

A novel approach: Handmade papermaking

Abstract

We can say that handmade paper is the heritage art of India which gives a huge opportunity of creating something novel only with very few resources. The paper industry is a forest based industry. Depleting forest cover is a major cause of concern. Thus the sustainable method for this is handmade paper making. Handmade paper industry is one of the fastest growing industries in India. Paper can be made either synthetically or naturally. Synthetic papers are generally preferred for work yet these papers have unfavorable impact on the climate and this can be replaced by handmade paper. The paper industry is a forest based industry. Depleting forest cover is a major cause of concern. Agricultural waste disposal is a major problem because of the presence of cellulose content and high lignin which results in pollution and affects the environment, which are very difficult to degrade. The misuse of natural resources has come closer to the limits of earth's capacity. The life cycle of mill made paper actually damages the environment from beginning to the end. Thus the study emphasizes on alternative eco-safe materials for production of handmade paper. The main purpose is to highlight the potential of agriculture waste used as non-wood materials for paper production.

Keywords: handmade paper, synthetic, agriculture, pollution, cycle, cellulose

Volume 7 Issue 1 - 2022

Shweta Bhodiwal,¹ Sunita Chauhan,² Reenu Agarwal,¹ Tansukh Barupal³

¹Department of Botany, IIS University, India

²Kumarappa National Handmade Paper Institute Pratap Nagar, India

³Department of Botany, MLSU, India

Correspondence: Shweta Bhodiwal, Department of Botany, IIS University, Jaipur, Rajasthan, India, Tel 7742313441, Email shwetabhodiwal.20@gmail.com

Received: February 09, 2021 | **Published:** February 22, 2022

Introduction

The human civilization saw a turning point in the form of innovation of paper when man created first sheet of paper to write upon for recording his feelings. Before that the metal surface, plant barks or rocks used to be the surfaces for the purpose of writing. With the growth of human population, need of knowledge, education and information within the society at large scale were forcing factors for innovation of the production of paper. As the time changed technology developed and we got the paper for writing and various other purposes.

Paper has been an essential part of our civilization for at least 2000 years and perhaps, because of our familiarity with it, we do not tend to think of it as a particularly complex material. We use it so commonly in our day to day life that we consider it just as a simple commodity material and we take paper for granted. However, paper is actually derived from plant sources and therefore has morphological as well as physical and chemical complexity.¹ Paper consists of a web of pulp fibers derived from wood or other plants from which lignin and other non-cellulose components are separated by cooking with chemicals at high temperature. In the final stages of papermaking, aqueous slurry of fiber components and additives is deposited on a wire screen and water is removed by gravity, pressing, suction and evaporation.²

Handmade paper making is a traditional art that has been practiced by a particular class of people for generations together. This art has been passed on from one generation of craftsmen to another.^{3,4} These craftsmen are known as "Kagzi's". Their name is derived from the Urdu word 'kavas', which means paper (Shinde et al., 2018). Today, many décor companies have been using handmade paper in creating attractive objects. Papers are not just used in writing or in official work but also a lot of things are created using paper like gift bags, greeting cards, cartoons and other packaging materials, colorful objects and many more. Thus, paper has become an essential part of our everyday life. It gives the mode of recording, storage and dispersion of data, besides being used for wrapping and packaging of numerous goods.⁵ Even the era of paperless office could not reduce its importance. Rather paper is the need of our life today.

Pollution concerns of papermaking/paper industry

Although paper is an essential need but actually it endangers our health and the planet Earth.

Plant invasion is a priority threat to worldwide biodiversity and henceforth malicious to both nature and economy of any nation. The demand and utilization of paper around the globe has been expanding gigantically with an increase in population. A sum of around 300 million tons of paper are delivered every day and 90% of this paper is created from the mature pulp (conventional method) (Alam et al., 2018). Thus, one horrifying fact is that a large number of trees are fallen on each passing day to make paper and thus the paper made by the conventional method causes high pollution problems. As indicated by the report on Ecology Global Network, the utilization of paper has become more than 400% in the past 40 years globally.⁶ Presently, in every continent, paper industries use almost 4 billion trees or 35% of the total trees cut throughout the world. The misuse of natural resources has come closer to the limits of earth's capacity. In less than 200 years, the earth has lost six million km² of forest.⁷ Probably the most serious issue that the world is confronting today is that of ecological contamination, expanding with each passing year and causing serious and permanent harm to the earth.

