3rd FUNCTIONAL TEXTILES AND CLOTHING CONFERENCE (FTC 2023)

Organized by

Indian Institute of Technology Delhi

In Association with

World University of Design, Sonipat

Venue: Lecture Hall Complex (LHC), IIT Delhi

Day 1: 10th February 2023

5:00 PM – 6:30 PM, Registration Central Atrium, LHC, IIT Delhi

Day 2: 11th February 2023

Inauguration & Plenary session I: 9.30 AM-11 AM

Chair: Prof. R. Alagirusamy			
Policy address- I	Keynote address- I	Keynote address- II	Industry lecture- I
National Technical Textiles Mission	Creation of a Green Textile Environment Protection-Oriented Supply Chain through Intelligent Digital Platform	Textile Materials in Defense Applications	Machineries and Technologies for Synthetic Fibres
Ministry of Textiles, Govt. of India	Prof. Xianyi Zeng, ENSAIT, France	Dr. Mayank Dwivedi Director, DMSRDE Kanpur	Mr. Debabrata Ghosh Sr. Vice President, Oerlikon

11 AM-11.30 AM Tea Break

1:00 PM-2:30 PM Lunch

2.30 PM – 4.00 PM Technical session IV

Parallel session 4A: Medical and Healthcare Textiles Chair: Prof. Wazed Ali	Parallel session 4B: Composites & Technical Textiles Chair: Prof. Amit Rawal	Parallel session 4C: Surface Functionalization of Textiles Chair: Prof. Manjeet Jassal
Dr.Shamayita Patra, A Rural Self Sustainable approach for Absorbing Layer of Sanitary Napkin fabrication	**Ms. Parna Nandi**, Surface modification of Himalayan nettle (Girardinia diversifolia) for nettle-reinforced PLA biocomposite by silane treatment	**Dr. Periyasamy Siddhan,** Application of Surface Modification Techniques in Textiles
Mr. Arpan Bipinchandra Kharva, Development of Biodegradable Sanitary Napkins using Silk, Organic cotton and Corn PLA.	**Mr. Vishal Srivastava**, Development of fibre reinforced biocomposite film for active packaging	**Mr. Ponnusamy MathiAzhagan** Promising trends of Carbonized Silk fibroin in Functional Textile applications
Dr. Sonu Rani, Study on effect of essential oil of Tulsi for Meditech development	**Ms. Debarati Bhattacharyya**, Effect of Surface Treatment on Creep Behaviour of Natural Fibre Based Polymeric Composites	**Dr. Karan Chandrakar**, In-situ plasma synthesis of carbon nanostructures for functionalization of poly(ethylene)terephthalate fabrics
Dr. Kandha vadivu Mallikarjunan, A Study on the Application of Weaver Ant Silk in Wound Healing	**Mr. Temesgen Regassa Woyessa,** Wicking and drainage properties of natural fibre geotextile yarns	**Mr. Hardeep Singh Jhinjer,** Zeolitic Imidazolate Frameworks functionalized cotton fabrics for the removal of air pollutants
Mr. Dilshan Poorna Hedigalla, Investigation on the pressure transmission characteristics of miniaturized air bladders for medical compression textiles	**Ms. Priyanka R**, Development of Sound Detection Tester and Study on Sound Properties on Different Fabrics	**Mr. Ankit Kr. Singh,** Synthesis of a novel disperse dye for imparting multifunctional mosquito repellent protection
Mr. Shashikumar KR, Conceptualization of finished surgical cooling caps to treat post chemotherapeutic effects	**Mr. Kuldip Singh,** Effect of carbonisation temperature on the fibrous nonwoven structures for ohmic heating applications	**Ms. Rupali Kakaria**, Microencapsulation of lantana camara essential oil for mosquito repellent and antimicrobial properties on cotton
Dr. Monisha Singh, Developing functionality in geriatric wear through designing	**Ms. Janki Rameshbhai Patel** Study of Sustainable Fibre (Sisal) Nonwoven Mulching for Watermelon Cultivation and its Effect on Soil Nutrition Values	**Ms. Subashini JM,** Development of Woven PPE with Regenerated Fibers to Enhance the Comfort Properties of the Wearer with Antimicrobial and Liquid Barrier Nano Particle Finish

4:00 PM-4:30 PM Tea Break

4.30 PM – 6.00 PM Technical sessions V

Parallel session 5A: Education & Ergonomics Chair: Prof. Kandha vadivu M	Parallel session 5B: Clothing Design for Special Needs Chair: Mr. Devender Kharb	Parallel session 5C: Traditional textiles and clothing science Chair: Dr. R. Rajagopalan
Dr. Paramita Sarkar, Design Education & Training for Empowering Women Artisans Practising Traditional Knitting Craft of Lahaul & Pangi Region, Himachal Pradesh, India	**Dr. Lynn Boorady**, Protective apparel for caregivers of children with autism	**Mr. Areef Shaik,** An Innovative Inter-panel Waist Belt System for a One-size-fits-all Life Jacket: Inspired from Traditional Indian Clothing - Sari & Dhoti

Development of Biodegradable Sanitary Napkins using Silk, Organic cotton and Corn PLA.

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Abstract: The demand for disposable items to maintain a healthy atmosphere and the growing consumer awareness of environmental friendliness have been the motivating factors for the start of this research on enhancing the eco-friendliness of this disposable sanitary product. The prepared sanitary napkins are made up of a biodegradable top sheet, an absorbent core, a super absorbent polymer, and a leak-proof substance that are all enclosed by cover stock. This paper explains the "green" (biodegradable) solution in sanitary napkins, the consciousness of those girls who use them, and the environmental impact of menstrual products. At present, the most popular types of hygiene products are also the most unfriendly to the environment, due to the amount of unseen plastic in disposable hygiene products. This subject of research finds out whether a person understands the seriousness of the injury and if the person who is more aware of the injury is likely to make choices that are less harmful to the environment. The results of the study provide clarity that those who use these types of products are not conscious of the extent of plastic in disposable menstrual products (sanitary napkins) and that this is linked to their green environmental impact that people are generally not aware of. Fewer members are more aware of the issues than others, and the research suggests that those with a higher level of awareness are more likely to choose products that are less harmful to the environment.

Keywords: Biodegradable, Ecofriendly Sanitary Napkins, Sustainable Materials.

1.0 Introduction

Today, everyone is focused on eliminating environmental issues and nature degradation in order to create an eco-friendly environment. In addition, maintaining good health and hygiene is crucial for humans. Consumers' heightened concern for their health and cleanliness has raised the need for antibacterial textiles, which serve two purposes: first, they protect the wearer, and second, they ensure that the textile material degrades naturally. [1]

The healthcare and hygiene industry, among other medical applications, is a significant area of textiles. The variety of products includes both disposable and non-disposable items needed in hospitals, such as surgical gowns, masks, drapes, towels, gloves, diapers for infants, sanitary napkins, and more.[2]

The production and clearance of sanitary napkins is one significant issue. The napkins made by these businesses are dangerous for women and not biodegradable. Menstrual fluid discharges are intended to be absorbed and retained by sanitary napkins. Menstrual fluid absorption and retention, stopping leaks, aesthetic look, preventing odour, staying in place, and providing a comfortable feeling are the main needs for sanitary napkins. The sanitary napkins must not only ensure a woman's comfort and safety, but also improve her lifestyle and general health. [3]

Women use these sanitary napkins for at least 20% of their lives. India is a developing nation with a population of 1.34 billion, of whom 323.6 million are females between the ages of 15 and 49. [1] In the past, when worn during menstruation, papyrus, moss, grass, and bandages could cause skin rashes, allergies, and other highly serious health issues due to the presence of microorganisms. Chemicals are also added by the manufacturers to

the scented napkins, which might have negative effects on both pregnant women wearing them and their unborn children. Here, we suggest environmentally friendly sanitary napkins by selecting alternative natural materials for production in order to get over these issues.

Today in the era of eco – friendly environment, it has become very important for human beings to live in the world of hygiene and freshness. The awareness of health and hygiene of consumers, has increased the demand for antibacterial textiles and has two functions – one protecting the wearer, and the second ensuring biodegradation of the textile material. [4] An important area of textiles is the healthcare and hygiene sector among other medical applications. The range of products includes disposable and non- disposable items such as surgical gown, mask, surgical drapes, towels, gloves, baby diapers, sanitary napkins and so on used in hospitals. Menstrual fluid discharges are intended to be absorbed and retained by sanitary napkins. Menstrual fluid absorption and retention, stopping leaks, aesthetic look, preventing odour, staying in place, and providing a comfortable feeling are the main needs for sanitary napkins. The sanitary napkins must not only ensure a woman's comfort and safety, but also improve her lifestyle and general health. [2]

The goal of the current study is to develop sanitary napkins using silk, organic cotton and corn PLA as top sheet materials and corn starch as a naturally absorbent material and barrier sheet with the poly (butylene adipate-co-terephthalate) (PBAT) and polylactide (PLA). The goal of this study is to develop the biodegradable sanitary napkins.

2.0 Materials and Methods

Sanitary napkin construction and composition are customary. We must first comprehend the fundamental principles behind the operation of sanitary pads in order to classify the raw materials used in making them. Once we are aware of these principles, we may choose the appropriate raw materials. Sanitary pads have a tiered construction, and each layer serves a certain purpose. The top sheet, absorbent core, and barrier sheet are the three primary layers. [5]

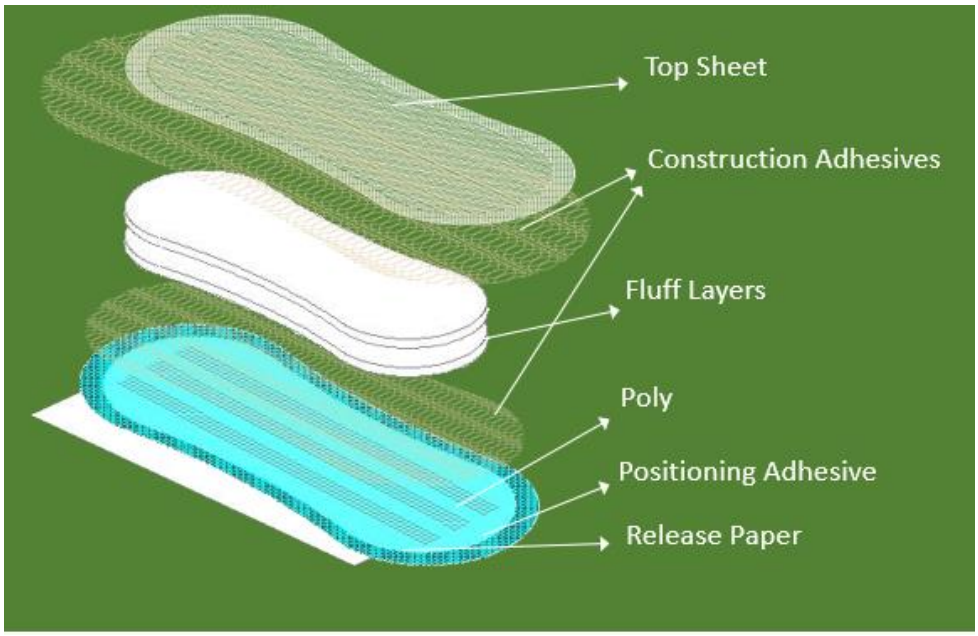
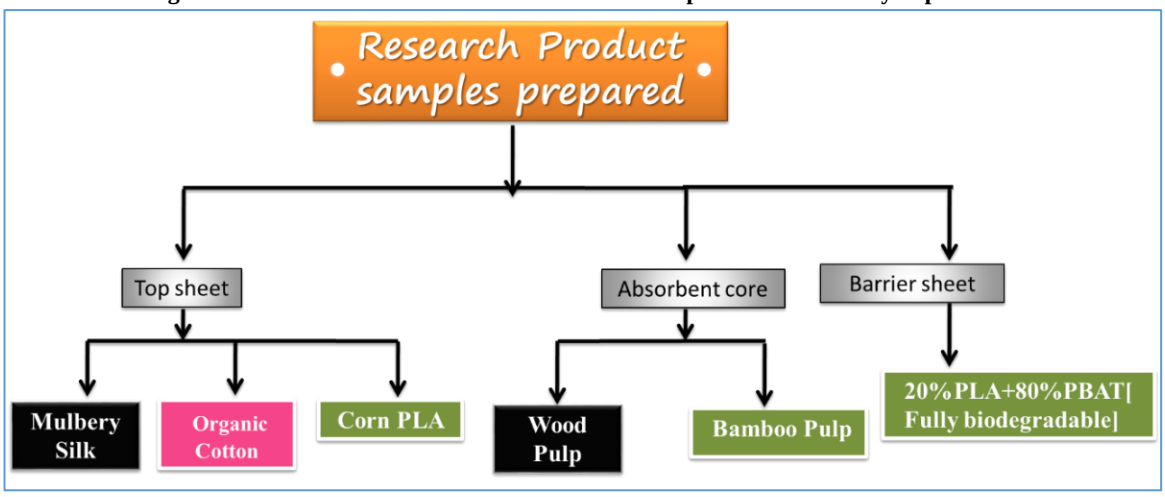


Figure 1: Conventional structure and material used in sanitary napkin.

Figure 2: Research Product made with different components for sanitary napkins



2.1 Materials

2.1.1 Top Sheet

Top sheet: It is made to quickly transmit fluid from the top sheet to the lower layers. The top sheet contains a small amount of hydrophilic absorbent fibre to allow fluid to absorb and thermoplastic fibres to prevent capillary collapse. The top sheets that are offered for sale are made of polypropylene fibre. [7]

2.1.1.1 *Organic* Cotton Top sheet

ECO friendly methods and materials are used to produce organic cotton. The usage of dangerous and insistent pesticides and fertilisers is decreased with organic production techniques, while biological diversity is increased in agriculture. Establishments that provide third-party certification confirm that organic planters only employ tools and substances that are appropriate for organic farming. Organic cotton is grown without the use of synthetic fertilisers and hazardous, long-lasting insecticides. All cotton that is marketed as organic in the US must adhere to stringent regulatory standards governing cotton cultivation. [6]

Approximately 151,079 metric tonnes (MT) of organic cotton (693,900 bales) were grown on 324,577 hectares (802,047 acres) between 2010 and 2011, according to the 2011 Textile Exchange Organic Cotton Farm & Fiber Report. Currently, 0.7 percent of all cotton produced worldwide is organic.

In 2010-–11, 20 nations throughout the world—including Syria, China, Turkey, United States, Tanzania, Egypt, Mali, Kyrgyzstan, Peru, Pakistan, Uganda, Burkina Faso, Benin, Paraguay, Israel, Tajikistan, Brazil, Nicaragua, and Senegal—grew organic cotton, with India leading the way. The fibre was grown by around 219,000 farmers. Natural cotton cultivation without the use of modern agricultural chemicals, such as fertilisers, pesticides, or transgenic technologies is referred to as organic cotton. In an effort to ensure sustainable, ecological, and biodynamic agriculture, it was initially planted in the 1980s.

One of the most frequently recommended raw materials for sanitary napkins is organic cotton because of its non-irritating, skin-friendly, and great liquid retention properties. Due to its flexibility and breathability, it offers comfort and dryness. Due to its compatibility with skin's pH and capacity to wick away moisture and keep skin dry, cotton is skin-friendly. Without the use of synthetic fertilisers or pesticides, organic cotton is grown from untreated genetically modified (GMO) seed. Additionally, it is grown utilising techniques and supplies that have little effect on the environment.

With 38% of the total production over the previous five years, Madhya Pradesh leads the list of organic cotton producers, followed by Odisha (20%) and Maharashtra (19 %). Gujarat (15%) and Rajasthan (8%), the other two largest producers of organic cotton, are next.

An intriguing initiative to increase production and productivity is being carried out by the Department of Agriculture and Farmers Welfare in 15 main cotton-growing States as part of the National Food Security Mission (NFSM). However, according to government statistics, just eight States produced organic cotton over the previous five years.

Characteristics: Comfortable, soft hand, easily absorbed, retains colour, prints good, dry-cleanable and machine-washable decent strength, covers well, Simple to work with and stitch. Cotton breathes and helps remove bodily sweat by absorbing it and wicking it away from the skin thanks to its special fibre structure, which can absorb up to 2.7 times its own weight in water.

2.1.1.2 *Mulberry* silk Top sheet

Silk has a lovely drape, shine, and texture. Furniture and apparel are its two principal uses. From hefty brocades and velvets to medium-weight crepe and sheer chiffons, silk is very versatile and used to create a variety of materials. It can be woven or knitted. The silk waste generated during the process of converting the cocoon into fabric can be manually spun and used more effectively for the development of silk than it is currently used for in the manufacture of yarns for spun silk, noil, throwster, and carpet. Nonwoven materials with added value and a larger range of applications. It is used to make sarees, underwear, socks, shirts, evening gowns, curtains for upholstery, and sheets.

Characteristics: 100% natural, odourless, and hypoallergenic Mulberry Silk is available. Without feeling damp, it can absorb up to 30% of its weight in moisture.

2.1.1.3 Corn PLA Top sheet

Corn fibre (PLA), also known as polylactic acid fibre, is very smooth, moisture-absorbing, breathable, and naturally antimicrobial, has a mild acidity that soothes the skin, and has good heat and UV resistance. It does not at all need petroleum or other chemical raw materials, and the microorganisms in soil and seas act on its waste.

It is capable of breaking down into water and won't harm the environment. Since starch serves as the fibre's primary building block, its regeneration cycle is brief—between one and two years—and plant photosynthesis can help to lower the amount of starch in the atmosphere. The heat of combustion of PLA fibre is essentially non-existent compared to polyethylene and polypropylene, being around one-third of each. [13]

Natural and renewable plant resources are used to make PLA fibre, which lessens reliance on conventional petroleum resources and satisfies international standards for sustainable development. Since Corn fibre has numerous unique features and has different biodegradation characteristics from other fibrous materials, it has drawn a lot of interest from the global textile industry.

It features a plush feel, potent moisture absorption, breathability, and antibacterial qualities. The material is near the skin and is pure, safe, healthful, and of great quality. Other substrates can't compare to its wide range of biological attributes. Ideal base material for face masks of the highest calibre. Natural antibacterial, anti-mite, and PH values close to the skin, also referred to as a person's second skin, are present in PLA and its PLA fibres. In

the medical field, polylactic acid is utilised as a cell culture medium in skin tissue engineering and can maintain the proper proliferation of skin fibroblasts. [14]

PLA is a substance that can be injected into the body and then absorbed. It has been applied to medicine for almost 30 years. Mask substrates separate some free small molecules using PLA fibres. Small molecules have a great ability to penetrate. In addition to inhibiting germs, it can also increase the skin's ability to absorb nutrients and boost the vitality and growth of the facial skin when combined with the lactic acid component of the skin. A deeper level of cleaning may be achieved by the facial skin because to the polylactic acid film cloth's strong adsorption, capacity to retain more essence, and good water absorption qualities, which allow it to absorb oil and eliminate pollutants more effectively.[15]

The polylactic acid film's porous structure allows for the passage of air and moisture, totally preserving the active ingredients in the essence, and having an excellent moisturising effect.

- Degradable
- Environmental protection and no pollution.
- Soft and skin-friendly.
- The surface of the cloth is smooth without crumbs, and the uniformity is good.
- Good ventilation performance.
- Good water absorption performance.

2.1.2 Core Material (wood Pulp)

Absorbency of menstrual fluid is the main need for a sanitary pad. As a result, the choice of fiber's absorbency and retention properties determines the core material entirely.

Its primary purpose is to absorb and hold the fluid and is positioned between the top sheet and barrier layer. Additionally, the absorbent core must be thin, soft, and flexible to be comfortable. The core was historically made of wood pulp but ongoing efforts are being undertaken to replace it with air-laid wood pulp and SAP to increase its absorption effectiveness. In order to prevent the absorbed liquid from retracting back, SAP transforms it into a jelly-like condition. [8,9]

The absorbent core of hygiene goods like diapers, tampons, sanitary napkins, and incontinence, all of which have a significant market share in the medical textiles, is made primarily of wood pulp. This wood pulp comes from a natural wood source that was obtained by cutting down trees, which resulted in deforestation and negative environmental repercussions. Table 1 displays the wood pulp's technical information. The development of a substitute for wood pulp is the main goal of this project.

