

The Effect of *Moringa oleifera* Fruits Extract in Lowering Triglycerides Levels in Obesity

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Abstract

Obesity is a global health problem that is often accompanied by hypertriglyceridemia as a manifestation of lipid metabolism disorders. Moringa fruit contains bioactive compounds that have the potential to be a natural hypolipidemic agent. Objective: This study aims to determine the effect of moringa fruit extract administration on triglyceride levels in obese model mice. An experimental study used 30 male Sprague Dawley mice divided into five groups: normal control, obesity negative control, positive control with vitamin C 15 mg/kgBB, moringa fruit extract treatment 500 mg/kgBB once daily, and moringa fruit extract treatment 500 mg/kgBB twice daily. Obesity was induced with a high-fat, high-protein feed for 49 days, followed by treatment for 14 days. Triglyceride levels were measured using the ELISA method and analyzed by the One-Way ANOVA test. The obese group showed the highest triglyceride levels (265.767 mg/dL) compared to the normal control (191.639 mg/dL). The administration of moringa fruit extract lowered the triglyceride level to 230,054 mg/dL for a once-daily dose and 212,463 mg/dL for a twice-daily dose. Statistical tests showed a significant difference ($p < 0.05$) between the twice-daily treatment group and the obesity group. Moringa fruit extract was effective in lowering triglyceride levels in obese rats, with administration twice daily showing more optimal results.

Keywords: Hypertriglyceridemia; moringa fruit extract; *Moringa oleifera*; obesity; triglycerides.

INTRODUCTION

Excessive fat accumulation due to an imbalance of energy intake with energy used for a long time is known as obesity. This condition has developed into a global health problem with a prevalence that continues to increase in various parts of the world. Data *World Health Organization* (WHO) shows that about 2.5 billion adults are overweight, and as many as 890 million people are classified as obese. This excessive accumulation of body fat can increase the risk of various chronic diseases such as diabetes mellitus, cardiovascular disease, and cancer (Agung et al., 2022). In Indonesia, the prevalence of obesity in adults >18 years old reached 23.4%, an increase of 1.6% over 5 years from 21.8% in 2018.

Excess fat accumulation in obese people results in an increase in the amount of free fatty acids hydrolyzed by the endothelial lipoprotein lipase enzyme. This increase triggers the production of oxidants that negatively affect the endoplasmic reticulum and mitochondria. *Free Fatty Acid* (FFA) released due to excess fat accumulation also inhibits lipogenesis, thereby inhibiting serum triacylglycerol metabolism and resulting in increased blood triglyceride levels (Setyani, 2023).

Physiologically, triglycerides are the main form of energy storage in adipose tissue and play a role in the supply of energy through the breakdown into free fatty acids that can be utilized by the body's cells when needed. Hypertriglyceridemia is one of the manifestations of dyslipidemia that is often found in obesity and is an important indicator of obesity related to lipid metabolism disorders, insulin resistance and metabolic syndrome so it is necessary to understand the mechanism to prevent various complications due to obesity. High triglyceride levels not only reflect metabolic disorders in obesity but are also associated with an increased risk of cardiovascular events such as heart disease and stroke. The triglyceride index to HDL-C is recognized as an effective biomarker in assessing the risk of insulin resistance and cardiometabolic complications in obesity (Tasnim et al., 2023).

Management of hypertriglyceridemia is generally carried out through pharmacological interventions, such as the administration of fibrate or niacin drugs to reduce triglyceride levels, but this management has several side effects such as gastrointestinal disorders, headaches, myopathy, increased liver enzymes, gallstones, and kidney dysfunction. Fibrates drugs have a relatively expensive price, so their use can be a limitation in the

management of hypertriglyceridemia (Sahiti et al., 2023). These limitations encourage the need to develop natural-based drugs that aim to minimize treatment side effects and are easy to obtain. Various medicinal plants that are widely found in Indonesia such as Dutch teak leaves, kemuning, galangal, and kencur have been proven to be effective as inhibitors of pancreatic lipase activity which plays a major role in fat absorption in the body. Other medicinal plants such as moringa leaves, gelugur acid, and citronella have great potential to lower lipid levels, such as triglycerides and cholesterol.

