Development and Characterization of Paper from Corn Husks as a New Material for Newsprint

Handika Dany Rahmayanti[1*] and Adhita Asma[2,3]

{handikadany44@gmail.com[1], adhita.asma02@gmail.com[2,3]}

State Polytechnic of Creative Media, Indonesia[1], Osaka University, Japan [2], Institut Teknologi Bandung, Indonesia[3]

Abstract. This study aims to develop and produce paper out of corn husks. It seeks to determine the physical, optical and chemical qualities of produced paper such as basis weight, thickness, brightness, opacity, oil absorption, water absorption, tearing strength, and tensile index through laboratory experiment, testing and results. the average weight of corn husk paper is 73.44 gr/m^2 and the thickness is 0.193 mm. Oil absorption on corn husk paper is 21.73% while that on newsprint is 22.807%. The results of the pH test showed that the paper from corn husks and newsprint both showed a pH on a scale of 7 which indicated that the pH was netral. It also aims to determine the level of acceptability of produced paper based on the sensory evaluation of the respondents regarding texture, absorption, color, and thickness. Most of the treatment combinations of the produced paper were acceptable as raw materials in making paper. Further studies were advisable to develop other raw materials to produced eco-friendly paper and other stuff.

Keywords: paper; corn husks; physical properties.

1 Introduction

Corn is one of the important commodities for Indonesia. Corn is still the main food need of the community and the value of the demand is quite high [1-4]. Currently, the government also makes corn as one of the main food commodities that are prioritized for development. Based on data from the Central Statistics Agency [5] corn production in Indonesia reaches more than 19 million tons and continues to increase. In 2018 corn production reached 30.1 million tons [6]. The increase in the amount of corn production is in line with the increase in the amount of corn husk waste. Corn husk is the part of the plant that protects the corn kernel. On the other hand, the increasing amount of corn husk waste has become one of the problems that have not been properly resolved until now. Corn husk is organic waste. Various solutions have been applied in solving organic waste problems such as the concept of recycling in the form of making compost, biomass, biodiesel and various improvements in waste management[7-10].

Corn husk has a high cellulose fiber content, so it can be used as a raw material for making paper [10]. The chemical composition of corn husk includes 15% lignin; 5.09% ash; 4.57% alcohol-cyclohexane and 44.08% cellulose [11]. The results of chemical analysis of corn cobs contain hemicellulose 30.91%; alpha cellulose 26.81%; lignin 15.52%; 39.80% carbon; nitrogen 2.12% and water content 8.38% [12]. The pulping process can use non-wood raw materials, one of which is corn husk agricultural waste [13]. Development pulp from chicken feathers and corn

JICOMS 2022, November 16, Jakarta, Indonesia

DOI 10.4108/eai.16-11-2022.2326122

husks, produced art paper with the highest tensile strength of 8.8410 N and the highest tear strength of 22.0088 N [14].

Paper is a thin sheet-shaped material that is often used by the public such as writing, drawing, printing, wrapping, crafts, and so on. Types of paper include HVS paper, newsprint, frosted paper, buffalo paper, tissue paper, oil paper, and art paper. Paper that is often encountered in everyday life is newsprint. Newsprint is generally made from wood pulp fibers. In this research paper will be made from corn husk. The use of corn husk material can reduce newsprint production costs because it uses cheap and waste materials and can help overcome the problem of corn husk waste.

2 Research Methods

The main ingredient in this research is corn husk. Other supporting materials used are NaOH (caustic soda) and aquades. The equipment used to support the research included a blender, scales, stove, stainless steel pan, wooden stirrer, measuring cup, screen printing, masks and gloves. Making corn paper begins with measuring the mass and concentration of corn husk material weighing 200 grams, and NaOH as much as 10% of the weight of corn husks (NaOH = 20 grams). Add distilled water into sodium hydroxide (NaOH) so that it becomes a NaOH solution. Continue making pulp by mixing corn husks and NaOH solution in a stainless steel pot, then boil for 1.5-2 hours. After boiling, cool for a moment and then separate the cooking water from the corn husks with a sieve. After that, the boiled corn husk is cleaned using 20 times the mass of water to make it cleaner. If you want to give it a color, mix alum and lime then mix it with dye. Then let it rest for about 1 hour. After letting it sit for about 1 hour, then blend it until it becomes like porridge (pulp). Then pulp printing. Prepare a large bucket / box filled with water and add the pulp that has been blended. Then, use a screen printing to filter the pulp that has been mixed with water, while shaking it or like it is sifted slowly until the filtered pulp is evenly distributed. The final step is drying. When it is completely dry, pull the pulp that has become paper slowly.

