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Evaluation for characterization of pulp and paper making from weed species *Lantana camara* L.

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Abstract- One of the significant purposes behind deforestation is logging of wood and utilizing a significant measure of this logged wood for the development of paper and pulp. Subsequently, non-woody plant species are being looked to complement the conventional process for production of paper and pulp. In the present study, proximate analysis is done for the weed plant *Lantana camara* which is available locally everywhere in abundance according to the Technical Association of the Pulp and Paper Industry standard method. The results show that holocellulose content found in twig of *Lantana camara* L. is 70.56% whereas in leaves of *Lantana camara* L. is 58.64% which were thus evaluated in comparison to the other species as like banana fibre, Datura fibre. Also the lignin content of twig and leaves of *Lantana camara* L. is compared which is observed as27.7% and 24.59% respectively. The results of the current study showed very good concentration of the alpha holocellulose i.e., 61.65% for twigs and 50.51% for leaves as compared to the other wood raw material. Thus the result shows the possible potential of this weed species for make its use in pulp and paper industries. Moreover, this species which is locally available can also become a very good source of income if an organized effort is considered to pool the biomass.

Key words: Paper, Industry, Pulp, Deforestation, Hollocellulose.

INTRODUCTION

Handmade paper is the heritage art of India which offers a chance of making something novel with only very few resources. Developing nations like India are struggling with the shortage of raw material, lack of funds and power resources. In the mean time development of handmade paper industry is inspiring an eco-friendly method of paper production with very few resources.[1] If we describe paper then we can say that paper is cellulose that is extracted from plant materials whose quality relies upon the brightness and fineness of the fibers. The most widely recognized source of natural fibers for making paper is wood pulp from pulpwood trees.[2] Indian paper industry represents around 3.7% of the world's production of the paper and paper board. The Indian paper industry produces 53% packaging grade, 38% waste paper grade and 8% newspaper grade.[3] With the CAGR of 8% during the period from 2011 - 2016 versus 1% for its worldwide peers, India is accounted to be one of the major rapid developing paper markets in the world.[3] As shown by the report on Ecology Global Network, the use of paper has become over 400% in the beyond 40 years worldwide. By and by, in each continent, paper industries utilize just about 4 billion trees or 35% of the absolute trees cut all through the world.

Thus the paper business is completely depends on the forest. Mill paper industry is using the raw material which is entirely based on forest that causes the

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deforestation as well as also the pollution problems. So it is strongly required to find the alternate method for the creation of paper and that can be the handmade paper which is entirely pollution free and is also eco-friendly. Besides handmade paper products protect the natural resources because it is truly tree free in nature and thus uses very little of machinery, chemicals and equipment.[4]

So this can be replaced by handmade paper which may be an eco-friendly option. Through handmade papermaking, one can utilize the non- woody raw material and weed plants which are of less commercial importance. Numerous such weed plants which are fibrous in nature are available and thus hold potential to be use as a raw material for making the eco-friendly handmade paper. It will tend to be a shelter that we can complement pulping process with the non-woody plant species, i.e., weeds, which are of less commercial significance. As we know, huge number of these weed species are fibrous in nature, and they can be better exploited for the eco-friendly methodologies.

All around the world *L. camara* is considered as a harmful weed. *L. camara* grows well in the tropical, subtropical, and mild locales at a high height up to 2000 m. The plant has a woody stem with a few distinct shades of flowers i.e., red, white, pink as well as plant also contain spines or prickles.[5] The genus *L. camara* L. is a significant ornamental, therapeutic, as well as medicinal oil producing plant from family Verbenaceae.[6] Plant invasion is the priority danger to overall biodiversity and consequently danger to both environment and economy of any nation.[7] In their new environment, this plant become predators[8], parasites[9], competitors,[10] hybridizers[11] and it causes the diseases to neighborhood and domesticated plants and animals.[12] Use of *Lantana* can be a convincing strategy for managing the weed. Weed is a weed until it has no usage, as bamboo around 200 years earlier. It transformed into asset when people started using it. Owing with the presence of fibres, *L. camara* can possibly make the esteem or worth added things, for instance, α-cellulose and its derivatives, handmade paper, wood composites.[6] Therefore the present study focus on weed plant *L. camara* for making handmade paper.