Moringa (*Moringa oleifera*) is a plant that often grows in tropical areas, this plant has a high nutritional value and is often used as a medicine because it contains bioactive compounds such as flavonoids, alkaloids, tannins, and saponins that are beneficial to the human body, as a heart stimulant, or potentially as a hypolipidemic agent (Rissa et al., 2021). *Phytomedicine* or treatment using herbal plants is still carried out because the price is affordable and easy to get (Prajapati et al., 2022). Previous research has shown that moringa leaves can significantly lower blood cholesterol levels (Pratiwi, 2023), while the leaf and root extracts of the moringa plant were able to reduce triglyceride levels, although in the root test there were weak toxic properties. The administration of moringa leaf extract in combination with moringa fruit extract resulted in a more optimal reduction in triglyceride levels compared to a single extract which requires a larger dose to achieve optimal effects (Saraswati et al., 2021). However, there are still limited studies that assess the effectiveness of moringa specifically on reducing triglyceride levels in an obese mouse model. This study aims to determine the effectiveness of giving moringa fruit extract (*Moringa oleifera* fruits) in reducing triglyceride levels in obese model mice, especially to determine the effect of giving moringa fruit extract doses of 1 x 500 mg/kgBB and 2 x 500 mg/kgBB on triglyceride levels, analyze the comparison of triglyceride levels reduction between treatment and control groups, and determine the most effective dose in reducing triglyceride levels.

METHODS

Types of Research

This study uses a type of experimental research, with a true-experimental research design, which is research conducted with the aim of determining the effect of the treatment given on the object being tested. Use postes with a control group (*Postest-only Control-group Design*) because the results will be taken after the research is conducted.

Research Time and Place

The manufacture of moringa fruit extract (*Moringa oleifera* fruits) will be carried out in March 2025, which will be extracted by the maceration method at the

Laboratory of the Department of Chemistry, Faculty of Medicine, UI. Testing on test animals will be carried out at the Pharmacology Laboratory and Stem Cell Laboratory of FK UPN "Veteran" Jakarta, while Triglyceride levels will be checked at the Biochemistry Laboratory of FK UPN "Veteran" Jakarta.

Research Sample

This study used white rats (*Rattus norvegicus*) *Sprague Dawley*, male, 8 weeks of age, weight >250 grams for obese rats, and 150-200 grams for normal rats. *Sprague Dawley white rats* are often used for research because they are known to have a stable physiological and metabolic response to a variety of pharmacological or toxicological treatments, making them suitable for testing the effects of drugs or chemicals. The mice were obtained from the Faculty of Medicine IPB, Bogor.

Inclusion and Exclusion Criteria

The inclusion criteria contained in this study refer to the characteristics of subjects that are relevant to the research problem, coming from the target population that meets the criteria. Samples must meet the following inclusion requirements: (a) *Sprague Dawley* white rats in general healthy condition; (b) 8-week-old rats; (c) Body weight >250 grams for obese rats, 150-200 grams for normal rats; (d) Male Sex. Exclusion criteria are requirements that exclude subjects from the study even if they meet the inclusion criteria, with the aim of reducing bias, the risk of obstacles in the implementation of the research, as follows: (a) Rats were sick at the time of the experiment or at the time of adaptation; (b) The rats died at the time of the study.