New paper mills are liable for both air and water pollution. Wastewater releases for the paper industry contains huge amount of solids, supplements and broke up natural issue.⁸ The paper business is totally based on forest. Mill industry is using the forest-based raw material which causes a lot of deforestation along with pollution problems. As in mill industry the cycles like Kraft measure for pulping, chlorine and Chlorine-based synthetic compounds for bleaching, immense energy and water utilization are included which is resultant into a large emission of CO_x, SO_x, NO_x,^{8,9} in the air as well as the - Dioxins and Furans in the effluents. And thus the equipment's and machineries used are huge having high levels of energy consumption.¹⁰ Due to mill sector over 30 million acres of forest is destroyed annually thereby endangering the natural habitat. Thus, the pulp and mill paper

industry is a big contributor to the problem of deforestation and is partly to blame for the endangerment of some species that live in the forest areas. The life cycle of paper actually damages the environment from beginning to the end. It starts off with a tree being cut down and ends its life by being burnt as emitting carbon dioxide and other harmful chemicals in the atmosphere or in the compost pills. Mill paper also requires a lot of water for the production of paper and the effluents also lead to the water pollution problems. 40% of the world's commercially cut timber is used for the production of paper in mill sector.¹¹

Environmental concern

Paper can be made either synthetically or naturally. Synthetic papers are generally preferred for work yet these papers have unfavorable impact on the climate and worldwide this industry is the largest consumer of energy and accounts for 4% of the entire world's energy use. Handmade paper industry is one of the fastest growing industries in India. Globally the paper industry requires substantial quantities of water to produce a ton of product than any other industry.^{12,13} The quantity of water consumed per ton of paper is 250 cubic meters for mill paper while 150 cubic meters for handmade paper.¹⁴ The waste water of the paper industry contains high level of Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), chlorinated compounds, fatty acids, tannins, resin acid, sulphur and sulphur compound, lignins, chlorinated phenols, guaiacols, catechols, furans, dioxins, aliphatic hydrocarbons etc. Many of these pollutants are known to be toxic, mutagenic, persistent, and bio-accumulating,¹⁵ so this can be replaced by handmade paper. It tends to be a shelter in the event that we can complement the pulping process with non-woody plant species, which are of less commercial significance. Thus, mill sector makes the adverse effect on environment. So we need to find the alternate method for production of paper and that is handmade paper.

Alternate way of paper production: sustainable development

Now, we get to know that mill sector makes the adverse effect on environment. So we need to find the alternate method for production of paper and that is handmade paper which is completely pollution free and is eco-friendly.¹⁶ Handmade paper products conserve the natural resources as it is actually tree free in nature and uses very little of machinery, equipment, chemicals. Handmade paper is nothing but a sheet of paper produced by hand. The process of handmade papermaking contributes to the sustainable development to a larger extent as it also generates lot of employment opportunity for the poor, rural people.

History of handmade paper

The handmade paper industry refers to an ancient craft of India. It is asserted that paper was created in 105 A.D. by Tsai-Lun in Lei-Yang region of China.¹⁷ Handmade paper producing method arrived at Tibet at around 650 AD, and from that point it was introduced to India (645AD).¹⁸ Ongoing explorers have the abundant proof to show that the paper was being made India as back as 250 B.C. But unfortunately this paper was not acknowledged then by the Indian culture since it was not treated as holy/pious for composing religious books. In this nation the information on papermaking initiated in the 11th century after the invasion of Mahmoud Gaznavi. The Indian Handmade paper industry was most successful and powerful during the Mughal period. Later during the British Rule, this flourished craft received a death

blow because of the import of Mill made paper. After independence, the program for revival of this industry was taken by Khadi and V.I Commission (KVIC), who were still pursuing this craft facing abject poverty. Individuals, organizations, and governments have to come together and join hands to safeguard human health along with the natural environment: air, water, and land. This industry has made a steady progress because of the support of the Government in past four decades. Research shows that the creation cycle of paper from non-wood fiber is essentially more affordable as compare to wood fiber. As given on estimate, there are in excess of 500 handmade paper units dispersed over India creating 50,000 huge loads of high quality papers and sheets. The high quality paper industry in the past for the creation of hand tailored paper industry has reached to a turnover of Rs 250,000 million (Saurabh S. Mahatme et al., 2019). The handmade paper industry is yet one of the potential art and craft small scale industry in India and also gives employment to nearly 37,000 people for the approximately 3000 production units.¹⁹ The handmade paper industry are now present throughout the country with concentration most in the Kalapi (Jhansi, Uttar Pradesh), Sanganer (Rajasthan), Kurukshetra (Haryana), Pune (Maharashtra), Mahaboobnagar (Andhra Pradesh) and some are in West Bengal (KVIC, India).²⁰ Kalpi (Jhansi, Uttar Pradesh, India) and San-ganer village near (Jaipur, Rajasthan, India) are considered as the biggest high quality paper creating centers in the world.

