Reaffirming the Critical Role of Transformative Research and Knowledge Production in the Age of Post-Truth

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Efficacy of Cattle Manure Cellulose Pulp and Kapok (*Ceiba pentandra*) Seed Hair Fibers for Paper Production

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Abstract: Paper is an indispensable product due to its versatility and convenience. However, the production of paper contributes to deforestation and increased carbon emissions. For this reason, the researcher ventured into using cattle manure as an alternative source of cellulose for paper production because of its high cellulose content and abundance. This study aimed to determine the quality and the significant difference between the paper made from cattle manure cellulose pulp and Kapok (*Ceiba pentandra*) seed hair fibers and the commercial paper in terms of scent, texture, writability, foldability, thickness, tensile strength, and tensile index. Observation and evaluation sheets (with the use of a 5-point Likert scale) were used as research instruments to gather data on the experimental and commercial papers' scent, texture, writability, and foldability. Thickness, tensile strength, and tensile index were measured using Dial Caliper, Salter Scale, and TAPPI/ANSI T494 om-01 equations. T-test was used to determine the differences in the quality of the paper made from cattle manure cellulose pulp and Kapok seed hair fibers and commercial paper. Results showed that the means of scent, texture, writability, and foldability of the product were comparable to that of commercial paper, leading to acceptance of the null hypotheses. The product's thickness was 0.60 mm, obtained 0.23 kN/m tensile strength, and a tensile index of 927.25 N-m/g (reject null hypotheses). In conclusion, the product has a huge potential as an alternative source of cellulose for paper production.

Keywords: Cattle manure cellulose pulp; Kapok seed hair fibers; paper production; commercial paper; quality

1. INTRODUCTION

Cutting down trees is an alarming issue that the society is currently facing. In other words, deforestation is done to collect natural resources, more specifically, wood. However, it also destroys the habitat of many species that live in forests and negatively impacts society. It can cause climate change, desertification, soil erosion, increased greenhouse emissions, and other problems. To avoid this impact on the community, the number of trees cut down must be minimized.

1.1. Cattle Manure Cellulose Pulp

Cattle manure is entirely organic. Because the nutrients were all retained in the excrement after the Cattle had digested it. Cattle are mostly fed grain and grass, which include cellulose fibers. This cellulose fiber is also known as lignocellulose, a material that can be used for paper production. Moreover, in the Philippines, cattle are abundant. The total Cattle inventory was 2.58 million heads last December 2022 (Philippine Statistics Authority, 2022). Therefore, leading to a large source of cellulose for paper.

1.2 Properties of Kapok (*Ceiba pentandra*) Seed Hair Fibers

Kapok seed hair fibers or *kapasanglay* have been identified as a potential source of cellulose fibers and great reinforcement for various textiles. It was found to have a considerable amount of hemicellulose, an integral component in papermaking (Sangalang, 2021). For every hectare of Kapok trees in the Philippines, there is an average yield of 450 kilograms of Kapok seed hair fibers (Philippine Fiber Industry Development Authority, 2016).

2. METHODOLOGY

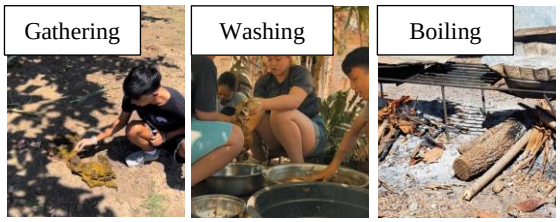
2.1 Research Design

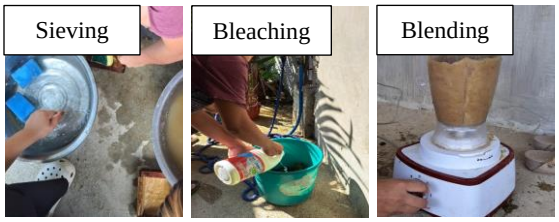
This study utilized the experimental design, which is a type of research design that relies on testing the relationship between variables. The paper made from cattle manure cellulose pulp and Kapok (*Ceiba pentandra*) seed hair fibers served as the experimental variable, and the commercial paper as the control variable. These variables were compared in terms of scent, texture, writability, foldability, thickness, tensile strength, and tensile index.

