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Beneficial effect of predominantly coconut oil consumption on lipid profile: a study of a rare population in Indonesia

Gaga Irawan Nugraha[1,*], Astri Hutabarat[2], Natalia Regina[2], Irma Susan Kurnia[2], Cut Novianti Rachmi[3]

[1]Basic Medical Science Department, Faculty of Medicine, Universitas Padjajaran
Jalan Raya Sumedang-Jatinangor KM 22 Sumedang, Indonesia

[2]Basic Medical Science Graduate School, Faculty of Medicine, Universitas Padjajaran
Jalan Raya Sumedang-Jatinangor KM 22 Sumedang,Indonesia

[3]Department of Public Health, Faculty of Medicine, Universitas Padjajaran
Jalan Raya Sumedang-Jatinangor KM 22 Sumedang,Indonesia

*E-mail address: gaga@unpad.ac.id

ABSTRACT

Coconut oil is a source of fat which still sparks controversies when it comes to function. Some stated it can worsen lipid profile which then play an important role as a risk factor of cardiovascular disease. This cross sectional study was conducted in Indonesia involving 57 participants who used coconut oil as a predominant source of fat. Body mass index, physical activity and dietary intake were considered as subject characteristics. Serum concentrations of total cholesterol, triglyceride, LDL-c, HDL-c were determined by using the enzymatic method and Apo A1 were determined by using immunoturbidometry method. Result implied normal range of lipid profile and 78.95% of the subjects have optimal LDL-c/HDL-c ratio. Majority of the subjects (61.4%) have acceptable level of Apo A1, it showed that they have good HDL-c level. These results are consistent with other studies that support beneficial effect of coconut oil on lipid profile.

***Keywords*:** coconut oil, profil lipid, Apolipoprotein A1, LDL-c/HDL-c ratio, Indonesia, *Cocos nucifera*

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1. INTRODUCTION

High consumption of saturated fatty acid (SAFA) is said to be related with higher prevalence of cardiovascular disease (CVD) [1]. Coconut oil consists of 92 % of SAFA [2]. Nevertheless, the structure of coconut oil is different with other sources of SAFA such as animal fat. Coconut oil is a medium of chain fatty acid that easily absorbed by the intestines and converted to energy therefore it has less chance to be stored in adipose tissue and become a risk factor of CVD [3]. On the other hand several previous observational studies showed that coconut oil consumption has association with abnormal lipid profile that can be risk factor for CVD [4-6].

Other studies has shown the opposite results. A longitudinal cohort study conducted by Feranil et al to women aged 35-69 years in Philiphine where coconut oil is the most commonly used cooking oil. The results revealed that mean total cholesterol, low density lipoprotein-cholesterol (LDL-c) and triglyceride levels and total cholesterol/high density lipoprotein-cholesterol (HDL-c) ratio of the sample women were within the desirable limits set by World Health Organization (WHO) and coconut oil intake may enhance HDL-c levels, therefore the result support the beneficial effects of coconut oil use [7]. Previous research also conducted on tribes living in the New Zealand archipelago where 34% of its energy intake comes from coconut oil. None of subject in the population suffered from dyslipidemia and CVD [8].

Therefore, there are still inconclusive results in terms of association between coconut oil consumption and risk factor of CVD especially lipid profile.

Thus, this study aims to know effect of consumption of coconut oil to the lipid profile as component of CVD risk factor. In specific, this study aims to investigate the lipid profile total cholesterol, triglyceride, LDL-c, HDL-c, ratio of LDL-c/HDL-c, apolipoprotein A1 (Apo A1) of a population that consume coconut oil as dominant source of fat.

2. MATERIALS & METHODS

2. 1. Design

Indonesia recently has lower consumption of coconut oil [9]. Despite, there are several rare district areas in Indonesia whose population use coconut oil as a dominant source of fat in their daily intake. A cross sectional study was conducted in two of these districts -Ciamis and Cipaku Districts- in Ciamis Regency, West Java, Indonesia from September to November 2004.

2. 2. Participants

Traditional coconut oil producers and consumers in Indonesia were consider as rare populations due to predominantly palm oil production and consumption [9]. In order to reach such populations, we searched regions in Indonesia that contributed the most to the production of coconut oil. We obtained Ciamis and Cipaku district populations based on local government officer data and recommendations from several personal communications. This rare populations not only produced coconut oil themselves but also consumed it as their daily fat intake for throughout their life. The inclusion criteria is healthy participant (confirmed by physical examination by general practitioner) and the exclusion criteria are participants with history of antidislipidemic drug consumption, those who are pregnant, and those who are unable to memorize due to any disease or other causes.

