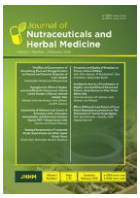
Journal of Nutraceuticals and Herbal Medicine

Journal Homepage: https://journals2.ums.ac.id/index.php/jnhm



Antiobesity Activity Of A Combination Of Extracts From Porang Tubers (Amorphopallus Muelleri) and Jati Belanda Leaves (Guazuma Ulmifolia) In Obesity Rat Models

Muhammad Zaini Fahmi[1], Muhtadi[1*], Muhammad Haqqi Hidayatullah[1]

[1]Faculty of Pharmacy, Muhammadiyah University of Surakarta, Surakarta

*Corresponding Author. Email: muhtadi@ums.ac.id

Received: 30 December 2023 | Revised:17 January 2024 | Accepted: 1 February 2024

Abstract

Obesity is excessive fat accumulation due to an imbalance between energy intake and energy used for a long time. One of the herbal medicines commonly used for obesity is porang tubers and Jati Belanda plants. The aim of this research was to prove the anti-obesity activity of a combination of porang tuber extract with Jati Belanda leaf extract in an obese mouse model. The antiobesity effect test was carried out for 14 days on obese model rats. The anti-obesity effect was measured using the Lee Index ≥ 0.3 and also weight reduction. This research was conducted using 5 groups of test animals, namely the negative group (PGS 1%), positive (orlistat 7.57 mg/kgBW), and 3 groups combining porang tuber extract and Jati Belanda leaves, 50 + 62.5; 50 + 125; 50 + 250 mg/kgBB. A reduction in body weight occurred in groups II, III , IV, and V, and an increase in body weight in group I. The average Lee index results for groups I, II, III, IV, and V respectively were 0.31 ± 0 . 02, 0.29 ± 0.01, 0.29 ± 0.01, and 0.30 ± 0.01. Data analysis using the Kruskall-Wallis test produced a no significant difference of 0.611 ($p>0.05$) on the 14th day, which shows that the combination of porang tubers and Jati Belanda leaves does not have an anti-obesity effect.

Keywords: Obesity, Porang tubers, Jati Belanda, Antiobesity, Lee Index;

INTRODUCTION

Obesity and *overweight* are defined as excessive accumulation of abnormal fat which will eventually cause many diseases and damage health. For adults, WHO states that obesity is a BMI greater than or equal to 30 and for *overweight* a BMI greater than or equal to 25 (WHO, 2017) . Obesity has become a problem in various parts of the world where the numbers are always increasing drastically, both in developed and developing countries. Obesity itself has a major contribution to several diseases such as cardiovascular disease, diabetes mellitus 2, cancer and osteoarthritis throughout the world (Seidell and Halberstadt, 2015) . Obesity and *overweight* can be reduced by using medication. Medicines derived from synthetic (chemical) materials or traditional (herbal) materials. One of the herbs used to treat obesity is porang tubers and Jati Belanda (Rathnayake *et al.* , 2014) . One of the chemical drugs that

is believed to reduce weight is Orlistat (Qi, 2018) . The mechanism of orlistat itself is by inhibiting gastric lipase, thereby inhibiting the absorption of dietary fat in the body (Al-Omar *et al.* , 2006) .

Carbohydrates, which are the most important part of porang tubers or *Amorphopallus muelleri* , consist of starch, glucomannan, crude fiber and reducing sugar. (Jansen *et al.* , 1996) . A review of studies evaluated the effects of glucomannan on body weight and BMI in healthy obese individuals. The result that can be taken from the evaluation is that if consumed in the short term it can help reduce weight. *Amorphopallus muelleri* or porang is said to contain glucomannan. The mechanism of action of glucomannan itself is to provide a feeling of fullness due to a delay in gastric emptying caused by a thick gel mass that forms in the stomach, and also delays the time of gastrointestinal transmission. (Behera and Ray, 2016) .

