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A Nutrient Analysis Of Various Taro Varieties in The Sangihe Islands Region

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Abstract: The Sangihe-Talaud region hosts several taro varieties whose nutritional compositions in raw, steamed, and fried states remain unknown. This study examined these varieties, their processing methods, and their impact on taro's nutritional components, encompassing energy, protein, fat, carbohydrates, dietary fiber, ash, calcium, phosphorus, iron, vitamin C, moisture content, and sensory preferences. The investigation encompassed *Macape Marramu*, *Macape Darrana*, and *Allae Mawira* taro types subjected to raw, steamed, and fried treatments. In this study, the researchers employed a complete randomized design with two factors and four replications. The findings revealed diverse effects of treatments and their interactions on taro's nutritional profile. Treatment A_1B_2 yielded the highest energy content at 116.6. The maximum protein content was observed in treatment A_2B_2. Treatment A_3B_2 exhibited the highest fat content at 6.87, whereas A_1B_1, while not significantly different from A_2B_1 and A_3B_1, showed lower fat content. Treatment A_2B_2 registered the highest carbohydrate content at 89.27. Treatment A_1B_2 resulted in the highest dietary fiber at 4.28. The lowest ash content was in treatment A_1B_1, while the highest was observed in treatment A_3B_2 at 1.07. Treatment A_3B_2 recorded the highest calcium at 125%. The maximum phosphorus content was noted in treatment A_3B_2, whereas the minimum was in A_2B_0. Treatment A_3B_2 exhibited the highest iron content. The richest vitamin C content emerged in treatment A_2B_2 at 15.79. The lowest moisture content was observed in treatment A_1B_2, which was not significantly different from A_2B_2 (*Macape Darrana*; fried). Meanwhile, the highest moisture content was observed in treatment A_2B_0.

Keyword: *Taro Varieties, Nutritional Composition, Food Processing.*

INTRODUCTION

Taro (*Colocasia esculenta* [L.] Schott) stands as a vital food source, providing not only the tuberous root for carbohydrate intake but also other essential nutrients, fulfilling caloric needs. Addressing food scarcity remains an ongoing global challenge, particularly in developing countries with rapidly growing populations. One approach to bolstering food resources involves harnessing natural assets and agricultural yields, thereby promoting the utilization of new food sources and diversification efforts (**Arif *et al.*, 2013**).

Several countries, such as the Philippines, Colombia, Japan, Brazil, and

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the United States, have widely adopted taro utilization. In Hawaii, taro serves as a primary food source for the population, while its tuberous roots are processed into raw materials for the food industry (Dewi *et al*., 2019). In Indonesia, particularly on Java and Madura islands, various forms of taro exist, each bearing distinct regional names. For instance, based on maturity until the tubers are ready for harvest, taro is categorized as follows: (1) "*talas genjah*" (Java), "*talas hawara*" (West Java), or "*talas nyama*" (Madura) for taros requiring 3-5 months until harvest, and (2) "*talas jero*" (Java), "*talas leuir*" (West Java), or "*talas jombang*" (Madura) for taros needing 8-12 months until completion. The variation in taro names across different regions is sometimes based on the size of the tubers. In Javanese culture, taro is categorized as follows: (1) "*talas pandan*" (taros with small tubers), (2) "*talas beureum*" or "*talas ronjok*" (taros lacking tubers), and (3) "*talas banteng*" (taros possessing large tubers) (**Habibah & Astika, 2022**). In Indonesia, taro tubers serve as a staple food, notably in several areas (e.g., Sorong Regency [Papua] and Maluku). Beyond a primary food source, taro is consumed in various forms, such as boiled, steamed, mashed, taro chips, sweet dishes like "*kolak*," and others. Taro flour, extracted for use as an alternative to wheat flour, finds application in making bread, cakes, thickeners, and even specialized foods like baby food (**Rialdi & Putri, 2021**). Considering the current situation in which food shortages may arise due to prolonged monetary and economic crises in Indonesia, it becomes crucial to highlight alternative food sources that can be consumed by the public yet have unknown nutritional content. In North Sulawesi, specifically in Sangihe Islands Regency and Talaud Islands Regency, several taro varieties are yet to undergo assessment for their nutritional content, whether raw, steamed, or fried, despite being a staple food in the areas. Moreover, the available foundational data on taro's nutritional value is generally limited.

