

# Extraction and Characterization of Fibres from Cyperus SPP and Evaluate Potential as Textile Fibres

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## ABSTRACT

Owing to environmental concerns caused by the use of synthetic fibres, there is an urgent need to find new eco-friendly fibres. In addition, conventional cellulosic fibres are becoming costly due to an increase in production cost, therefore, sustainable alternative sources of *eco*-friendly fibres need to be explored. This study investigates the extraction and characterization of fibres from the Umbrella sedge plant and evaluates its potential as textile fibres. Umbrella sedge plant fibres were extracted using water retting and chemical retting methods and their mechanical, physical, and chemical properties were studied. The fibre's chemical composition was established and alkaline extracted fibres contained.

**Keywords:** water retting, sustainable, cellulosic fibres, chemical retting, textile fibres, properties, eco-friendly, , physical properties.

## 1. INTRODUCTION

Umbrella sedge is a grass-like plant native to Madagascar and the Arabian Peninsula that is now widely cultivated worldwide for its ornamental foliage in water gardens and as a potted plant. It is a perennial herb with sturdy, triangular stems that are topped by a distinctive umbrella-like arrangement of narrow green leaves.

Umbrella sedge is a perennial, upright herb. has a perennial, clump-forming habit with erect, triangular, green stems (culms) topped by an umbrella-like cluster of long, narrow leaf-like bracts. It grows from a short, creeping [rhizome](#) and features fibrous roots, making it a semiaquatic plant found along streams, ponds, and in wet garden areas, though it also grows as a houseplant. It can reach heights of 0.3 to 2 meters (1 to 6.6 feet).

It is a fast-growing plant that can reach 3-5 feet (0.9-1.5 meters) in height with sufficient water. To encourage Umbrella sedge growth, provide consistently moist soil with the top inch of soil dry to the touch, bright indirect light, high humidity, and temperatures between 60-75°F (15-24°C

## 2. Objectives

To explore Umbrella sedge as an eco-friendly alternative to synthetic fibres.

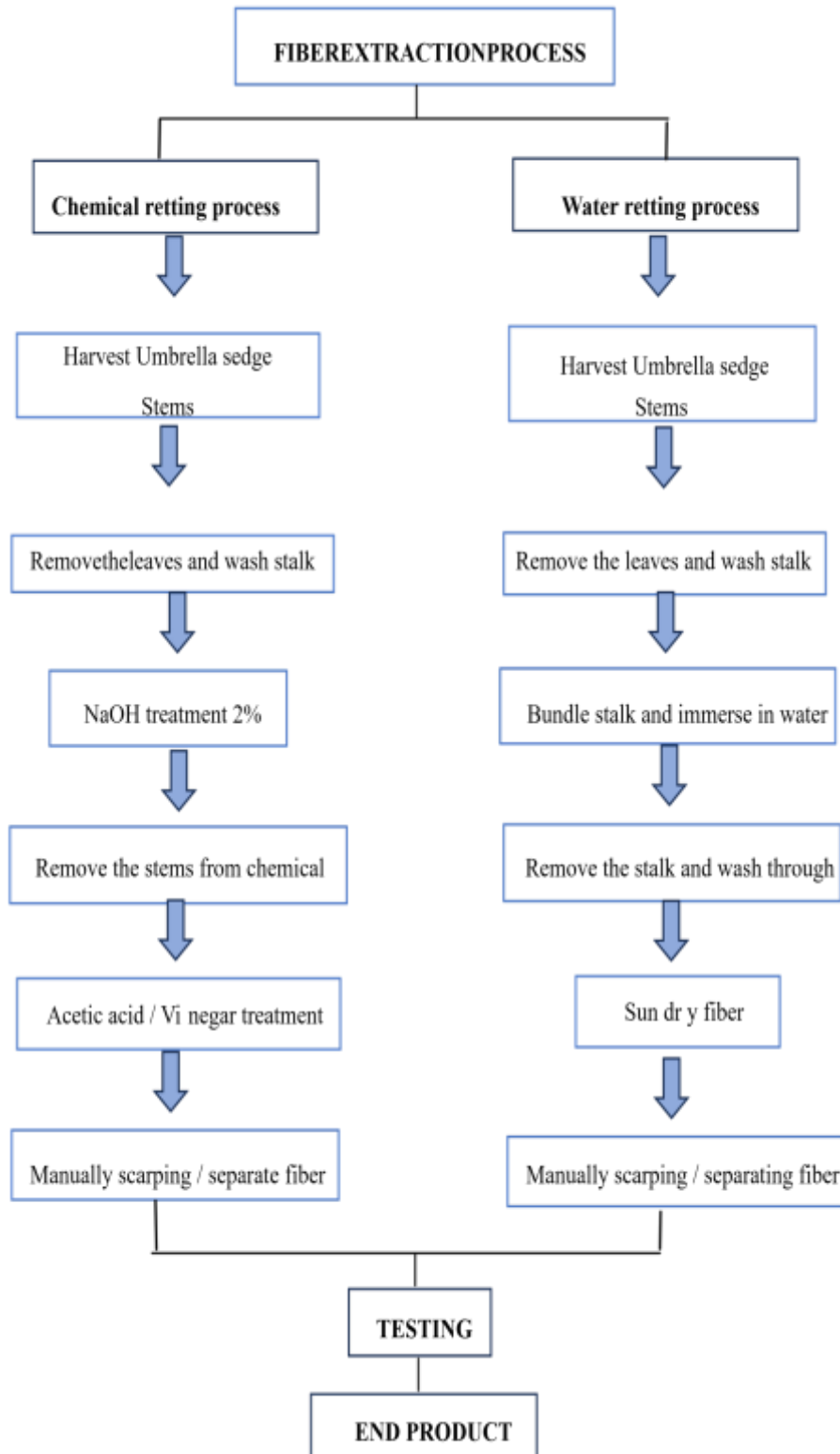
To compare performance with existing natural fibres (jute, sisal, hemp).

