

Article

Invasive Plant to Product: Exploring Japanese Knotweed (*Reynoutria japonica*) as an Absorbent Core in a Sustainable Feminine Pad

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Abstract

Menstruation, a biological phenomenon experienced by more than half of the global population, remains stigmatized and poorly addressed in the context of research and public discourse. One overlooked issue is that of “period pollution,” the waste generated by millions of feminine hygiene pads (menstrual pads) that end up in landfills or the environment. Simultaneously, Japanese knotweed (*Reynoutria japonica*), a non-native invasive plant which disrupts native species, leads to the disruption of ecological systems. This experimental study assesses the Japanese knotweed plant for its potential to serve as the absorbent core in a sustainable menstrual pad, helping to address both environmental challenges in tandem. As control groups, commercial pads (*Natracare* and *Saathi*) were tested for their performance as absorbent materials, as defined by the absorbency ratio (AR) test. All preliminary studies were done using normal saline solutions dyed with red food coloring. *Saathi* pads demonstrated significantly higher levels of AR compared to *Natracare* and knotweed pads due to the presence of superabsorbent polymers, making it an unreliable benchmark. Because Japanese knotweed is composed of cellulosic fibers that absorb water through hydrogen bonding to hydroxyl groups and capillary imbibition within porous fiber networks, lignin removal via alkaline processing was employed to enhance absorbency prior to experimental testing. The inner lumen of the knotweed was selected and delignified using a sodium hydroxide bath, later being shaped into an absorbent core akin to the measurements of the commercial pads and inserted into *Natracare* shells for proof-of-concept testing. Although knotweed-based pads exhibited lower AR values than *Natracare*, the testing places the knotweed prototype at approximately 40% of the fluid capacity, indicating a strong starting point for a natural fiber. To further evaluate the processing feasibility of Japanese knotweed beyond laboratory-scale pad prototyping, Japanese knotweed biomass was subjected to conventional Kraft pulping, which helps to remove lignin and increase absorbency. The Kraft pulping produced a moderately delignified brown pulp with a Kappa number of 20. Due to limiting factors, the absorbency of the pulp was not tested. However, the pulp’s fiber dimensions were comparable to hardwood pulps that are commonly used in absorbent applications, suggesting feasibility for future development into bleached fluff pulp and sustainable menstrual hygiene products.

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1. Introduction

Every year, billions of single-use menstrual products, such as pads and tampons, end up in landfills or bodies of water. These products are non-biodegradable, exacerbating the environmental crisis [1]. Many single-use menstrual products also contain harmful chemicals such as phthalates, dioxins, phenols, and fragrances, which can be detrimental in endocrine and reproductive health [2]. However, using traditional methods of menstrual management (such as using a cloth or paper) that do not contain the typical chemicals within some commercial feminine hygiene pads are often unreliable and hinder menstruators from attending school, while promoting the poor disposal of products. Offering a natural and trustworthy alternative can create the opportunity for a sustainable and affordable feminine hygiene pad while improving the availability of menstrual products for young women, particularly in developing nations where these products are not always available [3].

Companies in the rapidly growing feminine hygiene pad industry have started to integrate biodegradable components into their products. This includes the integration of plant species, as their cellulosic fibers are able to absorb liquid through hydrogen bonding to hydroxyl groups and capillary imbibition [4].

In feminine hygiene pads, this is often seen in the absorbent core, or the layer that primarily stores menstrual fluid. Recent innovations have explored natural fibers like agave sisalana [5] and bamboo foams [6] to serve as the absorbent core in menstrual products. Companies including *Lilypad* and *PadBack* have used water hyacinth, papyrus, and other plant fibers to create chemical-free pads [7]. Beyond menstrual products, alternatives to other plastic commodities are being explored, with some researchers investigating the repurposing of invasive plant species to produce eco-friendly products, such as paper or packaging materials [8] and disposable diapers.

