© 2019 IJSRSET | Volume 6 | Issue 3 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section : Engineering and Technology
DOI : https://doi.org/10.32628/IJSRSET196328

Manufacture and Characterization of Biofoam Based On Composite of Taro Leaves Powder Reinforced Polyvinyl Acetate

Arini Ulfah M.R, Syahrul Humaidi, Kurnia Sembiring
Department of Physics, Universitas of Sumatera Utara, Medan, Sumatera Utara, Indonesia

ABSTRACT

Biofoam material has been made for application of styrofoam substitute food packaging material from a mixture of raw materials: taro leaf powder and PVAc through a hot compaction method with variations of the composition of taro leaf powder: PVAc (80:20)% wt, (75:25)% wt, (70 : 30)% wt, (65:35) wt%, (60:40) wt%, (55:45)% wt, (50:50)% wt and (45:50)% wt. The first stage of taro leaves was blended and sifted with 100 mesh particle size. The second stage of the leaf powder of taro mixed with wet mixing was then mixed with PVAc as a matrix. The third stage of the homogeneous mixture was then put into the mold then compressed by heat to make it more dense with a pressure of 100 MPa and held for 10 minutes at 60 ^{o}C. Each biofoam sample that is ready to be characterized includes: physical properties (density, water absorption, functional groups and biodegredability), mechanical properties (tensile strength, elastic modulus, and elongation) and thermal properties (melting points). The characterization results showed that taro leaf powder: the optimum PVAc was (45: 55) wt% with a density value of 0.744 x 10^3 kg/m^3, water absorption capacity of 1.765%, composed of OH and CH groups of PVAc and cellulose and C = C groups of lignin so that it has degrading properties of 91.2% for 50 days. Mechanical properties with tensile strength of 0.357 MPa, elastic modulus of 1.449 MPa, and elongation of 246.416%. Thermal properties with a melting point of 350.21 ^{o}C whose results have met the standards of conventional brand Synbra Technology. The results of biofoam material based on composite taro leaves and PVAc can be applied as food packaging.

Keywords: *Biofoam Materials, Polyvinyl Acetate, Taro Leaf Powder*

I. INTRODUCTION

Today styrofoam is a synthetic polymer from petrochemical with a type of polystyrene whose raw materials come from petroleum products. Even though the raw material from th packaging includes non renewableresources, the production is currently limited. . The use of Styrofoam as a food packaging material in daily life is quite high. This happens because of the characteristics of styrofoam which are easy to form, lightweight, inexpensive, waterproof, and also heat resistant. The content in styrofoam for packaging food has an adverse effect on human health, this is due to chemicals contained in styrofoam into food consumed by humans.

Given the magnitude of the adverse effects caused by the use of styrofoam, efforts must be made to look for other alternativ packaging materials that are more environmentally friendly and not harmful to human health in addition to conducting 3R activities, namely reuse, reduce and recycle existing styrofoam packaging. Many studies have been carried out by utilizing various biological sources such as plants, animals or microbes. The material that has the potential to be used as raw material for biopolymers is agricultural products or wastes such as starch and cellulose for reasons that are renewable, abundant and inexpensive (Iriani, 2012).

In general, the selection of raw materials for the manufacture of biofoam weighs in terms of physical and mechanical properties of biofoam which are not much different from commercial styrofoam. Research on modification in biofoam raw materials has become an interesting theme of research objects to be developed as a solution to overcome the use of styrofoam which has an impact on health.

Pamilia Coniwanti, et al (2018) conducted a study on the effect of NaOH concentration and ratio of pineapple leaf and sugarcane fiber on biofoam making obtained the best characteristics of biofoam with 5% NaOH concentration and the ratio of pineapple leaf fiber and sugarcane pulp 75:25 to have a percentage tensile strength of 16.35%,compressive strength of 3.70%, water absorption capacity of 15.60%, moisture content of 6.90%, and biodegradable properties of 4.49%.In this study, a biofoam was made from the raw material of taro leaves reinforced with PVAc (Polyvinyl Acetate) using conventional heat press printing techniques.

