Bacterial Cellulose from Fermented Banana Peels (*Musa paradisiaca*) by *Acetobacter xylinum* as Matrix Of Biocellulose Mask

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Abstract

Banana peels contain high carbohydrates that can be utilized for the fermentation process of bacterial cellulose. Bacterial cellulose can be used as a matrix of face masks because it is safe to use, has a low toxicity and biodegradable. The purpose of this research is to know how to obtain the bacterial cellulose from various fruit skins of bananas (raja, ambon and nangka) and know wether it is good to used as matrix mask. The matrix mask made of banana peels fermented by *Acetobacter xylinum*. Formed bacterial cellulose then formed into matrix mask. Matrix characterization covering thickness test, pH test, mechanical test (tensile strenght and elongation), difusion test of vitamin C and the SEM test. The research showed that bacterial cellulose that has formed into the matrix show thickness of 0,02 cm for banana peel of raja and ambon,0,01 cm of nangka. The value of tensile streght which qualify is matrix from banana peel of raja and nangka with values 4380 kg/cm^2 and 3181,50 kg/cm^2. The results from data analysis of strenght tensile values using One Way ANOVA showed there was no significant difference among the three matrix mask. On the difussion test of vitamin C, the fastest matrix mask which reach the levels of 70% is matrix form banana peels of nangka that reaching levels 72,9% in 20 minutes. The three of matrix is good to use because it qualify the characteristic of matrix mask. They are thickness test, mchanical test and difussion test of vitamin C.

Keyword: *banana peels, fermentation, bacterial cellulose, biocellulose*

INTRODUCTION

When the skin becomes dry epidermal layer loses its ability to restore moisture. Without treatment, the skin can not repair itself. The use of a topical moisturizer is the primary treatment of epidermal layer of the skin becomes softer and pliable by increasing hydration and decrease evaporation of water. The application of the mask on the skin can improve hydration and protect against water loss[1].

Bacterial cellulose can be used as a face mask matrix because it is safe to use and able to treat dry skin. Besides bacterial cellulose also have a low toxicity and biodegradable nature[2,3]. Bacterial cellulose matrix masks can be made from the fermentation products formed by *Acetobacter xylinum* commonly called nata[4]. *Acetobacter xylinum* belonging to the kinds of acetic acid bacteria (aceto; acetate, bacter; bacteria). When bacteria implanted into a liquid medium containing sugar, the bacteria will produce acetic acid and the white layer that floats above the liquid medium. Bacterial cellulose can be made from coconut water, sugar cane or fruit juice such as pineapple juice, melon, grapefruit, guava, and banana skin even from themselves [5].

Banana is native to Indonesia, and accounts for about 50% of production in Asia. Conditions humus-rich soils and is supported by a tropical climate allows the banana plant is widespread in Indonesia[6]. Banana skin is organic waste that has nutrients that can still be used. The main content that can be used are carbohydrates, the carbohydrate content on a banana peel is high at 18.5%[7].

Requirements to make bacterial cellulose in general that the base material must have the content of glucose (carbohydrates) are quite high. Therefore the banana peel can be used as a basic ingredient in the product creation process bacterial cellulose because the carbohydrate content is high enough[8,9]. Based on this background, the research for the development of a face mask matrix with Bacterial cellulose from the skin of a banana.

MATERIAL AND METHOD

The study begins with the collection of banana peel (raja, Ambon and nangka) obtained from the Bandung area east then performed determination. Preparation starter which includes the preparation of the media and the manufacture of starter *Acetobacter xylinum*.

Making the matrix masks bacterial cellulose through fermentation by *Acetobacter xylinum*. Bacterial cellulose as a result of the fermentation is done with the purification soaked in 0.1% NaOH. Bacterial cellulose which has been purified water content removed by using a hard press to form a matrix. Created hydrogel matrix formed by the matrix soaked in a solution of 6% polyvinyl alcohol for 24 hours.

Characterization of the matrix masks consist of a pH test, test membrane thickness, test the mechanical properties, vitamin C release testing, test panelists and Scanning Electron Microscopy (SEM). PH test matrix is done by using a digital pH meter. The pH meter must be calibrated beforehand with buffer pH 4 and pH 7 then measure and determine the pH owned mask matrix derived from bacterial cellulose[10].

Test membrane thickness is done by using a caliper. Measurements were made on each side of the matrix masks randomly up to 10 times and then calculated the average thickness of the membrane. The thickness of the matrix of a

face mask should be in the range of 0.01 to 1 cm[10].