Raw materials used for the handmade paper

Cellulose is the base material for the development of paper as higher length to width proportion, cohesiveness, flexibility, elasticity, water absorbency, and resistance to tearing, are a portion of the properties which are attractive in a paper. Different sorts of cellulosic strands can be utilized in paper development. Their origin can be straight forwardly from plants or cellulosic waste materials. The mixing or blending of plant fibres and waste materials was a more practiced choice as because by using the combination of various fiber types and fiber sizes, various helpful properties could be accomplished. For example, long-staple fibres give anti-cracking properties and strength to the paper when used along with the short length fibres. It also reduces the cost of paper.²¹ Proof of one of the oldest Chinese paper introduced by Cai Lun was comprised of used clothes, old rope, fishing nets, hemp, and flax.^{22,23}

In India, Gunny bags produced using jute (*Corchorus capsularis* or *Corchorus olitorius*), nets and rope produced using Sun hemp (*Crotalaria Juncea*) were majorly used as raw materials.²⁴ It has been observed that earliest papermakers mostly used rags as a fibre source. Papers produced using cellulosic waste materials were considered as inappropriate for religious as well as ceremonial art work^{3,25} so later it was considered to use locally available fresh vegetative sources. Jute, hemp, paper mulberry, mulberry, flax, ramie, rat-tan and bamboo etc. fibers were used by the early Chinese paper creators.²⁶

Koreans mostly used the fibre strands of hemp, rattan, rice straw mulberry, bamboo, and seaweed to make paper pulp.²⁷ In Japan, the most used bast fibres for hand-made papermaking were Kozo, Mitsumata and Gampi. In Yaman, to get white fibres the inner bark of Fig tree (*Mudakh*) was suitable for papermaking.²⁸ Islamic and Indian handmade paper manufacturers regularly used the Flex, jute, banana and bamboo fibres. European paper creators majorly used the rags for handmade paper making.

In Nepal, high quality paper is produced using the internal bark of Lokta fibres (*Daphne bholua* and *Daphne*) and cotton cutting waste with the proportion of 70% and 30 % respectively. Abundantly this

fiber grows at Himalayan region and are resistant to mildew and insect.²⁹

Many scientists have worked to standardize the formula of handmade paper manufacturing through different plant fibers. Mason,³⁰ Lorente³¹ gave formula for paper making from a wide range of common plants. Kumar, V. & Mahe-swari, R.C.; Turner and Skiold^{23,32} gave a detailed description of fibres from seed hairs (cotton, cotton linters), bast fibers (linen/flax, jute, hemp, kozo, gampi, mitsumata, ramie), leaf fibres (esparto, manila, grasses, giant nettle, rice straw, rattan), and wood-derived fibres (made by wasps or by pulping processes).³

Cotton fiber plays an almost insignificant part in paper manufacturing till the eighteenth century, later huge amount of cotton was exported from India to Europe and cotton rags were utilized to make the handmade papers.²⁸ In present time cotton cutting waste created by garment manufacturing units is the most usable crude material for the creation of handmade paper in India. Blends of different materials like dry flowers, pigments, seeds, coloured fibres etc are also used to give useful and aesthetics properties in the paper. During the 18th century Afshani papers from Daulatabad, Maharashtra was world-popular during the 18th century because of its wonderful mixes with gold and silver pieces (Table 1).²⁴