Jati Belanda contains chemicals, namely alkaloids and flavonoids, and the main content in Jati Belanda leaves itself is tannin. The tannin content in Jati Belanda extract has a role in inhibiting the pancreatic lipase enzyme and also works as an astringent which is thought to reduce the ability to absorb food. (Lumbantobing, Zhafran Ramadhan., Muhartono., 2019) . In Jati Belanda itself, a clinical trial was carried out, namely a quasi-experimental study with a pre- and post-test design on obese sufferers who received treatment with Dutch finger extract. The results of the data taken showed that there was a reduction in body weight in obese sufferers after administering Jati Belanda leaf extract. The average patient's weight before treatment was 75.5 kg and after treatment the weight decreased to 73.9 kg. This research is statistically significant with a p value <0.05. (Permenkes RI, 2016) .

Based on this description, this research will prove the effect of giving a combination of porang tuber extract with Jati Belanda leaf extract to have anti-obesity activity in obese mouse models.

METHODS

2.1. Types of research

This research is an experimental category using a Completely Randomized Design method involving normal, negative control and treatment groups.

2.2. Research sites

The research was conducted at the Pharmacology and Clinical Pharmacy Laboratory, Faculty of Pharmacy, Muhammadiyah University, Surakarta.

2.2. Tools and materials

2.2.1 Tools

The equipment used is an animal cage, *rotary evaporator* , 2610 gram scale (*Lark* , *China*), analytical balance (*Presica A-SCS*), *porceline cup* , maceration vessel, beaker, oven, *centrifuge* (*Mini Spin*), sonicator (*Branson 1510*) , *Buchner funnel* , water bath, glassware (*Pyrex, Iwaki*), *Eppendorf* , mill, 80 mesh sieve.

2.2.2 Materials

The ingredients used are Wistar rats, orlistat, porang tubers, Jati Belanda leaves, ethanol, sodium bisulfate, normal rat feed, PEG, corn flour, fish meal, beef tallow, green bean flour, and fructose.

2.3. *Ethical Clearance* Management

Ethical Clearance certificate to the Health Research Ethics Committee (KEPK) Faculty of Medicine, Muhammadiyah University of Surakarta with No. 3733/A.1/KEPK-FKUMS/X/2021.

2.4. Plant Sampling and Determination

Samples of porang tubers and Jati Belanda leaves were obtained from the Boyolali area, Central Java and the two plant sample materials were collected in September 2021.

2.5. Plants Extraction

2.5.1 Porang Tuber Extract

Porang tubers are peeled, sliced and washed until clean. Then soaked with table salt in water until the tubers are soaked for 24 hours and drained (Haryani and Hargono, 2008) . Dry it in the sun and after drying it, grind it with a blender and sift it. Obtained flour Then 25 mg of porang tubers were soaked in 750 mL of 50% ethanol (1:15) and 25 mL of 2% $NaHCO_3$ was added to the solution, and stirred constantly using *a magnetic stirrer* for 4 hours. Filtered using a *Buchner funnel* and the filtrate was taken. Then it was dried in a desiccator for 24 hours by weighing the wet weight and dry weight (Pasaribu *et al.* , 2019) .

2.5.2 Jati Belanda Leaf Extract

The Jati Belanda leaves are washed clean and air-dried until half dry, then placed in the oven at 45°C to 60°C for 4 days. Dried Jati Belanda leaves are ground into fine flour with a size of ± 40 millimeters (Mohammad Arif Budiarto *et al.* , 2016) . After obtaining the flour, take 200 grams of Jati Belanda simplicia powder and put it in a macerator, add 2 liters of 95% ethanol. Soak for the first 6 hours, stirring occasionally, then leave for 18 hours. The maserate is separated by filtration, the filtration process is repeated 2 times using the same type and amount of solvent. Then the macerate was collected and concentrated to remove all solvent using *a rotary evaporator* (40 rpm, 60°C), to obtain a thick extract. To obtain dry simplicia extract, the thick extract is then put into a mortar and lactose (1 x the weight of the thick extract) is added little by little while grinding until evenly distributed. The dry mass was added with hexane solvent ± 300 mL for every 100 g of extract, then stirred thoroughly several times for 2 hours, allowed to settle and the liquid was poured. The remainder was mixed with 300 mL of hexane, stirred thoroughly and the excess hexane was separated, the washing process was repeated once with hexane, dried at a temperature of ± 70^0C (Rivai, 2016) .

