ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume 68 44 Number 3, 2020

CHARACTERISTICS OF PHYSICAL, CHEMICAL, AND ORGANOLEPTIC PROPERTIES OF VIRGIN COCONUT OIL (VCO) BY STUDYING THE RATIO BETWEEN COCONUT CREAM WITH INDUCEMENT OIL AND LENGTH OF FERMENTATION

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Link to this article: https://doi.org/10.11118/actaun202068030473
Received: 12. 9. 2019, Accepted: 22. 4. 2020

To cite this article: ANWAR CHAIRIL, IRMAYANTI, UMAR HA. 2020. Characteristics of Physical, Chemical, and Organoleptic Properties of Virgin Coconut Oil (VCO) By Studying the Ratio Between Coconut Cream with Inducement Oil and Length of Fermentation. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 68(3): 473–482.

Abstract

Coconut agribusiness development plays an important role in an effort to increase productivity as a raw material for processed products from coconut. Indonesia is one of the world's largest coconut plantation. Unfortunately, Indonesia's exports are in the form of ordinary coconut oil, while Philippines has begun to reach the world with the Virgin Coconut Oil (VCO). However, there is still a lack of diversification that can be done by coconut farmers made its little progress. In fact, the price of VCO which tripled from coconut oil used to make the oil can be potential to be developed in Indonesia The purpose of this research was to examine the cream ratio with inducement oil and length of fermentation on VCO quality. The research used a factorial randomized complete design (CRD) of 3 × 3 consisting of two factors, namely the ratio of coconut cream and inducement oil (A) and length of fermentation (B). The ratio of coconut cream and inducement oil (A) consisted of three levels, namely: A1 = 2 : 1, A2 = 3 : 1, and A3 = 4 : 1. Length of fermentation factors (B) consisted of three levels, namely: B1 = 8 hours, B2 = 10 hours, and B3 = 12 hours. The results showed that the treatment of cream ratio with inducement oil had a very significant effect on the yield, organoleptic aroma, and color. The length of fermentation had a very significant effect on yield, organoleptic aroma and color. The interaction between the two factors had a very significant effect on all parameters (water content, peroxide number, acid number, and iodine number) except yield and organoleptic (aroma and color) which had no effect. The best VCO quality was obtained by ratio of cream with inducement oil 2 : 1 and 8 hours length of fermentation.

Keywords: agribusiness development, coconut plantation, cream, inducement oil, length of fermentation, virgin coconut oil

INTRODUCTION

Coconut plants (*Cocos nucifera*) are one of the industrial plants that play an important role for the survival of the Indonesian people. Coconut is one of the plantation commodities besides cocoa, coffee, palm, vanilla and pepper. This commodity has

long been known and almost planted throughout Indonesia, especially in coastal areas. Production centers are spread in Sumatra, Java, Sulawesi, NTT and Maluku.

The main part of coconut which is utilized is coconut flesh. Coconut meat is generally only used to make copra, even though coconut fruit can be used as a variety of products. Therefore, it is necessary to diversify coconut products into other products that have high sales value. One of the diversified products from coconut is virgin coconut oil or VCO (Tanasale, 2013). Coconut oil is the most valuable part of coconuts. The oil content in old coconut meat is 34.7% (Tarwiyah, 2001). Coconut oil is used as industrial raw material or as cooking oil. Coconut oil as a cooking oil that is usually used for daily needs, serves as a conduit of heat in the frying pan and adds nutritional value to food.

Indonesia as the largest archipelago country has the largest coconut plantation in the world with an area of 3,654,478 Ha or equivalent to 30% of the total area of coconut plantations in the world (Ditjenbun, 2014). Unfortunately, Indonesia's exports are still in the form of ordinary coconut oil, while the Philippines has begun to reach the world with VCO, known as virgin coconut oil (VCO). However, the lack of diversification that can be done by coconut farmers makes it slow to develop. In fact, the price of VCO which is three times that of ordinary coconut oil makes this oil potential to be developed in Indonesia.

