International Journal of Advanced Technology in Engineering and Science
Vol. No. 13, Issue No. 03, March 2025
www.ijates.com
ijates
ISSN 2348 - 7550

# Sustainable Fiber Bhimal (Grewia optiva): Composition and Microscopic Analysis for Textile Use

**Ms. Anjali Singh & Dr. Shikha Bhardwaj**

*Ph.D.-Research Scholar (Shri Venkateshwara University Gajraula, Uttar Pradesh)*

*AP-III, Amity School of Fashion Design & Technology, Amity University Haryana*

**ABSTRACT**

Due to environmental changes eco- friendly and sustainable products are the need of the hour which will not contaminate the environment during production. Natural fiber is locating new aspect in terms of its functionality and its utility. Bhimal fiber (Grewia optiva) is acquired from the tree stems. Bhimal is a long-lasting, conifer tree has been discovered near agriculture fields in the hills or in lower Himalayan regions. It is widely present in the forest and in outer edge of the Thano village located in Dehradun and near cultivated land in Chamoli and Pauri districts of Uttarakhand. Bhimal is among the most underrated economically significant plant with capability of utilization in a variety of practice. Bhimal tree is essentially used in forest cultivation in the Himalayan territory. The uprooted fibers of bhimal are generally a fibrous biomass inherent feature. This paper seeks to understand the bhimal fiber composition which is extracted by the traditional method of water retting by the locals and the microscopic examination of Bhimal fibers, which will help to identify suitable end uses for unborn experimenters.

**Keywords:** - Bast fibre, Bhimal fibre, Extraction, Retting, Composition, Microscopic view, Natural fibre.

## Introduction

In India, amongst the varieties of natural fibers, the fiber-generating trees scored ranks second to food in terms of its economic value (Pandey and Gupta 2003). Fiber-grounded tree played a crucial role in ancient times along with a large number of provided support to human populations globally (Negi et al. 2010). Uttarakhand is rich in biodiversity, and the residents near the Himalayas heavily rely on timber resources (eg, fodder, energy, woods, drugs, shampoo and fibers) for their economic support. In today's context, the fibers which we opt naturally are environmentally friendly and have exhibited outstanding accomplishments and thus, in high demand from both the public and international markets, consequently, local residents are significantly engaged in producing a diverse range of marketable products (Goel, Goel, and Maurya 2011). In Uttarakhand, it has been acknowledged that these bast fiber trees, previously seen as undervalued, are now cultivated, harvested, and repurposed for various applications, processed for extra income, and their modern uses have expanded.

Natural fibers, originating by plants and animals, are capable of being spun into long strands. The spun material is then woven or knitted into fabric, which is essential for societal use. Fibers are commercially obtained from seeds, leaves, and stems, with stems being the primary source for extraction. Currently, natural fiber-reinforced composites have gained the interest of scientists and technologists due to their potential as an alternative to synthetic fiber composites (Singh, Halder, and Wang 2017; Singha and Rana 2012).

As findings by Srivastava, N., & Rastogi, D. (2018) in an article that Uttarakhand is a rich state in plant fibers. Fibers from plants can be derived from seed hairs, leaf fibres, stem fibre (bast) and husk fibres. Uttarakhand boasts a rich history of using natural fibres, including seed hairs like cotton, bast (or stem) fibers such as flax, bhimal, nettle, ramie and hemp, leaf fibers like sisal for textile purposes. Traditionally, the residents of Uttarakhand utilized these plant fibres for a variety of family needs, though their use has diminished over time. The state is exploring new feasible areas for utilizing plant fibres. Transforming these fibres into delicate yarn and subsequently into wearable garments is gaining popularity. If innovative methods for fibre extraction, weaving, and product creation are shared with artisan groups, it could result to sustainable livelihood opportunities for them. Traditionally, fibrous plants have been applied to make fabric, cord, bags for packing food grains, as transporting fodder and manure. It is true that even with the availability of 95 categories of fiber-yielding plants, both wild and cultivated, their contribution to Uttarakhand's economy is not fully realized.

