**Research Article**

# The Comparison of *Moringa oleifera* Seeds Oil and Fish Oil in Organ Weight and Blood Haematological Profile in Subchronic Male Mice

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**Abstract** | Livestock productivity can be increased by promoting growth using feed supplements such as fish oil containing omega 3, 6 and 9. These ingredients can also be found in Moringa seed oil which is cheaper and easier to find than fish oil. Omega 3 and 6 can increase dietary palatability thereby increasing feed intake which helps increase body weight which is correlated with organ weight. Based on this, a study was conducted that aims to compare the effect of Moringa seed oil and fish oil on organ weight and blood hematological profiles of mice. The study used 24 male mice of the DDY strain which were divided into three groups, namely the control group (Na-CMC-1%), KSO (moringa seed oil), and Omega-3 (fish oil). Mice were checked for temperature, GDP, and body weight at the beginning and end of the experimental period after 6 weeks. After that, the mice were sacrificed and blood samples were taken for hematological examination and the heart, liver, white fat tissue, and kidneys were weighed. The results showed that the average heart weight (0.120 grams) and white fat tissue (0.145 grams) decreased in the KSO group, as did RBC (8.285×106/µl), WBC (2,943×103/µl) and platelets (506 ,5×103/µl), but statistically there was no significant difference in hematological parameters, body temperature, GDP, body weight and liver and kidney weight p(> 0.05). However, there was a difference in heart weight and white fat tissue p(<0.05). In conclusion, Moringa seed oil can affect organ weight and blood hematological profiles like fish oil, but further research is needed to ensure that Moringa seed oil can be used as an alternative to fish oil substitute feed supplements.

**Keywords** | Organ weight, Moringa oil, Fish oil, Hematology profile, Feed supplement.

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## INTRODUCTION

Increasing livestock production is an effort made to increase the profits of farmers. In increasing livestock productivity, farmers can using alternative feed supplements as a substitute for antibiotics whose use causes dangerous side effects (Ashayerizadeh et al., 2009; Abdulla, et al., 2018). Such supplements, such as fish oil, contain omega 3, omega 6 and omega 9, which can improve the palatability of the diet. Omega-3 and omega-6 in particular, including polyunsaturated fatty acids (PUFA) which are useful in improving body weight and gaining weight (Alagawany et al., 2019). However, fish oil has a relatively more expensive price than vegetable oil. So that the use of Moringa seed oil which also contains omega 3, 6 and 9 which is easily found in Indonesia at a relatively cheaper price can be a good alternative in increasing livestock productivity (Alegbeleye, 2018; Leone, et al., 2016; Sahay et al. , 2017).

Omega 3 and omega 6 can increase dietary palatability which causes increased feed intake so as to increase body weight (Johnson and Wardle, 2014). Meanwhile, body weight correlated with an increase in organ weight. This is especially in the organs of the heart, liver, white fat tissue, and kidneys which are fat storage sites in the body (Chait & den Hartigh, 2020). Nmamonu et al. (2020) explained that omega 3 from fish oil can increase body weight, although not significantly. This is related to the administration of omega-3 which initiates anabolic and catabolic synergistic activity in protecting against excessive fat deposition and the activity of increasing adipocyte apoptosis which is related to its role in maintaining body weight balance so that obesity does not occur, but still balances body fat. (Nmamonu et al., 2020).

To find out the benefits of omega 3 fatty acids in livestock, a study was carried out using mice. Mice are considered very representative to analogize genetic disease models and body systems at an economical price and easier to use as experimental animals (Stevani, 2016). Research conducted on five-week-old DDY male mice showed that the ethanol extract of Moringa leaves had the potential to prevent the deterioration of hematological parameters in mice with a sub-chronic high-fat diet by increasing hemoglobin, decreasing WBC, granulocyte percentage and slightly decreasing MPV (Alia, et al. al., 2019). In a study conducted on rats given omega 3 from fish oil showed that omega 3 can significantly increase PCV, Hb, WBCs, MCV, and MCH and there was no significant change in RBCs and MCHC (Nmamonu et al., 2020). According to Nmamonu et al. (2020), omega 3 functions to modulate hematopoiesis which can affect blood parameters so that it acts as a parameter of health status. Not only that, Nmamonu et al. (2020) also explained that omega-3 fatty acids, especially DHA, supported the occurrence of spermatogenesis in male rats. Even so, there is still little information about the effect of giving omega-3 and omega-6 PUFAs to the health and male reproductive system (Yan et al., 2013; Gulliver, et al., 2012).

Based on this, a study was conducted that aims to compare organ weight and blood hematological profiles in male mice after being given Moringa seed oil and fish oil.

# MATERIALS AND METHODS

## Research Ethics

The study received a letter of approval from the Ethics Committee of the Faculty of Medicine, Padjadjaran University with number: 750/UN6.Kep/EC/2020.

## *Moringa* Seed Oil and Fish Oil Preparation

Moringa seed oil used comes from PT. Indonesian organic moringa and fish oil used are salmon oil products from Nature's Health ©. Based on the results of the analysis by PT. Saraswanti Indo Genetech, Moringa (Kelorina Seed Oil) used contain SFA, MUFA, and PUFA (Omega-3, Omega-6 and Omega-9). The two preparations used were analyzed their content in the Food Technology Test Laboratory and Agricultural Products, Faculty of Agricultural Technology, Gadjah Mada University. The ingredients are lauric acid, myhistic acid, palmitic acid, palmitoleic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, eccrucuic acid, lycnoserate acid, arachidic acid, and behenic acid.

## Animal Treatment

This study used 24 male DDY strain mice, aged more than three weeks and body weight ranging from 20-40 g from PT Bio Farma, Bandung, West Java, Indonesia. The acclimatization period was 7 days. Mice were placed in a room with a controlled system of air, temperature, and humidity. The lighting system is set on a 12 hour light/dark cycle. The mice were divided evenly into three groups (n=8 mice each group) consisting of the control group (given 1% Na CMC at a dose of @ 200µl/20gr BW mice), the KSO group (given Moringa seed oil at a dose of @ 200µl/20gr BB mice), and the Omega-3 group (given fish oil at a dose of @ 200µl/20gr body weight mice.). After the acclimatization period, body weight, blood sugar levels (GDP) and rectal temperature were measured to see the basal metabolic and health status of the mice.