VCO is processed from fresh coconut meat and the manufacturing process is carried out at relatively low temperatures. Some methods that are currently widely used in making VCO are: the gradual heating method, the oil-fishing method and the fermentation method. The gradual heating method is done by heating the coconut milk at a temperature of < 90 ºC then the oil obtained is reheated at a low temperature (< 65 ºC). The method of fishing for oil is done by adding fishing oil to coconut milk in a certain ratio. The fermentation method is carried out by adding yeast to coconut milk (Pontoh *et al*., 2008).

In addition to using these methods, another method used in making VCO is the fishing method. The principle of making VCO with the fishing method is to add pure coconut oil that has become ready to accelerate the breakdown of coconut milk cream emulsion so that it is separated into three phases, namely, oil, protein, and water. The use of the fishing method is basically changing the water-oil emulsion to become the oil-oil emulsion. In addition, the ratio of cream with fishing oil and fermentation time are two factors that affect the quality of the VCO produced. This study aims to produce VCO using a fishing method by examining the ratio of cream with fishing oil and fermentation time on the quality of VCO.

MATERIALS AND METHODS

The materials used in the research were old coconut flesh from coconut which is brown color and 11–13 months old. The coconut was obtained from a community plantation, Cot Suruy Village, Aceh Besar Regency, the water used to extract shredded coconut meat (coconut milk) was obtained from the Polytechnic of Indonesia Venezuela and the other material used was inducement oil. The tools used in this study are tubes, measuring cups, drop pipettes, erlenmeyers, filter paper, containers, funnels. This study used a 3 × 3 factorial Complete Randomized Design (CRD) consisting of two factors, namely the ratio of cream and inducement oil (A) and length of fermentation (B). The ratio factor of cream and inducement oil (A) consisted of three levels, namely: A1 = 2 : 1, A2 = 3 : 1, and A3 = 4 : 1. The length of fermentation factors (B) consisted of three levels, namely: B1 = 8 hours, B2 = 10 hours, and B3 = 12 hours. Thus, there were 9 treatment combinations and repeated 3 times to obtain 27 experimental units.

Production of VCO

As much as 5 old coconut is chosen (marked with a dark brown coconut shell color and when the coconut is shaken it will sound loud). The coconut is shredded, then mixed and extracted with water. The ratio of water and coconuts is 1 : 1.5 (1 liter of water for 1½ coconuts). Squeeze coconut milk by hand. Then strain the coconut milk using a filter cloth. Squeeze the pulp that is inside the filter cloth so that the coconut milk can come out all. Keep coconut milk in a transparent container for one hour to form coconut cream (coconut milk) and skim coconut milk. Coconut cream is at the top because it contains oil and skim coconut milk is at the bottom because it generally contains water and protein. There were no chemicals involved in the process of producing coconut milk.

Cream and skim formed are separated. Then the cream is put into a container and added inducement oil with a ratio of 2 : 1, 3 : 1, and 4 : 1 and stirring slowly until evenly distributed. Furthermore, the mixture of cream and inducement oil is fermented by 8 hours, 10 hours and 12 hours fermentation time. After fermentation, three layers will be formed, namely oil (VCO), blondo and water. Take oil (VCO) which is at the top by using a pipette slowly. Then filter the VCO obtained using filter paper. Filtering is done using filter paper. This screening aims to separate VCO from protein in order to obtain clear VCO (Hapsari and Welasih, 2010).

Physical, Chemical, and Organoleptic Analysis of VCO

The parameters observed in this study include yield (Ketaren, 1986), water content analysis (distillation) (Apriyantono *et al*., 1989),

acid number analysis using 0.1N KOH (Merck, Germany) and phenophtalein indicators (Merck, Germany) (Sudarmadji *et al.*, 1996), peroxide numbers (Apriyantono *et al.*, 1989), iodic numbers (Sudarmadji *et al.*, 1996), and organoleptic analysis on aromas and colors (appearance). The testing instrument for organoleptic analysis is panelists who have been recruited and trained to carry out specific tasks of organoleptic evaluation (Soekarto, 1985).