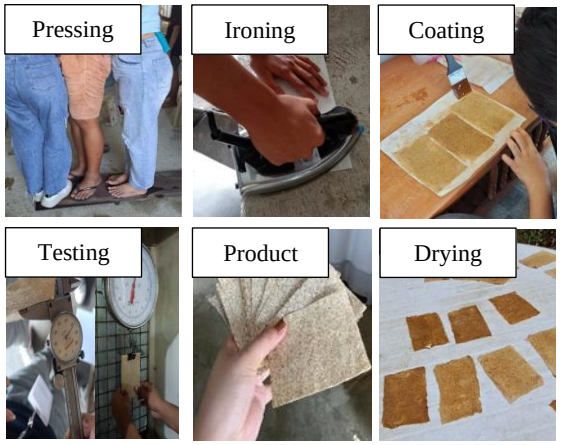
2.2 Materials

Cattle manure cellulose pulp and Kapok (*Ceiba pentandra*) seed hair fibers were the main materials for this research study. Bleach was the material that softened and whitened the cattle manure. Lye was then used as the main binding agent, while cornstarch and coffee grounds served as its coating agent.

The cattle manure and Kapok (*Ceiba pentandra*) seed hair fibers were collected, washed, and boiled separately. The manure was soaked in bleach and water overnight. The materials were blended and put in a bucket filled with water and 80 ml of lye liquid. A mold and deckle were used to sieve the refined fibers. The molds were flipped on a mesh screen, and a piece of plywood was placed above the sample and pressed using human weight. After the press, the samples were ironed. They were brushed front and back with a gelatinous cornstarch and coffee grounds solution. After brushing, it was sun-dried for 2 to 3 hours.







2.3 Data Gathering

The observation sheet was the primary research instrument in gathering numerical data. Once the Cattle manure cellulose pulp and Kapok (*Ceiba pentandra*) seed hair fibers papers were produced, an evaluation sheet consisting of the 5-point Likert scale was utilized to gather the respondents' evaluation of the scent, texture, writability, and foldability of the product. Three product and commercial paper samples underwent three trials to measure thickness, tensile strength, and tensile index. Thickness was measured using a dial caliper. Tensile strength was obtained using a Salter scale, while the tensile index was computed from the tensile strength utilizing the TAPPI/ANSI T494 om-01.

Tensile Strength (lbf/in.) = Breaking force (lbf) ÷ Width of specimen (in.)

Tensile Strength (kN/m) = Tensile Strength (lbf/in.) × 0.175

Tensile Index (Nm/g) = 1,000 × Tensile Strength (kN/m) ÷ Grammage (g/m2)

3. RESULTS AND DISCUSSION

Table 1

Quality of the Cattle Manure and Kapok Seed Hair Fibers Paper in terms of Scent, Texture, Writability, and Foldability

Variables	Cattle Manure and Kapok Paper	Descriptive Interpretation
Scent	3.71	Minimal scent
Texture	3.17	Coarse but pleasant to touch
Writability	3.59	Quite easy to write on
Foldability	3.54	Easy to fold and maintains shape

Table 1 shows the means of the quality of the cattle manure and Kapok seed hair fiber paper in terms of scent, texture, writability, and foldability.

It was observed that the scent of the Cattle manure and Kapok seed hair fiber paper was minimal ($\mu = 3.71$). The texture was coarse but pleasant to touch ($\mu = 3.17$). It was quite easy to write on the product ($\mu = 3.59$). Finally, it was easily foldable and able to maintain its shape ($\mu = 3.54$).

Table 2

Quality of the Commercial Paper in terms of Scent, Texture, Writability, and Foldability

Variables	Commercial Paper	Descriptive Interpretation
Scent	3.66	Minimal Scent
Texture	3.69	Smooth and pleasant to touch
Writability	4.03	Quite easy to write
Foldability	3.64	Easy to fold and maintains shape

Table 2 shows the means of the quality of the commercial paper in terms of scent, texture, writability, and foldability.

