MAKING VIRGIN COCONUT OIL (VCO) USING THE ENZYMATIC METHOD

Melanda Niuwa[1)], and Moh. Hadjrin Ma'ruf[2)]
[1,2,3)] University of Bina Mandiri Gorontalo
E-mail: melanniuwa@gmail.com

ABSTRACT

Virgin Coconut Oil (VCO) is one of the food sources of fat that is currently in great demand by people because of its health benefits, VCO has several advantages, namely high lauric acid content. Pure coconut oil contains ± 10% unsaturated fatty acids and ± 90% saturated fatty acids. The saturated fatty acid in VCO is lauric acid. Lauric acid is a medium chain fatty acid known as MCFA (Medium Chain Fatty Acid). Lauric acid and short chain saturated fatty acids can be beneficial for health to improve and moisturize skin conditions. This study aims to see how to make VCO by enzymatic method using papain enzyme from papaya fruit peel.

The method used is the enzymatic method using the papain enzyme of papaya fruit peel where the process of making VCO is enzymatically using the papain enzyme from papaya sap. Papain catalyzes a substrate through a hydrolysis reaction with the help of water molecules.

The results showed that there were three layers with the blondo layer and the oil being slightly mixed, which was caused by the ripe papaya skin, where the papain enzyme content was slightly reduced compared to the young papaya skin.

Keywords: VCO, Papain, Enzymatic

INTRODUCTION

The application of biotechnology has actually been going on for quite a long time, in human civilization; such as the production of antibiotics, fermentation, alcohol, food and waste treatment technology; all of which can be grouped into conventional biotechnology [6]. But why does it seem that biotechnology is only developing in the twentieth century? Because implicitly what is meant by biotechnology is modern biotechnology, which in essence is genetic engineering, with gene cloning techniques developed based on the discovery of the structure and function of DNA [21].

Coconut (coconut) is known by various names such as Nux indica, al djanz al kindi, ganzganz, nargil, narle, tenga, temuai and tree of life. Coconut fruit (Cocos nucifera) belongs to the family palmae of the genus Cocos. Coconut trees have an average height of 12.3 meters and from planting to fruiting until they are ready to be picked coconut trees take 12 months [28].

Coconut (Cocos nucifera lin) is a very important plantation commodity, because almost all parts of this plant can be utilized. In the nomenclature or systematic (taxonomy) coconut plants (Cocos nucifera) are classified as follows. [15].

1. Kingdom: Plantae (Plants)
2. Division: Spermatophyta (Seed plants)
3. Sub-Division: Angiosperms (Seeds closed)
4. Class: Monocotyledonae (one seed)
5. Order: Palmales

6. Family: Palmae
7. Genus: Cocos
8. Species: Cocos nucifera lin

There are two varieties of coconut plants, namely the typical variety (tall variety) and the early variety (dwarf variety) [20].

Coconut fruit consists of parts such as: [29].

1. Epicarp (Outer Shell), that is the outer skin that is green, yellow, or orange, the surface is smooth, slightly hard and 0.14 mm thick.
2. Mesocarp (Coir), that is, the middle part of the skin, called the fiber, consists of a fibrous section with a thickness of 35 mm.
3. Endocarp (shell), that is, the hard shell is 3.5 mm thick, the inside is attached to the skin outside the seed.
4. Testa (Fruit Flesh Skin), That is part of the yellow to brown.
5. Endosperm (Fruit), that is the white and soft part, often called coconut meat which is 8 10 . thick mm.
6. Coconut water, that is the part that tastes sweet, contains 4% minerals, 2% sugar, and water.
7. Institution, that will plant after the fruit is old.

Coconut trees are very beneficial for human life because almost all parts of the coconut can be utilized. Coconut fruit which consists of coir, shell, pulp and coconut water is not wasted and can be made to produce industrial products, including coconut husks, which can be made doormats, brooms, and mattresses. The shell can be used to make activated carbon and handicrafts. Coconut trunks can produce building materials both for the framework and for walls and roofs. Coconut leaves can be taken for the sticks that can be used as brooms, as well as woven items.

The flesh of the fruit can be used as raw material to produce copra, coconut oil, coconut cream, coconut milk and dry grated, while coconut water can be used to make vinegar and nata de coco. Coconut milk is a liquid obtained by squeezing the flesh of grated coconut. Coconut milk is a food ingredient that is used to process various dishes containing meat, fish, chicken, and for the manufacture of various cakes, ice cream, and confectionery. In addition, coconut also produces processed products that are popular in recent times, namely Virgin Coconut Oil (VCO) which is beneficial for human life [18].