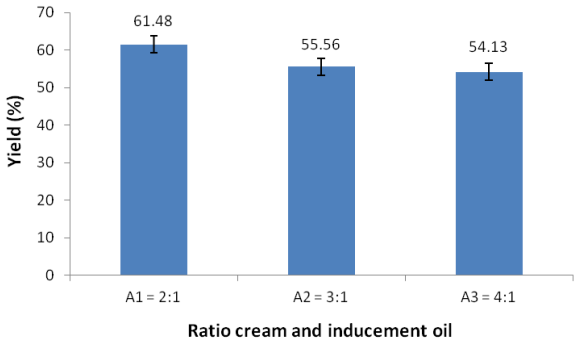
Data Analysis

All data presented in this study were analyzed using analysis of variance or Analysis of Variance (ANOVA) with SPSS 2010 software. If the ANOVA results indicate differences in treatment then proceed with the Least Significant Difference test (LSD) with a level of 5%.

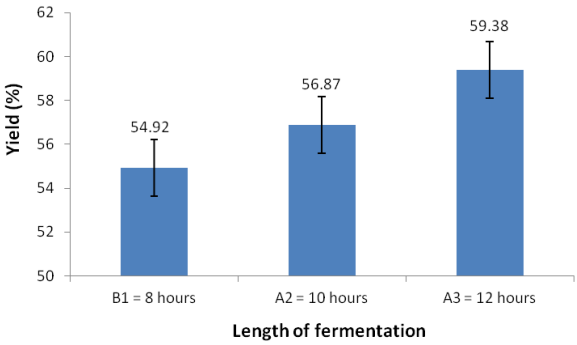
RESULTS AND DISCUSSION

Yields

The yield is the percentage of virgin coconut oil (VCO) produced. The average yield of VCO produced ranged from 52.00 to 59.00% with an average overall yield of 57.06%. Based on the analysis of variance of VCO yield showed that the treatment of cream ratio with inducement oil and fermentation time had a very significant effect while the interaction between the two factors did not significantly affect the yield of VCO produced.



1: *Effect of cream ratio with inducement oil on VCO yield*



2: *Effect of fermentation time on VCO yield*

The Least Significant Difference test results on VCO yield can be seen in Fig. 1 and Fig. 2. Fig. 1. showed that the highest amount of VCO yield was in the treatment ratio of cream with inducement oil with 2 : 1 (61.48%) and the lowest yield is in treatment ratio of cream with inducement oil 4 : 1 (54.13%). The higher the ratio of cream added, the lower the yield of VCO produced. The high yield of VCO was due to the large volume of cream added to inducement oil.

Fig. 2 showed the highest VCO yield was obtained at 12 hours fermentation time (59.38%) and the lowest yield was obtained at 8 hours fermentation treatment (54.92). The longer the fermentation, the higher yield produced. The high yield was due to the advanced fermentation process which will form water and acetic acid where acetic acid has the ability to break the bonds of fat-protein, consequently more fat is released from the protein. Ishak *et al.* (2016) added that the longer the fermentation time of the coconut milk emulsion breakdown process continues, the speed of protein hydrolysis reaction increases so that the oil that can be released from the protein envelope is also increasing so that the yield is higher.

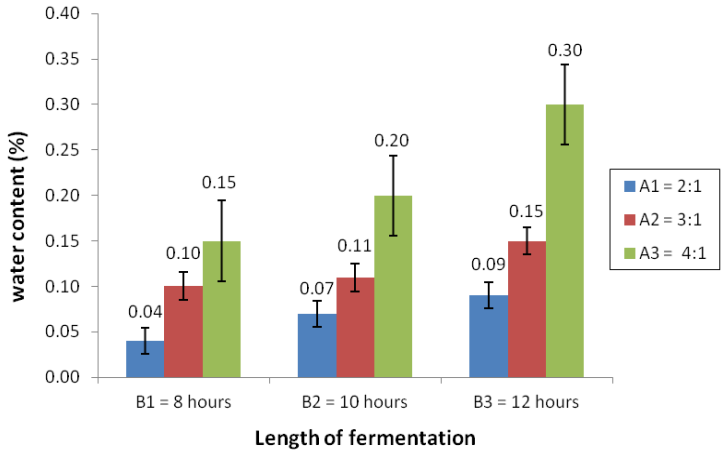
In addition, the yield of VCO is largely determined by the quality of the coconut meat. The better the quality of coconut that is used, the quality of the VCO produced will also be better, in addition to the higher yield, and vice versa.