Large Research Sample

Determining the minimum number of mice per group to be used in this study was determined using Federer's formula, namely:

$$\text{Federer's formula} = (n-1)(t-1) \geq 15$$

Description: n: sample size t: number of groups

The results obtained from the calculation:

$$(n-1)(5-1) \geq 15$$

$$(n-1)(4) \geq 15$$

$$n-1 \geq 3.75$$

$$n \geq 4.75$$

$$n \geq 5$$

As a result of the calculation, the minimum number of rats in each treatment group is 5 to ensure the validity of the research results, because in this study there are 5 treatment groups, a total of 25 animals. However, to anticipate the possibility of *drop out* due to death or conditions that are not in accordance with the research criteria, adjustments were made to the number of samples using the following formula:

$$N = \frac{n}{1 - f}$$

Remarks: N: correction sample size n: initial sample size
f: estimated *drop out* proportion of 10%

The results obtained from the calculation:

$$N = \frac{5}{1 - 10\%}$$

$$N = \frac{5}{0,9} = 5.56$$

$$N = 6$$

The number of samples used for each group was 6 rats after rounding up. The total test animals in this study amounted to 30 mice with 5 treatment groups.

Sampling Techniques

This study uses *purposive sampling* techniques, which are sampling techniques that are included in the *non-*

probability sampling category. Sampling was carried out using certain criteria from the researcher.

Research Variables

The independent variable in this study was moringa fruit extract (*Moringa oleifera fruits*) with a dose of 1 x 500 mg/kgBB, 2 x 500 mg/kgBB given to test animals, namely obesity model rats. This dependent variable is the result of a measured change from the previous independent variable. The dependent variable in this study was the blood triglyceride levels of rats after treatment. This study had three groups of control variables. The first group is the normal control, i.e. the test animals that did not receive any intervention. The second group was a negative control, namely test animals that were obese without additional treatment. Meanwhile, the third group was a positive control, namely experimental animals that were obese and given vitamin C as exogenous antioxidant.

How Research Works

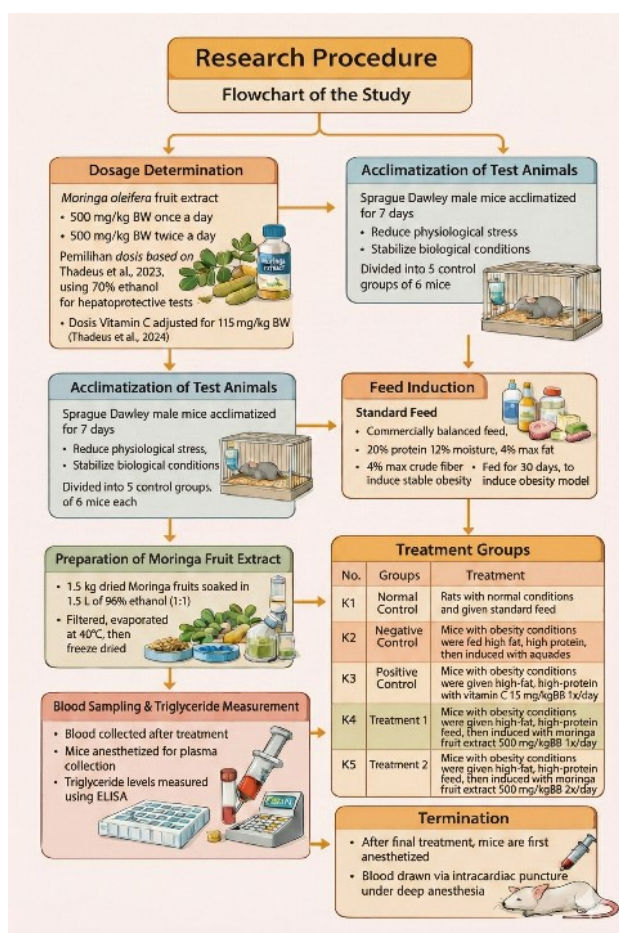


Figure 1. Flowchart of Research Methodology: A Stepwise Approach in Investigating the Effects of *Moringa oleifera* Fruit Extract on Triglyceride Levels in Obese Rat Models.

Research Ethics Submission

This study is part of a master study led by Dr. dr. Tiwuk Susantiningsih, M.Biomed., Sp.KKLP, with the main topic "Potential of *Moringa oleifera* fruits on Markers of Heart Senescence in Obesity Model Rats". This activity is supported by funding from the Institute for Research and Community Service (LPPM) for the 2025 fiscal year. All stages are designed by upholding the ethical principles of research, including respect for participants' rights, protection of security aspects, and maintaining data confidentiality. The implementation plan has gone through a rigorous ethical evaluation process, including a review of scientific methods and technical aspects in the field. The ethics submission process is carried out according to official procedures at UPN "Veteran" Jakarta and the implementation of research can only begin after obtaining ethical approval and official permission from the UPN "Veteran" Jakarta Research Ethics Committee.