2. 3. Informed consent and ethical clearance

Ethical clearance was obtained from ethics commitee of Faculty of Medicine, Universitas Indonesia number 138/PT02.FK/ETIK/2004. Written informed consent was obtained from all of the subjects prior to the study.

2. 4. Dietary Pattern History

History of dietary pattern was obtained by interview using 24 hour recall method for 2 consecutive days and food frequency questionnaires (e.g. Gibson, 1998 [10] & Gibson, 2017 [11]) The 24 hour recall method was focused to get estimation quantity of food intake by calculating mean of carbohydrate, protein and fat intake [11]. During the interview session, we used indonesian food model based on Daftar Komposisi Bahan Makanan Indonesia (DKBM- Indonesian Food Composition List) in order to help subjects remember the exact amount of their intake, similar approach with Madanijah, et al 2016 [12].

2. 5. Body Mass Index (BMI)

Height was measured barefoot using *Microtoise Stature Meter 2M.* Weight was measured using electrodigital weight scale SECA Alpha (Hamburg, Germany). All of procedure was conducted two times at the same day. Then, we calculated the average of these two measurements. Then we calculated body mass index (BMI) based on these meisurement and classified it according to World Health Organizatian Western Pacific Region (WPRO WHO). The formula of BMI is body mass in kilograms divided by the square of the body height in metre [13].

2. 6. Physical Activity Index (PAI)

Physical Activity Index (PAI) was calculated based on *Baecke* method so that component of physical activity while working, doing exercise and spare time can be taken into account [14]. A cut-off point of PAI below 6.2 was defined as having low physical activity, 6.3-7.1 as moderate and higher than 7.2 as having high physical activity [14].

2. 7. Lipid Profile and Apo A1 Level

For lipid profile and apo A1 level measurements, 5 ml of venous blood was collected after 10-12 hours fasting by one trained personal laboratory and then put into EDTA-containing tubes. The tube was inserted into a cool box with a temperature between 0-4 °C to be transported to the laboratory. Blood sample was centrifuged at 4 °C for 15 minutes, and stored at refrigerator with temperature at −20 °C until the analyses were conducted. Serum concentrations total cholesterol, triglyceride, LDL-c, HDL-c were determined using the enzymatic method and Apo A1 were determined using immunoturbidometry method. All of the biochemical parameters was conducted by trained health analyst in Prodia® laboratory. Interpretation of lipid profile plasma was based on National Cholesterol Education Program (NCEP)- Adult Treatment Panel (NCEP ATP III) (2001) [15], LDL-c/HDL-c ratio based on risk level in primary prevention by Millan et al [16] and interpretation of apo A1 level based on Beckman Coulter® tool.

2. 8. Statistical Analyses

The data that has been collected was verified, coded and analyzed as descriptive data (e.g. Feranil et al [7]) by IBM statistical package for scientific solution (SPSS) statistical software (SPSS Inc. Chicago, IL, USA) version 16.

3. RESULTS

Based on survey data of coconut oil producer population in Ciamis Regency, we obtained a total of 15 families who produce coconut oil. Fifty seven respondents participated in this study. We measure various parameters and express as mean ± SD. The baseline characteristics of the subjects are presented in Table 1.

It shows that 56.1% of the subjects were well nourished and having high physical activities. According to the criteria of Asia Pacific, the data of body mass index shows that 42.1% of the subject were "healthy" weight and 26.3% were classified as "obese I". As a traditional producers of coconut oil, they requires high physical labor.

This is in line with our physical activity assessment, that 56.0% of them have a high physical activity.

Table 1. Basic characteristics of coconut oil producer population (n = 57) in Ciamis district in 2004

Variables	**Numbers (%)**
Age (years) (mean ±SD)	39.36 ± 10.73
19-29	12 (21.0)
30-39	16 (28.1)
40-49	14 (24.6)
50-59	15 (26.3)
Educational level	
Elementary School	33 (57.9)
Junior High School	12 (21.0)
Senior High School	5 (8.8)
College / higher	7 (12.3)

BMI (kg/m^2) (mean ±SD)	22.66 ± 3.14
Underweight (<18.5)	6 (10.5)
Normal (18.5-22.9)	24 (42.1)
Having Risk (23.0-24.9)	12 (21.1)
Obese I (25.0-29.9)	15 (26.3)
Physical activity index (mean ±SD)	7.41 ± 1.66
Low (<6.2)	11 (19.3)
Medium (6.3-7.1)	14 (24.6)
High (≥7.2)	32 (56.1)

The average nutrient intake in this subject is normal based on the nutritional adequacy rate of Indonesia 2013 (Table 2). The fat intake is 424.6 kcals (46.1 g) per day, while the fibers only 2.6 g per day. These results based on NCEP III shows that fat intake is still within the recommended limits (20-30% of the total energy intake) while fiber intake is low than recommended limits (10-15% of the total energy intake).