Pure coconut oil has chemical-physical properties, among others [22]:

1. Appearance: colorless, needle-like crystals
2. Aroma: there is a slight sour smell plus the smell of caramel
3. Solubility: insoluble in water, but soluble in alcohol (1:1)
4. Specific Gravity: 0.883 at 20ºC
5. pH: not measured, because it is insoluble in water. However, because it is an acidic compound, it is certain to have a pH below 7.
6. Evaporation percentage: does not evaporate at 21ºC (0%)
7. Melting point: 20-25ºC
8. Boiling point: 225ºC
9. Air Density (Air = 1): 6.91
10. Steam pressure (mmHg): 1 at 121ºC
11. Evaporation rate (Butyric Acid = 1): unknown

Virgin Coconut Oil (VCO)

Virgin Coconut Oil (VCO) is a form of processed coconut flesh into oil, used as a medicine and believed to cure various degenerative diseases such as cancer, high blood pressure, cholesterol, heart disease and HIV/AIDS. The advantage of this oil lies in its high saturated fatty acid, which is about 90% which makes this oil the healthiest oil [19].

Pure coconut oil contains ± 10% unsaturated fatty acids and ± 90% saturated fatty acids. The saturated fatty acid in VCO is lauric acid. Lauric acid is a medium chain fatty acid known as MCFA (Medium Chain Fatty Acid). Lauric acid and short chain saturated fatty acids can be beneficial for health to improve and moisturize skin conditions. The fatty acid composition is presented in table 1 below [7] [12].

Tabel 1. Komposisi asam lemak minyakkelapa.

Asam lemak	Jumlah (%)
Asam lemak jenuh:	
Asam Kaproat ($C_5H_{11}COOH$)	0 – 0,8
Asam Kaprilat ($C_7H_{15}COOH$)	5,5 – 9,5
Asam Kaprat ($C_9H_{19}COOH$)	4,5 – 9,5
Asam Laurat ($C_{11}H_{23}COOH$)	44 – 52
Asam Palmitat ($C_{13}H_{27}COOH$)	7,5 – 10,5
Asam Stearat ($C_{17}H_{35}COOH$)	1 – 3
Asam Arachidat ($C_{19}H_{39}COOH$)	0 – 0,4
Asam lemak tak jenuh:	
Asam Palmitoleat ($C_{15}H_{29}COOH$)	0 – 1,3
Asam Oleat ($C_{17}H_{33}COOH$)	5 – 8
Asam Linoleat ($C_{17}H_{31}COOH$)	1,5 - 2,5

Sumber: Ketaren, 1986.

In the table above explained that oil is an ester of glycerol and fatty acids. The formation of triglycerides (oil) is generally a reaction between glycerol and fatty acids [12].

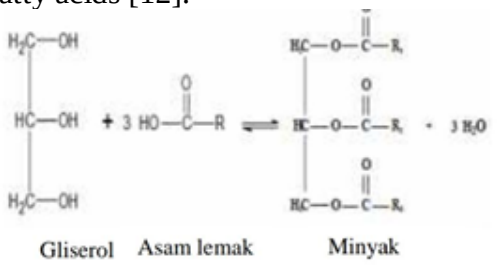

Figure 1. Chemical Reactions of Glycerol and Fatty Acids

The antioxidant content in VCO is very high such as tocopherol which functions to prevent premature aging and maintain body vitality [19]. In addition, VCO is also effective and safe to use as a moisturizer on the skin so that it can increase skin hydration and the abundant availability of VCO in Indonesia makes it potential to be developed as a carrier for drug preparations, including as a penetration enhancer and emollient [13].

Pure coconut oil (VCO) has many benefits, especially in the health sector, including:

1. It is a natural antibacterial, antiviral, antifungal and antiprotozoa
2. Helps relieve symptoms and reduce health risks associated with diabetes.
3. Helps protect against osteoporosis.
4. Helps prevent high blood pressure.
5. Helps prevent liver disease.
6. Maintain heart and blood vessel health.
7. Help prevent cancer.
8. Helps lose weight.
9. Maintain body stamina.
10. Maintain healthy skin and hair [18].