Table 1 Raw materials used in handmade papermaking

Sr. No.	Raw material	Process	Chemical used	Conditions	Availability	Remarks
1	Rag	Cooking	3-4% NaOH, 6-8% Na ₂ CO ₃ or 15%Ca(OH) ₂	6-8 hrs. 130-1400C Bath ratio- 1:3 2-2.5 hrs	White and new rags, old whites, threads and color rags from cotton textile industry, tailors, denim fabric industry and hosiery market	Soda silicate can be used up to 40%, when NaOH is being used
		Bleaching	Hypochlorite+ lime or H ₂ O ₂ +Na ₂ CO ₃ +Na ₂ SiO ₃			80% brightness can be achieved Ledger paper, Filter paper, Drawing paper, Bible or Skin Paper
2	Jute and Kenaf	Pressure Cooking	NaOH+Na ₂ SO ₃ as 14% Na ₂ O	4 hrs. 160-1650C	West Bengal, Bihar, Assam	Have high strength but very low brightness. Shopping bags, cover, tags, folders etc.
		Open Cooking	NaOH+Na ₂ SO ₃ as high as 20% Na ₂ O	8-10 hrs.		
3	Waste paper	Soaking	Mild dose of NaOH and deinking chemicals	12 hrs.	Pulp substitutes and high grade deinking waste	Admix with other high strength pulps
4	Banana	Soaking	Water	20 hrs.	Maharashtra, Kerala and	
		Pressure cooking	8% NaOH	2hrs., 1350C Bath ratio- 1:6	Andhra Pradesh	
		Bleaching	O ₂ diglification+ hypochlorite bleaching			Extremely thin transparent like papers, good quality strong tissues and decorative papers. Banana pulp is superior to Rag pulp
		cooking	.05% EDTA+8% NaOH+2% H ₂ O ₂	4hrs. Bath ratio- 1:6		
5	Sun Hemp	Pressure Cooking	NaOH+Na ₂ SO ₃	-	Uttar Pradesh	Used in tissue and cigarette tissue paper

Table Continued...

Sr. No.	Raw material	Process	Chemical used	Conditions	Availability	Remarks
6	Common Hemp	Pressure Cooking	20% NaOH	4hrs. 1450C Bath ratio- 1:5	Herbaceous and dioecious plant Produced in India for narcotic as well as medicinal values	80% ISO brightness
		Bleaching	Hypo, chlorination and then Hypo			
7	Ankhada (Calotropis)	Soaking	15% Na ₂ CO ₃ 30% Na ₂ CO ₃	70 hrs., 400C 139 hrs., 400C	Gujrat, Punjab, Bihar and Rajasthan	94% yield and 49% ISO brightness 94% yield and 55% ISO brightness 75% ISO brightness so it is possible to produce TCF pulp
		Bleaching	1%hypo			
8	Cotton linters	Pressure Cooking	6-8% NaOH	2-4 hrs. Bath ratio- 1:3	Cotton mills	Very high tear strength

Source: Kumar V, Maheswari RC. Handmade papermaking in India: a sustainable production system³²

Paper components and their composition (Source- Shinde et al., 2018)

- 1) Cellulose- 85-90%
- 2) Sizing agents-1-2%
- 3) Filler-1-2%
- 4) Colour-1-2%.

Advantages of handmade paper industry

Handmade paper comes under the socially responsible products because it is tree-free, cleanly produced, eco-friendly product. This is because the handmade paper making industry neither includes the woody or forest based raw materials nor it uses the toxic or harmful chemicals. Advantages of handmade paper making can be understood in following different points:

a) The people-friendly industry

Handmade paper industry requires low venture and capital expense with limited apparatus. Customary handmade paper industry requires approx. Rs 3 -3.5 lakh as initial investment. The industry needs just semiskilled or talented labour.²⁰

b) More strength

In comparison to machine-made paper, hand-made paper has more tearing strength, bursting as well as tensile strength. Twofold crease strength is additionally higher because the fibres of handmade paper can be shaken in all the four directions whereas those of machine-made paper can be shaken only side to side.³²

c) Creativity exploration

Strategy of handmade paper manufacturing is an outstanding medium of artistic expression where each and every piece of paper is

unique and handcrafted. There are various options to explore creativity via making infinite designs and products. At present, a wide variety of handmade papers based on thicknesses and surface embellishments are available.

d) Available for various uses

There are limitless choices for paper manipulations as like tearing, cutting, burning, scorching, mutilating, stamping, krumping, painting, drawing, packaging, writing, rolling, casting, recycling, upcycling, rolling, casting and weaving, etc. are possible with the help of handmade paper.³³

e) Eco friendly process

Handmade paper manufacturing is a eco-friendly and 100% wood-free process, which utilizes different used (textile waste, ropes, gunny bags, etc.) and unused (plant fibres) cellulosic crude materials which are locally available. A survey was done which shows that 1lakh greeting cards produced from handmade papers can save approx 500 trees.³⁴ Cellulosic fibres are independent to make paper but to impart specific desirable properties, mild chemicals as like (lime, soda as caustic soda, oxalates, oxygen, and peroxides) are utilized with the goal to make a simple effluent treatment plant which can treat the effluent, and industry can get zero effluent mill status easily without any problem.³²

Mill made paper vs handmade paper (Table 2) (Table 3)

Competitive strengths of handmade papers

- a. Enormous and developing domestic paper market
- b. Up to date research institute (CPPRI)
- c. Ability in non-wood pulping and applications
- d. Printing industry is well developed.

