

## RESEARCH ARTICLE

## The Influence of Coconut Oil and Palm Oil on Body Mass Index, Abdominal Circumference, and Fat Mass of Wistar Male Rats

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### Abstract

Overweight is one of the risk factors for degenerative diseases, one of which is due to excessive oil consumption. Coconut oil consists mostly of saturated fatty acids of 90% and medium chain fatty acids, making it easier to metabolize into energy, compared to palm oil. This study aims to compare the effect of coconut oil and palm oil on body mass index, abdominal circumference, and fat mass in male wistar rats. This study was conducted in November–December 2017 in Animal Laboratory Department of Pharmacology and Therapy in Fakultas Kedokteran Universitas Padjadjaran Bandung. This study was an experimental study conducted for 28 days in 3 groups, each consisting of 7 rats fed standard diet *ad libitum* (G0), standard diet plus coconut oil supplementation (G1), and standard diet plus palm oil supplementation (G2). The result showed that the difference of BMI before and after treatment  $G0=0.06\pm0.050$ ,  $G1=0.04\pm0.032$ ,  $G2=0.05\pm0.027$  ( $p=0.553$ ). Difference in mean abdominal circumference before and after treatment  $G0=1.85\pm0.852$ ,  $G1=0.71\pm1.318$ , and  $G2=0.42\pm1.789$  ( $p=0.149$ ). Mean fat mass group  $G0=4.61\pm1.318$ ,  $G1=4.02\pm3.439$ , and  $G2=6.03\pm2.568$  ( $p=0.179$ ). There were no significant differences in BMI, abdominal circumference, and fat mass among the experimental groups. In conclusion, supplementation of coconut oil and palm oil in rats can increase BMI, abdominal circumference, and fat mass.

**Key words:** coconut oil; palm oil; BMI; abdominal circumference; fat mass.

## Pengaruh Minyak Kelapa dan Minyak Kelapa Sawit terhadap Indeks Massa Tubuh, Lingkar Perut, dan Massa Lemak Tikus Wistar Jantan

### Abstrak

Berat badan lebih merupakan salah satu faktor risiko penyakit degeneratif, salah satunya akibat konsumsi minyak berlebihan. Minyak kelapa sebagian besar terdiri atas asam lemak jenuh 90% dan asam lemak rantai sedang, sehingga lebih mudah dimetabolisme menjadi energi, dibandingkan minyak kelapa sawit. Penelitian ini bertujuan untuk mengetahui pengaruh pemberian minyak kelapa dan minyak kelapa sawit terhadap indeks massa tubuh, lingkar perut, dan massa lemak pada tikus jantan galur wistar. Penelitian dilakukan pada bulan November – Desember 2017 di Laboratorium Hewan Departemen Farmakologi dan Terapi Fakultas Kedokteran Universitas Padjadjaran Bandung. Penelitian ini merupakan uji eksperimental yang dilakukan selama 28 hari pada 3 kelompok, masing-masing terdiri atas 7 ekor tikus jantan galur wistar yang diberi diet standar *ad libitum* (P0), diet ditambah minyak kelapa (P1), dan ditambah minyak kelapa sawit (P2). Pada hari ke-29 tikus dikorbankan untuk dilakukan pengukuran massa lemak. Hasil penelitian menunjukkan selisih rerata IMT sebelum dan sesudah perlakuan  $P0=0.06\pm0.050$ ,  $P1=0.04\pm0.032$ ,  $P2=0.05\pm0.027$  ( $p=0.553$ ). Selisih rerata lingkar perut sebelum dan sesudah perlakuan  $P0=1.85\pm0.852$ ,  $P1=0.71\pm1.318$ , dan  $P2=0.42\pm1.789$  ( $p=0.149$ ). Rerata massa lemak kelompok  $P0=4.61\pm1.318$ ,  $P1=4.02\pm3.439$ , dan  $P2=6.03\pm2.568$  ( $p=0.179$ ). Tidak ada perbedaan IMT, lingkar perut, dan massa lemak yang bermakna pada kelompok tikus wistar yang diberi minyak kelapa, minyak kelapa sawit, dibandingkan dengan kelompok kontrol. Kesimpulan, suplementasi minyak kelapa dan minyak kelapa sawit meningkatkan IMT, lingkar perut, dan massa lemak.

