**MENSTRUAL HYGIENE NONWOVEN PRODUCTS: COMPREHENDING SUSTAINABILITY AND SANITARY PRODUCT USAGE PATTERNS**

**ABSTRACT**

Nonwoven fabrics play a significant role in menstrual hygiene products, offering advantages such as superior absorbency, comfort, and cost-effectiveness. The reliance on synthetic materials in menstrual hygiene products raises concerns about environmental sustainability and health impacts. This study examines the usage patterns, type of material used in sanitary products and the potential of eco-friendly alternatives to mitigate the environmental footprint of menstrual hygiene products. Here, a survey was conducted among 200 female undergraduate students. A structured questionnaire was administered using Google Forms, encompassing sections on knowledge, attitudes, and usage patterns. The questionnaire consisted of questions based on the Likert scale which took readings on a five-point scale. The results showed that the majority of respondents (**66%**) were from semi-urban regions, followed by **24%** from urban areas and **10%** from rural areas. Social media emerged as the leading source of information about the environmental impact of conventional menstrual products, followed by schools/colleges (**21.8%),** peers (**16.8%**), and news/media (**8.69%**). Moreover, the high willingness to switch to eco-friendly options (**74.2%**) suggests a positive outlook for sustainability initiatives. Moreover, the survey identifies key barriers to adopting sustainable menstrual products, such as high costs, limited availability, and social stigma. It also highlights strategies for promoting eco-friendly practices, including raising awareness, providing subsidies, and addressing cultural taboos, giving readers a comprehensive preview of the findings. The study concluded that addressing the challenges of cost, accessibility, and awareness through targeted education, policy support, and affordable pricing can promote the adoption of eco-friendly menstrual products. By shifting towards sustainable nonwoven materials, environmental waste can be reduced and a more sustainable future in menstrual hygiene can be fostered.

***Keywords:*** *Nonwovens, sanitary products, hygiene, eco-friendliness*

**1. INTRODUCTION**

Nonwoven fabrics represent a unique and versatile category of textile materials that are neither woven nor knitted. Instead, these fabrics are produced through processes such as bonding or entangling fibers using mechanical, thermal or chemical methods. These materials have a wide range of applications, spanning from medical and industrial uses to hygiene products, including menstrual hygiene solutions. Their adaptability, combined with cost-effectiveness and superior performance characteristics, has made nonwoven fabrics integral to modern industries (Ajmeri and Ajmeri, 2006).

**Historical Development of Nonwovens**

The origins of nonwoven fabrics can be traced back to ancient times when early civilizations used felted materials for clothing and shelter. However, the modern nonwoven industry began to take shape in the mid-20th century with the development of synthetic fibers and advancements in textile machinery (Imran et al., 2020). These innovations have allowed nonwovens to gain prominence in a wide range of applications, particularly in healthcare and hygiene sectors, where their adaptability, combined with cost-effectiveness and superior performance characteristics, has proven invaluable (Ajmeri and Ajmeri, 2006).

**Role of Nonwovens in Menstrual Hygiene**

In menstrual hygiene products, nonwoven fabrics have revolutionized product design by offering superior absorbency, comfort, and cost-effectiveness (Parham et al., 2021). They are commonly used in sanitary napkins, tampons, and menstrual pads, serving critical functions in their multi-layered construction. For instance, the **top layer** provides a soft, skin-friendly surface that wicks moisture away, while the **absorbent core** combines nonwovens with superabsorbent polymers for enhanced fluid retention. Additionally, the **backsheet** acts as a leak-proof barrier through its laminated, nonwoven design. These features have made nonwovens an essential component of modern menstrual hygiene products. Their shorter production cycles, high flexibility and lower production costs have further cemented their dominance in this domain (Raipale and Heikkilä, 2024).

