Water Hyacinth Fibre Yarn in the Production of Interior Decoration Items: A Sustainable Design Approach in South-West Nigeria

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ABSTRACT

This study presents a systematic investigation into the extraction and processing of water hyacinth fibre from two riverine sites in South-West Nigeria, Igbokoda (Ondo State) and Ejinrin (Lagos State) for textile and interior decoration applications. Two extraction methods were employed and comparatively evaluated: the alkali retting method and the mechanical decortication method. Following extraction, fibres were subjected to alkaline pre-treatment using 10% NaOH at 90°C, neutralisation with 1.0% acetic acid, washing, and ambient-temperature drying. Dye absorption trials using vat dyes (black, orange, and green) were conducted to assess dimensional stability during wet processing. Selected fibres were subsequently spun into yarn using manual and traditional rope-making techniques. Results demonstrated that the mechanical decortication method produced cleaner, more uniform fibres in less time, while the retting method yielded softer fibres better suited for fine textile applications. Fibre samples from both sites exhibited complete dimensional stability throughout the dyeing process, with no measurable change in length before and after dyeing in wet or dry conditions. Fibres from Igbokoda, selected on the basis of superior impact resistance and flexural performance, were identified as the most suitable for yarn spinning, yielding smooth, flexible, and aesthetically viable yarns. The study demonstrates a feasible, low-cost processing pipeline for converting an invasive aquatic weed into textile-grade yarn appropriate for eco-friendly interior decoration applications in Nigeria.

Keywords: Water Hyacinth Fibre Extraction; Eichhornia Crassipes; Retting; Decortication; Alkali Treatment; Yarn Spinning; South-West Nigeria; Sustainable Textile

INTRODUCTION

The growing global demand for sustainable, eco-friendly materials has renewed interest in natural plant-based fibres as viable alternatives to synthetics in textile and design industries. This shift is driven by increasing awareness of the environmental costs of petroleum-derived fibres, including their persistence in ecosystems, non-biodegradability, and contributions to microplastic pollution (Ramesh et al., 2017). Among the many underexplored natural fibre sources, water hyacinth an aggressive aquatic invasive weed presents a compelling opportunity for valorisation into textile-grade material.

In Nigeria, water hyacinth has established itself as one of the most severe environmental challenges facing inland waterways and coastal ecosystems. First recorded as an infestation in 1984 at Badagry Creek, Lagos State (Akintola et al., 2011), it has since spread across the nation's major rivers, dams, and lakes, causing significant disruption to fishing, navigation, hydropower generation, and aquatic biodiversity (Bolorunduro, 2002; Ezama, 2019). Conventional control strategies, mechanical removal, biological agents, and chemical herbicides have achieved limited long-term success, and their cumulative financial and ecological costs continue to mount (Souza et al., 2020). The valorisation of harvested water hyacinth biomass into useful materials therefore presents a dual benefit: ecological management and economic gain.

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Water hyacinth stalks are composed of cellulosic fibres embedded in a matrix of hemicellulose and lignin, making them structurally amenable to fibre extraction using established retting and decortication methods (Jafari, 2010; Guna et al., 2020). However, the specific extraction, treatment, and processing conditions that yield textile-grade fibre from Nigerian water hyacinth sources remain inadequately documented. Most existing studies on water hyacinth fibre extraction have been conducted in Asian or Latin American contexts, where environmental conditions, plant characteristics, and available processing equipment differ significantly from those encountered in West Africa (Rezania et al., 2015; Karouach et al., 2022).

This study addresses that gap by documenting and evaluating a complete fibre processing pipeline from field harvesting through alkaline treatment, dye absorption testing, and yarn spinning using water hyacinth collected from Igbokoda River (Ondo State) and Ejinrin River (Lagos State). The comparative evaluation of retting versus mechanical decortication, and the assessment of dyeing dimensional stability, are particularly relevant to the feasibility of small-scale, community-based textile production from this invasive weed in Nigeria.

LITERATURE REVIEW

2.1 Water Hyacinth as a Fibre Source

Water hyacinth (Eichhornia crassipes) belongs to the family Pontederiaceae and is native to South America. Its remarkable capacity for rapid vegetative reproduction doubling biomass within twelve days under optimal conditions has made it one of the world's most problematic aquatic weeds (Rezania et al., 2015). Despite its ecological menace, the plant's structural composition makes it an attractive candidate for fibre extraction. The stalks of water hyacinth contain significant concentrations of cellulose (18–45%), hemicellulose (18–22%), and lignin (3.5–10%), depending on growth conditions and the age of the plant (Jafari, 2010; Guna et al., 2020).