Table 2. Mean values of intakes of energy, carbohydrate, protein, fat, and fibers of coconut oil producer population (n = 57) in Ciamis district in 2004

Variables	All (Mean ± SD)	Male (Mean ± SD)	Female (Mean ± SD)
Energy (kcals)	1916.1 ± 675.6	2118.1 ± 634.3	1721.1 ± 666.8
Carbohydrate (kcals)	1330.1 ± 479.5	1484.5 ± 451.8	1181.0 ± 464.9
Carbohydrate (% E)	69.3 ± 6.9	70.3 ± 7.6	68.4 ± 6.1
Protein (kcals)	161.4 ± 64.3	180.1 ± 65.8	143.4 ± 58.5
Protein (% E)	8.6 ± 2.0	8.7 ± 2.3	8.4 ± 1.8
Fat (kcals)	424.6 ± 210.4	453.4 ± 234.2	396.7 ± 184.3
Fat (% E)	22.0 ± 6.3	20.9 ± 6.9	23.1 ± 5.6
Fibers (g)	2.6 ± 3.2	2.8 ± 2.3	2.4 ± 3.9

% E = percentage specific nutrient intake from total energy intake

The total fat intake 424.6 kcals (46.1 g), and 41% (18.5 g) came from coconut fat (Figure 1). The coconut fat derived from coconut oil, coconut, and coconut milk. There is 1% of other fat derived from fat in the vegetables, cereals, and tubers.

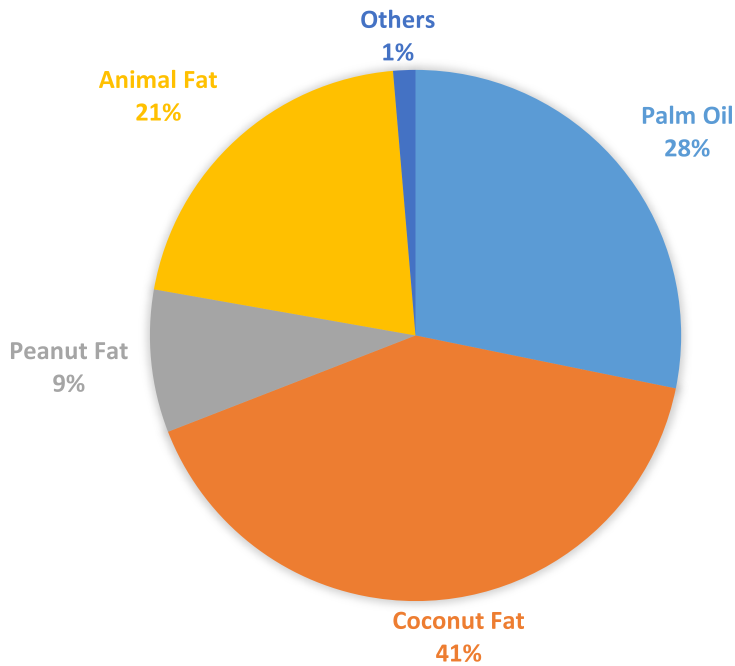

Figure 1. Proportion of various oil / fat of the total fat intake of 424.6 kcals (46.1 g) from coconut oil producer population (n = 57) in Ciamis district in 2004.

Table 3 shows the mean values of total cholesterol, LDL- c, HDL-c, triglyceride, Apo A-1 and LDL-c/HDL-c ratio. All of these values are within normal limits.

Table 3. Mean values of Total cholesterol, LDL-c, Triglyceride, HDL-c, apo A-I and LDL-c/HDL-c ratio from coconut oil producer population (n = 57) in ciamis district in 2004

Variables	**Value** (Mean ± SD)
Total cholesterol (mg/dL)	187.6 ± 39.8
LDL-c (mg/dL)	119.5 ± 35.8
Triglyceride (mg/dL)	114.0 ± 69.8
HDL - c (mg/dL)	54.1 ± 10.9
Apo A-I (mg/dL)	135.0 ± 17.2
LDL-c/HDL-c Ratio	2.3 ± 0.7

% E = percentage specific nutrient intake from total energy intake

Furthermore, we classified lipid profile and the result of number and proportion are showed in Table 4. It shows that 79% of the subjects have optimal LDL-c/HDL-c ratio and only 8.8% of the subjects have level LDL-c/HDL-c ratio considered at risk for CVD. The majority of the subjects (61.4%) have acceptable level of Apo A1, this corresponds to HDL-c levels where 94.7% of subjects have moderate and high HDL-c.