2.6. Preparation of Test Animals

The test animals used were Wistar rats aged 7-8 weeks with a body weight of 150-200 grams. Rats were grouped into 5 cages and each cage contained 5 rats. Animals are given food and drink distilled water, animals are acclimatized (adapted to the environment) for 7 days. Care for rats is carried out by feeding pellets once a day, drinking water, and sanitizing the cage.

2.7. Modelling Obese Rats

Rats were made fat by inducing fructose in drinking water and high-fat feed consisting of beef tallow, corn flour, fish meal and green bean meal for 21 days so that the

rats became obese. Body weight is then monitored every day. Rats are said to be obese if they have reached a Lee index number ≥ 0.3.

2.8. Test Treatment

The rats tested were divided into 5 groups, with 5 rats in each group. After the obese rats were placed in group IV, they were given oral treatment once a day for 14 days.

1. Group I (negative control), given 1% PGS
2. Group II (positive control), was given Orlistat 7.57 mg/Kg BW
3. Group III, given a combination of porang flour 50 mg/kgBB po, and Jati Belanda 62.5 mg/kgBB po
4. Group IV, given a combination of porang flour 50 mg/kgBB po, and Jati Belanda 125 mg/kgBB po
5. Group V, given a combination of porang flour 50 mg/kgBB po, and Jati Belanda 250 mg/kgBB po

Rats were induced on a high-fat diet from day 1 to day 21 (1 time a day), then rats were given ethanol extract of porang tubers (*Amorphophallus muelleri*) and Jati Belanda extract (*Guazuma ulmifolia)* at doses of 62.5, 125, and 250 mg /kg BW given for 14 days (1 time a day) on the 21st to the 35th day, every week the *Lee index is measured* , on that day the body weight and height are also measured.

For groups I, II, III, IV, V 30 minutes before giving food, all experimental animals were given orally for 14 consecutive days. The body weight of the test animals was weighed every 7 days at the same time and the body length of the rats was measured. From the results of measuring the body weight and body length of the rats, the body mass index was calculated using the formula:

$$\frac{\sqrt[3]{body}weight\ (g)}{naso-anal\ length\ (cm)}$$

Testing was carried out using SPSS software statistical tests. The body mass index data obtained was tested for normality using *the Shapiro-Wilk test* because the number of samples used was less than 50. Then statistical analysis was carried out using *the one way anova test* to see overall significance ($p<0.05$). Each test has a significance level of 95% (Putri *et al.* , 2011)

RESULTS AND DISCUSSION

The results of the extraction of porang flour and Jati Belanda leaves obtained yields of 63.36% and 15.4% respectively and the weight of the extract was 190.15 g and 15.4 g using the maceration method (Table 1).

Table 1. Extraction Result Data

Extract	Extract weight (g)	Simplicia weight (g)	Yield (%)
Porang Flour	190.15	300.08	63.36
Jati Belanda Leaves	15.4	100	15.4

Flour extraction using a mixture of $NaHSO_3$ and 50% ethanol aims to increase the glucomannan content in porang flour. The more solvent used (1:15), the higher the glucomannan content that will be obtained. (Pasaribu *et al.* , 2020) . Stir continuously for 4 hours to help increase the glucomannan content in porang tubers. Stirring encourages the release of components contained on the surface of the glucomannan particles and makes them dissolve in ethanol (Irawan and Widjanarko, 2013) . By using this extraction method, a yield of 68.36% was obtained.