Bhimal (*Grewia optiva)* is an evergreen, perennial tree with non-lignified, sclerenchymatic fibers in its bark. Various species within the bhimal family (Tiliaceae) yield bast fibers akin to flax, and these fibers have been utilized for textile and clothing production for millennia. The shoots of the Grewia optiva tree are processed to extract the natural fiber known as Grewia optiva.

Bhimal (Grewia optiva) is a famous tree located near agriculture fields in the hills. It takes place naturally in the field bunds and is preserved by the villagers for its versatile utility. It takes place in the outskirts of Thano village located in Dehradun and near cultivated land in Chamoli and Pauri district in Uttaranchal. Bhimal is a small to medium-sized tree getting to a height of 13-15 m. Wood is yellowish white or grey with an unpleasant odor and thus not used freely as firewood.

Production of bhimal (Grewia optiva) fiber and yarn is a cottage-based industry. In Uttaranchal manufacturing of bhimal (Grewia optiva) is very deficient at this stage. It was proposed by Uttaranchal Bamboo and Fiber Development Board that bhimal (Grewia optiva) is one of the most underrated profitable trees with possible utilization in broad spectrum of usage. Lack of knowledge and none existence of tools and machinery particularly for this fiber have left it undeveloped and undiscovered in this region.

Bhimal is an imperishable, evergreen tree. Fibers are obtained from the branches of the bhimal tree, which is plentiful in the Himalayan region. Retting has been the traditional method for extracting fibres. Residents of the Uttarakhand region engage in gathering, shelter-drying, drenching, and beating bhimal fibers. The fiber which is extracted has coarse texture and it is hand-twisted to make ropes, strings and handcraft items. Determining the microscopic structure of bhimal fibers could enhance their characteristics and open up new implementation possibilities. However, this microscopic view has not yet been reported. Numerous studies exists announcing chemical composition of bhimal fiber, mechanical characteristics of bhimal fiber certified epoxy resin Bio-Composite, polymer composites and chemical composition of bhimal tree leaves is documented, the microscopic structure of the fiber is not. This study has been documented regarding the examination of microscopic structure and the composition of extracted bhimal fibre.

ijates
ISSN 2348 - 7550

Bhimal Tree

The extracted Grewia Optiva (Bhimal) fibers are basically a dry in nature of the tree which is known as ligno-cellulosic. Bhimal fiber is a bast fiber, that is effective for producing yarns with thermal properties, offering both warmth and cooling effect. Additionally, it is known for its antimicrobial, antibacterial, fire-retardant, and moth-proof properties. Fiber resembles Jute in length, firmness and microscopic structure. Studies on bhimal fiber obtained from higher altitudes reveal that it can be spun into elongated fibre that exhibit greater density and tensile strength compared to jute (Uttarakhand Bamboo and Fiber Development Board, 2009).

Another advantage of bhimal is its environmental sustainability. Bhimal is easy to cultivate, needing minimal water and infrequent pesticide use, while cotton relies on more harmful pesticides than other crops. Despite being a natural fiber, cotton farming is not environmentally friendly.

**Composition of Bhimal Fibre**

**Table: Composition of Bhimal Fibre**

| S.No | Parameter | Value |
|---|---|---|
| **1** | **Cellulose (%)** | 35.91 |
| **2** | **Hemicellulose (%)** | 4.47 |
| **3** | **Lignin (%)** | 22.78 |
| **4** | **Ash (%)** | 5.20 |