Furthermore, the samples were characterized by measuring basic weight, thickness, oil absorption, acidity and whiteness. Measurements were also made on newsprint as a comparison. The method used in the basic weight test is the Gravimetric method with an analytical balance tool. The principle used in testing the basic weight of paper is by weighing a sample of paper measuring 10 cm x 10 cm, the weight will be obtained in grams/100cm^2 which is then multiplied by 100 to obtain the basic weight in g/m^2. The principle used in testing the thickness of the paper is by placing a sheet of paper measuring 10 cm x 10 cm between the two surfaces of the micrometer tool, the thickness of the paper can be directly read on the scale indicated by the tool. The tools in testing the oil absorption are IGT printing test equipment with pendulum speed, rubber pads and type PE 1 syringe, while the materials used are pure *dibutylphthalate* liquid which is colored Sudanese red, the paper to be tested, and washing solution. The principle of the oil absorption test is that by dropping the test oil on the surface of the paper at a certain speed, it produces an oval print. The way to test the absorbency is to install rubber pads and aluminum templates on the IGT printing test equipment. Then fill the syringe with dibutylphthalate liquid, then place it on the IGT test machine. Next, install the paper to be tested (size 27.5 cm x 2.5 cm) on the test printer in a print-ready position with a pressure of 40 kgf. Drop the *dibutylphthalate* solution by moving the syringe pressure slightly over the aluminum mold. Then drops it is rolled on the paper to be tested using a free-falling pendulum. Finally

measure the length of the mold in mm as soon as it takes the shape of the mold. The brightness test or the degree of whiteness of paper uses the principle of comparison between the intensity of blue light with a wavelength of 457 nm reflected by the surface of the paper and the intensity of that light reflected by magnesium oxide, under conditions of an angle of incidence of 45º and a reflection angle of 0º. The paper brightness value is written in percent (%). In this measurement, the Elrepho tool is used..

3 Results and Discussion

Corn husk is the part of the plant that protects the corn kernel. Based on data from the Central Statistics Agency [5] corn production in Indonesia reached more than 19 million tons and even in 2018 corn production reached 30.1 million tons [6]. Based on these data, of course, it will be able to produce large corn husk waste and will cause environmental pollution. Generally, corn plants contain approximately 30% of corn husks and cobs as useless waste that harms the environment if not handled properly [15]. The chemical composition of the dried corn husk can be seen in Table 1 [10], while the characteristics of the corn husk fiber can be seen in Table 2 [10].

Table 1. Chemical composition of corn husk. [10]

Component	%
Lignin	15
Ash	5.09
Alcohol-cyclohexane solubility (1:2 v/v)	04.57
Cellulose	44.08

Table 2. Fibre characteristics of Corn husk. [10]

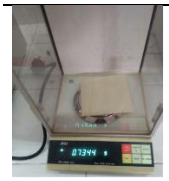
Fibre property		Dimension
Fibre Length (mm)	L	1.71±0.5
Fibre diameter (µm)	D	21.89±5.1
Cell wall thickness (µm)	CW	7.63±2.3
Lumen width (µm)	LW	6.63±3.5

Corn husks can be used for paper making because corn husks contain fiber (cellulose). In the process of making paper pulp, several stages are carried out, namely drying corn husks, cutting corn husks into small pieces, boiling corn husks by adding NaOH and water, filtering and cleaning, until finally a blender. Then the paper is screen printed using a filtering method on the pulp which is in a tub filled with water. The making of corn husk paper using corn husk material added with 10% NaOH (caustic soda) was successfully carried out. Physically, paper made from corn husk has the same characteristics as newsprint. The results of making paper based on corn husks are shown in Figure 1.

Fig. 1. Corn husk based paper.

In this article, we will describe the characteristics of the physical, chemical and optical properties of corn husk paper and newsprint as a comparison. Physical properties tests include weight, thickness and oil absorption. Testing of chemical properties includes the degree of acidity (pH). Testing of optical properties includes the degree of whiteness (brightness). The equipment used to characterize the properties of corn husk based paper is shown in Table 3.