Japanese knotweed (*Reynoutria japonica*) is notorious for being one of the most invasive floras in the world. Knotweed's dense nature allows it to outcompete native species, resulting in disrupted ecological systems. Direct root removal and cutting are two manual techniques for removing knotweed, but the knotweed continues to grow back quickly after being cut, showing how aggressive and regenerative the plant can be [9]. Regardless of its global impact, Japanese knotweed has not been widely studied for its use in any significant applications. Its stem cell structures, as well as its overall stem structure, show that Japanese knotweed is a highly complex fiber with a low density, demonstrating good potential for lightweight applications [10]. Japanese knotweed's stem can also be an excellent bio-based composite material, like flax or bamboo, all of which have been previously considered for sustainable menstrual pad production [7].

Aside from minimally processed fiber applications, plant-based absorbent materials are commonly produced through established industrial pulping processes such as Kraft pulping. Kraft pulp is produced by chemically breaking down lignocellulosic biomass under alkaline conditions to remove lignin and hemicellulose [11], resulting in fibers that have a high cellulose content, increased porosity, and enhanced absorbency [12]. These properties are essential in products such as facial tissue, toilet paper, and feminine hygiene pads [13] but are usually conceived after further chemical treatment. This chemical process is called bleaching, which improves fiber purity, softness, and color. Many companies within the menstrual pad industry such as *Natracare* use Elemental-Chlorine Free (ECF) and Totally Chlorine Free (TCF) processes to bleach their products [14], supporting

that it is a typical process for a product like a feminine hygiene pad. Kraft pulping forms the basis of many commercial absorbency cores because its high-cellulose and low-lignin composition contribute to strength and fluid uptake while maintaining softness and comfort in use [15], making it worth investigating Japanese knotweed for its Kraft pulping feasibility.

Japanese knotweed's characteristics and widespread availability open an opportunity to explore its applications as a sustainable feminine hygiene pad.

2. Materials and Methods

2.1. Primary Experimental Study: Absorbency Performance of Japanese Knotweed Fibers

The following information in Section 2.1 highlights the manual and mild delignification and processing of the Japanese knotweed. It also describes all of the experimental work conducted by the author to evaluate the absorbency behavior and the proof-of-concept of the construction.

2.1.1. Absorbency Ratio (AR) Testing of Natracare and Saathi Pads

Information on the absorbency and surface performance of commercially available and sustainable feminine hygiene pads is often inaccessible to the public. *Regular Natracare Ultra Pads* and *Regular Saathi Bamboo Pads* were subjected to standardized absorbency ratio (AR) testing to create a benchmark control with the tentative knotweed prototype. Both pads claim to be 100% sustainable, as *Natracare* contains a wood-pulp core, and *Saathi* a bamboo core.

To understand the structure of each pad prior to testing, both pads were manually reverse engineered with tweezers, as shown in Figure 1, with the separated layers displayed. Each pad contains four layers: a top sheet, which makes direct contact with skin; a dispersion layer, which helps menstrual fluid spread out longitudinally; an absorbent core, which absorbs fluid; and a back sheet, which prevents leakage.



Figure 1. Reverse-engineered examples of *Natracare* Regular Pad and *Saathi* Regular Pad. Each dissected menstrual pad depicts the top sheet, dispersion layer, absorbent core, and back sheet. Pad wrapping included as well.

Following a structural assessment of both the *Natracare* and *Saathi* pads, a 1 wt% saline solution (2.0 g NaCl/200 mL of distilled water), dyed with red food coloring, was created as a standardized menstrual pad fluid simulant. Adding various viscosifiers (such as glycerol) was considered but excluded due to the high variability of menstrual fluid

viscosity during the menstrual cycle [16]. Instead, ionic composition was prioritized using the saline solution.

The dry weight of three (3) whole *Natracare* and three (3) whole *Saathi* pads were measured using an Ohaus Scout STX Portable Balance, model STX2201 manufactured by the OHAUS Corporation in Changzhou, China. Using a 10 mL pipette, each pad was saturated in 10 mL increments with a one-minute break between increments. This was done until leakage was observed upon lifting. The fluid addition for each of the pads is shown in Figure 2.

