Profile of amino acids and fatty acids of some Indonesia tall coconut varieties

E Tenda, Miftahorrachman and J Kumaunang

Indonesian Palm Crops Research Institute, Manado Indonesia

Corresponding author email: elsjetineketenda@yahoo.co.id

Abstract. The main content of coconut kernels are fats and fatty acids as well as protein and amino acids, and these contents vary among the varieties. This variation of amino acids and fatty acids also occurs in Indonesian tall coconut varieties. The objective of this study was to characterize amino and fatty acids content of Indonesian tall coconut varieties, namely Mapanget Tall, Palu Tall, Bali Tall, Tenga Tall, Selayar Tall, OdeskaLobu Tall, Babasal Tall, and Mastutin Tall. This study was conducted in Manado and Bogor from 2014 - 2019 by using an observational method. The results showed that the coconut kernel has eight types of non-essential amino acids and eight types of essential amino acids. Palu Tall has the highest amino acid content: alanine, arginine, aspartate, glutamate, glycine, serine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, and valine. Mapanget Tall has the highest contents of caprylic, capric, and lauric fatty acids, each with 9.04, 6.71, and 53.67 %, respectively. The result of this study can be used to develop varieties to obtain coconuts with high essential amino acids and fatty acids for the production of VCO, desiccated coconut, and other raw food materials.

Keywords: tall coconut, kernel, amino acid

1. Introduction

Indonesia is one of the coconut plant distribution centers globally, with an area of 3,377,376 hectares and widely spread in almost all regions. Indonesia Palm Crops Research Institute has released 25 varieties of Local Superior Coconut from various regions in Indonesia as Superior Varieties, with various advantages. The minister can release the general requirements for candidates for coconut varieties to have high production; besides that, there are several other requirements, namely slow stems growing taller, early bearing, and nutritional properties that support coconut as a food raw material.

The nutritional properties analyzed were oil content because coconut kernel has a high oil content. In addition to protein content because as raw material for dry grated coconut, coconut meat with protein content > 6% is needed. Fatty acids are oils needed by the body and amino acids as a constituent of protein, especially essential amino acids that are needed but cannot be produced by the body. So, they must be gained through food.

Coconut oil contains lauric acid, caprylic acid, and caproic acid called MCFA (Medium Chain Fatty Acid) is a short-chain fatty acid that allows it to be metabolized without using the carnitine transport system. When these acids are in the body, they are immediately converted into the appropriate monoglycerides, namely monolaurin, monocaprin, monocaprylin, and mono caproin, all of which are capable of killing pathogenic microorganisms such as bacteria, fungi, yeasts, viruses, and protozoa. MCFA can also increase the body's immune system. In addition, [1] a new study at the Skin Care and
Cancer Foundation in Pasig, Philippines, showed VCO’s new antibacterial and antimollent effect on patients with a skin condition called atopic dermatitis, after being applied with VCO, stopped tumor development. Furthermore, coconut oil helps regulate sugar blood because MCFA increases insulin production and insulin sensitivity. Thus, coconut oil helps the body produce insulin and reverse insulin resistance, thereby relieving many of the symptoms associated with diabetes [2].

This study uses physiologically ripe coconuts from selected coconut varieties for analysis of amino acids and fatty acids; the content and composition of amino acids and fatty acids of each coconut variety will be used to identify suitable coconut raw materials for VCO production, as well as desiccated coconut, such as coconut milk and other food raw materials [3].

This study aimed to determine the composition and content of amino acids and fatty acids in each selected variety of tall-coconut to obtain suitable coconut varieties for the production of VCO and other food raw materials. In addition, the results of this study will be useful as information for coconut breeders to breeding programs for assembling varieties and manufacturers who process VCO and other coconut-based food ingredients.

2. Materials and methods
The material used for the Analysis of Fatty Acids and Amino Acids is fully ripe coconut kernel (11-12 months old) from the tall coconut varieties, namely: 1. Mapanget Tall (MTT) from North Sulawesi, 2. Tenga (TAT) from North Sulawesi, 3. Palu Tall (PUT) from Central Sulawesi, 4. Bali Tall (BIT) from Bali, 5. Selayar Tall (SRT) from South Sulawesi, 6. OdeskaLobu Tall (OLT) from North Sulawesi, 7. Babasal Tall (BLT) from Central Sulawesi, and 8. Mastutin Tall (MNT) from West Nusa Tenggara.

