World Journal of Environmental Biosciences
Available Online at: **www.environmentaljournals.org**

Volume 10, Issue 1: 35-38

https://doi.org/10.51847/tkMmywD2fA

ISSN 2277- 8047

Recycling Flower and Kitchen Waste to Make Biodegradable Paper

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ABSTRACT

Paper is one of the most used stationery commodities in the world. To reduce the dependency on timber and forest wood to make paper, there is an urgent need to look for alternative sources. This study aimed to generate biodegradable paper from floral waste. This would help save the environment from deforestation and improper management of garland waste. Dried flowers, boiled potato peels, newspaper shreds, and boiled corn husks were used in the ratio 5:3:2:1, pulp was formed in the grinder. Residual starch water was used as a binding agent. This pulp was spread and dried on a special mesh mold under uniform, moderate pressure. The formed paper was removed carefully and was tested at MSME, Mumbai, India, (as per IS 2617, Millboard, Greyboard & Strawboard), (Ministry of Micro, Small and Medium Enterprises, Govt of India), for its GSM (gm/sq mt), thickness, pH, ash content and moisture content. Statistical Analysis Used: Mean and SD. GSM of the paper was found to be 136.397 gm/sq.mt, with a thickness of 0.95mm. The pH of the paper was 6.17, ash content was 3.8% and moisture content was 5.8%. This paper has been categorized as Greyboard quality paper which is a homogenous board made of mixed waste paper with or without screenings and thickness not greater than 1mm. The produced paper was used to manufacture a paper bag. It can be used for pad backing, rigid boxes, cartons (not corrugated), toy packaging, and bookbinding.

Keywords: *Floral waste, Packaging, Greyboard paper, Recycling*

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Received: 12 December 2020
Accepted: 25 March 2021

INTRODUCTION

Paper is a basic stationery commodity that is used by everyone in the world. It is used to make carry bags, sachets, books, and much more. A large amount of the world's commercially cut timber is used to produce paper. The life cycle of paper is damaging to the environment. It starts with a tree being cut down and ends by being burned thereby emitting carbon dioxide into the atmosphere. Most of the paper manufacturing processes involve using pulp made from timber. Other environmentally conscious techniques include producing recycled paper (Fahmy *et al.*, 2017; Pathak *et al.*, 2021), producing paper from agricultural waste like banana fibers (Ekhuemelo, 2012; Arafat *et al.*, 2018), cotton stalks, wheat, and rice residues, etc. (Fahmy *et al.*, 2017). In a country like India, tons and tons of floral waste is produced in temples and other places every day (Bennett, 2017). It is now becoming imperative to contain the burden that this problem may pose. Statistically speaking, 800 crore kgs of flower waste is thrown into the Ganga river every day (Prasai, 2018; Ali *et al.*, 2021).

The current project is aimed at generating biodegradable paper from floral waste. This would help save the environment from deforestation and improper management of garland waste. Additionally, the manufacturing of this paper does not include the use of bleaching agents like hydrogen peroxide, which is used to lighten the overall color of the paper. Moreover, starch water has been used (Maurer, 2009), potato peels, and corn husks as a binding agent. This also helps to alleviate the problem of kitchen waste. Mohan *et al.* (2018) in their paper, have tried to tackle the problem of floral waste and at the same time produced a useful commodity that is 100% biodegradable. However, it does not provide information on the durability and characteristics of the paper. In the present study, a durability test on the paper produced has been done.

MATERIALS AND METHODS

The paper primarily was made of marigold flowers (*Calendula officinalis*) obtained from a flower market. A variant of the paper also included the use of tuberoses (*Polianthes tuberosa*) along with the marigold flowers. Other materials used were waste corn husks obtained from corn sellers, rice water, and peels obtained from potatoes (*Solanum tuberosum*). An important tool for making the paper was the mold and deckle (Muraleedharan & Perumal, 2010; Hasimun *et al.*, 2021). Miscellaneous materials, tools, and equipment required were newspapers, plastic trays, grinders, ladles, and vessels used for boiling.

Starch extraction and concentration

The potato peels were boiled in water for 90 minutes till the water became starchy, that is, the water gained the form of a thick broth. For the rice water, a similar procedure was followed and both solutions were brought to the same thick consistency.

However, a note was made that sometimes, the rice water had the same consistency as the water obtained from the potato peels post boiling. The rice water was not boiled in this case.

Creating the paper pulp

The flower petals were dried for 24 hours by wrapping them in newspaper and keeping them in an incubator at 37ºC. Next, as shown in **Figure 1**, the corn husks were cut into short pieces and boiled in water for about 45 minutes to one hour so that they became soft enough to tear easily. Using the dried flowers, boiled potato peels newspaper shreds, and boiled corn husks in the ratio 5:3:2:1, a pulp was formed in the grinder, as shown in **Figure 2**. To this, 100 ml of starch water concentrate was added. For every 110 grams of dry material, 100 ml of starch water was used.

Making the paper

Using a sieve, the excess water from the pulp was removed. The mold, as shown in **Figure 3**, was placed in a plastic tray and a uniform layer of the pulp was made on the metal mesh of it. The frame was carefully flipped onto a thick newspaper base. Using another newspaper to cover the paper, gentle uniform pressure was applied all over the surface. This was kept for drying in a dry place under moderate uniform pressure. After the pulpy layer dried completely, it was peeled out carefully from the newspaper. This peeled-out dry pulpy layer was the paper, as shown in **Figure 4a**.

Figure 1. Mixture Of Corn Husk, Floral Petals, Newspaper Shreds, Starch Water, and Potato Peels

Figure 2. Pulp Obtained after Grinding

Figure 3. Mesh Mold

Testing for starch

The presence of starch content in corn husks, potato peel, and rice water was detected using the qualitative Starch-Iodine Test.

