EINSTEIN (e-Journal)
Jurnal Hasil Penelitian Bidang Fisika
Available online http://jurnal.unimed.ac.id/2012/index.php/einsten
e-issn: 2407 – 747x, p-issn 2338 – 1981

THE EFFECT OF GRAMMAGE ON BULK IN A-GRADE PRINTING PAPER BASED ON TARO SKIN AND OIL PALM FRONDS

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Submit: December 2025. Approved: January 2026. Published: February 2026.

ABSTRACT

The use of wood as the main raw material for paper production causes environmental problems such as deforestation. This study aims to analyze the physical characteristics of paper made from taro skin and oil palm fronds through the parameters of grammage and bulk. Grammage and bulk are important parameters in determining the quality of printing paper A according to SNI 7274:2008. The composition variations used were samples A (60%:40%), B (40%:60%), and C (20%:80%). The results show that the lowest grammage value is 79 g/m2 in the 20%:80% variation and the highest grammage value is 90 g/m2 in the 60%:40% variation. For bulk testing, the lowest value was 1.11 cm3/g in the 20%:80% variation and the highest bulk value was 1.46 cm3/g in the 60%:40% variation. All samples met the SNI 7274:2008 standard for A-grade printing paper, with a grammage limit of 50-100 g/m2 and a maximum bulk of 1.5 cm3/g. Increasing the proportion of oil palm fronds reduced the grammage but increased the bulk. This study proves the potential of taro skin and oil palm fronds as raw materials for environmentally friendly paper.

Keywords : Grammage, Bulk, A-Grade Printing Paper, Taro Skin, Oil Palm Fronds

INTRODUCTION

Paper is an important material in various sectors, ranging from education, industry, to trade. Conventional paper production is still dominated by wood as a raw material, which causes environmental problems due to high deforestation rates. Therefore, efforts are needed to reduce dependence on wood by finding alternative materials that can be used as substitutes in paper manufacturing (Fitri Faradilla, 2021). The main raw material for paper manufacturing is still dominated by wood at 90% (Safrizal et al., 2022). Paper is a thin material made by compacting fibers from pulp. These fibers generally come from natural sources that are rich in cellulose and hemicellulose. In the paper manufacturing process, fibers serve as the main component. Almost all plants that contain cellulose can be used as raw materials for producing pulp (Aisyah & Trihernawati, 2023).

Pulp is a brown fiber slurry produced from the process of separating lignin from biomass. This material is usually used as the

main ingredient in paper manufacturing. Pulp sources can come from woody or non-woody plants and serve as an important base material in paper production. In the pulp manufacturing process, lignin is removed so that wood can be converted into fiber pulp. In addition to lignin, there are also extractive compounds such as plant hormones, resins, and fatty acids that also affect the characteristics of pulp and paper (Fajri et al., 2023).

Cellulose is an organic compound that is abundant in nature, especially in wood. This compound has fibrous properties with high tensile strength, is insoluble in water, and is difficult to dissolve in organic compounds (Saputra & Fauzi, 2022). These properties make cellulose very useful in various industrial and biological applications (Wibisono et al., 2013). Cellulose is a natural substance derived from plants and consists of small molecules. Wood contains many cellulose-rich chemical compounds, making it a very suitable source for paper production due to its abundant plant content (Pulungan et al., 2023).

Taro skin has great potential to be used as a raw material for making environmentally friendly paper. Its natural fiber content makes it an ideal choice for producing sustainable and economical paper products. Taro skin contains 40% cellulose, 35.7% hemicellulose, and 24.02% lignin (Nugroho et al., 2022).

Oil palm fronds have a main chemical composition of 34.89% cellulose, 27.14% hemicellulose, and 19.87% lignin. These contents indicate that oil palm fronds have the potential and characteristics to be processed into value-added products (Maulana et al., 2023).

Based on research by Ningsih et al. (2023) on "Manufacturing and Characterization of Paper from Cassava Peels and Pineapple Leaves," this study shows that cassava peels and pineapple leaves can be used as raw materials for paper manufacturing. Based on Nugroho's (2022) research on "Utilization of Taro Stems (Colocasia esculenta L.) as Raw Material for Pulp Production Using the Soda Process," this study shows that taro stems can be used as raw material for pulp production using varying concentrations of NaOH. Based on Maulana's (2023) research on "The Effect of Bleaching Solution Concentration (H_2O_2) on.

