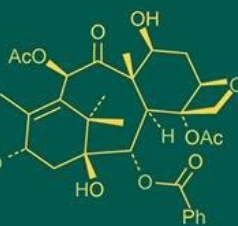
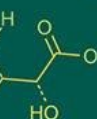
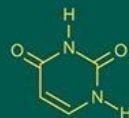


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Hemp fiber: Collection and extraction

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Abstract

Hemp (*Cannabis sativa* L.) is an important natural fibre crop with significant potential for sustainable textile and industrial applications. The present study was conducted to evaluate the effect of different water retting durations on hemp fiber extraction and quality. Hemp stalks were collected from Bisalpur, District Pilibhit and from Kanpur, where the plant grows abundantly. Water retting was carried out for 7, 14, and 21 days, followed by sun drying, to determine the optimum retting period for fiber separation and quality. The results revealed that retting duration significantly influenced fibre characteristics. Water retting for 14 days followed by sun drying for 4 days proved to be the most effective treatment, producing fibers with good separation, uniform colour, smooth texture, and satisfactory strength. Shorter retting duration (7 days) resulted in incomplete fiber separation, whereas prolonged retting (21 days) led to over-retting and fiber weakening. Hemp stalks from both collection sites were found to be suitable for fiber extraction, highlighting the potential utilization of naturally growing hemp for sustainable fiber production. The study confirms that water retting is a simple, low-cost, and eco-friendly method for hemp fibre extraction, suitable for adoption at the rural level. Further research is recommended to optimize retting conditions and assess the mechanical properties of fiber for diversified textile and industrial uses.

Keywords: Hemp, fiber, collection, extraction, stalk etc.

1. Introduction

Hemp (*Cannabis sativa* L.) cultivation for fiber has been recorded in China as early as 2800 BCE and was practiced in the Mediterranean countries of Europe early in the Christian era, spreading throughout the rest of Europe during the Middle Ages. It was planted in Chile in the 1500 CE and a century later in North America (Liu *et al.* 2017) [9].

Hemp is one of the plants that grow the quickest on Earth, along with bamboo. Fifty thousand years ago, it was also among the first plants to be woven into useful fabric. Among the many commercial products that may be made from it are paper, rope, textiles, clothes, paint, insulation, bio-fuel, food, and animal feed. It can also be developed into biodegradable plastics. Hemp fibers, which come from the stalk of the hemp plant, belongs to the Cannabis species. Hemp fibers are regarded as one of the powerful members of the natural bast fibers family. These fibers are now commonly used as reinforcements in composite materials (Callaway 2004) [5].

Hemp is among the oldest industries, going back more than 10,000 years to the beginning of pottery. The oldest relic of human industry is a bit of hemp fabric dating back to approximately 8,000 BC. It was found in Mesopotamia and was mentioned in Assyrian scripts. Hemp was considered as the most important textile of China in 3000 BCE, where silk production was flourishing. Hemp, one of the strongest fiber was popular during that time because it was cheaper than silk fibre for clothing. China, in ancient times referring to itself as "the land of hemp" (X, 2023) [12].

It is believed that hemp originated somewhere in Central Asia. There is evidence of hemp use as a food grain as well as for fish nets, clothing and rope 6500 years ago in China. The crop gradually moved into Europe. Hemp was so important to the natives of England and the American colonies that farmers were legislated to dedicate a portion of their land to the production of the crop (Blade *et al.* 1999) [4].

Hemp has been mentioned in many important documents over its recorded history, The Zend-Avesta, a sacred book used by the people of India dating back to 600 BC, spoke of hemp's intoxicating resin. The Chinese emperor and herbalist, Chen-Nung wrote about hemp's medicinal uses 5000 years ago, his pharmacopeia recorded its effects on malaria,

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female disorders, and many other illnesses, hemp was referred to as, Ma-fen “hemp fruit”, and said that; “if it taken in excess, will produce hallucinations”. The Anatomy of Melancholy, published in 1621 recommended hemp for depression. The New English Dispensatory, of 1764 suggested applying hemp roots to the skin for inflammation Admin (2001) ^[1]

Hemp is an annual plant from the cannabis family, belonging to the bast fiber category. The cultivated species is *Cannabis sativa* L., which has two distinct categories: *Cannabis sativa* L. var. *Vulgaris* (also known as fiber hemp) is found in moderate regions, while *Cannabis sativa* L. var. *Indica* (or drug hemp) is located in tropical regions.

“Hemp is a green, very abundant and ubiquitous plant, economically valuable, a versatile and multi-purpose product, possibly dangerous and certainly in many ways mysterious” Schultes (1970) ^[11] This definition is pertinent in describing the valuable but contradictory nature of this industrial crop.

