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EFFECTIVENESS OF SEMBALUN ARABIC COFFEE (*Coffea arabica*) ACTIVE COMPOUNDS AS AN ALTERNATIVE FOR REDUCING OBESITY

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ABSTRACT
Obesity has become a global public health and nutrition problem, both in developed and developing countries. Based on the latest Riskesdas data in 2018, the prevalence of obesity in adults aged >18 years is still increasing, at 21.8%. Arabica coffee (*Coffea Arabica*) has active compounds such as caffeine, alkaloids, flavonoids, saponins, and tannins that can be used to reduce the risk of causing obesity. This study aims to determine the decrease in obesity index of wistar male white rats given ethanol extract of arabica coffee beans for 24 days in obese model rats induced with high fat diet for 50 days. Extraction was carried out on Arabica coffee beans using 96% ethanol solvent for 3x24 hours by maceration method. The treatment was carried out with extract doses of 200 (D1), 400 (D2), and 600 (D3) mg/kg BW for 24 days. Experimental animals were divided into 5 groups, namely negative control given 1% CMC, positive control given orlistat 30 mg/kg BW, control group given ethanol extract of Arabica coffee beans at a dose of 200 (D1) mg/kg BW, 400 (D2) mg/kg BW, and 600 (D3) mg/kg BW. Obesity parameters were measured by Lee index and fat index. Arabica coffee extract (ACE) at a dose of D1 mg/kg BW showed a decrease in body weight of 47.88%, higher than the dose of D2 by (23.49%) and D3 by (14.00%). Caffeine contained in Arabica coffee beans (*Coffea arabica*) shows potential as an obesity inhibiting agent. The effective dose of ethanol extract from Arabica coffee beans (*Coffea arabica*) which has the effect of lowering the obesity index is in the D2 group.

Keywords: Arabica coffee beans, *Index lee*, Obesity, Weight loss

1. INTRODUCTION

Obesity has become a health and nutrition problem for the world community, both in developed and developing countries. Based on the latest Riskesdas data in 2018, the prevalence of obesity in adults aged >18 years is still increasing, at 21.8%. Obesity is a condition of imbalance between height and weight due to an excessive amount of body fat tissue (Sinaga, 2020). One of the diseases caused by obesity is type II diabetes mellitus which is a chronic condition and is associated with complications such as neuropathy, nephropathy, and other diseases that are dangerous to health.

One way to reduce obesity is to consume 200 ml/day of caffeine, based on a simulation of human habits of drinking a cup of coffee. Arabica coffee (*Coffea arabica*) has active compounds such as caffeines, alkaloids, flavonoids, saponins, and tannins so that they can be

used as functional foods to reduce the risk of obesity. Previous research conducted by Ardiansyah *et al*., (2019) about the obesity index reduction activity test from ethanol extract of robusta green coffee beans *(Coffea canephora)* against male white rats of the Wistar strain. The difference between this study and previous research on the type of sample used, and the location of sampling. Sembalun Arabica coffee samples have never been the subject of research related to obesity. Josephine *et al*., (2022) conducted a test on Tea (*Camellia sinensis*) which can help reduce the risk of obesity due to the presence of bioactive compounds such as flavonoids, tannins, 1-deoxynojirimycin, caffeine, catechins, and theaflavins. In vitro and in vivo experiments have demonstrated caffeine's ability to induce browning of adipose tissue, increase UCP1 protein abundance, and enha hance mitochondrial biogenesis (Velickovic *et al.,* 2019). According to Trivana *et al*., (2023), based on the research of Matsumoto *et al.,* (1993), in vitro data show that green tea catechins can reduce glucose absorption by inhibiting digestive enzymes involved in nutrient digestion, specifically the activity of α-amylase and α-glucosidase. Green tea catechins may also interfere with fat digestion and absorption. From this background, there are similarities between *Coffea arabica* and *Camellia sinensis* due to their caffeine content, which can be used as an alternative to reduce obesity.

