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Utilization of Unripened Coconut Waste as An Organic Fertilizer and Its Quality Testing

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Abstract

The aim of this study was to create and evaluate the quality of organic fertilizer using Unripened coconut waste. The process involves chopping the waste into small pieces and placing it in a container or bucket. EM4 activator liquid is then sprayed onto the waste, followed by the addition of molasses. This process is repeated for the second and subsequent batches. The prepared Unripened coconut waste is covered with black plastic to maintain anaerobic conditions and a temperature of no more than 60°C. The pile is turned multiple times to stabilize the temperature at ± 35-45°C. The first turning occurs after one week, followed by weekly turning for up to one month. The resulting fertilizer is dried through aeration, sieved, and tested for quality. The water content was determined using the distillation method, while total nitrogen was measured using the Kjeldahl method. Phosphorus was quantified using a UV-Vis Spectrophotometer, and potassium was analysed using AAS. The results indicate that Unripened coconut waste can be utilised as an organic fertiliser. The fertiliser is brown in colour, soft in texture, has an earthy smell, and a temperature of 28°C. The organic fertiliser contains 22.8% water, 0.833% nitrogen, 0.118% phosphorus, and 5.616% potassium. The produced organic fertilizer meets the specifications for fertilizer from organic waste based on nitrogen, phosphorus, and potassium content according to SNI 19-7030-2004.
Keywords: *Unripened coconut waste, organic fertilizer, nitrogen, phosphorus, potassium*

Abstrak

Tujuan dari penelitian ini adalah untuk membuat dan menguji kualitas pupuk organik dari limbah kelapa muda. Metode pembuatan pupuk organik dilakukan dengan cara memotong-motong limbah kelapa muda menjadi potongan-potongan kecil. Limbah kelapa muda tersebut kemudian dimasukkan ke dalam wadah/ember dan ditambahkan cairan aktivator EM_4 dengan cara disemprotkan dan ditambahkan tetes tebu. Kemudian lakukan proses kedua, ketiga, dan seterusnya. Limbah kelapa muda yang telah disiapkan ditutup dengan plastik hitam agar kondisi anaerobik dapat terjaga dan suhu terjaga tidak lebih dari 60°C. Pembalikan dilakukan berkali-kali agar suhu stabil ± 35-45°C. Pembalikan pertama dilakukan setelah 1 minggu. Pembalikan/pengadukan tumpukan dilakukan seminggu sekali hingga 1 bulan. Pupuk yang terbentuk dikeringkan dengan cara diangin-anginkan. Kemudian diayak dan diuji kualitasnya. Pengujian kadar air menggunakan metode destilasi, nitrogen total menggunakan metode Kjledahl, fosfor menggunakan Spektrofotometer UV-Vis, dan kalium menggunakan AAS. Hasil penelitian menunjukkan bahwa limbah kelapa muda dapat dijadikan pupuk organik yang berwarna coklat, bertekstur lembut, berbau tanah, dan bersuhu 28°C. Kandungan air, nitrogen, fosfor, dan kalium pada pupuk organik sebesar 22,8%, 0,833%, 0,118%, dan 5,616%. Pupuk organik yang dihasilkan memenuhi kriteria SNI 19-7030-2004 tentang spesifikasi pupuk dari sampah organik berdasarkan kandungan nitrogen, fosfor, dan kalium.
Kata Kunci: *limbah kelapa muda, pupuk organik, nitrogen, fosfor, kalium*

1. Introduction

The consumption of Unripened coconut is increasing day by day [1]. Increased consumption of Unripened coconut will result in an increased amount of waste [2]. During this time, Unripened coconut waste is just thrown away and used as rug places that are sunken. Along with the increase in Unripened coconut consumed, there is also more waste that has not been utilized by the community. This causes a buildup of waste in the environment [1]. The accumulation of garbage/waste has the potential to cause environmental pollution, namely the foul odor and dirt that occurs. A foul odor occurs due to the decomposition of organic material under anaerobic conditions. Organic materials decompose into NH_3 gas, sulfuric acid (H_2S), methane gas (CH_4), and simple compounds [3], [4], [5], [6], [7].

Unripened coconut waste has the potential to cause environmental pollution, it is necessary to handle experimental exploration of materials and processing techniques to explore the potential and increase the aesthetic value to be obtained based on the experimental exploration of materials and ways of making Unripened coconut waste to find out the potential and add aesthetic value according to the existing visual aspects and utilize Unripened coconut which contains elements needed by plants. The resulting product is a useful product from Unripened coconut waste [8], [9].