This study aims to find alternatives to wood as a raw material for paper by utilizing taro skin and palm fronds. The paper manufacturing process involves three main stages, namely pulp production from taro skin, pulp production from palm fronds, and the paper printing process. Physical properties tests, including measurements of grammage and bulk, are conducted to assess quality.

METHOD

This research was conducted using an experimental approach with quantitative methods. The tools used in this research were a hot plate, thermometer, magnetic stirrer, stirring rod, beaker glass, oven, blender, vessel, paper mold, digital scale, 100 mesh sieve, and screw micrometer. The materials used in the study were taro skin, palm fronds, 1.5% NaOH, acetic acid, 10% H2O2, 2% Na2SO3, PVP, and distilled water. It contains the research method/design, population and sample, instruments, validity and reliability of instruments, and data analysis methods.

Taro Skin Pulp Production

The taro skin was cleaned and dried under the sun for 3 days. After drying, the taro skin was refined and sieved with a 100 mesh sieve. Seventy-five grams of taro skin is mixed with 500 ml of acetic acid and heated at 80°C for 1.5 hours and washed using distilled water. The resulting pulp is added to 750 ml of 1.5% NaOH solution and 500 ml of 2% Na_2SO_3. Then it was heated at 50°C for 1 hour, after which it was filtered and washed using distilled water. The residue was added to 750 ml of 10% H_2O_2 solution and heated at 80°C for 30 minutes, then washed with distilled water. Next, the residue was added to 500 ml of 10% H_2O_2 solution and heated at 60°C for 15 minutes, then filtered and washed using distilled water. The taro skin pulp was dried in an oven at 105°C for 1.5 hours.

Production of Palm Frond Pulp

Palm fronds are cleaned and dried under the sun for 10 days. Once dry, the fronds are crushed and sieved using a 100 mesh sieve. 75 g of palm fronds are weighed and mixed with 500 ml of acetic acid solution and heated using a hotplate at 80°C for 1.5 hours and washed using distilled water. The resulting pulp is mixed with 750 ml of 1.5% NaOH solution and 500 ml of 2% Na_2SO_3 at a temperature of 50°C for 1 hour, then filtered and washed with distilled water. The residue was added to 750 ml of 10% H_2O_2 solution and heated at 80°C for 30 minutes, then washed again with distilled water. Next, 500 ml of 10% H_2O_2 was added to the residue at a temperature of 60°C for 15 minutes, then filtered and washed with distilled water. The palm frond pulp was dried in an oven at a temperature of 105°C for 1.5 hours.

Paper Making

Taro skin pulp and oil palm fronds are weighed to a total pulp weight of 10 grams with predetermined pulp weight variations, namely samples A (60%:40%), B (40%:60%), and C (20%:80%). Next, water is added and mixed using a blender, then PVP is added and mixed again using a blender. Then, 2 liters of clean water is poured into a container and the smooth, mixed pulp is added. It is then molded using a paper mold and dried at room temperature for 12 hours.

Physical Testing of Paper

Grammage

Grammage is an important parameter that represents the mass of paper or cardboard per unit area (g/m2), expressed in grams per square meter and measured under standard conditions. The grammage value provides an indication of the weight, thickness, and strength of the paper. The higher the grammage, the thicker and sturdier the paper, while a low grammage indicates a lighter and thinner paper. The test is carried out by cutting a 10 cm x 10 cm sheet of paper.

Bulk

Bulk is a parameter that describes the density of a sheet of paper, which is the ratio between the total volume of paper and its mass, expressed in centimeters cubed per gram (cm3/g). This value indicates how thick or dense a paper is at a certain weight, so that the higher the bulk value, the thicker the paper tends to be with a lower density. A low bulk value indicates that the paper is denser and thinner at the same mass.

RESULTS AND DISCUSSION

The results of physical tests on taro skin and palm frond paper consist of grammage and bulk tests, in accordance with the provisions of SNI 7274:2008 concerning A printing paper.

Grammage Test

Grammage testing of taro skin and oil palm frond paper was carried out to determine the weight of the paper. The results of the grammage test can be seen in Table 1.