Considering this reality, it is highly essential to conduct research to gather basic nutritional data for various types of taros, whether they are raw, steamed, or fried. This information could prove valuable for individuals in need, as well as for both the food and non-food industries. It would aid them in selecting the suitable type of taro and its processing method based on their specific needs.

MATERIALS AND METHODS

Materials

1. Antioxidant Activity Test

   The materials used in this study included a solution of 1,1-diphenyl-2-picrylhydrazyl (DPPH) and virgin coconut oil. The equipment employed in this research consisted of as following.

   1) Stirrer
   2) Micropipette
   3) 100 mL volumetric flask
   4) 100 mL Erlenmeyer flask
   5) Test tubes
   6) 100 mL measuring glass
   7) Vortex
   8) UV-Vis Spectrophotometer

2. Phenolic Compound Test

   The materials utilized in this study encompassed a 0.07% bipyridine solution, 0.2% FeCl3, and toluene. The tools used in this research were as follows.

   1) Stirrer
   2) Micropipette
   3) 100 mL volumetric flask
   4) 100 mL Erlenmeyer flask
   5) Test tubes
   6) 100 mL measuring glass
   7) Vortex
   8) UV-Vis Spectrophotometer

Methods

The type of this study was experimental research (Sugiyono, 2017). In experimental research, researchers formulate a minimum of 2 (two) hypotheses that describe cause-and-effect relationships among the variables involved. The variables under investigation include independent and dependent variables, which have been clearly defined by the researchers since the beginning of the study.

Testing Parameters

1. Phenolic compounds
2. Antioxidant activity
3. Moisture content
4. Peroxide value
5. Free fatty acid (FFA)

Experiment Design and Construction

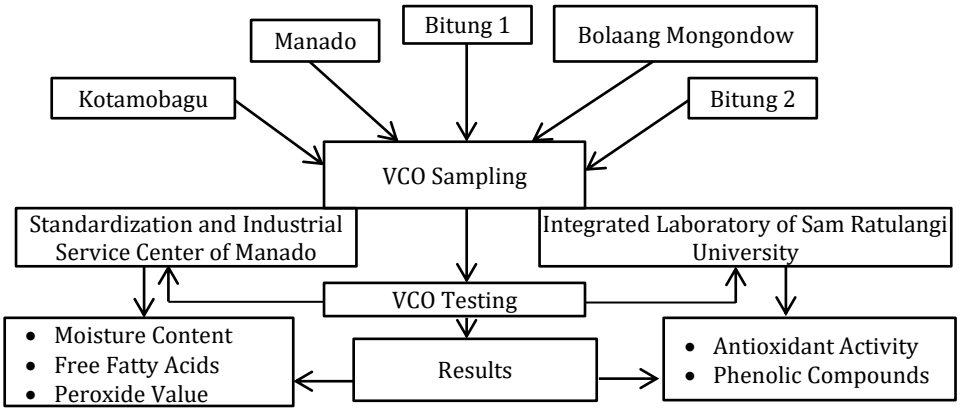

Figure 1. Experimental Design and Construction Chart

RESULTS AND DISCUSSION

Results

1. A Sampling of Virgin Coconut Oil

At this stage, virgin coconut oil (VCO) samples for testing were collected from small and medium enterprises in various regencies and cities in North Sulawesi, including Manado, Bitung, Bolaang Mongondow, and Kotamobagu.

2. Methods Used in VCO Production

1) Heating Method

The gradual heating method involves extracting the flesh from fresh coconuts, grating it, and then adding water and squeezing it. The obtained coconut milk is allowed to settle until two layers form (cream and water). The cream is separated and then heated (cooked) at a temperature below 90°C until oil and white sediments form. The oil is filtered to separate it

from the white sediments. The oil is then heated again for 10 hours at 65°C and filtered to obtain virgin coconut oil (VCO).

