The Effect of Adding Bread Yeast, Tempeh Yeast, and Tape Yeast on The Process of Making VCO from Coconut

Alexander Maruli Tua Sinaga[a,1], Adi Permadi [a,2*], Endah Sulistiawati[a,3], Totok Eka Suharto [a,4]

[a] Department of Chemical Engineering, Faculty of Industrial Technology, Universitas Ahmad Dahlan, Jl. Jend. Ahmad Yani, Banguntapan, Bantul, Yogyakarta, Indonesia 55166
[1] 2108054014@webmail.uad.ac.id; [2] adi.permadi@che.uad.ac.id*; [3] endahsulistiawati@che.uad.ac.id
[4]totok.suharto@che.uad.ac.id
*corresponding author

ARTICLE INFO

Article history
Received January 22, 2024
Revised January 23, 2024
Accepted January 27, 2024

Keywords
Bread yeast,
Coconut oil,
Tape yeast,
Tempeh yeast
VCO

ABSTRACT

Coconut (*Cocos nucifera* L.) is one of Indonesia's agricultural products with potential. The most valuable coconut product is coconut oil, which can be obtained from the flesh of fresh coconuts or copra. Virgin Coconut Oil (VCO) or pure coconut oil is the result of processing from the coconut plant in the form of a clear liquid with a distinctive coconut smell and has a long shelf life. Pure coconut oil or VCO has many benefits for body health, such as natural antibacterial, antiviral, anti-fungal, and anti-protozoa properties. This study aims to compare the effect of Tempeh yeast, bread yeast, tape yeast, and without yeast on variations in the ratio of grated coconut and water are 1: 1; 1:1,5, and 1:2, on the amount of VCO produced. The experiment was carried out again and then the average volume of VCO produced by each yeast was taken. The average VCO results obtained ratio of 1:1 were 209.5 ml for adding bread yeast, 153.5 ml for not using yeast, and 150.5 ml for adding Tempeh yeast. Meanwhile, adding tape yeast produces the smallest yield of 89 ml. Based on the ratio of grated coconut and water (1 kg: 1 liter) the optimum yield is 1:1. While the minimum yield is 1:1,5 ratio. The most VCO obtained is by adding bread yeast to thick coconut milk in the second fermentation process. The order of highest yield based on the addition of yeast is bread yeast, tempeh yeast, and tape yeast. The yield of VCO yeast tempeh was slightly better than the yield without adding yeast. The organoleptic results and some of the VCO test results based on SNI 7783:2008 have fulfilled the specified requirements.

1. Introduction

Coconut oil is one of the processed coconut products that is in high demand; it accounts for around 10% of the global market's oil and fat requirements [1]. Meanwhile, virgin coconut oil (VCO) is defined as oil obtained from the meat of fresh old coconuts (Cocos Nucifera L.), processed by pressing with or without water, and heated to a maximum of 60°C. It is safe for consumption, according to Indonesian National Standards (SNI) 7381-2008 concerning VCO [2]. VCO contains around 66% oil, 6-7% protein, 48% water, 5% crude fiber, and ±2% ash. Virgin coconut oil contains fatty acids, sterols, vitamin E, and phenolic acid. These chemical components exhibit antioxidant activity in plant materials, food products, and biological systems.[3] VCO has numerous benefits, including antiviral, antibacterial, antifungal, and antiphrastic properties. It can also aid in the treatment of metabolic disorders, such as digestive issues, absorption of amino acids and soluble vitamins in fat, diabetes management, and improved blood circulation. VCO is commonly used in beauty treatments to retain skin suppleness. VCO is also utilized as a raw material in soap production [4]. When VCO is absorbed into the skin and the tissue cell structure, it helps to build connective tissue. In this way, VCO can minimize tissue damage caused by overexposure to sunlight [5].

