted in partial shade. Moringa is said to thrive in regions with 250 to 1,500 mm of rainfall per year and can withstand lengthy periods of drought [19]. In Indonesia, moringa trees may grow naturally on hill slopes and at altitudes up to 1,000 m above sea level. It is expected to see this plant in river basins or grasslands. In its natural state, the Moringa plant is resistant to drought and disease. Moringa plants thrive in various tropical and subtropical climates, with ideal growing circumstances including temperatures between 25 and 35 degrees Celsius, annual rainfall of 250 to 2,000 millimeters, and adequate watering during dry spells. Soils with a pH between 5 and 9, fewer than 800 mm of silt or clay, and sand [20].

According to studies done on every component of the Moringa plant by [18]. According to these studies, the Moringa bloom is rich in phytochemicals. Flowers, seeds, leaves, roots, and bark are the plant parts with the highest concentrations of phytoconstituents. Hence, the efficacy of Moringa flower extract in lowering cholesterol and enhancing testicular function in obese mice is of great interest to the research community.

2. METHOD

As a form of experimental quantitative research, this study is an actual experiment. A serious experimental study involves controlling all external variables that might impact practical activities; this is what we mean when we say an experiment is actual [21]. In this study, male Wistar rats (*Rattus norvegicus*) that were overweight had their cholesterol levels and testicular histopathology compared before and after they were given an extract from the *Moringa Oleifera* flower. The Anatomic Pathology Laboratory and the Department of Pharmaceutical Pharmacology at the University of North Sumatra's Faculty of Medicine conducted the experiments.

This study utilized male Wistar rats (*Rattus norvegicus*) who were 2-3 months old, weighed 160–200 grams, and participated in the experiment [22]. Since male Wistar rats are one of the most popular research animals in biomedicine and share many physiological and behavioral traits with humans, they were an obvious choice for our study.

A dependent variable is defined as an outcome of an independent variable that affects or causes the dependent variable to exist. Every dependent variable has an independent variable that either influences it or is a result of it. Anything varying across research subjects is considered a variable [23]. Testicular histopathology, cholesterol levels, and the effects of administering Moringa flower extract to obese male Wistar rats (*Rattus norvegicus*) were the research variables in this study. One thing that may be changed is the outcome, which is based on ingesting *Moringa Oleifera* flower extract. Reducing cholesterol levels, symptoms of testicular histopathology, and the factors that must be considered include poor eating habits that cause an increase in body fat.

After that, SPSS (Statistics of Package for Social Science) 25.0 for Windows was used to analyze the research data. With a p-value greater than 0.05, the Kolmogorov-Smirnov test was used to examine the data for normality. To determine if there was a significant relationship between the groups, a one-way analysis of variance (One-way ANOVA) was used with a 95% confidence level ($p < 0.05$) [24]. To do further analysis or testing, the Post Hoc Test with the LSD approach was employed.

3. RESULTS AND DISCUSSION

Descriptions of research results to analysis and interpretation of research data:

Table 1. Characteristics Test Animals

Component	Group K	Group P1	Group P2	Group P3
Rat Type	White *Rattus norvegicus* Wistar strain			
Gender	Male			
General Conditions	White coat color, healthy and active			
Average Initial Body Weight	221gr	229gr	232gr	228gr
Average Final Weight	232gr	311gr	318gr	314gr

Every day, mice were given a diet heavily laden with fat and cholesterol. The quail egg yolk was the meal that was provided. Cholesterol levels are elevated exogenously by this meal. Before beginning the administration treatment of moringa flower extract (*Moringa Oleifera*), the patient was placed on a high-fat, high-cholesterol diet for 14 days. Body weight, as determined by the Lee index, was utilized to validate the mice's obesity.

Table 2. Mouse Body Weight

Parameters	Group	Average	
		Before a high-fat diet	After a high-fat diet
Body Weight (gr)	Control	221gr	232gr
	P1	229gr	311gr
	P2	232gr	318gr
	P3	228gr	314gr
Naso-anal Length (mm)	Control	212mm	213mm
	P1	213mm	214mm
	P2	214mm	216mm
	P3	217mm	218mm
Lee index	Control	0.28	0.28
	P1	0.28	0.31
	P2	0.28	0.31
	P3	0.28	0.31

According to the data, the Lee index value in the treatment group was 0.28 before the high-fat diet. The obesity condition does not contain this number if it is less than <0.3. The rats' body weight and nasal length were measured again to establish the Lee index value after 14 days of ingesting a high-fat diet consisting of quail egg yolk. A change to 0.31 in the Lee index was seen in the therapy group. This research suggests that the treatment group of rats was already fat before the moringa flower extract (*Moringa Oleifera*) was tested.