Anwar and Salima (2016) conducted a centrifugation research on VCO. The results of the study showed that the higher the centrifugation cycle and the longer the centrifugation time, the higher the VCO yield produced. The results showed that the highest yield was obtained at 10000 rpm centrifugation rotation for 20 minutes (26.99%).

Water Content

Determination of water content in oil is very important because the presence of water in oil will cause a hydrolysis reaction that can cause rancid oils caused by the oil turning into ketone compounds (Budiman *et al.*, 2012). Moisture content is also an important parameter that has an important role in determining the quality control of the VCO samples that have been produced. VCO water content produced from this study ranged from 0.04 to 0.30% with an average overall water content of 0.14%. The results of analysis of variance in VCO water content showed that the treatment of cream ratio with inducement oil and fermentation time as well as the interaction between the two factors had a very significant effect on the moisture content of VCO produced. The Least Significant Difference test results (BNT0.05) VCO water content can be seen in Fig. 3.

Fig. 3 shows that the VCO water content has increased with the increasing ratio of cream with inducement oil. In addition, fermentation time also



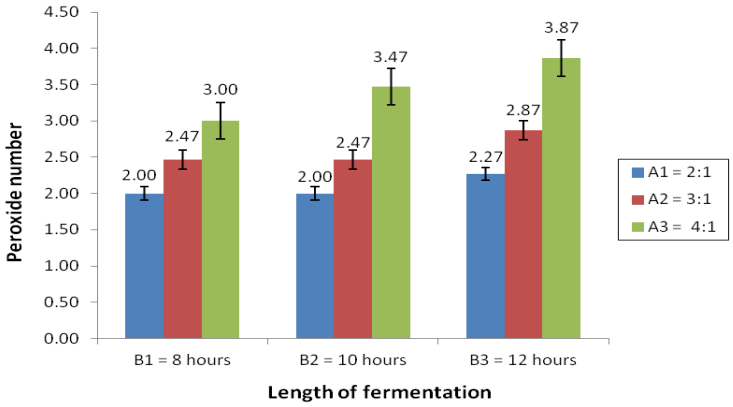
3: *Effect of cream ratio interaction with inducement oil and fermentation time on VCO water content*

determines the VCO water content produced, the longer the fermentation, the VCO water content which also increases. The higher the ratio of cream with inducement oil and fermentation time, the water content of the VCO produced increases. The high amount of water content is due to the large amount of cream that is thought to contain a lot of water so that the process of drawing oil molecules in coconut milk is not optimal. In Fig. 3, the highest water content was obtained in the cream ratio with 1 : 4 inducement oil and 12 hours fermentation time (0.30%) while the lowest water content was obtained in the cream ratio with 2 : 1 inducement oil and 8 hours fermentation time (0.04%). According to Bilang *et al.* (2010) states that in general oil will contain a certain amount of water. In the VCO which is used as an angler also has bound a certain amount of water so that the amount of water contained in the VCO produced using the angler must also increase. According to Sulistyo *et al.* (2009), the higher the water content, the faster it will rancid. In addition, the remaining protein can also trigger rancidity if it exceeds the 0.5% threshold. To see that the remaining protein in VCO can be deposited first, so that small, fine, and white granules will be seen. That means the protein is precipitating due to imperfect filtering. Protein is a means of microbes to grow, causing rancidity.

Anwar and Salima (2016) have conducted research on changes in yield and quality of virgin coconut oil (VCO) at various rotational speeds and length of centrifugation. From the results of the study it was produced that the lowest VCO produced from this centrifugation process was 0.20% and the highest was 0.32%.

Peroxide Number

VCO peroxide numbers from this study ranged from 2–3.87 with an average of 2.71. The results of analysis of variance of VCO peroxide numbers showed that the treatment of cream ratio with inducement oil and the length of fermentation as well as the interaction between the two factors significantly affected the VCO peroxide number produced. The Least Significant Difference test results (BNT0.05) VCO peroside numbers can be seen in Fig. 4.



4: *Effect of cream ratio interaction with inducement oil and fermentation time on VCO peroxide numbers*

Fig. 4 shows that the highest VCO peroxide number was obtained in the cream ratio with 4:1 inducement oil and 12 hours fermentation time (3.87) while the lowest VCO peroxide number was obtained in the treatment ratio of cream with fishing oil 2 : 1 and 8 hours fermentation time (2.00).