To analyze the physical, mechanical, and chemical properties of extracted fibres (length, fineness, tensile strength, cellulose, lignin content).

To evaluate yarn strength, flexibility, and texture.

To identify an effective method (mechanical, retting, chemical, or enzymatic) for extracting usable fibres from Umbrella sedge stems.

### 3. METHODS / METHODOLOGY



### 3.1 SELECTION OF FIBRE

The Umbrella sedge Grass comes from the bracts that grow atop of its tall stems. They have the appearance of the spokes of an umbrella. The bracts are sometimes referred to as leaves. The true leaves on this plant clasp the tall stem in a manner so that they are hard to distinguish from the stem. The Umbrella sedge Plant is a member of a large family of plants, with over 600 grass-like varieties, typically native to predominately tropical locations. Its root system is well-developed, anchoring the plant into the surrounding wet soil where it can spread via its rhizomes as well as by its self-seeding tendencies. In some locations, with the right conditions, it can become weedy and invasive. Typically reaching heights of 4', under ideal outdoor conditions of a warm, moist environment, they can grow up to 6'.



**Fig.1 Umbrella sedge**

### 3.1 CHEMICAL RETTING

Chemical retting uses chemical solutions, like acids or alkalis, to dissolve the pectin and other non-cellulosic materials that bind natural fibers (such as flax, hemp, and jute) to the plant stem. This process is a faster, though more expensive, alternative to microbial retting, yielding clean and high-quality fibers in a matter of hours instead of days or weeks. However, it generates polluted wastewater and can reduce the fibers' tensile strength if harsh chemicals are used at high concentrations.



**Fig.2 Stalk of Umbrella sedge**

#### 3.1.1 NaOH treatment 2%

In the chemical retting process, Sodium Hydroxide (NaOH) treatment is used to dissolve the non-cellulosic components like pectin and lignin from plant fibers, separating and cleaning the cellulose fibers from the plant stalk. The process involves soaking fibers in an aqueous NaOH solution of a specific concentration and duration, followed by thorough washing in water to remove excess alkali and remaining impurities before drying. This treatment increases the fiber's surface area and improves its physical, mechanical, and crystalline properties, making it suitable for applications such as biocomposites and textiles.

#### 3.1.2 Remove the stems from chemicals

After sodium hydroxide (NaOH) treatment in the chemical retting process, the fibers are thoroughly washed with water to remove residual chemicals, neutralized with a dilute acid, and then dried to complete

the extraction of non-cellulosic materials like lignin, pectin, and oils. This alkali treatment enhances the surface functionality, increases the surface area, and improves the quality and properties of the fibers, such as increasing their tensile strength, though excessive treatment can lead to degradation.

### 3.1.3 Manual scraping

In a chemical retting process, "manual scraping" refers to a post-chemical treatment action where workers physically scrape the plant material to remove the softened, non-fibrous components and expose the raw fibers. After chemicals have softened and dissolved the fibrous matrix, scraping tools like knives or specialized implements are used to scrape away the now-brittle woody parts, a process also known as scutching, leaving the desired fibers clean for further processing.



**Fig.3 Chemical retted fibre**

## 3.2 WATER RETTING

Water retting is a biological process for separating natural fibers from the nonfibrous tissues of plants, primarily by submerging harvested jute or flax stalks in water. Bacteria and fungi in the water break down pectins and lignins, which bind the fibers to the stalk, allowing them to be separated. The process is time-sensitive; under-retting makes separation difficult, while over-retting can weaken the fibers.



**Fig.4 Retting**

**Microbial Action:** The water penetrates the bundles, and the moisture and bacteria within the water begin to rot the non-fibrous material (like the pectin and lignin) that holds the fibers to the stalk.