Researchers are interested in VCO due to its potential health benefits, such as lowering the risk of cancer, preventing viral infections, boosting the immune system, maintaining soft and smooth skin, being cholesterol-free, and not contributing to obesity [6].VCO contains alkaloids and saponins, which are effective anti-inflammatory and antibacterial agents [7].

Five processes are used in the production of VCO: gradual heating, fishing methods oil, fermentation, enzymatic, centrifugation, and ultrasonic approaches. The microbe Saccharomyces cerevisiae, also known as Bread yeast, is used in the fermentation process to create VCO. The conditions of pH, temperature, energy source, and free water all affect the growth of bread yeast bacteria. At 30 ºC, Saccharomyces cerevisiae can grow to their maximum potential. The method of gradual heating involves heating coconut milk to a temperature below 90 ºC, and then returning the heated oil to a low temperature (below 65 ºC). Using a specific ratio, fishing oil is added to coconut milk to employ the oil fishing method. Whereas, to carry out the fermentation process, yeast is added to coconut milk [8][9]. The oil-protein linkages in the coconut milk emulsion phase can also be broken down with the aid of enzymes in the enzymatic technique. In this case, protein rather than fat is harmed. Inside-out protein protease enzymes are a class of protein enzymes that break down lipoprotein connections. Enzymes of the following kinds can be employed to dissolve inner lipoprotein bindings in fat emulsions: papain, bromelain, and protease enzyme. Centrifugal force was used to spin coconut milk in an attempt to disrupt the fat-protein linkages therein. Since oil has a lower specific gravity than water, centrifugation will force the two to separate on their own. 20,000 rpm was the rotational speed employed [10]. Meanwhile, the ultrasonic technique of producing VCO employs direct ultrasonic waves to break down the VCO and water emulsion, to increase yield and improve VCO quality[11].

The addition of yeast to coconut milk emulsion can also be accomplished by the activities of microorganisms that produce proteolytic enzymes, such as *Rhizopus Oligosporus*, which is present in tempeh yeast. Protease enzymes are hydrolases that can break down proteins into simpler molecules. A class of hydrolases known as proteases is capable of easily breaking down proteins into other molecules. Protease enzymes are used to break down the lipoprotein links that hold the proteins in coconut milk together. When these lipoproteins are destroyed, the oil that is held by the bonds breaks free and becomes one [12]. Coconut milk's lipoprotein linkages are broken down by protease enzymes, releasing the oil attached to them. This bacterium can create protease enzymes, which can degrade the protein bonds that surround the fat globules in coconut milk cream emulsions.[13] Adding bread yeast to VCO affects peroxide value, iodine value, acid number, percentage free fatty acid (FFA) or acid-free fat, and organoleptic test of VCO aroma. However, the substrate does not impact all VCO analyses.[14] Tape yeast can be used to make virgin coconut oil (VCO), which is produced by fermentation. The amount of tape yeast used to create the most virgin coconut oil (VCO) is 160.2 ml (yield 16.1%) [15]. The reason why yeast tape is utilized in VCO processing is because it contains microflora, such as yeast, which can produce lipase, which breaks up the coconut milk emulsion. Yeast tape is typically employed in tape production. Thus, chemical bond breakage will occur during the fermentation process [16]. Bread yeast contains Saccharomyces cerevisiae, which produces proteolytic and amylolytic enzymes when grown in an emulsion. Amylolytic enzymes degrade carbs to generate sour. The presence of acid lowers the pH of coconut milk until it reaches the protein's isoelectric point, causing it to coagulate. The coagulated proteins are then broken down by enzymes called proteolytics, and they may be easily removed from the oil [12].

Good quality VCO appears clear as crystal, does not smell rotten, and has a unique coconut flavor. This indicates that it is not blended with any other substances, such as water. The presence of water in oil can promote hydrolysis or oxidation events that produce a rotten odor. The hydrolysis reaction converts oil into free fatty acids and glycerol.[17] This research aims to determine the amount of VCO produced from variations in the use of yeast and the ratio between the weight of grated coconut and water. This fermentation method uses tape yeast, tempeh yeast, and bread yeast.