Table 1. Grammage Measurement Results

Sample	Grammage (g/m^2)
A	90
B	83
C	79

Based on Table 1, the grammage test results show that sample A has a value of 90 g/m2, sample B has a value of 83 g/m2, and sample C has a value of 79 g/m2. All three samples meet the requirements of SNI 7274:2008 regarding A printing paper.

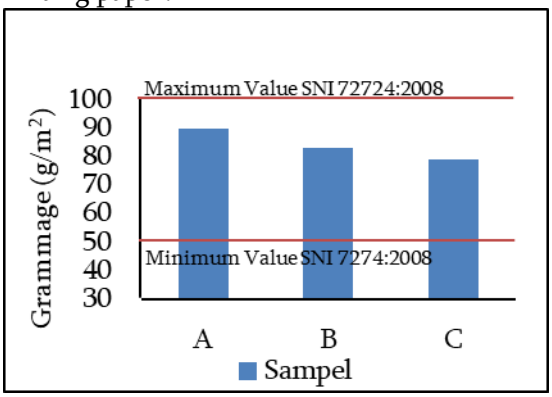

Figure 1. Grammage Measurement Results Graph

Figure 1. Shows that the grammage value tends to decrease as the proportion of palm fronds increases. The long fibers of palm fronds form a more porous and less dense tissue structure than the short fibers of taro skin. Short fibers produce a smaller yield than long fibers, and a lower yield actually results in a higher paper grammage value (Ayunda et al., 2020). Pulp with short fibers can produce better sheet formation because the small pores can be filled completely, but the strength of the resulting paper is lower than that of paper composed of long fibers (Ristianingsih et al., 2018).

Bulk Test

Bulk testing of paper from taro skin and oil palm fronds was conducted to determine the thickness and density of the paper. The bulk test results are shown in Table 2.

Table 2. Bulk Measurement Results

Sample	Bulk (cm^3/g)
A	1,11
B	1,33
C	1,46

Based on Table 2, the bulk test results show that sample A has a value of 1.11 cm3/g, sample B has a value of 1.33 cm3/g, and sample C has a value of 1.46 cm3/g. All three samples meet SNI 7274:2008 standards for A printing paper.

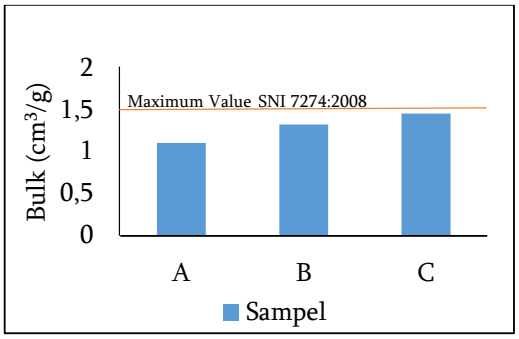

Figure 2. bulk value

Figure 2. Shows that bulk value increases as the proportion of oil palm fronds increases compared to taro skin. The long fibers in oil palm fronds interlock to form a more porous structure, resulting in larger spaces between fibers. This condition makes the paper thickness relatively greater even though the mass per unit area remains the same, thus increasing the bulk. The uneven thickness of the paper is also influenced by the manual printing method, which causes differences in thickness in each paper sample (Asngad & Syalala, 2018).

CONCLUSION AND RECOMMENDATIONS

Based on the results of the research conducted, it is known that cellulose in taro skin and oil palm fronds has the potential to be an alternative raw material for paper production due to its high cellulose content. Based on the physical properties testing of the paper, the grammage values obtained were 90 g/m2 for sample A, 83 g/m2 for sample B, and 79 g/m2 for sample C. The bulk values for sample A were 1.11 cm3/g, B 1.33 cm3/g, and C 1.46 cm3/g. Based on the paper characteristics data from taro skin and oil palm fronds, the best paper in sample C with a basis weight of 79 g/m2 and bulk of 1.46 cm3/g has met SNI 7274:2008 printing paper A. where the basis weight is 50-100 g/m2 and the maximum bulk is 1.5 cm3/g.

Recommendations for future researchers include using other alternative materials with higher cellulose content than taro skin in paper production, as well as using conventional printing to achieve uniform thickness.

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