## Samples Collection

After the treatment on the mice ended, the mice were fasted for 6-8 hours. Furthermore, the weight, temperature and GDP of the mice were checked and then the mice were anesthetized with a combination of ketamine (dose of 1.5 cc/mouse) and xylazine (dose of 1.5 cc/mouse) and then 0.3 ml was injected intraperitoneally. After that, 1-1.5 ml of blood was taken using the cardiac puncture method and then put into a 10% EDTA tube. The blood sample is then examined with a hematology analyzer. Then the organs in the mice were taken starting from the heart, liver, white adipose tissue and kidney. These organs were then weighed to see the effect of Moringa seed oil and fish oil on these organs.

### Statistical Analysis

Normality of the data is determined by Shapiro-Wilk to determine the distribution of the data. Differences between groups were determined using one-way ANOVA for normally distributed data, while the data were not normally distributed using Kruskal-Wallis (Petrie & Watson, 2013). The value is considered to be significantly different if p <0.05. (Syamsunarno, et al., 2019).

## RESULT AND DISCUSSION

### Result

Data is presented in the Mean ± SD graph if the data is normally distributed, and for non-parametric data it is presented in the median graph (min-max).

### Body Temperature

The body temperature of the mice was checked at the beginning of the experiment to ensure the health of the mice. After being given Moringa seed oil and fish oil preparations for six weeks, the mice's body temperature was re-examined as a health control.

The results of statistical analysis (Figure 1) showed that there was no significant difference in body temperature of male mice after treatment between groups of p (> 0.05).

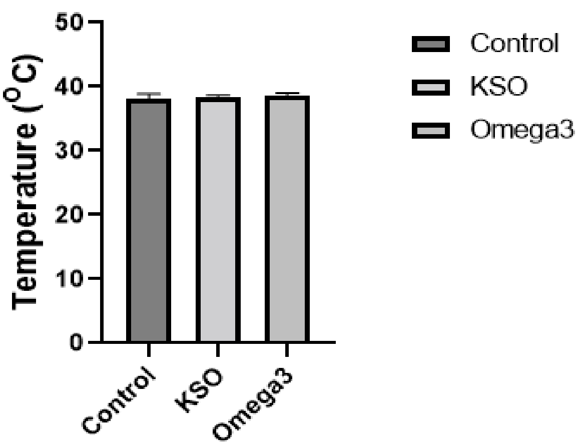


**Figure 1:** Body temperature of male mice in the control group, KSO and Omega-3.

### Fasting Blood Glucose (GDP)

Fasting Blood Sugar (GDP) examination is carried out to check glucose levels in the body which aims to check basal metabolism and determine whether an individual has diabetes. In this study, GDP was examined at the beginning and end of treatment as a health control of mice. In Figure 2. shows that there is no significant difference P (> 0.05) in the level of GDP of mice between the treatment groups.

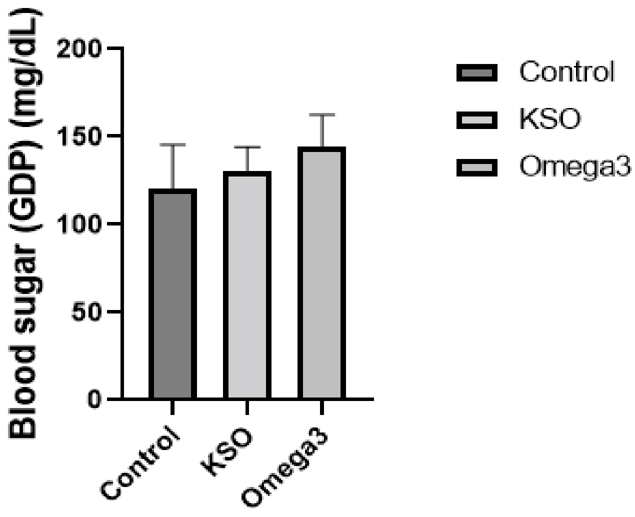


**Figure 2:** Blood sugar of male mice in the control group, KSO and Omega-3.

### Body Weight

Based on the results of statistical analysis on Figure 3, it showed that there was no significant difference in p(>0.05) body weight of mice in all treatment groups.

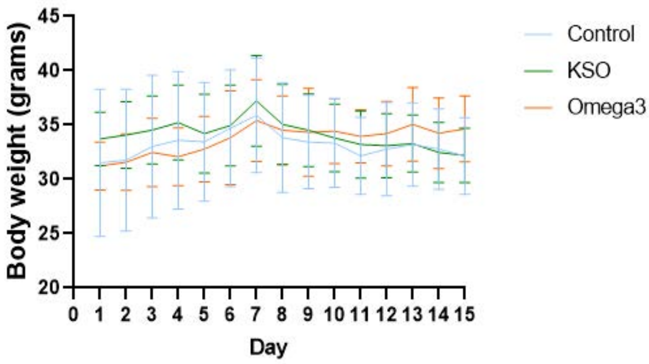


**Figure 3**: Body weight of male mice every three days in the control group, KSO and Omega-3.

### Organ Weight

Measurement of organ weight was carried out because the increase in organ weight correlated with the increase in body weight of mice which could be caused by dietary palatability which in this study was influenced by supplementation of Moringa seed oil and fish oil. The heart, liver, white fat tissue and kidneys are places for storing fat in the body so an examination is carried out after administration of Moringa seed oil and fish oil to determine whether there is fat accumulation in the tissues by measuring organ weight (Nmamonu et al., 2020) (Table 1).