The commercial paper was also observed to have a minimal scent ($\mu = 3.66$). It was smooth and pleasant to the touch ($\mu = 3.69$). It was quite easy to write ($\mu = 4.03$), and the paper was easy to fold and can maintain its shape after folding ($\mu = 3.64$).

Table 3

Quality of the Cattle Manure Cellulose Pulp and Kapok (Ceiba pentandra) Seed Hair Fiber Paper and the Commercial Paper in terms of Thickness, Tensile Strength, and Tensile

Variables	Cattle Manure and Kapok Paper	Commercial Paper
Thickness	0.60 mm	0.21 mm
Tensile Strength	0.23 kN/m	0.28 kN/m
Tensile Index	927.25 N-m/g	3460.38 N-m/g

Table 3 shows the measured means of the quality of the cattle manure cellulose pulp and Kapok (*Ceiba pentandra*) seed hair fibers paper and commercial paper in terms of thickness, tensile strength, and tensile index.

A mean thickness of 0.60 mm was computed for cattle manure cellulose pulp and Kapok seed hair fibers, while a mean thickness of 0.21 mm was computed for commercial paper. This implies that the commercial paper is significantly thinner than the cattle manure and Kapok seed hair fibers paper.

The results of the computed mean for tensile strength of the three trials are as follows: Cattle manure cellulose pulp and Kapok (*Ceiba pentandra*) seed hair fiber paper obtained 0.23 kN/m tensile strength, while the commercial paper obtained 0.28 kN/m tensile strength. This implies that the cattle manure cellulose pulp and Kapok (*Ceiba pentandra*) seed hair fiber paper is slightly weaker than the commercial paper.

The results of the computed mean for tensile index of the three trials are as follows: Cattle manure cellulose pulp and Kapok (*Ceiba pentandra*) seed hair fibers paper

obtained 927.25 N-m/g tensile index, while commercial paper obtained 3460.28N/m tensile index. This implies that the commercial paper is significantly stronger per grammage than the cattle manure paper.

Table 4

Difference Between the Cattle Manure Cellulose Pulp and Kapok (Ceiba pentandra) Seed Hair Fiber Paper and Commercial Paper in terms of Scent

	Cattle Manure and Kapok Paper	Commercial Paper
Mean	3.711	3.655
Variance	0.471	0.0405
T Stat	0.134	-
T Critical two-tail	2.776	-

Table 4 shows that there is no significant difference between the scent of the cattle manure and Kapok seed hair fibers (*Ceiba pentandra*) cellulose pulp paper and commercial paper since the computed T-value of .0134 is lesser than the value of the tabular T-value of 2.776. This means that the null hypothesis is to be accepted. It suggests that the product is comparable to the standard scent of commercial paper.

Table 5

Difference Between the Cattle Manure and Kapok (Ceiba pentandra) Seed Hair Fiber Paper and Commercial Paper in terms of Texture

	Cattle manure and Kapok paper	Commercial Paper
Mean	3.167	3.689
Variance	0.367	0.2604
T Stat	-1.142	-
T Critical two-tail	2.776	-

Table 5 shows no significant difference between the texture of the cattle manure and Kapok seed hair fibers (*Ceiba pentandra*) cellulose pulp paper and commercial paper since the computed T-value of 1.142 is lesser than the tabular T-value of 2.776. This means that the null hypothesis is to be accepted. It implies that the product is comparable to the standard texture of a commercial paper.

Table 6

Difference Between the Cattle Manure Cellulose Pulp Paper and Kapok (Ceiba pentandra) Seed Hair Fiber Paper in terms of Writability

	Cattle Manure and Kapok Paper	Commercial Paper
Mean	3.589	4.033
Variance	0.194	0.068
T Stat	-1.505	-
T Critical two-tail	2.776	-

Table 6 shows that there is no significant difference between the writability of the Cattle manure and Kapok seed hair fibers (*Ceiba pentandra*) cellulose pulp paper and commercial paper since the computed T-value of 1.505 is lesser than the tabular T-value of 2.776. This means that the null hypothesis is to be accepted. This further means that the product is comparable to the standard writability of commercial paper.