As observed in the table that the extraction of bhimal fiber by water retting which is the traditional method used by locals has cellulose content was 34.87 percent, hemicellulose content was 4.46 percent, lignin content was 22.77 percent and ash content was 5.20 percent. Cellulose is the most important element of plant fiber, followed by hemicellulose, lignin, wax, pectin, and other substances. High molecular weight and long chain of cellulose molecule affect the properties of fiber. The branched chain of Hemicellulose molecule affects the inner structure of fiber as unstructured and crystalline region. Fiber properties of each fiber are influenced by these molecular structure (Udomkichecha, 2005). Zai-sheng Cai (2008) found the chemical composition of jute fibre as 63% cellulose, 15% lignin, 24 % hemicelluloses and less than 1 % ash content. The levels of cellulose and non-cellulosic elements in a fiber influence its structure and characteristics, as well as its crystallinity and ability to retain moisture. Reddy and Yang (2005) as noted that even though the strength of fibers cannot be precisely linked to cellulose content and microfibrillar angle, fibers that typically have higher cellulose content, greater polymerization of cellulose, and a lower microfibrillar angle tend to exhibit improved mechanical properties.

## Methodology

The microscopic structure of Bhimal fiber was examined using a Zeiss digital microscope system. To prepare the slides, the fibers were mounted with glycerin, which facilitated clear visualization. The Zeiss microscope features a Micro-mirror Array Lens System camera, enabling larger samples to be brought into focus and easily imaged. **Longitudinal and cross-sectional** images of the fibers were captured using a digital camera (Cool Pix 995) connected to the microscope. This setup provided detailed insights into the structural characteristics of Bhimal fiber, enhancing our understanding of its properties and potential applications.

## Result & Discussion

Skilled team is essential for technical testing who can handle and utilize the equipments and chemicals for the examination of the textile fibres. Microscopic tests are primarily employed for natural fibers, as they allow for easier identification compared to synthetic fibers. Synthetic fibers often look quite similar, and the increasing variety makes it challenging to distinguish between them, even under a microscope.

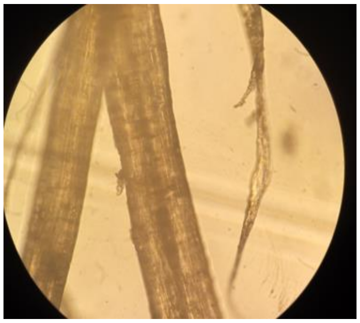

Figure 1: Longitudinal View

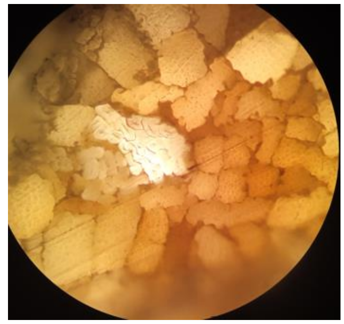

Figure 2: Cross Sectional View

1. **Longitudinal Structure**

   As shown in Figure 1, the longitudinal apparence of Bhimal fiber reveals a thick, regular fiber exhibiting a subdued luster. Notable cross markings or nodes are visible along the fiber's length, indicating its structural characteristics.

2. **Cross-sectional Appearance**

   The cross-sectional structure of Bhimal fiber is illustrated in Figure 2. It exhibits a polygonal shape with rounded edges and a narrow lumen within each cell. This observation aligns with findings reported by Sekhari (2012), confirming the fiber's distinct morphology.

The fiber bundles are found in the inner cortex, giving the fibers a central channel known as the lumen. Moreover, the fibers have a polygonal shape with rounded edges when viewed in cross section. Bodros (2008) indicated that the cross-sectional area of individual flax fibers was assessed. Both bhimal and flax can be considered to have a circular cross-section, making it easier to calculate an average diameter.

**Conclusion**

Meeting the rising demand for sustainable fibers in high-production applications is challenging due to the high mechanical strength required, which is often lacking in natural fibers. Bhimal (Grewia Optiva) possesses several remarkable properties, as the entire plant can be utilized for fodder, fuel, dyeing, medicinal uses, and textiles.