Arabica coffee has a distinctive and best taste compared to other types of coffee so Arabica coffee is more in demand in the world market (Arlius *et al*., 2017). One of the regions in Indonesia that cultivates coffee plants is Sajang Village, Sembalun District, East Lombok Regency, NTB. The Sajang area is an abundant coffee-producing area with the location of its plantations directly under the slopes of Mount Rinjani. The larger size of coffee compared to other types of Arabica makes it a superior product in the Sembalun area. Coffee cultivation in Sembalun is also directly carried out by coffee farmers and the community there. In addition, Lombok's local coffee also meets good coffee standards based on the standards of the *Specialty Coffee Association America* (SCAA) (Afifi *et al.,* 2022). This study was conducted to determine the activity of Arabica coffee beans as a decrease in the obesity index in male white rats Induced high-fat diet foods to obtain mice with an obese model.

2. METHOD

2.1. Tools and Materials

The tools used are evaporators, analytical scales, oral sondes, evaporation cups, glass utensils (pyrex), filter paper, Buchner funnels, and vacuums. The plant material used in this study is Arabica coffee beans from Sembalun District, East Lombok, West Nusa Tenggara. The materials used in this study were: CMC (Merck), Aquadest, Orlistat (Novell), beef fat, egg yolk, coconut oil, phokphand 551 standard feed, and chemicals used for phytochemical refining.

2.2. Symplisia Characterization and Phytochemical Filtration

Phytochemical filtration is carried out on simplicial and arabica coffee bean extract to determine the content of secondary metabolite compounds, the test is by MMI or Farnsworth which includes testing for alkaloids, flavonoids, tannins, phenolates, triterpenoids, steroids, monoterpenes, sesquiterpenes, and quinones (Ardiansyah *et al.,* 2019). The MMI or Farnsworth method is a method used to identify secondary metabolites in plant extracts. Various reagents are used to detect different classes of compounds, such as Mayer reagent for alkaloids, magnesium powder and HCl for flavonoids, and $FeCl_3$ for tannins and phenols (Handayani *et al*., 2017).

2.3. Extraction

Sembalun arabica coffee beans are obtained from Sembalun District, East Lombok, NTB. The plantation is located under the slopes of Mount Rinjani (-8.317242,116.482858) during the dry season in April 2024. The recommended spacing for coffee cultivation is 2,5x2,5 meters for arabica. This spacing is varied with a land elevation of 1,600 above sea level. The higher the land the moresparse and the lower, the tighter the spacing. Sembalun Arabica coffee harvest

period belongs to the winter season. Harvesting Coffee cultivation is done in stages gradually, the main harvest usually occurs in 4-5 months in April and May and this coffee harvest occurs twice a year 1 year 2 times with a picking time interval of every 10-14 days (Sarjan *et al*., 2021). A total of 1,500 kg of crushed arabica coffee bean powder was weighed and then macerated using 96% ethanol solvent as much as 1,000 ml for 3x24 hours. The resulting filtrate is accommodated and filtered and then concentrated using a rotary evaporator (Ardiansyah *et al*., 2019).

2.4. Preparation of Test Animals

The experimental animals were male white rats of the Wistar strain with a weight variation of 160-200 grams, with the age of 2-3 months given standard feed (Phokphand 551) and ad libitum drinking water. This experimental animal has obtained an *Ethical Clearance* (EC) from the University of Mataram. The experimental animals were divided into 5 experimental groups, namely the negative control was only given CMC 1%, the positive control was given orlistat 30 mg/kg BW, the control group was given ethanol extract of Arabica coffee beans with doses of 200 (D1) mg/kg BW, 400 (D2) mg/kg BW, and 600 (D3) mg/kg BW. The minimum number of groups based on Federer's formula is 5 mice (Ardiansyah *et al*., 2019).

2.5. Induction of Obesity in Experimental Animals

The experimental animals were induced with a high-fat diet for 50 days with a feed composition of 5% chicken egg yolk, 1% coconut oil, 10% beef fat, and 100% standard feed (phokphan 551) ad. Parameters to determine obese rats with lee index with the formula (rat weight (g)1/3/nasoanal length (cm)) x 103, rats that are said to be obese have a lee index value of >300 (Ardiansyah *et al*., 2019).