Unripened coconut waste is organic waste/material. So, it is important to develop or apply a technology to overcome this waste. The technology that needs to be developed is the technology of recycling waste into organic fertilizer which has high economic and environmental value. The technology of recycling organic waste into organic fertilizer is environmentally friendly because it aims to preserve the environment. The utilization of organic fertilizer has an important role in the economy and environment. The economic benefits are the use of organic fertilizers will reduce the use of inorganic fertilizers, make the environment more organic materials, increase microbial activity, and soil aggregation so that the soil is resistant to erosion hazards [8], [10].

Fertilizer making is the stage of decomposition of organic material using microorganisms. Organic fertilizer is made by adding organic material plus effective microorganisms (EM_4). The function of adding EM_4 is to accelerate the decomposition of organic matter, deodorize during decomposition, reduce pathogenic microorganisms, and increase the activity of good microorganisms [11]. Another function of EM_4 is to provide benefits so that microorganisms from soil and plants become diverse, soil health becomes good, and the process of growth and crop production increases [12]. These stages make organic matter can be made into organic fertilizer which has many macro and micronutrients needed by plants [11]. Macronutrients found in organic fertilizer are nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur. Micronutrients in organic fertilizer include boron, chlorine, iron, manganese, copper, zinc, and molybdenum [13].

Nitrogen nutrients have a role in preparing chlorophyll, enlargement, and division of apical meristem cells. This makes the plant grow taller and the number of leaves increases rapidly [14]. Phosphorus nutrients have an important role in the formation of proteins in seeds, and energy sources, and trigger root development in plants [15]. Potassium nutrients have an important function in the process of photosynthesis, transport of assimilation products, water, enzymes, minerals, and increased plant resistance to disease [16]. If deficient in phosphorus nutrients, plants will be stunted and dark green. Conversely, if nitrogen (N) nutrients are deficient, the leaves become old (dark brown) and die. If the plant lacks potassium nutrients, the leaves become old [17]. According to SNI 19-7030-2004 regarding the specifications of fertilizer from organic waste the minimum nitrogen (N) content is 0.40%, phosphorus (P) minimum of 0.10%, and potassium (K) minimum of 0.20% [18], [19].

The general objective of this research is to make organic fertilizer from Unripened coconut waste to handle it to become a useful product. The general objective can be achieved by answering the specific objectives, namely, 1) determining the water content, nutrients nitrogen (N), phosphorus (P), and potassium of Unripened coconut waste, 2) determining the water content, nutrients nitrogen (N), phosphorus (P), and potassium of organic fertilizer from Unripened coconut waste, 3) knowing the quality of organic fertilizer from Unripened coconut waste compared to SNI 19-7030-2004 concerning specifications for fertilizer from organic waste [20].

2. Material and Methods

The materials used for the study were Unripened coconut waste, organic fertilizer products, EM_4, water, molasses aquabides, sulphuric-salicylic acid, KH_2PO_4 (p.a), sodium thiosulphate pentahydrate ($Na_2S_2O_3 . 5H_2O$), kjeltabs, 40% NaOH solution, 1% H_3BO_3 solution, 1% PP indicator, Conway indicator, 0.05 N sulfuric acid (H_2SO_4) solution, molybdovanadate reagent, 0.5 mg/ml P_2O_5 standard solution, 70-72% $HClO_4$, 65% HNO_3, 1000 ppm potassium solution as standard, potassium suppressor solution, and toluene.

The tools used for the research were scales, black plastic, shovel, catch basin/bucket, sieve, 1L sprayer, thermometer, analytical balance, weighing paper, Kjeldahl flask, plastic spoon, Speed Digester K-425 for destruction, distillator, burette, measuring flask of various sizes, goblet, hot plate, watch glass, Whatman filter paper No. 40, funnel, Erlenmeyer. 40, funnel, Erlenmeyer, volume pipette, measuring pipette, Spectrophotometer, Atomic Absorption Spectrophotometer (Perkin Elmer, plastic container, boiling stone, aufhauser apparatus, condenser, and blender.

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Organic Fertilizer Production

Preparation of organic fertilizer from coconut waste as shown in **Figure 1**. Organic fertilizer is made by preparing a container (bucket). Unripened coconut waste is cut into small pieces. The small pieces are put into the container tub and added with EM_4 liquid that has been diluted by spraying it and then adding molasses as nutrients. The second, third, and so on layers are made in the same way. The organic materials that have been arranged are then covered using black plastic so that anaerobic conditions can be maintained.