The study was conducted in Manado and Bogor from 2014 – 2019 by using the observational method. First, preparation and determination of coconut samples for amino acid and fatty acid content were carried out in breeding laboratories of the Indonesian Palm Crops Research Institute in Manado. Then, each coconut variety’s amino acid and fatty acid analysis were carried out in the Bogor Post Harvest Research Institute laboratories.
Coconut kernel derived from fully ripe coconuts (11-12 months of age) of each variety consisted of 10 coconut meat, and then a sample of 2 kg was taken and dried in an oven with a temperature of 60°C to a moisture content of about 6%. Furthermore, samples of dried coconut meat weighing 1 kg each were packed with the cover paper, wrapped in plastic, and then brought to the Bogor postharvest laboratory for amino acid and fatty acid analysis.

Amino acid analysis of dried coconut meat samples was carried out using HPLC with Ultra Tech column parameters, mobile phase flow rate of 1 mL/min, and fluorescence detection. Analysis of the fatty acid profile of the dried fruit flesh of each variety was carried out using GC with parameters: GC column Cyanopropyl methyl (capillary column) (60 mx 0.25 mm x 0.25 um) nitrogen and hydrogen carrier gas, initial temperature 190°C (hold 15 minutes), increase in temperature 10°C/min, final temperature 230°C (hold 20 minutes). The mass spectra of compounds detected from GC/MS were then compared with the mass spectra contained in the data center or NIST library version 0.5a on the computer database.

3. Results and discussions

The protein and fat content of the kernel of eight varieties of tall coconut (Figure 1 to figure 8) are presented in Table 1.

| No | Varieties          | Protein (%) | Fat (%) |
|----|--------------------|-------------|---------|
| 1  | Mapanget Tall      | 8.90        | 62.95   |
| 2  | Palu Tall          | 6.60        | 69.28   |
| 3  | Bali Tall          | 6.63        | 65.52   |
| 4  | Tenga Tall         | 8.56        | 69.31   |
| 5  | Selayar Tall       | 8.89        | 60.08   |
| 6  | OdeskaLobu Tall    | 8.13        | 62.01   |
| 7  | Babasal Tall       | 8.13        | 61.09   |
| 8  | Mastutin Tall      | 7.13        | 60.09   |

Protein and fat content varied among varieties, and protein ranged from 6.60% - 8.90%. The highest is found in MTT, and the lowest is found in BIT. However, the protein content of all varieties was >6%, so it qualifies as a raw material for food products. Likewise, the fat content looks different among varieties, the highest is in TAT, and the lowest is in MTT. However, all varieties are still suitable for VCO raw materials because the fat content is 60.09%.

Coconut fat is easily digested and does not clot in the bloodstream, and is not stored in adipose tissue but is easily oxidized in the body to provide fast energy, which is beneficial for use as sports nutrition and diet products for people want to slim down [4].

A source of protein is an essential element of a healthy diet, allowing both growth and maintenance of the 25 000 proteins encoded within the human genome, as well as other nitrogenous compounds, which together form the body’s dynamic system of structural and functional elements that exchange nitrogen with the environment [12].

3.1 Amino acid profile

Amino acids are the smallest part of the protein structure, so the composition of amino acids determines the quality of a protein. Protein is one of the most important macronutrients for humans that is obtained through food. Lacking or limited amino acid consumption will affect human function, such as lack of hormone function and elastic muscular function, etc. [5]. There are 20 amino acids in the human body; information on the composition of essential amino acids and non-essential amino acids is known through the analysis of amino acid profiles from food samples[14]. Although the amino acid content in coconut
kernel is less than other plants, consumers will get 15 types of amino acids in different amounts (Table 2).

The result of coconut kernel analyzed, it had eight types of essential amino acids, namely histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, and valine, and there were 7 types of non-essential amino acids, namely: alanine, arginine, aspartate, glutamate, glycine, serine, and tyrosine.

| Amino Acid | MTT | PUT | BIT | TAT | SRT | OLT | BLT | MNT |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Alanine    | 0.07| 0.23| 0.19| 0.07| 0.10| 0.13| 0.10| 0.10|
| Arginine   | 0.67| 1.81| 1.26| 0.62| 0.70| 0.79| 1.22| 0.70|
| Aspartate  | 0.56| 0.95| 0.44| 0.55| 0.90| 0.71| 0.79| 0.90|
| Glutamate  | 1.37| 4.30| 1.52| 1.44| 1.30| 1.56| 1.45| 1.30|
| Glycine    | 0.31| 0.98| 0.77| 0.30| 0.10| 0.26| 0.60| 0.10|
| Serine     | 0.26| 0.97| 0.81| 0.25| 0.40| 0.28| 0.23| 0.40|
| Tyrosine   | 1.12| 1.11| 1.62| 1.07| 0.70| 0.87| 0.30| 0.70|
| Histidine  | 0.31| 0.46| 0.37| 0.15| 0.60| 0.21| 0.21| 0.60|
| Isoleucine | 0.25| 0.77| 0.59| 0.25| 0.20| 0.32| 0.31| 0.20|
| Leucine    | 0.44| 1.36| 1.07| 0.43| 0.40| 0.62| 0.87| 0.40|
| Lysine     | 0.28| 0.93| 0.65| 0.26| 0.40| 0.17| 0.42| 0.40|
| Methionone | 0.11| 0.35| 0.29| 0.23| 0.20| 0.18| 0.18| 0.20|
| Phenylalanine | 0.28| 0.92| 0.73| 0.28| 0.20| 0.23| 0.11| 0.40|
| Threonine  | 0.19| 0.72| 0.56| 0.19| 0.30| 0.27| 0.30| 0.30|
| Valine     | 0.37| 1.16| 0.90| 0.26| 0.50| 0.43| 0.51| 0.50|
| Total of Essential | 2.23| 5.67| 3.95| 1.45| 2.40| 2.43| 2.91| 3.0 |