The high VCO peroxide number from the study was caused by the large volume of coconut milk cream added that binds to inducement oil so that it affects the VCO peroxide number produced. In addition, fermentation time also affects the VCO peroxide number. The higher the ratio of cream with fishing oil and fermentation time will cause an increase in the VCO peroxide number. At 12 hours fermentation time. During the 12 hour fermentation period the coconut oil peroxide rate increased and was higher than all treatments. This is because the longer the fermentation time, the unsaturated fatty acids contained in coconut oil will be greater and make the oil can be in direct contact with oxygen, thus the reaction of free radical formation which is subsequently converted into hydroperoxide will increase. This is supported by the opinion of Winarno (2002), that the oil oxidation reaction begins with the formation of free radicals caused by factors that can accelerate reactions such as light, heat energy, metal catalysts and enzymes. Free radicals with oxygen will form active peroxides which can form hydroperoxides that are very unstable. The longer the fermentation time the pH conditions will return away from the pH isoelectric point so that the protein again dissolves. With the solubility of protein again, the protein content will affect oil damage. According to Ketaren (1986) if oil or fat is free from impurities in the form of proteins, microbes have little effect on changes in oil quality during storage. Damage to the oil in the form of rancidity that causes odors and unpleasant taste in the oil. Based on the results of this study, the VCO peroxide number still meets the quality standards set by CODEX (maximum 5 mg O_2/g).

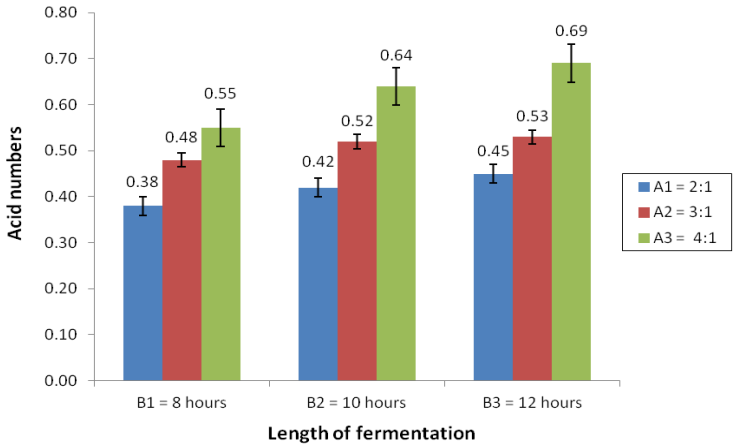
Research conducted by Patty (2015) found that the lowest peroxide rate was found in the 6-hour fermentation period of 0.0988%. This is because the unsaturated fatty acids found in fermented coconut oil for 6 hours are relatively smaller. The nature and resistance of oil to damage is very dependent on its constituent components, especially the content of fatty acids. In the 18 hour fermentation period, the peroxide value was 0.5630%, or higher than the control of 0.232%, and the 12 hour fermentation period was only 0.3494% peroxidation, but the 18 hour fermentation time had a lower peroxide number than the 24 hour fermentation time.

Acid Numbers

Fatty acids, produced through the hydrolysis reaction which can be caused by a number of water, enzymes or microorganism activity. The higher the water content in oil is likely to be also high in fatty acids. All enzymes that belong to the lipase group can hydrolyze fat, but the enzyme is inactive by heat. Free fatty acids produced by the hydrolysis process can affect oil flavor.

The results of the analysis of VCO acid numbers generated from this study ranged from 0.38 to 0.69 ml KOH/g sample. With an average overall acid number is 0.52 ml KOH/g sample. The results of analysis of variance of VCO peroxide numbers showed that the treatment of cream ratio with inducement oil and fermentation time as well as the interaction between the two factors significantly affected the VCO acid numbers produced. The Least Significant Difference test results VCO acid numbers numbers can be seen in Fig. 5.

