# EXTRACTION OF FIBRE FROM WATER HYACINTH AND ITS CONVERSION INTO YARN FOR TEXTILE APPLICATIONS

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## ABSTRACT

Water hyacinth, a prolific invasive aquatic plant, has become a significant ecological and economic challenge worldwide. Despite its reputation as a nuisance, water hyacinth is a rich source of cellulose, making it a potential raw material for sustainable fiber production. This thesis explores the extraction of fibers from water hyacinth and their subsequent conversion into yarn, with a focus on their application in the textile industry.

The research involves developing an efficient process for fiber extraction, characterizing the physical and chemical properties of the fibers, and overcoming challenges in spinning them into yarn. Advanced techniques are employed to enhance the spin ability of the fibers, including blending with other natural or synthetic fibers. The resultant yarn is evaluated for its mechanical strength, durability, and suitability for diverse textile applications.

## KEYWORDS

Water hyacinth fiber, natural fiber, fiber extraction, ring spinning, sustainable textile, yarn properties, retting process, fiber blending.

## 1. INTRODUCTION

Water hyacinth (Eichhornia crassipes), originally from South America, has rapidly become a global ecological threat due to its fast propagation and dense mat formation in freshwater bodies [1,10]. Its high cellulose and lignin content makes it suitable for fiber extraction, attracting attention from researchers seeking sustainable alternatives in the textile industry [2,12,13]. Natural fibers are gaining renewed interest amid environmental concerns surrounding synthetic fibers and their environmental impact [4,13,17].

Researchers have explored the potential of non-traditional plant fibers like water hyacinth for textile applications due to their biodegradable nature and renewable availability [3,16,21]. However, the coarse, rigid structure, short staple length, and inconsistent quality of water hyacinth fibers pose significant processing challenges, particularly in spinning [6,14,22].

This research aims to evaluate the feasibility of producing yarn from water hyacinth fiber blends using conventional spinning methods and standard textile quality metrics, building on earlier work that explored natural fiber preparation and mechanical enhancement techniques [5,18,19].

## 2. MATERIALS AND METHODS

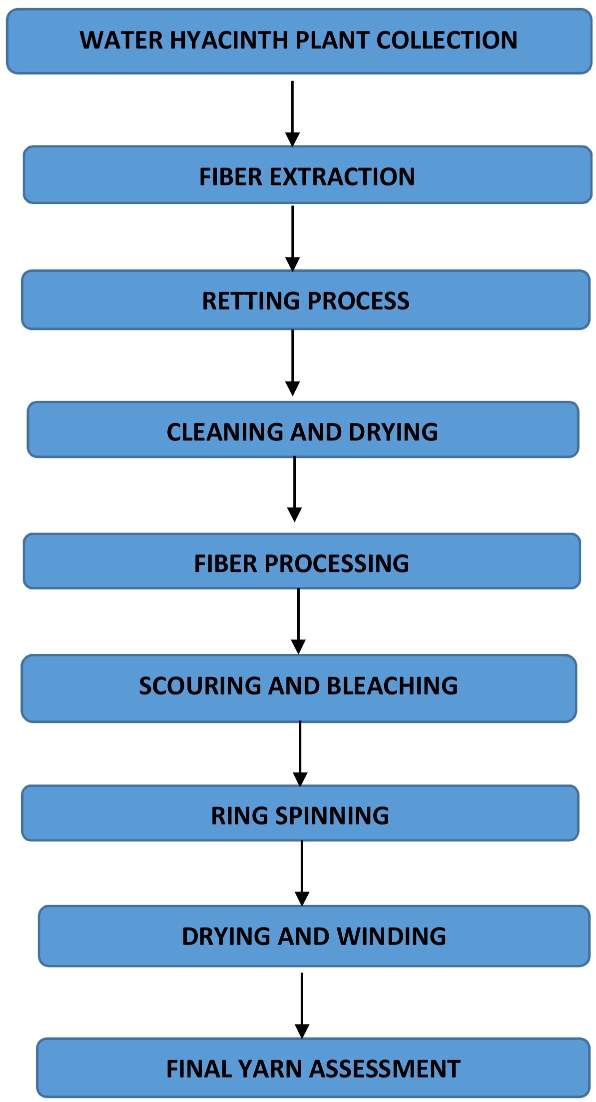
1.SAMPLE HARVESTING 2. RETTED SAMPLE 3. RETTED SAMPLE 4. PINCOMB 5. FINAL ALLINED FIBER

(Figure.1)

## 2.1 MATERIALS

Water hyacinth plants were harvested from local water bodies in Erode and Namakkal districts, Tamil Nadu. Mature stems with diameters of 2–4 cm and lengths of 20–50 cm were selected. Flax fibers were used as blending partners (40%) to improve spinnability.