Wash the Jati Belanda leaves until clean and leave them at room temperature until half dry, then dry them in the oven at a temperature of 45°C to 60°C for 4 days. The drying process aims to stop enzymatic reactions that can affect the active compounds in Jati Belanda leaves. After drying, it is ground into fine flour which functions to reduce the size of the simplicia so that more compounds are attracted during the extraction process (Moh Arif Budiarto *et al.* , 2016) . After it becomes flour, take 200 g of Jati Belanda simplicia powder and put it in a macerator with 2 liters of 95% ethanol. Soak for 6 hours while stirring occasionally, then leave for 18 hours. The maserate was separated by filtering and the filtering process was carried out in 2 repetitions using 95% ethanol. Then the macerate is collected and concentrated to remove all solvent using *a rotary evaporator* , then followed by a water bath at a temperature of 50^0C (Rivai, 2016) . The thick extract was weighed and a yield of 15.4% was obtained**.**

3.1 Results of Obesity Induction in Test Animals

The results of measuring the average weight gain and Lee index can be seen in Table 2 below.

Table 2. Average amount of weight gain and Lee Index Value during the obesity induction process

Group	Percentage weight gain Lee Index Value	
	Percentage of weight gain over 21 days (%)	Lee Index Day 21
Negative Control	29.76 ± 34.58	0.32 ± 0.02
Positive Control	15.42 ± 24.84	0.31 ± 0.02
Porang flour 50 mg/kgBB + Jati Belanda 62.5 mg/kgBB	8.97 ± 19.20	0.31 ± 0.00
Porang flour 50 mg/kgBB + Jati Belanda 125 mg/kgBB	35.64 ± 18.15	0.32 ± 0.01
Porang flour 50 mg/kgBB + Jati Belanda 250 mg/kgBB	14.49 ± 14.64	0.32 ± 0.02

Table 2 shows that feeding a fat diet for 21 days influenced a significant increase in body weight as measured using the *Lee index formula* , which is the formula used to measure obese rats. All test animals in all treatment groups experienced obesity as assessed by the *Lee index value* ≥ 0,3, (Tabel 2).

3.2 Antiobesity Activity Assay

Antiobesity activity tests were carried out on all test animals for 14 days starting on day 22 to day 35 after the test animals became obese. Treatment is given according to the treatment

group during the test time period. The results of the average body weight for 35 days are presented in Table 3.

Table 3. Data on body weight of test animals

Group	Average body weight (g)			
	Day 0	**Day 21**	**Day 28**	**Day 35**
Negative Control	193.20 ± 31.51	239.80 ± 34.58	246.00 ± 37.19	249.20 ± 36.92
Positive Control	184.80 ± 22.93	223.00 ± 24.84	213.20 ± 23.89	206.00 ± 24.40
Porang flour 50 mg/kgBB + Jati Belanda 62.5 mg/kgBB	175.20 ± 12.68	202.00 ± 19.20	192.40 ± 17.07	186.60 ± 17.44
Porang flour 50 mg/kgBB + Jati Belanda 125 mg/kgBB	220.20 ± 24.54	251.60 ± 18.15	243.00 ± 21.48	237.00 ± 20.28
Porang flour 50 mg/kgBB + Jati Belanda 250 mg/kgBB	236.00 ± 10.53	270.20 ± 14.64	258.60 ± 11.10	249.00 ± 10.70