Table 3. Total Cholesterol Level of Rats After Moringa Flower Extract Administration

No	Group	Repetition	Total cholesterol level after high-fat diet (mg/dl)	Whole cholesterol level after moringa flower extract administration (mg/dl)
1	Control	1	37.5	37.9
2		2	38.2	38.5
3		3	36.2	36.7
4		4	37.2	37.6
5		5	38.1	38.1
6		6	39.1	39.6
		Average	37.71	38.06
7	Treatment I	1	68.1	58.2
8		2	69.5	59.1
9		3	67.7	57.5
10		4	68.3	58.7
11		5	69.2	57.9
12		6	66.9	59.5
		Average	68.28	58.48
13	Treatment II	1	69.1	50.1
14		2	67.3	49.2
15		3	68.9	50.4
16		4	67.8	49.8
17		5	68.1	51.2
18		6	68.4	48.9
		Average	68.26	49.93
19	Treatment III	1	69.3	39.8
20		2	67.2	40.1
21		3	69.4	37.4
22		4	68.3	36.3
23		5	70.1	38.6
24		6	68.2	38.1
		Average	68.75	38.38

After 14 days of treatment with moringa flower extract therapy (*Moringa Oleifera*), researchers rechecked the animals' cholesterol levels. The cholesterol levels in each group are decreasing in the table above. The average cholesterol level in the control group increased from 37.71 mg/dl to 38.06 mg/dl after 14 days. The absence of a high-fat diet in the control group resulted in normal total cholesterol levels. The first treatment group dropped from an initial level of 68.28mg/dl to 58.48mg/dl after receiving 200mg/KgBW of Moringa flower extract (*Moringa Oleifera*).

Even if treatment group 1's cholesterol levels have dropped, they are still considered high. Group 2's dosage of 400 mg/kg of *Moringa Oleifera* flower extract (*Moringa Oleifera*) likewise reduced the initial level from 68.26 mg/dl to 49.93 mg/dl; group 3's dose of 600 mg/dl reduced the original level from 68.75 mg/dl to 38.38 mg/dl, the most significant drop. Cholesterol levels were reduced to less than 54 mg/dl in the group that received 400mg/KgBW and 600mg/KgBW doses of Moringa flower extract (*Moringa Oleifera*), according to the results.

Table 4. Phytochemical Test

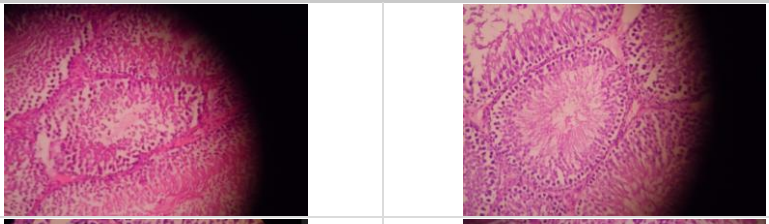
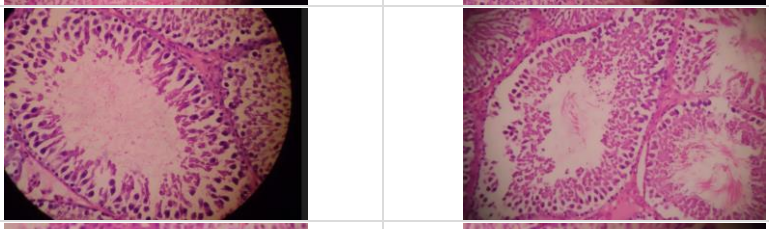
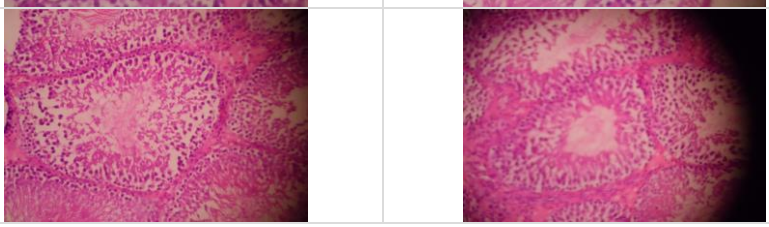
Secondary Metabolites	Color	Results
Flavonoid	Red	+
Saponin	Yellow and effervescent	+
Tannin	Blue-green	+
Alkaloid	Yellow	+
Steroid	Green	+

(+) = Contains the tested compound class

(-) = Does not contain the tested compound

Based on the results of phytochemical tests that have been carried out, it can be concluded that Moringa flower extract contains secondary metabolites in the form of flavonoids, saponins, tannins, alkaloids, and steroids.