**Kata kunci:** minyak kelapa; minyak kelapa sawit; indeks massa tubuh; lingkar perut; massa lemak.

## Introduction

The incidence of overweight and obesity in the world is increasing nowadays. Based on WHO data in 2014, 39% women and 38% men in the world are overweight, while prevalence obesity is 15% of women and 11% in men.<sup>1</sup> According to Riset Kesehatan Dasar (Riskesdas) 2013, prevalence of overweight in Indonesia is 13.5% and obesity is 15.4%.<sup>2</sup>

Overweight is one of the risk factors for degenerative diseases, one of which is due to excessive oil consumption. Various indicators such as body mass index (BMI), waist circumference, and fat mass are used to measure the nutritional status and risk of cardiovascular disease.<sup>1</sup> BMI is a method of measurement body composition that is widely used.<sup>1</sup>

Excessive fat consumption like palm oil is known to increase overweight and cardiovascular-related mortality, particularly in developing countries.<sup>3</sup> According to the 2014 Total Diet Study, the Indonesian population consumes oil and processed products amounted to 37.4 grams/person /day.<sup>2</sup> According to data from Oil World in 2013, Indonesia is the third largest country of oil consumption level in the world. Coconut oil is one of the nutraceuticals that available in Indonesia but not commonly used yet.<sup>4</sup>

Palm oil mostly consisted of LCFA (palmitic acid, 44%).<sup>5</sup> Coconut oil (*Cocos nucifera*) consists mostly of saturated fatty acids (SAFA) of 90% and medium chain fatty acids (MCFA), making it easier to metabolize into energy, compared to palm oil (*Elaeis guineensis*).<sup>6</sup> MCFA is transported directly to the liver, whereas LCFA has to be carried into the lymphatic and peripheral system first. MCFA is oxidized rapidly.<sup>7,8</sup> Coconut oil is a thermogenic food that can increase energy expenditure.<sup>9</sup> This study aims to compare the effect of coconut oil and palm oil on BMI, abdominal circumference, and fat mass in male Wistar rats.

## Methods

Twenty-one male Wistar rats (150-250 g, 8-10 weeks) were maintained at Animal Laboratory

Department of Pharmacology and Therapy in Fakultas Kedokteran Universitas Padjadjaran Bandung, Indonesia in November–Desember 2017. Rats were randomly divided into three experimental groups after 1 weeks of acclimatization. Group 1 was fed with normal diet and water ad libitum (control). Group 2 was administered normal diet and treated orally with coconut oil. Group 3 received normal diet and treated orally with palm oil. The daily dose was 1 ml/270 g BW/day.<sup>10</sup> All groups were treated for 28 days. This study was approved by Health Research Ethics Committee Medical Faculty Universitas Padjadjaran no. 1055/UN6.C.10/PN/2017.

The anthropometric data (body weight, naso-anal length, and abdominal circumference) were measured weekly. Body weight was measured by digital scale (camry), while abdominal circumference and naso-anal length were measured by using tape manually. Abdominal circumference was measured on the largest zone of the rat abdomen.<sup>11</sup> Furthermore, body mass index (BMI) was calculated using the formula:

In day 29, rats were sacrificed by ketamine intraperitoneal injection (400 mg/kgBW). Fat mass was measured as the sum of epididymal, retroperitoneal, and mesenteric fat tissues.<sup>11</sup> Statistical analysis was performed using SPSS for Windows version 24. One-way ANOVA and Kruskal-Wallis test was performed to compare among experimental groups. Paired t test and Wilcoxon test was used to assess the significance difference pre-post each groups respectively. The statistical differences were considered to  $p < 0.05$ .