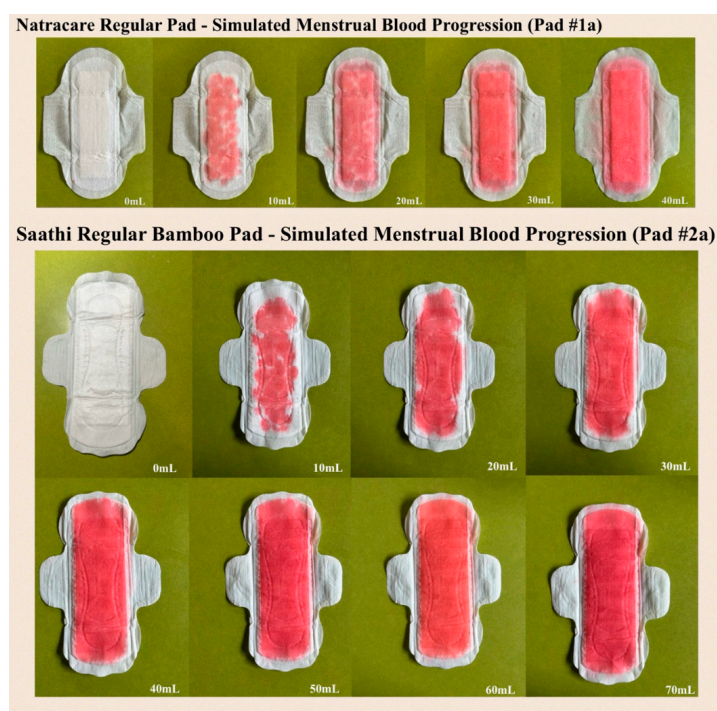


Figure 2. Progression of simulated menstrual blood flow between Natracare (top) and Saathi (bottom) pads for absorbency ratio testing.

The saturated pads were then reweighed to determine their total absorbency ratio (AR), defined as the mL fluid absorbed/mass of dry pad. According to the International Organization for Standardization ISO 17190-5:2020, this is the gold-standard method used for determining the gravimetric absorbency ratio, or free-swelling capacity, in polymer-based absorbent materials [17]. While other methods exist to evaluate absorbent performance, absorbency ratio (AR) testing provides a standardized, gravimetric framework for comparative screening of absorbent materials under free-swelling conditions. Although AR methods were originally developed for superabsorbent polymers, their adaptation enables reproducible and material-agnostic comparison of fluid uptake across commercial pads and experimental prototypes when applied with consistent controls, supporting the use of AR as a preliminary benchmarking tool in this study.

The six pads were then dissected using a pair of surgical scissors to isolate their absorbent cores. The absorbent cores were weighed post-saturation to evaluate AR specifically for the core (using the previously recorded dry weight of the absorbent core,) and to assess core integrity. The resulting AR data provided baseline performance metrics for both pad types and served as controls for later comparison with the Japanese knotweed prototype.

2.1.2. Mild Alkaline Delignification of Japanese knotweed Inner Lumen

Eight Japanese knotweed stalks (50–60 inches, or 127–152 cm, in length) were harvested from New York Botanical Garden in the Bronx, New York, NY, USA, with the leaves and branches removed. It is important to note that Japanese knotweed nodes create hollow chambers along the stalk, with the dampest portion typically near the center due to the lack of exposure to oxygen. Stalks were air dried at room temperature for four to five days to ensure that the inner lumen would be peelable; shorter dry-time made the inner lumen harder to remove due to its moisture, and longer dry-time hardened the lumen. Once dry, the stalk was split open to peel apart its different layers: the inner lumen, outer lumen, and combined lumen in Figure 3. Several 1.0 g samples of each layer were submerged into 200 mL of the 1 wt% saline solution to determine which layer would exhibit the highest absorbency ratio.