2) Baiting Method

The baiting method involves extracting the flesh from fresh coconuts, grating it, and then adding water and squeezing it. The obtained coconut milk is allowed to settle until two layers form (cream and water). The cream is separated. Baiting oil is added to the cream in a 1:3 ratio and mixed thoroughly. It is left to sit for 10-12 hours. The result is the formation of three layers: oil, white sediments, and water. The VCO is then carefully separated by filtering.

3) Fermentation Method

The fermentation method involves extracting the flesh from fresh coconuts, grating it, and then adding water and squeezing it. The coconut milk obtained (with or without the addition of a starter) is then left to ferment for 18-24 hours. After that, the formed components are separated or filtered.

4) Centrifugation Method

The centrifugation method begins with grated coconut flesh mixed with water, which is then squeezed and filtered to produce coconut milk. The coconut milk is collected in a container, and the subsequent process involves centrifuging the coconut milk to obtain three layers: an oil layer, white sediments (protein), and water. These three layers are components within the coconut milk separated due to differences in density. The uppermost layer, which consists of oil, is the virgin coconut oil (VCO) product.

3. Methods for Determining Moisture Content, Free Fatty Acids, Peroxide Value, Antioxidant Activity, and Phenolic Compounds

1) Moisture Content

Moisture content in oil can be determined using the oven method. In the oven method, approximately 5 g of the sample is weighed into a crucible and placed in an oven at 105°C for about 4-5 hours until a constant weight is

achieved. The sample is then removed, placed in a desiccator for approximately 15 minutes, and subsequently weighed.

$$Moisture\ Content = \frac{A - B}{A} \times 100\%$$

Where: A = the initial weight of the sample (oil)

B = the weight of the sample (oil) after heating

2) Free Fatty Acids (FFA)

The determination of free fatty acids (Mehlenbacher, as cited in Sudarmadji *et al*., 1981) involves weighing approximately 5 g of the sample in a 250 ml Erlenmeyer flask. The sample is added 50 ml of hot 96% neutral ethanol and 2 ml of phenolphthalein indicator. The sample is titrated with 0.05 N NaOH solution that has been standardized until a pink color is achieved and remains for 30 minutes. Free fatty acids are expressed as %FFA.

$$\%FFA = \frac{ml\ NaOH \times N \times Molecular\ Weight\ of\ Fatty\ Acids}{Sample\ Weight \times 1000} \times 100\%$$

3) Peroxide Value

The determination of peroxide value involves the weighing of approximately 5 g of the sample into a covered 250 ml Erlenmeyer flask. Then, 30 ml of acetic acid-chloroform solution (3:2) is added to the sample. The solution is shaken until all the material dissolves, followed by the addition of 0.5 ml of saturated potassium iodide solution. It is allowed to stand for 1 minute, with occasional shaking, and then 30 ml of distilled water is added. The sample is titrated with 0.01 N $Na_2S_2O_3$ solution until the yellow color nearly disappears. After that, 0.5 ml of 1% starch solution is added, and the titration continues until the blue color in the solution begins to fade. The peroxide value is expressed in milliequivalents of peroxide per 1000 g of the sample.

$$Peroxide\ Value = \frac{ml\ Na_2S_2O_3 \times N \times 100}{Sample\ Weight}$$

4) Antioxidant Activity

The antioxidant activity being tested is the capability to scavenge 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radicals at various

concentrations. Each 0.5 ml of extracted virgin coconut oil (VCO) at 1000 µg/ml is mixed with 1.5 ml of DPPH solution and vortexed for 2 minutes. The solution changes from purple to yellow, indicating the efficiency of free radical scavenging. This is further observed in the last 5 minutes before reaching 30 minutes at a wavelength of 517 nm using a UV-Vis spectrophotometer. The free radical scavenging activity is calculated as a percentage reduction in DPPH color using the following formula.

$$1 - \frac{Sample\ Absorbance}{Control\ Absorbance} \times 100\%$$

5) Tocopherols (Phenolics)

1 ml of virgin coconut oil is weighed, and 5 ml of toluene is added to a 25 ml Erlenmeyer flask. Then, 3.5 ml of 0.07% bipyridine solution is added, and the mixture is vortexed for 2 minutes. Subsequently, the solution is adjusted to 10 ml with 95% ethanol, and measurement is conducted at a wavelength of λ 520 nm.