Data Analysis

Data analysis of triglyceride levels after treatment was performed using a One-Way ANOVA statistical test to determine the average differences between treatment groups, as the research design used a posttest-only approach with several treatment groups. Before performing the ANOVA test, the assumption of normality was tested using the Shapiro-Wilk test, with a sample size of less than 50 ($n = 30$). The data was considered normally distributed if the p -value was greater than 0.05. After fulfilling the normality assumption, the homogeneity of variance test was performed using the Levene test, which was considered fulfilled if the p -value was > 0.05 . If both the normality and homogeneity of variance assumptions were fulfilled, the One-Way ANOVA test was performed. The ANOVA results were considered significant if the p -value was < 0.05 , indicating a significant difference in means between treatment groups. If the ANOVA results were significant, a follow-up test (Post Hoc) using the Bonferroni method was performed to determine which groups showed significant differences, with results considered significant if $p < 0.05$.

RESULTS AND DISCUSSION

Results

This study is part of a study on the potential of moringa (*Moringa oleifera* fruits) on markers of cardiac senescence in obesity model mice that have received ethical approval from KEPKK-UHAMKA with ethics number KEPKK/FK/091/09/2025. Moringa extraction was carried out at the Laboratory of the Department of Chemistry of FK UI Central Jakarta, animal care was carried out at the Animal House and termination at the Laboratory of the Department of Pharmacology of FK UPN Veteran Jakarta, while triglyceride levels were

measured at the STERC LABORATORY OF FK UPN Veteran South Jakarta. The extraction process of moringa fruit using the maceration method with 96% ethanol as much as 1.5 liters against 1.5 kg of simplicia powder produces a thick extract weighing 120 grams with a yield of 8%. The experimental animal used was a white rat (*Rattus norvegicus*) strain of *Sprague Dawley* with an initial weight of 150-200 grams. After acclimatization and high-fat feeding for 49 days, the mice achieved obesity with an average body weight of 258.67 grams (range 252-269 grams, standard deviation of 4.788). Each group then received an intervention for 14 days prior to termination. Triglyceride levels were measured from blood samples taken directly from the hearts of post-termination mice and read at 450 nm waves. The results of the measurement of triglyceride levels in each group are presented in Table 3.

Table 1. Average Triglyceride Levels.

Treatment	Mean (SD)	p -Value
K1 (Normal control)	191,639 (6.77)	
K2 (Negative control)	265,767 (21.94)	
K3 (Positive control)	193,628 (36.23)	$< 0,001$
K4 (Treatment 1)	230,720 (29.86)	
K5 (Treatment 2)	212,463 (32.67)	

Based on Table 1, the K2 group showed the highest triglyceride value with a mean of 265.767 mg/dL, while the K1 had lower levels (191.639 mg/dL). The K3 group had an average of 193.628 mg/dL which is close to K1. The treatment group showed a decrease in triglyceride levels compared to K2, where K4 had an average of 230.054 mg/dL and K5 of 212.463 mg/dL, indicating lower K5 and closer to the K1 and K3 groups. Statistical analysis began with a normality test using *Shapiro-Wilk* which showed that all groups were normally distributed with a $p >$ value of 0.05 for all groups (K1=0.716; K2=0.115; K3=0.649; K4=0.406; K5=0.973). The homogeneity test using *the Levene test* showed homogeneous data variance with a value of $p = 0.057$ ($p > 0.05$), thus qualifying for the parametric test.

The results of *the One-Way ANOVA* test in Table 3 show a value of $p = 0.000$ ($p < 0.05$), so H_0 is rejected and H_1 is accepted. This shows that there is an effect of giving moringa fruit extract (*Moringa oleifera* fruits) at a dose of 500 mg/KgBB 1x/day and 2x/day in reducing triglyceride levels in the obese rat model.