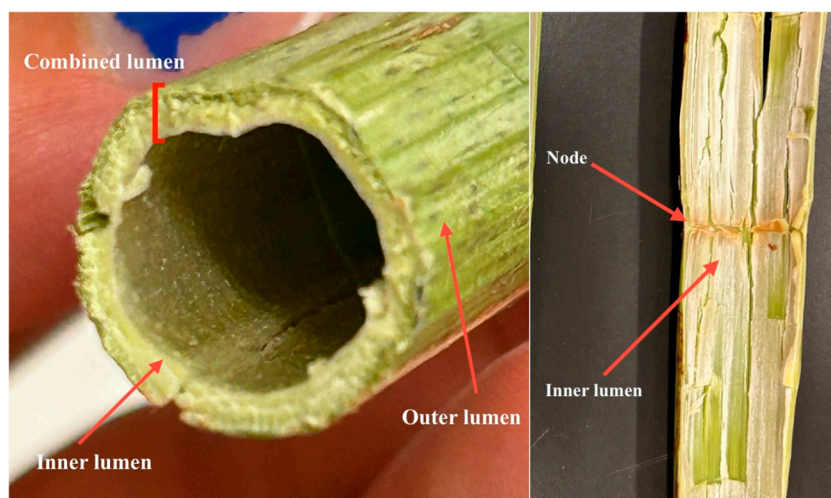


Figure 3. Diagram of placement of inner lumen, outer lumen, combined lumen, and node of Japanese knotweed stalk intact (left) and split open (right).

The inner lumen exhibited the highest AR value, so further testing was limited to this component.

A total of 12.0 g of inner lumen was peeled from three knotweed stalks. To break down the lignin and cellulose content, five mild delignification baths were prepared. A 0.2 M alkaline solution (0.8 g NaOH from Instant Power Crystal Lye Drain Cleaner/200 mL distilled water) was prepared in a 250 mL beaker as the delignification solution. To evenly distribute the heat applied to the solution, a surrounding oil bath with 200 mL of canola oil was maintained between 37° and 39 °C with a hot plate. A solution of 0.2 M NaOH at a temperature between 37 and 39 °C is effective because it is a simple method to reduce lignin content. Partial delignification of plant fibers is typically achieved with mild NaOH pretreatment in the lower molar range (0.1 M–0.5 M) to remove lignin and hemicellulose while preserving cellulose integrity, since higher concentrations can weaken fibers. Higher temperatures (often >80–100 °C) can cause significant degradation of cellulose and hemicellulose, but a 37–39 °C range honors the mild processing that is crucial for preserving the structural integrity of wood or fibers without reducing too much yield.

A total of 2.0 g of inner lumen material were placed into each delignification bath. The solution was stirred every 5 min. After 30 min, the fibers were rinsed until they reached a neutral pH (which was found using pH strips,) and then shaped to match the Natracare core geometry on a piece of parchment as seen in Figure 4.



Figure 4. Chronological order of knotweed processing. Inner lumen was peeled directly from knotweed stalk (A) until enough knotweed was collected (B), then transferred to delignification bath (C). After rinsing, the fibers were pressed into the shape of an absorbent core and placed in the oven (D).

The delignified fibers were oven-dried at 80 °C until reaching their original mass of 2.0 g (~1.5 h). To avoid burning, fibers were flipped onto their opposite side every 10 min.

After cooling down and reweighing, three 1.0 g samples of delignified knotweed fibers, untreated knotweed fibers, and Natracare absorbent cores were submerged in saline solutions to determine if the delignification was truly effective.

2.1.3. Japanese Knotweed Core Fabrication and AR Testing in a Simulated Whole Pad

After cooling down and reweighing once again, three knotweed absorbent cores were inserted into Natracare pads and sealed with Krazy Glue to develop a proof-of-concept prototype (Figure 5).

Shortly after, AR testing was conducted on the three prototypes.



Figure 5. Image of knotweed core placed into Natracare pad prior to being sealed (left) versus knotweed core when sealed in pad (right).

2.2. Secondary Feasibility Study: Kraft Pulping of Japanese Knotweed

Section 2.2 describes an independent laboratory-scale pulping study conducted to evaluate whether Japanese knotweed can be processed using conventional pulp and paper methodologies.

This pulping study is presented as a forward-looking feasibility assessment rather than a validation of absorbent performance, as limitations in material availability precluded absorbency or fluff-form testing of the produced pulp within the scope of this work. Thus, Kappa number and fiber dimensions were selected as primary metrics because they are standard indicators of delignification level and fiber architecture, which determine whether a pulp is suitable for further processing into absorbent structures prior to direct performance testing.

2.2.1. Biomass Preparation

Air-dried Japanese knotweed stalks were mechanically chipped using a Hammermill. The chipped material was then classified using a Williams Classifier (Figure 6). Only chips retained on the $5/8'' \times 3/8''$ screen were selected for pulping to ensure uniform geometry.