Test of mechanical properties is done by using a tensiometer. Mechanical properties test consists of tensile strength and elongation. The test sample used measuring a width of 2.5 cm and a length of 20 cm. Tensiometer tool turned on 15 minutes before use, set the load and speed of the desired device to decide the sample. Once the tool is heated for 15 minutes the membranes were then tested its strength. Elongation at break (elongation) is calculated on the sample experienced a rupture in the middle of the samples that have been marked along the 1 cm.

Test release vitamin C begins with the manufacture of membrane diffusion of whattman no.1 paper soaked in liquid Spangler. Making a calibration curve of vitamin C begins with determining the wavelength of maximum and making a series of dilutions consisting of 5, 7, 9, 11, 13, 15 ppm to determine the linear regression equation. Measurement of diffusion of vitamin C was conducted using Franz diffusion by taking a sample of 5 ml for 1 hour at minute 5, 10, 15, 20, 30, 40, 50 and 60 minutes. The sample is then analyzed using a UV-Vis spectrophotometer at a wavelength of 263 nm[10].

Panelists test conducted on 20 panelists, panelists were asked to pass judgment on the matrix masks. Parameter consists of organoleptic testing which includes color, aroma, and comfort. While testing the security of irritation and skin irritation include reddening, skin swelling, itching sensation, cold sensation and stickiness.

Analysis of the structure and morphology of bacterial cellulose is done by using Scanning Electron Microscopy (SEM). Data analysis using One Way ANOVA for tensile strength test result data and the Kruskal Wallis test for elongation test result data.

RESULT AND DISCUSSION

Making the matrix masks fermentation process begins with a banana peel. In the fermentation process of bacterial cellulose, sucrose contained in the banana skin will be converted into glucose by the enzyme isomerase issued by *A. xylinum*[11]. The next phase of glucose binds to other glucose form a β-1,4 glycoside bond. The last stage is the polymerization process or the formation of bacterial cellulose assisted by a polymerase enzyme released by bacteria *A. xylinum*[12].

Bacterial cellulose which has been purified and pressed and then molded PVA hydrogel by immersion in

the matrix masks have good physical properties and more elastic.

Table 1 shows the results of measuring the weight and thickness of the matrix masks before and after soaked in PVA. The data is used to calculate% absorption. The results of% absorption raja, Ambon, and nangka, respectively for 49.02%, 34.34%, 15.03%. The matrix of raja had the highest absorption value%.

The characterization results for the matrix masks pH tests show that the matrix has a pH of 6.78 to 6.9. The matrix masks should have a pH similar to the skin's pH ranged 4.5-6.5. If the pH of the matrix does not match the pH of the skin but does not cause irritation, then the matrix is still safe to use.

Test the thickness of the matrix masks carried on a matrix that has not soaked PVA PVA and after immersion. Can be seen in Table 1 that the thickness of the matrix masks before soaked PVA ranged between 0.01-0.02 cm while the thickness of the matrix masks after being soaked PVA ranges from 0.01-0.03 cm. Based on these data matrices obtained mask already meet the standards of the matrix masks in the market that have thicknesses ranging from 0.01-0.1 cm[10].

Mechanical testing (Table 2 and 3) aims to determine whether the matrix masks easily torn or not during use. Based on these results despite a matrix tensile strength values of banana supreme, the matrix does not meet the test characteristics of mechanical properties. While the matrix obtained from the rind of raja and Ambon meet the test characteristics of mechanical properties due to the requirements of the products on the market have a standard value of tensile strength in the range of 3000 - 5000 kg / cm2[10].

Tensile strength value obtained from the three matrices are then analyzed the data using the Kruskal-Wallis test. The results of data analysis showed a significance value above 0.05 means that there is no significant difference between the value of the tensile strength of the third matrix.

Based on data analysis was performed using one-way ANOVA on the percent elongation of the third matrix showing the results that there are significant differences between the three matrix masks with significant value below 0.05, which means there is significant difference between the value of the elongation of the third matrix

Sample	Raja		Ambon		Nangka	
	Wo	Wt	Wo	Wt	Wo	Wt
Weight(g)	127,07	189,37	67,76	91,03	95,68	110,67
Thickness (cm)	0,02	0,03	0,02	0,03	0,01	0,01

6% for 24 hours. The formation of hydrogels intended that

Table. 1. The measurement results matrix mask.