Alanine is an important energy source for brain tissue, brain, and central nervous system, strengthens the immune system by producing antibodies, and helps in sugar metabolism [6]. According to FAO/WHO (1985), the body's need for valine is 0.50%, while histidine is 0.26%. Valine, leucine, and isoleucine increase endurance and reduce sugar levels [7, 13]. Results showed that PUT, BIT, SRT, BLT, and MNT contained valine amino acid ingredients according to FAO/WHO, similarly that almost all varieties contain histidine appropriate.

All tall coconut varieties' total essential amino acid content ranged from 1.45-5.67, the highest is the PUT variety, and the lowest is TAT. It was seen that the PUT variety has the highest total essential and non-essential amino acids compared to other varieties tested, except for tyrosine and histidine. Leucine is an important molecule that can stimulate muscle protein synthesis and has medicinal value related to stress, trauma, and burns [8]. Lysine has an important role because it is part of antibodies' basic composition, strengthening basic circulation and maintaining normal cell circulation. Methionine is an important amino acid for fat metabolism, maintaining liver health, preventing fat accumulation in the liver and main arteries, preventing allergies and osteoporosis [9]. Histidine plays a role in interactions between proteins as a histamine precursor, a neurotransmitter, and is important for tissue growth and repair [8].
3.2 Fatty acid profile
The fatty acid content of each coconut variety is presented in Table 3.

| Type of Fatty Acid | MTT | PUT | BIT | TAT | SRT | OLT | TMN | BLT | Std APCC |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|----------|
| Caprilic (C 8:0)   | 9.04| 7.85| 7.64| 10.64| 2.88| 3.37| 7.90| 2.72| 5.0 – 10.0 |
| Capric(C10:0)      | 6.71| 6.05| 6.66| 7.88 | 4.85| 4.01| 7.90| 4.01| 4.5-8.5  |
| Lauric (C 12:0)    | 53.67| 41.64| 46.10| 51.12| 51.05| 51.12| 39.6| 45.90| 43.0-53.0|
| Myristic (C14:0)   | 12.27| 10.22| 11.69| 12.04| 9.14 | 19.40| 19.1| 12.50| 16.0-21.0|
| Palmitic (C 16:0)  | 4.44 | 4.86 | 5.72 | 4.42| 9.92 | 10.65| 13.9| 16.15| 7.5-10.0 |
| Stearic(C18:0)     | 1.71 | 1.47 | 1.83 | 2.19| 1.80 | 2.19 | 3.30| 3.27 | 2.0-4.0  |
| Oleic (C18:1)      | 2.82 | 2.64 | 2.41 | 8.91| 5.66 | 8.91 | 3.80| 8.10 | 5.0-10.0 |
| Linoleic(C18:2)    | 0.68 | 0.92 | 1.15 | 0.54| 4.89 | 2.79 | 0.50| 5.60 | 1.0-2.5  |
| Total MCFA (C8 – C14)| 81.69| 65.76| 72.09| 81.68| 67.92| 77.90| 74.50| 69.13|          |

Fats and oils are concentrated forms of energy, and the energy yield from the complete oxidation of fatty acids is about 9 kcal per gram, in comparison with about 4 kcal per gram for carbohydrates and proteins. Triglycerides are the most abundant fats found in foods. They are molecules made of fatty acids (chain-like molecules of carbon, hydrogen, and oxygen) linked in groups of three to a backbone of glycerol. When foods containing fats are consumed, the fatty acids are separated from their glycerol backbone during digestion. Fats and oils in the diet are thus available to the body as fatty acids [15].