Table 1: Technical Data of Wood pulp, Golden Isles Fluff, Grade 4881, Wood Species Southern Pine

Properties	Units	Typical Results
Fiber Length	mm	results
FQA Length Weighted mm	mm	2.4
FQA Weight Weighted mm	mm	2.8
Kajaani Length Weighted mm	mm	2.7
Kajaani Weight Weighted mm	mm	3.4
Moisture	%	8

Packaging	Units	Sizes
Roll Width	cm	25 - 152
Roll Diameter	cm	115 - 152
Core Diameter	cm	7.6

2.1.2.1 Corn Starch

A white, flavourless, and odourless powder known as corn starch is used in the creation of industrial adhesives, papermaking, food processing, and various cosmetic and oral medicinal items. It has been used to surgical gloves as a lubricant. The various aspects of starch structure are typically what govern the functional properties of starch granules, which include swelling power, starch solubility, gelatinization, retrogradation, syneresis, and rheological behaviour. Amylose and amylopectin are the chemical components of cornflour. Cornstarch and water are heated, which causes the starch granules to enlarge, become more viscous, and eventually solidify into a paste or gel.

The benefits of Corn Starch

- They help keep the skin dry.
- They help protect against skin irritation in diaper users by reducing skin wetness.
- They help prevent the spread of infections.
- They offer improved quality of life and personal dignity.

2.1.3 Barrier Sheet

It prevents leaks and discoloration of the fluid. It is a polyethylene film that is fluid-impermeable but breathable. Few sanitary pad components will fall apart and be attacked by bacteria in a public or private sewage disposal system, but barrier sheets made of polyethylene or polymeric films will remain intact since these materials are inert and do not harm the environment by being broken down by bacteria. [10]

Sustainable raw materials as an alternative to single-use hygiene products Polyethylene and polyurethane, two non-biodegradable plastics, are frequently utilised as protective film in hygiene items. Many research works on bio-plastic are in progress. Biodegradable plastic can be a Polymer blends of poly (butylene adipate-co-terephthalate) (PBAT) and polylactide (PLA) have been drawn attention due to the application potential as hygiene barrier film. The pricey synthesis of this high molecular weight PLA, which is 5–6 times more expensive than normal plastic, is the only downside at the moment. [16]

PLA is a biopolymer that is a biodegradable plastic that is made from renewable resource (starch). It is formed through condensation polymerisation, (Loss of water molecule)

History: produced first in 1954 but was only patented. Commercially produced in the 90's, growing in numbers. Developed by Scientists from ThyssenKrupp Uhde Polymer division.

Specific use: Plastic bag, plastic containers, garbage bags, food wrap, PLA fibre in textile, automotive industry

Production: Corn Starch – individual glucose hydrolysis – fermentation with bacteria or fungi – two lactic acid monomers – Condensation polymerisation reaction

2.2 Methods

Off-line inspection performed for the measurements of the performance of the product Quality the company has established and specify the monitoring and measurement requirements (including acceptance criteria) for product /process characteristics and data generated is utilized for improved process. The test protocol has been designed

on the basis of product specification including physical characteristics and performance of the product over the time of period.

Physical characteristics: Absorbency/strike through test with synthetic blood, Rewet test, Seal strength test, Peel adhesion test

The primed sanitary napkins after UV Sterilization were tested for the following properties.

2.2.1 Absorbency and Rewet Test

Check the expiration date of synthetic blood. Swirl the synthetic blood solution gently. Ensure no bubbles are formed. Calibrate the dispenser for 15ml amount = 15.35 +/- 0.05 gm. Place the pad on the stand with the body side up. Centre the surface of the funnel on the pad. Entire oblong surface of funnel must touch the specimen. Position the dispenser center to the funnel. Simultaneously start the timing device and begin dispensing the entire amount of synthetic blood into the funnel. Depress the liquid with constant flow. Do not move the funnel during all these activities. Stop the stopwatch when the liquid in the funnel reaches the end point and record the time. Remove the funnel from pad. Rinse the dispenser and the funnel with distilled water and pat dry with paper toweling after approximately one set of testing to prevent synthetic blood build up. [33] Use the same pad on which absorption test happened. Start the weighing scale. Wait until its showing Zero reading. Weigh three pieces of tissue in bi-fold condition. Note down the weight W1. Place the weighed tissue properly in the centre of the pad. Put the 5 kg metal block on centre of the tissue. Simultaneously start the stop watch. After 5 minutes, remove the metal block. Do it accurately. Weigh the tissue. Note down the weight W2. Calculate the difference W2-W1. Note down the rewet in grams.

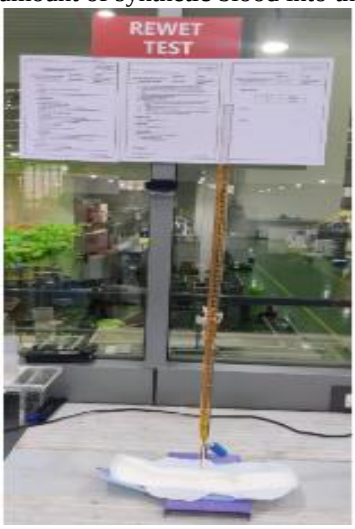


Figure 3: Absorption and rewet test

2.2.2 Peel adhesion

Peel adhesion test is used to determine the peel strength of pad with cotton fabric. Peel adhesion measures the force required to remove a pressure sensitive adhesive from a cotton fabric or its own backing material as per D1876 standard test method. The sample was tested on Universal Testing Machine with sample size of 2 inch x 5 inch.

Figure 4: Peel Adhesion tester (Universal Testing Machine)

2.2.3 Seal strength

Purpose: This test is used to determine the maximum strength (peak load) of the seam of the feminine care pads. Seal strength is the tensile strength of the seal at ambient temperature, which was tested as per ASTM F88. It is the maximum force required to separate the two layers of a seal under particular conditions. The sample was tested on Universal Testing Machine with sample size of 1 inch x 2 inch.

2.2.4 Adhesive residue

Equipment used : Oven, Use the 2 X 8 inch cotton strip

Adhesive residue test is used measures the adhesive's ability to adhere the fabric commonly used in the manufacture of underwear. As an adhesive tape is removed from a temporary application, the goal is to leave the surface as clean as possible. This test was carried out in oven with the sample size of 2 inch x 8 inch. For instance, when a barrier film is applied to a lady panty, it should pull up without leaving any ghosting or adhesive left behind. Aesthetics are vitally important.

If the goal of the application is simply to create a permanent or even semi-permanent bond, the residue isn't as important because these surfaces aren't meant to be separated. Peel adhesion provides insight into the amount of residue left behind once the adhesive is removed.

Factors that determine if residue is left behind:

- Type of adhesive used (and its strength)
- Cohesive strength; is it stronger than the adhesion?
- What substrates you're sticking to
- Application temperatures

2.2.5 pH test

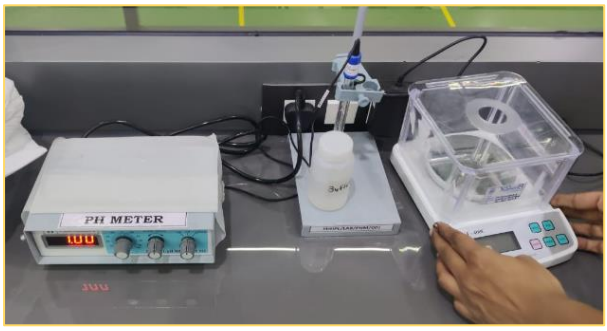


Figure 5: pH tester

Sanitary napkins should have neutral pH values; they should neither be acidic nor alkaline. For that, they are tested to determine their pH value. Testing sanitary napkins on these parameters according to IS 5405:2019 test, it can ensure purpose without leaking and without causing any discomfort. [17]

3.0 Results and Discussion

The use of textiles in the medical, applied healthcare, and hygiene industries is a significant and expanding component of the textile industry.

"Sanitary Napkins" is known as sanitary pads, sanitary pads, sanitary towels, or maxi pads, which form an important part of the gynaecological hygiene of every woman. Sanitary Napkins are absorbent disposable single-use products designed to receive, absorb, and retain menstrual fluid and isolate them from the rest of the body. It is worn externally, between the vulva and a woman's undergarment. It is a form of a porous item that has the capability of soaking the flow of blood. Hence, menstruating women wear them during their periods. Some women also prefer using them while recovering from vaginal surgeries, childbirth, or abortion. Sanitary napkins are made by inserting an absorbent pad between fabric sheets. The technical textile component of the sanitary napkin is the non-woven fabric which prevents leakage of menstrual discharge.

3.1 Absorption and Rewet test

Table 2: Absorption and Rewet test

Sr. No	Type of Sanitary Napkins	Sample Code	Absorbency (ml)	Absorbency rate (Sec)	Rewet (gm)
A	Corn PLA Sanitary	P240	15ml	12.0	2.5
			15ml	21.0	3.4
		P290	15ml	13.5	1.5
			15ml	21.3	4.1
			15ml	33.8	5.3
B	Organic Cotton	B240	15ml	11.4	3.4
			15ml	20.8	4.1
		B290	15ml	12.1	2.8
			15ml	19.3	3.9
			15ml	25.0	6.2
C	Mulberry silk	M240	15ml	15.0	2.8
			15ml	22.0	3.5
		M290	15ml	14.5	2.4
			15ml	24	6.4
			15ml	28	6.8
D	Soft Comfort	S240	15ml	17	1.52
			15ml	22.6	5.19
		S290	15ml	15.6	1.16
			15ml	22	3.31
			15ml	27	6.3
E	Dry Comfort	D240	15ml	25.6	0.7
			15ml	40.6	3.13
		D290	15ml	20.4	0.34
			15ml	31.8	1.69
			15ml	41.2	2.3

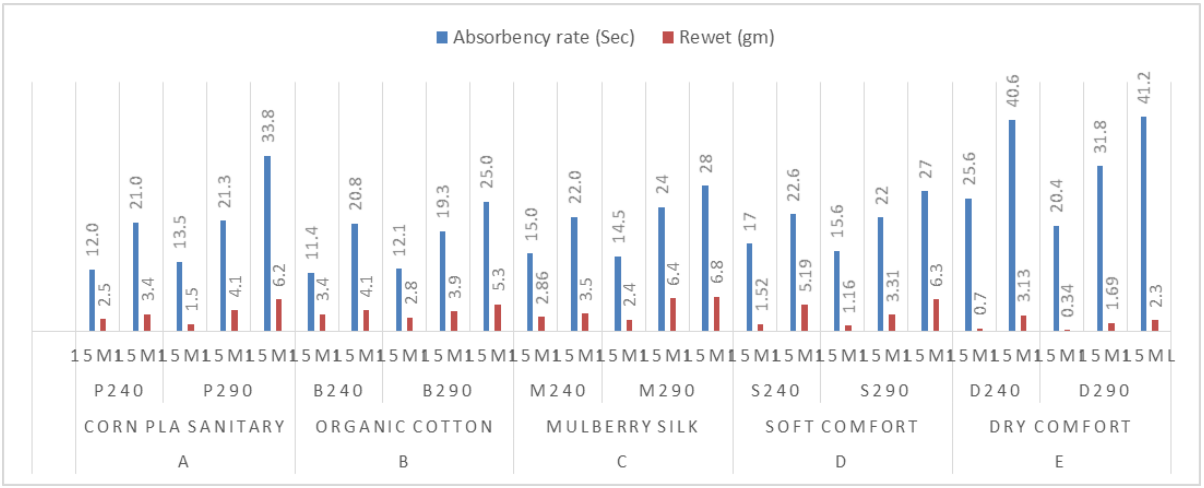


Figure 6: Absorption and Rewet test

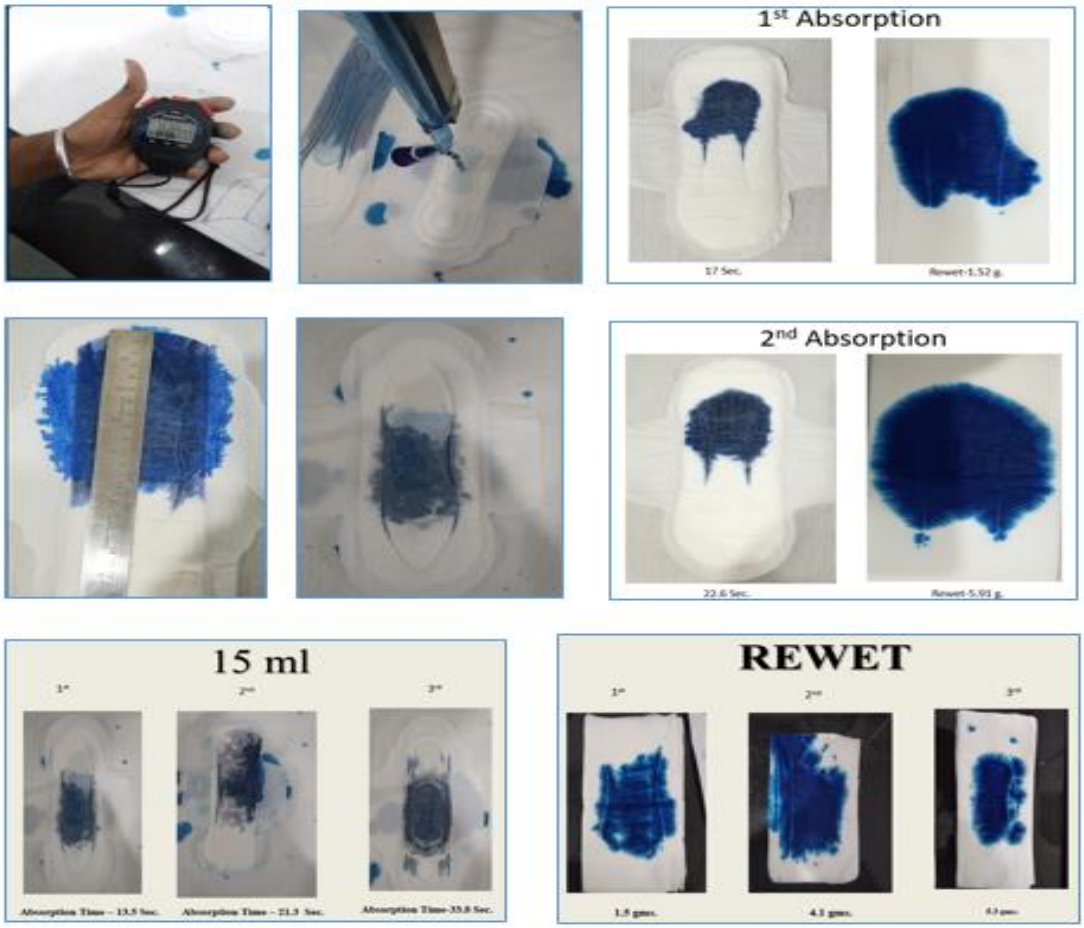


Figure 7: Absorption and rewet test images for the sanitary napkins

IS: 5405/ 1980 Absorption test method used. The sanitary napkins shall absorb 30 ml of coloured water or test fluid when flowed on to the centre of the napkin (at the rate of 15 ml per minute) and it shall not show up at the bottom or sides of the sanitary napkin, when tested according to Appendix A.

Utilizing wood pulp fibre as cake material mixed with SAP for soft comfort and dry comfort, and using wood pulp fibre as cake material combined with corn starch for Corn PLA, Organic Cotton, and Mulberry silk top sheet materials, all types of napkins were produced.

In table number 2, I've added the code name, alphabet number, and associated napkins. The time it took for various sanitary napkins to absorbed fluid ranged from 1 second to 40 seconds. The new napkins (A, B, and C types), which were produced from napkins, took the lowest amount of time—10 seconds—compared to the old napkins (D & E), which were constructed of soft comfort and dry comfort.

The top layer of the napkins is another crucial element that affects absorbency. D-Soft Comfort napkins' top sheet was spun bond. Nonwoven E-Dry Comfort napkins had top sheets made of perforated poly plastic, whereas all other napkins had top sheets made of A-Corn PLA, B-Organic Cotton, and C-Mulberry Silk.

In comparison to A, B, and C, Corn PLA, Organic Cotton, and Mulberry silk top sheet, old-made napkins D and E (soft comfort and dry comfort) have a good rewet value. This is because fluff pulp was mixed with SAP in earlier samples A and B, but corn starch was mixed with fluff pulp in more recent samples (A, B, and C). The product samples A, B, and C had a slightly slower absorption rate than samples D and E. In favour of the

biodegradable samples, this is a favourable indicator. When compared to the D and E, the rewet testing results for the A, B, and C are better.

As depicted in figures 6 and 7, the sample B (Organic cotton top sheet) has a very quick rate of absorption and a low rewet value.

3.2 Peeling Adhesion Test:

Table 3: Peel Adhesion test

Sr. No	Type of Sanitary Napkins	CODE	Peel Adhesion (gf)	
			Front	Back
A	Corn PLA Sanitary	P240	120	126
		P290	140	134
B	Organic Cotton	B240	145	156
		B290	154	143
C	Mulberry silk	M240	163	168
		M290	158	154
D	Soft Comfort	S240	135	129
		S290	127	126
E	Dry Comfort	D240	129	131
		D290	120	119

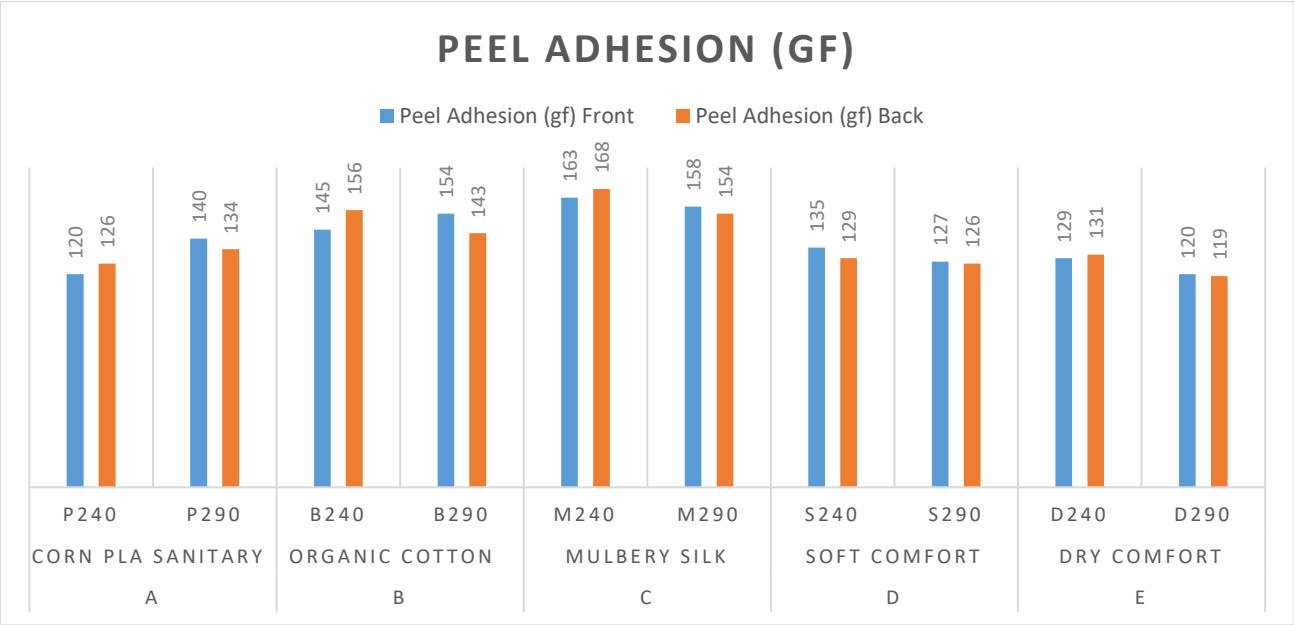


Figure 8: Peel Adhesion test

Results for the peel adhesion for several types of sanitary napkins are displayed in table 3 The peel adhesion test is used to calculate the force needed to separate two components that are adhered together. Bond strength, another name for the test result, is typically expressed as gf (force to de-bond). 1) Quality control, where the glued component must meet a minimum bond strength value, can be accomplished with the peel adhesion test.

Determine the ideal pressure and temperature for adhesive curing in order to get the highest bond strength. 3. Determine how temperature, humidity, and other external factors may affect the bond strength.

According to industry standards, 80 gf to 200 gf are needed for the peel adhesion value of sanitary napkins. We analysed all of the product samples, including A, B, C, D, and E. According to figure 8, which is a graphic representation of the Peel Adhesion test findings for samples A, B, C, D, and E, test results range from 120gf to 170gf.