Sample	Tensile Strength(kg/cm^2)
	Average
Raja	4380,75 ± 2194,06
Ambon	6174,00 ± 837,06
Nangka	3181,50 ± 323,75

Table. 2. Tensile Strength Test Results.

Sample	% Elongation
	Average
Raja	30 ± 7,14
Ambon	79,05 ± 15,78
Nangka	28,5 ± 26,66

Table. 3. Elongation Test Results

Sample test results release vitamin C by using a Franz diffusion cell was then measured its absorbance with UV-Vis spectrophotometry at a wavelength of 263 nm. The results of the absorbance of the sample calculation ppm value on the linear regression equation has been obtained is $y = 0,024x + 0.0955$ with a value of R = 0.9971. The ppm value is used to determine the % diffused.

Calculation% diffused aimed to know the minute how many percent of the vitamin C content reaches levels of 70% to be determined when the maximum use of the matrix masks.
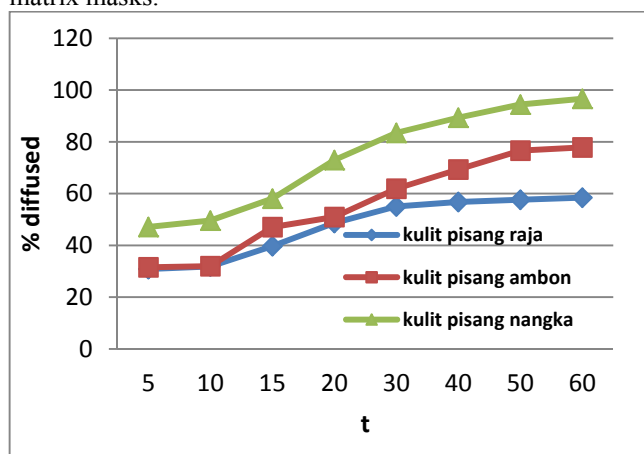

Figure 1. Curves time (t) against % Diffused

Can be seen in Figure 1 that the highest percentage obtained matrix diffusion banana peel nangka. At minute 5 to minute to 60 percent of its diffusion increases and at minute 20 percent of diffusion reached 72.96%. Banana skin also increased from minutes to 5 to 60 minutes, and minutes to 50 percent of diffusion reached 76.6%. While the skin matrix raja percent despite increasing diffusion of minutes to 5 to 60 minutes, the percent diffusion highest reaching only 58.44%. Diffusion percent who did not reach the 70% estimated for the thickness of the matrix masks raja skin thicker than the matrix masks another. In addition, when viewed from percent absorption PVA matrix, skin masks raja obtain the highest value. It affects the release of vitamin C. The higher the percent PVA gel coating which then formed more thick so it can hold the release of vitamin C longer.

From this experiment it can be concluded that the matrix masks that can diffuse the best vitamin C is a matrix of banana peel nangka. Time of use for the matrix masks nangka banana peels can be used to use in the face for 20-60 minutes.

The test results showed that the panelists panelists preferred the banana skin mask matrix and the matrix masks from nangka banana skin for organoleptic parameters. While irritation and security parameters shows the results that panelists preferred the matrix masks peel a banana and nangka banana skin matrix as well.

Testing the latest of which is the analysis of the structure and morphology of bacterial cellulose using a Scanning Electron Microscopy (SEM). Results of SEM of three such bacterial cellulose fiber structure shows an irregular and overlapping. This is because the bacterial cellulose hydrogel has been formed, according to the research conducted[13] that the hallmark of a hydrogel in the SEM image shows the structure of the fiber which tends to irregular and thicker in some point.
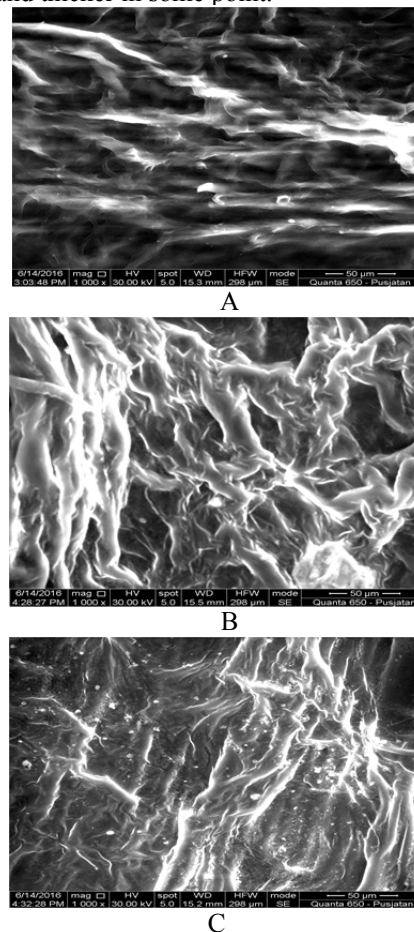

