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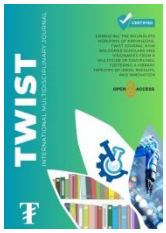

A Weed Species *Lantana camara* L.: An Alternative Raw Material in Handmade Paper Making

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Abstract
Lantana camara L. is amongst the 100 most famous weeds on the planet and got passage around in 60 nations. *Lantana camara* L. plant of family Verbenaceae indicates the potential for making paper. Handmade paper industry is one of the fastest growing industries in India. Paper industries are consistently in look for conceivable non wood sustainable raw material that can supplant customary timberland based species like bamboo and wood. The present study focuses on *Lantana camara* L. a notorious weed that could be potential source for paper and pulp production. The raw material utilized for this experiment was leaf and twigs of *Lantana camara* and was cut into an appropriate size and subjected to the different NaOH concentrations. Using a British Sheet Former, 60 GSM handsheets were created in accordance with Standard TAPPI TEST guidelines. The sheet was made, and then pressed dried, and subjected to additional testing. To add smoothness, a calendaring operation was performed.

The greater physical strength features at four different NaOH concentrations indicate that the 6% and 8% NaOH *Lantana* fibre has proven to be quite successful. From the present finding it can be concluded that *Lantana* fibre can be utilized to produce handmade papers. The pulp thus produced can be used for making variety of handmade papers / paper boards, and also can be used in making patal/dona. Due to the shortage of trees and forests, the pulp and paper businesses around the world are struggling. It's time to start looking for solutions to get out of this situation. In this study, alternative raw materials were used to create paper using the "Handmade Method".

Keywords
Lantana camara L., Handmade paper, Handsheets, NaOH concentrations

INTRODUCTION

The supply of the preferred softwood is unable to meet the increasing demand for paper and pulp products. This has led to the diversification of different raw materials as supplies for pulp production [1]. Paper is a potential alternative for plastic as it is biodegradable material [2].

Paper has become a ubiquitous part of everyday life, appearing in many forms and purposes. It is estimated that an average of 300 million tonnes of paper is consumed worldwide each year. Virgin cellulose is most commonly used to make paper. However, 38% of the world's fiber supply comes from recycled paper, and another 7% comes from non-wood fibers derived from plants such as hemp and Kenaf [3-4]. In addition, in areas where forest resources are scarce, it is necessary to discover non-woody plant fibers suitable for paper production [5-6]. Moreover, global warming and carbon emission restrictions have made logging more difficult. Wood pulp prices are currently unstable but are expected to rise exponentially in the long term [7].

Therefore, it could be of great benefit if the pulp production process could be supplemented with less commercially important non-tree plant species, i.e. weeds. The traditional approach to weed control is mass burning,

which can increase greenhouse gas levels. As we know, most of these weed species are quite fibrous in nature and could be better used for environmentally friendly strategies [8-9].

Lantana camara is amongst the 100 most famous weeds on the planet and got passage around in 60 nations [10-12]. This weed has been established as a significant weed in 12 nations and recorded amongst the 5 most toxic weeds predominant in Australia and covered 60% fields in Queensland [13]. Proximate chemical analysis of *Lantana camara* has been done by using Standard TAPPI Test methods shows that it can be a good source of handmade paper as it possesses the 61.65 % alpha cellulose [14]. Therefore, this study focuses on *Lantana camara* L. a notorious weed that could be potential source for paper and pulp production.

METHODOLOGY

This investigation was carried out during the season of 2021 and 2022 at Kumarappa National Handmade Paper Institute, Jaipur to evaluate the properties of paper pulping produced from the wood of *Lantana camara.* L. The handmade paper making involves various stages like collection of raw material, chopping, beating, pressing, cutting and drying.

STEPS INVOLVED IN PRODUCING HANDMADE PAPER

Preparation of raw material

The raw material utilized for this experiment was leaf and twigs of *Lantana camara* as shown in Fig 1. It was collected from the nearby wild areas of Pratap Nagar, Jaipur. To assess the compatibility of the sheet, the leaf and twig pieces were cut into lengths of 2 to 3 cm, washed many times to remove any contaminants and then subjected to various ratios of chemical and alkaline treatment.