Table 5. Histopathologic Features of Testicular Tissue

No	Group	Histopathologic features of testicular tissue
1	Control	
2	Treatment 1 (200mg/Kg BW)	
3	Treatment 2 (400mg/Kg BW)	
4	Treatment 3 (600mg/Kg BW)	

The histopathology showed different cell shapes. Routine testicular histopathology was seen in the regular pellet and distilled water control group. The score ten category includes normal tubule epithelium, complete spermatogenesis, and $\geqslant$ ten spermatozoa cells. The control group's testicular histopathology was standard because it was not fed a high-fat diet and *Moringa Oleifera* flower extract.

In treatment group 1, which received a high-fat diet and 200mg/KgBW *Moringa Oleifera* flower extract, the testicular structure changed due to a high-fat diet and obesity. Treatment group 1 (200mg/KgBW *Moringa Oleifera* flower extract) showed less densely packed spermatogenic cells than the control group, scoring 4 (Spermatozoa and spermatid cells 0, spermatocyte cells <5) in histology. The second group, which got 400 mg/kgBW of *Moringa Oleifera* flower extract, improved testicular histology but scored eight due to spermatozoa cells under 10. A high-fat diet and 600 mg/kgBW *Moringa Oleifera* flower extract gave the third treatment group a score of 10 for testicular histological structure identical to the control group.

Normality Test Data Analysis Results

The normalcy test aims to ascertain if the data follows a normal distribution. This study employed the Kolmogorov-Smirnov Test to investigate the possibility of normalcy. Because data that follows a normal distribution represents the population, the data normality test is crucial. The data is said to be regularly distributed if the p-value is more significant than 0.05 and not normally distributed if the p-value is less than 0.05 [24].

Table 6. Normality Test Results

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Result	Control	.151	6	.200*	.985	6	.972
	P1	.146	6	.200*	.976	6	.927
	P2	.144	6	.200*	.977	6	.936
	P3	.170	6	.200*	.962	6	.834

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on the results of the normality test that was carried out using the Kolmogorov-Smirnov Test, there was a significance of 0.200 in all groups. Data is said to be normally distributed if the p value> 0.05. Therefore, it can be concluded that the data is normally distributed. After the data is known to be normally distributed, the homogeneity test is continued using the Levene test to determine whether each variant of the research population group is the same or homogeneous.

Results of Homogeneity Test Data Analysis

Using a 5% significance threshold, the Levene test was used to check for group homogeneity. According to the rule of thumb for decision-making, a significance value less than 0.05 indicates that the data is not homogenous. In contrast, a significance value of more than 0.05 suggests that the data is homogeneous.

Table 7. Homogeneity Test Results

		Levene Statistic	df1	df2	Sig.
Result	Based on Mean	1.070	3	20	.384
	Based on Median	1.060	3	20	.388
	Based on the Median and with adjusted df	1.060	3	15.105	.395
	Based on trimmed mean	1.069	3	20	.384

In the table, you can see the outcomes of the Levene test for homogeneity. In the significance column, the probability value is 0.384. It may be inferred that the control group, treatment group-1, treatment group-2, and treatment group-3 are either homogenous or originate from populations with a variance equal to or greater than 0.05 based on the significant probability value obtained.

One-Way ANOVA Test Data Analysis Results

We use the One-way ANOVA test to see if there is a statistically significant difference in the efficacy of the trial groups after making sure the data is normal and homogeneous and that the findings follow a normal distribution with homogenous variances. This is the information retrieved by the One-way ANOVA analysis.

Table 8. One-Way Anova Test Results

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1787.191	3	595.730	551.134	.000
Within Groups	21.618	20	1.081		
Total	1808.810	23			

The significant value is 0.000, less than 0.05, according to the One-Way ANOVA test findings in the table above. It is clear from these numbers that the treatment group differs significantly from the control group. The

following table shows the results of the post hoc LSD further test that was used to examine the average difference in total cholesterol levels between the groups:

Table 9. LSD Post-Hoc Test Results

(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Control	P1	-20.76667*	.60025	.000	-22.0188	-19.5146
	P2	-12.21667*	.60025	.000	-13.4688	-10.9646
	P3	-.66667	.60025	.280	-1.9188	.5854
P1	Control	20.76667*	.60025	.000	19.5146	22.0188
	P2	8.55000*	.60025	.000	7.2979	9.8021
	P3	20.10000*	.60025	.000	18.8479	21.3521
P2	Control	12.21667*	.60025	.000	10.9646	13.4688
	P1	-8.55000*	.60025	.000	-9.8021	-7.2979
	P3	11.55000*	.60025	.000	10.2979	12.8021
P3	Control	.66667	.60025	.280	-.5854	1.9188
	P1	-20.10000*	.60025	.000	-21.3521	-18.8479
	P2	-11.55000*	.60025	.000	-12.8021	-10.2979

*. The mean difference is significant at the 0.05 level.