The most fatty acid content in cooking oil is a long-chain fatty acid, commonly called Long Chain Fatty Acid (LCFA). Coconut oil is a cooking oil containing 80-90% medium-chain fatty acids commonly called MCFA (medium-chain fatty acids) and 10-20% LCFA content, so that one of the distinctive characters of coconut oil from other vegetable oils is MCFA [10]. Coconut oil with a high lauric acid content, from this study, is clear that over 50% of the total fatty acids are lauric acid. For this reason, coconut oil is called commercial lauric acid. The fat in mother's milk that provides babies' immunity is almost the same as the structure of Medium Fatty Acid (MCFA) found in coconut oil and lauric acid and monoglyceride from mono laurin potential as an anti-microbial [11]. MCFA is a fatty acid with an atomic number of 8-14.

The specialty of medium-chain fatty acids is that they are very stable at high temperatures and have high solubility in most fats. Therefore MCFA can reduce cholesterol (LDL) content[10]. The ratio of fatty acid composition suited for clinical nutrition will be composed of 30-65%. Structured lipids contain short-chain Fatty Acid and medium-chain Fatty Acid, which function as quick energy and rapid absorption, especially for immature neonates, hospitalized patients, and individuals with lipid malabsorption disorders [5]. The study results showed that almost all varieties met the APCC requirements except PUT and MNT for lauric acid.

Overall, the eight varieties were analyzed for their fatty acid content, and none of the varieties met all APCC standards. As shown in Table 2, the MCFA that did not meet the requirements for MTT were myristate, PUT lauric, and myristate, BIT and TAT is myristic, SRT is caprylic and myristic, OLT are caprylic and capric, MNT is lauric, and BLT is caprylic, capric and myristic. The total MCFA from highest to lowest were TAT, MTT, BIT, SRT, OLT, PUT, BLT, and MNT, respectively[10]. The result showed that some varieties had high lauric fatty acids (>48.8%), and there is no significant difference at 5% level by coconut oil processed heating methods. It tends to have low MCFA, while coconut oil processed by the fermentation method produces MCFA fatty acids that meet the APCC requirements. APCC eligible LCFA are only OLT and BLT. All samples of coconut kernel were heat processed by
using an oven at a temperature of 60°C until the weight was constant so it is possible that this the reason why not all fatty acid composition meet APCC standards.

Some components of amino acids and fatty acids were not significantly different. This is probably caused by the same fruit harvest age, which is 11-12 months, so the metabolic processes among the coconut varieties tested are also similar.

4. Conclusion
The eight tall-coconut varieties have eight essential amino acids, namely histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, and valine. PUT had the highest total amino acids, followed by BIT, BLT, MNT, OLT, SRT, MTT, TAT. Almost all varieties of Tall-coconut meet APCC standards, especially lauric acid, except MTT and MNT. The highest total MCFA was found in TAT, followed by MTT, BIT, SRT, OLT, PUT, BLT and MNT. The eight varieties are suitable as raw materials for food products and VCO.

References
[1] Nair R, Whittall A, Hughes SJ, Aurict GC 2010 New Zealand Journal of Agriculture Research. New Zeal J Agric Res. 3.201–213.
[2] File BF. Coconut oil and Health. In 2005. p. 49–56.
[3] Horwitz W, G.W.Jr L. Official Methods of Analysis of AOAC Internasional.2006;(February).
[4] Ghosh DK, Ghosh A, Manojkumar C, Samsudeen K 2008 Indian Coconut J [Internet]. 15–19. Available from: http://coconutoilboard.nic.in/English-Article-Ghosh.pdf
[5] Twishri W, Runheem P, Usathit S. Study on fatty acid composition and amino acid content of coconut endosperm of selected coconut cultivars in Thailand. Cord. 2012;2:43–54.
[6] Krug PJ, Riffell JA, Zimmer RK 2009 J Exp Bio/2121092–100.
[7] Wang L, Han Y, Jiang Z, Sun M, Si B, Chen I, Bao N 2017 Fish Physiol Biochemistry 2017 43 1265–1278
[8] Vijayan DK, Jayarani R, Sing DK,Chatterjee NS, Mathew S, Mohanty BP, Sankar TV, Anandan R 2016 J Basic Appl Zool7741–48.
[9] Suryaningrum DT, Muljanah I, Tahapari E. Profil 2010 Jurnal Pascapanen dan Bioteknologi Kelautan dan Perikanan 5153–164.
[10] Salahudin F, Supriyatna A 2014 BiopropalIndustri 523-28
[11] Bawalan DD 2011 ‘SPC Suva Office. 88
[12] FAO/WHO 2002 Expert consultation. 265
[13] Han Y, Han R, Khushio S, Ishikawa M, Yokoyaman S, Gao J 2014. J Agriculture. 130-138
[14] Wilaowan T, Runheem P, Usathit S, Watanayothin S and Naka P 2012. In Thailand. Cord 2843-53
[15] Boatang L, Ansong R, Owusu BW, Asiedu MS 2016 Ghana Med.J 50 189-196