3.3 Seal Strength

Table 4: Seal Strength

Sr. No	Type of Sanitary Napkins	Code	Seal Strength - gms			
			Front	Back	Right side	Left Side
A	Corn PLA Sanitary	P240	368	399	376	380
		P290	244	270	255	264
B	Organic Cotton	B240	222	269	256	275
		B290	227	282	277	267
C	Mulberry silk	M240	475	508	480	505
		M290	508	510	503	514
D	Soft Comfort	S240	594.	578	425	440
		S290	642.	610	458	414
E	Dry Comfort	D240	519	535	460.	401
		D290	528	498	421	429

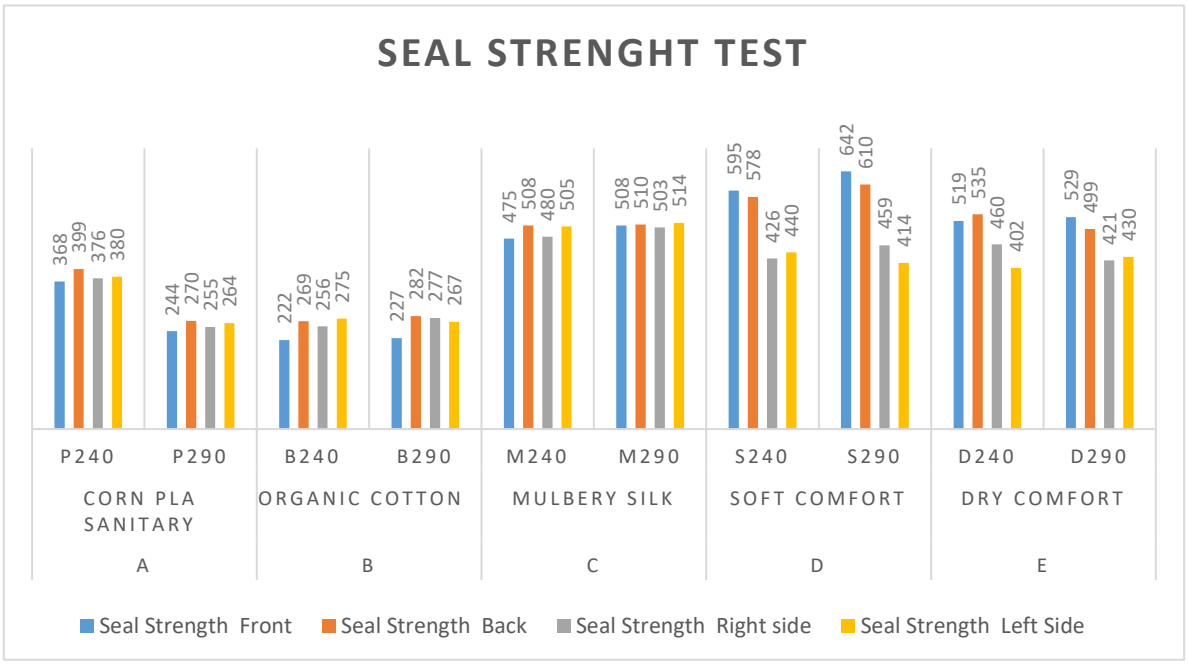


Figure 9: Seal Strength test

According to table 4, which displays the Seal Strength results for samples A, B, C, D, and E. The peak load (maximum strength) of the seam on the feminine care pads is ascertained by this test. The force necessary to separate the two layers is calculated using the seal strength test.

According to industry standards, sanitary napkins must have a seal strength value of greater than 300 gf. We analysed all of the product samples, including A, B, C, D, and E. Figure 9 illustrates the testing findings, which range from 255gf to 505gf.

3.4 Adhesive residue Test

Table 5: Adhesive residue test

Sr. No	Type of Sanitary Napkins	Code	Adhesive residue Test (Time in Second)
A	Corn PLA Sanitary	P240	2.84
		P290	2.9
B	Organic Cotton	B240	2.4
		B290	2.6
C	Mulberry silk	M240	1.5
		M290	2.5
D	Soft Comfort	S240	2.9
		S290	3.2
E	Dry Comfort	D240	1.5
		D290	2.5

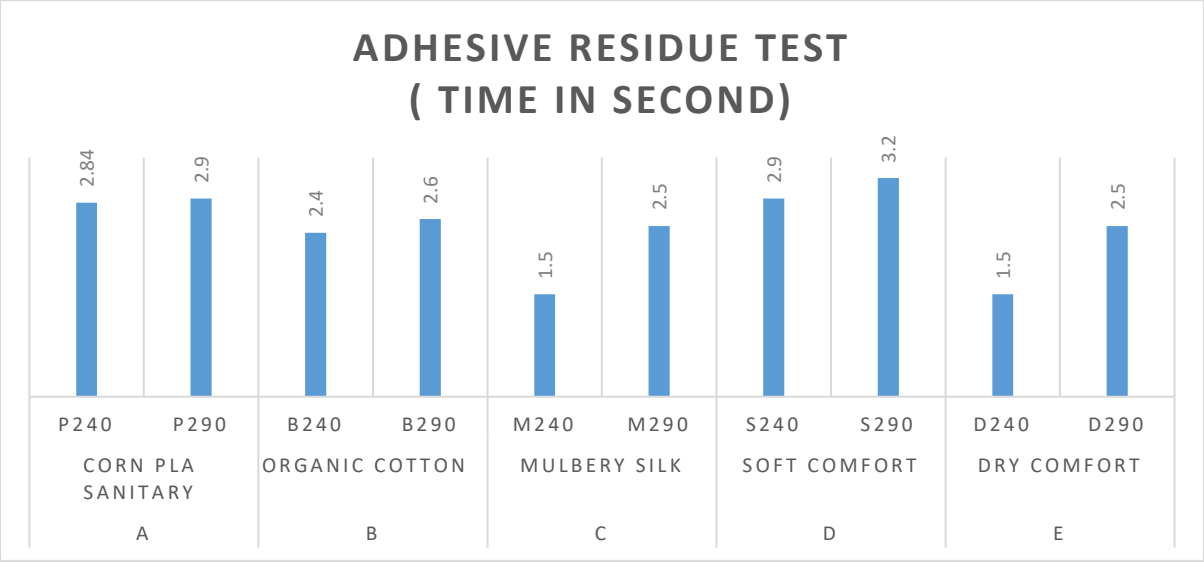


Figure 10: adhesive residue test

According to table 5, the results of the adhesive residue test for samples A, B, C, D, and E are displayed. The adhesive residue test is used to gauge how well an adhesive adheres to the typical fabric used to make underpants. The objective of removing adhesive tape from a temporary application is to leave the surface as spotless as possible. With the left hand holding the cotton fabric's end, the right hand utilised a consistent motion to peel the

product away from the cotton fabric, taking about three seconds to accomplish the separation. All of the product samples A, B, C, and E have been examined. Most product results fall within the following range of 3 seconds. Only Sample D exceeded the range for the testing depicted in Figure 10's testing.

3.5 pH Test

Table 6: pH Test

Sr. No	Type of Sanitary Napkins	CODE	PH Test
A	Corn PLA Sanitary	P240	7.3
		P290	7.3
B	Organic Cotton	B240	6.8
		B290	6.9
C	Mulberry silk	M240	6.4
		M290	6.4
D	Soft Comfort	S240	6.1
		S290	6.2
E	Dry Comfort	D240	6.4
		D290	6.4

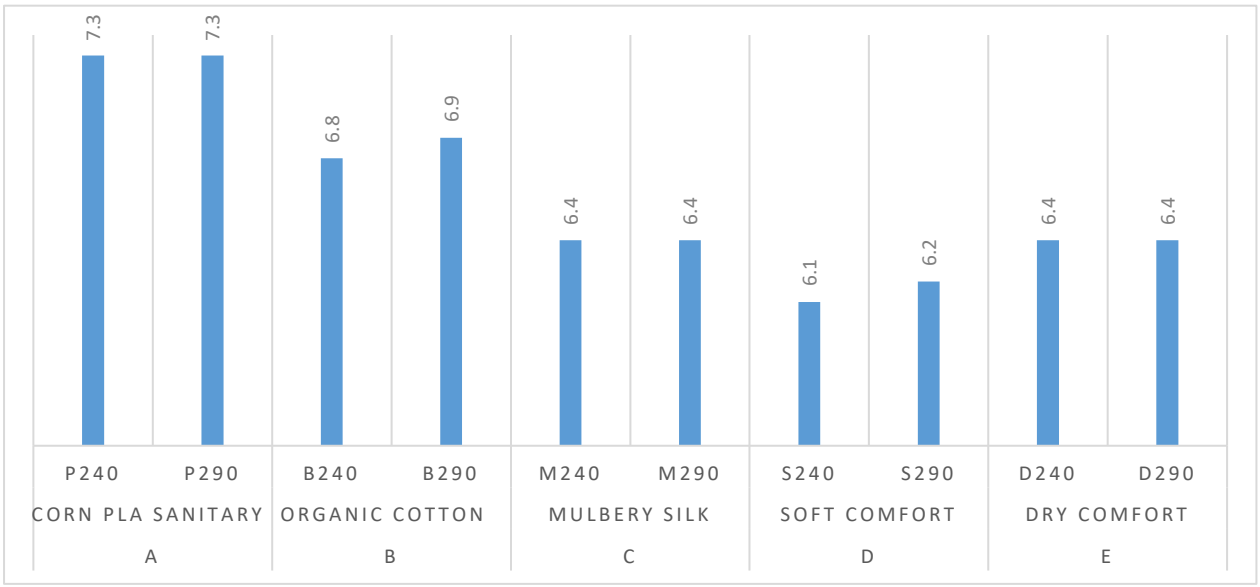


Figure 11: pH test

The pH of the absorbent substance must be between 6 and 8.5 when tested using the technique, and the sanitary napkin must be free of any acidic or alkali materials.

According to table 6, the pH of all the napkins ranged from 6.1 to 7.3. As a result, every sanitary napkin complied with the permissible pH range, which is 6 to 8.5. As demonstrated in Figure 11, both of the napkins that

were created using soft comfort materials—spun bond nonwoven and perforated poly plastic—and the dry comfort materials—organic cotton and mulberry silk top sheets—also fell within the permitted range and had pH levels that were almost identical.

4.0 Conclusion

Different sanitary napkins of Corn PLA sanitary Napkin, Organic Cotton, Mulberry silk, soft comfort and dry comfort are produced successfully. These all samples are developed with the use of easily available natural materials. In terms of absorption, rewet return, leakage resistance and pH value all the samples have shown the improvement.

The top sheet made of organic cotton, wood pulp fibre and corn starch mix has shown the fast absorption character among the all samples. The top sheet made of mulberry silk with wood pulp fibre has shown the lowest rewetting rate. The Corn PLA and Organic cotton top sheet have shown the better peel adhesion strength among all samples.

The seal strength of all samples has found as per the standards. All sanitary napkins have pH value in the range of 6 to 8.5 pH. Women obviously need menstrual hygiene products. The awareness about organic sanitary napkins has to be increased among the society, which is less than 15% at present. As a long term environment this may be a solution. As the natural biodegradable material are used for the sanitary napkins, these samples are hygienic and will decompose less time period as compare to synthetic sanitary napkins.

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6.0 Future Scope

- Need to develop absorption material like wood pulp replace with the bamboo pulp as well as banana fibre with large scale fracturing unit
- There should be a balance between home and environment as both health of women and environment are equally important. Moreover, on the part of government, there must be support given to the new techniques producing organic sanitary pads which are biodegradable and some restriction must be out on the use of synthetic sanitary pads.
- Government must segregate menstrual waste from household waste and decompose them with different techniques and method instead of burring them in landfills. Either they must be included under bio-chemical waste or separate category must be formed under CPCB.
- Even after studying the Act initiated by Indian Government it is concluded that there is lack of attention paid in this matter as menstrual waste is treated as household waste under Municipal Solid Waste according to CPCB.
- Here I'm conclude that the costing part for the biodegradable napkin costing is around the 40% to 52% cost is higher side. Tentative costing for the normal synthetic sanitary napkin cost is 2.15 Rs/ pcs and for Corn PLA type sanitary napkin with corn starch is around 3.60 Rs/pcs, for Organic cotton type sanitary napkin with corn starch is around 4.45 Rs/ Pcs and for Mulberry silk type sanitary napkin with corn starch is around 4.25 Rs/ Pcs. Here we need to inform to industry for developed new RM and PM for sustainable environment.

Man Made Textiles in India

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Sanitary Napkins

Smart Textiles

Gaddi goat and Wool fibre

sasmira

67th YEAR OF PUBLICATION

Himalayan Nettle and Polyester

Denim Stretchability

Past and present of sanitary napkins & their characteristics

S. B. Chaudhari and Arpan B. Kharva
Department of Textile Engineering, The M.S. University of Baroda, Vadodara

Abstract
One of the example of a medical textile, under technical textiles, is a sanitary napkin. This article provides a succinct overview of medical textile classification. Less than 20% of Indian women use sanitary napkins, while the remaining 80% turn to shockingly uncomfortable substitutes like worn-out clothing, ashes, and husk sand. The history of sanitary napkins, their fundamental desirable features, the raw materials utilised in their production, and sanitary napkins of various levels have all been covered in this paper. Here, we've covered some key considerations regarding sanitary napkins, along with some related restrictions. It's essential to choose the proper sanitary napkin for the situation in terms of hygiene.

Keywords:
Sanitary Napkin, Sanitary Pad, Menstruation, Medical Textile, Feminine hygiene Disposable products

Introduction

Although "technical textiles" have received a lot of attention, using fibres, yarns, and fabrics for things other than clothing and furnishings is nothing new. The emerging understanding of the economic and strategic possibilities of such textiles for the production and processing of fibre and fabric in both industrialized and developing nations is something that is relatively new. Technical items (broadly defined) already compensate up to 50% of total textile manufacturing activity and production in some of the most advanced markets.

Technical textiles are defined as "textile materials and products manufactured largely for their technical and performance capabilities rather than their aesthetic or decorative attributes" in the official Textile Terms and Definitions, issued by the Textile Institute [1, 2].

Medical Textiles

The type of technical textiles which offer a variety of technical and functional properties havingapplication in the field of medical and clinical care are manufactured primarily for their technical performance & functional properties rather than their aesthetic or decorative characteristics," is how medical textiles are defined [4].

The major goal is to increase the standard of health care delivery by reducing the risk of infections and improving the quality of care delivery through disposable items[3]. The following broad categories can be used to categorise the many uses of textile materials in the medical and healthcare sectors are:

Classification of medical textiles

Nonimplantable: These are finished textile products including swabs, bandages, gauze, plasters, pressure garments, orthopaedic belts, wipes, wound dressings, etc.

Implantable: Materials that can be installed on or inside the human body are known as implantable materials. Examples include sutures, heart valves, vascular grafts, artificial veins, synthetic tendons and ligaments, joints and bones, artificial skin, artificial cartilage

Extracorporeal: These are externally placed medical equipment that assist the function of essential organs like the heart, liver, kidney, and lungs [3].

Healthcare and hygiene sector

The medical, connected healthcare, and hygiene industries are all experiencing growth in the textile business right now. The primary component of the healthcare industry is textile. Although a vast variety of items are available, they are typically utilized in operating rooms or hospital wards for the hygiene, care, and safety of employees and patients. A wide range of applications, from basic cleaning wipes to cutting-edge barrier textiles used in operating rooms, are found in the healthcare and hygiene sectors [5].

Textiles used in healthcare and hygiene applications make up the Meditech segment's textile materials. Diapers, sanitary napkins, surgical supplies, prosthetic implants, masks, PPE kits, and surgical gowns are examples of comparable healthcare and hygiene items.

Three fundamental categories can be used to group medical textile items. patient-specific, generic patient management, and procedure-specific. The patient-specific supplies included things like sponges, linens, and burn sheets. Wipes, underpads, and adult incontinence products are all marketed as patient management items. Surgical gowns, drapes, tablecloths, face masks, headwear, and shoe covers make up the third group of procedure-specific items [6].

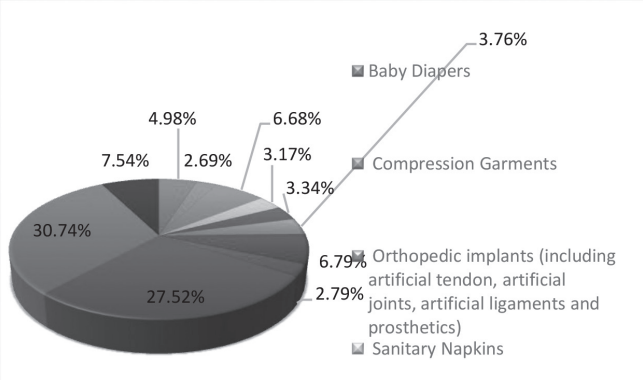

Figure 1: Contribution of Medical textile products in the domestic market

(Source: Technical Textiles, Industry in India, Opportunities and challenges, Baseline Study, 2020 [7])

Others include Extra corporeal devices and artificial kidney (dialyser)- 1.89%, Dental floss- 1.22%, Incontinence diapers- 1.14%, Heart valve0.84%, Vascular graft- 0.82%, Underpads- 0.59%, Compression stockings- 0.17%, Heart and soft tissue repair patch- 0.06%, Cotton buds- 0.04%, Eyepads (TT component)- 0.01%, and Miscellaneous items- 0.76%

Surgical dressings (30.74%) constituted the largest share of the Indian Meditech market in 2019-20, followed by surgical sutures at 27.52%

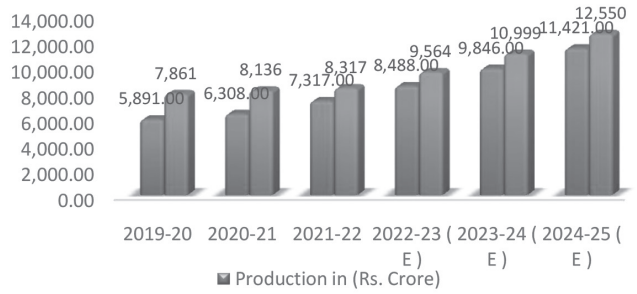

Figure 2: Production and Consumption of Medical textile segment in the domestic market

(Source: Technical Textiles, Industry in India, Opportunities and challenges, Baseline Study, 2020 [7])

Data about the contribution of Medical textile products in the domestic marketand the production and consumption of the medical textile segments are depicted in the figure 1 and 2. Production is only slightly below consumption in the Indian market. India is a net importer and in the following five years, the difference between production and consumption is anticipated to widen [7]. The third and largest group of healthcare and hygiene product manufacturers has mostly been served by an unorganized sector of producers. Due to their production of disposable hygiene products, MNCs like Johnson & Johnson, P&G, Kimberly Clark, and Unicharm are the key players in this industry. Manufacturers of textiles for medical purposes are aware of the difficulties and the necessity to find innovative, economically viable solutions for environmental issues [8].

Sanitary napkins

Sanitary napkins, sometimes referred to as sanitary pads, sanitary towels, or maxi pads, are an essential component of every woman's gynecological hygiene. Sanitary napkins are disposable, single-use absorbent materials that are intended to collect, hold, and separate menstruation fluid from the rest of the body. Between the vulva and a woman's undergarment, it is worn externally [9]. It is a type of porous object with the capacity to sponge up blood flow. Therefore, they are worn by menstrual women throughout their periods. While recuperating from vaginal surgery, childbirth or abortion, some women favor using them. By sandwiching an absorbent pad between two fabric sheets, sanitary napkins are created. The non-woven fabric that stops menstrual fluid from leaking is the technical textile component of the sanitary napkin. [10]

International corporations including Procter and Gamble, Johnson and Johnson Ltd., and Kimberly Clark Lever Pvt.

Ltd. have so far controlled the sanitary napkin business in India. In the recent years, Indian manufacturers have also entered this market. The market for sanitary napkins is dominated by brands like Whisper from Procter & Gamble and Stayfree and Carefree from Johnson & Johnson Ltd. Kotex and Shapers from Gufic Biosciences and Kimberly Clark Lever each own a portion of the remaining market.

Procter & Gamble, Hengan International Group Company Limited, Kimberly-Clark Corporation, Edgewell Personal Care Company, and Kao Corporation are a few of the key participants on a global scale.

A recent research by Research andMarkets titled "Global Feminine Hygiene Products Market (2021 to 2027)" predicts that the market for feminine hygiene products will generate US$38.9 billion in revenue by the year 2020. The expected global sale of feminine hygiene products in 2030, according to this report, will be US$68.7 billion registering a 6.1% CAGR between 2021 and 2030 [11].

History of sanitary napkins

As early as the 10th century in Ancient Greece, a lady is reported to have thrown one of her old menstruation rags at an admirer in an effort to get rid of him, which is when the first mention of menstrual pads in history occurs [12]. Most women used rags, cotton, or sheep's wool in their underwear to stop the flow of menstrual blood until the invention of the disposable pad. Women handled their periods with grass, knitted pads, and even rabbit fur.