Figure 6. Williams Classifier used for chip size selection (photo courtesy of Redmond Lab [18]).

2.2.2. Kraft Pulping Procedure

Kraft cooks were carried out in a 4 L M&K laboratory digester under the following conditions:

- Oven-dried biomass: ~200 g (OD basis);
- Active alkali (AA): 35% as Na_2O ;
- Sulfidity: 25%;
- Liquor-to-wood ratio: 8:1;
- Cooking temperature: 170 °C;
- Time at temperature: 120 min.

Following the cook, the black liquor was drained and collected (pH measured = 14), consistent with typical Kraft black liquor chemistry, as seen in Figure 7. The measured pH of the black liquor was 14, consistent with conventional Kraft liquors.



Figure 7. Japanese knotweed chips loaded into the digester (left) and black liquor collection after Kraft cooking (photo courtesy of Redmond Lab [18]).

2.2.3. Screening and Pulp Recovery

After the Kraft cook, the pulp was thoroughly washed with hot water, disintegrated, and screened using a vibratory flat screen to remove uncooked rejects. Japanese knotweed post Kraft cooking and its following brown pulp is seen in Figure 8.

Due to a temporary equipment malfunction, the pulp yield could not be accurately determined. Accepted pulp was subsequently dewatered, crumbled, and air-dried for chemical and morphological characterization.



Figure 8. Japanese knotweed after Kraft cooking (**left**) and resulting brown pulp (**right**). (photo courtesy of Redmond Lab [18]).

3. Results

3.1. Primary Experimental Study: Absorbency Performance of Japanese knotweed Fibers

The following information in Section 3.1 highlights the results from the manual and mild delignification and processing of the Japanese knotweed by the author.

3.1.1. Resulting Absorbency Ratio (AR) from Natracare and Saathi Pads

The reverse engineering of *Natracare* and *Saathi* pads revealed that the absorbent cores in each pad made up roughly 31% of the pad's total weight (excluding the wrapper) with the absorbent cores in each pad weighing 1.9 to 2.2 g on average. At first glance, neither core seemed to contain any traces of superabsorbent polymers (SAPs). AR testing revealed clear differences between both pads regarding their absorbency capacities. *Natracare* pads absorbed an average of 36.1 mL of saline solution, corresponding to an AR = 6.2 mL/g. *Saathi* pads demonstrated a higher absorbency with an average of 66.0 mL absorbed and an AR = 10.8 mL/g. This relationship continued into the AR analysis of the isolated absorbent cores as the *Natracare* cores averaged an AR = 8.45 mL/g, while *Saathi* cores averaged 30.7 mL/g. Upon closer inspection, this unexpectedly high performance was attributed to the visual observation of SAPs (Figure 9).

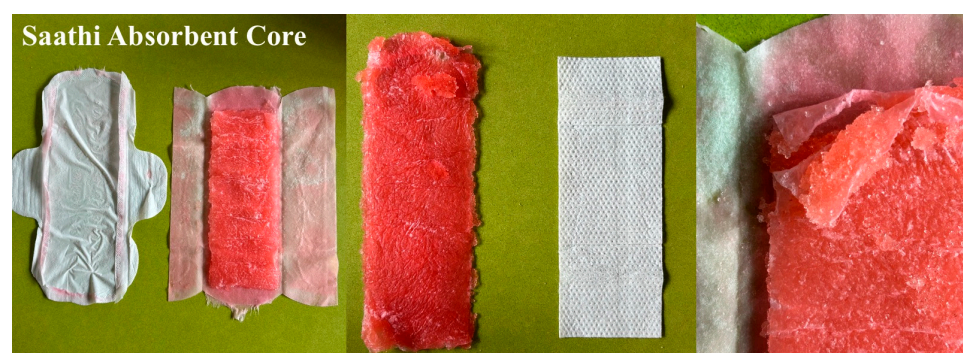


Figure 9. Dissected *Saathi* pad with wet absorbent core (**left**), comparison between wet and dry *Saathi* absorbent core (**middle**), and close-up of superabsorbent polymers in *Saathi* pad (**right**).

