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INFLUENCE OF RETTING DURATION ON THE PHYSICAL PROPERTIES OF HEMP (*CANNABIS SATIVA* L.) FIBRES

Sakshi*, Ritu Pandey and Vaishali Singh

Department of Textile and Apparel Science, College of Community Science,
Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, U.P. – 208002, India
*Corresponding author E-mail: sheetalgangwar1997@gmail.com

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ABSTRACT

Retting is a critical processing step that governs the separation and quality of bast fibres in hemp (*Cannabis sativa* L.), directly influencing their suitability for textile and other value-added applications. The present study investigates the effect of different retting durations on the physical properties of hemp fibre, with particular emphasis on fibre length and tensile strength. Hemp fibres were subjected to controlled retting for varying periods (7, 14, and 21 days), and the extracted fibres were evaluated using standard testing procedures. The results revealed a significant influence of retting duration on fibre quality. Fibres retted for 7 days exhibited the highest fibre length (500 cm) and maximum tensile strength (23.86 g/tex), indicating superior structural integrity and mechanical performance. In contrast, extending the retting period to 14 and 21 days resulted in a progressive reduction in both fibre length and tensile strength, attributed to excessive microbial and enzymatic degradation of the fibre bundles. These findings demonstrate that prolonged retting adversely affects hemp fibre quality. The study concludes that an optimum retting duration of approximately 7 days is most suitable for producing high-quality hemp fibres. Precise control of retting time is therefore essential to achieve effective fibre separation while preserving mechanical strength, thereby improving the overall usability and commercial value of hemp fibre for sustainable textile and industrial applications.

Key words: Hemp fibre, physical properties, hemp stalk, fibre retting

Introduction

Plant fibres in general and hemp fibres in particular have great prospects for their use in various innovative applications such as ecological, biodegradable, and renewable resources with unique properties (Sakshi *et al.*, 2026). Such properties together with the increased strength due to high-cellulose content and specific morphological parameters are widely used to produce plant fibre-based plastic composites. The properties of plant fibres that may influence the properties of composites depend on crop processing, but the basis for them is provided during fibre development in plants. It is known that two types of bast fibres are developed in the hemp stem: primary fibres formed from procambium cells and secondary fibres that originate as a result of cambium activity. Both types of fibres may significantly vary in their yield and quality depending on the variety and growth conditions (Tatyana *et al.*, 2017)

According to Bismarck (2005), retting is a crucial stage in natural fibre processing, as it determines fibre cleanliness, strength, colour, and spinnability. Improper retting may result in under-retted fibres (difficult separation and coarse texture) or over-retted fibres (reduced strength and poor quality).

Hemp fibres are finding increasing use as reinforcements in composite materials, often replacing glass fibres. Found in the bast of hemp plant, these fibres have specific strength and stiffness that are comparable to those of glass fibres. The physical and mechanical properties of these fibres are still being explored. (Jankauskienë *et al.*, 2015).

One of these properties is the thermal degradation at elevated temperatures. Natural fibres are heterogeneous

mixtures of organic materials and heat treatment at elevated temperatures can result in a variety of physical and chemical changes. The physical changes are related to enthalpy, weight, colour, strength, crystallinity, and orientation of microfibril angle (Shahzad, 2013).

The proportion of the main components in a fibre as well as fibre's physical properties depend also on climatic conditions during hemp vegetative period, growing technology, cultivar, and growth/maturity stage at harvest (Amaducci *et al.*, 2005; Pandey *et al.*, 2022). Chemical composition also varies among plant parts (Keller *et al.*, 2001).

The physical and mechanical properties of natural fibres depend on the cultivation method, environmental condition, extraction method and microfibrillar angle. Plant fibres are separated either by dew retting, water retting and/or mechanical decortications method. The properties of natural fibre reinforced composites could be enhanced by suitable chemical treatment processes (Sathish *et al.*, 2021, Pandey *et al.*, 2021).

The fibresare separated manually from the stems harvested post tankwater retting. High specific strength, low density, inexpensive production, non-abrasive nature and biodegradability are all factors that make hemp an attractive material as a composite reinforcement (Dhakal and Zhang, 2015).