Where taro leaves have lignicellulose content obtained from lignin substances of 27.95% which is water repellent and anti evaporation. Then it has a 76% holocellulose content, and 38% cellulose which makes the fiber has good mechanical properties with a density of 0.286 g / cm3 and is easily degredited and also has flovanoid content as an antibacterial (Qolby, 2016). While polyvinyl acetate as a matrix due to its density of 1150 kg / m3, the tensile strength of 65-79 MPa can increase the strength of the composite as biofoam. The mixture of taro leaves and PVAc fibers is expected to produce a biofoam which has good physical, mechanical and thermal properties which are almost the same as Styrofoam. Characterization tests for biofoam from taro leaves and PVAc include: physical properties (density, water absorption, and biodegredable properties), functional groups using Fourier Transform Infra Red (FTIR), mechanical properties (tensile strength, modulus of elasticity and elongation) and properties thermal with Differential Scanning Calorimetry (DSC). Biofoam is expected to have the advantage of styrofoam which is often used in the market that has carcinogenic properties, is toxic and is not easily decomposed (degredated).

II. METHODS AND MATERIAL

A. Research Equipment and Materials.

The equipment used in this study include, 100 mesh sieves, Digital Balance, Beaker Glass, Spatulas, Ovens, Mixers, Sample Molds, Hot Press Hydrolic, Sorong Term, Stopwatch, Blender, Ultimate Tensile Machine.

B. Research Variables

Research variables in the manufacture of biofoam materials include the composition of raw materials and characterization. Variations in the composition of raw materials are as follows:

Percentage of Biofoam Composition Based on Keladi Leaf Powder with PVAc Matrix as Food Packaging Material Application

Sample Code	Taro leaves Powder (%wt)	Polyvinyl Acetate (%wt)
A	80	20
B	75	25
C	70	30
D	65	35
E	60	40
F	55	45
G	50	50
H	45	55

As for the characterization of biofoam materials include: physical properties (density, water absorption, biodegredable and functional groups), mechanical properties (tensile strength, modulus of elasticity and elongation at break) and thermal properties (meltingpoint)

C. Research Procedure

Taro Leaf Powder preparation.

Selected taro leaves that are quite old in bright green, taro leaves are cleaned with running water and soaked taro leaves in water for 24 hours, dried taro leaves in the oven for 3 hours at 30 °C so that the lignin content and flavonoids are not lost (degeneration), Chopped taro leaves with random fiber size, Inserted chopped taro leaves into a blender and sifted with a size of 100 mesh.

.

D. How To make Biofoam

Weighed the base material as reinforcement, namely: taro leaf powder and PVAc with various compositions, dissolved PVAc adhesive with aquadest as much as 10% wt of PVAc mass and stirred evenly, mixed with taro leaf powder and PVAc with wet mixing while stirring with the mixer thickens (expands) for 30 minutes. After the material thickens and then poured into acrylic molds and then compacted at a pressure of 100 MPa at a temperature of 70 °C and held for 10 minutes, after being compacted, the biofoam sheet is removed and dried, characterized by characteristics physical (density, water absorption, biodegredable test and functional groups), mechanical properties (tensile strength, modulus of elasticity and elongation at break) and thermal properties (DSC).

III. RESULT AND DISCUSSION

Biofoam Material Based on Composite Keladi and Polyvinyl Acetate Leaves Powder (PVAc)

Biofoam based composites of taro leaf powder as filler and PVAc (polyvinyl acetate) as a matrix for the application of styrofoam substitute food packaging materials that have carcinogenic and toxic properties because they contain benzene and styrene compounds that have been successfully made using conventional printing techniques and heat presses mixed with methods wet mixing. Variations in the composition of taro leaves and polyvinyl acetate (PVAc) are made with a ratio of (80:20)% wt, (75:25)% wt, (70:30)% wt, (65:35)% wt, (60: 40)% wt, (55:45)% wt, (50:50)% wt and (45:50)% wt with a total mass of 10 grams which is compacted at a pressure of 100 MPa for 10 minutes at a temperature of 60oC. The characterization of biofoam material based on the composite of taro leaf powder and PVAc aims to see how the interaction between materials in forming biofoam on physical properties: density, water absorption, biodegredable and functional bonding groups, mechanical properties: tensile strength, elongation and modulus of elasticity and properties thermal includes the melting point with DSC (Differential Scanning Calorimetry).