2.6. Obesity Index Testing

Experimental animals that were said to be obese were given a weight loss treatment for 24 days in each group given standard feed and drinking water. The mice that were said to be not obese had a Lee index value (<0.05), and continued *Analysis of Variant* (ANOVA) and continued the test *Post Hoc Least Significant Difference* (LSD). Statistical tests were conducted with a confidence level of 95% P (<0.05) (Ardiansyah *et al*., 2019).

3. RESULTS AND DISCUSSION

3.1. Results of Simplicia Characterization

The extraction method in this study is the maceration method using 96% ethanol solvent. The maceration method was chosen because of its simple equipment and workmanship. The main reason for the use of 96% ethanol as an extraction solvent is its ability to dissolve a wide variety of compounds, both polar, semipolar, and nonpolar, and its relatively low level of toxicity to living organisms (Vonna *et al*., 2021). The extraction process is carried out for 3x24 hours, this aims to maximize the process of taking chemical compounds contained in Arabica coffee. The thick extract obtained was 282.85 grams with a yield of 14.1425%. Yield is a comparison between the results of many extraction processes and the weight of the sample used. The yield is said to be good if the value is more than 10%, so the yield obtained can be declared good (Noviyanto *et al*., 2024).

3.2. Simplicia Filtering Results

Phytochemical filtration is a qualitative analysis carried out to determine the content of secondary metabolites contained in the simplicial ethanol extract of Arabica coffee beans (*Coffea arabica*). The results of phytochemical filtration of arabica coffee bean extract are shown in Table 1**.**

Table 1. Results of Phytochemical Filtration of Extract and Simplicia of Arabica Coffee Beans *(Coffea arabica)*

Testing	Reagents	Result	Simplisia	Extract
Alkaloids	Dragendoff	Brownish orange	+	+
Flavonoids	Mg + HCl concentrate	Deep black	-	-
Phenol	$FeCl_3$	Blackish green	+	+
Tannins	$FeCl_3$	Blackish green	+	+
Steroids	H_2SO_4	Blue	+	+
Saponins	Shuffled	No foam formed	-	-

From the results of the phytochemical filtration test above, it shows that the ethanol extract of Arabica coffee beans contains alkaloid compounds that are proven to change color and brown deposits, The purpose of adding HCl is because the alkaloid is alkaline so it is usually extracted with a solvent containing acid (Hadi & Permatasari, 2019). In the flavonoid test, it was declared negative which was marked with a deep black color with a concentrated Mg and HCl powder reagent. A positive result will show red, yellow, or orange when reduced with Mg and HCl. In this test, hydrogen gas bubbles (H_2) due to the reaction between Mg and HCl metals so that it can reduce the nucleotide (Mangiwa & Maryuni, 2019). The phenol test using $FeCl_3$ showed positive results which were characterized by a change in color to blackish-green. Phenol compounds form complex bonds with iron, causing color changes from purple to blackish-green (Fajriaty *et al.*, 2017). Tannin compounds are polar because there is an OH group, when $FeCl_3$ is added, there will be a color change to dark blue due to hydrolyzed tannins, or blackish green due to condensed tannins (Ningsih, 2017). The saponin test was negative when there was no foam after being shaken. Positive results were shown on foam 1-10 cm high in a few minutes because saponins are compounds that are easily detected through their ability to form foam (Ningsih, 2017).