Due to the renewable and ecofriendly impacts of replacing traditional industrial fibers (carbon, synthetic, glass) with natural fibers, there is a demand for the ability to produce such natural fibers Anthony (2005) ^[3]

The hemp plant, referring to industrial hemp, is a high-yielding annual industrial crop grown, for the fibers from hemp stalk and for the oil from hemp seeds. Although hemp is a niche crop, hemp production is currently undergoing a renaissance. More than 30 countries grow hemp, with China being the largest hemp producing and exporting country. Europe and Canada are also important actors in the global hemp market Lichtfouse *et al.* (2020) ^[8]

The textile industry, in fact, during the autarchic period, had at its disposal an area of about 90,000 hectares for hemp production and the yarns produced in Italy were considered the best in the world. Textile Corporation and the establishment of the National Hemp Consortium (Consorzio Nazionale Canapa—CNC) which experimented new production techniques, such as green scutching with non-macerated plants, that allowed an increase in fiber yield per hectare, and new techniques for processing hemp fibers, that have increased their yarn obtaining a raw material intended for easier processing with other fibers and on existing installation New products are being created in this sector such as shoes with natural fibers that allow excellent flexibility by adapting the footprint to the footwear and favoring the so-called “natural walking”, that is the correct way to walk. Hemp fibers mixed with other natural and synthetic fibers have been adapted to the shoe making, promoting better breathability Ruzzenenti (2017) ^[10]

Though, hemp served to humans as a fiber plant for

thousands of years, its importance faded away due to miscellaneous reasons in the beginning of twentieth century. Since the last few decades, hemp plant has been revisited for a fiber source, but not without a reason, as a result of the sustainable raw material seeking. Global concerns such as shortening resources, pollution and global warming push the textile industry to choose environmentally friendly production methods, like all other industry branches. At this point, hemp fiber has shined out with its serious sustainable production potential. This chapter mainly focuses on hemp fiber usage and production methods in textile engineering rather than the sustainable features of hemp fiber Gedik *et al.* (2022) ^[6]

Over the last several decades, has become one of the most fashionable plants. To use the hemp potential for the development of a sustainable textile bio-product sector, it is necessary to learn about the effect of the processes creating hemp’s value chain on fibre properties. determines further processes and proves the diversity of ways to produce yarn by employing different spinning systems such as linen spinning, cotton and wool spinning technology with or without the use of the decortication process Zimmiewska (2022) ^[14]

Fiber derived from hemp has been used to make a variety of textiles and goods containing fiber (Horne *et al.* 2020) ^[7]

Retting is the main challenge faced during the processing of bast plants for the production of long fibre. The traditional methods for separating the long bast fibers are by dew and water retting. Both methods require 14 to 28 days to degrade the pectic materials, hemicellulose, and lignin. Even though the fibers produced from water retting can be of high quality, the long duration and polluted water have made this method less attractive. A number of other alternative methods such as mechanical decortication, chemical, heat, and enzymatic treatments have been reported for this purpose with mixed findings. This paper reviews different types of retting processes used for bast plants such as hemp, jute, flax, and kenaf, with an emphasis on kenaf. Amongst the bast fiber crops, kenaf apparently has some advantages such as lower cost of production, higher fiber yields, and greater flexibility as an agricultural resource, over the other bast fibers. The fibers produced from kenaf using chemical retting processes are much cleaner but low in tensile strength. (Tahir *et al.* 2011) ^[13]

2. Material and Methods

2.1 Collection of hemp fiber

Hemp stalk was selected for present study to extract fibre. The collected of hemp stalk from Bisalpur, District Pilibhit at 20 kg and CSAUAT, Kanpur at 25 kg. This plants grow abundantly in this area as a weed plant.



Fig 1: Collection of hemp fiber

2.2 Hemp plant fiber extraction

2.2.1 Water retting

Leaves from hemp stalk were removed prior to dipping it in water tank (M:L 1:20). An extra weight was added to the bundles of the stalk to keep them in place because the formation of gas causes the bundles to rise. Hemp stalk were

retted for 7 days. The hemp stalk were removed from water and washed with clean water. Hemp stalk were later scattered on cemented floor and sun dried for 5 days. Some hemp stalk were soaked for 14 days, then sun dried for 4 days and the same process was repeated again and hemp stalk were soaked for 21 days and then sun dried for 2 days.



Fig 2: Extraction of Hemp fiber

1. Results and Discussion

3.1 Hemp Fiber Extraction

Water retting duration significantly influenced the ease of fiber separation, fibre quality, colour, and overall cleanliness of hemp fibers. Progressive retting periods of 7, 14, and 21 days showed distinct variations in fiber characteristics due to increasing microbial degradation of pectins and hemicellulose binding the fibers to the woody core.

Recent research shows that the method of fibre extraction

influences not only raw fiber quality but also the performance of fiber-reinforced composites. For example, hemp fibers processed by water retting contribute effectively to composite strength and stability, albeit the composite performance also depends on downstream treatments such as degumming or surface modification of fiber. This underscores the importance of aligning retting processes with intended end uses, whether textile or composite materials.