## 2.2 METHODS




**FLOW CHART-1 METHODOLOGY**

### 3.1 FIBER EXTRACTION – WATER RETTING

Stems were submerged in water containers for 10–14 days. Microbial activity softened the tissues, facilitating fiber separation. After retting, fibers were combed using pin combs to remove non-fibrous residues and aligned.

### 3.2 CLEANING AND DRYING

Washed stems underwent detergent cleaning and distilled water rinsing. Air-drying was done under shaded, ventilated conditions at 25–35°C for 7–10 days, with mechanical drying (hot air oven at 40°C) as a backup.


1.Drawfame(input) 2. Delivery (output) 3. Roving frame 4. Sample bobbin

(Figure.2)

### 3.3 FIBER PROCESSING

**Draw Frame:** 1. Preparation of Slivers: Water hyacinth fibers were initially processed into sliver form in draw frame blend with Flax fiber in 60:40 ratios.

2. Machine Setup: The draw frame machine was set with a draft of 10, meaning the fibers were elongated ten times their original length. The doubling was set at 8, combining eight individual slivers into one.

3. Feeding Slivers: Eight carded slivers of water hyacinth fibre were fed simultaneously into the draw frame machine.

4. Drawing Process: The slivers were drawn through pairs of rollers, where drafting occurred to align and straighten the fibers, improving fiber parallelization.

5. Doubling Effect: The multiple slivers blended during the drafting process helped reduce mass variation and improve sliver uniformity.

6. Sliver Delivery: The processed sliver was delivered at a consistent rate of 7.9 grams per meter and collected in cans for the next stage of Roving frame.

7. The output sliver from the draw frame was fed into the roving frame. Here, the fibre was further attenuated and a small amount of twist was inserted to form a roving, making it suitable for final yarn spinning. The output roving 0.7 g/m with 33.6 TPM.

### 3.4 SCOURING AND BLEACHING

A one-bath process included:

Demineralization at 80°C for 30 mins

Scouring at 90°C for 20 mins

Bleaching at 85°C for 60 mins

Hot wash 90°C for 30 mins

Neutralization with acetic acid and catalase at room temperature.

| PROCESS NAME | CHEMICAL NAME | PURPOSE | GPL | Temperature & time |
|---|---|---|---|---|
| DM | IMEROL ZS | Wetting Agent | 0.5gpl | 80C - 30 min |
| | INVATEX ED | Cracking Agent | 0.5gpl | |
| | HEPTOL ASC | sequesting agent | 1.0gpl | |
| SCOURING | IMEROL ZS | Wetting Agent | 0.25gpl | 90 C -20min |
| | INVATEX ED | Cracking Agent | 0.3 gpl | |
| | CAUSTIC LYE | Scouring Agent | 8.0 gpl | |
| BLEACHING | IMEROL ZS | Wetting Agent | 0.13gpl | 85C- 60min |
| | INVATEX ED | Cracking Agent | 0.13gpl | |
| | CAUSTIC LYE | Scouring Agent | 5.0gpl | |
| | PRESTOGEN FCB | Bleaching stabliser | 3.5gpl | |
| | HYDROGEN PEROXIDE | bleaching agent | 8.0gpl | |
| HOTWASH | | | | 90C - 30min |
| NEUTRALIZATION | ACETIC ACID | Neutralizing agent | 0.5gpl | RT-20 min |
| | CATALASE BF SP | peroxide killer | 0.5 gpl | |

## 3.5 RING SPINNING

The bleached rove was spun using a ring spinning machine (Figure.3), which is widely regarded for producing high-quality yarns with excellent strength and uniformity. In this process, the rove—already bleached to achieve a desired whiteness and cleanliness—was drafted and twisted to create yarn with a twist per meter (TPM) of 427. This level of twist is considered relatively high, contributing to enhanced tensile strength and compactness of the final yarn. The ring spinning method employed in this stage ensures precise control over the yarn structure, making it suitable for fine and durable textile applications.

The selection of TPM was likely based on the optimal balance between yarn strength and softness, ensuring that the finished product meets both functional and aesthetic requirements.

Spinning process - Yarn making (Figure .3)

### 3.6 DRYING AND WINDING

Spun yarn cops were dried using RF dryers for rapid, uniform moisture removal. Cops were conditioned for 2–4 hours before winding on autoconer machines.