In addition, research and clinical trials have proven the efficacy and efficacy of VCO to cure various diseases and other healthy lives:

1. Provides a source of nutrition and energy.
2. Improve digestion and absorption of vitamins and amino acids that are slow in fat.
3. Helps protect the body from harmful free radicals that promote premature aging and degenerative diseases.
4. Improve the utilization of essential fatty acids and protect them from oxidation.
5. Relieves symptoms of chronic fatigue.
6. The calorie content is lower than other fats so that the maximum use effect for treatment is much better.
7. Supports the skin's chemical balance naturally.

8. Prevents damage caused by ultraviolet radiation on the skin.
9. Resistant to oxidation thus providing protection against over-oxidation [23].

The manufacture of coconut oil is by fishing the oil in coconut milk with coconut oil. This technology utilizes a simple chemical reaction, where coconut milk is a mixture of water and oil. These two compounds can unite due to the presence of protein molecules surrounding the oil molecules. With the fishing technique, the oil molecules in the coconut milk are pulled by the bait oil until they come together. That pull keeps the oil off the water and protein. The oil produced is coconut oil with high quality [24].

There are 2 types of damage that can damage the quality of VCO including:

1. Rancidity occurs when volatile taste and odor components are formed as a result of oxidative damage from unsaturated fats and oils. These components cause undesirable odors and tastes in fats and oils [19] [25].
2. Factors that accelerate oxidation can be divided into four classes, namely radiation, oxidizing agents, metal catalysts, especially salts of various heavy metals and oxidation systems [12].
3. Hydrolysis of oils and fats produces free fatty acids that can affect the taste and smell of the material. Hydrolysis can be caused by the presence of water in the fat or oil or due to enzyme activity [25].

One way to increase the yield of oil extracted from coconut cream can be done by adding an enzyme that can break down proteins that act as emulsifiers in coconut milk. The breakdown of coconut milk emulsion can occur in the presence of proteolytic enzymes. Papain enzyme is one of the proteolytic enzymes. This enzyme can catalyze protein breakdown reactions by hydrolyzing peptide bonds into simpler compounds [9].

Papaya plant (Carica papaya L.) is one of the fruit plants that are widely cultivated in Indonesia, because the papaya tree is easy to grow and the fruit contains many vitamins that are beneficial to humans. In addition to containing lots of vitamins, papaya fruit, stems and leaves also contain protease enzymes that can be used as decomposers or breakers of protein molecules [4].

Enzyme

Enzymes are organic catalysts produced by cells. Enzymes can speed up chemical reactions, while the enzymes themselves do not change. In simple terms, the enzymatic reaction can be written as:

E + S ES P

With: E = enzyme
S = substrate
P = Final Result
ES= substrate-enzyme temporary bond

The process of making VCO enzymatically uses the papain enzyme from papaya latex. Papain is a protease enzyme found in papaya latex. The enzyme is used for the perfect breakdown or breakdown of peptide bonds in proteins so that proteins break down into simpler peptide bonds because papain is able to catalyze hydrolysis reactions of a substrate [28].

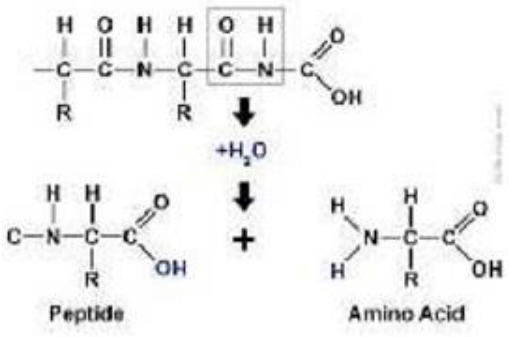

Figure 2. Molekular Formulas

Papain catalyzes a substrate through a hydrolysis reaction with the help of water molecules. Papain catalyzes a substrate through a hydrolysis reaction with the help of water molecules. Papain enzymes break lipoprotein bonds in fat emulsions. Protein absorbs water molecules with the help of enzymes, then the protein will be degraded into proteases, peptones and amino acids. This hydrolysis reaction makes the peptide bond in the protein can be broken so that the protein will be degraded into simple parts, namely the amino acid component and the carboxyl component, so that the oil bound by the bond will come out and agglomerate into one [14].

Protein breakdown causes the emulsion system to become unstable so that the oil can be separated from the emulsion system. So that three layers are formed, namely water in the lower layer, oil in the middle layer and clumps of protein in the upper layer [26].