**Table 1:** The average weight of the heart organ and WAT in the Control group, KSO and Omega-3

| Organ | Group | | | | | |
|---|---|---|---|---|---|---|
| | Control | | KSO | | Omega 3 | |
| | Mean (gr) | SD | Mean (gr) | SD | Mean (gr) | SD |
| Heart | 0,117 | 0,117 | 0,120 | 0,120 | 0,145 | 0,145 |
| WAT | 0,143 | 0,051 | 0,142 | 0,097 | 0,288 | 0,096 |

**Table 2:** The average level of blood haematological profile in the Control group, KSO and Omega 3.

| Parameter | Group | | | | | |
|---|---|---|---|---|---|---|
| | Control | | KSO | | Omega 3 | |
| | Mean | SD | Mean | SD | Mean | SD |
| RBC ($10^6$/µl) | 9,202 | 0,688 | 8,285 | 1,555 | 8,092 | 1,830 |
| Hb (g/dl) | 13,58 | 0,783 | 12,28 | 2,223 | 12,62 | 2,167 |
| HCT (%) | 40,06 | 1,782 | 36,30 | 5,716 | 35,46 | 8,445 |
| MCV (fl) | 43,67 | 2,422 | 44,67 | 5,086 | 43,83 | 2,317 |
| MCH (pg) | 14,80 | 0,721 | 14,97 | 1,050 | 15,92 | 1,785 |
| MCHC (g/dl) | 33,92 | 1,317 | 33,70 | 1,902 | 36,42 | 4,260 |
| RDWc (%) | 21,27 | 1,660 | 22,70 | 2,773 | 20,32 | 3,583 |
| WBC ($10^3$/µl) | 2,982 | 0,429 | 2,943 | 2,006 | 3,850 | 1,869 |
| Lym ($10^3$/µ) | 1,623 | 0,725 | 1,897 | 1,540 | 1,820 | 0,478 |
| Mon ($10^3$/µl) | 0,458 | 0,228 | 0,570 | 0,367 | 0,768 | 0,400 |
| Gra ($10^3$/µl) | 0,898 | 0,500 | 0,582 | 0,395 | 1,262 | 1,571 |
| Lym (%) | 53,55 | 19,34 | 59,03 | 17,00 | 55,18 | 22,52 |
| Mon (%) | 15,07 | 6,748 | 18,58 | 4,464 | 19,58 | 4,346 |
| Gra (%) | 31,42 | 18,43 | 22,42 | 16,31 | 25,28 | 21,17 |
| PLT ($10^3$/µl) | 533,3 | 43,28 | 506,5 | 222,5 | 565,8 | 134,6 |
| PCT (%) | 0,163 | 0,028 | 0,142 | 0,092 | 0,178 | 0,061 |
| MPV (fl) | 3,050 | 0,315 | 2,850 | 0,869 | 3,183 | 0,821 |
| PDWc (%) | 32,67 | 0,589 | 32,52 | 1,511 | 33,18 | 1,797 |

In this study, the average weight of the heart in the control group was 0.117 grams, the KSO group was 0.120 grams and the Omega 3 group was 0.145 grams. WAT weight in the control group was 0.143 grams, the KSO group was 0.142 grams and the Omega 3 group was 0.288 grams. The organ measurement data is then statistically processed and presented in a graph (Figure 4).

Figure 4. shows that there is a significant difference in the weight of the heart organ between the p groups (<0.05). Liver weight analysis did not show a significant difference p (> 0.05). The results of the analysis of the comparison of WAT weight between groups showed that there was a significant difference in p (<0.05). Meanwhile, the results of the analysis of kidney weight showed that there was no significant difference between the p groups (> 0.05).

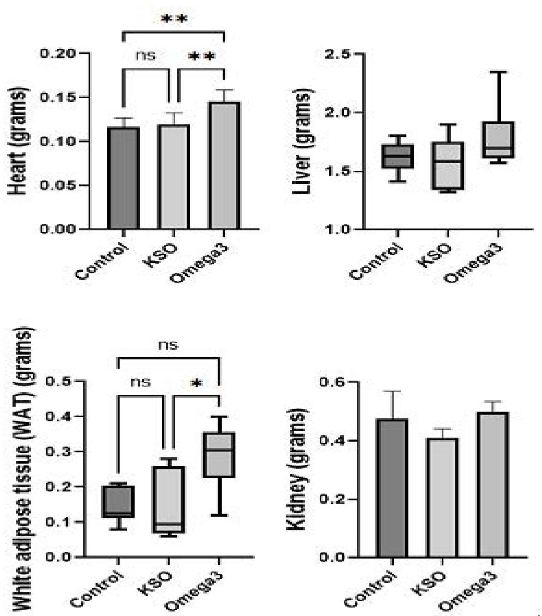


**Figure 4:** Weight of heart, liver, white adipose tissue (WAT), kidney in the control group, KSO and omega 3.

## Blood Haematological Profile

Blood hematology profile examination is used as a health control parameter which includes the examination of the components of RBC, WBC and platelets.

### RBC Component

The components of RBC (Red Blood Cell) examined in this study include Hb (hemoglobin), HCT (hematocrit), MCV (Mean Corpuscular Volume), MCH (Mean Corpuscular Haemoglobin), MCHC (Mean Corpuscular Haemoglobin Concentration), and RDWC (Red Blood Cell). Cell Distribution Width). Table 2 data shows that the RBC levels in the control group were 9.202 × 106/µl, the KSO group was 8.285 × 106/µl and Omega 3 was 8.092 × 106/µl. Then the hemoglobin (Hb) level from the control group was 13.58 g/dl, to 12.28 g/dl in the KSO group, and 12.62 g/dl in the Omega 3 group. The percentage of HCT in the control group was 40.06%. the KSO group was 36.30% and the Omega 3 group was 35.46%. Meanwhile, the average levels of MCV, MCH and RDW increased (Table 2). The MCV levels of the control group were 43.67 fl, the KSO group was 44.67 fl and the Omega 3 group was 43.83 fl. MCH levels in the control group were 14.80 pg, the KSO group was 14.97 pg and the Omega 3 group was 15.92 pg. MCHC levels in the control group were 33.92 g/dl, the KSO group was 33.70 g/dl and the Omega 3 group was 36.42 g/dl. Percentage of RDW in the control group 21.27%, KSO group 22.70% and Omega 3 group 36.42%. Based on the results of the analysis on the components of RBC, namely hemoglobin, hematocrit, MCV, MCH, MCHC and RDW, it showed that there were no significant differences in all treatment groups p (> 0.05) (Figure 5).