Groups were compared for significant differences in wound healing using the LSD Post Hoc test. The analysis revealed a substantial difference between the control group and treatment groups 1, 2, and 3 ($p = 0.000$) and between the control group and group 4 ($p = 0.000$). There were no significant changes ($p = 280$) between treatment groups 2 and 3.

Discussion

This study examined the effects of moringa flower extract (*Moringa Oleifera*) on testicular histopathology, cholesterol levels, and testicular function in obese male Wistar rats (*Rattus norvegicus*). Specifically, twenty-four white rats (*Rattus norvegicus*) Wistar will be split into four groups for this research. The first set of rats was a control; they received only ordinary pellet food and purified water. The treatment group was administered a high-fat diet and varying amounts of Moringa flower extract (*Moringa Oleifera*)—200, 400, and 600 milligrams per kilogram of body weight.

The experiment started with 14 days of a high-fat diet to prepare the animals for testing. To determine if the rats were obese after the high-fat diet, we measured their weight and nasal length again. According to the data, the rats in treatments 1, 2, and 3 had a Lee index value of 0.31 following a high-fat diet.

Many different things, including people's actions and their genes, contribute to the development of obesity, making it a complicated health concern. Exercising, sitting around all day, eating poorly, taking too many medications, and other exposures are all examples of behaviors [25]. One of the leading causes of the high cost of chronic illnesses is obesity. Elevated cholesterol levels are associated with an increased risk of obesity [26]. Cholesterol serves several purposes, yet it risks the organism when blood concentrations become abnormal. Several health problems might manifest when cholesterol levels are out of whack [27]. Obesity has detrimental impacts on male infertility as well [7]. This happens because of the oxidative stress that occurs when people are overweight.

New evidence points to oxidative stress—a state defined by an imbalance between ROS production and the antioxidant defense system—as a potential cause of male infertility [12]. Because testicular tissue has a comparable amount of unsaturated fatty acids as other tissues and a speedy cell division rate and mitochondrial oxygen consumption, oxidative stress is critical in the onset of male infertility. Also, the testicular arteries are not very strong, so there is not a lot of oxygen pressure, which means that cells are fighting for what little oxygen there is. The male reproductive system, including the testicles, is highly vulnerable to oxidative stress due to these circumstances [14].

Diet, pollution, and chemicals are among the environmental variables that might impact this capability. Consequently, antioxidant defenses are insufficient to keep oxidative stress and its dangerous byproducts at bay. To enhance spermatogenesis, it is necessary to increase the body's ability to combat free radical-induced oxidative stress, which may be achieved by using antioxidants and developing antioxidant treatments [14]. Moringa is one of the plants that is rich in antioxidants [28].

Moringa is among the most nutrient-rich food crops. An abundance of vital nutrients, including proteins, minerals, vitamins, and polyphenols, are present in it. A wide variety of phytochemicals, such as alkaloids, tannic acid, saponins, terpenoids, cardiac glycosides, isothiocyanates, anthraquinones, and flavonoids, are abundant in this plant [19]. Its pharmacological (hepatoprotective, antihypertensive, cholesterol-lowering, anti-urolithiasis, antifertility, antidiabetic, antioxidant, nutraceutical, and antimicrobial) and non-pharmacological aspects make it helpful in treating severe malnutrition [17]. According to phytochemical research, this plant is an excellent source of several nutrients, including potassium, calcium, phosphorus, iron, vitamins A and D, carbohydrates, vital amino acids, and powerful antioxidants, including ß-carotene, vitamin C, and flavonoids [18].

This finding motivated the current investigation into the potential of Moringa flower extract as a natural remedy for obesity, namely in lowering total cholesterol and improving testicular function. Data analysis was required to examine and test the data generated by this 14-day observational study approach. The next step is to run a standard test on the processed data. Using SPSS and the Kolmogorov-Smirnov test, we got data that passed the normalcy test. All test groups' findings followed a normal distribution; the p-values were less than 0.200. This data may be used to conclude the population since it follows a normal distribution.

Next, we used the Levene test to check if the normally distributed data was from a homogeneous population with the same variance. The results demonstrate a significance level of 0.384. It may be inferred that the control and treatment groups 1, 2, and 3 represent the same population since the resulting significant probability value is more extensive than 0.05. Next, we used the One-Way ANOVA test to see if the data was influential and statistically substantial, ensuring it was normally distributed and homogenous.