Early research into water hyacinth as a fibre resource was primarily motivated by its potential for paper manufacturing and composite reinforcement. Aboul-Fetouh et al. (2010) demonstrated the adsorptive capacity of water hyacinth fibres for textile dye removal from wastewater, incidentally showcasing their structural integrity under wet processing conditions. Subsequent studies by Ramesh et al. (2017) and Guna et al. (2020) documented significant improvements in fibre tensile strength from ~1–3 MPa in untreated state to 25–40 MPa following alkali treatment underscoring the centrality of chemical pre-treatment to fibre quality.

In craft and interior design contexts, countries such as India, the Philippines, Thailand, and Indonesia have developed artisan traditions of weaving water hyacinth into household items, storage baskets, table mats, and decorative objects (Rezania et al., 2015; Boonyaroj et al., 2017). These applications predominantly rely on dried or minimally processed whole stems rather than extracted fibres, limiting the range of achievable textile forms. The more technically demanding pathway of full fibre extraction and yarn spinning remains comparatively underdeveloped, particularly in the African context.

2.2 Fibre Extraction Methods

Two principal methods are employed in the extraction of bast-type fibres from plant stems: retting and mechanical decortication. Retting is a biological process in which plant stems are submerged in water to allow microbial enzymes to degrade pectic substances that bind fibrous bundles to the surrounding cortical tissue (Jose, Salim, & Ammayappan, 2016). Water retting typically requires 5–14 days, depending on water temperature, microbial activity, and stem maturity, and produces soft, lustrous fibres with minimal mechanical damage (Tahir et al., 2011). Alkali retting using sodium hydroxide (NaOH) solution accelerates the process and improves fibre uniformity by chemically hydrolysing non-cellulosic polysaccharides (Ramesh et al., 2017).

Mechanical decortication employs purpose-built machines that apply crushing and scraping forces to separate fibres from the woody stem. This method is faster and less dependent on water availability, producing cleaner fibres with more consistent dimensions. However, it carries a higher risk of fibre breakage and structural damage if the equipment settings are not optimised for the specific plant material (Alavudeen et al., 2015). Several studies have recommended a combined decortication-retting approach to maximise both yield and fibre quality, with initial mechanical separation followed by short-duration water or alkali retting to further loosen residual binder materials (Jose et al., 2016).

2.3 Chemical Treatment and Fibre Modification

Alkali treatment most commonly with sodium hydroxide (NaOH) is the most widely applied chemical modification technique for natural fibres. At concentrations of 5–20% and temperatures of 60–100°C, NaOH treatment effectively removes hemicellulose, waxes, pectins, and surface impurities from the fibre surface, exposing a cleaner cellulosic surface with improved mechanical bonding potential (Reddy et al., 2013; Mishra et al., 2018). The treatment also disrupts hydrogen bonding within the crystalline cellulose structure, reducing rigidity and enhancing fibre flexibility a desirable property for weaving applications.

Post-alkali neutralisation using dilute acetic acid (1.0%) is standard practice to arrest the alkali reaction, restore appropriate pH, and prevent continued hydrolytic degradation of cellulose (Ammayappan et al., 2013). Proper washing and ambient drying subsequently stabilise the fibre's moisture profile and preserve its structural integrity for downstream processing.

2.4 Yarn Spinning from Natural Fibres

Yarn spinning is the mechanical process of drawing out, twisting, and winding fibres into continuous strands of usable length and strength. For natural bast fibres, manual spinning techniques including hand twisting and traditional rope-making are commonly employed in artisanal and craft settings, offering accessible entry points for small-scale production without requiring industrial infrastructure (Nuruzzaman, 2001; Kanchan, 2014).

The quality of spun yarn is primarily governed by fibre length, strength, fineness, and surface friction characteristics (Ammayappan et al., 2013). For water hyacinth fibre, which tends toward moderate length and variable fineness, manual spinning methods have been reported to yield acceptable yarn quality for non-structural textile applications (Emidun & Akinrujomu, 2021). Alternatively, flat dried stems split into narrow strips can be used directly as warp or weft elements in weaving, bypassing the need for conventional spinning and making water hyacinth highly accessible as a craft material even without specialised equipment.