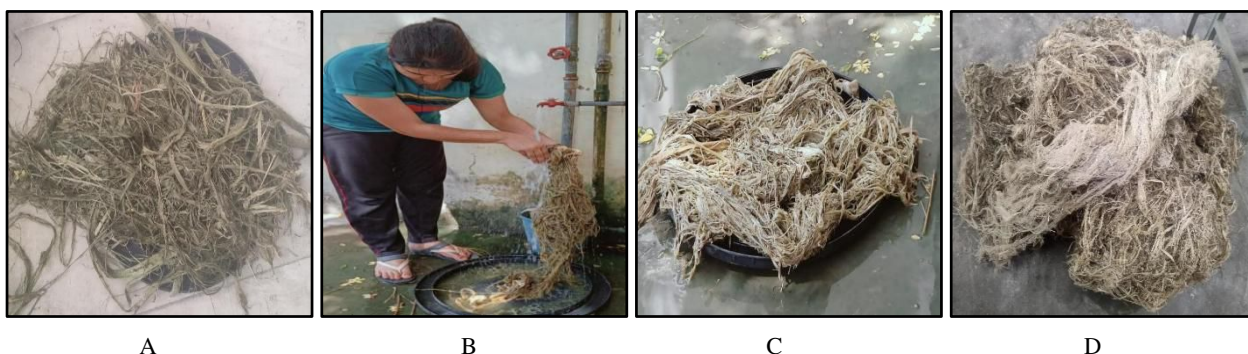


Fig 3: Cleaning and drying of Hemp fiber

3.2 Fiber Separation Efficiency

After 7 days of water retting, partial separation of fibers was observed. The fibers remained strongly adhered to the woody core, requiring considerable manual effort during extraction. Incomplete retting resulted in the presence of residual gums and non-fibrous materials, indicating insufficient microbial activity. In contrast, 14 days of retting provided optimum fiber separation. Fibers were easily detached from the stalk with minimal mechanical force, suggesting effective breakdown of cementing materials. This retting period allowed uniform microbial action without causing fibre damage. However, 21 days of retting led to over-retting of hemp stalks. Although fiber separation was very easy, the fibers appeared weakened and fragile due to excessive degradation of structural components. Over-retting negatively affected fibre integrity and strength.

In the initial stage (7 days), in complete retting results in strong adhesion between fibers and the woody core, necessitating higher manual effort for fiber removal. This aligns with the fundamental role of retting to degrade pectin and other binding materials; insufficient microbial activity

at shorter retting times leads to incomplete dissolution of these compounds, hindering fibre liberation. Conversely, moderate retting (14 days) promotes uniform breakdown of amorphous cell wall components, yielding easily separable fibers with smoother surfaces and improved visual quality. At extended retting times (21 days), over-retting causes excessive degradation not only of non-cellulosic materials but also of structural cellulose, weakening fibre integrity—a phenomenon also reported in related studies where prolonged retting deteriorates mechanical properties due to undesirable fiber degradation (Britannica; Angulu & Gusovius 2024) [2].

3.3 Fiber Appearance and Colour

Fibers obtained after 7 days of retting showed a light brown to greenish colour, indicating incomplete removal of non-cellulosic components. The surface appeared rough and uneven. Fibers retted for 14 days exhibited a uniform light cream to pale yellow colour, with smoother texture and better lustre. This retting duration was found to be most suitable for producing visually appealing fibers. In contrast,

fibers from 21 days retting were darker in colour, with signs of discoloration and uneven texture. Prolonged retting promoted excessive microbial action, leading to fibre surface deterioration.

3.4 Drying Behaviour and Fibre Cleanliness

Sun drying played an important role in improving fiber quality. Fibers retted for 14 days and sun dried for 4 days showed better cleanliness, reduced moisture content, and improved handling properties. The 7-day retted fibres retained more impurities even after drying, while 21-day retted fibres became brittle upon drying due to structural weakening.

3.5 Influence of Collection Site

No major qualitative differences were observed between hemp stalks collected from Bisalpur (Pilibhit) and CSAUAT, Kanpur, though slight variation in retting behaviour may be attributed to differences in stalk thickness and maturity. Both sources were found suitable for fiber extraction, confirming hemp's abundance as a viable raw material even when grown as a weed.

Recent research shows that the method of fiber extraction influences not only raw fiber quality but also the performance of fiber-reinforced composites. For example, hemp fibers processed by water retting contribute effectively to composite strength and stability, albeit the composite performance also depends on downstream treatments such as degumming or surface modification of fibers. This underscores the importance of aligning retting processes with intended end uses, whether textile or composite materials (Britannica; Angulu & Gusovius 2024) [2].

4. Conclusion

The present study demonstrated that water retting duration plays a crucial role in determining hemp fiber quality. Among the tested retting periods, 14 days of water retting followed by sun drying for 4 days was found to be the most effective treatment, producing fibers with optimal separation, uniform colour, smooth texture, and satisfactory strength. Shorter retting duration (7 days) resulted in incomplete fiber separation, while prolonged retting (21 days) caused over-retting and fiber weakening. Hemp stalks collected from both Bisalpur and CSAUAT, Kanpur proved to be suitable for fiber extraction, highlighting the potential utilization of hemp grown as a weed for sustainable fiber production. The study confirms that water retting is a simple, low-cost, and eco-friendly method for hemp fiber extraction and can be effectively adopted at the rural level. Further research may focus on optimizing retting conditions and evaluating the mechanical properties of extracted fibres for textile and industrial applications.

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