1.Density

Density testing is carried out to measure the density of atoms making up a material that binds to one another or interacts between one atom and another with a measurement of the mass of each unit of material volume

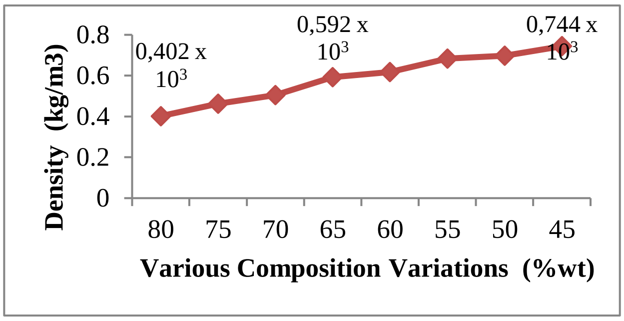


Figure 1 Test Results for Biofoam Density Based on Taro Leaves and PVAc in Various Composition Variations

shows that the density value increases in proportion to the addition of taro leaf powder composition. This is shown from the results of the research that the optimum biofoam conditions were obtained in the composition of keladi leaf powder: PVAc (45:55)% wt.

This composition is capable of producing a density of 0.744 x 103 kg / m3.However, thecondition of the less optimum variation occurred in the composition of taro leaf powder: PVAc (80:20)% wt with a density of 0.402 x 103 kg / m3. The results of testing the density of biofoam in this study have met the standard of conventional biofoam brand SynbraTechnology which is a density value of 0.66 x 103 kg / m3.

1. **Water Absorption**

Water absorption is the ability of a material to absorb water, which absorbs a very important role in making biofoam material for food packaging applications which has the purpose of knowing the optimum absorption capacity of the composite material

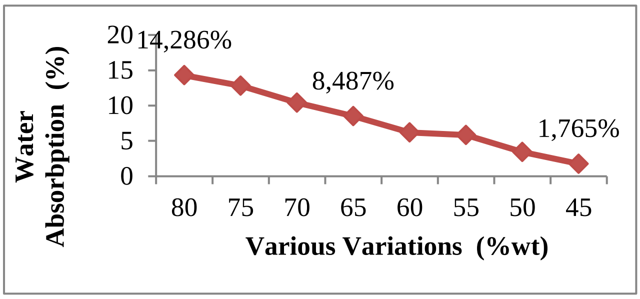


Figure 2 Results of Testing of Biofoam Water Absorption Based on Keladi Leaves and PVAc in Various Variations

the optimum value of biofoam water absorption occurs in the composition of keladi leaf powder: PVAc (45:55)% wt with a value of water absorption of 1.765%. Whereas poor water absorption on the composition of the composition of taro leaf powder: PVAc (80:20)% wt with the value of water absorption 14,286% is because the filler composition is so large that the biofoam composite bond between the PVAc matrix is imperfect resulting in the compacting process , the particles that make up biofoam are very weak due to the oxygen molecules entering and forming an empty space. The results of testing of biofoam water absorption in this study have been meets the standards of biofoam material for Synbra Technology's conventional biofoam with water absorption of <2%.

3.Biodegredeble

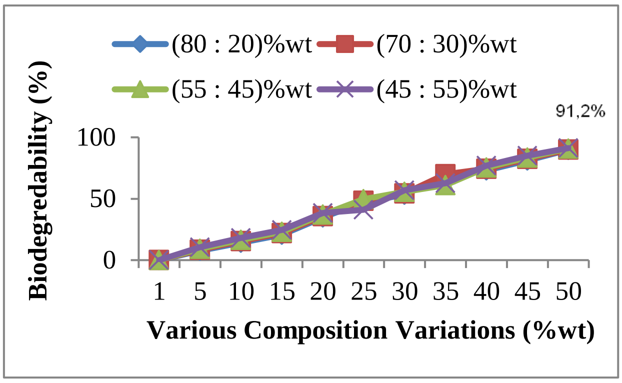


Figure 3 Biofoam Biodegradability Test Results Based on Taro Leaf Powder and PVAc

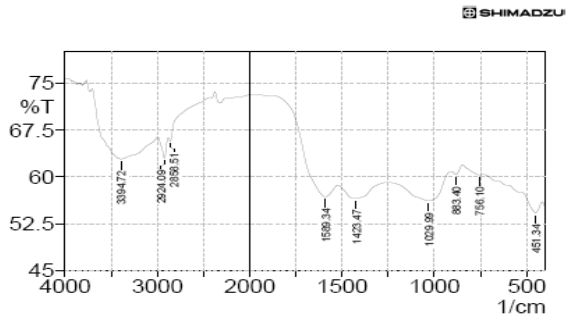
In Various Composition Variations

shows the relationship between the length of the burial time and the percent biodegradability rate of biofoam which refers to the Synof Technology biofoam standard which is declining for <6 weeks or 48 days. The results obtained for the biodegredability test buried in compost-type soil for 50 days showed the rate of biofoam degradation of certain compositions which produced a biodegredability interval of 89.8% - 91.2%