2. Research Methodology

Materials

The ingredients used in this research were grated coconut, water, Tempeh yeast, tape yeast, and bread yeast. The tools used in this research are a coconut milk filter, measure, basin, small filter, 2 kg plastic bag, plastic bottle, measuring cup, digital scale, and small straw.

Procedures

The process begins with obtaining grated coconut from the Giwangan market, which is then combined with warm water in specific weight ratios (w/w) of 1:1, 1:1.5, and 1:2. This mixture is kneaded and filtered to yield smooth coconut milk free of any impurities. Subsequently, the coconut milk is placed in a transparent plastic bag and allowed to sit for 3 hours. After this resting period, two distinct layers form: the upper layer consists of concentrated coconut milk, while the lower layer is primarily water. The concentrated coconut milk is carefully separated from the water. The concentrated coconut milk is then transferred to a new clear plastic bag, and 1.5 grams of yeast starter is added. Thoroughly stirring the mixture, it is left to ferment for 12 hours in a warm room.

After the fermentation period, the concentrated coconut milk is separated into four layers: residual water, sediment of coconut cream (blondo), Virgin Coconut Oil (VCO), and a floating sediment of coconut milk. To extract the VCO, a container is prepared, and the volume of the obtained VCO is measured. This meticulous process ensures the production of high-quality Virgin Coconut Oil with distinct layers for precise extraction.

Table 1. VCO quality requirements are based on SNI 7381:2008

No	Test type	Units	Requirement
1.	Condition :		
	1.1 Smell		Typical fresh coconut, not rancid
	1.2 Taste		Normal, typical coconut oil
	1.3 Color		Colorless to pale yellow
2.	Water and evaporated compounds	%	Max 0,2
3.	Iodine number	g iod/100 g	4,1 – 11,0
4.	Free Fatty Acid (calculated as lauric acid)	%	Max 0,2
5.	Peroxide number	mg ek/kg	Max 2,0

VCO Quality Testing According to SNI 7381-2008

Testing of VCO results was carried out at the Chemix Pratama Bantul Yogyakarta laboratory, where the samples were repeated once (duplo) and then averaged.

a. Organoleptic test

Color test

Analyze samples organoleptically using the sense of sight (eyes). VCO colors that fulfill SNI 7381:2008 specifications (table 1) range from colorless to pale yellow.

Smell test

Conduct organoleptic analysis of samples using the sense of smell (nose). The odor of the VCO sample meets the specifications outlined in SNI 7381:2008 for VCO odor requirements. It should smell normal, that is, typical for oil. Fresh coconut with no rancid scent.

Taste test

Perform organoleptic examination on samples using the sense of taste (tongue). The VCO samples meet the SNI 7381:2008 criterion for VCO taste, which requires a characteristic coconut oil flavor with no alien taste.

b. Water content

The weighing bottle is cooked in an internal oven at 105˚C for one hour. After cooling in a desiccator for ½ hour, record the weight. After adding 5 grams of pure coconut oil (VCO) to the bottle, weigh the result. Preheat oven to 105˚C for 1 hour, then chill in a desiccator for 30 minutes. Weigh the weighing bottle with the sample inside. Repeat heating and weighing until a consistent weight is achieved. Water content is represented as a percentage of weight per weight, calculated to two decimal places using the following formula:

$$Water\ content\ (\%) = \frac{w1-w2}{w1}\ x\ 100\%$$

Whereas :