Table 1. Characterization Equipment

Characterization Equipment	Function
	Measure weight
	Measure thickness
	Measure oil absorption
	Measure brightness

In addition, observations of the shape of the fiber from paper from corn husks were also carried out. When viewed under a microscope (Digital Optical Microscope (National, DC3-163)) the

shape of the fibers of corn husk paper also resembles newsprint. Measurements were made with a magnification of 100x and the results are as shown in Figure 2.

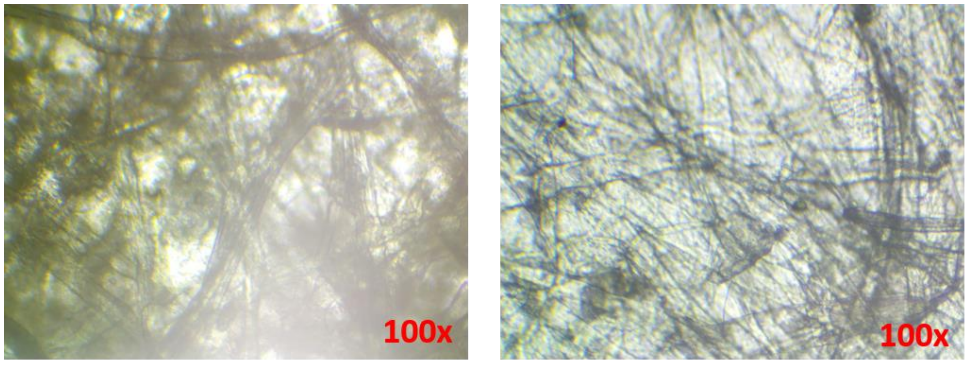


Fig. 2. fiber shape seen from a microscope with a magnification of 100 x (a) corn husk-based paper and (b) newsprint.

Furthermore, the basic weight of the paper is measured by weighing the mass of the sheet of paper or cardboard in grams divided by the unit area in square meters, measured under standard conditions using the gravimetric method. The result shows that the average weight of corn husk paper is 73.44 gr/m^2 while the average weight of newsprint is 48.35 gr/m^2. Then still with the Gravimetric method, the thickness of the paper is measured. Paper thickness is the perpendicular distance between the two paper surfaces measured under standard conditions. The results show that the average thickness of corn husk paper is 0.193 mm while the average weight of newsprint is 0.068 mm.

Next, the paper is measured its absorption capacity to oil. Oil absorption is a quantity that states the nature of paper absorption against standard liquids. By dropping the test liquid on the surface of the paper at a certain speed, it will produce an oval-shaped print, as shown in Figure 3. The stronger the absorbency of the paper, the shorter the oval length. Based on the printout, it shows that the average oval length of corn husk paper is 4.6 mm while the average oval length of newsprint is 4.4 mm. Oil absorption is calculated based on the reciprocal of the length of the printed liquid on the test line, expressed in units of 1000/mm, under standard conditions. Oil absorption on corn husk paper is 21.73% while that on newsprint is 22.807%.

Fig. 3. Oil absorption measurement results.

In testing the chemical proprties of paper, the component being tested is the degree of acidity (pH). The pH of the paper is the concentration of hydrogen ions in the paper extract solution measured under standard conditions. The method used in the test is the extraction method. The degree of acidity (pH) of the paper can affect the color, the length of time the ink drying on the printout. The acidity value can be read directly on the pH meter scale using litmus paper. The results of the pH test showed that the paper from corn husks and newsprint both showed a pH on a scale of 7 which indicated that the pH was netral.

The optical properties of the paper are tested by measuring the degree of whiteness of the paper (brightness). The brightness test or the degree of whiteness of paper uses the principle of comparison between the intensity of blue light with a wavelength of 457 nm reflected by the surface of the paper and the intensity of that light reflected by magnesium oxide, under conditions of an angle of incidence of 45º and a reflection angle of 0º. The paper brightness value is written in percent (%). In this measurement, the Elrepho tool is used as shown in Table 3. The results show that the average brightness of corn husk paper is 50.52% while the average weight of newsprint is 31.16%.