#### Environmental and Health Challenges

Despite their advantages, traditional menstrual hygiene products primarily rely on synthetic nonwoven fabrics such as polypropylene and polyester (Munoz et al., 2022). These materials, while cost-effective and efficient, pose significant environmental and health challenges. For example, a single sanitary pad may take 500–800 years to decompose, contributing substantially to plastic pollution and microplastic contamination (Panjwani *et al*., 2024; Ó Briain *et al*, 2020). The production of synthetic fibers consumes considerable energy and petroleum-based resources, adding to their carbon footprint (Flammand, 2018).

From a health perspective, synthetic nonwovens can lead to moisture retention, promoting bacterial growth and increasing the risk of infections. Additionally, chemical additives used in manufacturing may cause skin irritations and other adverse health effects. These drawbacks highlight the need for sustainable alternatives that address both environmental and health concerns (Ajmeri and Ajmeri, 2006).

#### Eco-Friendly Innovations in Nonwovens

In response to these challenges, the development of eco-friendly nonwoven materials has gained momentum. Several innovative materials have emerged as sustainable options for menstrual hygiene products (Tu et al., 2021). Bamboo-based nonwovens are gaining popularity due to their biodegradability, antibacterial properties, and rapid renewability. Organic cotton offers a hypoallergenic, breathable, and soft alternative, while hemp provides a durable and biodegradable option with minimal water and pesticide requirements. Banana fibers, extracted from banana plants, and polylactic acid (PLA) fibers derived from renewable sources like cornstarch, also represent promising eco-friendly materials (Panjwani et al., 2024).

Products made from these materials, such as biodegradable pads, reusable washable pads, and sanitary napkins derived from plants like sansevieria and water hyacinth, not only reduce waste but also address socioeconomic issues by restoring biodiversity and empowering local communities (Mekala, 2021).

#### Barriers to Adoption of Sustainable Products

Despite their potential, sustainable menstrual products face several barriers. The perception of high costs often deters users, even though reusable products provide long-term savings (Srivastava et al., 2022). Limited awareness about the benefits and availability of sustainable options further hinders adoption, as knowledge gaps remain significant in many regions. Additionally, cultural taboos surrounding menstruation limit open discussions, creating barriers to awareness and acceptance of alternatives.

#### Path Forward

Promoting sustainable menstrual hygiene practices requires a multifaceted approach. Innovations in materials must focus on developing affordable, high-performing nonwoven fabrics that combine effectiveness with eco-friendliness. Educating communities about the environmental impact of conventional products and the advantages of sustainable alternatives can bridge awareness gaps. Furthermore, policy support plays a crucial role in advancing sustainability. Governments should subsidize eco-friendly products to make them more accessible and regulate the use of non-biodegradable materials to encourage environmentally responsible choices.

By addressing these barriers and adopting sustainable practices, the menstrual hygiene sector can transition toward an eco-friendly future, ensuring both environmental preservation and user safety.

**2. MATERIAL AND METHODS**

**2.1 Survey Design**

A survey was conducted to evaluate awareness, attitudes, and practices regarding eco-friendly menstrual hygiene products among female undergraduate students. A structured questionnaire was administered using Google Forms, encompassing sections on knowledge, attitudes, and usage patterns. The questionnaire consisted of questions based on a Likert scale which took readings on a five-point scale, some questions were multiple choice based and some were even open-ended to get their opinions.

**2.2 Sampling**

The study targeted 200 female undergraduate students from G. B. Pant University of Agriculture and Technology, Pantnagar. Random samples of respondents were selected to ensure a diverse representation of age groups, regional backgrounds and financial support systems.

### 3. RESULTS AND DISCUSSION

#### 3.1 General Information

The survey was conducted among **200 female students** from various colleges within the university. A majority of respondents (**85%**) were between the ages of **18–23 years**, while **12%** belonged to the **21–23 years age group**, and a smaller portion (**3%**) were aged **24–26 years**.