w1 = sample weight

w2 = sample weight after drying

c. Iodine number

The determination of the iodine number through the Wijs technique involves a meticulous procedure requiring several reagents, such as chloroform or carbon tetrachloride, sodium solution, 0.1 N thiosulfate standard, 15% KI solution, starch indicator, and the crucial Wijs reagent. Employ a covered Erlenmeyer flask to collect samples weighing up to 0.5 grams. Initiate the process by adding 10 mL of chloroform and 25 mL of iodine-bromide reagent to the collected samples. Allow the mixture to stand undisturbed for 30 minutes in a darkened room. Following this incubation period, introduce 10 mL of 15% KI solution and proceed to titrate with 0.1 N $Na_2S_2O_3$ until the solution's color transforms into a vibrant yellow hue. To refine the determination, incorporate 3 drops of starch indicator and continue titrating until the blue color dissipates. The iodine number, indicative of grams absorbed per decimal, is then expressed using a formula as below:

$$Iod\ number = \frac{12{,}69\ x\ T\ x\ (V0 - V1)}{w}$$

Whereas :

T = Normality of sodium standard solutions thiosulfate 0.1 N

V0 = Volume of 0.1 N Na thiosulfate solution required for blank screening (ml)

V1 = Volume of 0.1 N Na thiosulfate solution required for sample titration (ml)

w = weight sample (gram)

d. Peroxide number

Accurately weigh a sample ranging from 0.3 to 5 grams. Dissolve the sample by vigorously shaking the Erlenmeyer flask with 10 mL of chloroform. Following this, introduce 15 mL of glacial acetic acid and 1 mL of a saturated potassium iodide solution. Seal the Erlenmeyer immediately and shake the mixture vigorously for 5 minutes in a dimly lit room at a temperature between 15-25°C. Conduct titration using a standardized sodium thiosulfate solution (0.02 N), employing starch solution as an indicator to detect the endpoint. It is essential to perform a blank determination for calibration. The peroxide number, expressing the concentration in milligrams of active oxygen per kilogram, is then reported based on the precise titration results. Calculated the number to two decimal places with the formula:

$$Peroxide\ number\ (mg/kg) = \frac{N\ x\ (V1 - V0)}{w} x\ 1000$$

Whereas:

V0= The volume of $Na_2S_2O_3$ is 0.02 N which is required for blank titration (mL)

V1= The volume of $Na_2S_2O_3$ is 0.02 N which is required for sample titration (mL)

N = Normality of $Na_2S_2O_3$

w = weight sample (gram)

e. Fe metal contamination

The sample is placed in 100 ml glass cups and shaken to ensure homogeneity. After that, 5 ml of nitric acid was added and heated in an electric heater until the solution was nearly dry. Add 50 ml of distilled water to this solution, then strain it through filter paper into a 100 ml measuring flask and fill to 100 ml with distilled water. Dilute to desired heavy metal concentrations (0.0 mg/l, 1.0 mg/l, 5.0 mg/l, 10.0 mg/l, 15.0 mg/l, and 20.0 mg/l). Heavy metal levels were detected using SSA at a wavelength of 283.3 nm [18].

3. Results and Discussion

1. Yield VCO

The most optimal yield was obtained with a 1:1 ratio of shredded coconut to water of 209.5 ml using Bread yeast (Table 2). Overall, bread yeast produces the highest output when compared to other yeasts or no yeast. In general, a 1:1 ratio of grated coconut to water results in greater VCO than other ratios. On average, tempeh yeast outperforms sans yeast by a small margin and tape yeast. The addition of tape yeast resulted in the lowest yield of 77 ml. The ratio of grated coconut to water has an optimum value at a ratio of 1:1 and a minimum value at a ratio of 1:1.5 in this study.

Table 2. Yield VCO with variations of yeast and grated coconut to water ratio.