DISCUSSION

1. Test Results for Moisture Content, Free Fatty Acids (FFA), Peroxide Value, Antioxidant Activity, and Phenolic Compounds

Table 1. Results of Analysis of Average Moisture Content, FFA, and Peroxide Value in the Samples of Virgin Coconut Oil

No.	Samples	Moisture Content (%)	Free Fatty Acid (FFA) (%)	Peroxide Value (meq/kg)
1.	V1	0.15	0.08	0.99
2.	V2	0.14	0.14	0.26
3.	V3	0.15	0.12	0.37
4.	V4	0.15	0.2	0.49
5.	V5	0.12	0.09	0.79

Source: Research Results, 2022

V1 : VCO from Kotamobagu

V2 : VCO from Manado

V3 : VCO from Bitung 1

V4 : VCO from Bolaang Mongondow

V5 : VCO from Bitung 2

a. Moisture Content

Based on the analysis results of moisture content presented in Table 1 and Figure 2, it is evident that the VCO samples have varying moisture content. The lowest moisture content is found in sample V5, at 0.12%, followed by V2 at 0.14%, and then V3 and V4 with the same moisture content of 0.15%. According to the Indonesian National Standard (SNI:7381, 2008), all VCO samples meet the quality standard requirement for moisture content, which is a maximum of 0.2%.

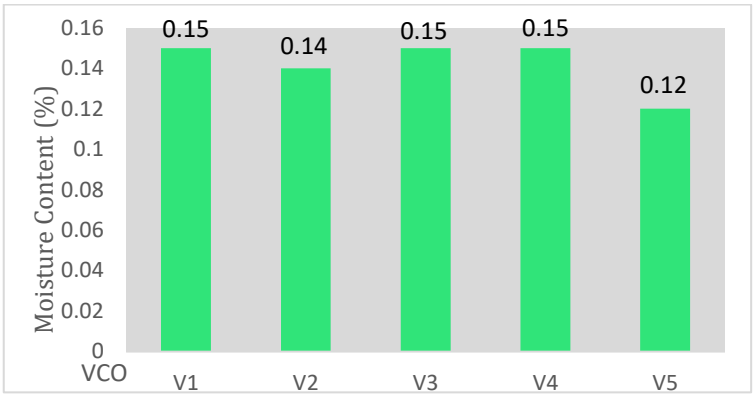

Figure 2. The Graph of Moisture Content

b. Free Fatty Acids (FFA)

Based on the analysis of free fatty acids (FFA) content presented in Table 1 and Figure 3, it is observed that the samples of VCO have varying levels of free fatty acids. The highest FFA content is found in sample V4, at 0.2%, followed by V2 at 0.14%, V3 at 0.12%, and V5 at 0.09%. The lowest is found in sample V1, which is 0.08%. According to the Indonesian National Standard (SNI:7381, 2008), all FFA content in the VCO samples meets the quality standard requirement, which is a maximum of 2%.