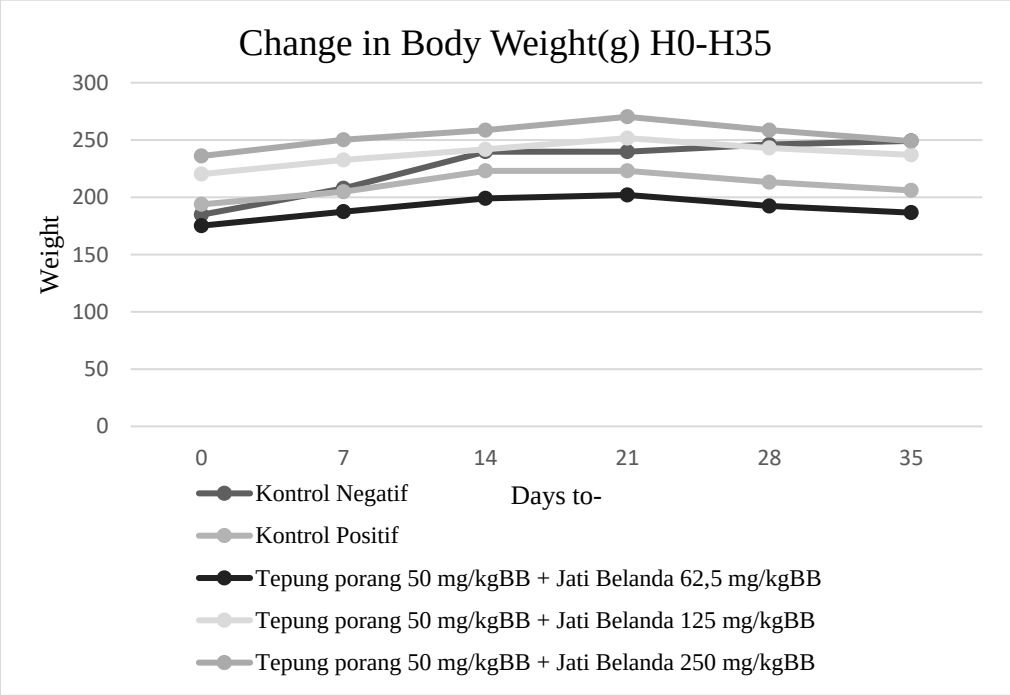


Figure 1. Graph of Average Rat Body Weight (g)

Anti-obesity testing aims to understand whether or not there is an effect of treatment with porang tuber ethanol extract (*Amorphophallus muelleri*) and Jati Belanda extract (*Guazuma ulmifolia)* at doses of 62.5, 125, and 250 mg/kgBW given for 14 days starting on the 1st day. 22 to 35 days are presented in (Table 3). The test animals were divided into 5 groups, namely group I negative control, group II positive control, group III porang flour 50 mg/kgBW with Jati Belanda 62.5 mg/kgBW and group IV porang flour 50 mg/kgBW with teak Dutch 125 mg/kgBW and group V porang flour 50 mg/kgBB with Jati Belanda 250 mg/kgBB. Antiobesity activity tests were carried out on all test animals for 14 days. During

the research period, treatment was carried out according to the treatment group, (Table 3) shows the average weight loss results for 14 days after the test animals became obese.

The negative control group's body weight increased to 249.20 ± 36.92 g (Table 2) were diabetic rats and the positive control group using a comparison drug, namely Orlistat, reduced their body weight to 206.00 ± 24.40 g. This group was used as a comparison against between dose groups to determine whether there is a significant difference in the effect of reducing the weight of rats.

These results (Table 3) show that administration of porang tuber ethanol extract combined with Jati Belanda extract can reduce body weight in obese mouse models during the study period, and these results also apply to the orlistat drug control group. These results indicate the potential of porang tubers combined with Jati Belanda extract as an anti-obesity drug compared to giving porang tubers alone. Group V porang flour 50 mg/kgBW with Jati Belanda 250 mg/kgBW showed the most significant weight reduction results, namely 249.00 ± 10.70 g, which was also higher compared to the positive control group given orlistat.

The reduction in body weight in the obese mouse model is thought to be due to the presence of bioactive compounds in the ethanol extract of porang tubers and Jati Belanda extract. Porang tubers are said to contain glucomannan. The mechanism of action of glucomannan itself is to provide a feeling of fullness due to the delay in gastric emptying caused by the viscous gel mass that appears to form in the stomach, and functions to delay the time of gastrointestinal transmission. (Behera and Ray, 2016) .