MATERIAL & METHOD

Raw Material Collection and Processing

To assess the suitability and feasibility in production, it is necessary to determine the composition and structure of the raw material. Plant has to be collected from the institute's garden i.e., Kumarappa National Handmade Paper Institute, Jaipur and nearby areas. The proposed raw material of the study involves leaves and twigs of *L. camara* plant. A fine quality dust will be prepared using the Dust Making machine for proximate analysis to get preliminary information about its suitability for paper making. The raw material shall be processed further as per the standard TAPPI Test procedures mentioned below in table-1. Different parameters of proximate analysis are to be evaluated will include Alcohol- Benzene solubility, Hot- Water Solubility, Cold- Water Solubility, N/10- NaOH Solubility, Holocellulose, Alpha- cellulose, Klason Lignin, Ash Content, etc.

Table 1- Standard TAPPI Test Methods for Proximate Chemical Analysis

Sl.No.	Standard methods	TAPPI No.
1	Cold-water Solubility	T 207 cm-99
2	Hot-water Solubility	T 207 cm-99
3	N/10- NaOH Solubility	T 212 cm-02
4	Alcohol-Benzene Solubility	T 204 cm- 97
5	Holocellulose	Useful method-249-75
6	Klason's Lignin	T 222 cm-02
7	Alpha-cellulose	T 203 cm-99
8	Ash Content	T 211 cm-02

Sample preparation

Preparation of sample for the analysis of proximate tests was done by drying the leaves and twigs of the plant Lantana camara separately in the hot air oven at 102 ± 2°C till the constant weight. Then make the dust of the sample by passing the sample in the dust making machine to convert it onto the fine powder. Now it can be used for the analysis of proximate parameters.

1) Cold- Water Solubility: Place the 2 g (O.D.) samples of *L. camara* into 400 ml flat bottom flasks with 300 ml of distilled water. Keep the flasks at room temperature for 48 hours. Filter the samples by vacuum suction into G-2 glass crucibles of known weight. The residues to be washed with distilled water. Oven dry the crucibles at 105 ± 2°C for overnight. Cool the crucibles in a desiccators and weighed until a constant weight is obtained.

The following formula is used to obtain the cold-water solubility of *L.camara*:

$$\text{Cold Water Solubility \%} = \frac{W2 - W1}{\text{O.D Weight of Sample}} \times 100$$

W2 - Stands for O.D. weight of sample.
W1 - Stands for weight of crucible with sample-weight of empty crucible.

2) Hot-Water Solubility Test: Place the 2 g (O.D.) samples of *L. camara* into 250 ml flat bottom flasks with 100 ml of distilled water and place it in the boiling water bath. Attach the reflux condensers to the flasks and place the apparatus on hot plate at 35- 40°C for three hour. Remove the samples from the hot plate and filter by vacuum suction into G-2 glass crucibles of known weight. The residues to be washed with distilled water. Oven dry the crucibles at 105 ± 2°C for overnight. Cool the crucibles in a desiccators and weighed until a constant weight is obtained.

The following formula is used to obtain the hot-water solubility of *Lantana camara:*

$$\text{Hot Water Solubility} = \frac{W2 - W1}{\text{O.D Weight of Sample}} \times 100$$

W2 - Stands for O.D. weight of sample.

W1 - Stands for weight of crucible with sample-Weight of empty crucible.

3) N/10-NaOH solubility: Take 2 g (O.D.) samples of *L. camara* in 500 ml flat bottom flasks with 100 ml of 1% NaOH solution. Attach the reflux condensers to the flasks and Place the apparatus on hot plate at 97-100°C for one hour. Remove the samples from the hot plate and filter by vacuum suction into G-2 glass crucibles of known weight. The residues to be washed with distilled water. Oven dry the crucibles at 105 ± 2°C for overnight. Cool the crucibles in a desiccators and weighed until a constant weight is obtained.

The following formula is used to obtain the N/10-NaOH solubility of *Lantana camara* :

$$\text{N/ 10 NaOH Solubility \%} = \frac{W2 - W1}{\text{O.D Weight of Sample}} \times 100$$

W2 - Stands for O.D. weight of sample.

W1- Stands for weight of crucible with sample-Weight of empty crucible

4) Alcohol-Benzene solubility Test: The extraction apparatus consists of a soxhlet extraction tube which is connected with a reflux condenser on the top and joined at the bottom to a boiling round bottomed flask. 2 g (O.D.) samples from *L. camara* is to be placed into whatman filter paper extraction thimbles. The thimbles were placed in a soxhlet extraction tubes. The boiling flasks are to be filled with the solution of benzene and alcohol in the different ratio of 2:1, 1:2, 1:1, 0:1 respectively and place on the heating mantles. Attach the flask with the extraction apparatus and start the water flow. The extraction is carried out for 8 hours (extraction is for two hours with the each ratio solution of benzene and alcohol). After extraction, remove the thimble from soxhlet tubes and dried at 105 ± 2°C for overnight. Remove the material from thimbles and weight it.