3.3. Obesity Index Test Results

The weight gain test of the mice was carried out for 50 days by feeding a high-fat diet (MDTL), the goal of which was to obtain mice with an obese model. Rat test animals have obtained a permit *EC* with the protocol number UNRAM266123 from the University of Mataram. Weight gain parameters related to the level of obesity in rats expressed by *Index Lee*. Average results *Index Lee* can be seen in Table 2 and Figure 1. In Table 2 values *Index Lee* experienced an increase on the 0th to 50th day. This is related to the higher the value *Index Lee*, the greater the obesity rate (Ardiansyah *et al.*, 2019). The positive group on day 0 showed an average *Index Lee* The weight is quite high compared to other groups. This is due to the age factor where the positive group is older than the other groups. These results are by the research of Jensen *et al.*, (2021) that younger mice (3-5 weeks old at the start of the study) experienced a noticeable decrease in bone mass 12-16 weeks after following a high-fat diet compared to older mice (12-16 weeks at the time of the study). Therefore, age is one of the important factors in the change in bone mass due to obesity compared to the severity of obesity.

The administration of high-fat diet feed (MDTL) was able to increase the weight of rats in all dosage and control treatments because the intake of food entering the body was much greater than necessary so that nutrients and fat were stored automatically in muscle tissue and adipose tissue resulting in weight gain (Ardiansyah *et al.*, 2019). Weight gain was followed by an increase in fat involving viscera adipose regions such as parirenal, epididymal, and retroperitoneal compared to the normal group given standard feed. This means that high-fat diet feed affects fat formation (Istiqomah *et al.*, 2022). Here is the results *Index Lee* before induction on day 0 and after induction on day 50 are shown in Table 2 and Figure 1.

Table 2. Lee's *Index* Value of Weight Gain Induced by MDTL Day 0 and Day 50

Treatment Groups	Before Induction After Induction			
	Day 0 Index Lee	Day 50 Index Lee		
Positive Control	207.33	257.53	211.66	267.65
Negative Control	164.83	250.18	147.33	313.51
D1 mg/kg BW	118.83	262.99	155.33	334.09
D2 mg/kg BW	123.33	257.86	157.85	298.00
D3 mg/kg BW	138.16	278.02	160.66	316.18

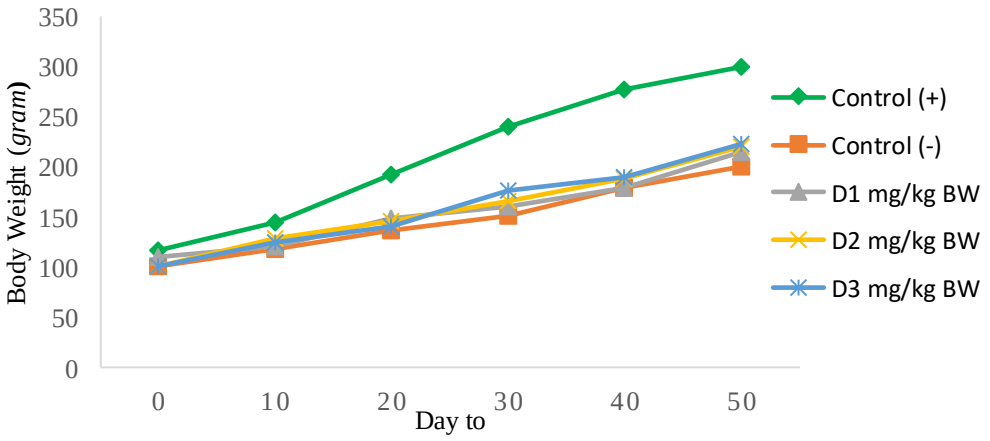

Figure 1. Weight Gain of Rats After MDTL Induction for 50 Days

3.4. Rat Weight Loss Results

Weight loss tests on rats were carried out for 24 days with standard feed and drinking water in each treatment group. Weight loss before the treatment, which is on the 50th day, is calculated as the 1st day, while the results after the treatment are calculated from the 51st day to the 74th day, as seen in Table 3.