The ratio of grated coconut to water	Experiment	Original	Tape yeast	Tempeh yeast	Bread yeast
	1	114	87	100	198
1: 1	2	193	91	201	221
	Average	153,5 ml	89	150,5	209,5
	1	130	57	145	111
1: 1,5	2	128	55	132	168
	Average	129	73	138,5	139,5
	1	130	68	155	143
1: 2	2	131	70	140	171
	Average	130,5	69	147,5	157
Average		137,6	77	136,5	168,6

2. Organoleptic Test Result

The VCO produced is clear in color, smells like coconut oil, and tastes bland (Figure 1). This meets the requirements for virgin coconut oil set by the Indonesian national standard. According to SNI 7381-2008, the standard VCO must be clear to pale yellow and smell like fresh coconut oil, not rancid. Based on Table 3, the results are presented organoleptic properties of odor in coconut oil. This is the typical smell of fresh coconut oil, not rancid. According to SNI 7381: 2008, scent VCO shall not be rancid and contain the aroma of coconut oil. This signifies that the odor of coconut oil already fits the criteria. The organoleptic results of the taste investigation match the standards of SNI 7381:2008, namely the usual taste of fresh coconut and not rancid.

Fig 1. Original VCO appearance and with the addition of yeast
(left to right: original, tempeh yeast, tape yeast, and bread yeast)

Table 3. Results of organoleptic testing of coconut oil

Parameter	Original	Tempehh yeast	Tape yeast	Bread yeast
Color	Clear white	Clear white	Clear white	Clear white
Smell	The distinctive smell of fresh coconut oil and no rancid smell	The distinctive smell of fresh coconut oil and no rancid smell	The distinctive smell of fresh coconut oil and no rancid smell	The distinctive smell of fresh coconut oil and no rancid smell
Taste	Typical taste of fresh coconut oil	Typical taste of fresh coconut oil	Typical taste of fresh coconut oil	Typical taste of fresh coconut oil

3. VCO Quality Testing Results According to SNI 7381-2008

Water content testing is done to determine oil resistance. Internal water content. Coconut oil (VCO) has a significant influence on quality. Oil with high water content typically has a short shelf life. The table displays the water content of coconut oil (VCO). The average water content of the VCO produced is 0.074%, meeting Indonesian National Standards (SNI) 7381: 2008 for oil quality criteria for pure coconut oil (VCO) of no more than 0.2%. VCO's high water content reduces its durability. Apart from that, the presence of water in VCO causes a hydrolysis process. If there is water in the oil, it will hydrolyze, resulting in free fatty acids and glycerol, which will turn the oil rancid [19].

Table 4. VCO Quality Testing Results

Parameter	Water content (%)	Iod number (g I_2/100g)	Peroxide number (mg ek/kg)	Fe metal contamination (mg/kg)
SNI Standar	Maximal 0,20	4,1 – 11,0	Maximal 2,0	Maximal 5,0
Original	0,092	0,3554	1,231 x 10^{-4}	1,342
Tempehh yeast	0,078	0,3456	8,49 x 10^{-3}	1,377

Tape yeast	0,062	0,3456	$8{,}67 \times 10^{-3}$	1,620
Bread yeast	0,062	0,3355	$8{,}81 \times 10^{-3}$	1,614

The results of water content, iod number, Peroxide number, and Fe metal contamination are shown in Table 4. The iodine number reveals how unsaturated the fatty acids in oils and fats are. Unsaturated fatty acids can bind iodine, forming saturated molecules. The amount of iodine attached reflects the number of double bonds found in the oil. When it combines with iodine, it forms a saturated molecule. The experiment yielded 3.455 mg/g of coconut oil iodine (VCO). These data show that the produced coconut oil has a lower value than the determined SNI. Heating or frying can cause the breaking of unsaturated bonds in oil to become saturated, lowering the iodine content.

The peroxide number analysis is used to evaluate how oxidized the oil is. Oil quality improves with a lower peroxide number, while a higher peroxide number leads to lower quality. The data obtained shows a peroxide number below 2,0 g iod/100g, which indicates a very low peroxide level. This means that the VCO produced is of very high quality and more difficult to oxidize.

According to the Fe content test findings, the four types of VCO were extremely low, with an average of 1.488 mg/l. This value fulfills SNI 7381:2008. Given the significance of the Fe element as an oxygen binder in the blood, the presence of Fe is required for VCO, which is used to treat a variety of disorders. However, it is important to note that if it exceeds the limit, it will undoubtedly become poison for the body.