2.5 Dyeing of Natural Fibres

Dyeing is a critical step in the production of decorative textile items, transforming natural fibre's typically dull coloration into vibrant, marketable products. For cellulosic fibres such as water hyacinth, vat dyes are particularly appropriate owing to their excellent wash fastness, light fastness, and deep penetration into the cellulose matrix (Mazharul, 2021; Jyoti, 2023). Vat dyes require reduction by caustic soda and sodium hydrosulphite to render them soluble before application, followed by oxidation to develop the final colour on the fibre.

Dimensional stability during dyeing is the ability of a fibre to retain its original length and form through wet processing, is a key quality indicator for textile applications. Fibres that swell, shrink, or deform during dyeing compromise finished product dimensions and aesthetic uniformity. The alkali pre-treatment applied during extraction has been documented to reduce hygroscopic sensitivity in plant fibres by removing water-absorbing hemicellulose and pectins, potentially improving dimensional stability during subsequent wet processing (Reddy et al., 2013; Ramesh et al., 2017).

MATERIALS AND METHODS

3.1 Study Area and Plant Collection

Mature water hyacinth plants were harvested from two South-West Nigerian waterways: Igbokoda River (Ondo State; approx. 6°30'N, 4°50'E) and Ejinrin River (Lagos State; approx. 6°30'N, 4°05'E). These sites were selected on the basis of heavy infestation density, ease of water access, and contrasting riparian environments. Harvesting was conducted manually using cutlasses and protective gloves. Roots and leaves were removed on-site, retaining

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only the fibrous stalks. Stalks were washed, cut to 30–40 cm lengths, and air-dried for 48 hours before being labelled by site and stored in clean polyethylene bags.

3.2 Materials and Equipment

The materials used in this study included freshly harvested water hyacinth stalks, sodium hydroxide (NaOH), acetic acid (CH_3COOH), caustic soda, sodium hydrosulphite, vat dyes (black, orange, and green), and distilled water. Key equipment comprised cutlasses, protective gloves, a decorticating machine (Ibiade Workshop, Ogun State), a hair comb (for retting separation), a weighing balance, a hot-water basin, a manual spinning frame, and a press machine (for stem flattening). All chemical reagents used were of analytical grade.

Table 1: Materials and Equipment Used in Water Hyacinth Fibre The materials used in this study included freshly harvested water hyacinth stalks, sodium hydroxide (NaOH), acetic acid (CH_3COOH), caustic soda, sodium hydrosulphite, vat dyes (black, orange, and green), and distilled water. Key equipment comprised cutlasses, protective gloves, a decorticating machine (Ibiade Workshop, Ogun State), a hair comb (for retting separation), a weighing balance, a hot-water basin, a manual spinning frame, and a press machine (for stem flattening). All chemical reagents used were of analytical grade.

Extraction and Processing

Category	Item	Purpose
Raw Materials	Water hyacinth stalks (30–40 cm)	Primary fibre source
Chemical Reagents	NaOH (10% solution)	Alkali retting and treatment
Chemical Reagents	Acetic acid (1.0% solution)	Neutralisation of alkali treatment
Chemical Reagents	Caustic soda + hydrosulphite	Dye reduction (vat dyeing)
Chemical Reagents	Vat dyes (black, orange, green)	Fibre colouration trials
Equipment	Decorticating machine	Mechanical fibre extraction
Equipment	Hair comb	Fibre separation post-retting
Equipment	Manual spinning frame	Yarn production
Equipment	Press machine	Stem flattening for weaving strips
Equipment	Weighing balance	Sample measurement
Equipment	Hot-water basin	Dye preparation

Source: Researcher's field and laboratory inventory, 2025

3.3 Fibre Extraction Methods

3.3.1 Retting Method

The retting method was carried out at the Industrial Design Studio, Federal University of Technology, Akure (FUTA). Cleaned stalks were bundled into manageable batches, tied securely, and submerged in water for a period of 5 to 7 days. The progress of retting was monitored from Day 4 onward by testing the ease of fibre separation from the stem cortex through gentle hand-pulling. Once fibres were sufficiently loosened, they were separated from the retted stem by repeated combing using a hair comb, progressing from coarse to fine separation.