Intrepid develops a large range of patented devices in the middle of the 18th century, including catamenial sacks, bandages, and flaps, elastic straps, valves, and girdles. When the Comstock Act was passed in the United States in 1873, the phrase "feminine hygiene" was first used by the birth control business. The first commercial sanitary pad produced by J&J, Lister's Towels, went on sale at the turn of the 20th century, in 1896 [13]. During the Second World War, nurses in France discovered that cellulose bandages, which troops used, were significantly superior at absorbing blood than ordinary cotton. The earliest pads, according to their current flow, were created by French nurses using bandages composed of wood pulp. It was inexpensive and very absorbent; after usage, it was discarded.

KCC developed the cotton and texture combination around the start of the nineteenth century, creating the disposable pads. They had a Kotex on their head, according to Kimberly Clark. It is advised that customers refrain from using the word "menstruation". J&J launched comparable goods made by Medess in 1927 [13]. In 1940, the Modess Print campaign was unveiled and transformed into menstrual advertisement as a display of high fashion and fashion photography. Numerous American women in the early 20th century used handmade pads, frequently constructed from "bird's eye," the same absorbent cotton fabric used for infant diapers. These fabrics or rags would be pinned to their handmade muslin belts or undergarments. The first continuous birth control pill, which simultaneously suppresses periods and offers birth control, received FDA approval in 2003. Only four menstrual cycles occur annually for women using seasonal.

In 2007the FDA approvedLybrel, the first birth control medication that stops periods. Nevertheless, the website openly acknowledges that "menstrual cramps and vaginal bleeding" may be experienced by women. Even sanitary napkins were available in the past, but because they are expensive for most women, they continued to use the traditional way. Women were permitted to leave money in the box when they could do so without speaking to the person and collect the KOTEX pad napkin box from the front desk alone. Before disposable sanitary pads are widely used, these items must be around for a while [13].

In the past, disposable sanitary napkins were coated with an absorbent lining and made of cotton, wool, or a similar fibrous material. The pad's front and rear sides have an extended shape that allows it to pass through the loops of a specific belt used below undergarments. The future position of this design was notorious for shifting backward and forward [14]. Later, an adhesive strip was added to the back of the sanitary pad to make it easier for women to glue them to their underwear. Thank heavens, belted sanitary napkins quickly disappeared in 1980 [13-16].

The sanitary napkin manufacturing business has made great strides in research over the past two decades. The days of hefty pads and long belts are over. The development of extremely absorbent fabrics and enhanced designs has made sanitary napkins more comfy and useful than before. The development of "wings" secures the pad in the undergarments, and the prepared "scented pads" lessen smells. The most common method of the menstrual cycle is using sanitary napkins, especially in underdeveloped nations.

Structure of conventional sanitary napkins

A sanitary napkin consists of the following four essential parts: three layers: the top sheet, the core (an absorbent structure), and the underneath adhesive layer. The fundamental design of sanitary napkins is shown in Figure 3. It is made up of an absorbent layer, an upper sheet layer that lets organic fluids pass through, and a bottom sticky layer that provides structural support.

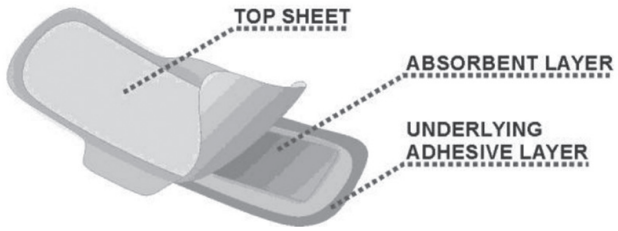

Figure 3: Conventional design of sanitary napkin

Composition of conventional sanitary napkins

More than 70% of the weight of earlier sanitary napkins was made up of fluff pulp, which is responsible for distributing liquids throughout the length of the pad. As a result, fluff pulp is a crucial and critical component of the creation of sanitary napkins. This paper uses the average percentage of raw materials utilised in the product as an example. In terms of material composition, the table 1 and figure 4 shows the typical sanitary napkin has 43% fluff pulp, 35% PE, PP, and PET, 7% adhesives, 3% SAP Powder, 9% glue, and 3% release paper [17].

Table 1: Sanitary napkin compositions

Sr. No	Components	%Component in Sanitary pads
1	Fluff pulp	43
2	Super absorbent polymer	6
3	Polypropylene and Polyethylene	36
4	Adhesives	7
5	Release paper	3

Source: Edana (2008)

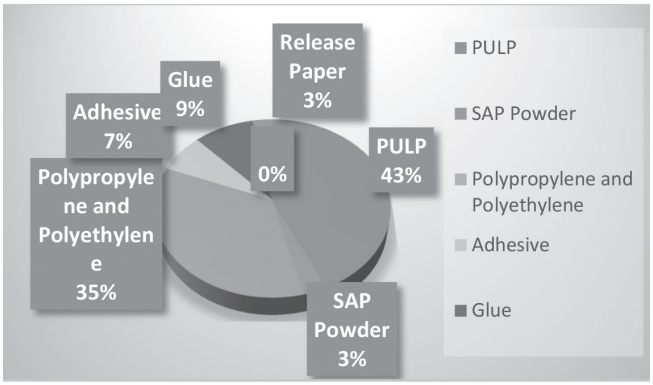

Figure 4: Percentage composition of the components in Conventional Sanitary Pads

Conventional sanitary napkins include chemicals in them that can hurt and irritate the area around the vagina, resulting in infections, rashes, and allergic reactions [18, 19]. Many sanitary napkins back in the day included chlorine, which can cause cervical cancer. Additionally, the most widely used sanitary napkins are non-biodegradable and environmentally harmful due to their almost 90% plastic content [20]. Market-available conventional sanitary pads include a lot of plastic. The majority of women all over the world use these sanitary napkins for at least 4-6 days per month. The statistics provided above indicates that a significant volume of plastic garbage is produced each month on the international market. Since sanitary pads are made of non-biodegradable plastic, they can pose risks to human health and the environment and can take 600–800 years to breakdown in the soil [21].

One woman will use between 7,000 and 17,000 sanitary napkins throughout her lifetime, or around 7 years' worth, depending on the length of her menstrual cycle [20]. In India, 64.4% of women between the ages of 15 and 24 use sanitary napkins, followed by 49.6% who use cloth, 15% who use locally produced napkins, and only 0.3% who use menstruation cups.

The most crucial raw ingredient is Fluff-pulp, which is produced from pure cellulose fibres and is found in cold mountain areas of North and Central America, Europe, and northern Africa. These soft woods include spruce, pine, fir, larch, and hemlock. Since India lacks access to the fluff pulp needed to produce high-quality sanitary napkins, Indian producers must rely on imports, which come with import charges of up to 10% and IGST, which raises the price of the finished product. Softwood fibers measure around 30 µm in breadth and 3 mm in length. The sector now has ambitions to transform the imported raw materials into products that are easily accessible on the Asian market.

Structure of reusable sanitary napkin

Design of Resusable Cloth - sanitary napkin

A reusable sanitary napkin, made up of cotton, cotton flannel, or cotton fleece at the top layer. A thick fabric, like an old towel, in the center of your cloth pad (core). These materials are not only incredibly soft and stain-resistant, but they also have a thin wicking quality that draws moisture into the inner absorbent layers, keeping the layer against your skin dry. The pads have a bottom layer of PUL fabric to add a waterproof layer. This makes the pad waterproof, though breathable. The laminated

surface is on the inside of the pad, so it does not come in contact with the skin.

Advantages of Reusable textile component for the Sanitary Napkins

Reusable pads are advantageous in many other ways in addition to making sense from a sustainability and environmental perspective. Comfortable, skin breathes permanently; no moisture build-up, no unpleasant odors or plastic rustling, design designed for maximum protection, Easy to use/wash, eco-friendly, economical and chemical-free

Basic desired properties considerations in the sanitary napkins

- Comfortable to wear,
- Hygienic
- No Leakage,
- No noise,
- No odour,
- No anaesthetic appearance or colour,
- Stay in place

Quality requirements of sanitary napkins as per BIS

This standard establishes the prerequisite for sanitary napkins for exterior usage. Absorbency, the capacity to sustain pressure following adsorption, disposability, and pH value are only a few of the significant performance characteristics mentioned in the standard.

BIS IS 5405: Testing of Sanitary Napkins: This standard specifies the requirements and test methods for disposable sanitary napkins. It covers parameters such as dimensions, absorbency, rewet properties, pH value, odor control, and packaging requirements.

BIS IS 10910: Testing of Sanitary Napkins (Part 1 and Part 2): This standard provides specific test methods for assessing the absorbency, rewet properties, and liquid retention capacity of sanitary napkins.

BIS IS 15223: Testing of Sanitary Napkins: This standard outlines the test methods for determining the pH value of the absorbent core of sanitary napkins.

Absorbency

The hygienic tissues when lowered in the center of the sanitary napkin (at a rate of 15 ml per minute), it must absorb 30 ml of synthetic blood and not discolour or leak through at the bottom of the napkin.

pH Value

Acids and alkalis must not be present in the sanitary napkin, and the absorbent material's pH must range from 6 to 8.5.

Disposability

The covering of a disposable sanitary pad must be removed before it is submerged in 15 litres of water and agitated. The pad must dissolve in the water in less than five minutes.

Standard size of sanitary napkins

Below are specifications for the sanitary pad's standard size.

Width	:70 mm
Length	: 190 mm
Thickness	: 8 mm or more
Weight	: 6 gm

A sanitary napkin typically measures around 245 millimetres, or 9.65 inches, in length. The average width is around 6.30 inches, or 160 millimetres. Although it might vary, the thickness is typically close to 3 millimetres (0.12 inch). While certain pads could be larger or smaller than this, they are still quite close to these dimensions.

Selection of suitable design

Think about the many brands, sizes, styles, and thicknesses on the market. To prevent leaking, the vulva and female genital region must be covered by the sanitary napkin. A size 6 panty size match with a hip and waist measurement is usually supported by pad designs. For complete covering of bigger pant sizes, choose a Large, Extra Large, or overnight protection.

Select a shape or design

With or without wings, and curved or contoured to avoid leakage on the sides, sanitary napkins are selected based on women's lifestyles.

Consider the absorbency rate

The absorbency level should be increased.

Thickness for comfort

Identify the ideal thickness for any type of physical activity. While some people like extensive padding, others choose lightweight cushions to meet their demands without adding bulk.

Best support system for preventing slippage

Find the ideal support setup to stop pad sliding. The napkin is held in place within the panty by wrap-around wings

and adhesive strips on the pad's bottom. After exercise or after being exposed to other constant movement or wetness, such as sweat, observe how long a napkin's support lasts.

Characteristics of Ideal sanitary napkins / choosing the right Sanitary Napkins

Air Permeable

The skin of a woman's sensitive portion is at its most vulnerable during menstruation. According to surveys, 73% of women experience itching and soreness in certain areas of their skin during their period. The usage of sanitary pads, which are not air-permeable, was largely to blame for this. The use of sanitary napkins that are not air permeable is the main cause of this. To guarantee safety, appropriate sanitary napkins are used during menstruation. The top sheet, absorbent core, and back sheet are the three layers that typically make up sanitary pads. The selection of sanitary napkins is based on factors related to the composition and use of raw materials.

Surface Layer Consideration

To prevent the wet skein surface, the top sheet should have a cotton net surface with quick absorption. The discharge absorbed would not readily backflow to the top surface, making the funnel type of design superior to the bucket type. Some sanitary napkins on the market contain artificial fibre as the primary material for the surface, which might cause allergic reactions in some women.

Absorbency Layer

Effective absorption agents that can transform the discharge of absorbed liquid into a jelly-like condition should be present in the intermediate layer so that it won't backflow when squeezed and won't feel sticky. Avoid utilising recycled paper pulp as absorbency agents; some women with sensitive skin may experience discomfort from such products.

Underlying Layer

To allow for the migration of water molecules in the gaseous form, the bottom layer should be constructed of air-permeable materials. These items keep damp air at bay and effectively minimise heat and moisture between sanitary napkins and the body, leaving a dry and revitalising sensation.

Performance characteristics of sanitary napkins

The three components (top sheet, absorbent cake material, and back sheet) are exposed to synthetic blood, and the absorbent cake material is the primary element influencing how well sanitary napkins operate. Synthetic blood is passed through each layer of the sanitary pad in order to better understand the sanitary napkin's operating concept [23].

Artificial blood contacts the top sheet vertically and travels along the acquisition layer's length to the absorbent layer without distributing it. Synthetic blood spreads and may retain once it contacts the absorbent cake substance without changing the flow direction [17].

The boundary between the acquisition layer and the absorbent layer is the main challenge with sanitary napkins. Since the hydrophobic fibres used to create the acquisition layer and the absorbent layer are both hydrophobic, fluid must move from the acquisition layer to the absorbing layer with ease. The movement of fluid between two layers is challenging if there is little room between them. Any void will cause the flow pattern to shift, and spilling liquid might cause the product to malfunction.

The bulk of sanitary napkins use core absorbent materials and fluffed cellulose pulp. Crossed cellulosic boards are crushed to create this fluff. There is always a potential that portion of the unopened board may remain, giving the absorbent material some variability. Therefore, there is a possibility that the region will have unequal fluid flow and fluid retention.

Fluid retention capability or the volume of fluid retained after applying pressure can be used to predict how sanitary napkins will perform. Density is one element that interferes with the fluid holding. Both compacted and uncompacted kinds of super absorbent fibre are utilised to make the new generation commercial sanitary napkins. Density has a deliberate impact on the product's absorption and stability. While a fibre that has been loosely compressed will fail due to absorption, a fibre that has been tightly crushed will maximise absorption. Therefore, the absorbent core material must be strong in order to preserve its structural integrity.

Choice of raw material

Fluid transfer layer: To move fluid from the top cover to the immediate secondary layer, there is a top sheet layer. For comfort, good sanitary napkins should be dry. Cellulosic substance was used in the multilayer sanitary napkins of the past. Fluid tended to stay at or near the surface until the synthetic blood had fallen [12]. Using thermoplastic fibre has been suggested as a remedy because this caused pain. In order to generate enough capillary attraction to draw the fluid through the cover and give a dry surface, it has been discovered that at least 20% of the fibre should be hydrophilic.

Acquisition and distributing layer: This layer imbibes the fluid, pulling it away from the source of discharge, distributing it laterally, and holding it in place for the

absorbent core to absorb since an absorbent core cannot rapidly absorb fluid. The thermally bonded air-bonded composite nonwoven is often used to create this layer [19].

Absorbent layer: There have been several compositional alterations to the fluff pulp that typically makes up the sanitary napkin's absorbent centre. For the time being, SAP is airlaid with pulp to boost absorbency. The SAP polymer is attached to tissue and positioned between the pulp and back sheet since the SAP's location might obstruct the structure's pores and limit blood absorption.

Barrier sheet: The back sheet, which typically consists of polyethylene, is a fluid-impermeable layer that stops leaks.

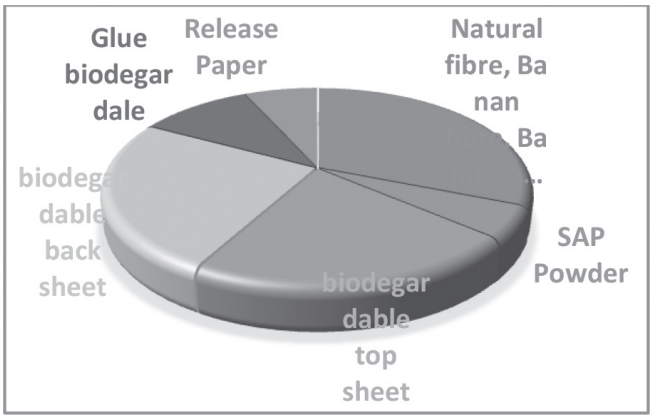

Figure 5: Compositions of present sanitary napkin

Figure 5 explains the different materials used in the present sanitary napkin in which, bamboo pulp is a healthier and more ecologically friendly product as compare to pine wood pulp. Bamboo is a naturally helpful substance that has antibacterial and bacteriostasis properties. It is especially good for usage by pregnant women, women during their periods, and newborns. Bamboo pulp has three benefits over wood pulp: it is safer and 300% more absorbent; it uses less wood; and it can be turned into compost. The environmentally friendly pads will be available by the end of the year for around the same price as ordinary pads. Polypropylene is currently being replaced in the industry together with natural fibre and biodegradable materials. The market is now moving as cheaply as it can while yet producing the finest results for environmentally friendly applications.

Sanitary napkins and their environmental impacts

Sanitary napkins, also known as menstrual pads or sanitary pads, are absorbent products used by individuals who menstruate to manage their menstrual flow. While sanitary napkins provide convenience and hygiene during menstruation, they do have certain environmental impacts. Here are some of the key environmental considerations associated with sanitary napkins:

i) Waste Generation: Sanitary napkins contribute to significant waste generation. Most pads are made from a combination of plastic materials, such as polyethylene, polypropylene, and absorbent materials like wood pulp or superabsorbent polymers. These materials take a long time to decompose and can persist in the environment for hundreds of years.

ii) Landfill Accumulation: Improper disposal of sanitary napkins leads to their accumulation in landfills. Due to their non-biodegradable nature, pads can take up valuable landfill space and contribute to long-term environmental pollution.

iii) Plastic Pollution: The plastic components present in sanitary napkins can contribute to plastic pollution when not disposed of properly. They can end up in oceans, rivers, and other water bodies, harming marine life and ecosystems. Microplastics, resulting from the breakdown of larger plastic items, are also a concern.

iv) Energy and Resource Consumption: The production of sanitary napkins involves the use of energy, water, and raw materials. The extraction and processing of these resources, as well as the manufacturing process, contribute to carbon emissions and environmental degradation.

v) Water Footprint: The production of sanitary napkins requires significant amounts of water, particularly during the cultivation of raw materials. This water consumption contributes to water scarcity issues in regions facing water stress.

vi) Chemicals and Toxins: Some sanitary napkins may contain chemicals like dioxins, furans, and pesticide residues, which are potential environmental pollutants. Moreover, the bleaching process used in pad production can release chlorine compounds, which can have harmful effects on aquatic ecosystems.

Efforts are being made to address these environmental impacts and promote more sustainable menstrual hygiene options. Some initiatives include Biodegradable and Organic Alternatives: Biodegradable and organic sanitary napkins made from plant-based materials or compostable fibers are becoming more widely available. These options aim to reduce the environmental impact associated with traditional pads. The other prions are Menstrual Cup and Reusable Cloth Pads: Menstrual cups and reusable cloth pads are gaining popularity as sustainable alternatives to disposable pads. These options produce less waste and can be used over an

extended period, reducing environmental burden. Yet another option is Education and Awareness: Promoting awareness about the environmental impact of sanitary napkins and sustainable menstrual hygiene practices can help individuals make more informed choices. Encouraging proper disposal methods and advocating for responsible consumption play crucial roles in reducing the overall impact.

Conclusion

The sanitary napkins were first used throughout the 18th and 20th centuries. The industry has undergone several innovations to expand its line of hygiene goods. After examining every article, the findings indicated that women and girls in India still don't have a good understanding of how to manage their menstrual hygiene. Teenage females avoided talking about their periods with their moms because they felt ashamed. When unsanitary products are used, dangerous illnesses can develop in the body. According to a study, women's purchasing decisions regarding sanitary pads are also influenced by their price. Because they are typically too expensive for women to afford in rural areas, the government and manufacturers should consider making sanitary pads tax-free in order to create a sustainable environment in the future. Manufacturers ought to employ raw materials that aren't harmful to the environment. It's important to note that access to affordable and sustainable menstrual hygiene products may vary depending on geographical location, economic factors, and cultural norms. Nonetheless, the development and adoption of environmentally friendly alternatives are positive steps towards mitigating the environmental impact of sanitary napkins. The research also suggested that advertising should be more creative, have better information, and should invest more in creating awareness in the society.