4. Conclusion

According to the findings of the research, the highest yield of Virgin Coconut Oil (VCO) was obtained by adding bread yeast, Tempeh yeast, and tape yeast in order of size. The highest average VCO results obtained ratio of 1:1 were 209.5 ml for adding bread yeast, 153.5 ml for not using yeast, and 150.5 ml for adding Tempeh yeast. Meanwhile, adding tape yeast produces the smallest yield of 89 ml. Organoleptically, the VCO results met the standards of SNI 7381-08. The results of the quality test revealed that the water content (<0,20%), peroxide number (<2,0 mg ek/kg), and Fe metal contamination (<5,0 mg/kg) met SNI 7381-2008 standards. Meanwhile, the iodine number was beyond the established standard limits (4,1-11,0 g iod/100g). A small iodine number suggests a high level of saturation. The smaller the amount of iodine indicates the less unsaturated fatty acids.

Acknowledgment

The researcher would like to thank Ahmad Fatwa Zufar and Habibatunnisa for the coorporation during the research.

References

[1] M. Paputungan, “Optimasi Penggunaan Starter dengan Metode Pancingan dan Fermentasi Berbantuan Bakteri Saccharomyces cerevisiae untuk Optimalisasi Pemisahan Lemak, Protein dan Air pada Pembuatan VCO,” *Jambura J. Chem.*, vol. 3, no. 1, pp. 57–68, 2021, doi: 10.34312/jambchem.v3i1.10467.

[2] G. Ayu, D. Lestari, and K. D. Cahyadi, “Analisis Mutu Minyak Kelapa (Vco) Yang Diperoleh Dari Buah Kelapa (Cocos nucifera L.),” *Pros. Simp. Kesehat. Nasional*, vol. 2, no. 1, pp. 7–12, 2023.

[3] M. L. Pulung, R. Yogaswara, and F. R. D. N. Sianipa, “Potensi Antioksidan dan Antibakteri Virgin Coconut Oil Dari Tanaman Kelapa Asal Papua,” *Chem. Prog.*, vol. 9, no. 2, pp. 63–69, 2016, [Online]. Available: file:///C:/Users/nurdt/Downloads/gene,+6.+Maria+Ludya+Pulung+New.pdf

[4] N. P. P. M. S. Dewi, N. W. Bogoriani, and N. M. Suaniti, “Identifikasi Dan Karakterisasi Profil Asam Lemak Virgin Coconut Oil Dengan Penambahan Ekstrak Etanol Kunyit Putih (Curcuma zedoaria Rosc.),” *Chim. Nat. Acta*, vol. 7, no. 3, p. 125, 2019, doi: 10.24198/cna.v7.n3.26288.

[5] F. H. Amrullah, M. Arini, S. Dewi, and N. Komari, “SEL DARAH MERAH AKIBAT PAPARAN LAMPU UV SECARA IN VITRO THE INFLUENCE OF VIRGIN COCONUT OIL TO HEMOLISIS RED BLOOD Pengaruh Pemberian Minyak Kelapa … (Fitri Hadi A , dkk),” *Sains dan Terap. Kim.*, vol. 3, no. 2, pp. 154–163, 2009.

[6] F. P. K. Lim, L. F. G. Bongosia, N. B. N. Yao, and L. A. Santiago, “Cytotoxic activity of the phenolic extract of virgin coconut oil on human hepatocarcinoma cells (HepG2),” *Int. Food Res. J.*, vol. 21, no. 2, pp. 729–733, 2014.

[7] E. Kardinasari and A. Devriany, “Phytochemical identification of Bangka origin virgin green coconut oil: Anti-inflammatory and anti-bacterial potential,” *Enferm. Clin.*, vol. 30, pp. 171–174, 2020, doi: 10.1016/j.enfcli.2019.10.062.

[8] Laili Nailul Muna, “Metode Pembuatan Virgin Coconut Oil,” *Akfarindo*, vol. 2, no. 2, pp. 19–24, 2017.

