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## Influence of different extraction methods on physic-chemical characteristics and chemical composition of coconut oil (*Cocos nucifera* L)

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**Abstract.** Extraction method which used to obtain natural compounds from grade materials is a critical process to obtain quality product, especially to protect its nutritional value. Physical-chemical characteristics and chemical composition of oils extracted from coconut (*Cocos nucifera*) by different techniques needs to be identified to assess the effect of extraction methods, by solvent and hydraulic, on their physical and chemical properties. Mandal and Lee method was employed to extract the raw materials, whilst Association of Official Analytical Chemistry International (AOAC) and American Oil Chemists Society (AOCS) methods were used to analyze the physical-chemical of their extracted oils. T-test was performed to assess the different between data. Result showed that significant differences ( $P < 0.05$ ) in parameters of physical-chemical properties of the coconut extracted at saponification, peroxide, iodine, flash point and viscosity, while there was no significant difference in density, FFA and ash content. Significant difference was also found in saponification, iodine, peroxide and density of coconut oils by both method extraction with FAO and WHO standard. It is concluded that the different in extraction techniques affect to the oil productivity, physical and chemical properties, and fatty composition of coconut oils.

### 1. Introduction

Coconut oil is widely used in food, industrial and other applications; also, it has capable to health promotion and disease prevention [1]. Coconut plants have been spreading widely in tropics and islands of pacific, they are providing almost all of the requirements for life good, drink, oil, medicine, fiber, timber, thatch, mats, fuel, and domestic utensils. They are considered as an important economic and subsistence crop in many small pacific island states [2-4]. The coconut oil can be extracted from the fruits of *Cocos nucifera* L., which is edible oil. They are used for edible and non-edible products such as cooking, bakery, confectionary, cosmetics and pharmaceutical [5, 6]. Virgin coconut oil is capable to reduce serum lipid, tissue and LDL oxidation levels by physiological oxidants, thus having potential to reduce cardiovascular risk [7]. The properties of coconut oil can be attribute to the biologically active polyphenols components present in oil [8, 9]. Coconut oil considered as functional food oil, which is



well accepted by the consumer, and has increase demand in baking industries, processed foods, infant formulae, pharmaceuticals, and cosmetics [10].

There are two distinct ways to extract oil from raw material, namely mechanical presses and solvent extraction. The mechanical presses also called dry or wet method. In the dry method, oil was extracted by applying mechanical pressure to press the mixture ingredients, to the crushed mash. The other method called solvent extraction, is considerate as non-suitable to small processing, due to they need high capital and operating cost [11]. Different oil techniques extraction from raw materials affect to oil productivity and physico-chemical properties [12], lead to the different on oil yield and characteristics [13]. The operating parameters such as heating temperature, heating time and moisture content effect on the oil yield and the efficient expression [14]. The objective of this study was to identify the effect of coconut oils extraction method to the quality and fatty acid composition of extracted oil.

## 2. Materials and methods

The study conducted on November 2015- February 2016 in laboratories of postharvest, pilot plant, and chemistry at Universitas Padjadjaran, Indonesia. The materials were coconut fruits, hexane, sodium hydroxide, filter paper, methanol, potassium iodine, phenolphthalein (pp), potassium hydroxide, chloroform, acidic acid, iodine bromide, distilled water, and sodium disulphate. Equipment and tools which were employed were machine press, digital viscometer, soxhlet, thermometer, pycnometer, oven, sensitive balance, centrifuge, refrigerator, mixer, water bath, beakers, flasks, burets, pipets, dissector, erlenmeyer, bottles, dropper, spatulas, and conical flask.

### 2.1. Samples

Coconut fruits were collected from around Bandung West Java-Indonesia.

### 2.2. Oil extraction

The oil extraction was performed according to previous method [15]. Oil was extracted using mechanical extraction "extruder" (temperature 40–60°C) using centrifuge. The solvent method extraction was using Hexane. The condition of working ASE was in oven at temperature 105°C, pressure at 1500 psi, flow volume at 100%, disinfection time for 60 seconds, fixed cycle, 3 times. The solvent was uninterested under cover of smoke.

### 2.3. Chemical composition and physico-chemical analysis of extracted coconut oils

Proximate analysis of coconut fruits was performed according to AOAC method of [16], iodine value was determined according to AOAC official method 993.20 methods of [16]. The peroxide values were determined according to Association of Official Analytical Chemist method of [17]. The saponification value of Coconut oils was determined According to AOAC, method of [16]. The Free Fatty Acid value was determined according to AOCS method of [16]. Density of coconut oils were determined according to AOAC method of [17]. Viscosity of coconut oil was determined by digital Viscometer using spindle L1, rpm 100 [18]. The color characteristics of the coconut oils were determined by sighting according to method of [19], and fatty acid composition were determined by digital GCMS device according to method of [16].