Table 4. Distribution of lipid profile classification from coconut oil producer population (n = 57) in Ciamis district in 2004

Variables	Classification	Number	Proportion (%)
LDL-c (mg/dL)*			
<100	Optimal	14	24.6
100-129	Near optimal	24	42.1
130-159	Borderline high	11	19.3
160-189	High	7	12.3
≥190	Very high	1	1.7
Total cholesterol (mg/dL)*			
<200	Desirable	38	66.7
200-239	Borderline high	12	21.0
≥240	High	7	12.3
HDL- c (mg/dL)*			
≤40	Low	3	5.3
41-59	Medium	38	66.7
≥60	High	16	28.0
Triglycerides (mg/dL)*			
<150	Normal	48	84.2
150-199	Borderline high	3	5.3
200-499	High	6	10.5
≥500	Very high	0	0
LDL-c/HDL-c ratio (mg/dL)**			
< 3.0 (men)	Optimal	26	45.6
< 2.5 (women)		19	33.3
3.0 – 3.5 (men)	Average	2	3.5
2.5 – 3.0 (women)		5	8.8
> 3.5 (men)	At risk	2	3.5
> 3.0 (women)		3	5.3
Apo A1 (mg/dL)***			
<120 (men)	Low	9	15.8
<140 (women)		13	22.8
≥120 (men)	Acceptable	21	36.8
≥140 (women)		14	24.6

* based on NCEP ATP III classification
** based on risk level in primary prevention by Millan et al
*** based on Beckman Coulter® tool

4. DISCUSSIONS & CONCLUSIONS

Most of the subjects (66.7%) in this study have normal lipid profile (cholesterol 187.6 mg/dl and triglycerides 114 mg/dl). The subjects also have normal BMI range (56.1%) and have high PAI value (56.1%). Subjects in this study have 424.6 kcals (46.1 g) of fat intake which is 41% came from coconut fat (18.5 g). Fat contributed only 22% of the total calories and carbohydrate contributed 69.3 % of the total calories.

Based on Indonesia Basic Health Survey/ *Riskedas* study 2013 [17], it reported around 22.9% of population had low HDL-c cholesterol and 75.1% had low triglycerides. Compare to this study, most of the subjects (84%) have low triglycerides and 97% of the subject have moderate and high level of HDL-c cholesterol. Most of the subjects have low triglycerides due to fact that 56.0% of them have a high physical activity.

A study conducted by Hatma et al. [18] in the same region and ethnic with this study, showed the cholesterol intake in Hatma's study (181.5 mg/day) is almost the same with cholesterol intake in this study (187.6 mg/day) but the value of HDL-c (54 mg/dl) in this study is better compared from Hatma's (36.8 mg/dl). The higher value of HDL-c in this study because the coconut consumption is associated with higher levels of serum HDL-c[2].

Lipoeto et al. [19] conducted similar study in high coconut consumers in Indonesia and reported among CVD group and control group, that coconut was not a predictor for CVD cases [19]. Both group consumed high coconut product everyday (42 gr/day). They reported the intakes of animal foods, total protein, dietary cholesterol and less plant derived was the predictor for CVD. Another case-control study conducted by Kumar et al [20]. in South Indians, where the people consumed high coconut products (58 gr/day) showed no specific role for coconut or coconut oil in the causation of CVD among Indians

The Seven Countries Study by A Keys showed that dietary saturated fat leads to CVD, and that the relationship is mediated by serum cholesterol [21]. The cholesterol value in this study (187.6 mg/dl) is below the recommendation from the NCEP ATP III (2001) (< 200 mg/day) [15]. Based on NCEP III recommendation of SAFA intake consumption be limited to 7% of calories [15].

Coconut fat contains 90-92% of SAFA [7]. In this study all the subjects consumed 23.2 gr of coconut fat or 10 % from total calories. The main source of SAFA in this study is from coconut fat. The main fatty acid in coconut fat is lauric acid which has the largest cholesterol-raising effect of all fatty acids, but much of this is due to HDL –c [22]. As a result, lauric acid had a more favorable effect on total: HDL–c than any other fatty acid, either saturated or unsaturated [22]. LDL-c/HDL-c ratio among coconut user is significantly lower than the same ratio in Monounsaturated Fatty Acid (palm oil) and Polyunsaturated Fatty Acid (corn oil) consumers [22]. Subjects in this study show 78.9 % of them have optimal LDL-c/HDL-c ratio and 61.4 % have acceptable level of Apo A1.

While many studies reported inconsistent findings in the effects of coconut oil on HDL-c, this study show most of the subjects have moderate and high level of HDL-c. The study about lipid profile and CVD risk among coconut consumers in Indonesia is very limited. Very small number of people rely on coconut as their main source of fat. As a matter of fact, this population group might not even exist nowadays. Future well-design studies that consider other confounding factors such as smoking, sugar consumption and examine ranges of CVD risk factor are required.

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