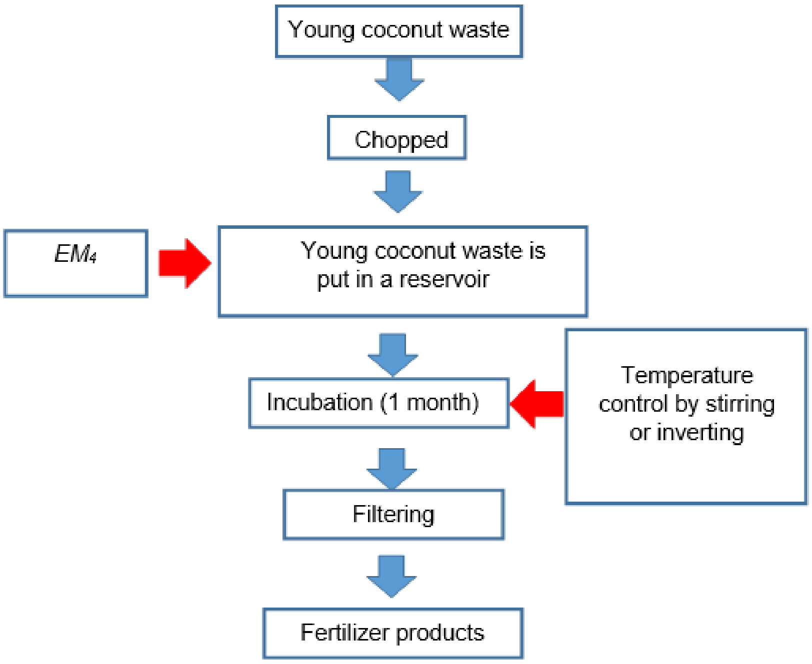

Fig. 1: Flowchart of Procedure for the Preparation of Organic Fertiliser from Unripened Coconut Waste

If anaerobic conditions cannot be maintained, there will be an increase in temperature in week 1 (first) so the temperature needs to be measured. If the temperature exceeds 60^0C, the mixture is turned over so that the position of the top layer becomes the bottom layer and then aerated for 5 minutes. The organic materials are rearranged into a pile and then covered again. This treatment is carried out repeatedly so that the temperature stabilizes between 35-45^0C. Turning/stirring the pile is done once a week for 1 month. The mature organic fertilizer is aerated so that the water content is low. Organic materials that have not decomposed are separated by sieving [11], [21].

Organic Fertilizer Sampling

Organic fertilizer is taken according to the number of lots or matches and the type of test to be carried out. Organic fertilizer is taken from several places throughout the layer randomly and weighs the same. Detailed sampling of organic fertilizer is shown in **Figure 2**.

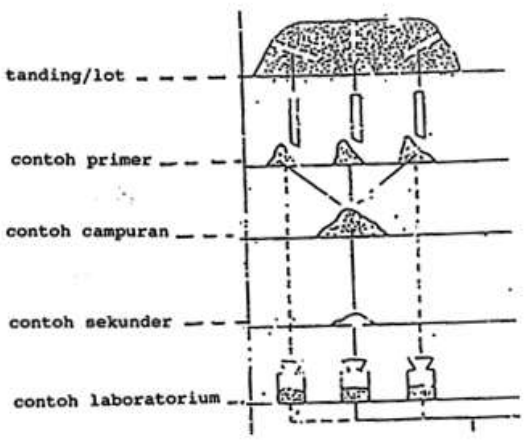

Fig. 2: Chart of Sampling Process of Organic Fertiliser from Unripened Coconut Waste

Organic fertilizer samples before being analyzed in the laboratory are mashed first with a blender. Organic fertilizer samples to be analyzed are wrapped so that they are protected during transportation and storage and labeled [13], [16].