### 2.4. Statistical analysis

T-test was employed to assess the different between data with the help of SPSS version 16. The analysis was carried out in triplicates. To discuss the results were used descriptive explanatory method.

## 3. Results and discussions

### 3.1. Oils recovery rate

**Figure 1** showed the results of oil yield obtained using mechanical presses and solvent. The extraction ratio of coconut oils by solvent and Hydraulic were 76 and 52.87% respectively. The coconut extraction

by solvent ratio was higher yields compared to the mechanical presses. This different may due to method of extraction, different temperature and extraction condition. This result was agreed with [20], it was reported that the seed kernels with higher moisture content yielded less oil as compared to those with lower moisture contents. Also, this study agree with [13]. The different extractions methods effect in the oil yield and characteristics of oil [12], and [14], they reported that factor in operating parameters such as heating temperature, heating time and moisture content effect on oil yield.

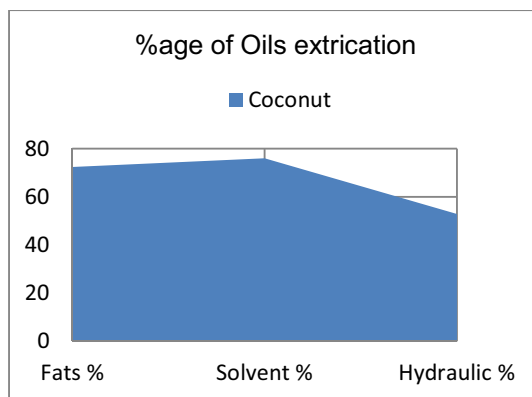


**Figure 1.** Percentage of oils extrication

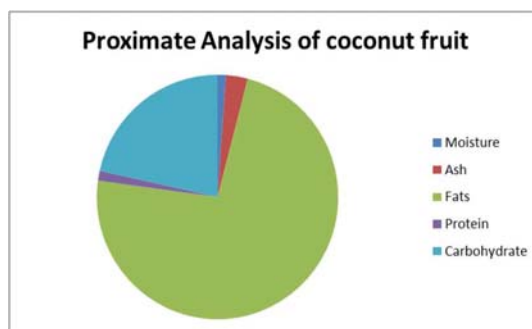


**Figure 2.** Proximate analysis of coconut fruit (%)

### 3.2. Composition of coconut fruit

Proximate composition of coconut fruit showed in **Figure 2**. The moisture mean value of coconut was 1.11%. This is showed that moisture content of coconut fruit is disagree with [21], causes to soil, genotype, environment factors. The fats content of coconut was 72.40%. These results showed that fats content of coconut is highest. The ash content of coconut was 2.89%. From these results obtained the ash content of coconut fruits is agree with results of [22], them reported 4.9% range for crude ash. The protein content of coconut was 1.29%. These results showed that protein content of coconut fruit is lower causes genotype, temperature and soil, this is referring to lower viscosity of oil. The carbohydrate content of coconut fruit was 21.35% seeds.

### 3.3. Composition of coconut oils

3.3.1. *Proximate composition of coconut oils.* Proximate composition of coconut oils showed in **Table 1**. The moisture value of coconut oils extracted by hydraulic and solvent was  $0.12 \pm 0.00$  and  $13.60 \pm 0.00\%$ , respectively. These results showed that the moisture content of coconut oil extracted by

solvent is higher than other oil, that indicate coconut oil by solvent absorption moisture due extracted and more prone to rancidity than others. This is different due to extraction conditions. In addition, these results were agreed with [12], they mentioned that the different methods extraction techniques influence the oil yield and the oil physical chemistry properties, and agree with [13], that reported the different seed extraction techniques influence the oil yield and the seed oils properties. The ash value of coconut oils extracted by hydraulic was  $0.02 \pm 0.00$  and extracted by solvent was  $0.01 \pm 0.00$  %. The protein content of coconut oils was  $2.33 \pm 0.00$ ,  $1.69 \pm 0.00$  % respectively. These results showed that protein content of coconut oils by hydraulic is higher than solvent. This is different due to methods of extraction and environment conditions due extraction period. In addition, these results agree with [13], they reported that different extraction techniques influence in oil productivity and the oils physic-chemical proprieties.