The Power of *Moringa Oleifera* Fruits Extract in Lowering Triglycerides Levels in Obesity

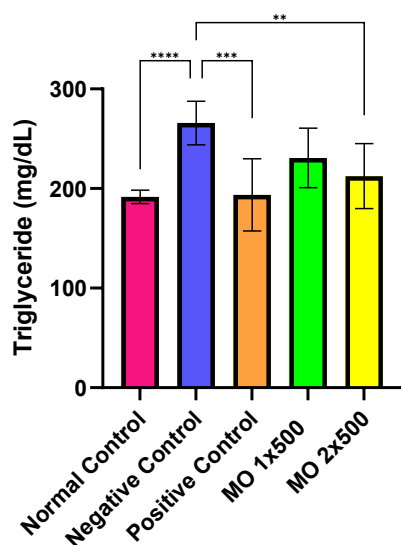


Figure 2. Titration of triglyceride levels (mg/dL) in different treatment groups. p-Values indicate significant differences between the groups ($p < 0.05$). Data are shown as means \pm SD, with statistical significance indicated by asterisks (< 0.05 , < 0.001). **K5 vs K2: p-value is 0.026** ($p < 0.05$), indicating a significant difference. **K3 vs K2: p-value is 0.001** ($p < 0.001$), indicating a highly significant difference. **K1 vs K2: p-value is < 0.001** ($p < 0.001$), indicating a very high and significant difference.

The results of *Bonferroni's post-hoc* test in Figure 2 show a significant difference between K1 and K2 ($p < 0.001$). The K3 group showed a significant difference in K2 ($p = 0.001$), but no significant difference in K1 ($p = 1.000$). The K4 group showed no significant difference in K2 ($p = 0.371$), while K5 showed a significant difference in K2 ($p = 0.026$). A comparison of K5 with K3 and K1 shows a value of $p = 1,000$, which means there is no real difference. The diagram also presents the average or mean triglycerides levels for each group.

Discussion

The K2 group showed a significant increase in triglyceride levels compared to K1, with triglyceride levels of 265.767 mg/dL versus 191.639 mg/dL. These results are in line with research (Mthiyane et al., 2022) which states obesity can make the body tend to produce more triglycerides in response to excess unused energy, which is then stored in adipose tissue. Obesity and body fat accumulation are associated with changes in serum lipoprotein levels that include triglycerides, and are part of metabolic disorders that can trigger cardiometabolic diseases such as type 2 diabetes and cardiovascular disease. This study shows that obesity can cause metabolic disorders that create oxidative stress so that there are disturbances in lipid metabolism, which leads to an increase in triglyceride levels. This is in line with research (Pizzirusso & Antonio Brasiello, 2022) which explains that the influence of oxidative stress can damage mitochondria, reduce efficient energy production, and

trigger lipid peroxidation, so it can trigger disorders of fat metabolism, including an increase in triglycerides. This explanation is in accordance with the results of this study, namely a significant increase in triglyceride levels with a value of ($p < 0.001$) in the K2 group compared to the K1 group.

The results showed that the K4 group that was given moringa fruit extract at a dose of 500 mg/kgBB once a day had a triglyceride level of 230.054 mg/dL, while the K5 group that received treatment twice a day was recorded at 212.463 mg/dL. The triglyceride levels of the two treatment groups decreased significantly when compared to the K2 group which had a triglyceride level of 265.767 mg/dL. This difference shows that the administration of moringa fruit extract is able to reduce triglyceride levels in obese rats. This is in line with scientific reports that moringa seed extract has hypolipidemic properties that can lower triglyceride and total cholesterol levels in animal models with lipid metabolic disorders. The bioactive compounds contained in moringa seeds, including unsaturated fatty acids and antioxidants, play a role in modulating lipid metabolism and increasing the activity of enzymes that affect fat metabolism, thereby reducing the accumulation of triglycerides in the blood.