Starch was extracted from each of the samples. Iodine reagent was added to 1 ml of extracted starch and a blue-black color change was observed.

Testing for paper

These tests were performed at MSME, Mumbai, India, (as per IS 2617 (2006): Millboard, Greyboard & Strawboard) (Ministry of Micro, Small and Medium Enterprises, Govt of India).

GSM measurement: GSM stands for Grams per square meter. It is a measurement of the paper density, also known as grammage, used to determine the quality of the paper. The higher the GSM, the heavier the paper (Alam *et al.*, 2016).

GSM calculation: (Weight of Sample in Grams)/ (Length of the Sample in Meters * Width of the Sample in Meters)

Thickness measurement: The thickness of the paper was measured using the Digital Calliper (Mitutoyo Absolute, P65, Least count 0.001mm)

pH measurement: The sample was cut into a piece of 2.0cm^2. It was completely soaked in distilled water and pH was determined using the standard pH strip.

Ash content measurement: The sample was cut into pieces of 2.0 cm^2 and weighed. The cut pieces were put in a crucible and introduced in a furnace at 180℃ where it was burned till the entire sample reduced to ashes. The crucible containing the ashes was weighed again and the percentage of ash content was calculated.

Ash content in % = [(Wf)/Wi]×100, where Wi is the initial weight of the paper and Wf is the final weight of the paper taken after conversion to ash.

Moisture content: The samples were cut into square pieces of 2.0cm^2 and weighed. The weight of the sample was recorded upon drying in an oven at 110 ℃ until a fixed dry weight was obtained.

Moisture Content in % = [(Wi - Wf)/Wi]×100, where Wi is the initial weight and Wf is the final weight after drying.

RESULTS AND DISCUSSION

Table 1. Qualitative Test for Starch

Starch Sample	Observation	Inference
Corn husk	Blue-black color not observed	The presence of starch was not detected
Potato peels	Blue-black color observed	The presence of starch was detected
Rice water	Blue-black color observed	The presence of starch was detected

Table 1 shows that the presence of starch was detected in samples extracted from potato peels and rice water whereas no color change was detected in the corn husk sample.

Table 2. Characteristics of Paper

CHARACTERISTICS	OBSERVATIONS
Grams per square meter (GSM)	136.397 ± 7.096 gm/sq.mt
Thickness	0.95 ± 0.02 mm

Observations are Mean and SD where n=3

Table 2 shows that the GSM of the paper cade in this study was found to be 136.397 gm/sq.mt. As per the regulations of the Government of India, the GSM for Greyboard ranges from 100 – 400 gm/sq.mt. Hence, the paper of this study was characterized as Greyboard based on the GSM value.
Table 2 also shows that the thickness of the paper was found to be 0.95 mm which is under the requirement of 1 mm of Greyboard.

Table 3. pH, Ash Content, and Moisture Content of the Paper

CHARACTERISTICS	OBSERVATIONS
pH	6.17
Ash content	3.8 ± 0.8 %
Moisture content	5.8 ± 0.4 %

Observations are Mean and SD where n=3

Table 3 shows that the pH of the paper was found to be 6.17 which is within the Greyboard requirement range of 5.5 to 7.5. It also shows that the ash content of the paper was found to be 3.8% which is under 10% as per the regulations. The moisture content of the paper was found to be 5.8%. As per regulations of the Government of India, the moisture content must be under 10% for Greyboard.

Effect of craft glue for sticking paper
Craft glue was used to stick two pieces of the paper. It was found that the paper did not stick together when craft glue was used for the same. Hence the paper had to be stapled to make a bag out of it, as shown in **Figure 4b**.

Application of paper made using floral waste

a)

b)

Figure 4. a) Floral Waste Paper, b) Bag Prepared Using the Floral Waste Paper.

Everyday use of flowers in temples and houses for worship or ornamental purposes, on disposal, contribute to a significant amount of local wet waste. Hence, floral waste can be used to prepare the biodegradable paper. All ingredients used in this study were sourced from daily kitchen waste which ensures cost-effectiveness. The binding of the paper was attributed to potato peels and rice water which are sources of naturally available starch. Corn husk and newspaper pieces contribute to the strength of the paper due to their fibrous nature. Excess of flowers, starch, or water compromises the form and quality of the paper. Therefore, the integration of floral waste and binding material must be in proper proportion for a steady final product.

Paper currently in use increases deforestation and consequently leads to other ill-effects such as loss of natural habitat of animals and global warming. The paper produced from floral waste can be utilized in the preparation of bags and packaging material. The paper made in this study was used to prepare a bag that carried a load of up to 500 g. With the additional layering of more such biodegradable paper, its weight carrying capacity can be further increased. This paper has been categorized as Greyboard quality paper which is a low grade, 100% recycled, greyboard of thickness not greater than 1mm used for pad backing, rigid boxes, carton (not corrugated) toy packaging, and bookbinding. Paper obtained from floral and other vegetable waste ingredients is eco-friendly and can prove to be an effective method in solid waste management.

CONCLUSION

This paper has been categorized as Greyboard quality paper which is a homogenous board made of mixed waste paper with or without screenings and thickness not greater than 1mm. The term Greyboard is used to describe a low-grade, 100% recycled, grey-colored thick board used for pad backing, rigid boxes, carton (not corrugated) toy packaging, and bookbinding.

ACKNOWLEDGMENTS: The authors would like to thank the MSME Centre, Mumbai (Ministry of Micro, Small and Medium Enterprises, Government of India) for allowing using their testing facilities.

CONFLICT OF INTEREST: None

FINANCIAL SUPPORT: None

ETHICS STATEMENT: None

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