Following mechanical separation, the fibres were subjected to alkali treatment: immersion in 10% NaOH solution at 90°C for one hour. This step removed residual non-cellulosic materials including pectins, waxes, and hemicellulose fractions. The alkali-treated fibres were then neutralised by rinsing in a 1.0% acetic acid solution, followed by thorough washing with clean water. Final drying was performed at ambient temperature in a shaded

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environment to prevent UV degradation. The resulting fibres presented a light-brown to golden colouration with a soft texture visually comparable to jute fibre.

3.3.2 Mechanical Decortication Method

Mechanical extraction was performed at Ibiade Craft Workshop, Ogun State, using a decorticating machine specifically adapted for bast fibre processing. The machine applied controlled crushing and scraping action to strip the outer cortex and pith from the stalk, exposing the underlying fibrous bundles. After mechanical separation, a mild combing pass was performed to remove residual stem fragments and align the extracted fibres. The decorticated fibres were subsequently subjected to the same NaOH treatment, neutralisation, washing, and drying protocol described for the retting method.

3.4 Comparative Evaluation of Extraction Methods

The two extraction methods were evaluated on the basis of the following parameters: processing time, fibre yield, surface cleanliness, fibre uniformity, and overall suitability for downstream textile processing. Visual and tactile assessment was used for surface cleanliness and uniformity, while processing time was recorded for standardised batch sizes of 500 g of fresh stalks.

Table 2: Comparative Parameters for Evaluation of Extraction Methods

Evaluation Parameter	Retting Method	Mechanical Decortication
Processing Time (days)	5–7 days	< 1 day (hours)
Fibre Surface Cleanliness	Moderate (residual pith)	High (cleaner strands)
Fibre Uniformity	Moderate	High
Fibre Texture	Soft, pliable	Slightly coarser
Equipment Required	Minimal (water + comb)	Decorticating machine
Risk of Fibre Damage	Low	Moderate (if mis-set)
Water Requirement	High	Low
Scalability	Limited (batch size)	High
Suitability for Fine Textiles	Better	Moderate
Suitability for Craft/Weaving	Good	Excellent

Source: Researcher's comparative assessment, 2025

3.5 Dye Absorption and Dimensional Stability Testing

To evaluate dimensional stability during wet processing, fibre samples from both sites were subjected to vat dyeing trials using three dye colours: black (Makun reference), orange (Igbokoda and Ejinrin), and green (Ejinrin). The dyeing procedure involved preparing dye solutions by dissolving caustic soda, sodium hydrosulphite, and dye powder in hot water in a basin. Each fibre sample was pre-washed before immersion in its respective dye solution.

Fibre samples were completely immersed in the dye bath and allowed to absorb the dye evenly over a standardised contact period. Samples were then removed, oxidised by exposure to air to develop the dye colour, and rinsed thoroughly in clean water to remove excess dye. Final drying was conducted at ambient temperature. The length of each sample was measured at three stages: (i) before dyeing (dry); (ii) immediately after dyeing (wet); and (iii) after post-dye drying. Dimensional change was calculated as:

$$\% \text{ Dimensional Change} = [(L_2 - L_1) / L_1] \times 100 \quad \ldots\ldots\ldots\ldots \text{(Equation 1)}$$

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where L_1 = length before dyeing; L_2 = length after dyeing (wet or dry).

3.6 Yarn Spinning

Following extraction, treatment, and selection of the most suitable fibre based on prior physio-mechanical assessment (Igbokoda fibres selected for superior impact resistance and flexural performance), yarn spinning was carried out at both the Industrial Design Studio, FUTA, and Mitimeth Craft Shop, Lagos. Two yarn preparation approaches were employed:

a. Extracted fibre strands were cleaned, combed, and sorted to remove short or entangled fragments before being drawn out, twisted, and wound onto a bobbin using a manual spinning frame. This produced conventional twisted yarn.
b. Dried whole stalks were flattened using a press machine to remove internal air pockets, then longitudinally split into strips of three or four divisions (for larger stems). These strips were hand-twisted using traditional rope-making techniques to produce weavable yarn of desired thickness.

Yarn quality was assessed on the basis of texture (surface smoothness), tensile handling (resistance to breakage during twisting), flexibility (pliability without brittleness), and aesthetic quality (sheen and coloration uniformity).