**Decay & Separation:** This microbial activity softens the tissues and causes them to decay, gradually loosening the connection between the fiber and the woody core.

**Duration & Monitoring:** The retting time is crucial; it must be carefully monitored to avoid under-retting or over-retting. The process can take anywhere from a week to a few weeks, depending on factors like water temperature and the quality of the plant material.

**Fiber Extraction:** Once the process is complete, the non-fibrous core has softened enough for the fibers to be manually separated from the stalks.



**Fig.3 Water retted fibre**

## 4. RESULT AND DISCUSSION

### 4.1 FTIR TESTING

A Fourier Transform Infrared spectroscopy analysis that uses infrared light to create a unique molecular fingerprint of the fiber's chemical structure, allowing for its identification, characterization, and analysis of its components like cellulose and lignin.

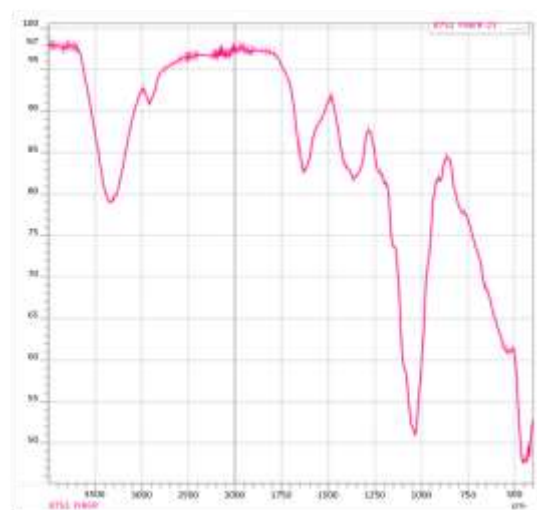
#### 4.1.1 RESULT

The FTIR spectrum of fibers obtained by water retting and chemical treatment indicate band associated with to cellulose, hemicellulose, and lignin substances. The water treated fibre sample shows stronger signals of natural non-cellulosic substances such as lignin and hemicellulose. In comparison, the alkali treated fiber displays reduced intensity of these peaks, suggesting unwanted elimination of impurities. This indicates that chemical retting results in comparatively cleaner and better refined fiber structure.

#### CHEMICAL RETTING



#### WATER RETTING



### 4.2 TENSILE STRENGTH

Tensile strength is the maximum pulling stress a material can withstand before breaking or fracturing under tension.

#### 4.2.1 METHOD

- Fibre should be attached to be clamp stand
- Attach a weight on the other end of the plant fibre
- Carefully continue to add one weight at a time until the fibre breaks
- This represents the tensile strength

- To increase the accuracy of your results, this process should be repeated with more samples.

#### 4.2.2 RESULT

##### Single fibre strength and elongation

S.no	Testparameter	Water retting fibre	Chemical retting fibre
1	Mean breaking strength Fmax (gf)	151	111
2	Mean breaking elongation dL at Fmax(%)	8.8	8.0

The tensile strength of a fibre is its ability to withstand a maximum pulling force or stress without breaking or permanently deforming.

It represents the maximum force a fibre can endure when being stretched or pulled.

A fibre with high tensile strength can hold more weight before tearing and is often used to determine the overall strength and structural integrity of a material.

#### 4.3. MOISTURE CONTENT

A moisture content test in fiber determines the weight of water in a sample, typically by oven-drying it until it's completely dry and then calculating the percentage of water lost relative to the original total weight.

##### 4.3.1 METHOD

- Weigh a representative sample of fiber.
- Place the sample in a convection oven, typically at 103–105°C.
- Dry the sample to a constant weight.
- Cool the sample in a desiccator to prevent it from reabsorbing atmospheric moisture.
- Weigh the dried sample and calculate the percentage of moisture lost.
- Place the fiber sample on the instrument's tray.
- The microprocessor controls the drying process, measuring the moisture loss rate as the sample is heated.
- The instrument stops when the sample's weight stabilizes and directly displays the moisture content.

##### 4.3.2 RESULT

S.NO	Moisture content	Water retting fibre	Chemical retting fibre
1	Moisture content, %	14.34	14.11

#### 5. CONCLUSION

This study focused on the extraction and evaluation of fibres from *Cyperus spp* to explore its potential as a sustainable textile fibre. The fibres were successfully extracted using water retting and chemical retting methods and were further analyzed for their physical and chemical properties. The results show that the fibres possess good characteristics that can make them suitable for textile and related applications. Since the plant is natural, renewable, and ecofriendly, it can serve as an alternative to synthetic fibres and help support sustainable textile development. Further research and improvement in processing techniques can enhance the quality and usability of these fibres in the textile industry.

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