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CONTRIBUTION OF TEXTILES TO THE CREATION OF ECONOMIC AND ENVIRONMENTAL ASPECTS OF HEALTHCARE PRODUCTS FOR WOMENS MENSTRUAL UNDERWEAR

Category: Fiber Innovations // Natural Fibers

Title *

CONTRIBUTION OF TEXTILES TO THE CREATION OF ECONOM

Key Message *

silk non-woven fabrics from silk reeling waste and hard waste generated during twisting and weaving on a shuttle-less loom. 90% of India's silk waste exports go to China. Chinese country making nonwoven form silk fibre and

Should not be more than 3 sentences

Description *

Textiles are used nowadays for imagined applications throughout a wide range of industries. One of them is the medical sector. The medical, hygiene, and health sector are major and growing segment of the textile industry. The simultaneous development and technological advancement in the medical and textile industries is what is causing the development to occur. Applications range from a single thread stitch to intricate composite constructs for bone replacement, from a straightforward cleaning

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Arpan Kharva	The Maharaja Sayajrao Univeristy of Baroda	

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CONTRIBUTION OF TEXTILES TO THE CREATION OF ECONOMIC AND ENVIRONMENTAL ASPECTS OF HEALTHCARE PRODUCTS FOR WOMEN'S MENSTRUAL UNDERWEAR

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Abstract: *Textiles are used nowadays for imagined applications throughout a wide range of industries. One of them is the medical sector. The medical, hygiene, and health sector is a major and growing segment of the textile industry. The simultaneous development and technological advancement in the medical and textile industries is what is causing the development to occur. Applications range from a single thread stitch to intricate composite constructs for bone replacement, from a straightforward cleaning wipe to cutting-edge barrier textiles used in operating rooms. The purpose of this article is to outline the classification of medical textiles based on their intended uses and the harmonisation of the worldwide market for medical textiles. The purpose of this paper is to provide the harmonisation of the medical textiles according to their intended uses. In this paper research work on managing menstrual hygiene, particularly with menstrual underwear. The goal of this research was to construct inexpensive menstrual underwear by using eco-friendly materials.*

Keywords: *Period Panties, Menstrual Underwear*

1. Introduction

Today, everyone is focused on eliminating environmental issues and nature degradation in order to create an eco-friendly environment. In addition, maintaining good health and hygiene is crucial for humans. Consumers' heightened concern for their health and cleanliness has raised the need for antibacterial textiles, which serve two purposes: first, they protect the wearer, and second, they ensure that the textile material degrades naturally. [1]

The healthcare and hygiene industry, among other medical applications, is a significant area of textiles. The variety of products includes both disposable and non-disposable items needed in hospitals, such as surgical gowns, masks, drapes, towels, gloves, diapers for infants, sanitary napkins, and more.[2]

The production and clearance of sanitary napkins is one significant issue. The napkins made by these businesses are dangerous for women and not biodegradable. Menstrual fluid discharges are intended to be absorbed and retained by sanitary napkins. Menstrual fluid absorption and retention, stopping leaks, aesthetic look, preventing odour, staying in place, and providing a comfortable feeling are the main needs for sanitary napkins. The sanitary napkins must not only ensure a woman's comfort and safety, but also improve her lifestyle and general health. [3]

Women use these sanitary napkins for at least 20% of their lives. India is a developing nation with a population of 1.34 billion, of whom 323.6 million are females between the ages of 15 and 49. [1] In the past, when worn during menstruation, papyrus, moss, grass, and bandages could cause skin rashes, allergies, and other highly serious health issues due to the presence of microorganisms. Chemicals are also added by the manufacturers to the scented napkins, which might have negative effects on both pregnant women wearing them and their

unborn children. Here, we suggest environmentally friendly sanitary napkins by selecting alternative natural materials for production in order to get over these issues.

Today in the era of eco – friendly environment, it has become very important for human beings to live in the world of hygiene and freshness. The awareness of health and hygiene of consumers, has increased the demand for antibacterial textiles and has two functions – one protecting the wearer, and the second ensuring biodegradation of the textile material. [4] An important area of textiles is the healthcare and hygiene sector among other medical applications. The range of products includes disposable and non- disposable items such as surgical gown, mask, surgical drapes, towels, gloves, baby diapers, sanitary napkins and so on used in hospitals. Menstrual fluid discharges are intended to be absorbed and retained by sanitary napkins. Menstrual fluid absorption and retention, stopping leaks, aesthetic look, preventing odour, staying in place, and providing a comfortable feeling are the main needs for sanitary napkins. The sanitary napkins must not only ensure a woman's comfort and safety, but also improve her lifestyle and general health. [2]

The goal of the current study is to develop sanitary napkins using silk, organic cotton and corn PLA as top sheet materials and corn starch as a naturally absorbent material and barrier sheet with the poly (butylene adipate-co-terephthalate) (PBAT) and polylactide (PLA). The goal of this study is to develop the biodegradable sanitary napkins.

2. What is Women's Menstrual Underwear.

Period underwear are undergarments designed to be worn during your period to replace disposable protection products such as tampons or pads — while some women prefer to use period underwear just on lesser flow days and as a backup on heavier flow days. Period knickers are designed to look and feel like regular pants (i.e. not bulky), with extra layers and special textiles in the crotch area to absorb menstrual blood. Wash, re-wear, and wash again – these are a reusable alternative throughout the cycle.

2.1 How period panties work

Period knickers is made out of an absorbent material that can store one to two tampons' worth of flow, a moisture barrier to keep you comfortable and a layer to prevent leaks or discoloration. Still afraid to make the transition and entirely entrust your flow to knickers? Before progressing to full-time use, many users begin with milder flow days or use their period pants as backup protection.

2.2 Why make the switch to Menstrual underwear from Sanitary Napkin & Tampons?

Aside from the comfort and leak-proofing benefits, period trousers are becoming popular as an environmentally sustainable and cost-effective option. Try them if you want a solution that is less irritating than tampons, more comfortable than sanitary pads, and less messy than using a menstrual cup.

3. Materials and Methods

Menstrual Underwear construction and composition are customary. We must first comprehend the fundamental principles behind the operation of sanitary pads in order to classify the raw materials used in making them. Once we are aware of these principles, we may choose the appropriate raw materials. Menstrual underwear have a tiered construction, and each layer serves a certain purpose. The top sheet, absorbent core,barrier sheet are the three primary layers and fabric. [5]

3.1 Materials

3.1.1 Top Sheet

Top sheet: It is made to quickly transmit fluid from the top sheet to the lower layers. The top sheet contains a small amount of hydrophilic absorbent fibre to allow fluid to absorb and thermoplastic fibres to prevent capillary collapse. The top sheets that are offered for sale are made of polypropylene fibre. [7]

3.1.1.1 Organic Cotton Top sheet

ECO friendly methods and materials are used to produce organic cotton. The usage of dangerous and insistent pesticides and fertilisers is decreased with organic production techniques, while biological diversity is increased in agriculture. Establishments that provide third-party certification confirm that organic planters only employ tools and substances that are appropriate for organic farming. Organic cotton is grown without the use of synthetic fertilisers and hazardous, long-lasting insecticides. All cotton that is marketed as organic in the US must adhere to stringent regulatory standards governing cotton cultivation. [6]

Characteristics: Comfortable, soft hand, easily absorbed, retains colour, prints good, dry-cleanable and machine-washable decent strength, covers well, Simple to work with and stitch. Cotton breathes and helps remove bodily sweat by absorbing it and wicking it away from the skin thanks to its special fibre structure, which can absorb up to 2.7 times its own weight in water.

3.1.1.2 Mulberry silk Top sheet

Silk has a lovely drape, shine, and texture. Furniture and apparel are its two principal uses. From hefty brocades and velvets to medium-weight crepe and sheer chiffons, silk is very versatile and used to create a variety of materials. It can be woven or knitted. The silk waste generated during the process of converting the cocoon into fabric can be manually spun and used more effectively for the development of silk than it is currently used for in the manufacture of yarns for spun silk, noil, throwster, and carpet. Nonwoven materials with added value and a larger range of applications. It is used to make sarees, underwear, socks, shirts, evening gowns, curtains for upholstery, and sheets.

Characteristics: 100% natural, odourless, and hypoallergenic Mulberry Silk is available. Without feeling damp, it can absorb up to 30% of its weight in moisture.

3.1.1.3 Corn PLA Top sheet

Corn fibre (PLA), also known as polylactic acid fibre, is very smooth, moisture-absorbing, breathable, and naturally antimicrobial, has a mild acidity that soothes the skin, and has good heat and UV resistance. It does not at all need petroleum or other chemical raw materials, and the microorganisms in soil and seas act on its waste.

It is capable of breaking down into water and won't harm the environment. Since starch serves as the fibre's primary building block, its regeneration cycle is brief—between one and two years—and plant photosynthesis can help to lower the amount of starch in the atmosphere. The heat of combustion of PLA fibre is essentially non-existent compared to polyethylene and polypropylene, being around one-third of each. [13]

Natural and renewable plant resources are used to make PLA fibre, which lessens reliance on conventional petroleum resources and satisfies international standards for sustainable development. Since Corn fibre has numerous unique features and has different biodegradation characteristics from other fibrous materials, it has drawn a lot of interest from the global textile industry.

It features a plush feel, potent moisture absorption, breathability, and antibacterial qualities. The material is near the skin and is pure, safe, healthful, and of great quality. Other substrates can't compare to its wide range of biological attributes. Ideal base material for face masks of the highest calibre. Natural antibacterial, anti-mite, and PH values close to the skin, also referred to as a person's second skin, are present in PLA and its PLA fibres. In the medical field, polylactic acid is utilised as a cell culture medium in skin tissue engineering and can maintain the proper proliferation of skin fibroblasts. [14]

PLA is a substance that can be injected into the body and then absorbed. It has been applied to medicine for almost 30 years. Mask substrates separate some free small molecules using PLA fibres. Small molecules have a great ability to penetrate. In addition to inhibiting germs, it can also increase the skin's ability to absorb nutrients and boost the vitality and growth of the facial skin when combined with the lactic acid component of the skin. A deeper level of cleaning may be achieved by the facial skin because to the polylactic acid film cloth's strong adsorption, capacity to retain more essence, and good water absorption qualities, which allow it to absorb oil and eliminate pollutants more effectively.[15]

The polylactic acid film's porous structure allows for the passage of air and moisture, totally preserving the active ingredients in the essence, and having an excellent moisturising effect.

- Degradable
- Environmental protection and no pollution.
- Soft and skin-friendly.
- The surface of the cloth is smooth without crumbs, and the uniformity is good.
- Good ventilation performance.
- Good water absorption performance.

3.1.2 **Core Material (wood Pulp)**

Absorbency of menstrual fluid is the main need for a sanitary pad. As a result, the choice of fiber's absorbency and retention properties determines the core material entirely.

Its primary purpose is to absorb and hold the fluid and is positioned between the top sheet and barrier layer. Additionally, the absorbent core must be thin, soft, and flexible to be comfortable. The core was historically made of wood pulp but ongoing efforts are being undertaken to replace it with air-laid wood pulp and SAP to increase its absorption effectiveness. In order to prevent the absorbed liquid from retracting back, SAP transforms it into a jelly-like condition. [8,9]

The absorbent core of hygiene goods like diapers, tampons, sanitary napkins, and incontinence, all of which have a significant market share in the medical textiles, is made primarily of wood pulp. This wood pulp comes from a natural wood source that was obtained by cutting down trees, which resulted in deforestation and negative environmental repercussions. Table 1 displays the wood pulp's technical information. The development of a substitute for wood pulp is the main goal of this project.

Table 1: Technical Data of Wood pulp, Golden Isles Fluff, Grade 4881, Wood Species Southern Pine

Properties	Units	Typical Results
Fiber Length	mm	results
FQA Length Weighted mm	mm	2.4
FQA Weight Weighted mm	mm	2.8
Kajaani Length Weighted mm	mm	2.7
Kajaani Weight Weighted mm	mm	3.4
Moisture	%	8
Packaging	Units	Sizes
Roll Width	cm	25 - 152
Roll Diameter	cm	115 - 152
Core Diameter	cm	7.6

3.1.2.1 Corn Starch

A white, flavourless, and odourless powder known as corn starch is used in the creation of industrial adhesives, papermaking, food processing, and various cosmetic and oral medicinal items. It has been used to surgical gloves as a lubricant. The various aspects of starch structure are typically what govern the functional properties of starch granules, which include swelling power, starch solubility, gelatinization, retrogradation, syneresis, and rheological behaviour. Amylose and amylopectin are the chemical components of cornflour. Cornstarch and water are heated, which causes the starch granules to enlarge, become more viscous, and eventually solidify into a paste or gel.

The benefits of Corn Starch

- They help keep the skin dry.
- They help protect against skin irritation in diaper users by reducing skin wetness.
- They help prevent the spread of infections.
- They offer improved quality of life and personal dignity.

3.1.3 Barrier Sheet

It prevents leaks and discoloration of the fluid. It is a polyethylene film that is fluid-impermeable but breathable. Few sanitary pad components will fall apart and be attacked by bacteria in a public or private sewage disposal system, but barrier sheets made of polyethylene or polymeric films will remain intact since these materials are inert and do not harm the environment by being broken down by bacteria. [10]
Sustainable raw materials as an alternative to single-use hygiene products Polyethylene and polyurethane, two non-biodegradable plastics, are frequently utilised as protective film in hygiene items. Many research works on bio-plastic are in progress. Biodegradable plastic can be a Polymer blends of poly (butylene adipate-

co-terephthalate) (PBAT) and polylactide (PLA) have been drawn attention due to the application potential as hygiene barrier film. The pricey synthesis of this high molecular weight PLA, which is 5–6 times more expensive than normal plastic, is the only downside at the moment. [16]

PLA is a biopolymer that is a biodegradable plastic that is made from renewable resource (starch). It is formed through condensation polymerisation, (Loss of water molecule)

History: produced first in 1954 but was only patented. Commercially produced in the 90's, growing in numbers. Developed by Scientists from ThyssenKrupp Uhde Polymer division.

Specific use: Plastic bag, plastic containers, garbage bags, food wrap, PLA fibre in textile, automotive industry

Production: Corn Starch – individual glucose hydrolysis – fermentation with bacteria or fungi – two lactic acid monomers – Condensation polymerisation reaction

3.1.4 Fabric used

3.1.4.1 Cotton:

Cotton is completely natural and does not contain any dangerous chemicals. Natural textiles, such as cotton, are highly breathable and allow for air movement. This is a fabric that may be worn in every season. It is a very breathable fabric, making it suitable for panties. Cotton fabric is an excellent choice for regular wear. These cotton panties are ideal for everyday usage in the summer and winter.

3.1.4.2 Modal

Modal fabric is made from highly refined beech-tree pulp. It is a natural and eco-friendly type of viscose that has just begun to appear as a cotton substitute due to its extremely soft, smooth texture and moisture absorbing characteristics. Depending on the fabric's manufacturing, modal can be more breathable than cotton.

3.1.4.3 Silk

This is yet another great fabric that will make your everyday trousers look more fascinating and exotic. It feels light and weightless on your skin and sits effortlessly on it. These panties allow you to engage in any activity without discomfort. These elegant silk panties are both functional and attractive. Silk is an excellent choice for both practicality and luxury since it allows air to flow, wicks moisture away from the skin and allows it to evaporate, and is naturally hypoallergenic, anti-fungal, and anti-bacterial.

3.2 Methods

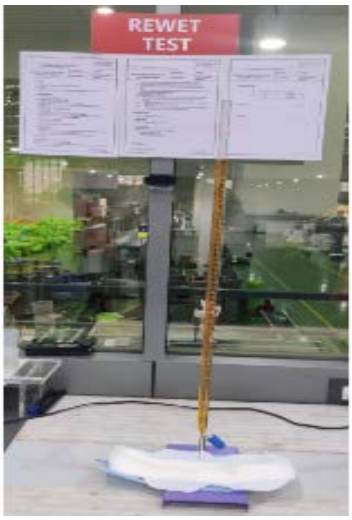
Off-line inspection performed for the measurements of the performance of the product Quality the company has established and specify the monitoring and measurement requirements (including acceptance criteria) for product /process characteristics and data generated is utilized for improved process. The test protocol has been designed on the basis of product specification including physical characteristics and performance of the product over the time of period.

Physical characteristics: Absorbency/strike through test with synthetic blood, Rewet test, Seal strength test, Peel adhesion test

The primed sanitary napkins after UV Sterilization were tested for the following properties.

2.2.1 Absorbency and Rewet Test

Check the expiration date of synthetic blood. Swirl the synthetic blood solution gently. Ensure no bubbles are formed. Calibrate the dispenser for 15ml amount = 15.35 +/- 0.05 gm. Place the pad on the stand with the body side up. Centre the surface of the funnel on the pad. Entire oblong surface of funnel must touch the specimen. Position the dispenser center to the funnel. Simultaneously start the timing device and begin dispensing the entire amount of synthetic blood into the funnel. Depress the liquid with constant flow. Do not move the funnel during all these activities. Stop the stopwatch when the liquid in the funnel reaches the end point and record the time. Remove the funnel from pad. Rinse the dispenser and the funnel with distilled water and pat dry with paper toweling after approximately one set of testing to prevent synthetic blood build up. [33]

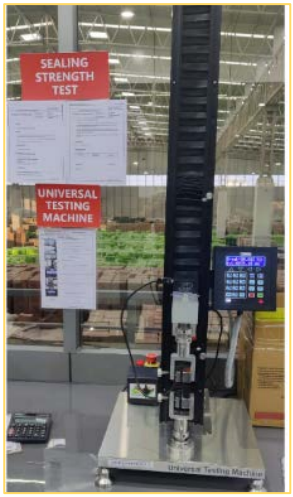


Use the same pad on which absorption test happened. Start the weighing scale. Wait until its showing Zero reading. Weigh three pieces of tissue in bi-fold condition. Note down the weight W1. Place the weighed tissue properly in the centre of the pad. Put the 5 kg metal block on centre of the tissue. Simultaneously start the stop watch. After 5 minutes, remove the metal block. Do it accurately. Weigh the tissue. Note down the weight W2. Calculate the difference W2-W1. Note down the rewet in grams.

Figure 3: Absorption and rewet test

2.2.2 Peel adhesion

Peel adhesion test is used to determine the peel strength of pad with cotton fabric. Peel adhesion measures the force required to remove a pressure sensitive adhesive from a cotton fabric or its own backing material as per D1876 standard test method. The sample was tested on Universal Testing Machine with sample size of 2 inch x 5 inch.

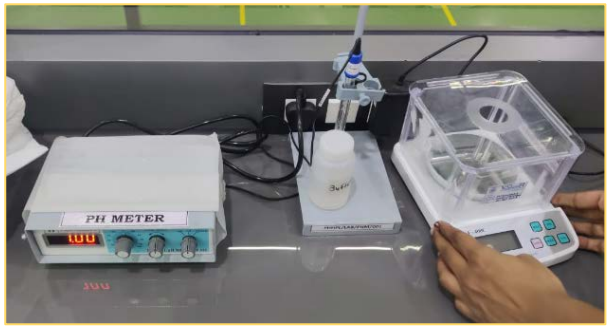


2.2.3 Seal strength

Purpose: This test is used to determine the maximum strength (peak load) of the seam of the feminine care pads. Seal strength is the tensile strength of the seal at ambient temperature, which was tested as per ASTM F88. It is the maximum force required to separate the two layers of a seal under particular conditions. The sample was tested on Universal Testing Machine with sample size of 1 inch x 2 inch.

Figure 4: Peel Adhesion tester (Universal Testing Machine)

2.2.4 pH test



Sanitary napkins should have neutral pH values; they should neither be acidic nor alkaline. For that, they are tested to determine their pH value. Testing sanitary napkins on these parameters according to IS 5405:2019 test, it can ensure purpose without leaking and without causing any discomfort. [17]

Figure 5: pH tester

4. Results and Discussion

The use of textiles in the medical, applied healthcare, and hygiene industries is a significant and expanding component of the textile industry.

“Sanitary Napkins” is known as sanitary pads, sanitary pads, sanitary towels, or maxi pads, which form an important part of the gynaecological hygiene of every woman. Sanitary Napkins are absorbent disposable single-use products designed to receive, absorb, and retain menstrual fluid and isolate them from the rest of the body. It is worn externally, between the vulva and a woman's undergarment. It is a form of a porous item that has the capability of soaking the flow of blood. Hence, menstruating women wear them during their periods. Some women also prefer using them while recovering from vaginal surgeries, childbirth, or abortion. Sanitary napkins are made by inserting an absorbent pad between fabric sheets. The technical textile component of the sanitary napkin is the non-woven fabric which prevents leakage of menstrual discharge.

