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# VCO Rancidity Analysis refers to Fermentation Time that Produced by Gradual Heating Method

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***Keywords*— *VCO, fermentation time, moisture content, free fatty acid, peroxide value***

***Abstract*—** *One of the final processed products from coconut that is popular in Indonesia, even in several other countries, for the last 3 years is Virgin Coconut Oil (VCO), which is processed directly from coconut meat. Processing of these products is part of the application of Applied Technology in the development of Coconut commodity products, and is very affordable in terms of production costs for the people in Belu district, NTT province, which has a land border between the Republic of Indonesia and Timor Leste, where the people does not well know about VCO processing technology accordance with quality standards. This study aims to analyze rancidity of VCO produced by gradual heating method on the effect of fermentation time by determining parameters of water content, peroxide value, and free fatty acid content based on the applicable Indonesian National Standard (SNI). Each parameter has been fermented for 2 hours, 6 hours and 10 hours as a treatment in this observation and analyzed in a descriptive way through the results chart. The results showed that the treatment for 2 hours, 6 hours and 10 hours had a moisture content of 0,15%; 0,12%; 0,1% then free fatty acid content is 0,09%; 0,10%; 0,11% and also peroxide value 0,52 mg ek/kg respectively. Based on the results of this study, it can be concluded that each test result is still below the threshold value according to the provisions of the Indonesian National Standard (SNI) 7381:2008.*

## I. INTRODUCTION

Belu regency is one of the regencies that are part of NTT province at Indonesia. It is located in the easternmost region of the province and is directly bordered by land with the Republic Democratic of Timor Leste (RDTL) with an area of 1284,94 km$^2$ (BPS, 2021a). Dewi et al (2022) mentioned that the dry season at NTT, including the Belu regency, is very different from other regions in Indonesia. This regency also has a longer dry season than the rainy season, wherein the dry season can last for 8 months compared to the rainy season.

Coconut is the most extensively cultivated plant, grown and used for human life, especially for the people of Belu. This is because these plants greatly influence the social, cultural, and economic roles of society wherein almost all parts of these plants can be used by humans, so that they become the most potential multi-purpose plants.

Based on the conditions of the season, several superior potential plantation crops can grow well as a source of wealth of natural resources in Belu Regency. One of them that is Coconut (*Cocos Nucifera* L.) with plantation area about 1303 hectares, which is spread over several sub-districts on this regency (BPS, 2021b). The availability of existing natural resource potential become momentum for the Belu government to establish the agricultural sector as one of the mainstay sectors (Boboy, 2022), in community-based economic development in this regency.

There are various benefits derived from coconut plants. One of the most widely used is the ripe kernel (Coconut meat) to be processed into coconut oil, desiccated coconut, also coconut milk, and what is really needed during the Covid-19 pandemic era until now to help sufferers to recover that is Virgin Coconut Oil (VCO). According to Snowdon et al (2003) the amount of nutrients contained in coconut meat depends on the type/variety, age, and other ecological factors. The most significant nutrient in fresh coconut water is sugar and ripe coconut it is fat. Specifically, the ripe kernel contains protein 4.08 g, fat 39 g, energy 389 kcal, sugar 4 g, dietary fiber 7.5 g, moisture 46.30%, crude fiber 3.39%, and carbohydrates 11.29% (Snowdon et al., 2003; Woodroof, J. 1979).

The process of making VCO is one part of the application of post-harvest handling technology to processed food products. The application of this technology, among other things, can play a role in producing derivative products that have a longer shelf life and have a higher economic value when farmers face problems with very abundant crop commodities. The results of its implementation will be very beneficial for the community, especially those in areas with limited sources of information based on the results of studies that have been conducted (Malingkas et al, 2021; Tongkeles et al, 2022)

Processing to produce VCO is often done in a traditional way. The resulting product often has a fairly high water content which can be seen with the naked eye in the presence of white lumps. The existence of these white lumps can accelerate the process of damage to VCO which can cause a decrease in quality due to rancidity. This could be caused by the presence of a protein component in the form of blondo which was not properly filtered during the oil separation process.