Determination of Water Content

The organic fertilizer sample was weighed carefully as much as 5 grams, then put into a 500 ml Erlenmeyer. Toluene as much as 400 ml and boiling stones were added to the Erlenmeyer. Erlenmeyer was connected to an aufhauser device and then heated on a hot plate for 1 hour. Heating for 1 hour was calculated from the start of boiling. The hot plate was turned off and the aufhauser device could cool. The Liebig condenser (cooling device) was rinsed with toluene. The volume of water in the Aufhauser was read. The water content in the sample was calculated. [22], [23], [24]

The water content was calculated by the formula:

$$\% \text{ Content of water} = \frac{V}{W} \times 100 \%$$

description:

V = volume of water on the aufhauser scale (ml)

W = Sample weight (g)

100 = Conversion factor

Determination of Total Nitrogen (N)

A 0.5 g sample of organic fertilizer was carefully weighed and put into a Kjeldahl flask. Sulfuric-salicylic acid solution of 25 ml was added and then shaken until homogeneous. $Na_2S_2O_3.5H_2O$ in the amount of 4 g and 2 kjeltabs tablets were added to the Kjeldahl flask. The mixture was heated at low temperature until no bubbles were emitted. The heating temperature was increased gradually to a maximum of 300^0C for 2 hours and then allowed to cool. The solution in the Kjeldahl flask was diluted with aquabides, and then transferred to a 500 ml volumetric flask. After that, it was cooled and adjusted with aquabides until the limit mark. Measuring flask in gojog until evenly distributed. The solution was pipetted as much as 25 ml and put into the Kjeldahl flask. The solution was added 3 drops of 1% PP indicator. Kjeldahl flask is mounted on a distillation device.

The Erlenmeyer containing the distillation results containing 3 drops of Conway indicator is mounted on the distillation device. The tip of the cooler was set to be submerged in the collection solution. During distillation, 150 ml of aquabides will automatically enter the Kjeldahl flask and 20 ml of 1% boric acid (H_3BO_3) will enter the distillation collection Erlenmeyer. Distillation of the solution is carried out in an alkaline atmosphere with 40% NaOH added to the Kjeldahl flask until the solution is red. Distillation is stopped if the distillate reaches ± 100 ml. The 0.0525 N H_2SO_4 solution is used to titrate until the end point of the titration is reached, namely, the green color turns to the red jamb. The volume of 0.0525 N H_2SO_4 solution used is recorded. Then the test was carried out for the blank solution.

Nitrogen content (N) was calculated by the formula:

$$\% \text{ of total N} = \left(\frac{(V1 - V2) \times N \times 14{,}008 \times P \times 100}{W}\right) \times \left(\frac{100}{100 - KA}\right)$$

Information:

V_1 = volume of 0.05 N H_2SO_4 solution used for sample titration (ml)

V_2 = volume of 0.05 N H_2SO_4used for blank titration (ml)

N = Normality of 0.05 N H_2SO_4 solution used as titrant

14,008 = Nitrogen atomic weight

P = Dilution factor

100 = Conversion factor

W = Sample weight (mg)

KA = Water content (%).

[1], [2], [3]

Determination of Phosphorus (P) Contents

a. Preparation of sample solution

A 5 g sample of organic fertilizer was weighed carefully. The sample was placed in a 250 mL glass goblet. A 10 mL solution of 70% $HClO_4$ was added to the beaker. HNO_3 65% solution of 20 mL was added, then the glass cup was covered using a watch glass. The solution was slowly brought to a boil until colorless and white smoke appeared, then cooled. The solution was transferred to a 250 ml volumetric flask and adjusted with aquabides to the limit mark. The solution was stirred until homogeneous. The solution was filtered with Whatman No. 40 filter paper and then collected in a dry Erlenmeyer [1].

b. Phosphorus content determination procedure

50 ml of sample solution was pipetted into a 100 ml volumetric flask. 20 ml ammonium molybdovanadate reagent was added and diluted with distilled water to the limit. The mixture was stirred for 10 minutes. The same work was done on the blank solution. The spectrophotometer was optimized at a wavelength of 400 nm. The absorbance of the sample and standard solutions was read at a wavelength of 400 nm. A standard curve was prepared and the phosphorus (P) content in the samples was calculated.