3.1 Absorption and Rewet test

Table 2: Absorption and Rewet test

Sr. No	Type of Sanitary Napkins	Sample Code	Absorbency (ml)	Absorbency rate (Sec)	Rewet (gm)
A	Corn PLA Sanitary	P240	15ml	12.0	2.5
			15ml	21.0	3.4
		P290	15ml	13.5	1.5
			15ml	21.3	4.1
			15ml	33.8	5.3
B	Organic Cotton	B240	15ml	11.4	3.4
			15ml	20.8	4.1
		B290	15ml	12.1	2.8
			15ml	19.3	3.9
			15ml	25.0	6.2
C	Mulberry silk	M240	15ml	15.0	2.8
			15ml	22.0	3.5
		M290	15ml	14.5	2.4
			15ml	24	6.4
			15ml	28	6.8
D	Soft Comfort	S240	15ml	17	1.52
			15ml	22.6	5.19
		S290	15ml	15.6	1.16
			15ml	22	3.31

			15ml	27	6.3
E	Dry Comfort	D240	15ml	25.6	0.7
			15ml	40.6	3.13
		D290	15ml	20.4	0.34
			15ml	31.8	1.69
			15ml	41.2	2.3

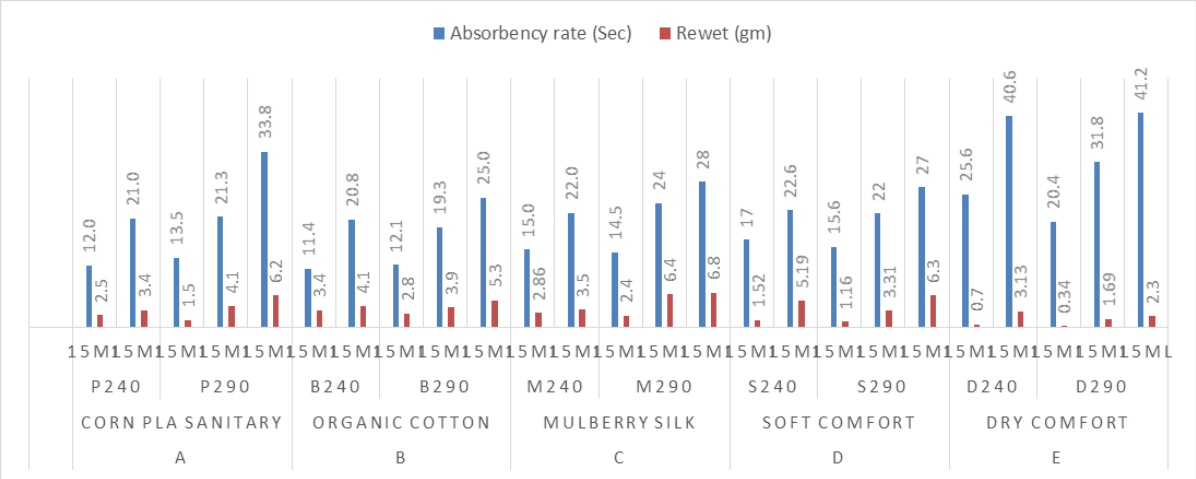


Figure 6: Absorption and Rewet test

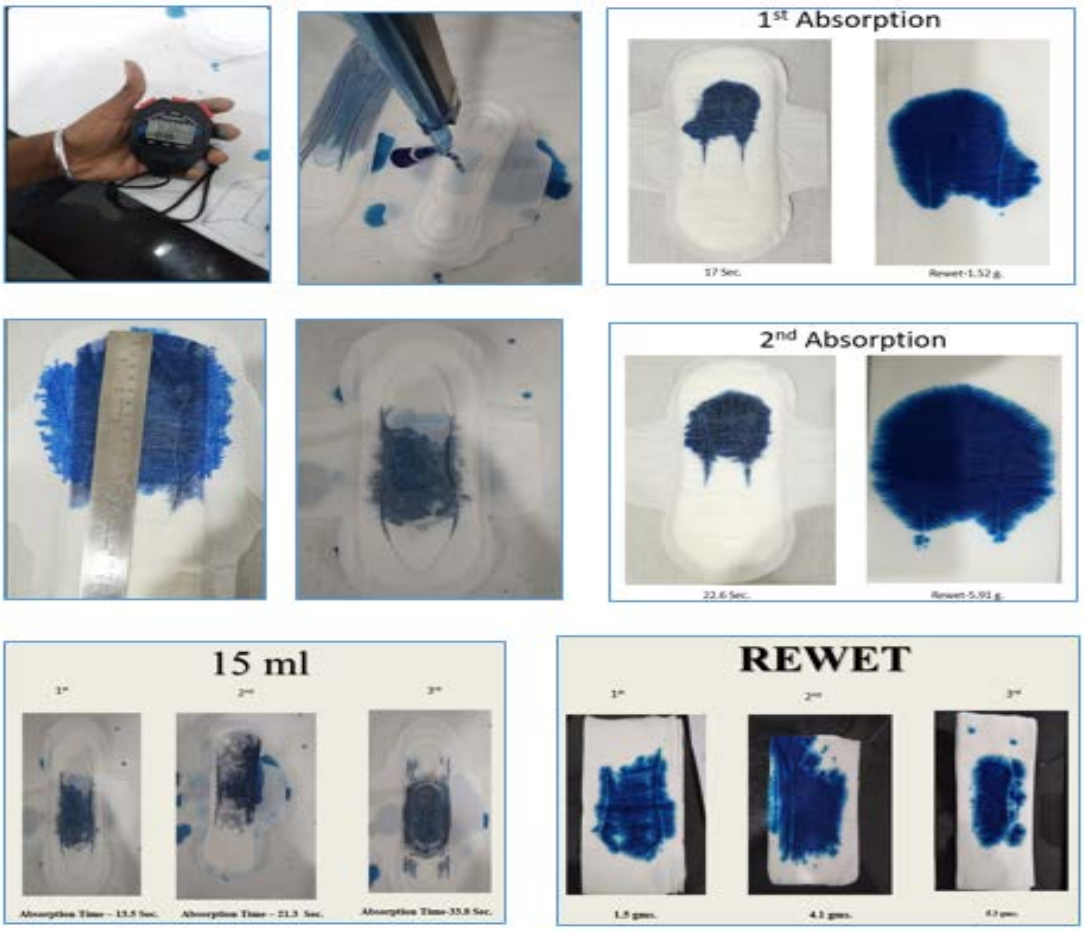


Figure 7: Absorption and rewet test images for the sanitary napkins

IS: 5405/ 1980 Absorption test method used. The sanitary napkins shall absorb 30 ml of coloured water or test fluid when flowed on to the centre of the napkin (at the rate of 15 ml per minute) and it shall not show up at the bottom or sides of the sanitary napkin, when tested according to Appendix A.

Utilizing wood pulp fibre as cake material mixed with SAP for soft comfort and dry comfort, and using wood pulp fibre as cake material combined with corn starch for Corn PLA, Organic Cotton, and Mulberry silk top sheet materials, all types of napkins were produced.

In table number 2, I've added the code name, alphabet number, and associated napkins. The time it took for various sanitary napkins to absorbed fluid ranged from 1 second to 40 seconds. The new napkins (A, B, and C types), which were produced from napkins, took the lowest amount of time—10 seconds—compared to the old napkins (D & E), which were constructed of soft comfort and dry comfort.

The top layer of the napkins is another crucial element that affects absorbency. D-Soft Comfort napkins' top sheet was spun bond. Nonwoven E-Dry Comfort napkins had top sheets made of perforated poly plastic, whereas all other napkins had top sheets made of A-Corn PLA, B-Organic Cotton, and C-Mulberry Silk.

In comparison to A, B, and C, Corn PLA, Organic Cotton, and Mulberry silk top sheet, old-made napkins D and E (soft comfort and dry comfort) have a good rewet value. This is because fluff pulp was mixed with SAP in earlier samples A and B, but corn starch was mixed with fluff pulp in more recent samples (A, B, and C). The product samples A, B, and C had a slightly slower absorption rate than samples D and E. In favour of the biodegradable samples, this is a favourable indicator. When compared to the D and E, the rewet testing results for the A, B, and C are better.

As depicted in figures 6 and 7, the sample B (Organic cotton top sheet) has a very quick rate of absorption and a low rewet value.

3.2 Peeling Adhesion Test:

Table 3: Peel Adhesion test

Sr. No	Type of Sanitary Napkins	CODE	Peel Adhesion (gf)	
			Front	Back
A	Corn PLA Sanitary	P240	120	126
		P290	140	134
B	Organic Cotton	B240	145	156
		B290	154	143
C	Mulberry silk	M240	163	168
		M290	158	154
D	Soft Comfort	S240	135	129
		S290	127	126
E	Dry Comfort	D240	129	131
		D290	120	119

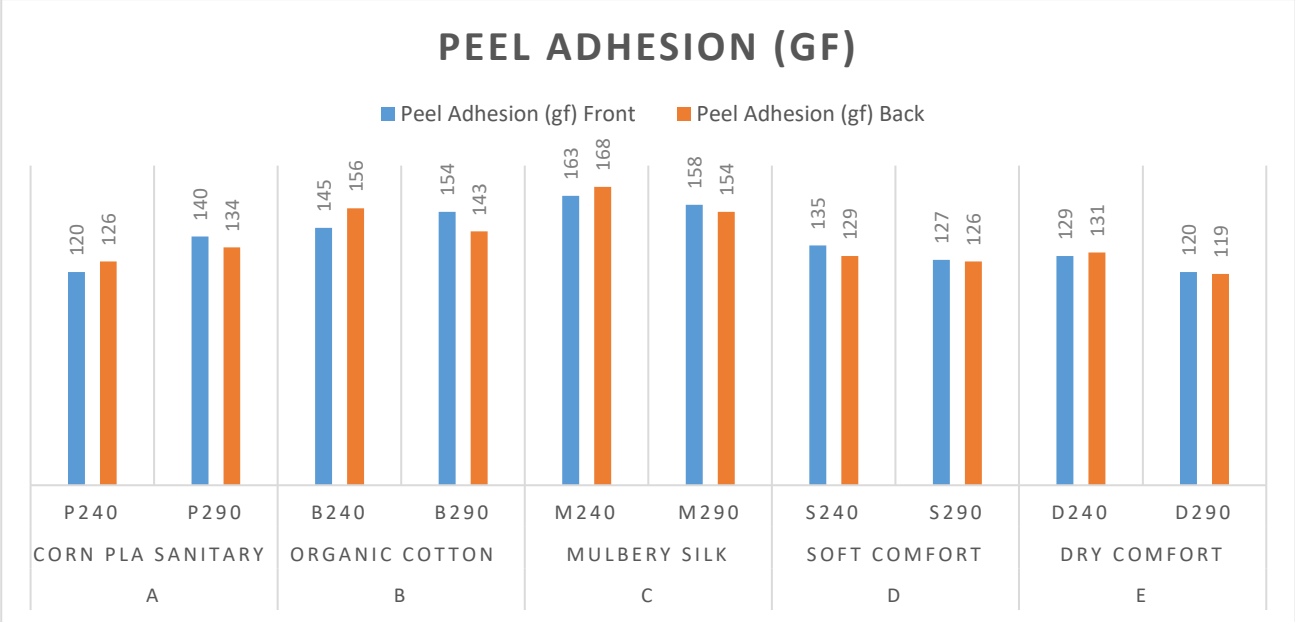


Figure 8: Peel Adhesion test

Results for the peel adhesion for several types of sanitary napkins are displayed in table 3 The peel adhesion test is used to calculate the force needed to separate two components that are adhered together. Bond strength, another name for the test result, is typically expressed as gf (force to de-bond). 1) Quality control, where the glued component must meet a minimum bond strength value, can be accomplished with the peel adhesion test. Determine the ideal pressure and temperature for adhesive curing in order to get the highest bond strength. 3. Determine how temperature, humidity, and other external factors may affect the bond strength.

According to industry standards, 80 gf to 200 gf are needed for the peel adhesion value of sanitary napkins. We analysed all of the product samples, including A, B, C, D, and E. According to figure 8, which is a graphic representation of the Peel Adhesion test findings for samples A, B, C, D, and E, test results range from 120gf to 170gf.

3.3 Seal Strength

Table 4: Seal Strength

Sr. No	Type of Sanitary Napkins	Code	Seal Strength - gms			
			Front	Back	Right side	Left Side
A	Corn PLA Sanitary	P240	368	399	376	380
		P290	244	270	255	264
B	Organic Cotton	B240	222	269	256	275
		B290	227	282	277	267
C	Mulberry silk	M240	475	508	480	505

		M290	508	510	503	514
D	Soft Comfort	S240	594.	578	425	440
		S290	642.	610	458	414
E	Dry Comfort	D240	519	535	460.	401
		D290	528	498	421	429

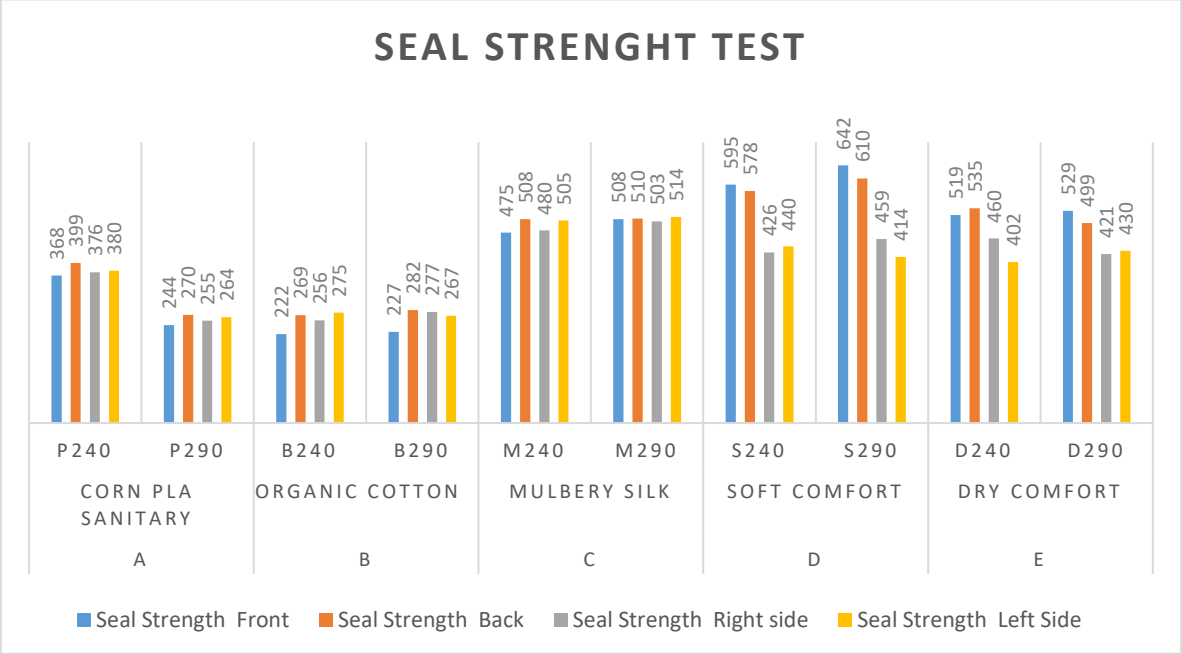


Figure 9: Seal Strength test

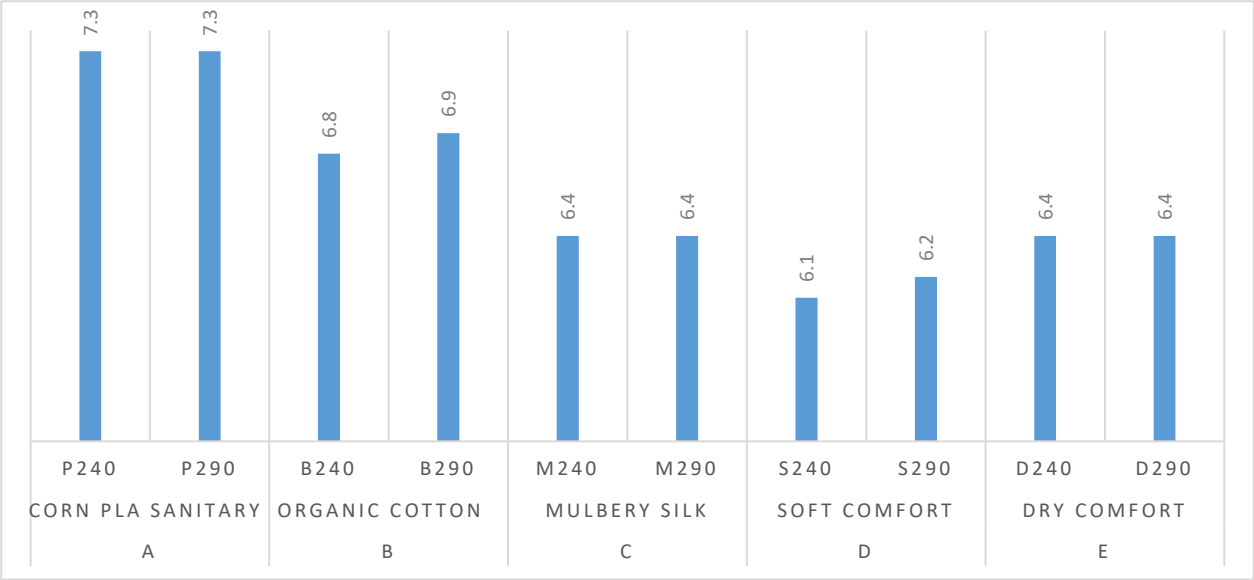
According to table 4, which displays the Seal Strength results for samples A, B, C, D, and E. The peak load (maximum strength) of the seam on the feminine care pads is ascertained by this test. The force necessary to separate the two layers is calculated using the seal strength test. According to industry standards, sanitary napkins must have a seal strength value of greater than 300 gf. We analysed all of the product samples, including A, B, C, D, and E. Figure 9 illustrates the testing findings, which range from 255gf to 505gf.

3.4 pH Test

Table 6: pH Test

Sr. No	Type of Sanitary Napkins	CODE	PH Test
A	Corn PLA Sanitary	P240	7.3
		P290	7.3
B	Organic Cotton	B240	6.8
		B290	6.9
C	Mulberry silk	M240	6.4

		M290	6.4
D	Soft Comfort	S240	6.1
		S290	6.2
E	Dry Comfort	D240	6.4
		D290	6.4



4.1.1

Figure 11: pH test

The pH of the absorbent substance must be between 6 and 8.5 when tested using the technique, and the sanitary napkin must be free of any acidic or alkali materials. According to table 6, the pH of all the napkins ranged from 6.1 to 7.3. As a result, every sanitary napkin complied with the permissible pH range, which is 6 to 8.5. As demonstrated in Figure 11, both of the napkins that were created using soft comfort materials—spun bond nonwoven and perforated poly plastic—and the dry comfort materials—organic cotton and mulberry silk top sheets—also fell within the permitted range and had pH levels that were almost identical.

5. Conclusion

Various types of period underwear, including those made from Corn PLA, organic cotton, mulberry silk, as well as materials that provide soft comfort and dry comfort, have been successfully produced using cotton, silk, and Modal. All of these samples are created using readily accessible natural materials. All the samples have shown improvement in terms of absorption, rewet return, leakage resistance, and pH value.

Among all the samples, the top sheet made of organic cotton, wood pulp fibre, and corn starch mix has demonstrated a remarkable ability to absorb quickly. The top sheet made of mulberry silk with wood pulp fibre has demonstrated the lowest rewetting rate, indicating its superior performance. Based on the results, it can be concluded that the Corn PLA and Organic cotton top sheet exhibited superior peel adhesion strength compared to the other samples.

All samples have been tested for seal strength according to the standards. Period underwear typically have a pH value ranging from 6 to 8.5 pH. It is clear that women require menstrual hygiene products. It is important to raise awareness about organic Period Underwear among the society, as the current level of awareness is less than 15%. This could potentially be a viable long-term solution for the environment. The Period Underwear samples are made from natural biodegradable materials, making them hygienic and decompose more quickly than synthetic alternatives.

Man Made Textiles in India

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Sanitary Napkins

Smart Textiles

Gaddi goat and Wool fibre

sasmira

67th YEAR OF PUBLICATION

Himalayan Nettle and Polyester

Denim Stretchability

Past and present of sanitary napkins & their characteristics

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Abstract
One of the example of a medical textile, under technical textiles, is a sanitary napkin. This article provides a succinct overview of medical textile classification. Less than 20% of Indian women use sanitary napkins, while the remaining 80% turn to shockingly uncomfortable substitutes like worn-out clothing, ashes, and husk sand. The history of sanitary napkins, their fundamental desirable features, the raw materials utilised in their production, and sanitary napkins of various levels have all been covered in this paper. Here, we've covered some key considerations regarding sanitary napkins, along with some related restrictions. It's essential to choose the proper sanitary napkin for the situation in terms of hygiene.