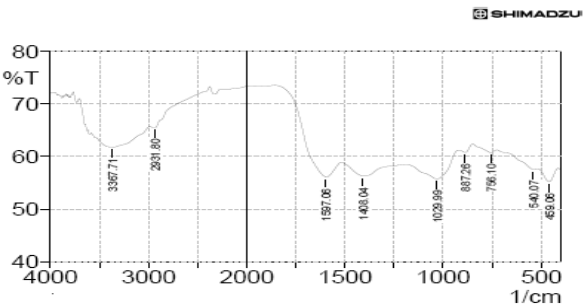
and fulfilled SNI requirements, namely achieving 90% biodegredability no more than 180 days.

4.FTIR (Fourier Transform Infra Red)

FTIR test using the Shimadzu type tool shows the vibrational peaks of certain wave numbers of materials used to make biofoam material based on the functional groups owned by each biofoam maker.



4 Analisis FTIR Material Biofoam Pada Variasi Komposisi 80%wt Serbuk Daun Keladi



Characterization of Mechanical Properties of Biofoam Based on Composite Leaves of Keladi and Polyvinyl Acetate (PVAc)

Tensile strength

Tensile strength is the ability of biofoam material to withstand the load or mechanical force given to the occurrence of damage or breakage where tensile strength testing uses Universal Testing Machine (UTM) with ASTM D 638. From the results of research carried out using

:

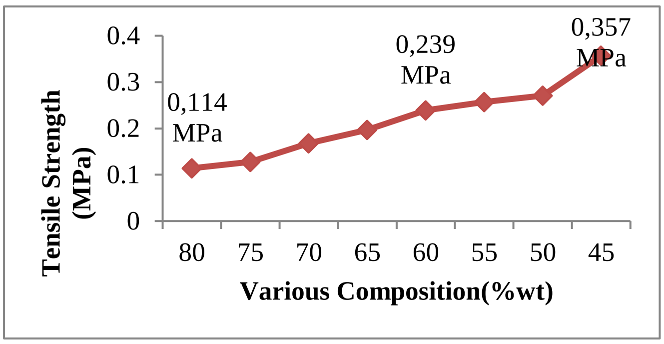


Figure 6 Test Results of Biofoam Tensile Strength Based on Leaves and PVAc at Various Variations in Composition,

From the results of the graph observation above shows that the tensile strength value increases in proportion to the decrease in the composition of taro leaf powder. This is shown from the results of the study that the optimum conditions obtained good tensile strength values in the composition of taro leaf powder: PVAc (45:55)% wt which is 0.357 MPa and less optimum conditions in the composition of taro leaf powder: PVAc (80:20)% wt with the tensile strength of 0.114 MPa with the conventional biofoam standard Synbra has a tensile strength of 300 kPa, equivalent to 0.3 MPa. The value of tensile strength increases when decreasing the filler mass of taro leaf powder. This is because in taro leaves powder contains lignocellulose (cellulose and lignin) which has a cluster free group hydroxyl (-OH) and carboxyl (-COOH) which form covalent bonds to achieve a bond between the surface of the PVAc matrix well between the biofoam composite composers

.

Modulus Young (*Modulus of Elasticity*)

The elastic modulus test is a test that aims to determine how resistant a biofoam material is to strain to elastic deformation when given vertically outside stress. Where the procedure for testing the modulus of elasticity refers to ASTM D 882-97 which is done using equation 2.6 to produce the following graphic form:

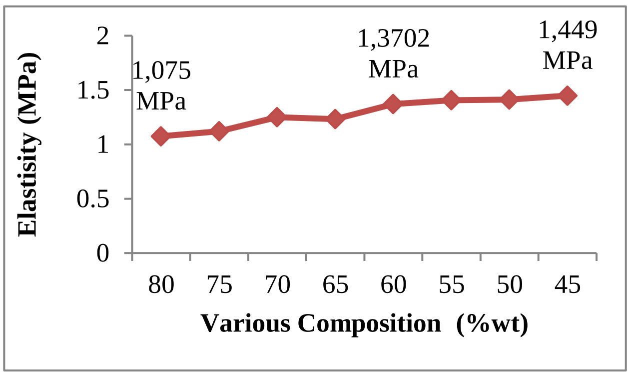
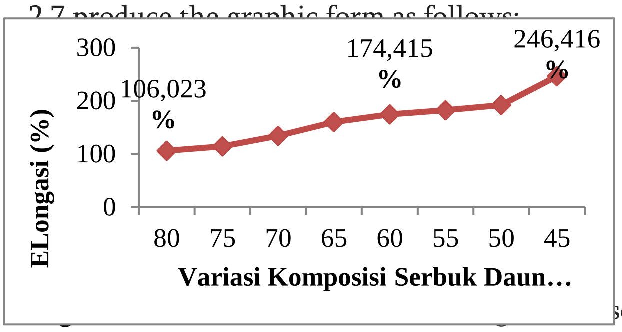


Figure 7 Elasticity Based on Keladi Leaves and PVAc in Various Composition Variations

showed that the optimum condition obtained a good modulus of elasticity in the composition of keladi leaf powder: PVAc (45:55)% wt ie 1.075 MPa and unfavorable conditions on the composition of taro leaf powder: PVAc (80:20)% wt with modulus of elasticity 1,449 MPa meets Synbra Technology's conventional biofoam standards, namely modulus of elasticity from 1.0 to 4.0

Elongation (*Elongation of Break*)

Elongatioin at break is a part of tensile strength testing, this test was carried out to find out how long the biofoam stretches after experiencing a withdrawal force before and after a breakdown. From the results of the research carried out using equation 2.7 produce the graphic form as follows:



sed on Keladi Leaves and PVAc in Various Composition Variations

From the results of the observations of the graph above, it shows that the value of breakup increases in proportion to the decrease in the composition of taro leaf powder filler. This is shown from the results of the study that the optimum conditions obtained optimum breakdown value in the composition of keladi leaf powder: PVAc (45:55) wt% which is 246.416% and less optimum conditions on the composition of taro leaf powder: PVAc (80:20)% wt produce the breakout was 106.023% which met Synbra Technology's biofoam with an elongation of 200%.

due to changes and chemical reactions followed by changes in temperature in the test sample. Chemical reactions that occur in DSC devices are exothermic and endothermic reactions.

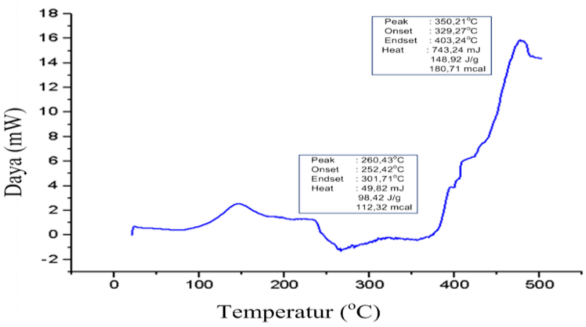


Figure 9 : Thermal Analysis (DSC) of Biofoam Materials in Composition Variations of 80% wt.

Taro Leaves Powder Based on the results of DSC testing, it can be seen in Figure 9 showing the results of 80% thermal properties analysis of biofoam taro leaf powder displayed by the first maximum peak for the thermal change process of biofoam material beginning at 252.42 ° C - 301.71 ° C producing the valley peak informs the crystallization point (Tc) where the polymer is crystalline at a temperature of 260.43 ° C then an endothermic process occurs where the composition of the biofoam material begins to absorb heat from the heat energy of 98.42 J / g. In the endothermic process the biofoam material undergoes a change in shape (deformation) of rubber at the glass transition point (Tg) of 301.71 oC. After that, the highest maximum peak was formed at a temperature of 329.27 °C - 403.24 °C where at the temperature of the biofoam material has undergone an exothermic process in which the material begins to emit as much heat.

148,92 J / g so that there are physical and chemical changes with a melting point of 350.21 °C

IV. CONCLUSION AND SUGGESTIONS

In the research obtained biofoam material for the application of composite-based styrofoam food packaging, taro leaf powder and polyvinyl acetate (PVAc) produced the optimum composition, namely variations in taro leaf powder composition: PVAc (45: 55)% wt has good physical properties with a density value of 0.744 x 103 kg / m3, and water absorption 1.765% ,. Mechanical properties with tensile strength of 0.357 MPa, elastic modulus of 1.449 MPa and breakdown (elongation) 246.416%. Thermal properties with a melting point of 390.24 oC whose results have met the standards of conventional brand Synbra Technology.