Various research on VCO as a coconut derivative product have been carried out by experts, especially on how it is made by traditional method or even with processing technology. Pontoh et al (2008) have tested several methods for processing VCO in terms of the water content and rancidity (peroxide value and free fatty acid content) of the VCO. According to him, the best VCO processing technology is using gradual heating method. Furthermore, refers to the quality standards of VCO from APCC (2004) that is limits of free fatty acid content maximum of 5%, water content ranges from 0.1% to 0.5%, and a maximum VCO peroxide value is 3 meq/kg oil. The limit values for each criteria in that standard are adjusted to the needs of VCO standards in Indonesia through the Indonesian National Standard (SNI) 7381:2008 (BSN, 2008), where the maximum free fatty acid content is 0.2%, water content maximum of 0.2%, and a maximum VCO peroxide value is 2 meq/kg

This study aims to determine the quality of VCO through rancidity analysis produced by gradual heating method on the effect of natural fermentation time by determining parameters of water content, free fatty acid content, and peroxide value based on Indonesian National Standard (SNI) 7381:2008. Each parameter has been natural fermented for 2 hours, 6 hours and 10 hours as a treatment in this observation and descriptive analyzed by chart.

## II. MATERIALS AND METHODS

### Materials and Tools

This study used materials such as Coconuts, with a harvest age of between 10 and 12 months were collected from the vicinity of Kaluk Mesak District at Belu Regency East Nusa Tenggara province, water, and other materials used for samples analysis in the laboratory. Then the tools used are 2 in 1 coconut milk producing tools (designed from the Faculty of Military Logistics, Republic of Indonesia Defense University), gas stoves, gas cylinders, pots, pans, plastic containers, filter cloth, VCO container bottles, filter papers, and other tools used when analyzing samples in the laboratory.

### Coconut Processing into Virgin Coconut Oil

Coconut milk was obtained using a 2 in 1 coconut milk production tool, then left for natural fermentation with 2 hours, 6 hours and 10 hours as a treatment in this study until 2 layers were formed, namely cream, and skim (water). Then the cream is carefully separated to extract the oil which will be filtered using a filter cloth.

The filtered oil still has a mixture of cream on it, so it is heated at $<90^{O}C$ until formed oil and blondo (heated cream) with white in color. Furthermore, the oil is separated from the blondo and heated again for 10 hours at a temperature of $60^{O}C$, then cooled in containers. The final stage is the oil filtered again using filter papers (for more clear oil) and stored in a bottle container.

**Sample Analysis Procedure**

The VCO samples examination were held at the Food and Drug Control Agency in Kupang city, according to SNI Virgin Coconut Oil number 7381:2008 standard quality. The choice of this place was due to the limitations of the laboratory test which was close to the place where the research was carried out. Determination of these quality standards on this research is limited to the parameters for determining moisture content, free fatty acids (FFA), and peroxide value of VCO.

*Moisture Content*

Moisture content for VCO was determined by gravimetry method, where the weight loss during heating at 105°C is considered as the moisture content present in the sample. According to Dalmadi (2019) principle of this method is to find out the amount of water in the sample by weighing the initial weight of the sample before heating and after heating. Samples were heated in an oven at 105 °C for 3 hours by weighing the sample weight every 1 hour. Moisture content was determined using equation:

**Moisture Content (%wb)** (BSN, 2008) :

$$\frac{[m_1 - m_2]}{m_1} x100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Note:

$m_1$ = weight of material before drying (gram)

$m_2$ = weight of material after drying (gram)

*Free Fatty Acid (FFA)*

Free fatty acids are fatty acids that exist as unbound free acids as triglycerides. Free fatty acids are produced from hydrolysis and oxidation processes which usually combine with neutral fats (Dalmadi, 2019). The principle in determining free fatty acids is to dissolve the fat/oil sample in a certain organic solvent (96% alcohol is neutral) then proceed with the titration process using NaOH or KOH solution (BSN, 2008).

This method was determined by adding 10 g of sample to a 200 mL Erlenmeyer and adding 50 ml of 95% ethanol. Into the mixture added 3-5 drops of Phenolphthalein indicator. Then it was titrated with 0.0991 N NaOH standard solution until it turned pink. The final step is to record the amount of KOH solution used during the titration to determine the free fatty acid content (expressed as a percent of fatty acids) based on the following equation.

**Free Fatty Acid (FFA) (%)** ((BSN, 2008) :

$$\frac{V \times N \times 200}{m \times 10} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Note :

V = volume of NaOH solution used during the titration (ml)

N = NaOH Normality

*Peroxide Value (PV)*

The principle in determining the peroxide number is that the sample solution in glacial acetic acid and chloroform is reacted with KI solution. The liberated iodine is titrated with a standard sodium thiosulphate solution (BSN, 2008).

The steps taken in determining the value of the peroxide number were by inserting 5 grams of sample into an Erlenmeyer with a volume of 300 ml then while shaking 25 ml of a solvent mixture consisting of 60% glacial acetic acid and 40% chloroform was added to it. After the oil has dissolved, 1 ml of saturated potassium iodide solution is added while shaking. Furthermore, allowed to stand for thirty minutes in a dark room, then 30 ml of distilled water was added. The excess iodine is titrated with 0.1012 N sodium thiosulfate solution until the yellow color almost disappears. Then 0.5 ml of 1% starch solution was added, and the titration process was continued until the blue color disappeared.