Although a chemical analysis was not performed on the absorbent core to confirm the presence of SAPs, the contact with the saline solution produced visible clear, solid, jelly-like particles. Additionally, SAPs result in a large fluid uptake capacity of typically 1000 times of the dry weight of the SAP [19]. This is accurate as the average dry weight of the absorbent core was 1.5 g, while the average wet weight of the absorbent core was 47.6 g. This is approximately 3000 times its dry weight, supporting the typical behavior of a SAP.

This observation raises question to *Saathi's* claim of “avoid[ing] the use of Super Absorbent Polymers” [20].

Moving forward, *Saathi* was no longer perceived as a valid comparator for a sustainable absorbent core as SAPs would not be used in the tentative Japanese knotweed cores.

3.1.2. Absorbency of Inner Lumen Japanese Knotweed Post Delignification

Across the dry inner, outer, and combined lumen structure of the Japanese knotweed, the inner lumen demonstrated the highest absorbency when submerged in 200 mL of saline solution overnight; 1.0 g dry inner lumen absorbed $8.0\times$ its dry weight, compared to the 1.0 g of dry outer and combined lumen that absorbed roughly $2.1\times$ times their dry weight.

While there was no quantitative way to measure the specific lignin/pulp removal post delignification, the delignified core samples absorbed $10.5\times$ their dry weight, while the untreated core samples absorbed $8.1\times$ their dry weight, demonstrating that the mild delignification process increased their absorbency. The *Natracare* absorbent core still absorbed more than both groups, absorbing 15.8 times its weight.

3.1.3. Absorbency Ratio of Japanese Knotweed Cores

When tested for absorbency ratio (AR), the knotweed cores provided promising results. Across the three knotweed proof-of-concept whole pads, the average AR was 3.3 g/mL, which was approximately 50% of the *Natracare* pad (AR = 6.2 mL/g). By comparison, the isolated knotweed core had an average AR of 3.4 g/mL, roughly 40% of the *Natracare* core AR of 8.45 mL/g. A dissected Japanese knotweed pad can be seen in Figure 10.



Figure 10. Japanese knotweed proof-of-concept pad after absorbency ratio testing.

An analysis of variance (ANOVA) was conducted to determine whether there were statistically significant differences in the average AR among the different pads. Statistical significance was found ($p < 0.01$). A post hoc Tukey's range test was performed to identify which specific pairs of pads were significantly different. The results showed that all

pairwise comparisons (*Natracare*–*Saathi*, *Knotweed*–*Natracare*, *Knotweed*–*Saathi*) were statistically significant ($p < 0.01$). However, the *Knotweed*–*Natracare* pair exhibited the smallest mean difference (-2.83 g), meaning their performances were most similar. Figure 11 shows a graph of the *Natracare*, *Saathi*, and *knotweed* proof-of-concept pad and their AR relationships.

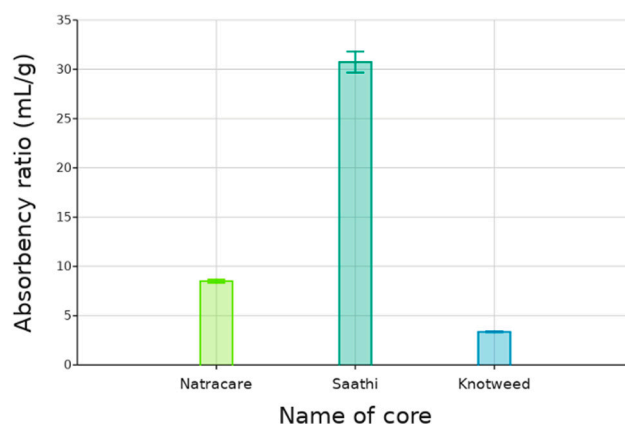


Figure 11. Graph depicting the relationship between the three pad types (*Natracare*, *Saathi*, and *knotweed* proof-of-concept pad) and the absorbency ratio, or AR. Bars show the mean. Error bars above and below show Standard Deviation.

An ANOVA was also performed for the three core types. A statistical significance was found ($p < 0.01$). A post hoc Tukey's test confirmed that all pairwise comparisons were statistically significant ($p < 0.01$). Among these, the *Knotweed*–*Natracare* pair showed the smallest mean difference (-5.13 g), suggesting the most similar performance. Figure 12 shows a graph of the *Natracare*, *Saathi*, and *knotweed* proof-of-concept core and their AR relationships.