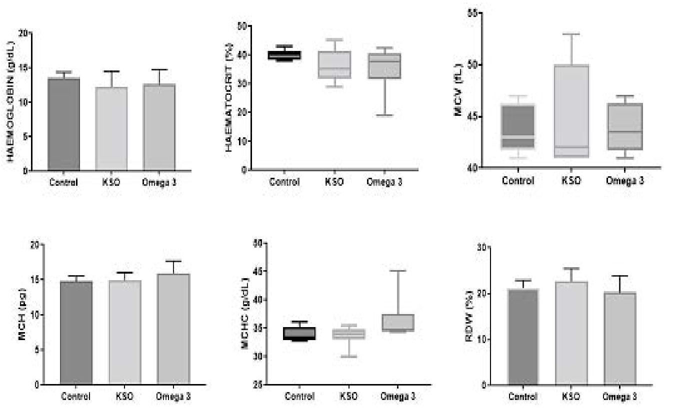

**Figure 5:** RBC components (hemoglobin, hematocrit, MCV, MCH, MCHC, RDW).

### WBC Component

The components of WBC (White Blood Cell) examined in this study include lymphocytes, monocytes, granulocytes, %lymphocytes, %monocytes and %granulocytes. The data in Table 2 shows the value of the WBC component. The value in the control group was 2,982 × 103/µl, in the KSO group it decreased to 2,943 × 103/µl and the Omega 3 group increased to 3,850 × 103/µl. Lymphocyte levels increased in the KSO group of 1.897 × 103/µl and Omega 3 1.820 × 103/µl compared to the control group of 1.623 × 103/µl. Likewise, monocytes experienced an increase in the KSO group of 0.570 × 103/µl and the Omega 3 group 0.768 × 103/µl compared to the control group of 0.458 × 103/µl. Based on the results of the analysis on the components of WBC, namely lymphocytes, monocytes, granulocytes, %lymphocytes, %monocytes, and %granulocytes (Figure 6). The result showed that there were no significant differences in all treatment groups p (>0.05).

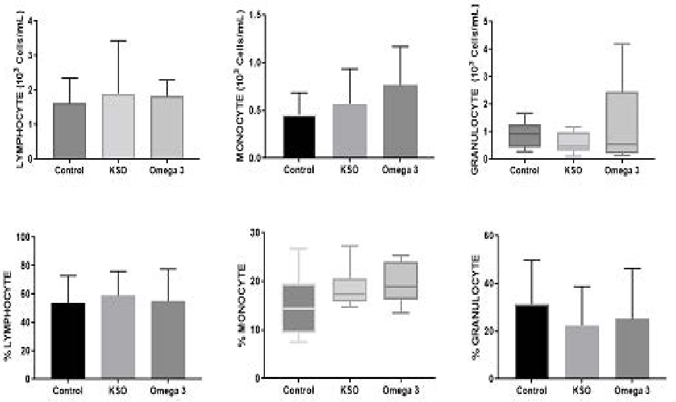

**Figure 6:** WBC components (lymphocytes, monocytes, granulocytes, %lymphocytes, %monocytes, %granulocytes)

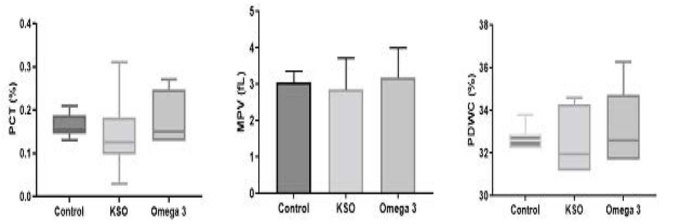

**Figure 7:** shows that there is no significant difference in p (>0.05) in the platelet components, namely PCT, MPV, and PDWC, between the treatment groups.

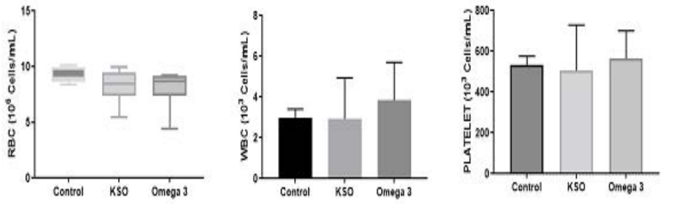

**Figure 8:** RBC, WBC, Platelet Profile

### Platelet Component

Platelet components include PCT (Plateletcrit), MPV (Mean Platelet Volume), and PDWC (Platelet Cell Distribution Width). The data in table 2 shows the values of the platelet components examined in this study. PLT levels in the control group were 533.3 × 103/µl, the KSO group was 506.5 × 103/µl and the Omega 3 group was 565.8 × 103/µl. Meanwhile the percentage of PCT in the control group was 0.163%, decreased in the KSO group was 0.142%, and increased in the Omega 3 group was

0.178%. MPV levels in the control group were 3,050 fl, the KSO group was 2,850 and the Omega 3 group was 3,183 fl. The percentage of PDWc in the control group was 32.67%, the KSO group was 32.52% and the Omega 3 group was 33.18%. Figure 7. shows that there is no significant difference in p (>0.05) in the platelet components, namely PCT, MPV, and PDWC, between the treatment groups.

### Profil RBC, WBC, Platelet

The hematological profile of the blood examined in this study included the components of RBC, WBC and platelets. The result as shown in Figure 8 shows that there is no significant difference p (> 0.05). on RBC, WBC and platelets in all groups

## DISCUSSION

### Comparison of Body Temperature

Giving PUFA, for example, omega 3, can modulate metabolism, thermogenesis, immune system and satiety. This thermogenic activity in omega 3 arises from the formation of white adipose tissue, increased mitochondrial respiration in BAT or miRNA modulation via free fatty acids (Rice et al., 2021). In addition, omega 3 also acts as a vasodilator that increases blood flow so that the effects of body heat appear (Buckley & Howe, 2010; Nmamonu et al., 2020). In this study, Moringa seed oil and fish oil both have omega 3 PUFAs. Therefore, both of them cause the effect of body heat on mice.

### Comparison of GDP

In this study, it was found that the GDP level of male mice in all groups did not have a significant difference. This is in accordance with Moodley's research (2018) which states that there is no significant difference in blood sugar levels after subchronic administration of Moringa in male mice. Omega 3 fatty acid supplementation can increase plasma blood sugar levels by increasing glycerol gluconeogenesis (Chauhan et al., 2017). This increase occurs because the administration of high doses of omega 3, which includes free fatty acids, can increase the process of gluconeogenesis in the liver. This condition is related to the production of acetyl-CoA, NADH, and ATP from the oxidation of free fatty acids. This oxidation process can decrease the activity of phosphofructokinase 1 and increase the activity of fructose-1,6-bisphosphatase (FBP-1) thereby stimulating gluconeogenesis (Lam, et al., 2003). In addition, Moringa also plays a role in glucose homeostasis and increases insulin sensitivity, so that Moringa functions as an antihyperglycemic (Vergara-Jimenez et al, 2017).