Regarding geographical background, the majority of respondents (**66%**) were from semi-urban regions, followed by **24%** from urban areas and **10%** from rural areas. These proportions reflect a predominance of semi-urban participants, which might influence the awareness and adoption patterns of eco-friendly menstrual products due to varying access to resources and exposure to sustainability-related discussions.

In terms of financial support, **95%** of respondents relied on pocket money from parents, **4%** were supported through scholarships, and **1%** earned through part-time jobs. This limited financial independence among the majority could directly impact their purchasing decisions, particularly when considering higher-priced eco-friendly products.

Table .1: Demographic profile of respondents

|  |  |  |
| --- | --- | --- |
| **Variable** | **Category** | **Percentage (%)** |
| Age | 18-20 years | 85 |
| 21-23 years | 12 |
| 24-26 years | 3 |
| 26 years and above | - |
| **TOTAL** | **100** |
| Geographical background | Urban | 66 |
| Semi-urban | 24 |
| Rural | 10 |
| **TOTAL** | **100** |
| Financial support | Pocket money | 95 |
| Scholarship | 4 |
| Part-time job | 1 |
| **TOTAL** | **100** |

#### 3.2 Knowledge of the respondents

Social media emerged as the leading source of information about the environmental impact of conventional menstrual products, followed by schools/colleges (**21.8%),** peers (**16.8%**), and news/media (**8.69%**). This finding highlights the effectiveness of social media, as **50.5%** of respondents cited it as their primary source of knowledge. The accessibility, visual appeal and ability to quickly disseminate relatable content make social media a valuable educational tool (Deb and Jain, 2023).

Despite these benefits, **2%** of respondents lacked any awareness of the environmental impact of menstrual products, underscoring a significant gap in education. This suggests that while social media is effective, it is not universally accessed or utilized by all demographics. Targeted educational initiatives in schools and communities could bridge this gap, particularly in semi-urban and rural areas where such knowledge is less prevalent.

When asked about the key benefits of using eco-friendly sanitary pads, it was found the respondents had knowledge about those items being sustainable, eco-friendly, reducing plastic waste and carbon footprint, healthier for the body, products being cost-effective in the long run. Despite knowing all the benefits, the majority of respondents (**72.3%**) were not going for the eco-friendly options.

#### 3.3 Attitude of the respondents

The survey explored respondents' attitudes towards comfort and eco-friendliness when selecting menstrual products. Comfort was deemed the most important factor, with **90%** of respondents prioritizing it in their purchasing decisions. In contrast, eco-friendliness was valued by **56%** of respondents, while **44%** were indifferent or uncertain.

Environmental concerns surrounding disposable menstrual products were prominent, with **95%** of respondents expressing some level of concern. Encouragingly, **74.2%** were open to exploring biodegradable options, especially products that decompose within six months. This indicates a growing willingness to transition toward sustainable alternatives, provided they meet other important criteria like comfort and affordability.

#### 3.4 Practices of the respondents

The adoption of eco-friendly menstrual products remains low among respondents. **72%** had never used such products, only **20%** of respondents used such products and **8%** were unsure if they had. Conventional disposable sanitary pads (**62.4%**) were the most commonly used product, followed by cotton pads (**40%**), menstrual cups (**10%**), menstrual underwear (**5%**), and reusable cloth pads (**5%**).

The frequency of changing pads among respondents further underscores the environmental impact. **49%** of respondents reported changing pads every **4–6 hours**, **28%** every **6–8 hours**, and **20%** every **2–4 hours**. This practice generates significant waste, given the widespread use of disposable products. The volume of waste produced could be substantially reduced with greater adoption of reusable and biodegradable options.

Barriers to adopting eco-friendly menstrual products were also explored. Key challenges cited included:

* **High cost** (75%)
* **Limited availability** (68%)
* **Lack of awareness** (56%)
* **Concerns about effectiveness or comfort** (52%)
* **Inconvenience in washing or cleaning reusable options** (40%)
* **Social stigma** (30%)

Fig 1-Barriers to adoption of eco-friendly menstrual products

Despite these challenges, **71.3%** of respondents indicated a significant influence of environmental concerns on their purchasing decisions, and **74.2%** expressed a willingness to transition to eco-friendly products within the next 12 months.