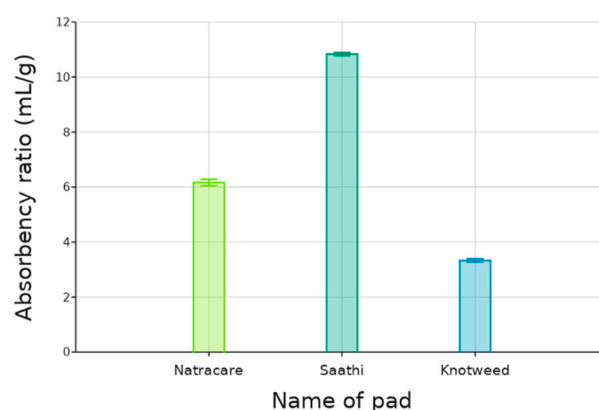


Figure 12. Graph depicting the relationship between the three core types (*Natracare*, *Saathi*, and *knotweed* proof-of-concept pad) and the absorbency ratio. Bars show the mean. Error bars above and below show Standard Deviation.

3.2. Secondary Feasibility Study: Kraft Pulping of Japanese Knotweed

The following information in Section 3.2 provides the results from the laboratory-scale pulping. The findings for the Kraft cook are reflected upon the single cook carried out under controlled laboratory conditions. These findings are preliminary experiments on the feasibility of producing pulp from Japanese knotweed for potential fluff applications.

3.2.1. Kappa Number Measurement

The Kappa number was measured following TAPPI T 236 om-13.

- Kappa number: 19.67 (reported as ≈ 20);
- Replicate measurements showed a variability of approximately $\pm 5\%$, which is acceptable for laboratory pulping conditions.

3.2.2. Fiber Morphology Analysis

Fiber morphology was evaluated using a Lorentzen & Wettre Fiber Analyzer according to TAPPI T 271.

Experimental Details:

- Pulp sample: 1.0 g OD, dispersed in 1 L distilled water;
- Measurement temperature: 22.4 °C;
- Total fibers analyzed: 20,036 fibers from 4445 images.

Fiber Morphology Results (Figure 13)

- Mean fiber length: 1.19 mm;
- Mean fiber width: 23.8 μm ;
- Total fines: 5.5%
 - Primary fines: 1.3%
 - Secondary fines: 4.3%.

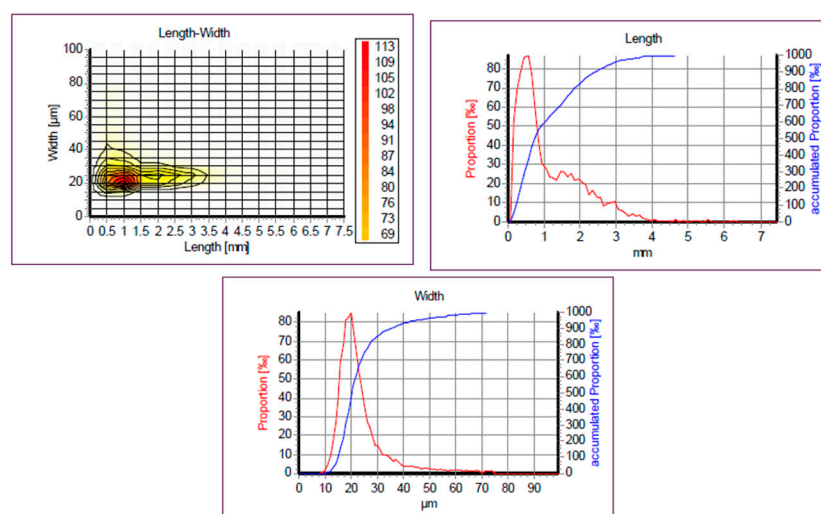


Figure 13. Fiber analysis results for Japanese knotweed brown pulp. The length–width distribution shows the relationship between fiber length and fiber width across 20,036 analyzed fibers (unpublished data Redmond Lab [18]).