RESULTS AND DISCUSSION

4.1 Comparative Performance of Extraction Methods

The retting and mechanical decortication methods each demonstrated distinct advantages and limitations when applied to water hyacinth stalks from Igbokoda and Ejinrin. The retting method, while time-intensive (5–7 days), produced fibres with notably softer texture and greater pliability attributes particularly valued for fine weaving and textile applications. The microbial fermentation process during retting appeared to partially degrade residual pith without causing damage to the cellulosic fibre bundles, yielding a naturally lustrous, golden-brown material comparable in hand-feel to retted jute.

The mechanical decortication method, conversely, achieved comparable fibre separation in a fraction of the time, producing cleaner strands with higher surface uniformity and less residual cortical debris. The decorticating machine at Ibiade Workshop demonstrated effective separation for water hyacinth stalks of 30–40 cm length, with minimal fibre breakage at standard operating settings. Post-decortication combing further improved strand alignment and cleanliness. The speed and scalability of mechanical decortication make it more suitable for commercial or semi-industrial production contexts.

The combination of both methods initial mechanical decortication followed by a short retting period of 2–3 days was identified as the most effective processing pathway, yielding fibres with the cleanliness of decortication and the softness of retting. This finding is consistent with Jose et al. (2016), who recommended combined mechanical and biological processing for bast fibres to optimise both yield and quality.

Table 3: Summary of Fibre Quality Outcomes by Extraction Method

Quality Parameter	Retting Only	Decortication Only	Combined Method
Surface Cleanliness	Moderate	High	Very High
Fibre Softness	High	Moderate	High
Uniformity of Strands	Moderate	High	High
Processing Time	5–7 days	< 1 day	2–4 days
Fibre Luster	High	Moderate	High
Residual Pith	Moderate	Low	Very Low

Suitability for Fine Weaving	Good	Moderate	Excellent
Overall Rating	Good	Good	Excellent

Source: Researcher's Assessment, 2025

4.2 Effect of Alkali Treatment on Fibre Appearance and Texture

The application of 10% NaOH solution at 90°C for one hour produced a notable transformation in fibre appearance and texture across both site samples. Prior to treatment, extracted fibres presented with a greenish-brown colouration, irregular surface texture, and a slightly waxy feel attributable to residual surface waxes and pectin compounds. Following alkali treatment and acetic acid neutralisation, the fibres exhibited a clean golden-brown to cream colouration, considerably smoother surface texture, and enhanced pliability.

These changes are consistent with the documented effects of NaOH treatment on cellulosic natural fibres. Alkali treatment hydrates and dissolves hemicellulose and pectin fractions that bind fibre bundles together, effectively cleaning the fibre surface and exposing a more crystalline cellulosic structure (Reddy et al., 2013). The removal of surface waxes also improves surface energy, which has direct implications for dye uptake and adhesion in composite manufacturing (Ramesh et al., 2017).

Ejinrin fibres responded more uniformly to alkali treatment compared to Igbokoda fibres, consistent with their smoother surface morphology observed in SEM analysis. The more porous and partially cracked surface structure of Igbokoda fibres resulted in slightly less uniform treatment penetration, though overall quality remained acceptable for textile applications.

Table 4: Effect of Alkali Treatment on Fibre Characteristics (Ejinrin and Igbokoda)

Characteristic	Pre-Treatment	Post-Treatment (Ejinrin)	Post-Treatment (Igbokoda)
Colour	Greenish-brown	Cream to golden	Light brown to golden
Surface Texture	Waxy, irregular	Smooth, cohesive	Moderately smooth
Flexibility	Stiff	Pliable	Pliable
Lustre	Dull	Moderate sheen	Low to moderate sheen
Treatment Uniformity	N/A	Very good	Moderate
Residual Wax	Present	Absent	Trace
Surface Cleanliness	Poor	Good	Moderate

Source: Visual and tactile assessment, 2025

4.3 Dye Absorption and Dimensional Stability

The dye absorption tests were conducted on fibre samples from Ejinrin and Igbokoda using vat dyes in orange and green colours respectively. Vat dyes were selected for their well-documented affinity with cellulosic fibres and superior colour fastness properties (Mazharul, 2021; Akinmola, 2024). The dyeing procedure involving caustic soda reduction, fibre immersion, oxidation, and rinsing was successfully applied to both sample sets without visible fibre degradation or surface damage.