RF dryer (Figure.3)

Winding (Figure.4)

## 4. RESULTS AND DISCUSSION

Testing five aspects of Water Hyacinth yarn's physical properties were counts of yarn using ASTM D1578 & IS1671, Unevenness: test using D1425 tensile strength: test using ASTM D 2256, ISO2062 & IS 1671 standard.

### 4.1 YARN COUNT AND CSP

Actual Count: 11.75 Nm

Count CV: 1.1%

CSP (Count Strength Product): 1178

CSP CV: 3.33%

The actual count of 11.75 Nm (approximately 7 Ne) aligns well with the target range, indicating good control over drafting. The low Count CV of 1.1% shows uniformity in yarn fineness [4,5].

The CSP value of 1178 reflects the combined effect of yarn strength and fineness. For coarser yarns, a CSP above 1000 is generally acceptable, so this result indicates moderate strength performance [9,20]. The CSP CV of 3.33% is also within tolerable limits, pointing to consistent spinning [5,9].

### 4.2 EVENNESS AND IMPERFECTIONS

Parameter Value Interpretation

U% (Unevenness) 28.38% Very High – indicates mass variation

Thin Places (-50%) 3170/km

Thick Places (+50%) 2205/km

Neps +200% 3885/km

Neps +400% 450/km

H% (Hairiness) 3.55 Moderate – acceptable

U% of 28.38% is considerably higher than industry norms for coarse yarns (typically <15–18%), which suggests poor fiber alignment and uneven fiber feed.

The imperfection values (thin, thick, neps) are well beyond acceptable thresholds, indicating processing inefficiencies—likely at the carding and drawing stages [6,22].

High nep counts (especially +200%) indicate either the presence of immature fibers or a lack of fiber individualization in carding [3,6,18].

Hairiness (H%) of 3.55 is within normal ranges but could lead to higher pilling in fabrics.

**4.3 TENSILE PROPERTIES**

Parameter Value Comments

RKM 10.66 g/tex Moderate strength

RKM CV 19.79% High variability – strength is unstable

Elongation 1.71% Very Low – brittle yarn

B-Force 907 gf Moderate – but depends on fiber type

CV (Tensile) 21.45% High – inconsistent yarn performance

An RKM of 10.66 g/tex places the yarn in a usable strength range for coarse applications but lower than standard for finer yarns [4,7,19]. The RKM CV of

19.79% shows inconsistency in strength distribution, possibly due to non-uniform fiber structure [3,19].

Elongation at 1.71% is very low, indicating brittleness—possibly linked to lignin rigidity and insufficient ductility [12,16].

The B-Force of 907 gf is within usable limits but varies due to the inconsistent fiber quality typical of mechanically retted water hyacinth [6,18].

| YARN PARAMETERS | UNIT | TEST RESULTS |
|---|---|---|
| Actual Count | NM | 11.75 |
| Count CV | % | 1.1 |
| CSP | | 1178 |
| CSP CV | % | 3.33 |
| U% | % | 28.38 |
| Thin-50% | /km | 3170 |
| Thick +50% | /km | 2205 |
| Neps+200% | /km | 3885 |
| Neps+400% | /km | 450 |
| H% | | 3.55 |
| Sh | | 1.89 |
| RKM | g/tex | 10.66 |
| RKM CV | % | 19.79 |
| Elongation | % | 1.71 |
| CV | % | 21.45 |
| B-Force | gf | 907 |

YARN TEST RESULTS

FINAL YARN SAMPLE (LEA FORM)

## 5. CONCLUSION

This study successfully demonstrated that water hyacinth fiber, when blended with flax, can be spun into yarn using conventional ring spinning techniques. However, significant limitations exist in yarn quality, particularly in terms of high unevenness, elevated imperfection counts, and low elongation. These challenges are primarily attributed to the coarse texture, short staple length, and inconsistent structure of untreated water hyacinth fibers [6,13,21].

To commercialize this process, improved retting methods, fiber length enhancement through mechanical or enzymatic techniques, and compatibility optimization in spinning need to be explored [12,16,18]. Enzymatic retting, in particular, offers potential for better fiber separation and flexibility compared to traditional water retting [13,17].

Nevertheless, the findings affirm that water hyacinth holds significant promise as a low-cost, biodegradable, and eco-friendly fibre source, contributing to environmental management and sustainable textile production efforts [13,17,22]. With refinement in pre-processing and spinning strategies, this underutilized resource could play a viable role in green textile innovation.

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