Over 76% of the respondents believed that governments, organizations, schools or colleges should do more to promote sustainable menstrual hygiene products. This would definitely help the environment in the long run.

When asked about the encouraging factors for adopting eco-friendly menstrual products, the respondents believed that low-cost products, easy accessibility, positive reviews, better product design, more information and government subsidies for purchasing eco-friendly menstrual products, will encourage them to switch to these options.

Fig 2-Encouraging factors to adopt ecofriendly menstrual products

The findings reveal a clear disparity between awareness, attitude and actual practices. While social media plays a pivotal role in spreading awareness about the environmental impact of menstrual products, gaps in knowledge persist, particularly among certain demographics. The reliance on disposable products indicates that comfort, cost and availability heavily influence purchasing behavior.

The correlational analysis between respondents’ consideration of eco-friendly menstrual products and their likeliness to switch over to those products in the next 12 months revealed a moderate positive correlation (0.365). This suggests that as individuals increasingly consider eco-friendliness in their menstrual product choices, they are moderately more likely to switch to eco-friendly products within the next 12 months. The respondents are willing to switch over to sustainable options but some constraints need to be solved for better adoption.

Table 2: Correlation coefficient

|  |  |
| --- | --- |
| Correlation coefficient between consideration of eco-friendliness for menstrual product and likeliness to switch over eco-friendly products in 12 months | p-value |
| +0.365 | 0.0001 |

Eco-friendly menstrual products face adoption barriers primarily due to financial constraints and lack of accessibility. With **95%** of respondents depending on pocket money, the higher upfront cost of sustainable options poses a significant challenge (van Eijk, et al., 2021). Subsidizing these products or introducing cost-effective alternatives could encourage wider adoption.

The high willingness to switch to eco-friendly options (**74.2%**) suggests a positive outlook for sustainability initiatives. However, addressing the perceived inconveniences and social stigma surrounding reusable products will require targeted awareness campaigns and community support. Educational programs that emphasize the long-term benefits and cost savings of sustainable products could further bridge the gap between intention and practice.

**4. CONCLUSION**

The study emphasizes the urgent need to shift towards sustainable menstrual hygiene products, particularly in the context of nonwoven fabrics, which are commonly used in conventional products. While nonwoven materials offer advantages such as superior absorbency, comfort, and cost-effectiveness, their environmental and health impacts due to the reliance on synthetic fibers raise significant concerns. Despite facing barriers like high costs, limited availability, and social stigma, the majority of respondents (80%) expressed a willingness to transition to eco-friendly alternatives within the next year. This suggests a positive shift in attitudes toward more sustainable options. With the increasing development of biodegradable and renewable nonwoven materials, such as bamboo, organic cotton, and polylactic acid fibers, there is potential for these products to offer both comfort and environmental sustainability. Addressing the challenges of cost, accessibility, and awareness through targeted education, policy support, and affordable pricing can promote the adoption of eco-friendly menstrual products. By shifting towards sustainable nonwoven materials, we can significantly reduce environmental waste and foster a more sustainable future in menstrual hygiene.

**Consent**

As per international standards or university standards, respondents’ written consent has been collected and preserved by the author(s).

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**REFERENCES**

**Ajmeri, M. C. J., and Mr, J. R. A. 2006.** Application of nonwovens in healthcare and hygiene sector. In *Medical Textiles and Biomaterials for Healthcare* (pp. 80-89). Woodhead Publishing.

**Barman, A., Katkar, P. M., and Asagekar, S. D. 2018.** Natural and sustainable raw materials for sanitary napkin. *Man-Made Textiles in India, 46*(12).

**Deb, M.C. and Jain, M., 2023**. Changing The Red to Greens-Buying Behavior of Menstrual Products. *Utkal Historical Research Journal*, *1*(4), pp.117-126.