Fig. 5 shows that the VCO acid number decreases with increasing volume of the cream ratio with inducement oil and the duration of fermentation. The figure also shows that the lowest VCO acid number produced from the ratio of cream with fishing oil 2 : 1 and 8 hours fermentation time is 0.38 ml KOH/g sample and the highest is 0.69 ml KOH/g sample at the treatment ratio of cream with



5: *Effect of cream ratio interaction with inducement oil and fermentation time on VCO acid numbers*

inducement oil 4 : 1 and 12 hours fermentation time. The length of fermentation also determines the high VCO acid number from this study, this is due to the more hydrolysis that occurs due to the longer fermentation (12 hours) so that the acid number is increasing. VCO acid numbers generated from this study still meet Codex standards of 13.

In addition, the high content of free fatty acids naturally found in coconut oil is also related to the high water content in coconut oil from the results of this study. According to Meilina *et al* (2010), free fatty acids are produced through hydrolysis reactions which can be caused by a number of water, enzymes or microorganism activities. In addition, the increase in free fatty acids is caused by the presence of water content in the substrate, coconut milk which will be used as a source of coconut oil. The presence of water on the substrate causes the hydrolysis process in coconut oil during the mixing process which triggers the formation of free fatty acids (Nodjeng *et al*., 2013). The higher the water content in the oil is most likely the high free fatty acid levels.

Witono *et al.* (2007) added that free fatty acids are one of the parameters of oil damage due to the hydrolysis process by the interaction with water and lipase activity. In the presence of water, fat can be hydrolyzed into glycerol and fatty acids. It can be concluded that the lower free fatty acids indicates the better quality of oil produced.

Iod Number

The iodine number is one of the parameters determining the quality of oil or fat. The iodine number represents a measure of unsaturation of oil or fat and is related to the content of unsaturated fatty acids in oil or fat. The iodine number is expressed as the number of grams of iod which is bound by 100 grams of oil or fat. Iodic numbers indicate the number of double bonds found in oil and when they react with iod they will form saturated compounds (Awolu *et al*., 2013 and Laureles *et al*., 2002).

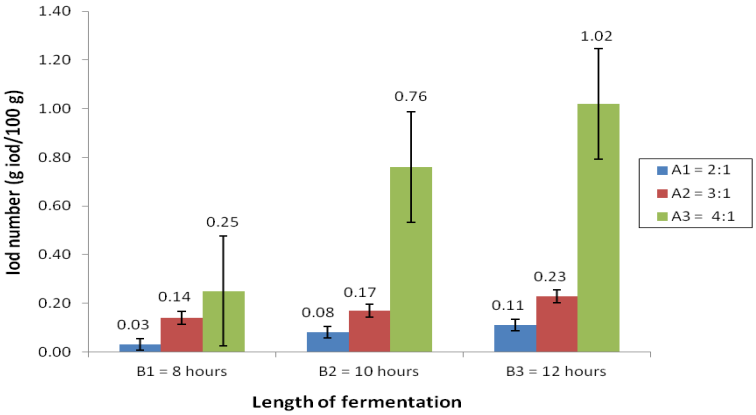
The results of the analysis of VCO acid numbers generated from this study ranged from 0.38 to 0.69 ml KOH/g sample. With an average overall acid number is 0.52 ml KOH/g sample. The results of analysis of variance of VCO peroxide numbers showed that the treatment of cream ratio with fishing oil and fermentation time as well as the interaction between the two factors significantly affected the VCO acid numbers produced. The Least Significant Difference Test VCO iod number can be seen in Fig. 6.

Fig. 6 shows that the VCO iod number has decreased with the increasing volume of the cream ratio with inducement oil and the duration of fermentation. The results showed that the lowest VCO acid number produced from the cream ratio with 2 : 1 inducement oil and 8 hours fermentation time was 0.03 g iod/100 g sample and the highest was 1.02 g iod/100 g sample in the treatment ratio of cream with oil 4 : 1 inducement oil and 12 hours fermentation time. The large amount of iodine absorbed indicates the number of double bonds or unsaturated bonds. The increase in iodine number is not due to the increase in double bonds in oil but because of the separation of non-oil compounds containing double bonds such as polymers, proteins, hydrocarbons, glycosides and b-carotene (Effendi *et al*., 2012). The iod number obtained in the VCO of this study showed that the oil contained unsaturated fatty acids both free and bound.