Phosphorus (P) content was calculated by the formula:

$$\% \text{ Phosphor } = \left(\frac{C \times P}{W}\right) \times \left(\frac{100}{100 - KA}\right) \times 100\ \%$$

description:
C = mg P from standard curve reading
P = Dilution factor
W = Sample weight (mg)
KA = Water content (%); and
100 = Conversion factor
[1], [2]

Determination of Potassium (K) Content

a. Preparation of sample solution

A carefully weighed organic fertilizer sample of 5 g was placed in a 250 ml goblet. A solution of 70% $HClO_4$ as much as 10 ml and 65% HNO_3 as much as 20 ml was added, then covered with a watch glass. The solution was slowly brought to a boil until colorless and white smoke appeared, then cooled. The solution was transferred to a 250 ml volumetric flask and then added with aquabides to the mark. The solution was stirred until homogeneous. The solution was filtered using Whatman No. 40 paper and then collected in a dry Erlenmeyer.

b. Procedure for determination of Potassium content

2 ml of sample solution was pipetted into a 50 ml volumetric flask. 5 ml of suppressor solution was added, and then aquabides were added to the limit. The solution was stirred until homogeneous. Potassium content was determined by AAS at a wavelength of 766.5 nm.
Potassium content was calculated by the formula:

$$\% K = \left(\frac{C \times P \times 1{,}2046 \times 100}{W}\right) \times \left(\frac{100}{100 - KA}\right)$$

description:
C = mg K from standard curve reading (mg/l)
P = Dilution factor
1,2046 = K_2O conversion factor to K
100 = Conversion factor
W = Sample weight (mg)
KA = Water content (%)
[1], [2]

3. Results and Discussion

Making organic fertilizer from Unripened coconut waste

The results of making organic fertiliser from Unripened coconut waste and its properties as shown in **Figure 3** and **Table 1**.

Fig 3: Preparation of organic fertilizer from Unripened coconut waste

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Table 1. Properties of Organic Fertiliser from Unripened Coconut Waste

Criteria	SNI 19-7030-2004	Organic fertiliser
Colors	Blackish brown	Brown
Textures	Soft as soil	Soft as soil
Smells	The smell of soil	The smell of soil
Temperatures	$\leq 30^oC$	28^OC

Figure 3 shows that Unripened coconut waste can be made into organic fertilizer. **Table 1** shows that the properties of organic fertilizer from Unripened coconut waste are following SNI 19-7030-2004 standards according to the criteria of color, soft texture, temperature 280C, and smell-like soil [20].

Unripened coconut waste can be processed into organic fertilizer. This is because Unripened coconut waste is classified as organic material so that it can be processed into organic fertilizer [9], [11], [12]. Part of the Unripened coconut waste used for making organic fertilizer is coconut fiber. Coconut fiber contains nutrients such as phosphorus, calcium, magnesium, and carbon [25], [26], [27]. The content of these elements in waste becomes a source of bacterial growth for waste treatment [15], [19], [21].

The technology of making organic fertilizer cannot be separated from the composting process by adding a solution of microorganisms to spur the process of decomposing organic waste as raw material for making fertilizer (28). The solution of microorganisms as a decomposer to spur the composting stage is EM4 (29). EM4 contains fermented and synthetic microorganisms, namely lactic acid bacteria (Lactobacillus sp), photosynthetic bacteria (Rhodopseudomonas sp), Actinomycetes sp, and yeast [29], [30].

Decomposing microbes need food that contains high nutrients to fulfill their needs. One way to do this is by adding molasses. The content contained in molasses is a source of carbon and nitrogen for yeast. In addition, molasses also contains nutrients for Saccharomyces cerevisiae, a type of microbe that belongs to yeast [16], [17].

The stage of making organic fertilizer from Unripened coconut waste takes place anaerobically (in conditions that do not require oxygen) or by fermentation because it does not need sunlight [30]. Reactions under anaerobic conditions are:

Organic materials $\xrightarrow{\text{Bakteri anaerob}}$ CH_4 + Nutrients + Humus [4], [5]

The anaerobic fertilizer manufacturing process produces an unpleasant odor. In this process, organic acid compounds (acetic acid, butyric acid, valeric acid, putrescine), ammonia gas, and sulphuric acid are produced. Mature fertilizer is formed at a temperature of 26 - 27^oC on day 30. This temperature is the same as the soil temperature and by the requirements of mature fertilizer [31], [32].

Mature fertilizer smells like soil, as its material content is like that of soil. The color is blackish brown because the organic matter has stabilized. The final texture is not like the shape of fibers because it has been destroyed through natural decomposition by microbes in the material [4], [5], [6].

Quality Test Results of Unripened Coconut Waste and Organic Fertiliser

The quality test results of Unripened coconut waste and organic fertilizer from Unripened coconut waste are shown in **Table 2**.