### Comparison of Body Weight

Figure 3 shows the effect of treatment on body weight of mice. Even so, based on the results of statistical analysis showed that there was no significant difference in each group. This study is in accordance with the research of Buckley & Howe (2010) which states that the provision of vegetable oil to replace fish oil does not provide a significant difference to weight gain. This is supported by Moodley's research (2018) which showed that the administration of Moringa oil did not provide a significant difference. Omega-3 in Moringa seed oil and fish oil has an anti-obesity effect (Bais et al., 2014). The results obtained from this study are thought to be related to the administration of omega-3 which initiates synergistic anabolic and catabolic activities in overcoming excessive fat deposition. Omega-3 does not increase fat accumulation in the body, but modulates fat accumulation in tissues (Nmamonu et al., 2020). In addition, the administration of these fatty acids can increase satiety which can lead to reduced subsequent food intake. It is also associated with changes in the expression of genes involved in the regulation of fat oxidation that favor the reduction of fat deposition (Buckley & Howe, 2010).

### Comparison of Organ Weight

In this study, it was found that there was no significant difference in the weight of the liver and kidneys, while the heart and white adipose tissue showed significant differences. The difference in heart weight was observed in the control group vs Omega-3 and the KSO vs Omega-3 group. Fat is stored in adipose tissue which is found in several organs, one of which is the heart. Just like fish oil, Moringa seed oil contains omega-3, omega-6, and omega-9. Omega 3 (linonelic acid) and 6 (linoleic acid) play an important role in cardiovascular disease, namely as anti-obesity and lowering cholesterol levels. Although the two oils used both have omega 3, but the percentage levels are different.

In addition, fish oil contains more Omega 3 in the form of EPA and DHA than Moringa oil which is a vegetable oil (Ayisi, 2021). DHA has an important role in cardiovascular health and spermatogenesis while EPA has anti-inflammatory benefits related to its chemoprotective role in cardiovascular disease by modulating body fat accumulation and reducing fat deposition, one of which is in the heart (Bais et al., 2014; Nnamonu et al., 2020). In this study, the average heart weight in the Omega 3 group was greater than the control and KSO groups. According to Hidayat & Rivati (2021), this weight increase can be related to excessive consumption of DHA and EPA, thereby inhibiting the formation of arachidonic acid (AA) from omega 6 which plays a role in the growth process and reducing body fat accumulation.

In addition to the heart, the difference in organ weight occurred in WAT, precisely in the KSO group against the

Omega 3 group. Based on research by Buckley & Howe (2010) explained that the accumulation of epididymal fat, which is the location where WAT was found in rodents, was less in the omega 3 group than the increase in fat mass in the kidneys (retroperitoneal). The difference between epididymal and retroperitoneal fat is due to a reduction in adipocyte size without a change in adipocyte number. In this study, the difference in WAT weight that was not accompanied by a difference in fat mass in the kidneys was thought to be due to a decrease in circulating triglycerides associated with lower plasma triglyceride concentrations in medium and high omega supplementation. Therefore, this effect is mainly seen in visceral fat depots as observed in the epididymis.

The difference in WAT weight is thought to be caused by a reduction in the accumulation of visceral fat mediated by DHA, which is abundant in fish oil. Based on the research of Ruzickova et al. (2004) explained that EPA and DHA can attenuate epididymal fat accumulation, but have a limited effect on subcutaneous fat accumulation. DHA is responsible for the anti-obesity effect of increased intake of omega 3. This effect is associated with increased fat oxidation in heart, liver, skeletal muscle and visceral fat thereby decreasing the availability of substrate for deposition in adipose tissue. Consequently, fat storage capacity is reduced due to decreased expression of lipogenic genes in adipose tissue thereby contributing to the reduction of body fat (Buckley & Howe, 2010).

## Comparison of Blood Haematological Profile

**Red Blood Cells Components:** In this study, the results showed that the average levels of RBC, Hb, and Hct decreased. Even so, based on the results of statistical analysis in this study, it showed that RBC, Hb, and Hct did not have a significant difference. This condition was also found in several studies, namely, Alia et al. (2019) and Moodley (2018) which stated that the administration of Moringa did not have a significant difference in these components. Research by Nnamonu et al. (2020) also stated that giving omega 3 from fish oil did not give a significant difference in RBC. This is supported by Asare (2011) which states that there is no difference in RBC after being given vegetable oil as a substitute for fish oil. Decreases in the number of RBC, hemoglobin and hematocrit are often associated with anemia or lack of blood, trauma, bacterial and parasitic infections, immune mediation, and excess water consumption (Jackson, 2007).

Although the values obtained varied, statistically the components of MCV, MCH, and MCHC did not have a significant difference, which was in accordance with the research of Alia et al. (2019) and Nnamonu et al. (2020). This statement is supported by the research of Babalola et al. (2016) which stated that the provision of vegetable oil compared to fish oil did not show significant differences in MCV, MCH and MCHC. An increase in MCV can be associated with macrocytosis, anemia, or folate disorders while an increase in MCH can be associated with anemia (Jackson, 2007). In this study, the increase in MCV showed that the administration of omega 3 fatty acids did not cause erythrocyte shrinkage. This shrinkage occurs due to stress, anemic conditions or as a result of poor erythropoiesis due to the entry of harmful substances into the hemopoietic tissue (Nwani et al., 2013).

**White Blood Cells Components:** The average levels of the WBC component in this study showed varying values. Although they showed varying values, statistically the WBC components (lymphocytes, monocytes, granulocytes, %lymphocytes, %monocytes, and %granulocytes) did not show a significant difference. This is in accordance with the research of Alia et al. (2019) and Nnamonu et al. (2020) which states that there is no significant difference to the WBC component. The increase in lymphocytes can be related to the release of the hormone epinephrine while the increase in monocytes is associated with phagocytic activity, inflammation, corticosteroids, secondary hemolysis and neoplasia (Jackson, 2007). Variations in the value of the WBC component in this study illustrate that omega 3 fatty acids can inhibit the immune system and cause inflammatory reactions (Suzana et al., 2017). This reaction results in inhibition of lymphocyte proliferation by reducing neutrophil chemotaxis, natural killer cell (NK-cell) responses and the production of proinflammatory cytokines such as interleukin (IL-1β), TNFα, proinflammatory eicosanoids-prostaglandin E2 (PGE2) and leukotrienes B4 (LTB4) (Kelley, 2001).