4. Conclusion

The making of corn husk paper using corn husk material added with 10% NaOH (caustic soda) was successfully carried out. shape of the fibers of corn husk paper also resembles newsprint. The result shows that the average weight of corn husk paper is 73.44 gr/m^2 while the average weight of newsprint is 48.35 gr/m^2. Oil absorption on corn husk paper is 21.73% while that on newsprint is 22.807%. The results of the pH test showed that the paper from corn husks and newsprint both showed a pH on a scale of 7 which indicated that the pH was netral. The optical properties of the paper are tested by measuring the degree of whiteness of the paper (brightness). The average brightness of corn husk paper is 50.52% while the average weight of newsprint is 31.16%.

References

[1] Timmer, C. P.: The corn economy of Indonesia. Cornell University Press, US (2019)

[2] Wanto, A., Hartama, D., Bhawika, G. W., Chikmawati, Z., Hutauruk, D. S., Siregar, P. H., and Windarto, A. P.: Model of Artificial Neural Networks in Predictions of Corn Productivity in an Effort to Overcome Imports in Indonesia. In Journal of Physics: Conference Series. Vol. 1339, No. 1, p. 012057 (2019)

[3] Bachtiar, R. R., Chang, W. I., Anindita, R., and Mustadjab, M.: Supply Response and Corn Price Volatility in Indonesia. Greener Journal of Business and Management Studies. Vol. 4, No. 3, pp. 058-069 (2014)

[4] Susilowati, S. H., Ariningsih, E., Saliem, H. P., Roosganda, E., and Adawiyah, C. R.: Opportunities and challenges to increase corn export from Gorontalo province of Indonesia. In IOP Conference Series: Earth and Environmental Science, Vol. 672, No. 1, p. 012027, (2021)

[5] BPS.: Produksi Jagung Menurut Provinsi (ton) 1993-2015. Badan Pusat Statistik, Indonesia (2015)

[6] LokaData.: Jumlah impor dan produksi Jagung, 2013-2018. LokaData, Indonesia (2018)

[7] Siwal, S. S., Zhang, Q., Devi, N., Saini, A. K., Saini, V., Pareek, B., and Thakur, V. K.: Recovery processes of sustainable energy using different biomass and wastes. Renewable and Sustainable Energy Reviews. Vol. 150, p. 111483 (2021)

[8] Tjhin, V. U., Riantini, R. E., and Windihastuty, W.: Utilization of Digital Technology in Managing Fabric Waste into Garments. In ICEBE 2021: Proceedings of the 4th International Conference of Economics, Business, and Entrepreneurship, European Alliance for Innovation. p. 376 (2022)

[9] Mourad, M.: Recycling, recovering and preventing "food waste": Competing solutions for food systems sustainability in the United States and France. Journal of Cleaner Production. Vol. 126, pp. 461-477 (2016)

[10] Fagbemigun, T.K., Fagbemi, O.D., Otitoju, O., Mgbachiuzor, E. and Igme, C.C.: Pulp and paper-making potential of corn husk. Int. J. AgriScience. Vol. 4, no. 4, pp.209-213 (2014)

[11] Fagbemi, O.D., Fagbemigun, T.K., Otitoju, O., Mgbachiuzor, E. and Igwe, C.C.: Strength properties of paper from pulp blend of kenaf bark and corn husk: A preliminary study. British Journal of Applied Science & Technology. Vol. 4, no. 28, p.4124 (2014)

[12] Septiningrum, K.: Produksi xilanase dari tongkol jagung dengan sistem bioproses menggunakan bacillus circulans untuk pra-pemutihan pulp. Journal of Industrial Research (Jurnal Riset Industri). Vol. 5, No. 1 (2011)

[13] Ningsih,. E,. R.: Uji Kinerja Digester Pada Proses Pulping Kulit Jagung Dengan Variabel Suhu dan Waktu Pemasakan. Tugas Akhir, Program Diploma, Fakultas Teknik, Universitas Diponegoro, Semarang, Indonesia (2012)

[14] Daniatri, N. and Asngad, A.: Pemanfaatan Limbah Bulu Ayam Dan Kulit Jagung Kering "Klobot" Sebagai Bahan Pembuatan Kertas Seni Dengan Penambahan Cao Dan Pewarna Alami Yang Berbeda. Doctoral dissertation, Universitas Muhammadiyah Surakarta, Indonesia (2015)

[15] Susilowati.: Pemanfaatan Tongkol Jagung Sebagai Bahan Baku Bioetanol dengan Proses Hidrolisis H2SO4 Fermentasi Saccharomyces Cervisiae. Tugas Akhir. Universitas Diponegoro, Semarang, Indonesia (2011)