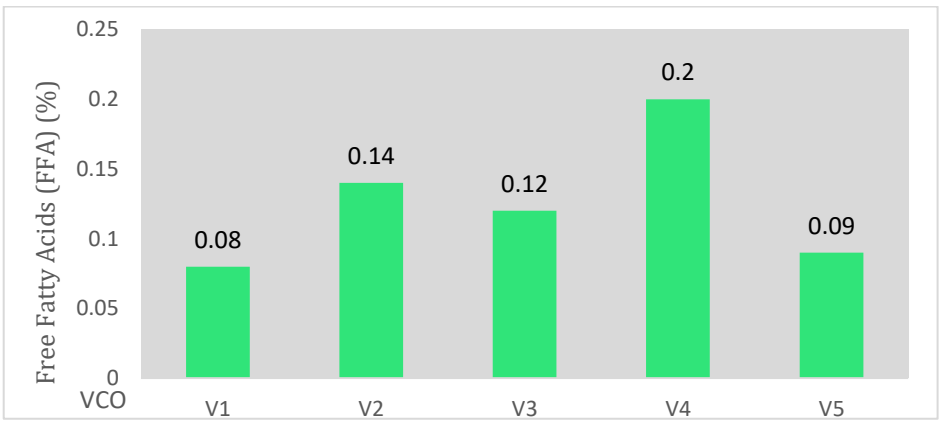

Figure 3. The Graph of Free Fatty Acid (FFA)

c. Peroxide Value

Peroxide value is a critical parameter for assessing the extent of damage in oils and fats. Peroxide compounds form as a result of oxidative reactions, which occur when oxygen comes into contact with oil and fat. Based on the analysis results of the peroxide value presented in Table 1 and Figure 4, it is evident that the five VCO samples exhibit varying peroxide value levels. Sample V1 has the highest peroxide value at 0.99 meq/kg, followed by V5 at 0.79 meq/kg. Next is V1 with 0.49 meq/kg, followed by V3 with 0.37 meq/kg. The lowest value is found in sample V2 at 0.26 meq/kg. All VCO samples meet the quality standard requirements outlined in the Indonesian National Standard (SNI:7381, 2008), which specifies a maximum peroxide value of 2 meq/kg.

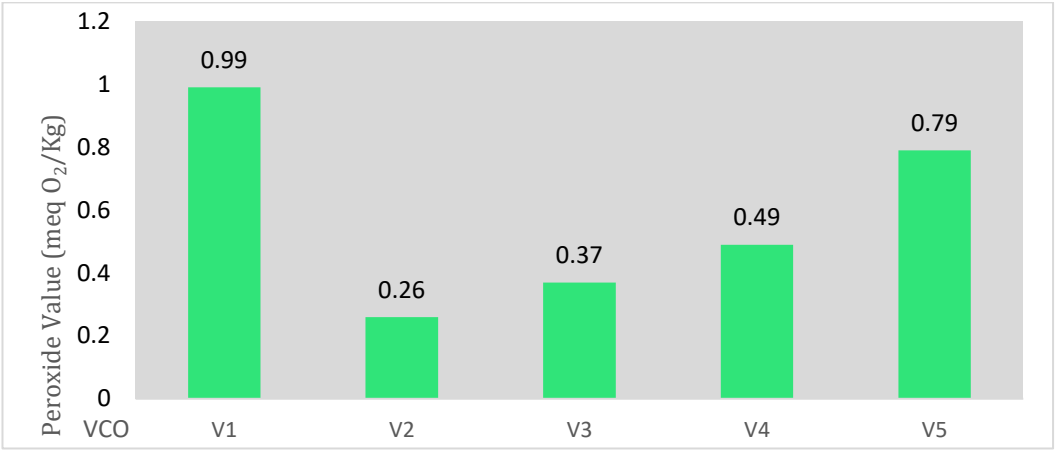

Figure 4. The Graph of Peroxide Value

d. Phenolic Compounds

Virgin coconut oil (VCO) has the potential to prevent and assist in the treatment of specific diseases, such as cancer, coronary heart disease, diabetes, gout, cholesterol-related issues, and various degenerative diseases. Furthermore, it can aid in the digestion of food and the absorption of nutrients. Research findings have indicated that the medical and health benefits of VCO are attributed to phenolic compounds, which are minor constituents within VCO.