Figure 2. SEM Results of Bacterial Cellulose: A. Raja; B. Ambon; C. Nangka

Figures 2 show the fiber is thick while the thinner fibers tend to be obvious. Image fiber is not so obvious can be caused by any means of SEM magnification different to the sample. The SEM image taken at a magnification of 1000x because when taken at 1000x magnification over already entered the cell surface tissue.

The tissue structure of bacterial cellulose were piled caused due to the manufacturing process of pressing on the matrix masks. As in the study[14] who did the analysis of the structure of bacterial cellulose which has been pressed, using SEM. SEM results showed similar results with[14] that the structure of the bacterial cellulose irregular and overlapping.

CONCLUSION

Face mask matrix obtained by the fermentation of banana peels Raja, ambon, and nangka by *Acetobacter xylinum*. Matrix mask obtained dr banana skin types eligible to be used as the matrix masks meet the characteristics of which include: pH test, thickness, mechanical and hedonic. To test the release of vitamin C most quickly reached levels of 70% is a matrix of nangka banana skin in the 20th minute had reached a value of 72.9%.

REFERENCES

1. Flynn T. C., Petros J, Clark R. E., Dry Skin And Moisturizers, Clin Dermatol, 2001, 19, 387–392.
2. Keshk, Bacterial Cellulose Production and its Industrial Applications, J Bioproces Biotechniq, 2014, , 4:2.
3. Amnuaikit. T., Effects Of A Cellulose Mask Synthesized By A Bacterium On Facial Skin Characteristics And User Satisfaction, Medical Devices: Evidence And Research, 2011, 4, 77-81.
4. Esa, F., Tasirin, S. M., Rahman, N. A., Overview of Bacterial Cellulose Production and Application, Agriculture and Agricultural Science Procedia 2, 2014, 113 – 119.
5. Sutanto. A., Pineapple Liquid Waste As Nata De Pina Raw Material, Makara, Teknologi, 2011, 16 (1), 63-67.
6. Astawan N., Nata De Coco Yang Kaya Serat.Teknologi Pangan Dan Gizi. IPB: Bogor, 2004.
7. Gunawan, Kandungan Dan Manfaat Kulit Pisang. 2013.
8. Tsouko, E., Kourmentza, C., Ladakis, D., Kopsahelis, N., Mandala, I., Papanikolaou, S., Paloukis, F., Alves, F., Koutinas, A., Bacterial Cellulose Production from Industrial Waste and by-Product Streams, *Int. J. Mol. Sci.* 2015, *16*, 14832-14849
9. Suprapti, M.L., Aneka Olahan Pisang. Kansius, Yogyakarta, 2005.
10. Felasih. E., Pemanfaatan Selulosa Bakteri-Polivinil Alcohol (PVA) Hasil Iradiasi (Hidrogel) Sebagai Matriks Topeng Masker Wajah. Skripsi. Program Studi Farmasi Fakultas Kedokteran Dan Ilmu Kesehatan Universitas Islam Negri Syarif Hidayatullah Jakarta, 2010.
11. Chawla, P. R., Bajaj, I. B., Survase, S. A., Singhal, R. S., Microbial Cellulose: Fermentative Production and Applications. Food Technol. Biotechnol, 2009, 47 (2), 107–124.
12. Indarti D. and Asnawati, Karakterisasi Filom Nata De Coco-Benedict secara Adsorpsi untuk Sensor Glukosa Urine. Jurnal ILMU DASAR, 2011, 12 (2), 200-209.
13. Moraes, Saska S., Barud H., Lima, Martins, Plepis, Ribeiro, Gaspar, Bacterial Cellulose/Collagen Hydrogel for Wound Healing, Mat. Res., 2015, 19 (1).
14. Grande Cristian J., Torres G. Fernando., Gomez M. Clara, Morphological Characterisation of Bacterial Cellulose-Starch Nanocomposites. Polymers & Polymer Composites, ProQuest Science Journals, 2008, 16 (3), 181.