The variation of the composition of taro leaves and PVAc which is optimum in composition (45:55)% wt which has good biodegredability with a degradation rate of 91.2% for 50 physical days, due to the presence of lignocellulose compounds with active hydroxyl groups, carbonyl and CH Alkyne at wave number 3367.71 cm-1, 2931.80 cm-1, and 1408.04 cm-1 which has been proven and tested by FTIR (Fourier Transform Infra Red).

V. SUGGESTION

Make biofoam based on taro leaf nanocellulose in order to have physical, mechanical and thermal strength which was superior to biofoam which only measured macroparticles.

VI. REFERENCES

[1]. Coniwanti, P Roosdiana, & Mu'in 2018. Pengaruh Konsentrasi NaOH Serta Rasio Serat Daun Nanas Dan Ampas Tebu Pada Pembuatan Biofoam. Jurnal Teknik Kimia, vol 24, no 1, hlm 1 – 7.

[2]. Iriani, E 2013. Pengembangan Produk Biodegradable Foam Berbahan Baku Campuran Tapioka Dan Ampok. Disertasi. Institut Pertanian Bogor

[3]. Kartin, E & Fahrul, N 2012. Karakteristika Dan Khasiat Daun Keladi Tikus (Typhonium Divaricatum (L) Decne) Iradiasi Issn 1907 0322. Jurnal Ilmiah Aplikasi Isotop Dan Radiasi, vol 8, no 1, hlm 31 - 42.

[4]. Khairuna, 2018 Pemanfaatan Batang Genjer (Limnocharis Flava) Dan Batang Talas (Colocasia Esculenta) Dalam Pembuatan Kertas Dengan Menggunakan Naoh Dan Cao Klorofil. issn 2598-6015, vol. 1, no. 2, hlm 56 – 63.

[5]. Listiyaningsih, D 2013 Pembuatan Dan Karakterisasi Biofoam Pati Gembili-Kitosan Dengan Plasticizer Polivinil Alkohol (PVA). Skripsi. UNS.

[6]. Qolby, E 2016. Kandungan Serat Kasar Dan Protein Kasar Pada Daun Talas (Colocasia Esculenta) Yang Difermentasi Dengan Trichoderma Viride DanBacillus Subtilis Sebagai Bahan Pakan Alternatif Ikan. Media Journal Of Aquaculture And Fish Health, vol 1, no. 3, hlm 1 – 8.

[7]. Obradovic, J & Mikko, V 2017, Cellulose Fibre-Reinforced Biofoam For Structural Applications, Journal Of Material. 10(169) pp.10

[8]. Rahmatunisha, R 2015. Pengaruh Penambahan Nanopartikel ZnO Dan Etilen Glikol Pada Sifat Fungsional Kemasan Biodegradable Foam Dari Tapioka Dan Ampok Jagung, Thesis. Institut Pertanian Bogor

[9]. Saleh, E & Muhammad, A 2014. Penentuan Kondisi Terbaik Pembuatan Biofoam Dari Limbah Pertanian Lokal Maluku Utara. Prosiding Sains Dan Teknologi Material. issn 2407 – 1846, hlm 1 – 4.

[10]. Taufiqirraman, A 2014. Modifikasi Asam Ampas Sagu Dan Pengaruhnya Terhadap Sifat Fisik Mekanik Biofoam. Skripsi. Institut Pertanian Bogor.

[11]. Wijaya, B Gayatri, C & Frenly, W 2016. Potensi Ekstrak Etanol Tangkai Daun Talas (Colocasia Esculenta) Sebagai Alternatif Obat Luka Pada Kulit Kelinci (Oryctolagus

Cuniculus). Jurnal Ilmiah Farmasi. vol. 3, no. 3, issn 2302 – 2493, hlm 211 – 219.

Cite this article as :

Arini Ulfah M.R, Syahrul Humaidi, Kurnia Sembiring, "Manufacture and Characterization of Biofoam Based On Composite of Taro Leaves Powder Reinforced Polyvinyl Acetate", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 6 Issue 3, pp. 141-148, May-June 2019. Available at doi : https://doi.org/10.32628/IJSRSET196328
Journal URL : http://ijsrset.com/IJSRSET196328