Keywords:
Sanitary Napkin, Sanitary Pad, Menstruation, Medical Textile, Feminine hygiene Disposable products

Introduction

Although "technical textiles" have received a lot of attention, using fibres, yarns, and fabrics for things other than clothing and furnishings is nothing new. The emerging understanding of the economic and strategic possibilities of such textiles for the production and processing of fibre and fabric in both industrialized and developing nations is something that is relatively new. Technical items (broadly defined) already compensate up to 50% of total textile manufacturing activity and production in some of the most advanced markets.

Technical textiles are defined as "textile materials and products manufactured largely for their technical and performance capabilities rather than their aesthetic or decorative attributes" in the official Textile Terms and Definitions, issued by the Textile Institute [1, 2].

Medical Textiles

The type of technical textiles which offer a variety of technical and functional properties havingapplication in the field of medical and clinical care are manufactured primarily for their technical performance & functional properties rather than their aesthetic or decorative characteristics," is how medical textiles are defined [4].

The major goal is to increase the standard of health care delivery by reducing the risk of infections and improving the quality of care delivery through disposable items[3]. The following broad categories can be used to categorise the many uses of textile materials in the medical and healthcare sectors are:

Classification of medical textiles

Nonimplantable: These are finished textile products including swabs, bandages, gauze, plasters, pressure garments, orthopaedic belts, wipes, wound dressings, etc.

Implantable: Materials that can be installed on or inside the human body are known as implantable materials. Examples include sutures, heart valves, vascular grafts, artificial veins, synthetic tendons and ligaments, joints and bones, artificial skin, artificial cartilage

Extracorporeal: These are externally placed medical equipment that assist the function of essential organs like the heart, liver, kidney, and lungs [3].

Healthcare and hygiene sector

The medical, connected healthcare, and hygiene industries are all experiencing growth in the textile business right now. The primary component of the healthcare industry is textile. Although a vast variety of items are available, they are typically utilized in operating rooms or hospital wards for the hygiene, care, and safety of employees and patients. A wide range of applications, from basic cleaning wipes to cutting-edge barrier textiles used in operating rooms, are found in the healthcare and hygiene sectors [5].

Textiles used in healthcare and hygiene applications make up the Meditech segment's textile materials. Diapers, sanitary napkins, surgical supplies, prosthetic implants, masks, PPE kits, and surgical gowns are examples of comparable healthcare and hygiene items.

Three fundamental categories can be used to group medical textile items. patient-specific, generic patient management, and procedure-specific. The patient-specific supplies included things like sponges, linens, and burn sheets. Wipes, underpads, and adult incontinence products are all marketed as patient management items. Surgical gowns, drapes, tablecloths, face masks, headwear, and shoe covers make up the third group of procedure-specific items [6].

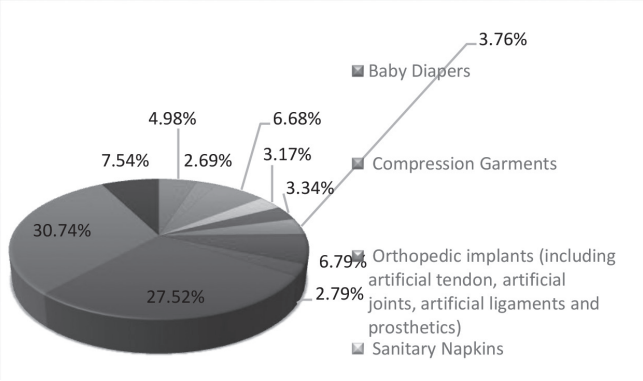

Figure 1: Contribution of Medical textile products in the domestic market

(Source: Technical Textiles, Industry in India, Opportunities and challenges, Baseline Study, 2020 [7])

Others include Extra corporeal devices and artificial kidney (dialyser)- 1.89%, Dental floss- 1.22%, Incontinence diapers- 1.14%, Heart valve0.84%, Vascular graft- 0.82%, Underpads- 0.59%, Compression stockings- 0.17%, Heart and soft tissue repair patch- 0.06%, Cotton buds- 0.04%, Eyepads (TT component)- 0.01%, and Miscellaneous items- 0.76%

Surgical dressings (30.74%) constituted the largest share of the Indian Meditech market in 2019-20, followed by surgical sutures at 27.52%

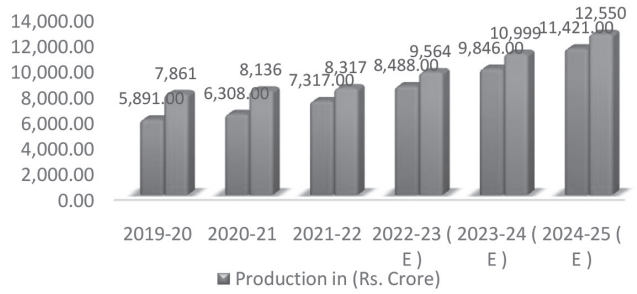

Figure 2: Production and Consumption of Medical textile segment in the domestic market

(Source: Technical Textiles, Industry in India, Opportunities and challenges, Baseline Study, 2020 [7])

Data about the contribution of Medical textile products in the domestic marketand the production and consumption of the medical textile segments are depicted in the figure 1 and 2. Production is only slightly below consumption in the Indian market. India is a net importer and in the following five years, the difference between production and consumption is anticipated to widen [7]. The third and largest group of healthcare and hygiene product manufacturers has mostly been served by an unorganized sector of producers. Due to their production of disposable hygiene products, MNCs like Johnson & Johnson, P&G, Kimberly Clark, and Unicharm are the key players in this industry. Manufacturers of textiles for medical purposes are aware of the difficulties and the necessity to find innovative, economically viable solutions for environmental issues [8].

Sanitary napkins

Sanitary napkins, sometimes referred to as sanitary pads, sanitary towels, or maxi pads, are an essential component of every woman's gynecological hygiene. Sanitary napkins are disposable, single-use absorbent materials that are intended to collect, hold, and separate menstruation fluid from the rest of the body. Between the vulva and a woman's undergarment, it is worn externally [9]. It is a type of porous object with the capacity to sponge up blood flow. Therefore, they are worn by menstrual women throughout their periods. While recuperating from vaginal surgery, childbirth or abortion, some women favor using them. By sandwiching an absorbent pad between two fabric sheets, sanitary napkins are created. The non-woven fabric that stops menstrual fluid from leaking is the technical textile component of the sanitary napkin. [10]

International corporations including Procter and Gamble, Johnson and Johnson Ltd., and Kimberly Clark Lever Pvt.

Ltd. have so far controlled the sanitary napkin business in India. In the recent years, Indian manufacturers have also entered this market. The market for sanitary napkins is dominated by brands like Whisper from Procter & Gamble and Stayfree and Carefree from Johnson & Johnson Ltd. Kotex and Shapers from Gufic Biosciences and Kimberly Clark Lever each own a portion of the remaining market.

Procter & Gamble, Hengan International Group Company Limited, Kimberly-Clark Corporation, Edgewell Personal Care Company, and Kao Corporation are a few of the key participants on a global scale.

A recent research by Research andMarkets titled "Global Feminine Hygiene Products Market (2021 to 2027)" predicts that the market for feminine hygiene products will generate US$38.9 billion in revenue by the year 2020. The expected global sale of feminine hygiene products in 2030, according to this report, will be US$68.7 billion registering a 6.1% CAGR between 2021 and 2030 [11].

History of sanitary napkins

As early as the 10th century in Ancient Greece, a lady is reported to have thrown one of her old menstruation rags at an admirer in an effort to get rid of him, which is when the first mention of menstrual pads in history occurs [12]. Most women used rags, cotton, or sheep's wool in their underwear to stop the flow of menstrual blood until the invention of the disposable pad. Women handled their periods with grass, knitted pads, and even rabbit fur.

Intrepid develops a large range of patented devices in the middle of the 18th century, including catamenial sacks, bandages, and flaps, elastic straps, valves, and girdles. When the Comstock Act was passed in the United States in 1873, the phrase "feminine hygiene" was first used by the birth control business. The first commercial sanitary pad produced by J&J, Lister's Towels, went on sale at the turn of the 20th century, in 1896 [13]. During the Second World War, nurses in France discovered that cellulose bandages, which troops used, were significantly superior at absorbing blood than ordinary cotton. The earliest pads, according to their current flow, were created by French nurses using bandages composed of wood pulp. It was inexpensive and very absorbent; after usage, it was discarded.

KCC developed the cotton and texture combination around the start of the nineteenth century, creating the disposable pads. They had a Kotex on their head, according to Kimberly Clark. It is advised that customers refrain from using the word "menstruation". J&J launched comparable goods made by Medess in 1927 [13]. In 1940, the Modess Print campaign was unveiled and transformed into menstrual advertisement as a display of high fashion and fashion photography. Numerous American women in the early 20th century used handmade pads, frequently constructed from "bird's eye," the same absorbent cotton fabric used for infant diapers. These fabrics or rags would be pinned to their handmade muslin belts or undergarments. The first continuous birth control pill, which simultaneously suppresses periods and offers birth control, received FDA approval in 2003. Only four menstrual cycles occur annually for women using seasonal.

In 2007the FDA approvedLybrel, the first birth control medication that stops periods. Nevertheless, the website openly acknowledges that "menstrual cramps and vaginal bleeding" may be experienced by women. Even sanitary napkins were available in the past, but because they are expensive for most women, they continued to use the traditional way. Women were permitted to leave money in the box when they could do so without speaking to the person and collect the KOTEX pad napkin box from the front desk alone. Before disposable sanitary pads are widely used, these items must be around for a while [13].

In the past, disposable sanitary napkins were coated with an absorbent lining and made of cotton, wool, or a similar fibrous material. The pad's front and rear sides have an extended shape that allows it to pass through the loops of a specific belt used below undergarments. The future position of this design was notorious for shifting backward and forward [14]. Later, an adhesive strip was added to the back of the sanitary pad to make it easier for women to glue them to their underwear. Thank heavens, belted sanitary napkins quickly disappeared in 1980 [13-16].

The sanitary napkin manufacturing business has made great strides in research over the past two decades. The days of hefty pads and long belts are over. The development of extremely absorbent fabrics and enhanced designs has made sanitary napkins more comfy and useful than before. The development of "wings" secures the pad in the undergarments, and the prepared "scented pads" lessen smells. The most common method of the menstrual cycle is using sanitary napkins, especially in underdeveloped nations.

Structure of conventional sanitary napkins

A sanitary napkin consists of the following four essential parts: three layers: the top sheet, the core (an absorbent structure), and the underneath adhesive layer. The fundamental design of sanitary napkins is shown in Figure 3. It is made up of an absorbent layer, an upper sheet layer that lets organic fluids pass through, and a bottom sticky layer that provides structural support.

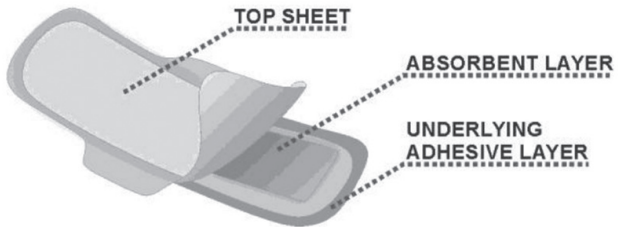

Figure 3: Conventional design of sanitary napkin

Composition of conventional sanitary napkins

More than 70% of the weight of earlier sanitary napkins was made up of fluff pulp, which is responsible for distributing liquids throughout the length of the pad. As a result, fluff pulp is a crucial and critical component of the creation of sanitary napkins. This paper uses the average percentage of raw materials utilised in the product as an example. In terms of material composition, the table 1 and figure 4 shows the typical sanitary napkin has 43% fluff pulp, 35% PE, PP, and PET, 7% adhesives, 3% SAP Powder, 9% glue, and 3% release paper [17].

Table 1: Sanitary napkin compositions

Sr. No	Components	%Component in Sanitary pads
1	Fluff pulp	43
2	Super absorbent polymer	6
3	Polypropylene and Polyethylene	36
4	Adhesives	7
5	Release paper	3

Source: Edana (2008)

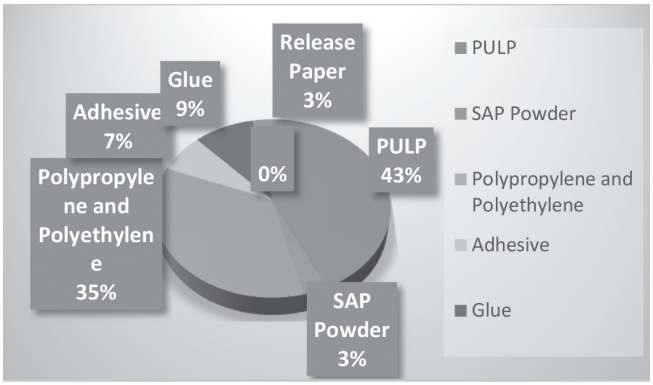

Figure 4: Percentage composition of the components in Conventional Sanitary Pads

Conventional sanitary napkins include chemicals in them that can hurt and irritate the area around the vagina, resulting in infections, rashes, and allergic reactions [18, 19]. Many sanitary napkins back in the day included chlorine, which can cause cervical cancer. Additionally, the most widely used sanitary napkins are non-biodegradable and environmentally harmful due to their almost 90% plastic content [20]. Market-available conventional sanitary pads include a lot of plastic. The majority of women all over the world use these sanitary napkins for at least 4-6 days per month. The statistics provided above indicates that a significant volume of plastic garbage is produced each month on the international market. Since sanitary pads are made of non-biodegradable plastic, they can pose risks to human health and the environment and can take 600–800 years to breakdown in the soil [21].

One woman will use between 7,000 and 17,000 sanitary napkins throughout her lifetime, or around 7 years' worth, depending on the length of her menstrual cycle [20]. In India, 64.4% of women between the ages of 15 and 24 use sanitary napkins, followed by 49.6% who use cloth, 15% who use locally produced napkins, and only 0.3% who use menstruation cups.

The most crucial raw ingredient is Fluff-pulp, which is produced from pure cellulose fibres and is found in cold mountain areas of North and Central America, Europe, and northern Africa. These soft woods include spruce, pine, fir, larch, and hemlock. Since India lacks access to the fluff pulp needed to produce high-quality sanitary napkins, Indian producers must rely on imports, which come with import charges of up to 10% and IGST, which raises the price of the finished product. Softwood fibers measure around 30 µm in breadth and 3 mm in length. The sector now has ambitions to transform the imported raw materials into products that are easily accessible on the Asian market.

Structure of reusable sanitary napkin

Design of Resusable Cloth - sanitary napkin

A reusable sanitary napkin, made up of cotton, cotton flannel, or cotton fleece at the top layer. A thick fabric, like an old towel, in the center of your cloth pad (core). These materials are not only incredibly soft and stain-resistant, but they also have a thin wicking quality that draws moisture into the inner absorbent layers, keeping the layer against your skin dry. The pads have a bottom layer of PUL fabric to add a waterproof layer. This makes the pad waterproof, though breathable. The laminated

surface is on the inside of the pad, so it does not come in contact with the skin.

Advantages of Reusable textile component for the Sanitary Napkins

Reusable pads are advantageous in many other ways in addition to making sense from a sustainability and environmental perspective. Comfortable, skin breathes permanently; no moisture build-up, no unpleasant odors or plastic rustling, design designed for maximum protection, Easy to use/wash, eco-friendly, economical and chemical-free

Basic desired properties considerations in the sanitary napkins

- Comfortable to wear,
- Hygienic
- No Leakage,
- No noise,
- No odour,
- No anaesthetic appearance or colour,
- Stay in place

Quality requirements of sanitary napkins as per BIS

This standard establishes the prerequisite for sanitary napkins for exterior usage. Absorbency, the capacity to sustain pressure following adsorption, disposability, and pH value are only a few of the significant performance characteristics mentioned in the standard.

BIS IS 5405: Testing of Sanitary Napkins: This standard specifies the requirements and test methods for disposable sanitary napkins. It covers parameters such as dimensions, absorbency, rewet properties, pH value, odor control, and packaging requirements.

BIS IS 10910: Testing of Sanitary Napkins (Part 1 and Part 2): This standard provides specific test methods for assessing the absorbency, rewet properties, and liquid retention capacity of sanitary napkins.

BIS IS 15223: Testing of Sanitary Napkins: This standard outlines the test methods for determining the pH value of the absorbent core of sanitary napkins.

Absorbency

The hygienic tissues when lowered in the center of the sanitary napkin (at a rate of 15 ml per minute), it must absorb 30 ml of synthetic blood and not discolour or leak through at the bottom of the napkin.

pH Value

Acids and alkalis must not be present in the sanitary napkin, and the absorbent material's pH must range from 6 to 8.5.

Disposability

The covering of a disposable sanitary pad must be removed before it is submerged in 15 litres of water and agitated. The pad must dissolve in the water in less than five minutes.

Standard size of sanitary napkins

Below are specifications for the sanitary pad's standard size.

Width	:70 mm
Length	: 190 mm
Thickness	: 8 mm or more
Weight	: 6 gm

A sanitary napkin typically measures around 245 millimetres, or 9.65 inches, in length. The average width is around 6.30 inches, or 160 millimetres. Although it might vary, the thickness is typically close to 3 millimetres (0.12 inch). While certain pads could be larger or smaller than this, they are still quite close to these dimensions.

Selection of suitable design

Think about the many brands, sizes, styles, and thicknesses on the market. To prevent leaking, the vulva and female genital region must be covered by the sanitary napkin. A size 6 panty size match with a hip and waist measurement is usually supported by pad designs. For complete covering of bigger pant sizes, choose a Large, Extra Large, or overnight protection.

Select a shape or design

With or without wings, and curved or contoured to avoid leakage on the sides, sanitary napkins are selected based on women's lifestyles.

Consider the absorbency rate

The absorbency level should be increased.

Thickness for comfort

Identify the ideal thickness for any type of physical activity. While some people like extensive padding, others choose lightweight cushions to meet their demands without adding bulk.

Best support system for preventing slippage

Find the ideal support setup to stop pad sliding. The napkin is held in place within the panty by wrap-around wings

and adhesive strips on the pad's bottom. After exercise or after being exposed to other constant movement or wetness, such as sweat, observe how long a napkin's support lasts.

Characteristics of Ideal sanitary napkins / choosing the right Sanitary Napkins

Air Permeable

The skin of a woman's sensitive portion is at its most vulnerable during menstruation. According to surveys, 73% of women experience itching and soreness in certain areas of their skin during their period. The usage of sanitary pads, which are not air-permeable, was largely to blame for this. The use of sanitary napkins that are not air permeable is the main cause of this. To guarantee safety, appropriate sanitary napkins are used during menstruation. The top sheet, absorbent core, and back sheet are the three layers that typically make up sanitary pads. The selection of sanitary napkins is based on factors related to the composition and use of raw materials.

Surface Layer Consideration

To prevent the wet skein surface, the top sheet should have a cotton net surface with quick absorption. The discharge absorbed would not readily backflow to the top surface, making the funnel type of design superior to the bucket type. Some sanitary napkins on the market contain artificial fibre as the primary material for the surface, which might cause allergic reactions in some women.

Absorbency Layer

Effective absorption agents that can transform the discharge of absorbed liquid into a jelly-like condition should be present in the intermediate layer so that it won't backflow when squeezed and won't feel sticky. Avoid utilising recycled paper pulp as absorbency agents; some women with sensitive skin may experience discomfort from such products.

Underlying Layer

To allow for the migration of water molecules in the gaseous form, the bottom layer should be constructed of air-permeable materials. These items keep damp air at bay and effectively minimise heat and moisture between sanitary napkins and the body, leaving a dry and revitalising sensation.

Performance characteristics of sanitary napkins

The three components (top sheet, absorbent cake material, and back sheet) are exposed to synthetic blood, and the absorbent cake material is the primary element influencing how well sanitary napkins operate. Synthetic blood is passed through each layer of the sanitary pad in order to better understand the sanitary napkin's operating concept [23].

Artificial blood contacts the top sheet vertically and travels along the acquisition layer's length to the absorbent layer without distributing it. Synthetic blood spreads and may retain once it contacts the absorbent cake substance without changing the flow direction [17].

The boundary between the acquisition layer and the absorbent layer is the main challenge with sanitary napkins. Since the hydrophobic fibres used to create the acquisition layer and the absorbent layer are both hydrophobic, fluid must move from the acquisition layer to the absorbing layer with ease. The movement of fluid between two layers is challenging if there is little room between them. Any void will cause the flow pattern to shift, and spilling liquid might cause the product to malfunction.