Fig. 1 *Lantana camara* weed chopped in small pieces

Alkaline Treatment of Raw material

Alkaline solutions are applied during alkali treatments. Treatments with alkali are crucial for producing paper. NaOH treatment has been utilised among these to delignify a particular raw material. The swelling brought on by the alkali treatment increases the internal surface area, lowers the degree of polymerization, reduces crystallinity, separates the structural links between lignin and carbohydrates, and disrupts the structure of the lignin. As a result, the lignin is dispersed from the raw material and separated as a liquid with a high concentration of phenolic chemicals, or the process effluent. The disadvantage of this method is that some of the hemicellulose is also degraded. The raw material was cut into an appropriate size before being treated to the different NaOH ratios shown in table 1 and subjected to the alkaline pulping procedure through open hot digestion. The raw material was cooked for three hours in an open pan on a gas burner at a temperature of 100° C. As a result, water must be regularly added to keep the water level constant.

Table 1 Different parameters used for the process of pulping

Parameters	**Character**			
Oven Dry weight taken	1200gm	1200gm	1200gm	1200gm
Chemical NaOH used	6%	8%	10%	12%
Time for pulping	3 Hrs.	3 Hrs.	3 Hrs.	3 Hrs.
Water added	4 Ltr	4 Ltr	4 Ltr	4 Ltr
Temperature	100^{o}C	100^{o}C	100^{o}C	100^{o}C

Stock preparation

After the NaOH treatment, the raw material was washed with flowing tap water on a muslin cloth. Black liquors were then collected and held for analysis.

After washing, the pulp was recovered, but it is still not ready to form sheets. It must go through a mechanical process to impart a number of qualities that are necessary in various grades of paper. The lab beater was used to beat lantana pulp. The lab beater was filled with the pulp as depicted in Fig 2. It was kept the same consistency when water was added to it. As mentioned in Table 2, different pulp ratios required a different beating period.

Fig. 2 Small laboratory beater used for beating the *Lantana*

Table 2 Alkaline treated raw material of different concentration with different time period in beater

Chemical concentration	Time taken in beater
6%	52 minutes
8%	45 minutes
10%	36 minutes
12%	30 minutes

Dryness of pulps

To determine the dryness of sample first of all weigh the pulp (total net weight of the pulp) and then take 2-3 petri plates with and without pulp samples which allows us to establish how dry the pulp was. After that, it was left overnight in a hot air oven set at 102^{o}C. Cool the plates in a desiccator and weighed up to the constant weight is obtained. The following formula is used to determine the dryness:

$$\text{Dryness in \%} = \frac{(W1-W2)X100}{WI}$$

W1 = Sample weight prior to drying
W2 = Sample weight after drying

Yield determination of pulp

Weighing the pulp ("W" total net weight of pulp) and taking two to three petri plates and weighing them with and without pulp samples to calculate the pulp yield. It was then kept in a hot air oven that was heated to 102+2 degrees Celsius for the entire night. Pulp yield was determined by drying the sample upto a constant weight and following formula is used oven dry weight (O.D.W) calculation:

$$\text{O.D.W.} = \frac{W\ X\ Dryness}{100}$$

W = Total weight of the pulp
O.D = Oven Dried

$$\text{\% yield of obtained fiber} = \text{O.D.} \times 100$$

$$Yield\ \% = \frac{OD\ Weight\ of\ the\ taken\ pulp}{OD\ Weight\ of\ the\ obtained\ pulp}\ X\ 100$$

Sheet making

Using a British Sheet Former, 60 GSM handsheets were created in accordance with Standard TAPPI TEST guidelines [15]. The sheet was made, then pressed (Fig. 3 and 4), dried, and subjected to additional testing. To add smoothness, a calendaring operation was performed.