The following formula is used to obtain the alcohol-benzene solubility content of *Lantana camara:*

$$\text{Alcohol} - \text{Benzene Solubility \%} = \frac{W2 - W1}{\text{O.D Weight of Sample}} \times 100$$

W2 - Stands for O.D. weight of the sample before extraction.

W1 - Stands for O.D. weight of the sample after extraction.

5) Hollo cellulose: Place the 3 g (O. D.) extractive-free samples of *L.camara* in 250 ml flasks with small watch glass covers. Treat the samples with 80 ml of distilled water, 0.5 ml of cold glacial acetic acid, and 1.5 gram of $NaClO_2$. Place the flasks into the water bath maintained between 70°-80°C. Every hour for three hours add the 0.5 ml of cold glacial acetic acid and 1 g of $NaClO_2$ and stir the contents of the flask constantly. At the end of three hours, cool the flasks until the temperature of the flasks get reduced to 25°C. Filter the contents of the flasks into G-2 glass crucibles of known weight followed by recycling. The residues are washed with acetone. Oven dry the crucibles at 105 ± 2°C for overnight. Cool the crucibles in a desiccator and weighed until a constant weight is obtained.

The following formula was used to determine the Holocellulos content in *Lantana camara:*

$$\text{Holocellulos} = \frac{W2 - W1}{\text{O.D Weight of Sample}} \times 100$$

W2 - Stands for weight of crucible + sample.

W1 - Stands for weight of empty crucible.

6) Klason lignin of *L. camara*: Place the 1g oven-dried extractive-free dusts in 100 ml beakers. Now add 15 ml of cold sulfuric acid (72%) slowly in beaker with stirring and mixing. The reaction proceeded for two hours with frequent stirring. Thereafter add 10ml of distilled water and stir the solution for 30 minutes. After two hours transfer the residues into flask and make the total volume up to 575 ml by adding 450 ml of distilled water in it. Place the flasks on hot plates for four hours. The flasks are then removed from the hot plates and the insoluble materials are allowed to settle. Filter the contents of the flasks by vacuum suction into G-3 glass crucibles of known weight. Wash the residues with distilled water and then oven dry the crucibles at 105 ± 2°C for overnight. Cool the crucibles in a desiccator and weighed until a constant weight is obtained.

The following formula is used to obtain the klason lignin content in *Lantana camara:*

$$\text{Lignin \%} = \frac{W2 - W1}{\text{O.D Weight of Sample}} \times 100$$

W2- Stands for weight of crucible + sample.
W1- Stands for weight of empty crucible.

7) Alpha-cellulose of *L.camara*: Place the 2 g oven-dried samples of holocellulose in 250 ml beakers with small watch glass covers. Now treat the samples with 75 ml of 17.5% NaOH and thoroughly mixed the sample. Now after dispersal, add exactly 100 ml of reagent to the sample. Suspension was then placed in water bath at 28± 2°C for the 30 minutes and later add 100 ml of cold (25±2°C) distilled water with continuous stirring. After this filter the solution with G-2 glass crucibles of known weight. Wash the residues firstly with100 ml of 8.3% NaOH, then with 15 ml of 10% acetic acid and 1000 mlof hot tap water. Oven dry the crucibles at 105 ± 2°C for overnight. Cool the crucibles in a desiccator and weighed until a constant weight is obtained.

For titration the following procedure is done-

Place the 2 g oven-dried samples of holocellulose in 250 ml beakers with small watch glass covers. Now treat the samples with 75 ml of 17.5% NaOH and thoroughly mixed the sample. Now after dispersal, add exactly 100 ml of reagent to the sample. Suspension was then placed in water bath at 28± 2°C for the 30 minutes and later add 100 ml of cold (25 ± 2°C) distilled water with continuous stirring. The contents of the beaker are then filtered and 100 ml of that filtrate was collected in a clean and dry flask. Now take 25 ml of filtrate in a beaker and add 10 ml of 0.5 N potassium dichromate followed by the addition by 50 ml concentrated H_2SO_4 and allow the solution to be warm for 15 minutes. After this add 50 ml of water to the solution so that it can again come at the room temperature.

Perform the titration with 0.1N ferrous ammonium solution and 2-4 drops of ferroin indicator as an indicator. The end is noted when the solution changed its Colour to purple.