Several factors that influence enzyme activity are:

1. Substrate levels and enzyme levels If the enzyme level is constant, while the substrate level is increased gradually, the increase in the substrate level will increase the reaction rate. The increase will decrease after the substrate level reaches a certain level.
2. Temperature The increase in temperature to an optimum will be followed by an increase in the reaction rate. Most enzymes are denatured at a temperature of 50 o-80 oC.
3. The influence of the degree of acidity (pH) Enzymes are proteins, therefore pH will affect the amino groups and carboxylic acids of protein enzymes. The optimum degree of acidity (pH) for different enzymes [27].

This study aims to see how to make VCO by enzymatic method using papain enzyme from papaya fruit peel.

RESEARCH METHODS

Research Time and Place

This research was carried out in the Microbiology laboratory of Bina Mandiri University, Gorontalo in the even semester of March 2020.

Tools and materials

The tools used in this research are:

1. jar,
2. Funnel,
3. Knife,
4. mixers,
5. Basin,
6. Filter,
7. Soup spoon,
8. cup,
9. Clear plastic bag, and
10. Small hose.

The materials used in this study include:

1. Coconut,
2. 0.5 kg cotton,
3. tissue,
4. Papaya fruit, and
5. Aquadest.

Experimental method

The working method used is the enzymatic method of papaya, are:

1. Peel the coir and skin from the coconut, then split the coconut and wash it with running water and drain.
2. Grate coconut meat.
3. Pour clean water into the grated coconut, stir until smooth while kneading so that the coconut milk comes out.
4. Strain and put into a large jar.
5. Grate the skin of the young papaya fruit, then put it in a blender, add enough water and then blend until smooth.
6. Mix the mashed young papaya skin into coconut milk in a ratio of 1:2 1 part mashed young papaya skin to two parts coconut milk.
7. Strain the mixture and put it in a clear jar and close it tightly.

8. Let stand for about 12 hours to form 3 layers.
9. Separate the oil layer, then filter it using a funnel that has been lined with cotton on the bottom and a tissue on top.

Organoleptic Test

Organoleptic test is a way to physically test the quality of food ingredients. Organoleptic is an assessment using the senses (physical) to determine the consumer's response to a product in this case is coconut oil [3]. Organoleptic tests were carried out to determine the color and odor of VCO oil produced based on the sense of smell (nose) and sense of sight (eyes).

RESEARCH RESULT

Making VCO

Making VCO is done by enzymatic method using papain enzyme. Papain is a protease enzyme found in papaya latex. These enzymes are used for the perfect breakdown or breakdown of peptide bonds in proteins so that proteins break down into simpler peptide bonds because papain is able to catalyze hydrolysis reactions of a substrate [8].

In this study, coconut samples were separated from coconut husks, cut into two and washed using running water. Washing using running water aims to clean the coconut fruit samples from dust and dirt caused by coconut husks and various adhering dirt, after that it is followed by grating and the coconut flesh is accommodated in a cleaned baking sheet. Then pour clean water into a pan with grated coconut while stirring with a spoon and then squeeze to get the coconut milk out. Take a sample of young papaya fruit and grate the skin using a grater before cutting the fruit into small pieces. Grate is done only until the skin layer is no longer attached to the papaya fruit flesh.,

Mixed coconut milk and grated papaya is easy to put into a jar with a ratio of 1: 2, with 1 part of young papaya skin and 2 parts of coconut milk. After that, the mixture was filtered and put into a medium-sized plastic water and allowed to stand for 12 hours to form 3 layers. The oil layer that has been formed is taken from the oil using a hose that is inserted by perforating the plastic in the part that contains the oil.

Table 2. Results of Making VCO

Layer			Picture
Upper layer	Middle Layer	Bottom Layer	
Blondo	VCO	Water	

Organoleptic Test

In the organoleptic test carried out, the oil produced from standing for 12 hours was separated and put into a small jar. In organoleptic testing, which was carried out by assessing the shoulder and the taste that emerged from the VCO oil, the color of the VCO oil was clean yellow with a slightly rancid shoulder, with this quality due to the quality of the formation of the oil which can be seen in table 1 is quite poor, which is indicated by blondo and oil that are still mixed and taking oil from the plastic so that blondo is not taken which is difficult to do so it is possible that the shoulder is rancid because of this.

Table 3. Organoleptic Test

Organoleptic Test	
Shoulder Test	Color Test
Slightly Rancid	Clean Yellow

DISCUSSION

Pure Coconut Oil or VCO (Virgin Coconut Oil) is processed from fresh coconut raw materials without going through a refining process, so the temperature used in the process iii is lower. In this study, Virgin Coconut Oil (VCO) was made using the enzymatic method using the papain enzyme contained in papaya fruit. In addition to using the enzymatic method, in general, VCO is made using the heating method. Where in this method must use drying or heating media. Oil drying can be done by controlled heating or using drying media. Drying using controlled heating is carried out so as not to reduce the distinctive aroma of the oil.