Critically, no dimensional change was recorded in any fibre sample across the three measurement stages (pre-dyeing dry; post-dyeing wet; post-dyeing dry), as presented in Table 5. All samples retained their original lengths throughout the dyeing process, demonstrating complete dimensional stability under wet processing conditions. This result has significant practical implications: it confirms that water hyacinth fibres, following alkali pre-treatment, can undergo standard vat dyeing without the shrinkage or elongation that would compromise finished product dimensions.

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This dimensional stability is attributable to the NaOH pre-treatment, which removed hemicellulosic and pectic materials that typically drive fibre swelling in wet environments (Reddy et al., 2013). With these hygroscopic components eliminated, the crystalline cellulose framework of the fibre is less susceptible to water-induced dimensional change. Furthermore, the improved intermolecular bonding within the treated cellulose-lignin structure contributes to structural rigidity during wet processing (Mishra et al., 2018).

Both Ejinrin (orange dye) and Igbokoda (orange dye) samples showed uniform colour absorption with no patchiness or uneven dye distribution, indicating adequate surface activation by the alkali treatment. Colour fastness assessment by visual inspection after rinsing confirmed good initial dye retention in both samples. This bodes well for the colouration of water hyacinth fibre products intended for interior decoration, where aesthetic consistency and durability of colour are important quality attributes.

Table 5: Dimensional Stability of Water Hyacinth Fibres During Vat Dyeing

Sample Site	Dye Colour	Length Before Dyeing	Length After Dyeing (Wet)	Length After Drying	Dimensional Change
Ejinrin (Lagos)	Orange	20 inches (51 cm)	20 inches (51 cm)	20 inches (51 cm)	0% (Nil)
Igbokoda (Ondo)	Orange	18 inches (46 cm)	18 inches (46 cm)	18 inches (46 cm)	0% (Nil)

Source: Researcher's Dyeing Experiment, 2025

4.4 Yarn Spinning: Process and Quality

Yarn spinning from Igbokoda fibres was selected as the primary focus for this stage, given the site's superior overall impact resistance and flexural energy absorption identified in prior physio-mechanical testing. However, both site fibres were assessed for spinnability during preliminary trials.

For the extracted fibre spinning method, fibres were first sorted and aligned by length, with short fragments and entangled sections removed. The prepared fibres were drawn out gradually and twisted using a manual spinning frame, applying progressive tension to build twist angle and reduce diameter. Igbokoda fibres demonstrated better handling continuity during this process, maintaining strand integrity without frequent breakage. Ejinrin fibres, though comparable in performance, exhibited slightly greater stiffness attributed to their higher silica content which marginally increased the effort required to achieve a consistent twist.

For the split-stem strip method, dried stalks were first flattened by pressing to remove internal air cavities and compact the cross-section. Larger stems were split longitudinally into four strips; smaller stems into three. The strips were then hand-twisted using traditional techniques to produce thick, rope-like yarn. This method produced yarns with excellent structural integrity and an appealing natural texture particularly suited to rustic interior decoration aesthetics.

Yarn quality assessment results are summarised in Table 6. Igbokoda fibre-spun yarns demonstrated optimal scores across most quality parameters, while Ejinrin fibre yarns were rated slightly lower on flexibility but higher on dimensional uniformity. Both were assessed as suitable for weaving into interior decoration items.

Table 6: Yarn Quality Assessment from Water Hyacinth Fibres (Igbokoda and Ejinrin)

Quality Parameter	Igbokoda Fibre Yarn	Ejinrin Fibre Yarn	Split-Stem Strip Yarn
Surface Texture	Smooth and even	Smooth, slightly stiff	Coarse, natural texture
Tensile Handling	High — no breakage	High — minimal breakage	Very high
Flexibility	Excellent	Good	Good
Aesthetic Quality	Natural sheen, uniform	Good sheen, uniform	Rustic, earthy tone
Twist Consistency	High	High	Moderate

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Suitability for Weaving	Excellent	Good	Excellent
Overall Rating	Excellent	Good	Very Good

Source: Researcher's Assessment, 2025

4.5 Processing Pipeline Summary

Based on the findings of this study, a recommended processing pipeline for the production of textile-grade water hyacinth yarn in South-West Nigeria is presented in Table 7. This pipeline is designed for accessibility at community and small-enterprise scale, minimising reliance on industrial infrastructure while maximising fibre quality.