Fig 3 British sheet maker for making round sheet

Fig 4 Laboratory level small sheet pressing machine

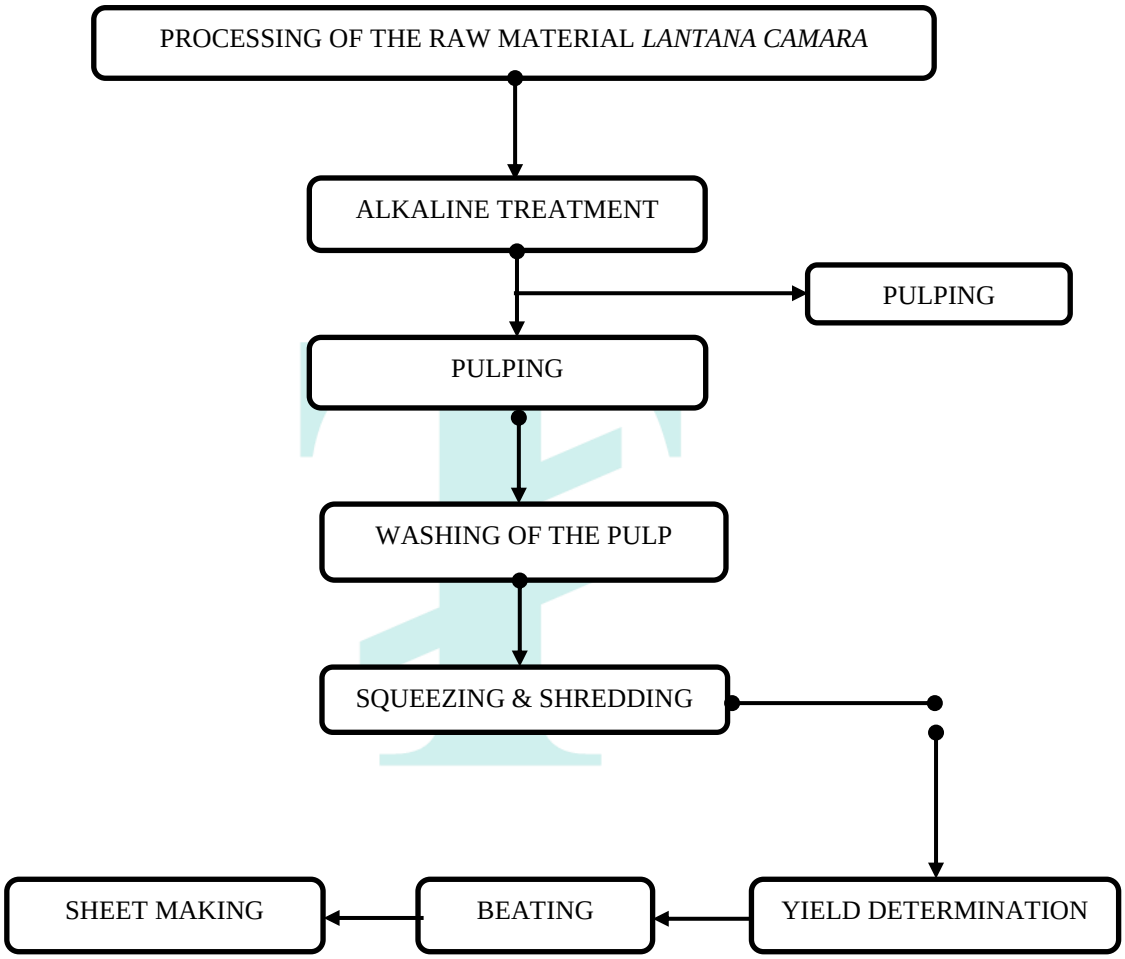

Fig. 5 Steps involved in handmade paper making process

RESULTS

In *Lantana camara* plant the moisture was assessed according to method given above and the results are tabulated in table 3 which shows that the average dryness of raw material was 45.56% for 6 and 8 % NaOH and 34.39% for 10 and 12% NaOH which on deducting from 100 the moisture content is equivalent to 54.44% for 6 and 8 % NaOH and 65.61% for 10 and 12% NaOH

Table 3 Some parameters of the *Lantana* pulp

Parameters	**Chemical Concentration (NaOH)**			
	6 %	**8 %**	**10 %**	**12 %**
Dryness of raw material	45.56 %	45.56 %	34.39 %	34.39 %
Moisture of the raw material	54.44 %	54.44 %	65.61 %	65.61 %
Total pulp obtained	817.31gm	783.07gm	726.92gm	686.93gm
Black liquor obtained	1850ml	1780 ml	1700 ml	1650 ml
Dryness of the pulp	21.48 %	21.51 %	22.23 %	23.73 %
Moisture of the pulp	78.52 %	78.49 %	77.77 %	76.27 %

Beating of the used pulp samples

All the treated chopped raw material was oppressed for pulping methods using the circumstances referenced before. Entire obtained pulp was properly cleaned before being pressed and shredded to determine its dryness and, consequently, its pulp yield.

Subsequently, the pulps were beaten until 350ml of CSF were obtained. Additionally, table 2 displays the period of time that was required to beat different concentration of pulp ratio into this CSF. It can be easily seen from the table 4 that the yield of pulp decreases gradually by adding NaOH concentration. As it was 68.10% for 6%NaOH, 65.25% for 8%NaOH, 60.57% for 10%NaOH and 57.24% for 12%NaOH concentration. Based on the obtained data, it can be said that pulp yield falls as chemical concentration rises. Arafat, *et al*, [16] also observed a similar trend of decrease in pulp yield on increasing the chemical dose while treating banana fiber for handmade paper making. Thus, the greater physical strength features of all 4 distinct concentrations indicate that the 6% and 8% NaOH *Lantana* fibre has proven to be quite successful Fig. 5.