Then the enzymatic method is used to make VCO more economical. In the manufacture of VCO using enzymes from papaya fruit, namely papain. Papain is a protease enzyme that can break down proteins, so the addition of papain enzymes in the manufacture of VCO is expected to improve the quality of the resulting VCO because it contains more protein than VCO without papain enzymes added, because the papain enzyme is able to break the lipoprotein bonds of coconut milk emulsion, so that the more Many papain enzymes are used, with this the formation of oil will be more and more [11].

Papaya peel samples were used as a papaya peel extract as part of the enzyme used because the papaya skin contains much more papain enzymes, especially in young fruit skins.

Mixing coconut milk and grated young papaya which is put into a jar with a ratio of 1:2, with 1 part of young papaya skin and 2 parts of coconut milk and let stand for 12 hours and form 3 layers.

Obtained 3 layers in the form of a blondo layer on the top because it has a smaller mass compared to VCO oil and water which is in the middle and bottom. This separation occurs because the papain enzyme found in papaya can function as a protein network breaker, so that the oil will be extracted out. However, from the results obtained, the VCO layer is not completely separated from the blondo layer, which is indicated by the 2 parts that are still somewhat mixed. This may occur because the papaya fruit used is a little ripe where the papain enzyme content has begun to decrease or is not as thick as in the skin of the young papaya which was taken as a papain enzyme sample [16].

In the organoleptic test carried out where the oil produced from standing for 12 hours was separated and put into a small jar container. Here in organoleptic testing, the color of VCO oil is clean yellow with a slightly rancid shoulder. Quality VCO is not easily rancid because the content of saturated fatty acids is high so that the oxidation process is not easy to occur. A good VCO smells good, is clear and tastes acceptable, when you drink VCO you vomit because of rancidity, this rancidity occurs due to the oxidation process caused by the high water content in the VCO. In addition to the high water content, the remaining protein from the filtering process can also accelerate the rancidity of VCO if it exceeds the 0.5% threshold. At the bottom of the VCO bottle sometimes there are small, fine and white granules. This indicates that the protein precipitated due to imperfect filtration. The protein contained in VCO is a means for microbes to grow, causing rancidity in VCO [1][19].

To produce good quality Virgin Coconut Oil, it is necessary to consider various factors, including the age of the head, because the content and quality of virgin coconut oil is largely determined by the maturity level of the coconut. The maximum oil content of ± 60.3% will be obtained after 11-12 months of fertilization, and is characterized by a

blackish-brown shell, three holes where the plant will grow and black in the epidermis [5].

Fruit that is too old and in conditions that are starting to germinate is not recommended for pure coconut oil. Coconut fruit suitable for processing into VCO must be 12 months old [17].

The amount of oil formed is quite small, this is influenced by the short incubation period, which is only 12 hours when compared with previous research that the longer the incubation time of the papain enzyme in coconut milk cream, the more coconut oil volume produced until the incubation time is between 19 hours. until 21 hours, and after that it will tend to be constant [2].

CONCLUSION

VCO (Virgin Coconut Oil) is processed fresh coconut fruit into oil. In the manufacture of VCO with the enzymatic method, it is carried out using the help of enzymes to break down lipopoproteins contained in the fat emulsion in coconut. The results obtained from the manufacture of VCO oil which is still not completely separated from blondo and VCO oil are in the middle. This may be because the papaya fruit used is ripe enough, this causes the papain enzyme content in the papaya fruit to be too little to break down the protein network so that the oil does not separate perfectly.

In the organoleptic test, the VCO oil was clean yellow with a slightly rancid shoulder, rancidity was caused by the components of the shoulder and the taste was evaporated and oxidized, this caused the shoulder of virgin coconut oil to be quite rancid.

As a recommendation that in making VCO using the enzymatic method, it is better to use immature papaya fruit in order to obtain good papain enzymes.

REFERENCES

[1] Ahkam. 2005. Choice of clothes for the Virgin, Trubus. Volume 431. October.

[2] Andaka, G. Fitri, K. 2017. Extraction of Coconut Oil Using Papain Enzymes. Proceedings of the XII National Seminar "Industrial and Information Technology Engineering 2017. Yogyakarta National College of Technology.