The K2 group and the K4 group showed statistically insignificant differences, but the treatment can still lower triglyceride levels but is not very effective. This is consistent with the results of the meta-analysis (Panova et al., 2025), which reports that the granting of *Moringa oleifera* may lower triglyceride levels in some trials, but do not always achieve statistical significance, depending on the dose, length of treatment, and model used. The suspected mechanism involves bioactive compounds such as flavonoids and polyphenols that have antioxidant and anti-inflammatory properties, then saponins that have the ability to affect lipid metabolism, then phenolic acids and glucosinolates that can modulate metabolic pathways including fat metabolism, but their biological responses can vary between research models.

The K5 group and the K2 group showed a significant difference, because they could significantly lower triglyceride levels. This is supported by scientific evidence showing that the administration of the *Moringa oleifera* at equivalent doses it has a hypolipidemic effect. (Nakashima et al., 2025) found that *Moringa oleifera* administered at a dose of 500 mg/kgBB in combination with *Turmeric longa* significantly optimizes lipid metabolism and improves antioxidant defenses in a mouse model of hypercholesterolemic, reflecting a decrease in triglycerides in the lipid profile of test animals. Reviews (Mthiyane et al., 2022) explains that supplementation *Moringa oleifera* regulates lipid metabolic pathways, including decreased triglyceride synthesis through increased lipolysis and modulation of gene expression related to lipid metabolism. The administration of moringa fruit extract at a similar dose (500 mg/kgBB) in obese rats showed an improvement in

lipid metabolism so that there was a reduction in oxidative stress in experimental animals.

Comparisons between the K2 group and the K3 group showed a significant difference in triglyceride levels, with a significant decrease close to the value in the K1 group. This is in line with the results (Mag et al., 2021), which suggests that vitamin C supplementation in rats induced by a high-fat diet was able to significantly lower triglyceride levels compared to rats induced by a high-fat diet without supplementation. Vitamin C supplementation plays an important role as an antioxidant that helps reduce oxidative stress and metabolic disorders caused by obesogenic diets, thus helping to improve lipid metabolism. Meanwhile, in the comparison between the K1 and K3 groups, there is no significant difference, so that vitamin C induction in the K3 group can restore triglyceride levels to normal conditions.

In a comparative analysis between the K4 group and the K5 group with the K3 group, the three can reduce triglyceride levels in obese rats but the effectiveness is different. According to the data from the study, the K4 and K5 groups that were given moringa fruit extract had a not as good effect as K3 given vitamin C. This is in line with the research (Usman et al., 2022) which suggests that vitamin C provides a stronger antioxidant response compared to the extract *Moringa oleifera*, especially in lowering lipid peroxidation activity and increasing glutathione (GSH) levels in the blood. Vitamin C administration results in a faster and more consistent reduction in oxidative stress compared to extracts *Moringa oleifera*, although the extract *Moringa oleifera* It also showed metabolic improvement and a significant decrease in oxidative stress. This is in line with the findings in this study which show that the administration of vitamin C as an antioxidant is more effective in lowering triglycerides compared to extracts *Moringa oleifera* against the mice of the obesity model. The increased effectiveness of vitamin C can be explained by its higher ability to neutralize free radicals, which directly affects the improvement of lipid metabolism and the reduction of excess triglycerides in obesity conditions. This is reinforced by a systematic review of the metabolic and dyslipidemia literature stating that vitamin C supplementation in animal and human models can lower triglyceride, LDL, and VLDL levels through direct antioxidant activity that inhibits lipid peroxidation and improves metabolic homeostasis. Moringa fruit extract contains antioxidant compounds such as flavonoids, polyphenols, and saponins that can also help reduce oxidative stress, but its effectiveness is not as fast or as potent as vitamin C in terms of metabolic repair and oxidative stress control which can lead to improvements in lipid profiles, including a decrease in triglycerides. Vitamin C works more effectively because it directly acts as the main antioxidant agent in the body, while the

extract *Moringa oleifera* It takes more time to metabolize and interact in the body (Dawley et al., 2024).