The following formula is used to obtain α-cellulose in *L. camara*: α-Cellulose % (On the basis of Holocellulose=100)

$$\alpha - \text{Holocellulose} = \frac{W2 - W1}{\text{O.D Weight of Sample}} \times 100$$

W2=Weight of the oven-dry α-cellulose residue
W1=Weight of the original oven-dry holocellulose sample.
Total Alpha Cellulose % =
A- Alpha cellulose on the basis of holocellulose.
B- Percentage of holocellulose in the sample

8) Ash content of *L.camara*: Ignite the empty crucibles in the muffle at 575°C. After ignition place thecrucibles in a desiccator to make it cool down. When cooled to the room temperature, weighed the crucibles on the analytical balance. Place the 2 g (O.D.)samples of *L. camara* in the crucible. Place the crucibles with contents in the muffle furnace and ignite for 2 hours. Thetemperature of final ignition is 575°C. Removed the crucibles with its contents to a desiccator, cool and weight accurately.

The following formula was used to obtain the ash percent of *Lantana camara*:

$$\text{Ash \%} = \frac{W2 - W1}{\text{O.D Weight of Sample}} \times 100$$

W2 - Stands for weight of crucible + sample.
W1- Stands for weight of empty crucible

RESULTS

A proper study of chemical composition of the chosen plant material is very important to have a superior understanding of their characters and thus it helps in the determination of the pulping procedure.[13] In table 2 the results are recorded for the proximate chemical analysis. It demonstrates the appropriateness of *Lantana camara* for papermaking.

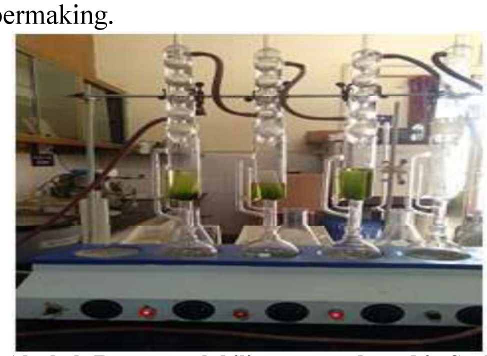


Fig. Alcohol- Benzene solubility test conducted in Soxhlet apparatus

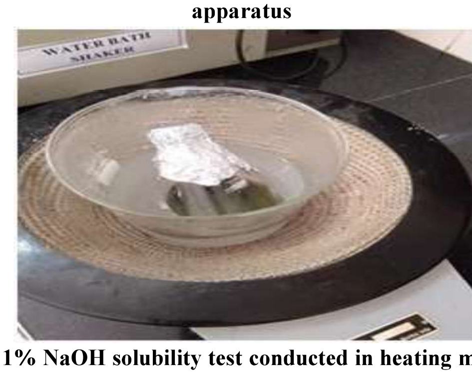


Fig. 1% NaOH solubility test conducted in heating mantle

Fig. Holocellulose after applying the complete procedure.

Table 2: Results for Proximate Chemical Analysis for *Lantana camara* twigs and leaves

Parameters	Result in percentage for twigs	Result in percentage for leaves
Hot water solubility	9.25 %	12.55 %
Cold water solubility	6.25 %	13.45 %
Ash content	7.6 %	12.62 %
Alcohol Benzene solubility	9.36 %	7.57 %
Lignin (klason)	27.7 %	24.59 %
1% NaOH Solubility	17.38 %	20.26 %
Hollocellulose	70.56 %	58.64 %
Alpha-cellulose	61.65 %	50.51 %

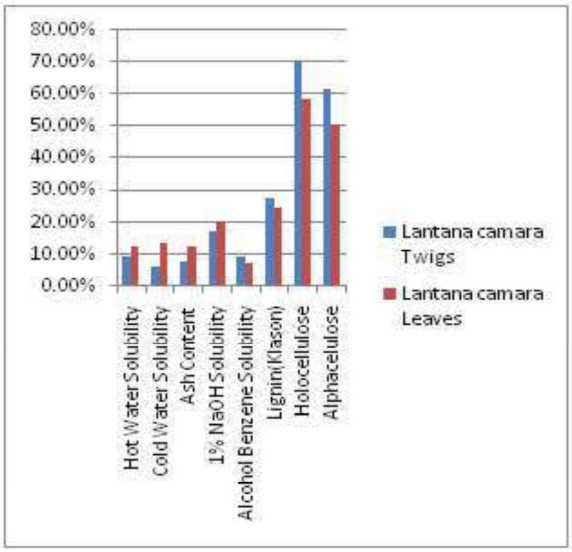


Fig. Comparison for the results of Proximate Chemical Analysis for *Lantana camara* twigs and leaves