The final step is to calculate the peroxide number expressed in milligrams equivalent of peroxide in every 1000 g of sample. The equation used in this calculation is:

**Peroxide Value** (Pontoh et al., 2008) :

$$\frac{ml\ Na_2S_2O_3 \times N \times 1000}{G} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Note:

G = Weight of sample (gram)

N = $Na_2S_2O_3$ Normality

## III. RESULTS AND DISCUSSION

The quality of VCO obtained through a comparison of the natural fermentation time of coconut milk to produce VCO using the gradual heating method has gone through testing parameters in the form of water content, peroxide value and free fatty acid levels which were carried out in the laboratory of the food and drug control agency, Kupang city, NTT province. The test results data from the laboratory were then analyzed descriptively through a graphical display of each parameter.

**Moisture Content of VCO**

The percentage of water content in a material that plays an important role in the process of damage, spoilage and rancidity in food ingredients. According to Rindawati et al (2020), one of them is the high water content in the oil can cause a hydrolysis reaction which converts the oil into free

fatty acids and glycerol and will cause rancidity in the oil. The results of determining the VCO water content from three lengths of fermentation using the gradual heating method can be seen in Figure 1 below.

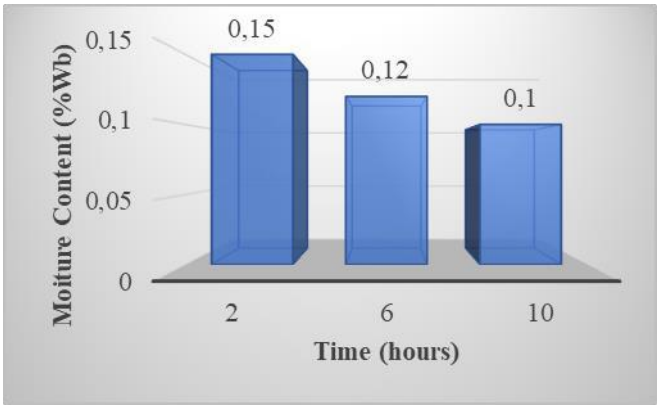


*Fig 1. VCO Moisture Content*

Based on the results of Figure 1, the water content values for all VCO samples still meet the requirements of SNI 7381:2008 with a maximum moisture content value of 0.2%. The data showed that for the length time of natural fermentation for 2 hours, 6 hours and 10 hours the water content was 0.15% wb; 0.12%wb; 0.1%wb.

That is shows that the longer the natural fermentation of coconut milk, the lower the water content of the VCO produced. This is because when the coconut milk was fermented there is a separation process into two layers, where the part that has a lot of oil content called cream is at the top, and the part that has a lot of water content called skim is located at the bottom. To produce VCO, part that will be processed next is the cream part, more longer the natural fermentation is carried out lead to water content more less in the cream part will be.

In addition, results of this study also in accordance with the research conducted by Pontoh et al (2008), where the gradual heating method can produce VCO with the lowest water content because it has gone through 2 stages of heating the VCO. The results of the water content according to the SNI standard were obtained in the second stage of the heating process, because on this stage the VCO was heated to a temperature < 65 $^{O}$C for 10 hours with aim to reducing the high water content from previous stage.

**Free Fatty Acid (FFA) of the VCO**

Parameters for determining the content of free fatty acids in oil, especially in VCO, are very important to do. This is because these free fatty acids are present in oil or fat, so they are an early indicator of rancidity and as a determinant of oil quality. Figure 2 shows the amount of free fatty acid content in VCO based on the treatment carried out.

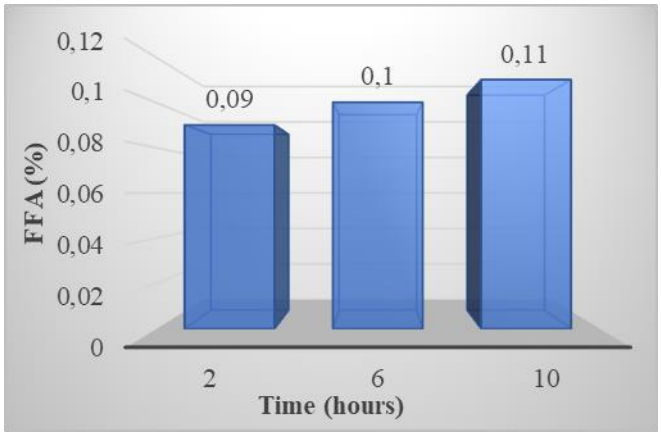


*Fig 2. Free Fatty Acid (FFA) Content in VCO*

The test results show that the free fatty acid values for all VCO samples still meet the requirements of SNI 7381:2008 with a maximum free fatty acid content value of 0.2%. The treatment of natural fermentation time for 2 hours, 6 hours and 10 hours and the application of the gradual heating method for each treatment respectively contained free fatty acids, namely 0.09%; 0.10%; 0.11%.