Table 2. Quality test results of organic fertilizer from Unripened coconut waste

Criteria	Unripened coconut waste					Organic fertiliser					
	YCW 1	YCW 2	YCW 3	Total	Average	OF1	OF2	OF3	Total	Average	Quality standard (%)
Water content (%)	79,83	79,81	79,85	239,5	79,83	22,79	22,80	22,81	68,4	22,8	50
N content (%)	1,362	1,363	1,363	4,09	1.363	0,738	0,850	0,910	2,498	0,833	0,40
P content (%)	0,07	0,071	0,072	0,213	0,071	0,101	0,122	0,130	0,353	0,118	0,10
K content (%)	5,147	5,148	5,148	15,44	5,148	5,626	5,538	5,685	16,849	5,616	0,20

Description:
YCW: Unripened coconut waste
OF: Organic fertilizer

The water content is determined first because the water content will be used to calculate the correction factor. This correction factor will be used to calculate the nitrogen, phosphorus, and potassium content [1]. Water content criteria from Table 2 on coconut waste showed an average water content of 79.83% to 22.8% after becoming organic fertilizer. The water content decreases, due to the evaporation process when organic matter is turned into fertilizer by microbes and in the process of turning the fertilizer raw materials. The reversal process is carried out so that the resulting fertilizer has less water content. Moisture plays an important role in microbial metabolism and oxygen addition. If the raw material is too moist, it will cause the fertilizer production process to take longer [4].

Table 2 also shows that as the time for making fertilizer increases, the nitrogen content decreases. This is because as the time for making fertilizer increases, nitrogen nutrients will be lost in the form of NH3 which evaporates into the air. After all, it is in the form of gas. The reduction in nitrogen content is also because of cell metabolism. This will cause nitrogen to be assimilated and volatilized/lost to evaporate in the form of ammonia [4], [7].

Nitrogen content will affect phosphorus content. The higher nitrogen content causes the multiplication of microbes that break down phosphorus nutrients to increase so that the phosphorus content will also increase [1], [7]. The increase in phosphorus nutrients is due to the mineralization process by microbes in the formation of phosphorus nutrients. At this stage, microbes have an important role in the formation of phosphorus nutrients. Organic phosphorus compounds are converted and mineralized into phosphorus nutrients [8], [9]. The increase in phosphorus content is also due to the increasing volume of EM4 added. So, the number of microorganisms that decompose organic material will increase, resulting in mineral phosphate produced from the metabolic process of microorganisms will also increase [10], [11], [12].

Organic fertilizer from Unripened coconut waste meets the criteria required in SNI 19-7030-2004 on fertilizer specifications based on nitrogen, phosphorus, and potassium nutrient criteria. The water content will affect the length of time for composting or decomposition of organic materials in the fertilizer base material. Water content is related to the availability of oxygen for micro-organism activity. If the water content of the material is ± 40-60.5%, the decomposing microbes will work optimally. The water content of the raw material is around 79.83%, so the decomposing microbes cannot work optimally to break down the organic matter in the fertilizer raw material. If the humidity is greater than 60%, the air volume will decrease, so that the activity of microorganisms will decrease and a bad smell will appear [7], [8], [9].

Microbes that dissolve phosphate generally also dissolve potassium nutrients in organic matter [7], [8]. The increase in potassium content is also caused by the activity of microorganisms that decompose organic matter. Active microbes will affect the increase in potassium nutrient content [6], [7]. Potassium nutrients can be bound and stored in cells by fungi and bacteria. The more volume of EM4 added, the more microorganisms in the degradation process which results in carbon chains being broken into simple carbon chains. The disconnection of the carbon chain causes phosphorus and potassium nutrients to increase. Potassium is a nutrient obtained from bacterial metabolism that uses unbound K+ ions in the fertilizer for metabolism. From the results of fermentation, potassium will increase proportionally to the number of bacteria in the raw material for making organic fertilizer [1], [7], [9].

4. Conclusion

This research concludes that Unripened coconut waste can be made into organic fertilizer which is brown in color, soft in texture, smells like soil, and has a temperature of 28OC. The content of water, nitrogen, phosphorus, and potassium in Unripened coconut waste is 79.83%, 1.363%, 0.071%, and 5.148%. The organic fertilizer's water, nitrogen, phosphorus, and potassium contents were 22.8%, 0.833%, 0.118%, and 5.616%. The results of making organic fertilizer meet the criteria of SNI 19-7030-2004 concerning specifications for fertilizer from organic waste based on the criteria of nitrogen (N), phosphorus (P), and potassium (K).

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