This high quality comes at the cost of throughput as the scutching mechanism can typically handle a smaller amount of hemp stalk per time as compared to other mechanisms Bargale (1990), Grégoire *et al.* (2021)

The great challenge in producing composites containing natural fibres and with controlled features is connected to the great variation in properties and characteristics of fibres. The quality of the natural fibres is largely determined by the efficiency of the treatment process and can dramatically influence the properties of the final composites. The overall fibre extraction processes, applied to vegetable fibres, is called retting and consists in the separation of fibre bundles from the cuticularized epidermis and the woody core cells. Today, many efforts are being made to optimize the retting methods in terms of fibre quality production, reduction of environmental issues and production costs (Laura.S., 2018)

The high-quality physical pulp properties and tensile strength make hemp an ideal non-wood-based raw material for making specialty paper. Barbash *et al.*, 2022) developed hemp paper from fibre with density of up to 1.56 g/cm^3, tensile strength of up to 66.7 MPa and transparency of up to 87.3% (Cetin *et al.*, 2022). Keeping in mind the above facts the present study was undertaken to investigate the effect of duration of retting on hemp stalk.

Materials and Methods

Fibre extraction

The fibre separation and extraction process has a significant impact on fibre yield as well as fibre quality. It directly influences the structural integrity, chemical composition, surface characteristics, and mechanical properties of the extracted fibres. Efficient extraction ensures maximum recovery of bast fibres while maintaining their strength, flexibility, and fineness.

Hemp fibres are obtained from the bast region of the stem. The process responsible for separating fibre bundles from the central woody core (xylem) and loosening them from the surrounding tissues is known as retting. Retting involves the degradation of pectic substances and hemicelluloses that bind fibre bundles to the woody core, thereby facilitating fibre separation. Water retting was carried out for three different durations, namely 7, 14, and 21 days in a tank.

Physical Properties

Hemp (*Cannabis sativa* L.) fibre samples extracted through tank water retting were considered as the standard control samples for the assessment of physico-chemical properties, as these fibres were free from the influence of chemical treatments. Extracted fibres were evaluated for their physical properties in order to determine the most suitable days for retting.

Fibre length

The physical parameters analyzed included fibre length was carried out at the Department of Clothing and Textiles, College of Home Science, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur. An individual hemp fibre was carefully drawn from the combed fibre sample obtained through the tank water retting method. Both ends of the fibre were gently gripped with forceps in such a manner that the fibre ends were aligned precisely with the tips of the forceps to ensure accurate measurement. The forceps holding one end of the fibre was positioned at the reference (zero) point of a measuring scale. Without applying any stretching force, the fibre was extended to its full natural length by gradually moving the second forceps along the measuring scale to remove any crimp present in the fibre. The fibre length was then measured in centimeters.

The determination of fibre length, as one of the important physical parameters, was carried out at the Department of Clothing and Textiles, College of Home

Science, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur

Tensile strength

Tensile strength analysis of physical properties, was carried out at the Central sheep and wool research institute, Avikanagar. The tensile strength of hemp fibres was determined using a Digital Tensile Strength Tester based on the Constant Rate of Extension (CRE) principle. The instrument was calibrated prior to testing to ensure accuracy of results.

Individual fibre strands were carefully selected and mounted between the upper and lower jaws of the tester. The gauge length was maintained at 20 mm. Care was taken to align the fibre centrally between the clamps to avoid slippage or uneven stress distribution. After proper clamping, tensile force was applied at a constant rate until the fibre ruptured.

The maximum load at break (breaking strength) was automatically recorded by the digital display unit of the instrument. The elongation at break was also noted simultaneously. Each fibre sample was tested multiple times (minimum 30–50 readings) to reduce experimental error and variability.

Results and Discussion

The results presented in the Table 1 indicate a clear effect of retting duration on the physical properties of hemp fibre, particularly fibre length and tensile strength. As the retting period increased from 7 to 21 days, both fibre length and tensile strength showed a decreasing trend.

At 7 days of retting, the hemp fibres exhibited the maximum fibre length (500 mm) and highest tensile strength (23.86 g/tex). This suggests that shorter retting duration was sufficient to loosen the pectic substances binding the fibre bundles without causing damage to the cellulose structure. Limited microbial activity at this stage helps in effective fibre separation while maintaining fibre integrity.