Table 7: Recommended Processing Pipeline for Water Hyacinth Fibre Extraction and Yarn Production

Stage	Process	Key Parameters	Expected Output
1. Harvesting	Manual collection of mature stalks	Remove roots and leaves; cut 30–40 cm	Clean, raw stalks
2. Washing	Water rinse to remove mud and debris	Thorough rinsing; air-dry 48 hrs	Clean, surface-dry stalks
3. Extraction	Decortication + 2–3 day retting	Machine decorticator; water soak	Raw fibre strands
4. Alkali Treatment	10% NaOH at 90°C for 1 hour	Continuous stirring; controlled temp	Cleaned, softened fibre
5. Neutralisation	1.0% acetic acid rinse + water wash	pH ~6.5–7.0 target	Chemically stable fibre
6. Drying	Ambient temperature, shaded	Avoid direct sunlight; 24–48 hrs	Dry, processable fibre
7. Dyeing (optional)	Vat dye application	Caustic soda + hydrosulphite reduction	Coloured, stable fibre
8. Spinning	Manual spinning or split-stem twisting	Sort fibres; consistent tension	Textile-grade yarn
9. Quality Check	Visual and tactile assessment	Texture, uniformity, flexibility	Market-ready yarn

Source: Researcher's Process Development, 2025

CONCLUSION

This study has demonstrated that water hyacinth (Eichhornia crassipes) harvested from Igbokoda (Ondo State) and Ejinrin (Lagos State) can be successfully processed into textile-grade fibre and yarn through a practical, low-cost pipeline accessible at community and small-enterprise scale in South-West Nigeria. The comparative evaluation of retting and mechanical decortication revealed that a combined approach initial mechanical separation followed by short-duration alkali retting yields the most favourable fibre quality in terms of cleanliness, softness, and uniformity. Alkali treatment with 10% NaOH proved essential in removing surface impurities, improving fibre pliability, and enhancing dye uptake.

The vat dyeing trials confirmed complete dimensional stability of water hyacinth fibres throughout wet processing, an important quality assurance finding for textile applications. No measurable dimensional change was recorded in any sample from either site across three measurement stages. Both orange-dyed Ejinrin and Igbokoda fibres exhibited uniform colour absorption, confirming adequate surface activation and dye affinity following alkali pre-treatment.

Yarn spinning trials, particularly with Igbokoda fibres, produced smooth, flexible, and aesthetically viable yarns suitable for weaving into interior decoration items. Both conventional manual spinning from extracted fibres and the split-stem strip method yielded weave-ready yarns, providing flexibility in production approach based on available equipment and desired aesthetics.

Therefore, the findings of this study establish a reproducible, evidence-based processing framework for the valorisation of South-West Nigerian water hyacinth into textile yarn. Future research should focus on optimising retting duration and NaOH concentration for maximum fibre yield per unit weight, developing consistent spinning parameters for mechanised production, and evaluating colour fastness and durability of dyed fibres under washing and light exposure conditions representative of interior decoration use.