**Platelet Components:** In this study, it was found that there was a variation in the average levels of the Platelet component (PLT). However, there was no statistically significant difference between the platelet components in all groups. The results of this study are in accordance with Alia et al. (2019) which showed that the administration of Moringa did not have a significant difference in the platelet component. This is supported by research by Babalola et al. (2016) which stated that the provision of vegetable oil used to replace fish oil did not provide a significant difference in total platelets. The increase in the platelet component can be related to the presence of iron deficiency, causing anemia, inflammation and neoplasia of megakaryocytes (Jackson, 2007).

**RBW, WBC, Platelet:** The levels of RBC, WBC and Platelets in this study also showed varying values. However, there was no statistical difference between groups). In a study explained that Moringa oleifera contains ascorbic acid and beta-carotene which can increase the absorption of non-heme iron, and amino acids in the leaves can contribute to erythropoietin activity (Idohou-dossou, 2011). Moringa seed extract also plays a role in anti-inflammatory activity by stimulating cellular and humoral immunity as a cyclophosphamide-induced immunodeficient response through an increase in white blood cell (WBC) count, neutrophil percentage and serum immunoglobulin (Vergara-Jimenez et al, 2017). In addition, Moringa seed extract also contains omega 3 (linolenic acid), such as fish oil. Omega 3 has the ability to affect the process of hematopoiesis. These fatty acids can modulate hematopoiesis by restoring the fast-differentiating compartments of myeloid progenitor cells in the bone marrow to healthy progenitor cells (Nnamonu et al., 2020). Therefore, in this study, various values of hematological parameters were obtained, but did not show significant differences.

## CONCLUSION

The results showed that there were no significant differences in body weight, fasting blood sugar, liver weight, kidney weight, and blood hematological profiles (RBC, WBC, and platelets), while heart and white adipose tissue weights showed significant differences. This shows that Moringa seed oil has an effect on organ weight and blood hematological profile of male mice. Therefore, to ensure that the oil can be used as a feed supplement, further research is needed on other organ systems.

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## CONFLICT OF INTEREST

The author declares that there is no potential conflict of interest reported by the author.

## NOVELTY STATEMENT

In this study we showed the effect of plant oil (M. oleifera) and animal oil (FIsh) to the hematological profile and body composition.

## AUTHORS CONTRIBUTION

A.H, R.S.Q, M.R.A.A.S : Idea conceptualization.
A.H, R.S.Q, I.S, N.A, N.N.I, V.A.S : Conducting experiment
A.H, R.S.Q, M.R.A.A.S :Data analyzed and Writing manuscript
I.S, N.A, N.N.I, V.A.S : Manuscript Criticized
A.H, M.R.A.A.S : Manuscript finalization.

## REFERENCES

Abdulla N.R., Sabow A.B., Foo H.L., Loh T.C., Zamri A.M. (2018). Growth performance, fatty acid profile and lipid oxidative stability of breast muscle in chickens fed probiotics and antibiotics or their mixture. South African J. Anim. Sci. 48(6): 1082-1092. https://dx.doi.org/10.4314/sajas.v48i6.11.

Alagawany M., Elnesr S. S., Farag M. R., Abd El-Hack M. E., Khafaga A. F., Taha A. E., Dhama K. (2019). Omega-3 and omega-6 fatty acids in poultry nutrition: effect on production performance and health. Animals., 9(8): 573.

Alegbeleye O.O. (2018). How functional is Moringa Oleifera? A review of its nutritive, medicinal, and socioeconomic potential. Food Nutrit. Bullet., 39(1): 149-170.

Ali H., Al-Dujaili A. (2018). Effect of fish oil and unsaturated fatty acidOmega-3 on fertility of female's albino rats Rattus rattus.

Alia F., Syamsunarno M. R. A., Sumirat V. A., Ghozali M., Atik N. (2019). The Haematological Profiles of High Fat Diet Mice Model with Moringa oleifera Leaves Ethanol Extract Treatment. Biomed. Pharmacol. J., 12(4): 2143-2149.

Ameh S.S., Alafi O.F. (2018). Effect of Ethanol Extract of Moringa Oleifera Leaves in Protecting Anaemia Induced in Rats by Aluminium Chloride. IOSR J. Biotechnol. Biochem.; 4(6):34–52.

Annur C.M. (2021). BPS: Impor Daging Sapi Turun 14,80% pada 2020. Badan Pusat Statistik (BPS), 2021.

Asare George, Gyan, Ben K, Bugyei Adjei, Samuel Mahama, Raymond Addo, Phyllis L, Otu-Nyarko, Wiredu, Edwin Nyarko, Alexander. (2012). Toxicity potentials of the nutraceutical *Moringa oleifera* at supra-supplementation levels. Interdisciplinary Toxicol.

Ashayerizadeh A., Dabiri N., Ashayerizadeh O., Mirzadeh K. H., Roshanfekr H., Mamooee M. (2009). Effect of dietary antibiotic, probiotic and prebiotic as growth promoters, on growth performance, carcass characteristics and hematological indices of broiler chickens. Pakistan journal of biological sciences : PJBS., 12(1): 52–57. https://doi.org/10.3923/pjbs.2009.52.57.

Atzmon G., Yang X. M., Muzumdar R., Ma X. H., Gabriely I., Barzilai N. (2002). Differential gene expression between visceral and subcutaneous fat depots. Hormone Metabol. Res., 34(11/12): 622-628..

Ayisi C. L. (2021). Implication of total replacement of fish oil with vegetable oils on nutritional and lipid profiles of fish. IJOTA Indonesian J. Trop. Aquat., 4(1): 14-23.