[3] Aziz, Rosdiana. 2018. Quality Characteristics of Coconut Oil from Coconut Milk Processing and Cooking. Journal of Agritech Science. Vol. 2 No. 2. Gorontalo Polytechnic, Agricultural Product Technology Study Program.

[4] Baga, MK 2008. Papaya Planting XXV Edition. Self-Help Spreader. Jakarta.

[5] Barlina R., 2004, Easy Virgin Oil Production, Trubus 417-August 2004/XXXV.

[6] Bawalan, DD and Chapman, KR 2006. Virgin coconut oil production manual for micro- and village-scale processing. In FAO Regional Office for Asia and the Pacific. Thammada Press Co. Ltd., Bangkok, Thailand

[7] Fife, B., 2003. The Healing Miracles of Coconut Oil, 3rd Edition. Piccadilly Books Ltd. Accessed athttp://www.coconut-oil.compada.

[8] Muchtadi, D., SR Palupi, and M. Astawan, 1992. Enzymes in the Food Industry. Inter-University Center for Food and Nutrition. Bogor Agricultural University, Bogor. 118 p.

[9] Muhidin. 2001. Papain and Pectin. Self-help spreader, Jakarta.

[10] Goniwala, E. 2008. Virgin Coconut Oil Processing Techniques Using Tape Yeast. 13(2): 69-72.

[11] Iskandar, A., Ersan, and Edison, R., 2015, Effect of Papain Enzyme Dosage on the Yield and Quality of

Virgin Coconut Oil (VCO), Journal of Agro-Industrial Plantation, Vol. 3, No. 2, p. 82-93.
[12] Ketaren, S., 1986, Introduction to Food Oil and Fat Technology, UI Press, University of Indonesia, Jakarta.
[13] Lucida, Henny., Salman, M Sukma H. (2008). Penetration Enhancement Test of Virgin Coconut Oil (VCO) in Cream Base, Journal of Pharmaceutical Science and Technology, Vol., 13, No. 1.
[14] Onyeike, EN and Acheru, GN, 2002, Chemical Composition of Selected Nigerian Oil Seeds and Physicochemical Properties of the Oil Extracts, Food Chemistry, 77: 431-437. Setiadji B. 2004. Fishing Oil With Coconut Oil. TEMPO, July 18, 2004.
[15] Palungkun, R., 2004. Various Coconut Processed Products. Self-help spreader: Jakarta.
[16] Pelczar, Michael J., and Chan, ECS, 1986, 190-191, Fundamentals of Microbiology, University of Indonesia, UI-Press, Jakarta.
[17] Rindengan, B and Novarianto, H. 2004. Production and Utilization of Pure Coconut Oil. Independent Publisher. Jakarta.
[18] Suhardiyono, L, 1993, Cultivated Coconut Plants and Its Utilization, Yogyakarta: Kanisius
[19] Setiaji, Bambang., and Prayugo, Surip., (2006), Making High-Quality VCO, Independent Publisher Publisher, Jakarta.
[20] Setyamidjaja, D. 1995. Coconut Planting. Kanisius Publisher: Yogyakarta.
[21] Nurcahyo, Heru. 2011. Diktat Biotechnology. Biology education department. FMIPA. UNY.Yogyakarta.
[22] Setiwono, W. 2006. Healthy Lifestyle with Virgin Coconut Oil. Jakarta: PT. Index.
[23] Wise. 2007. Pharmacy. Yogyakarta: Gadjah Mada University Press, p. 39.
[24] Setiadji B. 2004. Oil Fishing With Coconut Oil. TEMPO, July 18, 2004.
[25] Adiono, Hari Purnomo. 1987. Food Science. Jakarta: UI-Press.
[26] Silaban, TF, Santoso, L., and Suparmono. 2012. In Improving Water Filter Work to Reduce Ammonia Concentration in Carp (Cyprinus carpio) rearing. Journal of Aquaculture Engineering and Technology 1: 47-56.
[27] Joetono, Soedarsono, S., Hartadi, S., Kabirun, S., Darmosuwito, S., and Soesanto, 1975, Microbiology Practicum Guide for Higher Education, Ministry of Agriculture, Faculty of Agriculture UGM, Yogyakarta.
[28] Muchtadi, D., SR Palupi, and M. Astawan, 1992. Enzymes in the Food Industry. Inter-University Center for Food and Nutrition. Bogor Agricultural University, Bogor. 118 p.
[29] Wahyuni, Mita Ir., 2000, Kopyor Coconut Planting, Self-Help Spreader, Jakarta.