4. Discussion

This study evaluated the potential application of invasive Japanese knotweed (*Reynoutria japonica*) for use in a sustainable feminine hygiene pad through the construction of a homemade pad prototype, contributing to the first known absorbency evaluation of Japanese knotweed fibers specifically as a feminine hygiene pad absorbent core.

In practical terms, the knotweed prototype reached roughly half the absorbency of the *Natracare* pad. This two-fold difference is modest for minimally processed plant fiber. These results support the idea that invasive plant fibers such as Japanese knotweed

(*Reynoutria japonica*) can be engineered into viable absorbent media with further optimization and fiber processing.

Raw inner lumen knotweed material demonstrated a high ability to absorb fluid, confirming that the plant's natural structure contains a promising absorbent region. The absorbency of the inner lumen knotweed increased because of a mild alkaline delignification process, supporting that even incremental processing can improve performance.

The benchmark absorbency ratio (AR) values that were used as a control group for the Japanese knotweed prototype were produced by the assessment of *Saathi* and *Natracare* pads. Upon testing, *Saathi* pads were no longer used as a reliable benchmark for the tentative knotweed pad due to the observed presence of superabsorbent polymers (SAPs). *Saathi* states that the "absorbent layer is made using banana and bamboo fibers...we avoid the use of Super Absorbent Polymers (SAP)..." [20]. However, the gelled, glossy, and cohesive structure of the core after applying the saline solution is a behavior consistent with SAP-containing materials and inconsistent with bamboo and banana fibers as natural fibers could not produce a crystalline-like structure.

Some SAPs can be biodegradable [21]. So, while there is no assumption being made on *Saathi*'s core biodegradability, there should be further analysis on what is embedded within the pad's absorbent core. Further chemical analysis would be needed to assess what is present.

Natracare whole pads had an AR = 6.2 mL/g and an absorbent core AR = 8.45 mL/g. The knotweed prototype whole pads averaged an AR = 3.3 mL/g, and a core AR = 3.4 mL/g. This places the knotweed prototype at approximately 40% of the fluid capacity of the *Natracare* core. Although it cannot be directly comparable with a commercial product, the knotweed prototype produced a level of performance that indicates a strong starting point for a natural invasive fiber, considering the absence of typical industrial processing (such as pulping, bleaching, density optimization, grinding, etc.).

As for the Kraft cooking, the entire pulp mass was utilized. Under the cooking conditions applied, very little reject material was observed. The Kappa number indicates a moderately delignified pulp appropriate for further bleaching or refining studies [22]. However, the Kappa number is comparable to conventional hardwood pulps such as eucalyptus, which is commonly used in commercial fluff pulp production and feminine hygiene pads such as Yeijimiin [23]. Additionally, values from the fiber morphology demonstrate that Japanese knotweed produces fibers with dimensions within the typical hardwood range. The fiber content and fiber length suggest that the pulp may provide desirable sheet stiffness and bulk in papermaking applications. So, while no absorbency testing was conducted, the Kappa number and fiber morphology offers a solid base for knotweed's potential.

5. Conclusions

Japanese knotweed (*Reynoutria japonica*) fibers exhibit a good starting potential as an absorbent material for sustainable menstrual products for their absorbency potential as a raw material and slightly delignified material. Although the produced Japanese knotweed prototype did not reach the absorbency of the commercial *Natracare* control, the differences in absorbency ratio (AR) values between the *Natracare* and Japanese knotweed proof-of-concept pads is relatively small (two-fold) and not exponential. For a first home-made try, this is a promising start; the prototype exhibits a typical AR value found in the literature in several alternative and under-processed absorbent core layers. Additionally, similar studies of biopolymer pads also reported lower AR values compared to their commercial controls, with improvements achieved through extended fiber treatment and optimized core density [24].

Preliminary Kraft pulping studies confirmed that Japanese knotweed can be processed into a moderately delignified pulp with fiber dimensions comparable to hardwood pulps used in commercial absorbent applications, such as feminine hygiene pads. Controlled pulping, bleaching, or density adjustment could further enhance performance.

This work produces a baseline for future development of feminine hygiene pads using Japanese knotweed. Japanese knotweed's abundance, rapid growth, and fiber structure can make it an appealing candidate for sustainable product design.

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Conflicts of Interest: The author declares no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

AR Absorbency Ratio

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