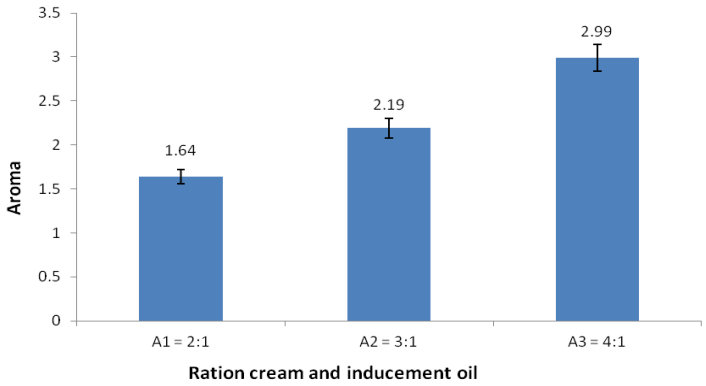
Organoleptic Test

Aroma

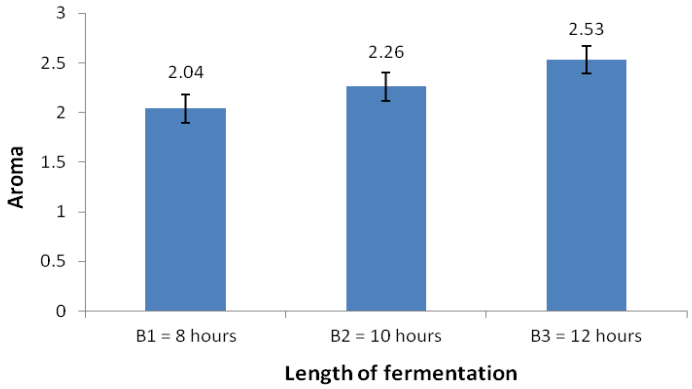
The hedonic test results on the average VCO aroma ranged from 1.35 (very like) – 3.20 (ordinary) and an overall average of 2.28 (ordinary). The results of analysis of variance showed that the treatment of cream ratio with inducement oil and fermentation time had a very significant effect while the treatment of fermentation time and interaction between the two factors did not significantly affect the aroma of VCO produced.



6: *Effect of cream ratio interaction with inducement oil and fermentation time on VCO iod numbers*



7: *Effect of cream ratio with inducement oil on organoleptic aroma*



8: *Effect of fermentation time on organoleptic aroma of VCO*

The Least Significant Difference test results for the VCO oraganoleptic test with the effect of centrifuge rotation and centrifugation time can be seen in Fig. 7 and Fig. 8.

In Fig. 7 and shows that the panelists liked the aroma of VCO in the treatment of cream ratio with inducement oil (1.64) and 8 hours fermentation time. Panelist acceptance rates tend to decrease. However, VCO created using the fishing method, the aroma was liked by respondents. VCO obtained from this study has a distinctive aroma of coconut oil. The organoleptic scent results in this study had fulfilled the Indonesian National standardization (SNI) requirements that have been set, namely having a distinctive aroma of fresh coconut and not rancid (BSN, 2008). Ketaren (1986) states that the rancid odor found in oil naturally also occurs due to the formation of acids that are very short chain as a result of decomposition of oil damage that can affect the aroma of oil produced.

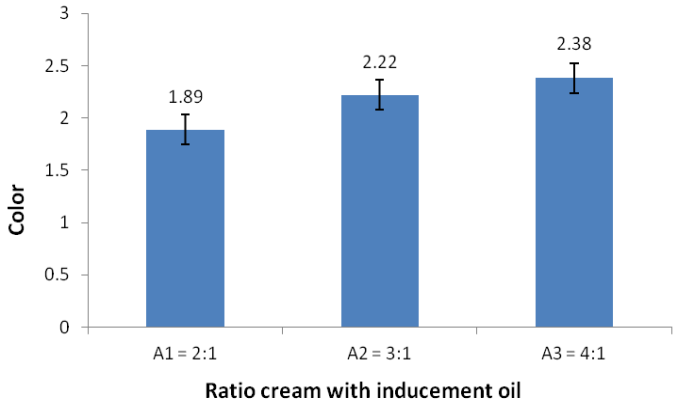
The main difference between VCO and commercial coconut oil is the smell and taste of the oil (taste). VCO has a unique aroma and taste while commercial coconut oil does not have any unique characteristics due to the refining process (Sutarmi and Rozaline, 2006).