With an increase in retting duration to 14 days, a noticeable reduction in fibre length (400 mm) and tensile strength (18.95 g/tex)was observed. Prolonged retting likely intensified microbial and enzymatic action, leading

Table 1: Physical properties of extracted hemp fibre.

Physical Properties	Extracted hemp fibre		
	7 days	14 days	21 days
Fibre length (mm)	500	400	250
Tensile strength (g/tex)	23.86	18.95	16.98

Fig. 1: Hemp fibre extracted for different durations.

to partial degradation of non-cellulosic materials as well as the onset of fibre weakening. This stage represents a balance between fibre separation and structural degradation.

At 21 days of retting, the fibres showed the lowest fibre length (250 mm) and minimum tensile strength (16.98 g/tex). Excessive retting resulted in over-decomposition of binding materials and possible damage to the cellulose microfibrils, causing fibre breakage and loss of mechanical strength. Over-retting is therefore detrimental to fibre quality, particularly for applications requiring longer and stronger fibres.

Overall, the results demonstrate that retting duration significantly influences the physical properties of hemp fibre. Shorter retting periods favor higher fibre length and tensile strength, while extended retting leads to fibre deterioration. Based on the present findings, a 7-day retting period appears most suitable for obtaining superior-quality hemp fibres with better mechanical performance. These observations are consistent with earlier studies reporting that controlled retting is critical for optimizing fibre quality and end-use performance.

Similar trends have been reported by A. Bismarck *et*

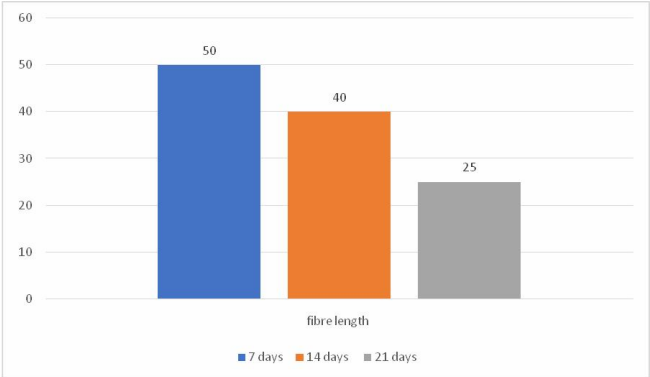

Fig. 2: Fibre length.

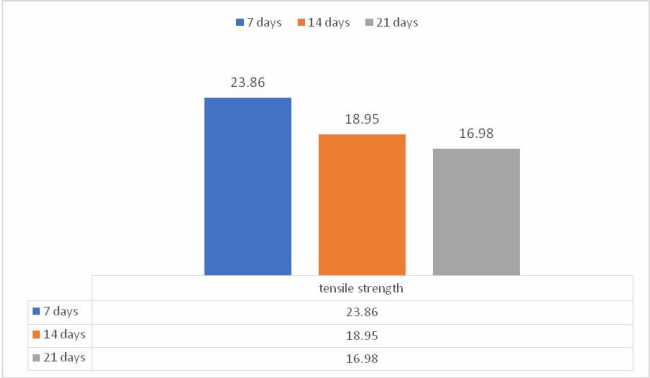

Fig. 3: Tensile strength.

al. (2005), who noted that improper or prolonged retting can significantly reduce fibre strength and quality, and by S. Varadarajan *et al*. (1990), who emphasized that excessive retting leads to weakening of bast fibres due to microbial degradation of cell wall components.

Conclusion

The present study concludes that retting duration has a significant influence on the physical properties of hemp fibre, particularly fibre length and tensile strength. Among the different retting periods evaluated, fibres retted for 7 days exhibited the highest fibre length (50 cm) and maximum tensile strength (23.86 g/tex), indicating superior fibre quality and structural integrity. As the retting period increased to 14 and 21 days, a progressive decline in both fibre length and tensile strength was observed, which can be attributed to excessive microbial and enzymatic action leading to fibre degradation and breakage.

Therefore, prolonged retting beyond the optimum duration adversely affects hemp fibre quality. Based on the findings of this study, a shorter retting period of approximately 7 days is recommended for obtaining high-quality hemp fibres suitable for textile and other value-added applications. Proper control of retting duration is essential to balance effective fibre separation with the preservation of mechanical strength, thereby enhancing the overall usability and commercial value of hemp fibre.

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