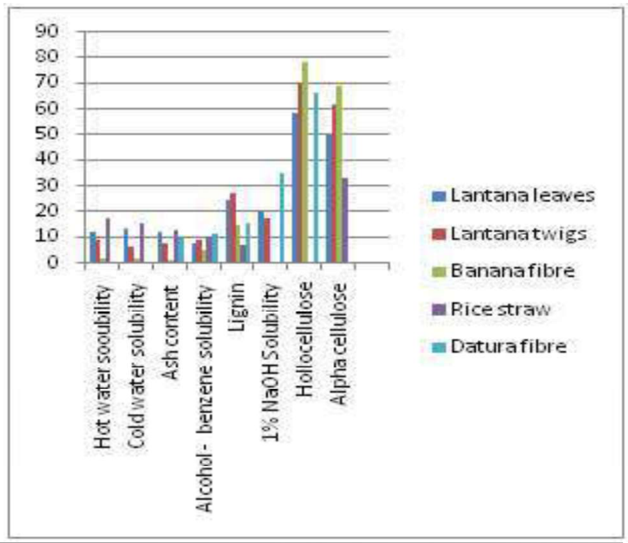
Plant material i.e., twig of *Lantana camara L.* contains 9.25% of hot water solubility and 6.25% of cold water solubility. The ash content and alcohol benzene solubility was 7.6% and 9.36% respectively. The lignin was observed 27.7%. Besides, 1% NaOH solubility is of significance in evaluating the sufficiency wood for decay and the value ranges from 10% to 30% is considered adequate and sufficient for further research.[14] The 1% NaOH solubility was 17.38%. The plant material contains 70.56% of Hollocellulose and 61.65% of alpha cellulose, which is favorable.

Plant material i.e., leaves of *Lantana camara L.* contains 12.55% of hot water solubility and 13.45% of cold water solubility. The ash content and alcohol benzene solubility was 12.62% and 7.57% respectively. The lignin was observed 24.59%. The 1% NaOH solubility was 20.26%. Hollocellulose found in the leaves was 58.64%. The results of *Lantana camara* can be compared through various other fibres as seen in table 3, such as Banana fibre[15], Rice straw[16], Datura fibre[17].

Table. 3 Results for Proximate Chemical Analysis for *Lantana camara* twigs and leaves is compared with Banana fibre, Rice straw, Datura fibre.

Parameters	*Lantana* leaves	*Lantana* twigs	Banana fibre	Rice straw	Datura fibre
Hot water solubility	12.55%	9.25 %	-	17.8%	-
Cold water solubility	13.45%	6.25 %	-	15.6%	-
Ash content	12.62%	7.6	1.6%	12.8%	9.57%
Alcohol Benzene solubility	7.57%	9.36 %	4.9 %	10.4%	11.66%
Lignin (klason)	24.59%	27.7 %	15.3 %	7.4%	15.79%
1% NaOH Solubility	20.26%	17.38 %	-	-	35.34%
Hollocellulose	58.64%	70.56	78.2%	-	66.55%
Alpha cellulose	50.51%	61.65	69.4%	33.4%	-

Fig. Results for Proximate Chemical Analysis for Lantana camara twigs and leaves is compared with Banana fibre, Rice straw, Datura fibre.



DISCUSSION

The earth is covered with about 30% of forest land. Between the years 1990 and 2005, there was a net decrease (1.7%) in the global forest area at an annual rate of change of 0.11%. The results of the current study showed very good concentration of the alpha-cellulose for twigs i.e.,61.65% as compare to the leaves i.e., 50.51%. Also the study indicated very good concentrations of holocellulose (60% to 70%) in comparison with the conventional soft and hardwood sources (75% to 85%).[18,19] The literature studies also additionally propose that potential weed species, for example, Torpedo grass, Water hyacinth, Giant bulrush, and Lantana can likewise be the better source of fibre for pulping.[13,14] Thus it has been seen that the *Lantana camara* can be a good source of paper making as it possess the 61.65 % alpha cellulose whereas rice straw only have the 33.4% for the same. To the next

Datura fibre also have 66.55% of the holocellulose but *Lantana* has 70.56% holocellulose. Supplementing these weed based pulp along with the conventional sources would be a viable alternative for managing the weed.

CONCLUSION

With the proximate analysis values, we can conclude that the used plant samples can be proposed as potential sources to complement the conventional ones. They open horizons to explore other weed varieties and also reduce the burden on the trees and thus the environment. They also provide opportunities for better management of weeds and production of value-added products using these sources. A proper awareness about the better utilization of such weeds cum agricultural wastes toward paper production will benefit both farmers as well as the environment. To add value, a community for pooling the potential biomass can be formed, and localized small-scale manufacturing units can be set up. This can provide opportunities for employment and waste management at community level.

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