Jati Belanda, the chemical content found in the bark and leaves of Jati Belanda is alkaloid and flavonoid compounds, with tannin as the main content found in the leaves (Agung *et al.* , 2014) .The flavonoid, saponin and tannin compounds in Jati Belanda leaves have a mechanism for inhibiting the pancreatic lipase enzyme by reducing triglyceride levels, total cholesterol, and reducing body weight (Hidayat *et al.* , 2015) . The positive control group used orlistat for comparison. Orlistat helps reduce body weight by inhibiting the lipase enzyme and preventing fat from being absorbed by the intestines and more excreted through feces (Putri *et al.* , 2011) .

3.3 **Effect of Extract Administration on Lee Index Values in Test Animals**

Table 4. Lee index value for each treatment group for 35 days

Group	Lee index value			
	Day 0	**Day 21**	**Day 28**	**Day 35**
Negative Control	0.29 ± 0.02	0.32 ± 0.02	0.31 ± 0.02	0.31 ± 0.02
Positive Control	0.31 ± 0.02	0.31 ± 0.02	0.30 ± 0.02	0.29 ± 0.01
Porang flour 50 mg/kgBB + Jati Belanda 62.5 mg/kgBB	0.30 ± 0.01	0.31 ± 0.00	0.29 ± 0.01	0.29 ± 0.01
Porang flour 50 mg/kgBB + Jati Belanda 125 mg/kgBB	0.31 ± 0.01	0.32 ± 0.01	0.30 ± 0.01	0.29 ± 0.01
Porang flour 50 mg/kgBB + Jati Belanda 250 mg/kgBB	0.32 ± 0.02	0.32 ± 0.01	0.31 ± 0.01	0.30 ± 0.01

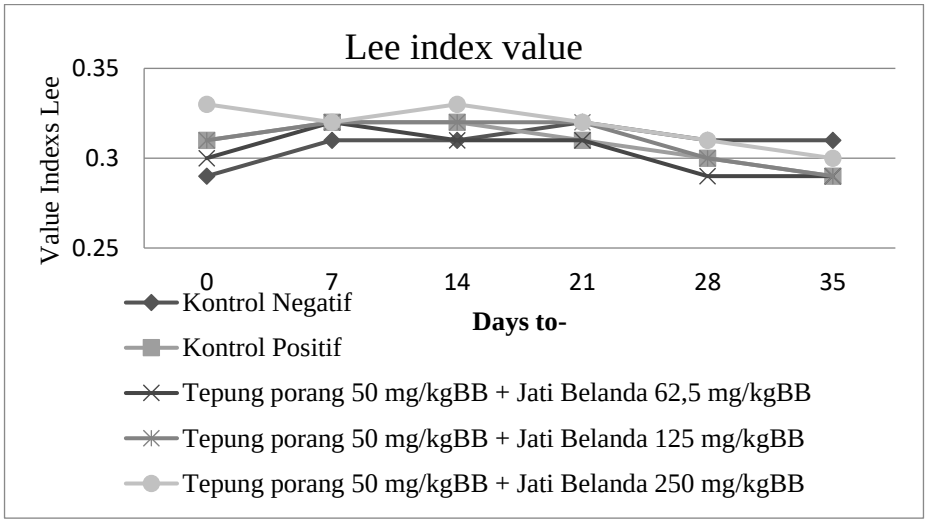


Figure 2 Graph of Lee Index Values

The Lee index measurement in the positive control decreased from 0.31 to 0.29, in the group dosed with porang flour 50 mg/kgBW with Jati Belanda 62.5 mg/kgBW there was also a decrease from 0.31 to 0 .29, the group dose of porang flour 50 mg/kgBW with Jati Belanda 125 mg/kgBW also saw a decrease from 0.32 to 0.29, then for the group dose of porang flour 50 mg/kgBW with Jati Belanda 250 mg/kgBW there was also a decrease from 0.32 to 0.30. The highest reduction was found in the group with a dose of 50 mg/kgBB porang flour and Jati Belanda 125 mg/kgBB. The purpose of measuring the *Lee index* is to determine the degree of obesity in rats. The *Lee* Index measurement was obtained according to (Lee *et al.* , 2011) .