Table 3. Average Weight Loss Before and After Arabica Coffee Bean Extract Treatment and Weight Loss Percentage Over 24 Days

Treatment Groups	Average Weight Loss (grams) in ±SD Rats		Percentage Decline Body Weight (%)
	Before Treatment	After Treatment	
Positive Control	211.67 ± 73.21[a]	140.83 ± 50.08	-33%
Negative Control	160.67 ± 48.38[b]	207.33 ± 33.00	29%
D1 mg/kg BW	157.67 ± 42.95[a]	118.33 ± 26.16	-24%
D2 mg/kg BW	155.33 ± 38.24[a]	143.5 ± 10.15	-9%
D3 mg/kg BW	147.33 ± 37.46[a]	138.16 ± 6.48	-6%

Remarks: a,b = if the letters are different, then significant (P<0.05)

Table 4. Post Hoc test results of arabica coffee bean extract treatment

Treatment Groups	Comparison Group	Mean Difference
Positive	Negative	64.333[b]
Negative	Positive	-64.333[b]
D1	D2	-10.333[a]
	D3	-13.333[a]
D2	D1	2.333[a]
	D3	-3.000[a]
D3	D1	5.333[a]
	D2	3.000[a]

Remarks: a,b = if the letters are different, then significant (P<0.05)

Caffeine functions as an adenosine receptor antagonist, which plays a role in increasing the release of the neurotransmitter dopamine. An increase in dopamine can improve mood and concentration, but can also cause side effects such as anxiety and restlessness at high doses.

Small doses of caffeine are generally anxiolytic (reducing anxiety), while high doses can be anxiogenic (causing anxiety), especially in susceptible individuals (Dewanti & Tadjudin, 2022). According to Dr. Erich Harnack (Tsatsakis *et al*., 2018), the minimum level of observable action that a drug induces is called the minimum effective dose. Therefore, the minimum dose of D1 is effective in reducing the body weight of rats. In the positive control group, Orlistat was given as an obesity reduction rate where the weight loss rate was (-33%), while the negative group was only given CMC 1% (29%), this means that CMC 1% does not affect weight loss. From the results of the *ANOVA* statistical analysis, there was no significant difference between the treatment groups, with a significance value of (P>0.05) which means that the results of the study did not show strong enough evidence to conclude that there was a difference between the treatment groups.

The Post Hoc test was carried out to determine the difference in the activity of arabica coffee bean ethanol extract at D1, D2, and D2, respectively, which showed significant or insignificant pharmacological effects on weight loss compared to the negative control group (CMC 1%) and positive control group (Orlistat 30 mg/kg BW). Based on the results of the Post Hoc test in the negative control group, there was a significant difference with the positive control group with a significance value (*P<0.05*). This showed that the positive control group (Orlistat 30 mg/kgBW) experienced greater weight loss than the negative control group (CMC 1%), so the positive group did not have the same effectiveness as the negative group or orlistat 30 mg/kgBW was more effective in losing rat weight than CMC 1%.

In the positive group, there was no significant difference in the significance value (*P>0.05*) with the D2 group so it is interpreted that D1 does not have the same effectiveness as the positive group (orlistat 30 mg/kg BW) in weight loss. Post Hoc test results between ethanol extract of Arabica coffee beans at D1, D2, and D3 showed no significant difference (*P>0.05*) (Table 4), this means that the dose group of Arabica coffee bean ethanol extract does not have the same effectiveness as orlistat 30 mg/kg BW which can cause weight loss. Orlistat works by inhibiting the absorption of fat and the pancreatic lipase enzyme, resulting in the excretion of fat from the body through feces (Shiyan *et al.,* 2017). Lipases are enzymes that catalyze the hydrolysis of fats and oils, breaking down triglycerides into free fatty acids and glycerol (Sholeha & Agustini, 2021). Therefore, the pancreas that does not produce enough lipase enzymes will result in impaired fat absorption.

Then, the weight gain parameter was related to the obesity rate in the mice which was expressed by *the lee index*. The average results of the decline *in the lee index* before and after the treatment as well as the percentage of decline in *the lee index* can be seen in Table 5 and Figure 2.