**Table 1.** Proximate analysis of extracted oils (%)

|          | Coconut Oil by Hydraulic | Coconut Oil by Solvent |
|----------|--------------------------|------------------------|
| Moisture | $0.12 \pm 0.00$          | $13.60 \pm 0.00$       |
| Ash      | $0.02 \pm 0.00$          | $0.01 \pm 0.00$        |
| Protein  | $2.33 \pm 0.00$          | $1.69 \pm 0.00$        |

3.3.2. *Fatty acid composition.* The fatty acid composition of coconut oil extracted by hydraulic and solvent was show in **Table 2**. The major fatty acid of coconut oil extracted by hydraulic 9-Octadecadienoic acid was 9.06%, and coconut oil extracted by solvent was 7.09%, palmitic acid of coconut oil extracted by hydraulic was 9.90% and by solvent was 7.63%, Lauric acid of coconut oil extracted by hydraulic was 41.12% and by solvent was 44.54%. These results showed that the palmitic acid value of coconut oil extracted by hydraulic is higher than coconut oil extracted by solvent, and Lauric acid value is lower than other oil extracted by solvent. This is result of coconut oil showed that agree with [23-25]. This different of fatty acids composition amount of coconut oils extracted by both methods may due to oxidation during extraction process by hydraulic, techniques of extraction and nature of structure fatty acids. These results obtained have established that the different extraction techniques influence in fatty acids composition of oils.

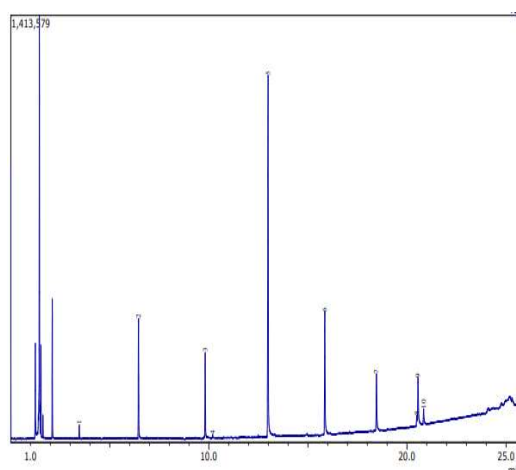


**Figure 3.** Fatty acids composition of coconut oil extracted by solvent

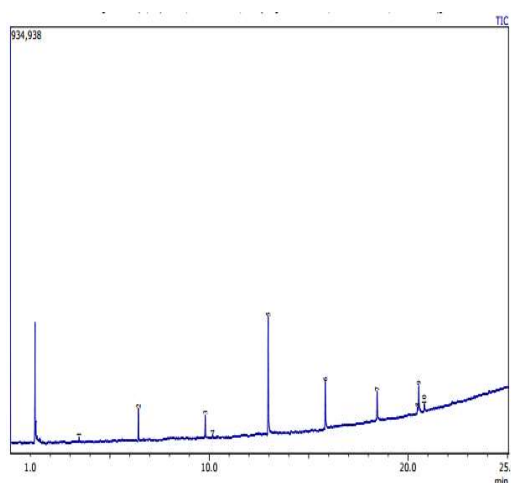


**Figure 4.** Fatty acids composition of coconut oil extracted by hydraulic

**Table 2.** Fatty acids composition of coconut oil extracted by hydraulic and solvent

| Name                               | Hydraulic |               | Solvent |               |
|------------------------------------|-----------|---------------|---------|---------------|
|                                    | A/H       | Area% (Value) | A/H     | Area% (Value) |
| Octanoic acid (Caprylic acid)      | 1.75      | 9.71          | 1.65    | 11.72         |
| Hexanoic acid (Caproic acid)       | 1.28      | 0.93          | 1.30    | 1.06          |
| Decanoic acid (Capric acid)        | 1.76      | 6.46          | 1.75    | 8.81          |
| Dodecanic acid (Lauric acid)       | 2.07      | 41.12         | 2.08    | 44.54         |
| Tetradecanoic acid (Myristic acid) | 2.19      | 17.30         | 2.18    | 15.80         |
| Hexadecanoic acid (Palmitic acid)  | 2.14      | 9.90          | 2.27    | 7.63          |
| 9-12- Octadecadienoic acid         | 2.24      | 2.16          | 2.17    | 1.29          |
| 9- Octadecadienoic acid            | 2.11      | 9.06          | 7.09    | 2.53          |
| Octadecanoic acid                  | 2.15      | 2.50          | 2.09    | 1.80          |
| 2- Dodecenal                       | 1.72      | 0.85          | 1.48    | 0.26          |