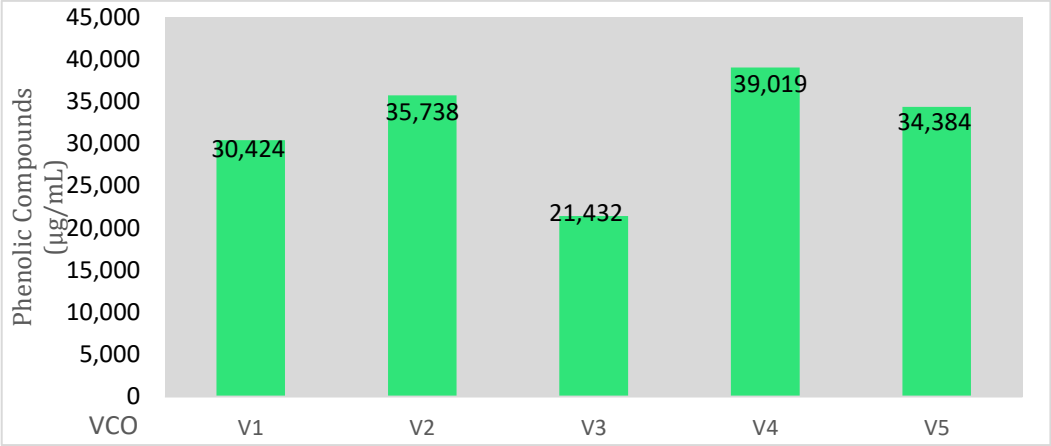

Figure 5. The Graph of Phenolic Compounds

Natural plant antioxidants typically consist of phenolic compounds, including flavonoids, tocopherols, and organic acids. One of the objectives of this study was to determine the phenolic compound content in various virgin coconut oil (VCO) samples produced by small and medium-sized enterprises (SMEs) from different regencies and cities in North Sulawesi.

Based on the research findings and phenolic compound content analysis shown in Figure 5, the five VCO samples have varying levels of phenolic compound content. The highest content is found in sample V4 at 39.19 µg/ml, followed by V5 at 34.38 µg/ml, V2 at 35.73 µg/ml, and V1 at 30.42 µg/ml. The lowest content is found in sample V3 at 21.43 µg/ml. The phenolic compound content in VCO is influenced by several factors, including the coconut harvesting age, coconut variety, growing location, and VCO processing methods and techniques.

The VCO samples used in this research were collected from different regencies and cities, with varying coconut harvesting ages, resulting in different phenolic compound contents. Sample V3 has the lowest phenolic compound content because, as obtained from the information, during the processing, the coconut fruit's epidermis is removed from the coconut flesh (paring). Research results indicated that phenolic compounds are most abundant in the flesh portion closest to the coconut fruit's epidermis.

The coconut fruit's epidermis refers to the outer surface of coconut flesh removed during the processing of coconut flesh into flour, coconut milk, oil, and other coconut products, with a thickness of approximately 2mm. This

part consists of coconut flesh (endosperm) and coconut fruit's epidermis (brown skin). Research findings have shown that the total phenolic compound content in oil from coconut fruit's epidermis is around 0.15 - 0.2%. In addition, this part contains antioxidant and photoprotective compounds, making it beneficial for health and capable of preserving the quality of the resulting oil (Muis, A., 2017). Other research results have also indicated that the phenolic compound content in VCO made from coconuts with epidermis is three times higher than VCO from coconuts without epidermis because phenolic compounds in coconuts are primarily found in the epidermis. VCO from coconuts with epidermis contains 75.92 mg/kg of phenolic compounds, while VCO from coconuts without epidermis contains 23.87 mg/kg of phenolic compounds (Audsyah & Yusuf, 2021).

e. Antioxidant Activity

Antioxidant compounds exhibit their free radical scavenging activity by reacting with peroxyl radicals before these radicals can interact with long-chain unsaturated fatty acids (Abbas *et al*., 2016). In this study, we assessed the antioxidant activity using the DPPH method, a widely recognized approach for estimating the antioxidant capacity of various compounds. The DPPH method is renowned for its simplicity, speed, sensitivity, and multiple advantages, such as cost-effectiveness, ease of use, stability (remaining in a monomeric state in solution), and oxidation resistance (Pulung *et al*., 2016). The DPPH method relies on the reduction in absorbance due to a color change in the solution. Initially, the purple solution turns yellow as the DPPH radical is captured by the antioxidant, releasing a hydrogen atom to form a stable DPPH-H.