## Results

The mean body weight, BMI, naso-anal length, and abdominal circumference of rats before and after treatment are shown in Table 1. None of the animals in this study became ill or died before the experimental endpoint.

**Table 1. Rat's BMI, Abdominal Circumference, and Fat Mass Before and After Treatment**

Parameters	Groups		
	Control (n=7)	Coconut oil (n=7)	Palm oil (n=7)
BW day 0 (g)	243.14±25.912	220.00±33.376	227.57±35.151
BW day 29 (g)	283.14±28.121	246.28±53.193	266.57±59.087
BMI day 0 (g/cm <sup>2</sup> )	0.47±0.033	0.48±0.050	0.46±0.036
BMI day 29 (g/cm <sup>2</sup> )	0.54±0.035	0.52±0.055	0.51±0.028
AC day 0 (cm)	14.71±0.906	14.57±1.397	15.28±0.951
AC day 29 (cm)	16.57±0.607	15.28±1.679	15.71±2.157

BW: body weight, BMI: Body mass index, AC: abdominal circumference

Coconut oil group showed the lowest abdominal circumference compared to control and palm oil group, but there were no significant differences ( $p>0.05$ ) in abdominal circumference among the experimental groups (Table 2). The effects of coconut oil and palm oil supplementation on fat

mass were assessed after 28 days experimental period. Coconut oil group showed the lowest fat mass and palm oil group showed the highest fat mass (Table 2). However, no significant differences ( $p>0.05$ ) among the groups were observed.

**Table 2. Rat's BMI, Abdominal Circumference, and Fat Mass Changes after Treatment**

Parameters	Groups			p
	Control (n=7)	Coconut oil (n=7)	Palm oil (n=7)	
Δ BW (g)	40.00±20.215	26.28±24.136	39.00±24.899	0.481†
Δ BMI (g/cm <sup>2</sup> )	0.06±0.050	0.04±0.032	0.05±0.027	0.553†
Δ AC (cm)	1.85±0.852	0.71±1.318	0.42±1.789	0.149†
Fat Mass (g)	4.61±1.318	4.02±3.439	6.03±2.568	0.179††

† One Way ANOVA test, †† Kruskal Wallis test

Body weight increased significantly during the 28 days experimental period in all experimental groups. Although coconut oil group showed the lowest body weight throughout the experimental period, there were no significant differences ( $p>0.05$ ) in body weight among the experimental groups (Table 2).

## Discussions

During the intervention, the rats' weight increase was not affected by the oil type, but rather affected by the supplementation of oil.<sup>13</sup> The increase in body weight in all three groups was due to fat accumulation due to the imbalance of food intake and energy expenditure. However, the weight increase in coconut oil group was less than the weight increase in palm oil group. We postulated that this finding was explained by the high concentration of MCFA in coconut oil (more than 50%) and the high concentration of LCFA in palm oil (44% palmitic acid). Coconut oil is thermogenic food so more easily metabolized into energy.<sup>6</sup> Many factors affect body weight such as basal metabolic rate (BMR) variation, physical activity, and amount of food intake.<sup>14</sup> A slow metabolic rate risks weight gain. Onyeali et al,<sup>15</sup> compared the effect of palm oil diet versus standard diet for 12 weeks and found no significant weight increase between the two groups.

BMI was one of the anthropometric parameter used to diagnose obesity in rats and humans. Rats' BMI was calculated by the division of weight (gram) with the squared naso-anal length (cm<sup>2</sup>).<sup>12</sup> Normal value for male rats was 0.45±0.02–0.68±0.05 g/cm<sup>2</sup> and for female rats was 0.4504–0.5044 g/cm<sup>2</sup>.<sup>16</sup> Despite the BMI increase, the final BMI in all groups was within normal limit. BMI increase

was caused by the weight increase due to the high caloric intake from coconut and palm oil.<sup>15</sup> Ahmad et al<sup>17</sup> compared the effects of palm oil diet and standard diet for 8 weeks and found no significant weight and BMI increase between the two groups.