The data results between the K4 and K5 groups did not have a significant difference because there was no significant difference in the reduction in triglyceride levels between the two treatments, but the effect was better given twice a day, and both treatments could still reduce triglyceride levels. Based on the scientific literature that shows that increased doses of phytochemical compounds from *Moringa oleifera* does not always increase the hypolipidemic effect linearly or directly proportional to the dose given. For example, studies on hyperlipidemia mice that were given extracts *Moringa oleifera* in diverse doses (250, 500, 750 mg/kgBB) it was found that all doses were able to significantly lower lipid parameters including triglycerides, but dose increases did not necessarily result in a higher effectiveness response between the dose groups tested. This is consistent with the fact that the biological activity of plant compounds such as flavonoids, saponins, or polyphenols is strongly influenced by animal metabolism, bioavailability, and absorption mechanisms that do not always show a direct dose-response relationship (Kavita et al., 2025). The limitations of this study include the absence of quantitative phytochemical analysis tests so that the percentage of each bioactive compound contained in moringa fruit cannot be determined, safety studies on the toxicity of moringa fruit have not been carried out so that the safety of its use cannot be evaluated thoroughly, and the limited duration of treatment can cause the observed effect on triglyceride levels to be temporary, so that the long-term effects of the Interventions on lipid profiles have not been thoroughly evaluated.

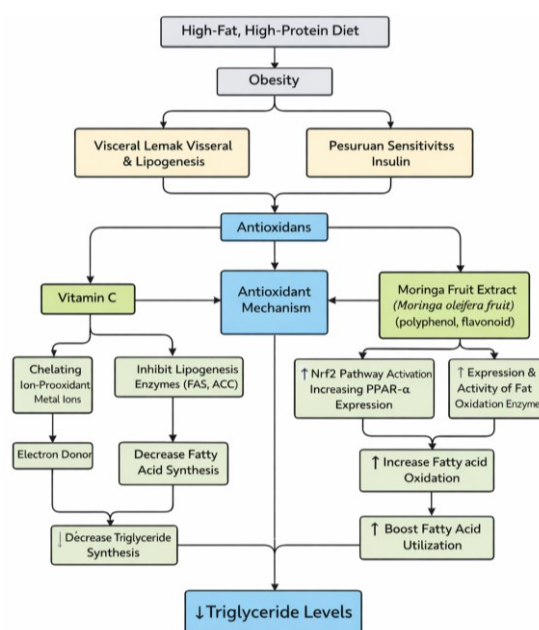


Figure 3. Prediction of the Mechanism of Administration of Moringa Fruit Extract (*Moringa oleifera* fruits) on Triglyceride Levels in Obesity Model Rats

CONCLUSION

This study succeeded in proving that the administration of moringa fruit extract had an effect on reducing triglyceride levels in obese model mice. The untreated group of obese mice showed significant increases in triglyceride levels compared to the normal group, reflecting obesity-induced lipid metabolism disorders. The administration of moringa fruit extract at a dose of 500 mg/kgBB either once or twice a day is able to reduce triglyceride levels, although with different levels of effectiveness. Doses of 500 mg/kgBB twice daily showed better results with a significant decrease in triglyceride levels close to the positive control group given vitamin C. Nonetheless, the effectiveness of moringa fruit extract is still below vitamin C as a standard antioxidant. The difference in effectiveness between giving once and twice a day did not show a statistically significant difference, but giving twice a day tended to provide more optimal results in lowering triglyceride levels in obesity conditions.

Authors' Contributions: Abdul Halim Arif & Tiwuk Susantiningsih designed the study. Tiwuk Susantiningsih as the originator of the idea, concept, and theme. Sri Wahyuningsih, Melly Kristanti, & Fajriati Zulfa as contributors of suggestions and evaluations. Abdul Halim Arif carried out the laboratory work & analyzed the data. Abdul Halim Arif wrote the manuscript. All authors read and approved the final version of the manuscript.

Competing Interests: The authors declare that there are no competing interests.

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