Table 2 Different parameters of handmade and mill made paper making

Parameters units	Handmade paper sector	Mill paper sector
A) Economic Considerations:		
1. Quantity	Relatively very small	High
2. Harvesting of raw material	Easy(Waste & Residues)	Difficult to harvest
3. Transportation	Low	High
4. Regular Supplies	Assured	Uncertain/Unsettled
5. Cost for Processing	Cheap labor, cheap management, cheap infrastructure	Economics of mass production
B) Technical Considerations:		
1. Removal of non-fibrous material	Simple process Not important	Complex process, high tech- process Important at the cost of strength properties & due to drastic chemical action on fibres permanence is also low.
2. Color to strength ratio	HMP is known for natural white color, No chemicals used so permanence is also high	
3. Yield	Low	High

Source: Singh SN, Sunita C. Handmade paper in the context of green, clean and closed loop system. *IPPTA*, 2000;12(4):67–76³⁵

Table 3 Comparison of handmade and mill made papers

Sr. No.	Mill made paper	Handmade paper
1	In the mill sector for pulping kraft process is used.	For pulping beating/ refining method is used.
2	For bleaching chlorine and Chlorine-based chemicals are used.	No chemicals that harm the health of people are used.
3	Huge energy and water consumption In large quantity emission of CO _x , SO _x , NO _x in the air, Dioxins and Furans in the effluents.	Consumption of energy and water is less. No chemical emission.
4	The machinery and equipment requirement in the mill-sector are more.	The machinery and equipment requirement in the handmade sector are less.
5	Capital cost is high	Capital cost is less
6	Strength and durability is weak in comparison to handmade paper.	Strength and durability has been so far excellent as compared to the mill-made paper
7	Scope for employment to people is less.	Handmade paper industry provides more employment to people.

Source: Chauhan Sunita. Socially responsible products and services for sustainable Asia and beyond. 2012¹⁰

Various opportunities in handmade paper industry

- i. Domestic market potential
- ii. Present day, world scale paper machine would be cost serious in many grades
- iii. Forest plantation potential
- iv. Incorporates of joined wood and agro based papermaking
- v. Government education program – expanding interest for printing/composing papers
- vi. Low work costs (eg. cost effective sorting of imported mixed waste)
- vii. Commodity potential.³⁶⁻⁴⁰

Conclusion

As the Indian economy is a rural economy so this handmade paper making industry establish a strong industrial base for rural

development. The World is struggling because with time population as well as pollution increases continuously and every person need paper in daily life in different form. Thus, due to paper industries shortage of forest and trees are observed. It is time to look for alternatives to overcome this situation. In this study, “Handmade Method” was adopted to produce paper from alternative raw materials. Handmade paper has the advantage of being 100% wood free which makes it the most eco-friendly form of paper around. It is also 100% recycled. Handmade paper is excellent for writing as well as printing and has great tensile, bursting, tearing, and double-fold strength compared to conventional paper. This study can contribute to the global environment and national economy by producing the eco-friendly handmade papers and various paper products. Thus, handmade paper creates much healthier environment so in this regarding researchers should focus on this field.

Acknowledgments

None.

Funding

None.

Conflicts of interest

Authors declare that there is no conflict of interest.