The dose used in this study based on the daily dose of coconut oil in humans as much as 45ml/day was converted to 1ml/270 gBB/day.<sup>10</sup> This finding was in contrary with a study by Liau et al<sup>18</sup> which found that coconut oil consumption for 6 weeks in human was able to decrease waist circumference. Another study with similar result was a study by Ahnan et al,<sup>19</sup> which found rats' abdominal circumference increase in group given 0.015 virgin coconut oil (VCO) and another group given 0.02% VCO for 28 days (dose 3.25 ml/gramBW). Coconut oil contained 30% LCFA, which causing some fat deposition in adipose tissue. Difference in dose and duration of interventions between this study and other studies could also explain the different result. The increase in caloric intake with coconut oil and palm oil supplementation caused by larger intake calories than calories released, thus deposited in the form of abdominal fat reserves, characterized by increased abdominal circumference. There has been little research on the impact of palm oil and crude palm oil on abdominal circumference in experimental animals and humans with normal nutritional status, so there is no standard effective dose to reduce abdominal circumference.

There was no difference of fat mass in all groups. The mean fat mass in coconut oil group was the lowest among all groups. This finding was consistent with the theory of higher MCFA in coconut oil than palm oil, causing easier metabolism and less deposition of fat.<sup>8</sup>

There is no fat mass measurement method that can clearly illustrate visceral fat in rats. According to Sibio, no visceral fat is composed of retroperitoneal, epididymal, and mesenteric fats, whereas according to Lac, no visceral fat is measured only from left perirenal fat, where most abdominal fat deposits are present. The fat mass in this study was obtained from visceral retroperitoneal fat, epididymal, and mesenterium. MRI, DEXA, and CT-Scan can be used to measure fat mass accurately, specifically, and non-invasively, but few studies have examined the fat mass of rats using this tool. The measurable fat mass in this study was only visceral fat is visible to the eye, whereas ectopic fat deposits such as skeletal muscle, hepatic, bone, pancreas, and neural tissue can't be measured.<sup>21</sup> Viscous abdominal fat levels in both subcutaneous and omentum account for more than 60% of total visceral fat, the abdomen is valid enough to describe the overall fat mass condition. In rats, the abdominal circumference is only relevant to visceral fat in obese conditions.<sup>11</sup>

In this study no exercise was given to animals to maintain the homogeneity aspect of activity, eliminate confounding factors, and illustrate the lifestyles of urban societies today that are largely inadequate physical activity. The effectiveness of coconut oil metabolism increases with exercise. Physical exercise could induce the expression of proliferator-activated receptor  $\gamma$  coactivator 1 $\alpha$  in skeletal muscle, followed by the expression of fibronectin type III domain containing 5 (FNDC5) which produced irisin. Irisin was a muscle tissue peptide that induce the conversion of subcutaneous adipocytes from white to brown; it also increased energy expenditure and fat oxidation.<sup>22</sup>

This research had limitations. There was no procedural standard in duration of intervention and effective dose of coconut oil in rat due to inconsistencies in previous literatures. In this study, measurements were done manually with simple items and there was no physical activity added to the intervention.

Further research is needed to be done on the Indonesian population about the effect of coconut oil and palm oil on body mass index, waist circumference, and fat mass, because most Indonesians consume palm oil daily. Although coconut oil has a positive effect on health, consumption should also be limited, because the consumption of excess fat is bad for health.

## Conclusions

Coconut oil and palm oil supplementation can increase BMI, abdominal circumference, and

fat mass. There is a tendency to increase BMI, abdominal circumference, and higher fat mass in palm oil supplementation compared with coconut oil supplementation.

## Conflicts of Interest

All authors declare no conflict of interest.

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