Based on the test results, it can be seen that the longer the natural fermentation process is carried out, the more free fatty acid content in the VCO produced. This is because when natural fermentation takes place, the oil molecules that are formed react with the water in the coconut milk so that an enzymatic hydrolysis process occurs against triglycerides resulting in free fatty acids for the VCO. these results are also as stated by Ngatemin et al (2013), namely the longer the fermentation time the impact on the free fatty acid content in VCO will increase.

In addition, the gradual heating method is also one of the determining factors for the formation of free fatty acids in oil/fat. Heating also affects the performance of the enzyme, in this case the Lipase enzyme which breaks down fat to produce free fatty acids. The acquisition of the value of the fatty acid content of the results of this test is supported by a statement from Ayu and Juliadi (2019), where the effect of heating on natural fermentation can increase the content of free fatty acids in the resulting VCO.

**Peroxide Value (PV)**

The peroxide value is an index of the amount of fat or oil that has undergone oxidation caused by unsaturated fatty acids. Peroxide is formed at the oxidation initiation stage, at this stage hydrogen is taken from oleofine compounds to produce free radicals. The presence of light and metal plays a role in the process of taking the hydrogen. Free

radicals that are formed react with oxygen to form peroxy radicals, which can take hydrogen from other unsaturated molecules to produce peroxides and new free radicals.

Dalmadi (2019) wrote that value of peroxide can speed up the process of causing rancid and unwanted odors in food, in this case including VCO. The process of oxygen oxidation that occurs as a result of several factors such as light, exposure to oxygen and temperature due to heating also determines the amount of peroxide value in the VCO produced.

Therefore the peroxide value is included as one of the important things in determining the damage to the oil. Figure 3 below shows the amount of peroxide value in VCO based on the treatment carried out.

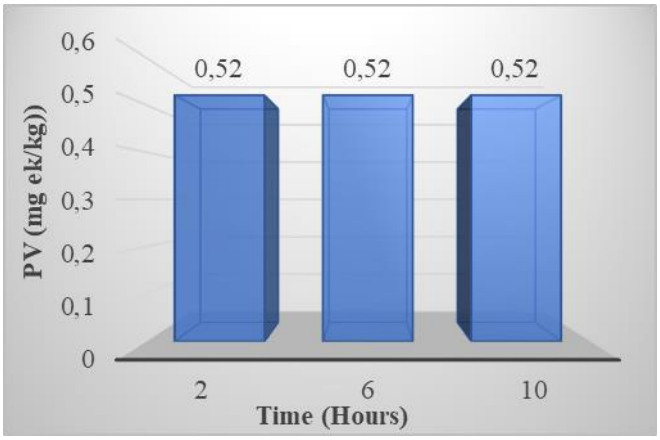


*Fig 3. Peroxide Value in VCO*

The results of testing the peroxide value for the VCO produced with natural fermentation time at 2 hours, 6 hours and 10 hours were the same at 0.52 mg oak/kg. The test results obtained still meet the requirements of SNI 7381:2008 with a maximum peroxide value of 2 mg.ek/kg. The test results indicate that the natural fermentation duration does not affect the formation of peroxide values.

In addition, the gradual heating method for VCO obtained from natural heating produces peroxide values that are far below the safe limits of the provisions of SNI 7381:2008. In terms of the gradual heating method the scorching can be caused by the absence of heating at high temperatures, that is <95 $^{O}$C, and the second stage of heating which is carried out for 10 hours but at temperatures <60 $^{O}$C and the presence of contact with oxygen from ambient air.

## IV. CONCLUSION

Research results showed that the treatment for 2 hours, 6 hours and 10 hours had a moisture content of 0,15%; 0,12%; 0,1% then free fatty acid content is 0,09%; 0,10%; 0,11% and also peroxide value 0,52 mg ek/kg respectively. Based on the results of this study, it can be concluded that each test result is still below the threshold value according to the provisions of the Indonesian National Standard (SNI) 7381:2008

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