Then, to determine the difference in the decrease in the *Lee Index* from day 22 to day 35 after the rats experienced obesity, data analysis was carried out using the *Shapiro-Wilk normality test* , the result was 0.003 (P<0.05), so the data obtained was not normally distributed. then continued with the non-parametric statistical test *Kruskal-Wallis test,* the results obtained were not significant 0.715 (p<0.05), which means there were significant differences in all groups.

Kruskal-Wallis analysis test showed that the results were not significantly different, this could be caused by several factors, the ineffectiveness of the dose used could cause it to be insignificant, if you look at previous research (Nissa and Madjid, 2016) porang flour has anti-obesity or weight loss effects. effective at a dose of 200 mg/kg BW, whereas in this study the highest dose only reached 50 mg/kg BW.

REFERERENCES

Agung, J., K, D., & Setiabudi, E. (2014). Pengaruh Pemberian Ekstrak Daun Jati Belanda (Guazuma ulmifolia Lamk.) Terhadap Penurunan Berat Badan Pada Penderita Obesitas. *Fakultas Kedokteran Universitas Manantha*.

Al-Omar, M. A., Al-Suwailem, A. K., Al-Tamimi, A. S., & Al-Suhibani, M. S. (2006). Safety and Mechanism of Action of Orlistat (Tetrahydrolipstatin) as the First Local Antiobesity Drug. *Journal of Applied Sciences Research*, *2*(4), 205–208.

Behera, S. S., & Ray, R. C. (2016). Konjac glucomannan, a promising polysaccharide of Amorphophallus konjac

K. Koch in health care. *International Journal of Biological Macromolecules*, *92*(March), 942–956. https://doi.org/10.1016/j.ijbiomac.2016.07.098

Budiarto, Moh Arif, Yusuf, E., & Yuniwarti, W. (2016). *Buletin Anatomi dan Fisiologi Volume 1 Nomor 1 Agustus 2016 Pengaruh Pemberian Tepung Daun Jati Belanda (Guazuma ulmifolia L .) dalam Pakan terhadap Kadar Trigliserida Darah dan Lemak Abdominal Ayam Broiler The Effect of Jati Belanda (Guazuma ulmifolia . 1*, 43–47.

Budiarto, Mohammad Arif, Yuniwarti, E. Y. W., & -, I. (2016). Pengaruh Pemberian Tepung Daun Jati Belanda (Guazuma ulmifolia L.) dalam Pakan terhadap Kadar Trigliserida Darah dan Lemak Abdominal Ayam Broiler. *Buletin Anatomi Dan Fisiologi*, *1*(1), 43. https://doi.org/10.14710/baf.1.1.2016.43-47

Departemen Kesehatan RI. (2016). Formularium Obat Herbal Asli Indonesia. In *Permenkes RI No 6 2016*. Jakarta: Kementrian Kesehatan RI.

Haryani, K., & Hargono. (2008). Proses pengolahan iles-iles (Amorphophallus sp.) menjadi glukomannan sebagai gelling agent pengganti boraks. *Momentum*, *4*(2), 38–41.

Hidayat, M., Soeng, S., Wahyudianingsih, R., Ervy Ladi, J., Ari Krisetya, Y., & Elviora, V. (2015). Ekstrak Kedelai Detam 1, Daun Jati Belanda Serta Kombinasinya Terhadap Berat Badan Dan Histopatologis Hepar Tikus Wistar. *Jurnal Kedokteran Dan Kesehatan Indonesia*, *6*(4), 167–178. https://doi.org/10.20885/jkki.vol6.iss4.art2

Irawan, S. S., & Widjanarko, S. B. (2013). *Menggunakan Pereaksi Dimetil Sulfat Berbagai Variasi Konsentrasi Methylation At Porang Flour (Amorphophallus muelleri) Using Dimethyl Sulfate Reagent In Varied Concentration*. *1*(1), 148–156.