Table 4 Pulp yield of different ratio of alkaline from *Lantana* weed

Chemical Concentration (NaOH)	Pulp Yield
6%	68.10%
8%	65.25%
10%	60.57%
12%	57.24%

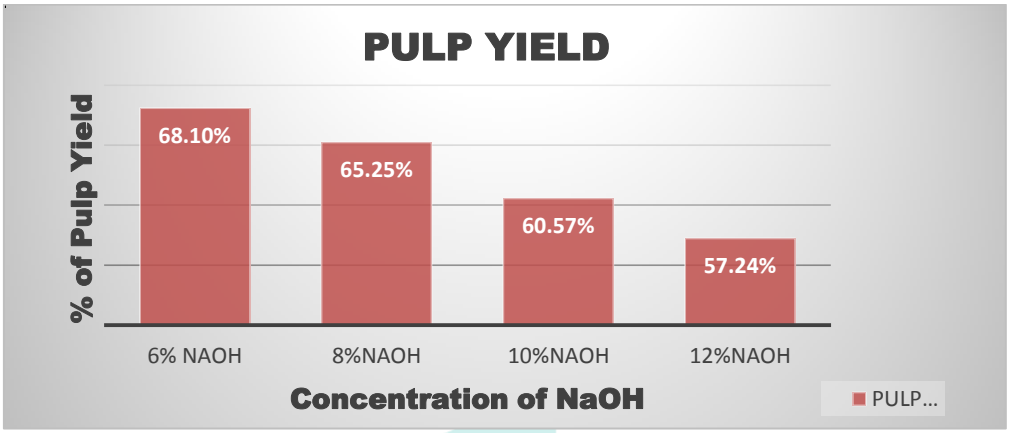

Fig. 5 Graphical representation to obtained pulp yield

Thus, employing NaOH in a digester, *Lantana* fibre can be utilized to produce handmade papers as shown in figure 6, 7, 8 and 9 with different concentrations. The pulp thus produced can be used for making variety of handmade papers / paper boards, and also can be used in making Patal/ Dona. For those working in the industry that have cooking utensils such as digesters or even if they do not, they can employ open digestion instead.

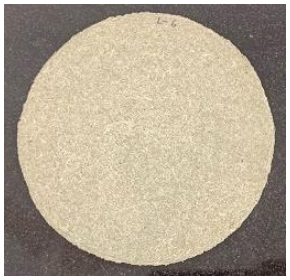

Fig. 6 Sheet prepared using 6% NaOH concentrations

Fig. 7 Sheet prepared using 8% NaOH concentrations

Fig 8 Sheet prepared using 10% NaOH concentrations

Fig 9 Sheet prepared using 12% NaOH concentrations

DISCUSSION

Handmade paper making is processed manually in contrast to the industrial mill-made paper. Handmade making paper is a unique and elaborate process which can be done with natural variations at a time [17-18]. The main objective of this study was to ascertain whether the fibre of *Lantana camara* L. might be utilised as a source of lignocellulosic fibres for the production of paper or not. In the present study, paper was produced with the "Handmade Method" with alternative raw materials. The main goal of this research was to introduce low-cost alternative raw materials for the production of handmade paper. It was found that the pulp yield was maximum at 6% and 8% NaOH concentration when the pulping was carried out at various concentrations. Thus the paper produced from the *Lantana Camara* can be used for many things, including producing dona or patals and rough papers. The fibre obtained from Comparing lantana camara to other different fibres like banana fibre [19-20], rice straw [21], and Datura fibre [22] reveals that this toxic plant can be used in the paper industry as an alternative and can lessen the strain of toxicity on other crops, allowing this weed to be used commercially [23-24]. This research can help the environment and the country's economy by producing handcrafted, environment friendly papers and other paper items [25-26].

CONCLUSIONS

The global lack of forests and trees is having a negative impact on the pulp and paper sectors. Searching for other options to get out of this situation is now necessary. The "Handmade Method" was used in this study to make paper using substitute raw materials. The main goal of this research was to introduce low-cost alternative raw materials for the production of handmade paper. At this moment, alternative raw materials such as wastepaper, recycled pulp, and paddy straw were used. The physical test results revealed that the papers made from a blend of wastepaper, recycled pulp, and paddy straw were not only worthwhile but is also similar to the standard of "Printer Paper". Ultimately, wastepaper and paddy straw can be considered as appropriate substitute raw materials for the handmade paper industries because of the cost-effectiveness. The production of handmade papers and other paper goods that are environment friendly can benefit both national economy as well as the global environment.

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