[9] J. Pontoh, “Kualitas Virgin Coconut Oil Dari Beberapa Metode Pembuatan,” vol. 1, no. 1, pp. 60–65, 2008, doi: 10.35799/cp.1.1.2008.28.

[10] R. Rifdah, A. Melani, and A. A. R. Intelekta, “P Pembuatan Virgin Coconut Oil (Vco) Dengan Metode Enzimatis Menggunakan Sari Bonggol Nanas,” *J. Tek. Patra Akad.*, vol. 12, no. 02, pp. 18–25, 2021, doi: 10.52506/jtpa.v12i02.131.

[11] N. Fatwatun, K. Chusna, and B. Pramudono, “Pembuatan Virgin Coconut Oil (Vco) : Pemecahan Emulsi Dengan Metode Ultrasonik,” *J. Teknol. Kim. dan Ind.*, vol. 2, no. 4, pp. 184–188, 2013.

[12] Y. C.C. Kusuma, I. D. G. Mayun Permana, and P. Timur Ina, “Pengaruh Jenis Ragi dan Lama Fermentasi terhadap Karakteristik Virgin Coconut Oil (VCO),” *J. Ilmu dan Teknol. Pangan*, vol. 11, no. 1, p. 74, 2022, doi: 10.24843/itepa.2022.v11.i01.p08.

[13] V. H. Ramlan Silaban, Riza Sahala Mnullang, “Pembuatan Virgin Coconut Oil (VCO) Melalui Kombinasi Teknik Fermentasi dan Enzimatis Menggunakan Ekstrak Nenas,” *J. Kim.*, pp. 56–64, 2014, [Online]. Available: http://digilib.unimed.ac.id/11906/

[14] S. Fathurahmi and P. Hadi Siswanto, “Penambahan Ragi Roti Dan Lama Fermentasi Pada Proses Pengolahan Virgin Coconut Oil Addition of Baker Yeast and Fermentation Period in Virgin Coconut Oil Processing,” *J. Pengolah. Pangan*, vol. 5, no. 2, pp. 48–53, 2020.

[15] L. Abudu, K. Kamaruddin, and F. Hulopi, “Pemanfaatan Ragi Tape dalam Pembuatan Virgin Coconut Oil (VCO) Melalui Teknik Fermentasi,” *J. Agrohut*, vol. 11, no. 2, 2020, doi: 10.51135/agh.v11i2.126.

[16] M. L. P. Tanasale, “Aplikasi Starter Ragi Tape Terhadap Rendemen dan Mutu Virgin Coconut Oil (VCO),” *Ekosains*, vol. 2, no. 1, pp. 47–52, 2013, [Online]. Available: https://ejournal.unpatti.ac.id/ppr_iteminfo_lnk.php?id=420

[17] D. F. C. Negari and C. E. Lusiani, “Karakteristik Fisik Virgin Coconut Oil (Vco) Hasil Fermentasi Menggunakan Ragi Roti Selama < 24 Jam Dengan Konsentrasi Nutrisi Yeast 4% B/V,” *DISTILAT J. Teknol. Separasi*, vol. 8, no. 2, pp. 359–366, 2022, doi: 10.33795/distilat.v8i2.382.

[18] T. Rahayu, “Kualitas VCO Berdasarkan Kadar Protein, Kadar Air dan Logam Berat (Fe dan Pb) Berbagai Produk VCO (Virgin Coconut Oil) Quality,” *J. Penelit. Sains Teknol.*, vol. 7, no. 1, pp. 1–10, 2006.

[19] R.- -, “Studi Perbandingan Pembuatan Vco (Virgin Coconut Oil) Sistem Enzimatis Dan Pancingan Terhadap Karakteristik Minyak Kelapa Murni Yang Dihasilkan,” *Indones. J. Lab.*, vol. 2, no. 1, p. 25, 2020, doi: 10.22146/ijl.v2i1.54196.