REFERENCES

1. Aboul-Fetouh, M.S., Elmorsi, T., El-Kady, J.M., & El-Adawi, H.A. (2010). Water hyacinth stems as a potential natural adsorbent for the adsorption of Acid Green 20 dye. Environmental Science Indian Journal, 5(1), 257–266.
2. Adiji, B.E., & Oladumiye, E. (2015). Assessment of handcrafted dyed and printed textile designs in selected cities in South-Western Nigeria. International Journal of Contemporary Applied Sciences, 2(3), 17–38.
3. Akinmola, E.A. (2024). Production of resist decorated fabrics for rattan upholstery. Research Journal of Industrial Design, 1(2), 2811–2474.
4. Akintola, S., Anatekhal, M., & Lawson, E. (2011). Some physicochemical characteristics of Badagry Creek, Nigeria. West African Journal of Applied Ecology, 18(1), 1–10.
5. Alavudeen, A., Rajini, N., Karthikeyan, S., Thiruchitrambalam, M., & Venkateshwaren, N. (2015). Mechanical properties of banana/kenaf hybrid fibre composites reinforced with water hyacinth fibres. Composites Part B: Engineering, 80, 1–9.
6. Ammayappan, L., Nayak, L.K., Ray, D.P., Das, S., & Roy, A.K. (2013). An overview of production and processing of natural bast fibres. Fibre2Fashion Technical Papers. Retrieved from www.fibre2fashion.com.
7. Bolorunduro, S.A. (2002). Water hyacinth in Nigeria: Spread and impact on fisheries. NIFFR Technical Report, 12, 1–14.
8. Boonyaroj, V., Chiemchaisri, C., Chiemchaisri, W., & Yamamoto, K. (2017). Use of water hyacinth biomass for interior household product applications. Resources, Conservation and Recycling, 120, 113–122.
9. Emidun, O.B., & Akinrujomu, A. (2021). Cottage industries and interior design in Nigeria: The water hyacinth opportunity. Journal of Applied Arts, 5(2), 34–45.
10. Ezama, O.D. (2019). The history of water hyacinth infestation in Nigeria: Origins and consequences. Nigerian Journal of Environmental Science, 8(1), 12–25.
11. Guna, V., Ilangovan, M., Vighnesh, H., Srinivas, C.V., & Reddy, N. (2020). Engineering water hyacinth fibres with improved mechanical, thermal and moisture performance by alkali treatment. Journal of Natural Fibres, 18(10), 1454–1462.
12. Jafari, N. (2010). Ecological and socio-economic utilisation of water hyacinth (Eichhornia crassipes) from Anzali Wetland, Caspian Sea, North Iran. Journal of Applied Sciences and Environmental Management, 14(2), 43–48.
13. Jose, S., Salim, R., & Ammayappan, L. (2016). An overview on production, properties, and value addition of pineapple leaf fibre (PALF). Journal of Natural Fibres, 13(3), 362–373.
14. Jyoti, K. (2023). Modern dyeing of natural fibres: Innovations and practices. Textile Science and Technology Review, 18(1), 22–35.
15. Kanchan, B. (2014). Rattan and cane products in global markets: Trends and opportunities. International Forestry Review, 16(2), 189–198.
16. Karouach, F., Bakraoui, M., El Gnaoui, Y., Lahboubi, N., El Bari, H., & Abdelmoumen, H. (2022). Water hyacinth as a valuable resource for sustainable production of goods and energy. Sustainable Production and Consumption, 32, 1–15.
17. Mazharul, I. (2021). Textile dyeing: Science and technology. Dhaka: Textile Education Press.

18. Mishra, V., Biswas, S., & Patra, A. (2018). Extraction and characterisation of water hyacinth fibre. Journal of Natural Fibres, 16(4), 596–605.
19. Nandiyanto, A.B.D., Dani, A.K., Ragadhita, R., & Aziz, M. (2023). Water hyacinth (Eichhornia crassipes) as a low-cost and eco-friendly material for sustainable engineering applications. Sustainability, 15(4), 3480.
20. Nuruzzaman, M. (2001). Jute and allied fibres: Processing and spinning. Dhaka: Bangladesh Jute Research Institute.
21. Ramesh, M., Palanikumar, K., & Reddy, K.H. (2017). Plant fibre based bio-composites: Sustainable and renewable green materials. Renewable and Sustainable Energy Reviews, 79, 558–584.
22. Reddy, K.O., Maheswari, C.U., Shukla, M., Song, J.I., & Rajulu, A.V. (2013). Tensile and structural characterization of alkali treated Borassus (Palmyra) fruit fine fibres. Composites Part B: Engineering, 44(1), 433–438.
23. Rezania, S., Ponraj, M., Din, M.F.M., Songip, A.R., Sairan, F.M., & Chelliapan, S. (2015). The diverse applications of water hyacinth with main focus on sustainable energy and production for new decade: An overview. Renewable and Sustainable Energy Reviews, 41, 943–954.
24. Sierra-Carmona, C.G., Hernández-Orduña, M.G., & Murrieta-Galindo, R. (2022). Artisanal products from water hyacinth in Mexico: A value chain analysis. Journal of Cleaner Production, 344, 131061.
25. Sneha, G., Sabu, T., Namitha, N.N., & Jose, S. (2023). Value-added utilisation of aquatic weeds for sustainable product development. Journal of Cleaner Production, 391, 136210.
26. Souza, E.B.C., Filho, E.B., Silva, D.N., Tonello, P.S., Foloni, L.L., Barbosa, M.H.P., & Freato, T.A. (2020). The effects of herbicides on water quality and aquatic biodiversity in Brazilian water bodies: A review. Chemosphere, 251, 126432.
27. Tahir, P.M., Ahmed, A.B., SaifulAzry, S.O.A., & Ahmed, Z. (2011). Retting process of some bast plant fibres and its effect on fibre quality: A review. BioResources, 6(4), 5260–5281.