Basically, extracted bhimal fibres have an average cellulose content, hemicellulose low and lignin content high as contrast to chemical composition of other fibres like Jute, Flax, Ramie, Hemp. The unique structural features of Bhimal fiber, such as its irregular, polygonal cross-section and large lumen, suggest excellent insulation properties, which could be beneficial for performance apparel. Each fibre which is visible to the nude eye was in fact a bundle of fibres as observed in the microscopic view. This is suggested by the findings of Mwaikambo and Ancell, 1999, which proclaimed that the cross-sectional examination of various bast fibers revealed that they appeared multicellular, consisting of very small individual cells tightly bonded together. Longitudinal view showed cross wise markings called nodes similar to that of flax and jute fibres (Cockett & Hilton, 1955). The microscopic characteristics of bhimal fiber could unlock opportunities in performance apparel, surpassing other bast fibers whose property limitations may hinder their potential in this field. It has the potential for a broad range of applications.

**References**

1. Cockett, S. R., & Hilton, K. A. (1955). Natural fibres. In Basic Chemistry of Textile Preparation (pp. 12-49). London: The National Trade Press Ltd.
2. B.P.Corbman "Textile: fibre to fabric", 4th ed, *McGraw–Hill,NewYork*,(1967).
3. P.G.Tortora, *"Understanding Textile", 2nd ed, Macmillan Publishing Co, New York*, (1982).
4. Joshie P and Narain P. (1992). "Bhimal: a multipurpose tree for agro forestry". Indian Farming 41: 14-15.
5. Khosla PK, Toky OP, Bisht RP and Hamidullah S. (1995). "Growth patterns of early versus late successional multipurpose trees of the western Himalaya Trees" 10: 108-113.
6. Mwaikambo, L. Y. & Ancell, M.P. (1999). "The effect of chemical treatment on the properties of hemp, sisal, kapok and jute fibres for composite reinforcement". Proceedings of the 2nd International Wood and Natural Fibre Composites Symposium. Germany
7. Reddy N. & Yang Y. (2005). "Biofibres from agricultural byproducts for industrial applications." Science Direct, 23(1), 22-27. doi: 10.1016/j.tibtech. 2004.11.002.
8. Samant S.S., Bhatt I.D., Rawal R.S., Nandi S.K. & Dhyani P.P. (2010). "Promising Fiber- yielding Plants of the Himalayan Region. Himachal Pradesh, India": G.B. Pant Institute of Himalayan Environment and Development.
9. Mehta. H., P. C. Tyagi and K.S. Dadhwal. (2011). "High yielding provenances of Bhimal Grewia optiva J.R. Drumm. Ex Burret ) for fodder and fuel wood production in North Western Himalaya". Indian Journal of Agric. Sciences, 81(8)717-722.

10. Goel, A., B. Goel, and P. Maurya. (2011). “Potential of natural eco-friendly fibers of Uttarakhand for textile application.” Asian Agri-History 15:153-60.

11. Singha, A.S., and A.K. Rana. (2012). “Effect of Surface modification of Grewia optiva fibres on their physicochemical and thermal properties”. Bulletin of Materials Science 35 (7):1099-110.

12. Adak, B. & Mukhopadhyay, S. (2015). “Jute based all-cellulose composite laminates.” Indian Journal of Textile and Fibre Research, 41(4), 380-384.

13. Verma A, Singh N.B., Saresh N.V., Choudhary Punit, Sankanur M., Aggarwal Gaurav and Sharma Jai Pal. (2015). “RAPD and ISSR markers for molecular characterization of Grewia optiva: an important fodder tree of north western Himalayas”. Range Management and Agroforestry 36 (1): 26-32

14. Sindwani S, Chanana B, Bhagat S, Datt C. (2017) “Chemical Composition of Bhimal Fibres,” Int. J. Curr. Adv. Res.;6(8):5343-5347. DOI: 10.24327/ijcr.2017.5347.0702.

15. Singha, A.S., S. Halder, and J. Wang. (2017). “Extraction of bamboo micron fibres by optimized mechano-chemical pocess using a central composite design and their surface modification”. Material Chemistry and Physics 199(15)-23-33.

16. Murasing. K, Kumar. M. and Kumar. A. (2021). “Effect of altitude on the Mechanical strength of Grewia optiva fiber in Garhwal Himalaya, India”. Journal of Natural Fibers, 18(7).