Jansen, P. C. M., Wilk, C. Van der, & Hettersheid, W. L. . (1996). Amorphophallus Blume ex Decaisne . E-Prosea Detail. *E-Porsea Detail*, *3*(336), 1–6.

Lee, S.-I., Kim, J.-W., Lee, Y.-K., Yang, S.-H., Lee, I.-A., Suh, J.-W., & Kim, S.-D. (2011). Anti-obesity Effect of Monascus pilosus Mycelial Extract in High Fat Diet-induced Obese Rats. *Journal of Applied Biological Chemistry*, *54*(3), 197–205. https://doi.org/10.3839/jabc.2011.033

Lumbantobing, Zhafran Ramadhan., Muhartono., dan U. G. M. (2019). Jati Belanda (Guazuma ulmifolia Lamk.) as an alternative therapy for Obesity. *Jurnal Medula*, *8*, 161–167.

Nissa, C., & Madjid, I. J. (2016). Potensi glukomanan pada tepung porang sebagai agen anti-obesitas pada tikus dengan induksi diet tinggi lemak. *Jurnal Gizi Klinik Indonesia*, *13*(1), 1. https://doi.org/10.22146/ijcn.22751

Pasaribu, G. T., Hastuti, N., Efiyanti, L., Waluyo, T. K., & Pari, G. (2019). Optimasi Teknik Pemurnian Glukomanan Pada Tepung Porang (Amorphophallus muelleri Blume) (The Glucomannan Purification Tecniques Optimation of Porang (Amorphophallus muelleri Blume) Flour Amorphophallus. *Jurnal Penelitian Hasil Hutan*, *37*(7), 197–203.

Pasaribu, G. T., Hastuti, N., Efiyanti, L., Waluyo, T. K., & Pari, G. (2020). OPTIMASI TEKNIK PEMURNIAN GLUKOMANAN PADA TEPUNG PORANG (Amorphophallus muelleri Blume). *Jurnal Penelitian Hasil Hutan*, *37*(7), 197–203. https://doi.org/10.20886/jphh.2019.37.3.197-203

Putri, C. A., Pradana, D. A., & Susanto, Q. (2011). EFEK EKSTRAK ETANOLIK DAUN BAYAM MERAH (Amaranthus tricolor L.) TERSTANDAR TERHADAP INDEKS MASSA TUBUH DAN KADAR GLUKOSA DARAH PADA TIKUS SPRAGUE DAWLEY YANG DIBERIKAN DIET TINGGI LEMAK SEBAGAI UPAYA PREVENTIF OBESITAS. *SpringerReference*, *13*(02), 150–161. https://doi.org/10.1007/springerreference_68038

Qi, X. (2018). Review of the Clinical Effect of Orlistat. *IOP Conference Series: Materials Science and Engineering*, *301*(1). https://doi.org/10.1088/1757-899X/301/1/012063

Rathnayake, K. M., Roopasingam, T., & Dibley, M. J. (2014). High carbohydrate diet and physical inactivity associated with central obesity among premenopausal housewives in Sri Lanka. *BMC Research Notes*, *7*(1), 1–7. https://doi.org/10.1186/1756-0500-7-564

Rivai. (2016). Pembuatan Dan Karakterisasi Ekstrak Kering Simplisia Jati Belanda (Guazuma ulmifolia lamk). *Jurnal Farmasi Higea*, *5*(1), 1–8.

Seidell, J. C., & Halberstadt, J. (2015). The global burden of obesity and the challenges of prevention. *Annals of Nutrition and Metabolism*, *66*(suppl 2), 7–12. https://doi.org/10.1159/000375143

WHO. (2017). Diet , overweight and obesity. *World Health Organization Media Centre Fact Sheet*, (Cvd), 4–5.