### 3.4. Physico-chemical properties of coconut oils

**Table 3** showed significant different ( $P < 0.05$ ) of the coconut oils extracted by different methods between six physico-chemical parameters. Viscosity of coconut oil extracted by hydraulic was  $25.67 \pm 0.00$ , and by solvent was  $27.67 \pm 0.01$ . From these results the viscosity of coconut oil extracted by hydraulic is lower than viscosity of coconut oil extracted by solvent. These results disagree with [26], the viscosity of coconut oil by hydraulic disagrees with [27] and not matches with composition of coconut seed (protein and fats %), this different may due to temperature, dry seeds and extraction method. In addition, these results agree with [12, 13]. The saponification of coconut oil extracted by hydraulic was  $227.60 \pm 0.00$  and by solvent was  $231.81 \pm 0.01$ , this result showed that saponification of coconut oil extracted by solvent is higher than coconut oil extracted by hydraulic. These results show that saponification is obtained from coconut oils extracted by both methods agree with values for most vegetable oil ranged from 188-253 mg KOH/g [28-29]. The Iodine value of coconut oil extracted by hydraulic was  $7.04 \pm 0.01$  and extracted by solvent was  $15.91 \pm 0.00$ . From this result showed that iodine value of coconut oil extracted by hydraulic is lower than coconut oil extracted by solvent. These results showed that disagree with [19], this different may due to extraction methods and extraction conditions. Also indicate to coconut oil extracted by solvent has high percentage of unsaturated fatty acid. The peroxide value of coconut oil by hydraulic obtained from these results was  $2.57 \pm 0.01$  and coconut oil by solvent was  $7.22 \pm 0.00$ , these results showed that coconut oil by solvent has higher peroxide value than

coconut oil by hydraulic. This is indicating to high level of rancidity of coconut oil by solvent. The FFA of coconut oil by hydraulic obtained from results was  $3.62 \pm 0.02$  and coconut oil by solvent was  $0.07 \pm 0.00$ , from these results showed that FFA value of coconut oil by hydraulic is higher than coconut oil by solvent. The FFA of coconut oil by solvent disagrees with [19], and coconut oil by hydraulic has FFA values agree with [19]. The high FFA value of coconut oil by hydraulic indicate to highly acidic than coconut oil by solvent. The color of coconut oil by hydraulic obtained from results was yellow cloudy and by solvent was faded yellow color of oils are most probable may due to pigments content and could be removed by bleaching. However, the color of the oils is not an important factor in end use applications except in some cases where bright color is a prime consideration such as in pigmented coatings. The oils properties are highly influenced by the extraction techniques, effect of two different extraction methods on quality characteristics of oils. The techniques are referred as the hot and cold methods applied in extracting the oil obtained from the seeds were analyzed for its free fatty acids, peroxide, iodine. As recommended by [30], guidelines the allowable value of saponification 230-254 mg KOH/g, peroxide < 15mg KOH/g, iodine 14.1-21.0mg KOH/g, Density 0.899-0.914g/cm<sup>3</sup>, According to the standards of FAO and WHO these results showed that the saponification of coconut oils  $231.81 \pm 0.01$  S-  $227.60 \pm 0.00$  H, Peroxide  $7.22 \pm 0.00$  S-  $2.57 \pm 0.01$  H, Iodine  $15.91 \pm 0.00$  S -  $7.04 \pm 0.01$  H, Density  $0.91 \pm 0.00$  S -  $0.91 \pm 0.00$  H by solvent and hydraulic respectively. In these results saponification, peroxide, Density, and iodine that were extracting by both methods showed no significant difference with the standards of FAO and WHO. Moreover, the extraction by hydraulic is the better than solvent.

**Table 3.** Physico-chemical properties of coconut oils

| Parameters                          | Extracted Coconut oils Values |                           |            |
|-------------------------------------|-------------------------------|---------------------------|------------|
|                                     | By Hydraulic                  | By Solvent                | FAO&WHO    |
| Density 25°C (g/cm <sup>3</sup> )   | $0.91 \pm 0.00^a$             | $0.91 \pm 0.00^a$         | 0.89- 0.91 |
| viscosity 27°C (mm <sup>2</sup> /s) | $25.67 \pm 0.00^a$            | $27.67 \pm 0.01^b$        | -          |
| Saponification value (mg KOH/)      | $227.60 \pm 0.00^a$           | $231.81 \pm 0.01^b$       | 230-254    |
| Peroxide value (mgKOH/g)            | $2.57 \pm 0.01^a$             | $7.22 \pm 0.00^b$         | < 15 mg    |
| Iodine value (mgKOH/g)              | $7.04 \pm 0.01^a$             | $15.91 \pm 0.00^b$        | 14.1- 21.0 |
| FFA %                               | $3.62 \pm 0.02^a$             | $0.07 \pm 0.00^b$         | -          |
| Flash point °C                      | $276.00 \pm 2.00^a$           | $269.00 \pm 0.00^b$       | -          |
| Color                               | yellow cloudy <sup>a</sup>    | faded yellow <sup>a</sup> | -          |

ab: significance different  $P < 0.05$ , aa: no significant, FAO: standard of Food and Agricultural organization

#### 4. Conclusion

This study has established that the different of extraction methods was affect to the oil yield, physical and chemical characteristics, fatty acid composition and chemical composition of coconut oils. However, the extraction of coconut oil by hydraulic method was better than solvent extraction.

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