**Flamand I. 2018.** The Menstrual Cup Effect: An environmental impact analysis of four menstrual products and a menstrual waste scenario analysis of increasing future menstrual cup use. 4:1- 4. <https://doi.org//10.25609/sure.v4.2858>

**Harrison, M.E. and Tyson, N. 2023.** Menstruation: Environmental impact and need for global health equity. *Int J Gynecol Obstet,* 160: 378-382. <https://doi.org/10.1002/ijgo.14311>

**Imran, M. A., Khan, M. Q., Salam, A., and Ahmad, A. 2020**. Cotton in nonwoven products. *Cotton Sci. Process. Technol.*: Gene.

**Lather, D. 2023.** A study on factors affecting consumer buying behavior towards sanitary napkins.

**Mehta, S. 2023.** An analytical study of the factors influencing the purchase decision of a female in buying a sanitary napkin.

**Mekala, M., 2021.** Development of eco-friendly sanitary napkins using *Sansevieria trifasciata* fibres coated with Rosa damascena extracts. *International Research Journal on Advanced Science Hub*, *3*(2S), pp.76-82.

**Ó Briain, O., Marques Mendes, A. R., McCarron, S., Healy, M. G., and Morrison, L. 2020**. The role of wet wipes and sanitary towels as a source of white microplastic fibres in the marine environment. *Water Res., 182*, 116021. https://doi.org/10.1016/j.watres.2020.116021.

**Panjwani, M., Rapolu, Y., Chaudhary, M., Gulati, M., Razdan, K., Dhawan, A., and Sinha, V. R. 2024.** Biodegradable sanitary napkins—a sustainable approach towards menstrual and environmental hygiene. *Biomass Conv. Bioref.*

**Raipale, N., & Heikkilä, P. 2024**. SUSTAFIT – Sustainability Strategies for Nonwovens. *VTT Technical Research Centre of Finland.*

**Rajamani, K., Prateeba Devi, J., and Princelin Raj Kumar, N. A. 2022**. Consumer perception and purchase intention towards personal hygiene products during COVID-19: Using SEM model. *Int. J. Health Sci., 10389–10396.* <https://doi.org/10.53730/ijhs.v6nS2.7711>.

**Rodrick, S.S., Islam, H., Sarker, S.A. and Hema, M.H., 2024.** Branding and Promotional Incentives on Purchase Behavior for Sanitary Napkins among Young Adult Female Consumers in Bangladesh.

**van Eijk, A.M., Jayasinghe, N., Zulaika, G., Mason, L., Sivakami, M.,Unger, H.W. and Phillips-Howard, P.A. 2021**. Exploring menstrual products: A systematic review and meta-analysis of reusable menstrual pads for public health internationally. PLOS ONE.2021;16(9):e0257610. <https://doi.org//10.1371/journal.pone.0257610>

Srivastava, D., Kumari, A., & Prasad Lal, S. (2022). Factors Influencing Adoption of Climate-Friendly Oxo-Biodegradable Jan Ausadhi Suvidha Sanitary Napkins among Women in India. *International Journal of Environment and Climate Change*, *12*(12), 1754–1760.

Parham, S., Kharazi, A. Z., & Nur, H. (2021). Breathable nonwoven hygienic products. In *Antimicrobial Textiles from Natural Resources* (pp. 397-420). Woodhead Publishing.

Munoz, L. P., Baez, A. G., Purchase, D., Jones, H., & Garelick, H. (2022). Release of microplastic fibres and fragmentation to billions of nanoplastics from period products: preliminary assessment of potential health implications. *Environmental Science: Nano*, *9*(2), 606-620.

Tu, J. C., Lo, T. Y., & Lai, Y. T. (2021). Women’s cognition and attitude with eco-friendly menstrual products by consumer lifestyle. *International Journal of Environmental Research and Public Health*, *18*(11), 5534.