Table 5. Average Lee *Index Decline* Before and After Caffeine Extract Treatment and Percentage Decrease in *Lee Index* Over 24 Days

Treatment Groups	Average Lee Index Results in Rats		Percentage Decline *of Lee Index* (%)
	Dad1y 0	Day 24	
Positive Control	267.65	262.72	1.84%
Negative Control	313.51	308.12	1.71%
ACE 200 mg/kg BW Dose (D1)	334.09	281.66	15.69%
ACE 400 mg/kg BW Dose (D2)	298.00	284.45	4.54%
ACE 600 mg/kg BW Dose (D3)	316.18	278.85	10.03%

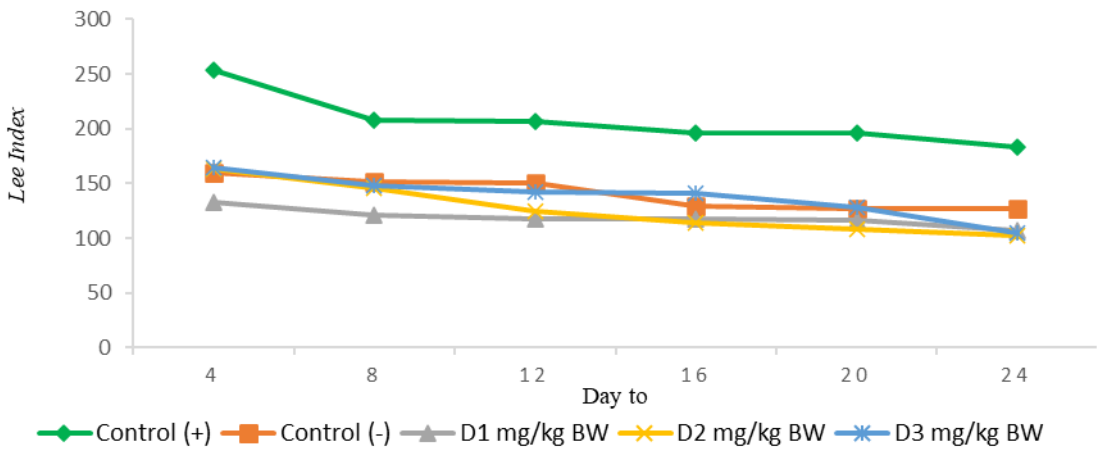

Figure 2. Caffeine Extract Rat Weight Loss for 24 Days

From Table 5 above, it is explained that there was a decrease in obesity in the treatment group of Arabica coffee bean ethanol extract with the highest D1 with a decrease in *Index Lee* (15.69%), when compared to D3 (10.03%), D2 (4.54%), positive control (1.84%), and negative control group with the lowest percentage (1.71%). Arabica coffee bean ethanol extract may contain various active compounds i.e. caffeine and chloronic acid with different mechanisms of action. At D1dose, this combination of compounds may work synergistically to boost metabolism and suppress appetite, thereby losing weight. On the other hand, in D2 and D3 Dose, the effects of either compound may be dominant, causing side effects. which inhibits weight loss. If you look at Table 4 above, the obesity rate after 24 days of extract treatment in the positive control group, the doses of D2, D2, and D3 extracts showed that they were not obese, while in the negative control group they were obese, this is because CMC 1% did not have an effect as an obesity reduction (Ardiansyah *et al*., 2019) So that the negative control group experienced obesity with a decrease in value *Index Lee* lowest (1,71%). Rats that were said to be not obese had an index value of Lee <300 (Ardiansyah *et al*., 2019). This means that weight loss and gain affect *Index Lee* as a parameter of the obesity index.

The average result of the increase in BW based on *the Lee index* for 50 days and the decrease in BW based on *the Lee index* for 24 days before and after the treatment of Ethanol Extract of Arabica coffee beans can be seen in Figure 3.