The results of research conducted by Lisna and Purnama (2010) with a number of VCO processing procedures namely by the centrifugation (mechanical) method, fermentation and the gradual heating method show that the VCO processing process with the centrifugation method produces a distinctive VCO aroma, while the VCO aroma with the fermentation method and heating produces a slightly sour aroma and the aroma of cooking oil, namely the manufacture of VCO by the heating method.

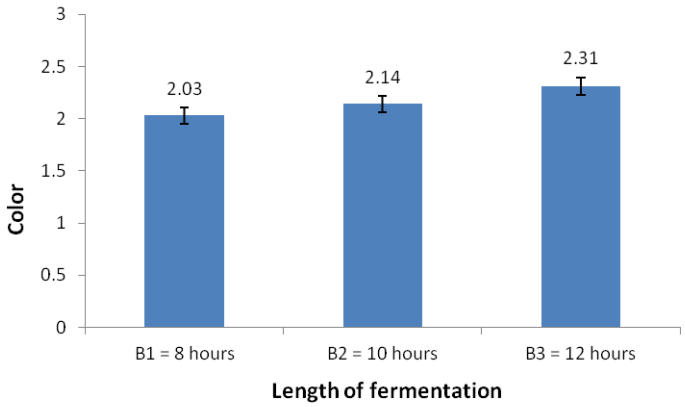
Color

The hedonic test results on the average VCO color ranged between 1.67–2.52 (clear) and an overall average of 2.16 (clear). Results of analysis of variance showed that the treatment of cream ratio with fishing oil and fermentation time had a very significant effect while the treatment of fermentation time and interaction between the two factors did not significantly affect the color of the VCO produced. The Least Significant Difference (BNT0.05) test results for the VCO oraganoleptic test can be seen in Figs. 9 and 10.

Figs. 9 and 10 show that the organoleptic value of the produced VCO color tends to be the same ie no color (clear) for all treatments. There is no significant color difference between the treatment of cream ratio with inducement oil and fermentation time. The color organoleptic results in this study have also fulfilled the SNI requirements that have been set namely colorless (clear) to pale yellow (BSN, 2008). According to Erika *et al.* (2014), good coconut



9: *Effect of cream ratio with inducement oil on organoleptic color of VCO*



10: *Effect of fermentation time on organoleptic color of VCO*

oil is a clear yellow with a good taste and smell, while rancid coconut oil is usually yellowish brown and has an unpleasant taste and odor.

The results of research conducted by Lisna and Purnama (2010) with a number of VCO processing procedures, namely by the centrifugation method (mechanical), fermentation and the gradual heating method show that the VCO processing process with the centrifugation method produces clear (clear) color on the VCO, while the VCO color with Fermentation and heating methods produce a yellowish color each and slightly turbid colors in the heating method. Lisna and Purnama (2010) add that the VCO color produced by the fermentation method is rather yellowish in color, this is probably caused by the brown husk of coconut flesh mixed with coconut meat when shredded so that it affects the final result of VCO. The turbid color of the VCO resulting from the process of processing with this gradual heating method might be caused because when heating the oil it is stirred continuously so that the oil is mixed with the blondo.

Physically, VCO must be clear, crystal-like. This indicates that the inside is not mixed with other materials and impurities. If there is still water in it, usually there will be white lumps. The existence of this water will speed up the rancid process. In addition, the lumps may also be a component of blondo (protein) which is not completely filtered. Contaminants like this will directly affect the quality of VCO (Setiaji and Prayugo, 2006).

CONCLUSION

Treatment cream ratio with inducement oil had a very significant effect on yield, organoleptic aroma, and color. The length of fermentation treatment had a very significant effect on yield, organolpetic aroma and color. The interaction between the two factors had a very significant effect on almost all parameters (water content, peroxide number, acid number, and iodic number) except the yield and organoleptic (aroma and color) which had no effect. The decreasing water content, peroxide number, acid number, iodic number, the better the quality of the VCO produced. The best VCO quality was obtained in the treatment of cream ratio with 2 : 1 inducement oil and 8 hours length of fermentation.

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