Babalola T. O., Oyawale F. E., Adejumo I. O., Bolu S. A. (2016). Effects of dietary fish oil replacement by vegetable oil on the serum biochemical and haematological parameters of African catfish (Heterobranchus longifilis) fingerlings. Iranian J. Fisher. Sci., 15(2): 775-788.

Bais S., Singh G. S., Sharma R. (2014). Antiobesity and hypolipidemic activity of Moringa oleifera leaves against high fat diet-induced obesity in rats. Adv. Biol., 2014.

Bagchi D. P., MacDougald O. A. (2019). Identification and Dissection of Diverse Mouse Adipose Depots. J. Visual. Exper.: JoVE. (149): 10.3791/59499. https://doi.org/10.3791/59499.

Bankole O., Madarikan G., Osho A., Otuechere C.A., Simisola T. (2014). Virgin coconut oil protects against liver damage in albino rats challenged with the anti-folate combination, trimethoprim-sulfamethoxazole. J. Basic Clin. Physiol. Pharmacol., 25(2);249–253.

Bazinet R.P., Domenichiello A.F., Kitson A.P. (2015). Progress in Lipid Research Is docosahexaenoic acid synthesis from a-linolenic acid sufficient to supply the adult brain?, Prog. Lipid Res., 59: 54–66.

BPOM (Badan Pengawas Obat dan Makanan). (2014). Peraturan Kepala Badan Pengawas Obat dan Makanan Republik Indonesia Nomor 7 Tahun 2014 Tentang Pedoman Uji Toksisitas Nonklinik Secara In Vivo. Badan Pengawas Obat dan Makanan (BPOM).

Buckley J. D., Howe P. R. (2010). Long-chain omega-3 polyunsaturated fatty acids may be beneficial for reducing obesity-a review. Nutrients., *2*(12): 1212–1230. https://doi.org/10.3390/nu2121212.

Chait A., den Hartigh L.J. (2020). Adipose Tissue Distribution, Inflammation and Its Metabolic Consequences, Including Diabetes and Cardiovascular Disease. Front. Cardiovasc. Med. 7:22. https://doi.org/10.3389/fcvm.2020.00022.

Chauhan S., Kodali H., Noor J., Ramteke K., Gawai V. (2017). Role of Omega-3 Fatty Acids on Lipid Profile in Diabetic Dyslipidaemia: Single Blind, Randomised Clinical Trial. J. Clin. Diagnost. Res.: JCDR., 11(3): OC13–OC16. https://doi.org/10.7860/JCDR/2017/20628.9449.

Chusyd D.E., Wang D., Huffman D.M., Nagy T.R. (2016). Relationships between Rodent White Adipose Fat Pads and Human White Adipose Fat Depots. Front. Nutr. 3:10. https://doi.org/10.3389/fnut.2016.00010.

Colville T. P., Bassert J. M. (2015). Clin. Anat. Physiol. vet. Tech.- third edition. Elsevier Health Sciences.

Ferrier D. R. (2014). *Biochemistry*-sixth edition. Lippincott Williams & Wilkins.

FDA (Food and Drug Administrations's). (2003). Toxicological Principles for the Safety Assesment of Food Ingredients, *Redbook 2000* Chapter IV.C.4.a. Subchronic Toxicity Studies with Rodents. *Food Drug Administrat.* (FDA). Accessed from: https://www.fda.gov/food/ingredients-additives-gras-packaging/redbook-2000-ivc3a-short-term-toxicity-studies-rodents.

Gad S. C. (Ed.). (2007). Animal models in toxicology, second edition. CRC press.

Gulliver C. E., Friend M. A., King B. J., Clayton E. H. (2012). The role of omega-3 polyunsaturated fatty acids in reproduction of sheep and cattle. Anim. Reprod. Sci., 131(1-2): 9–22. https://doi.org/10.1016/j.anireprosci.2012.02.002.

Gunawan M. I. F., Prangdimurti E., dan Muhandri T. (2020). Upaya Penghilangan Rasa Pahit Tepung Biji Kelor (Moringa oleifera) dan Aplikasinya untuk Pangan Fungsional. Jurnal Ilmu Pertanian Indonesia, 25(4): 636- 643.

Hall J. E. (2015). Pocket Companion to Guyton & Hall Textbook of Medical Physiology E-Book. Elsevier Health Sciences.

Hedrich H. (Ed.). (2004). The laboratory mouse. London: Elsevier Academic Press.

Hidayat R., Riviati N. (2021). Omega-3 as an Anti-Inflammatory Modality: Literature Review. Biomed. J. Indonesia., 7(1): 141-147. https://doi.org/10.32539/BJI.v7i1.1.

Indrayani I., Nurmalina R., Fariyanti A. (2012). Analisis efisiensi teknis usaha penggemukan sapi potong di Kabupaten Agam Provinsi Sumatera Barat. J. Peternakan Indonesia (Indonesian J. Anim. Sci.), 14(1): 286-296.

Jackson M. L. (2007). Veterinary clinical pathology: an introduction. John Wiley & Sons.

Jensen T., Kiersgaard M., Sørensen D., Mikkelsen L. (2013). Fasting of mice: a review. *Laborat. Anim.*, *47*(4): 225–240. https://doi.org/10.1177/0023677213501659.

Johnson F., Wardle J. (2014). Variety, palatability, and obesity. Advances in nutrition (Bethesda, Md.), 5(6): 851–859. https://doi.org/10.3945/an.114.007120.

Kelley D. S. (2001). Modulation of human immune and inflammatory responses by dietary fatty acids. Nutrition Journal, 17(7–8): 669–673.

Lam T. K., Carpentier A., Lewis G. F., van de Werve G., Fantus I. G., Giacca A (2003). Mechanisms of the free fatty acid-induced increase in hepatic glucose production. American J. Physiol.- Endocrinol. Metabol., 284(5): E863-E873.

Leone A., Spada A., Battezzati A., Schiraldi A., Aristil J., Bertoli S. (2016). Moringa oleifera Seeds and Oil: Characteristics and Uses for Human Health. Int. J. Molecul. Sci., 17(12): 2141. https://doi.org/10.3390/ijms1712214 HYPERLINK «https://doi.org/10.3390/ijms1712214.».

Luciano A.P., Benedet J., de Abreu L.C. *et al.* (2013). Median ages at stages of sexual maturity and excess weight in school children. Reprod. Health., 10(56). https://doi.org/10.1186/1742-4755-10-56.