We evaluated the antioxidant activity of VCO by measuring its ability to scavenge DPPH radicals. VCO samples collected from various regencies and cities in North Sulawesi exhibited varying antioxidant activities. Figure 6 illustrates that the highest antioxidant activity was observed in sample V4 at 97.93%, followed by sample V2 at 97.13%. Sample V5 and V1 exhibited antioxidant activities of 96.98% and 95.52%, respectively, while the lowest antioxidant activity was found in sample V3 at 20.56%. The differences in antioxidant activity among the samples were generally not very significant,

except for sample V3, which displayed a highly significant difference compared to the other VCO samples.

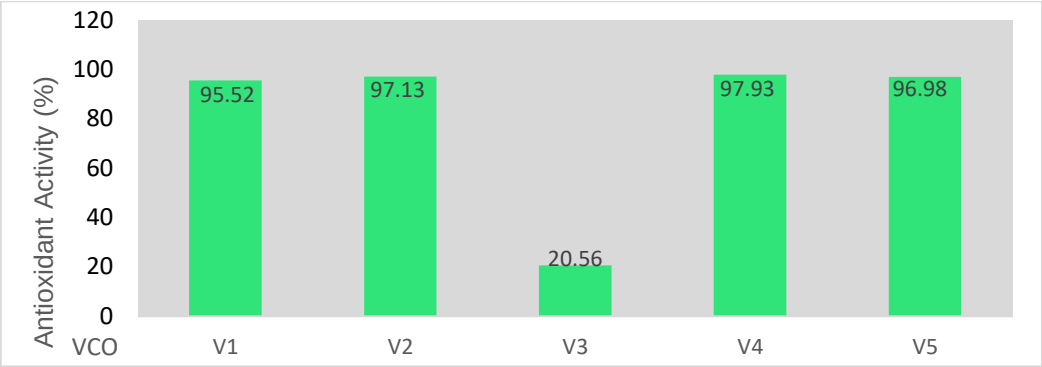

Figure 6. The Graph of Antioxidant Activity

The differences observed are influenced by the fact that the samples have the lowest phenolic compound content (see Figure 5).

Natural antioxidants derived from plants generally consist of phenolic compounds, including flavonoids, tocopherols, and organic acids. Coconut oil contains various components, such as tocopherols and β-carotene, which are commonly found in almost all vegetable oils, including VCO, and are classified as natural antioxidants. Therefore, the lower the phenolic compound content is, the lower the antioxidant activity will be (Muis, A., 2007, 2014, 2017).

One effective way to inhibit lipid oxidation is through the use of antioxidants. Antioxidants are compounds that can be employed to protect food items by slowing down damage, rancidity, or color changes caused by oxidation. Antioxidants play a role in inhibiting oxidation through various mechanisms, including controlling substrates (oxygen and lipids), managing peroxidation (reactive oxygen species and catalytic metals), and controlling free radicals. The most effective antioxidants perform their function by interrupting the chain reaction of free radicals in lipid oxidation (Bintanah *et al*., 2021).

CONCLUSIONS

1. Virgin coconut oil (VCO) from various regions/small and medium enterprises (SMEs) was processed using the cold method (cold process), specifically through spontaneous fermentation. Based on the test results, the VCO samples

exhibited different qualities, but all still met the quality standards based on SNI:7381, 2008, especially regarding moisture content, peroxide value, and free fatty acids (FFA). The phenolic compound content in the VCO samples varied, with the highest found in sample V4 at 39.19 µg/ml and the lowest found in sample V3 at 20.56 µg/ml. These differences can be influenced by several factors, including coconut harvesting age, coconut variety, growing location, and processing methods and techniques. The antioxidant activities of the VCO samples also varied, with the highest in sample V4 at 97.93% and the lowest found in sample V3 at 20.56%. The differences in antioxidant activity among the samples were not very significant, except for sample V3, which showed a highly significant difference from the other samples, likely due to differences in phenolic compound content.

2. Based on the phenolic compound content and antioxidant activity, it can be recommended that all samples except for sample V3 should be used as raw materials or additives for pharmaceutical products.

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