Table 7

Difference Between the Cattle Manure Cellulose Pulp and Kapok (Ceiba pentandra) Seed Hair Fiber Paper and Commercial Paper in terms of Foldability

	Cattle Manure and Kapok Paper	Commercial Paper
Mean	3.533	3.944
Variance	0.301	0.174
T Stat	-1.032	-
T Critical two-tail	2.776	-

Table 7 shows no significant difference between the foldability of the Cattle manure and Kapok seed hair fibers (*Ceiba pentandra*) cellulose pulp paper and commercial paper since the computed T-value of 1.032 is lesser than the tabular T-value of 2.776. This means that the null hypothesis

is to be accepted. It indicates that the product is comparable to the foldability of commercial paper.

Table 8

Difference Between the Cattle Manure Cellulose Pulp and Kapok (Ceiba pentandra) Seed Hair Fiber Paper and Commercial Paper in terms of Thickness

	Cattle Manure and Kapok Paper	Commercial Paper
Mean	0.6	0/206
Variance	0.0172	0.000633
T Stat	5.102	-
T Critical two-tail	2.776	-

Table 8 shows a significant difference between the thickness of the cattle manure and Kapok seed hair fibers (*Ceiba pentandra*) cellulose pulp paper and commercial paper since the computed T-value of 5.102 is greater than the tabular T-value of 2.776. This means that the null hypothesis is to be rejected. This implies that the product is not comparable to the thickness of commercial paper.

According to Alambra et al. (2022), the common office paper ranges in thickness from 0.05 mm to 0.10 mm. In addition, the kind of paper that is 0.06 mm thick is usually grayboard paper (ZX China Industrial Ltd., n.d.). Therefore, the cattle manure cellulose pulp and Kapok (*Ceiba pentandra*) seed hair fiber paper is more comparable to grayboard paper.

Table 9

Difference Between the Cattle Manure Cellulose Pulp and Kapok (Ceiba pentadra) Seed Hair Fiber Paper and Commercial Paper in terms of Tensile Strength

	Cattle Manure and Kapok Paper	Commercial Paper
Mean	0.23	0.276
Variance	0.00274	0.00116
T Stat	-1.276	-
T Critical two-tail	2.776	-

Table 9 shows no significant difference between the tensile strength of the cattle manure and Kapok seed hair fibers (*Ceiba pentandra*) cellulose pulp paper and commercial paper since the computed T-value of 1.276 is lesser than the tabular T-value of 2.776. This means that the null hypothesis is to be accepted. It further suggests that the product is comparable to the tensile strength of commercial paper.

Table 10

Difference Between the Cattle Manure Cellulose Pulp and Kapok (Ceiba pentandra) Seed Hair Fiber Paper and the Commercial Paper in terms of Tensile Index

	Cattle Manure and Kapok Paper	Commercial Paper
Mean	927.253	3460.38
Variance	147199.556	181714.638
T stat	-7.650	-
T Critical two-tail	2.776	-

Table 10 shows a significant difference between the tensile index of the cattle manure and Kapok seed hair fibers (*Ceiba pentandra*) cellulose pulp paper and commercial paper since the computed T-value of 7.650 is greater than the tabular value of 4.303. This means that the null hypothesis is to be rejected. It implies that the product is not comparable to the tensile index of commercial paper. Based on Adams (n.d.), the tensile index of paper is dependent on the grammage of the paper, which means the higher the grammage, the higher the tensile strength.

4. CONCLUSIONS

Through the different mass experiments, the researcher was able to produce paper primarily made from cattle manure and Kapok (*Ceiba pentandra*) seed hair fibers. This product was comparable to commercial paper in terms of scent, texture, writability, foldability, and tensile strength, closely resembling coarse art paper, and has a light brown color. When it comes to its thickness, it is much more similar to board paper. In terms of the tensile index, there is a huge difference when comparing the experimental product to commercial paper. As of now, the cattle manure and Kapok seed hair fibers cellulose pulp paper is not viable as printing paper. Through further research, there is a huge potential for the cattle manure and Kapok seed hair fibers cellulose pulp paper to become a print paper, providing an alternative

source of cellulose fibers for paper production. In the near future, this product may help reduce the continuous reliance on wood for paper production, decreasing deforestation.

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