Monteiro Júnior J., de Oliveira Cipriano Torres D., Filho, D. (2019). Hematological Parameters as Prognostic Biomarkers in Patients with Cardiovascular Diseases. Curr. Cardiol. Rev., 15(4): 274–282. https://doi.org/10.2174/1573403X15666190225123544.

Moodley I. (2018). Evaluation of sub chronic toxicity of Moringa oleifera leaf powder in mice. J. Toxicol. Pharmacol., 2(1): 1-19.

Nelson D. L., Lehninger A. L., Cox M. M. (2008). Lehninger principles Biochem. Macmillan.

Nugroho R.A. (2018). Mengenal Mencit Sebagai Hewan Laboratorium. Samarinda: Mulawarman University Press.

Nnamonu E.I., Mgbenka B.O., Ezewudo B.I., Mbegbu E. C., Ezechukwu C.S., Ugwu G. C. (2020). Omega-3 fatty acids as feed supplement modulates blood formation and body weight in Rattus norvegicus model. J. Basic Appl. Zool., 81(1): 1-8.

Nwani C. D., Mkpadobi B. N., Onyishi G., Echi P. C., Chukwuka C. O., Oluah S. N., Ivoke N. (2013). Changes in behavior and hematological parameters of freshwater African catfish Clarias gariepinus (Burchell, 1822) following sublethal exposure to chloramphenicol. Drug Chem. Toxicol., 1–7.

Obediah G. A., Paago G. (2018). Effects of ethanolic extract of M. oleifera seeds and leaves on the reproductive system of female albino rats. SOJ Biochem., 4(1): 1-8. http://dx.doi.org/10.15226/2376-4589/4/1/00131

Petrie A., Watson P. (2013). Statistics for veterinary and animal science-third edition. John Wiley & Sons.

Prabhu RA, Rajan AP, Santhalia S. (2011). Comparative analysis of preservation techniques on Moringa oleifera. Int. J. Agric. Food Sci.; 1(2):12-22.

Rice S. A., Mikes M., Bibus D., Berdyshev E., Reisz J. A., Gehrke S., Drew K. L. (2021). Omega 3 fatty acids stimulate thermogenesis during torpor in the Arctic Ground Squirrel. Scient. Rep., 11(1): 1-14. https://doi.org/10.1038/

s41598-020-78763-8.

Ruzickova J., Rossmeisl M., Prazak T., Flachs P., Sponarova J., Veck M., Tvrzicka E., Bryhn M., Kopecky J. (2004). Omega-3 PUFA of marine origin limit diet-induced obesity in mice by reducing cellularity of adipose tissue. Lipids., 39(12): 1177–1185. https://doi.org/10.1007/s11745-004-1345-9.

Sahay S., Yadav U., Srinivasamurthy S. (2017). Potential of Moringa oleifera as a functional food ingredient: A review. Magnesium (g/kg), 8(9.06): 4-90.

Saini R.D. (2017) Chemistry of Oils & Fats and their Health Effects. Int. J. Chem. Engineer. Res., 9(1):105-119.

Sartika R.A.D. (2008). Pengaruh asam lemak jenuh, tidak jenuh dan asam lemak trans terhadap kesehatan. Kesmas: National Pub. Health J., 2(4):154-160.

Selan R., Riwu D., Tobe A., Bunganaen W., Gusnawati G., dan Nurhayati N. (2019). Perancangan Wujud Alat Pres Biji Kelor. Sainstek, 4(1): 457-460.

Silva-Santana G., Bax J. C., Fernandes D., Bacellar D., Hooper C., Dias A., Silva C. B., de Souza A. M., Ramos S., Santos R. A., Pinto T. R., Ramão M. A., Mattos-Guaraldi A. L. (2020). Clinical hematological and biochemical parameters in Swiss, BALB/c, C57BL/6 and B6D2F1 Mus musculus. Anim. Models Experimen. Med., 3(4): 304–315. https://doi.org/10.1002/ame2.12139.

Sriyani N., Putra S., Saka I., Gaga Partama I. (2014). The Increase Of Omega-3 by Feeding Bali Cattle With Supplementation Lemuru Fish Oil in Molamix Concentrate. E-Journal Of Animal Science Udayana University, . Retrieved from https://ojs.unud.ac.id/index.php/jas/article/view/10895

Stevani H. (2016). Modul Bahan Ajar Cetak Farmasi Praktikum Farmakologi. Badan Pengembangan dan Pemberdayaan Sumberdaya Manusia Kesehatan. Kementerian Kesehatan Republik Indonesia.

Stockham, S. L., & Scott, M. A. (2008). Fundamentals of veterinary clinical pathology-second edition. Blackwell Publishing.

Suzana, D., Suyatna, F. D., Andrajati, R., Santi, P. S., & Mun'im, A. (2017). Effect of Moringa oleifera leaves extract against hematology and blood biochemical value of patients with iron deficiency anemia. J. Young Pharmacs., 9(1): S79.

Syamsunarno M.R.A., Amalia F., Ariyanto F.F., Widyastuti R., Anggaeni N., Sumirat V.A., Shabib M.N. (2019). Short-term effects of virgin coconut oil and cod liver oil treatment in blood metabolite profile of mice. Res. J. Chem. Environ. 23(12).

Vergara-Jimenez, M., Almatrafi, M. M., & Fernandez, M. L. (2017). Bioactive components in Moringa oleifera leaves protect against chronic disease. Antioxidants., 6(4): 91.

Wahyono T., Kusumaningrum C. E., Suharyono S. (2010). Pengaruh Pemberian Suplemen Pakan Multin Utrien Tanpa Olases Terhadap Pertambahan Berat Badan Harian Sapi Potong Dara. Prosiding Simposium dan Pameran Teknologi Aplikasi Isotop dan Radiasi.

Weiss D. J., Wardrop K. J. (Eds.). (2010). Schalm's veterinary hematology-sixth edition. John Wiley & Sons.

Yan L., Bai X. L., Fang Z. F., Che L. Q., Xu S. Y., Wu D. (2013). Effect of different dietary omega-3/omega-6 fatty acid ratios on reproduction in male rats. Lipids Health Dis., 12(1): 1-9. https://doi.org/10.1186/1476-511X-12-33