The one-way ANOVA test results in a significant value of 0.000 or more than 0.05. This data suggests that the control, treatment 1, and therapy two groups differ significantly from one another, necessitating additional post hoc LSD testing. If there are statistically significant variations in the rate of wound healing across groups, the LSD post hoc test will reveal them. The analysis revealed a substantial difference between the control group and treatment groups 1, 2, and 3 ($p = 0.000$) and between the control group and group 4 ($p = 0.000$). There were no significant changes ($p = 280$) between treatment groups 2 and 3.

This study demonstrates total cholesterol levels in obese male Wistar rats (*Rattus norvegicus*) drop across all experimental groups. By comparing the various average numbers, we can observe that the reduction in total cholesterol levels varies. The intermediate cholesterol level in the control group increased from 37.71 mg/dl to 38.06 mg/dl after 14 days. The control group's lack of a high-fat diet allowed their total cholesterol levels to remain within the normal range. The first treatment group dropped from an initial level of 68.28mg/dl to 58.48mg/dl after receiving 200mg/KgBW of Moringa flower extract (*Moringa Oleifera*). Although there has been a reduction, the cholesterol levels in the first therapy group are still considered excessive. In group 2, the dosage of 400 mg/kg of *Moringa Oleifera* flower extract (*Moringa Oleifera*) was likewise reduced from 68.26 mg/dl to 49.93 mg/dl; in group 3, the dose of 600 mg/dl was the most effective, resulting in a decline from 68.75 mg/dl to 38.38 mg/dl. High cholesterol levels were no longer an issue for the group that received 400mg/KgBW and 600mg/KgBW doses of Moringa flower extract (*Moringa Oleifera*), as their cholesterol levels dropped below 54mg/dl.

The histological findings revealed that the control group, which was given ordinary pellets and distilled water, had a typical testicular histology image and scored a 10, which means that there was normal tubule epithelium, complete spermatogenesis, and at least ten spermatozoa cells. Compared to the treatment group that received a high-fat diet and *Moringa Oleifera* flower extract, the control group's testicular histopathology was in standard shape since it was not given a high-fat diet.

Because the organs had been exposed to the high-fat diet and obesity, there were variations in the form of the testicular structure in treatment group 1, which was administered a high-fat diet and *Moringa Oleifera* flower extract (*Moringa Oleifera*) at a level of 200mg/KgBW. Treatment group 1, which received 200mg/KgBW of *Moringa Oleifera* flower extract, had spermatogenic cells arranged less tightly than the control group, placing it in the score four categories (Spermatozoa and spermatid cells 0, spermatocyte cells <5) in the histology image. The histological structure of the testes improved in treatment group 2, which received 400mg/KgBW of *Moringa Oleifera* flower extract. However, the group was still classified as having a score of 8 spermatozoa cells since their number was less than 10. Group 3, which had a high-fat diet and 600 mg/kg of *Moringa Oleifera* flower extract, had a testicular histological structure similar to the control group, so they were placed in score category 10. Obese male white rats (*Rattus norvegicus*) had their testicular organs histologically improved by the chemical content of *Moringa Oleifera* flower extract.

Phytochemical studies have shown that the extract of moringa flowers includes a variety of phytochemicals, including steroids, alkaloids, tannins, saponins, and flavonoids. Activated chemicals having inherent antioxidant activity, such as flavonoids and alkaloids, can lower cholesterol levels in rat blood [29]. In addition to their potent antioxidant capacity and physiological benefits, tannins have been found to aid in the weight reduction of obese mice by reducing blood pressure and serum cholesterol levels [30].

The results showed that compared to the group that received merely distilled water, the one given moringa flower extract had better testicular function and lower cholesterol levels. These findings corroborate a prior study by [31] that indicated that the *Moringa Oleifera* plant extract might lower cholesterol levels in the Wistar strain of white rats (*Rattus norvegicus*).

4. CONCLUSION

Studies show that lowering total cholesterol levels in obese white rats may be achieved with 400mg/KgBW and 600mg/KgBW of Moringa flower extract (*Moringa Oleifera*). Both groups' cholesterol levels are below 54 mg/dl, which indicates this. Group 3, which received 600 mg/KgBW of moringa flower extract (*Moringa Oleifera*), showed the most improvement and was close to the control group compared to the other groups. Phytochemical tests revealed that this extract contained secondary metabolite compounds, such as steroids, alkaloids, tannins, saponins, and flavonoids. These chemicals enhance testicular function and lower overall cholesterol in overweight Wistar white rats (*Rattus norvegicus*).

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