References

1. Chauhan S. Paper: A Simple Commodity with Complex Nature. In *Hath Kagaz*. KNHPI, Jaipur. 2009;16:10–12.
2. Biermann CJ. Essentials of pulping and paper-making. San Diego, CA, USA: Academic Press; 1993.
3. Hubbe MA, Bowden C. Handmade paper: A review of its history, craft, and science. *BioResources*. 2009;4(4):1736–1792.
4. Liebl M, Roy T. Handmade in India: Traditional craft skills in a changing world. *Poor people's knowledge: Promoting intellectual property in developing countries*. 2004:53–74.
5. Quader MMA. Paper sector in Bangladesh: Challenges and scope of development. *Journal of Chemical Engineering*. 2011;26:41–46.
6. Neelagar R, Yathish R, Srinivasa S, et al. Characterization of paper and pulp properties from weed species. *Journal of Applied Biology & Biotechnology*. 2018;6(06):61–63.
7. Rani N, Maheshwari RC, Kumar V, et al. Purification of pulp and paper mill effluent through Typha and Canna using constructed wetlands technology. *Journal of Water Reuse and Desalination*. 2011;1(4):237–242.
8. Nazhad MM. Recycled fibre quality – A review. *Journal of industrial and engineeringchemistry*. 2005;11(3):314.
9. Malesic J, Kolar J, Strlic M, et al. Photo-induced degradation of cellulose. *Polymer Degradation and Stability*. 2005;89(1):64–69.
10. Chauhan Sunita. Socially responsible products and services for sustainable Asia and beyond. 2012.
11. https://www.theworldcounts.com/stories/Environmental_Impact_of_Paper_Production
12. Pokhrel D, Viraraghavan T. Treatment of pulp and paper mill wastewater—a review. *Science of the total environment*. 2005;333(1–3):37–58.
13. Iqbal HMN, Kyazze G, Keshavarz T. Advances in the valorization of lignocellulosic materials by biotechnology: an overview. *BioResources*. 2013;8(2):3157–3176.
14. Ibramian TN, Kumar A. Development of the Indian handmade paper industry. *TARA—A case study*. 1993.
15. Bajpai P. Application of enzymes in the pulp and paper industry. *Biotechnology progress*. 1999;15(2):147–157.
16. Agarwal S, Sharma A, Singh K, et al. Decolorization of direct red and direct blue dyes used in the handmade paper making by ozonation treatment. *Desalination and Water Treatment*. 2016;57(8):3757–3765.
17. Hunter D. *Papermaking. The history of and technique of an ancient craft*, Dover, New York; 1947.
18. Hunter D. *Papermaking by hand in India*. 1939.
19. Dwivedi AK, Dangayach GS. Handmade paper industry—Experience of Indian manufacturing units. *International Journal of Business Innovation and Research*. 2013;7(3):318–339.
20. Dwivedi AK, Dwivedi DP. Rural entre–preneurial development: a study on indian hand–made paper industry. *Osmania Journal of Interna–tional Business Studies*. 2009: 66–72.
21. Heller J. *Papermaking*. 1978.
22. Clapperton RH. An historical account of its making by hand from the earliest times down to the present day. 1934.
23. Turner S, Skiöld B. *Handmade paper today: a worldwide survey of mills, papers, techniques and uses*. 1983.
24. Teijgeler R. *Handmade paper from India: Kagaj yesterday, today and tomorrow*. 2001.
25. Jugaku B. *Making by Hand in Japan*. 1959.
26. Tsien TH. Raw materials for old papermaking in China. *Journal of the American Oriental Society*. 1973:510–519.
27. Tstang H. Chapter–II Origin and Growth of Paper Industries in Indian Context. 2015.
28. Bloom JM. Papermaking: the historical diffusion of an ancient technique. In: *Mobilities of Knowledge*. Springer, Cham. 2017:51–66.
29. Biggs S, Messerschmidt D. Social responsibility in the growing handmade paper industry of Nepal. *World Development*. 2005;33(11):1821–1843.
30. Mason B. The carbonaceous chondrites. *Space Science Reviews*. 1963;1(4):621–646.
31. Lorente MJ. *The art of papermaking with plants*. WW Norton & Company. 2004.
32. Kumar V, Maheshwari RC. Handmade papermaking in India.
33. Jain P, Gupta C. A Sustainable journey of handmade paper from past to present: A Review. *PROBLEMY EKOROZWOJU*. 2021;16(2):234–244.
34. A detailed project report on handmade paper manufacturing & conversion unit.
35. Singh SN, Sunita C. Handmade paper in the context of green, clean and closed loop system. *IPPTA*. 2000;12(4):67–76.
36. Tripathi JG. Study of India's paper industry—potential and growth in 21st century. *Indian J Appl res*. 2014;4:112–115.
37. Kulria S. Making hand–made paper from linen waste – an initiative to contribute towards green environment. 2016.
38. Mahbub Alam, Sharmin Yousuf Rikta, Khalid Md Bahauddin, et al. Production of eco–friendly handmade paper from wastepaper and other local biomass material. *Academia Journal of Environmental Science*. 2018.
39. Saurabh S Mahatme, Yogesh A Landge, Hitesh A Tawade, et al. Experimental investigation on producing paper using non–wood fibre. *Journal of Emerging Technologies and Innovative Research (JETIR)*. 2019.
40. Umesh Shinde, Omkar Nirmal, Shreyas Oundhakar, et al. Improvement in the texture of handmade paper – a review. *International Journal for Research in Engineering Application & Management (IJREAM)*. 2018.