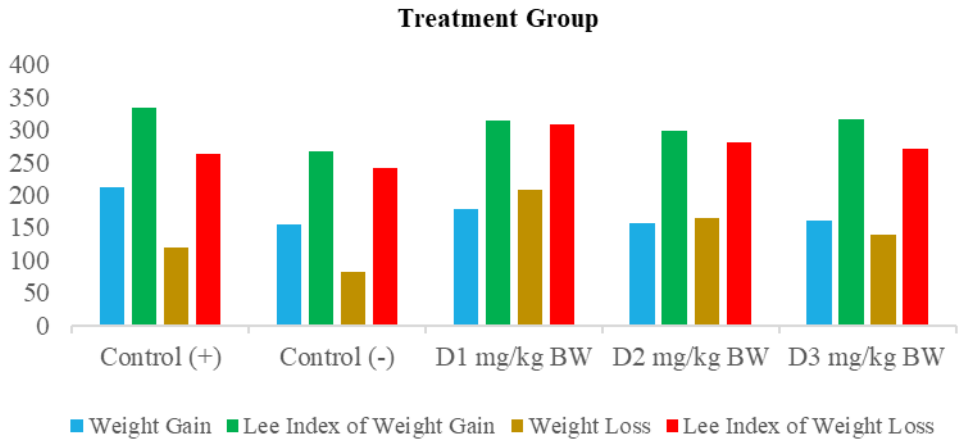

Figure 3. The average increase in BW based on the Lee index for 50 days and decrease in BW based on the Lee index for 24 days Before and After Ethanol Extract treatment of arabica coffee beans

From the figure above, it is explained that the average increase in BW and *Lee index* increased BW for the highest 50 days in the positive control group, while the increase in BW and *Lee index* increased the lowest BW in the negative control. The decrease in BW and *lee*

index of the highest 24-day decrease in BW was in the D1 group compared to the positive group and the negative group as well as D2 and D3. This shows that Arabica coffee bean ethanol extract has the potential as a weight loss and fat reduction agent. The most effective ethanol extract of arabica coffee beans is found at D1. Higher doses of D2 and D3 are less effective in promoting weight loss and fat reduction.

3.5. Fat Index and Organ Index

The fat index test is carried out by taking samples of abdominal fat tissue from the retroperitoneal area located behind the kidneys and liver. The following average results of testing fat index and organ index parameters over 74 days can be seen in Table 6. In Table 6, the fat index results at D1 were lower than all treatment groups, while the highest fat index was found at D2. The results of the analysis showed a significance value ($P<0.05$), meaning that there was a significant difference in the fat index between the treatment groups. The fat index can be interpreted as the body mass index (BMI), the higher the BMI, the higher the fat mass. This is by research by Susantini, (2021) which states that the relationship between BMI and body fat percentage with a positive coefficient means that there is a positive relationship between BMI value and fat mass percentage, the higher BMI will increase fat mass percentage. A high BMI is often associated with various health problems such as type 2 DM. Research by Masruroh, (2018), proves that there is a relationship between BMI and blood sugar levels of people with Type 2 *Diabetes Mellitus*.

Furthermore, the testing of organ index parameters aims to determine the fat deposits contained in the liver. Based on the analysis test, it showed a significance value ($P>0.05$) in the liver index, meaning that there was no significant difference in the treatment group and there was no fat accumulation in the liver.

Table 6. The average value of fat index and organ index parameter testing for 74 days

Treatment groups	Fat Index (%)	Organ Index (%)
Negative Control	5.91 ± 2.03	0.12 ± 0.18
Positive Control	6.90 ± 0.76	0.03 ± 0.01
ACE 200 mg/kg BW Dose (D1)	1.60 ± 0.55	0.05 ± 0.01
ACE 400 mg/kg BW Dose (D2)	7.64 ± 2.45	0.06 ± 0.02
ACE 600 mg/kg BW Dose (D3)	1.81 ±0.73	0.08 ± 0.04

4. CONCLUSION

Caffeine contained in Arabica coffee beans (*Coffea arabica*) shows potential as an obesity inhibiting agent. The effective dose of ethanol extract from Arabica coffee beans (*Coffea arabica*) which has the effect of lowering the obesity index is in the D2 group.

5. SUGGESTIONS

It is recommended to conduct pre-test and post-test tests to obtain more comprehensive data on changes in fat levels before and after obesity treatment.

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7. CONFLICTS OF INTEREST

The author states that there is no conflict of interest in this study.

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