The bulk of sanitary napkins use core absorbent materials and fluffed cellulose pulp. Crossed cellulosic boards are crushed to create this fluff. There is always a potential that portion of the unopened board may remain, giving the absorbent material some variability. Therefore, there is a possibility that the region will have unequal fluid flow and fluid retention.

Fluid retention capability or the volume of fluid retained after applying pressure can be used to predict how sanitary napkins will perform. Density is one element that interferes with the fluid holding. Both compacted and uncompacted kinds of super absorbent fibre are utilised to make the new generation commercial sanitary napkins. Density has a deliberate impact on the product's absorption and stability. While a fibre that has been loosely compressed will fail due to absorption, a fibre that has been tightly crushed will maximise absorption. Therefore, the absorbent core material must be strong in order to preserve its structural integrity.

Choice of raw material

Fluid transfer layer: To move fluid from the top cover to the immediate secondary layer, there is a top sheet layer. For comfort, good sanitary napkins should be dry. Cellulosic substance was used in the multilayer sanitary napkins of the past. Fluid tended to stay at or near the surface until the synthetic blood had fallen [12]. Using thermoplastic fibre has been suggested as a remedy because this caused pain. In order to generate enough capillary attraction to draw the fluid through the cover and give a dry surface, it has been discovered that at least 20% of the fibre should be hydrophilic.

Acquisition and distributing layer: This layer imbibes the fluid, pulling it away from the source of discharge, distributing it laterally, and holding it in place for the

absorbent core to absorb since an absorbent core cannot rapidly absorb fluid. The thermally bonded air-bonded composite nonwoven is often used to create this layer [19].

Absorbent layer: There have been several compositional alterations to the fluff pulp that typically makes up the sanitary napkin's absorbent centre. For the time being, SAP is airlaid with pulp to boost absorbency. The SAP polymer is attached to tissue and positioned between the pulp and back sheet since the SAP's location might obstruct the structure's pores and limit blood absorption.

Barrier sheet: The back sheet, which typically consists of polyethylene, is a fluid-impermeable layer that stops leaks.

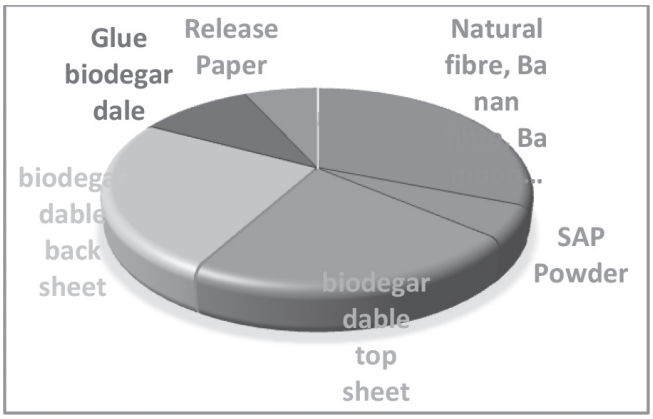

Figure 5: Compositions of present sanitary napkin

Figure 5 explains the different materials used in the present sanitary napkin in which, bamboo pulp is a healthier and more ecologically friendly product as compare to pine wood pulp. Bamboo is a naturally helpful substance that has antibacterial and bacteriostasis properties. It is especially good for usage by pregnant women, women during their periods, and newborns. Bamboo pulp has three benefits over wood pulp: it is safer and 300% more absorbent; it uses less wood; and it can be turned into compost. The environmentally friendly pads will be available by the end of the year for around the same price as ordinary pads. Polypropylene is currently being replaced in the industry together with natural fibre and biodegradable materials. The market is now moving as cheaply as it can while yet producing the finest results for environmentally friendly applications.

Sanitary napkins and their environmental impacts

Sanitary napkins, also known as menstrual pads or sanitary pads, are absorbent products used by individuals who menstruate to manage their menstrual flow. While sanitary napkins provide convenience and hygiene during menstruation, they do have certain environmental impacts. Here are some of the key environmental considerations associated with sanitary napkins:

i) Waste Generation: Sanitary napkins contribute to significant waste generation. Most pads are made from a combination of plastic materials, such as polyethylene, polypropylene, and absorbent materials like wood pulp or superabsorbent polymers. These materials take a long time to decompose and can persist in the environment for hundreds of years.

ii) Landfill Accumulation: Improper disposal of sanitary napkins leads to their accumulation in landfills. Due to their non-biodegradable nature, pads can take up valuable landfill space and contribute to long-term environmental pollution.

iii) Plastic Pollution: The plastic components present in sanitary napkins can contribute to plastic pollution when not disposed of properly. They can end up in oceans, rivers, and other water bodies, harming marine life and ecosystems. Microplastics, resulting from the breakdown of larger plastic items, are also a concern.

iv) Energy and Resource Consumption: The production of sanitary napkins involves the use of energy, water, and raw materials. The extraction and processing of these resources, as well as the manufacturing process, contribute to carbon emissions and environmental degradation.

v) Water Footprint: The production of sanitary napkins requires significant amounts of water, particularly during the cultivation of raw materials. This water consumption contributes to water scarcity issues in regions facing water stress.

vi) Chemicals and Toxins: Some sanitary napkins may contain chemicals like dioxins, furans, and pesticide residues, which are potential environmental pollutants. Moreover, the bleaching process used in pad production can release chlorine compounds, which can have harmful effects on aquatic ecosystems.

Efforts are being made to address these environmental impacts and promote more sustainable menstrual hygiene options. Some initiatives include Biodegradable and Organic Alternatives: Biodegradable and organic sanitary napkins made from plant-based materials or compostable fibers are becoming more widely available. These options aim to reduce the environmental impact associated with traditional pads. The other prions are Menstrual Cup and Reusable Cloth Pads: Menstrual cups and reusable cloth pads are gaining popularity as sustainable alternatives to disposable pads. These options produce less waste and can be used over an

extended period, reducing environmental burden. Yet another option is Education and Awareness: Promoting awareness about the environmental impact of sanitary napkins and sustainable menstrual hygiene practices can help individuals make more informed choices. Encouraging proper disposal methods and advocating for responsible consumption play crucial roles in reducing the overall impact.

Conclusion

The sanitary napkins were first used throughout the 18th and 20th centuries. The industry has undergone several innovations to expand its line of hygiene goods. After examining every article, the findings indicated that women and girls in India still don't have a good understanding of how to manage their menstrual hygiene. Teenage females avoided talking about their periods with their moms because they felt ashamed. When unsanitary products are used, dangerous illnesses can develop in the body. According to a study, women's purchasing decisions regarding sanitary pads are also influenced by their price. Because they are typically too expensive for women to afford in rural areas, the government and manufacturers should consider making sanitary pads tax-free in order to create a sustainable environment in the future. Manufacturers ought to employ raw materials that aren't harmful to the environment. It's important to note that access to affordable and sustainable menstrual hygiene products may vary depending on geographical location, economic factors, and cultural norms. Nonetheless, the development and adoption of environmentally friendly alternatives are positive steps towards mitigating the environmental impact of sanitary napkins. The research also suggested that advertising should be more creative, have better information, and should invest more in creating awareness in the society.

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CONTRIBUTION OF TEXTILES TO THE CREATION OF ECONOMIC AND ENVIRONMENTAL ASPECTS OF HEALTHCARE PRODUCTS FOR WOMENS MENSTRUAL UNDERWEAR

Category: Fiber Innovations // Natural Fibers

Title *

CONTRIBUTION OF TEXTILES TO THE CREATION OF ECONOM

Key Message *

silk non-woven fabrics from silk reeling waste and hard waste generated during twisting and weaving on a shuttle-less loom. 90% of India's silk waste exports go to China. Chinese country making nonwoven form silk fibre and

Should not be more than 3 sentences

Description *

Textiles are used nowadays for imagined applications throughout a wide range of industries. One of them is the medical sector. The medical, hygiene, and health sector are major and growing segment of the textile industry. The simultaneous development and technological advancement in the medical and textile industries is what is causing the development to occur. Applications range from a single thread stitch to intricate composite constructs for bone replacement, from a straightforward cleaning

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CONTRIBUTION OF TEXTILES TO THE CREATION OF ECONOMIC AND ENVIRONMENTAL ASPECTS OF HEALTHCARE PRODUCTS FOR WOMEN'S MENSTRUAL UNDERWEAR

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Abstract: *Textiles are used nowadays for imagined applications throughout a wide range of industries. One of them is the medical sector. The medical, hygiene, and health sector is a major and growing segment of the textile industry. The simultaneous development and technological advancement in the medical and textile industries is what is causing the development to occur. Applications range from a single thread stitch to intricate composite constructs for bone replacement, from a straightforward cleaning wipe to cutting-edge barrier textiles used in operating rooms. The purpose of this article is to outline the classification of medical textiles based on their intended uses and the harmonisation of the worldwide market for medical textiles. The purpose of this paper is to provide the harmonisation of the medical textiles according to their intended uses. In this paper research work on managing menstrual hygiene, particularly with menstrual underwear. The goal of this research was to construct inexpensive menstrual underwear by using eco-friendly materials.*

Keywords: *Period Panties, Menstrual Underwear*

1. Introduction

Today, everyone is focused on eliminating environmental issues and nature degradation in order to create an eco-friendly environment. In addition, maintaining good health and hygiene is crucial for humans. Consumers' heightened concern for their health and cleanliness has raised the need for antibacterial textiles, which serve two purposes: first, they protect the wearer, and second, they ensure that the textile material degrades naturally. [1]

The healthcare and hygiene industry, among other medical applications, is a significant area of textiles. The variety of products includes both disposable and non-disposable items needed in hospitals, such as surgical gowns, masks, drapes, towels, gloves, diapers for infants, sanitary napkins, and more.[2]

The production and clearance of sanitary napkins is one significant issue. The napkins made by these businesses are dangerous for women and not biodegradable. Menstrual fluid discharges are intended to be absorbed and retained by sanitary napkins. Menstrual fluid absorption and retention, stopping leaks, aesthetic look, preventing odour, staying in place, and providing a comfortable feeling are the main needs for sanitary napkins. The sanitary napkins must not only ensure a woman's comfort and safety, but also improve her lifestyle and general health. [3]

Women use these sanitary napkins for at least 20% of their lives. India is a developing nation with a population of 1.34 billion, of whom 323.6 million are females between the ages of 15 and 49. [1] In the past, when worn during menstruation, papyrus, moss, grass, and bandages could cause skin rashes, allergies, and other highly serious health issues due to the presence of microorganisms. Chemicals are also added by the manufacturers to the scented napkins, which might have negative effects on both pregnant women wearing them and their

unborn children. Here, we suggest environmentally friendly sanitary napkins by selecting alternative natural materials for production in order to get over these issues.

Today in the era of eco – friendly environment, it has become very important for human beings to live in the world of hygiene and freshness. The awareness of health and hygiene of consumers, has increased the demand for antibacterial textiles and has two functions – one protecting the wearer, and the second ensuring biodegradation of the textile material. [4] An important area of textiles is the healthcare and hygiene sector among other medical applications. The range of products includes disposable and non- disposable items such as surgical gown, mask, surgical drapes, towels, gloves, baby diapers, sanitary napkins and so on used in hospitals. Menstrual fluid discharges are intended to be absorbed and retained by sanitary napkins. Menstrual fluid absorption and retention, stopping leaks, aesthetic look, preventing odour, staying in place, and providing a comfortable feeling are the main needs for sanitary napkins. The sanitary napkins must not only ensure a woman's comfort and safety, but also improve her lifestyle and general health. [2]

The goal of the current study is to develop sanitary napkins using silk, organic cotton and corn PLA as top sheet materials and corn starch as a naturally absorbent material and barrier sheet with the poly (butylene adipate-co-terephthalate) (PBAT) and polylactide (PLA). The goal of this study is to develop the biodegradable sanitary napkins.

2. What is Women's Menstrual Underwear.

Period underwear are undergarments designed to be worn during your period to replace disposable protection products such as tampons or pads — while some women prefer to use period underwear just on lesser flow days and as a backup on heavier flow days. Period knickers are designed to look and feel like regular pants (i.e. not bulky), with extra layers and special textiles in the crotch area to absorb menstrual blood. Wash, re-wear, and wash again – these are a reusable alternative throughout the cycle.

2.1 How period panties work

Period knickers is made out of an absorbent material that can store one to two tampons' worth of flow, a moisture barrier to keep you comfortable and a layer to prevent leaks or discoloration. Still afraid to make the transition and entirely entrust your flow to knickers? Before progressing to full-time use, many users begin with milder flow days or use their period pants as backup protection.

2.2 Why make the switch to Menstrual underwear from Sanitary Napkin & Tampons?

Aside from the comfort and leak-proofing benefits, period trousers are becoming popular as an environmentally sustainable and cost-effective option. Try them if you want a solution that is less irritating than tampons, more comfortable than sanitary pads, and less messy than using a menstrual cup.

3. Materials and Methods

Menstrual Underwear construction and composition are customary. We must first comprehend the fundamental principles behind the operation of sanitary pads in order to classify the raw materials used in making them. Once we are aware of these principles, we may choose the appropriate raw materials. Menstrual underwear have a tiered construction, and each layer serves a certain purpose. The top sheet, absorbent core,barrier sheet are the three primary layers and fabric. [5]

3.1 Materials

3.1.1 Top Sheet

Top sheet: It is made to quickly transmit fluid from the top sheet to the lower layers. The top sheet contains a small amount of hydrophilic absorbent fibre to allow fluid to absorb and thermoplastic fibres to prevent capillary collapse. The top sheets that are offered for sale are made of polypropylene fibre. [7]

3.1.1.1 Organic Cotton Top sheet

ECO friendly methods and materials are used to produce organic cotton. The usage of dangerous and insistent pesticides and fertilisers is decreased with organic production techniques, while biological diversity is increased in agriculture. Establishments that provide third-party certification confirm that organic planters only employ tools and substances that are appropriate for organic farming. Organic cotton is grown without the use of synthetic fertilisers and hazardous, long-lasting insecticides. All cotton that is marketed as organic in the US must adhere to stringent regulatory standards governing cotton cultivation. [6]

Characteristics: Comfortable, soft hand, easily absorbed, retains colour, prints good, dry-cleanable and machine-washable decent strength, covers well, Simple to work with and stitch. Cotton breathes and helps remove bodily sweat by absorbing it and wicking it away from the skin thanks to its special fibre structure, which can absorb up to 2.7 times its own weight in water.

3.1.1.2 Mulberry silk Top sheet

Silk has a lovely drape, shine, and texture. Furniture and apparel are its two principal uses. From hefty brocades and velvets to medium-weight crepe and sheer chiffons, silk is very versatile and used to create a variety of materials. It can be woven or knitted. The silk waste generated during the process of converting the cocoon into fabric can be manually spun and used more effectively for the development of silk than it is currently used for in the manufacture of yarns for spun silk, noil, throwster, and carpet. Nonwoven materials with added value and a larger range of applications. It is used to make sarees, underwear, socks, shirts, evening gowns, curtains for upholstery, and sheets.

Characteristics: 100% natural, odourless, and hypoallergenic Mulberry Silk is available. Without feeling damp, it can absorb up to 30% of its weight in moisture.

3.1.1.3 Corn PLA Top sheet

Corn fibre (PLA), also known as polylactic acid fibre, is very smooth, moisture-absorbing, breathable, and naturally antimicrobial, has a mild acidity that soothes the skin, and has good heat and UV resistance. It does not at all need petroleum or other chemical raw materials, and the microorganisms in soil and seas act on its waste.

It is capable of breaking down into water and won't harm the environment. Since starch serves as the fibre's primary building block, its regeneration cycle is brief—between one and two years—and plant photosynthesis can help to lower the amount of starch in the atmosphere. The heat of combustion of PLA fibre is essentially non-existent compared to polyethylene and polypropylene, being around one-third of each. [13]

Natural and renewable plant resources are used to make PLA fibre, which lessens reliance on conventional petroleum resources and satisfies international standards for sustainable development. Since Corn fibre has numerous unique features and has different biodegradation characteristics from other fibrous materials, it has drawn a lot of interest from the global textile industry.

It features a plush feel, potent moisture absorption, breathability, and antibacterial qualities. The material is near the skin and is pure, safe, healthful, and of great quality. Other substrates can't compare to its wide range of biological attributes. Ideal base material for face masks of the highest calibre. Natural antibacterial, anti-mite, and PH values close to the skin, also referred to as a person's second skin, are present in PLA and its PLA fibres. In the medical field, polylactic acid is utilised as a cell culture medium in skin tissue engineering and can maintain the proper proliferation of skin fibroblasts. [14]

PLA is a substance that can be injected into the body and then absorbed. It has been applied to medicine for almost 30 years. Mask substrates separate some free small molecules using PLA fibres. Small molecules have a great ability to penetrate. In addition to inhibiting germs, it can also increase the skin's ability to absorb nutrients and boost the vitality and growth of the facial skin when combined with the lactic acid component of the skin. A deeper level of cleaning may be achieved by the facial skin because to the polylactic acid film cloth's strong adsorption, capacity to retain more essence, and good water absorption qualities, which allow it to absorb oil and eliminate pollutants more effectively.[15]

The polylactic acid film's porous structure allows for the passage of air and moisture, totally preserving the active ingredients in the essence, and having an excellent moisturising effect.

- Degradable
- Environmental protection and no pollution.
- Soft and skin-friendly.
- The surface of the cloth is smooth without crumbs, and the uniformity is good.
- Good ventilation performance.
- Good water absorption performance.

3.1.2 **Core Material (wood Pulp)**

Absorbency of menstrual fluid is the main need for a sanitary pad. As a result, the choice of fiber's absorbency and retention properties determines the core material entirely.

Its primary purpose is to absorb and hold the fluid and is positioned between the top sheet and barrier layer. Additionally, the absorbent core must be thin, soft, and flexible to be comfortable. The core was historically made of wood pulp but ongoing efforts are being undertaken to replace it with air-laid wood pulp and SAP to increase its absorption effectiveness. In order to prevent the absorbed liquid from retracting back, SAP transforms it into a jelly-like condition. [8,9]

The absorbent core of hygiene goods like diapers, tampons, sanitary napkins, and incontinence, all of which have a significant market share in the medical textiles, is made primarily of wood pulp. This wood pulp comes from a natural wood source that was obtained by cutting down trees, which resulted in deforestation and negative environmental repercussions. Table 1 displays the wood pulp's technical information. The development of a substitute for wood pulp is the main goal of this project.

Table 1: Technical Data of Wood pulp, Golden Isles Fluff, Grade 4881, Wood Species Southern Pine

Properties	Units	Typical Results
Fiber Length	mm	results
FQA Length Weighted mm	mm	2.4
FQA Weight Weighted mm	mm	2.8
Kajaani Length Weighted mm	mm	2.7
Kajaani Weight Weighted mm	mm	3.4
Moisture	%	8
Packaging	Units	Sizes
Roll Width	cm	25 - 152
Roll Diameter	cm	115 - 152
Core Diameter	cm	7.6

3.1.2.1 Corn Starch

A white, flavourless, and odourless powder known as corn starch is used in the creation of industrial adhesives, papermaking, food processing, and various cosmetic and oral medicinal items. It has been used to surgical gloves as a lubricant. The various aspects of starch structure are typically what govern the functional properties of starch granules, which include swelling power, starch solubility, gelatinization, retrogradation, syneresis, and rheological behaviour. Amylose and amylopectin are the chemical components of cornflour. Cornstarch and water are heated, which causes the starch granules to enlarge, become more viscous, and eventually solidify into a paste or gel.

The benefits of Corn Starch

- They help keep the skin dry.
- They help protect against skin irritation in diaper users by reducing skin wetness.
- They help prevent the spread of infections.
- They offer improved quality of life and personal dignity.

3.1.3 Barrier Sheet

It prevents leaks and discoloration of the fluid. It is a polyethylene film that is fluid-impermeable but breathable. Few sanitary pad components will fall apart and be attacked by bacteria in a public or private sewage disposal system, but barrier sheets made of polyethylene or polymeric films will remain intact since these materials are inert and do not harm the environment by being broken down by bacteria. [10]
Sustainable raw materials as an alternative to single-use hygiene products Polyethylene and polyurethane, two non-biodegradable plastics, are frequently utilised as protective film in hygiene items. Many research works on bio-plastic are in progress. Biodegradable plastic can be a Polymer blends of poly (butylene adipate-

co-terephthalate) (PBAT) and polylactide (PLA) have been drawn attention due to the application potential as hygiene barrier film. The pricey synthesis of this high molecular weight PLA, which is 5–6 times more expensive than normal plastic, is the only downside at the moment. [16]

PLA is a biopolymer that is a biodegradable plastic that is made from renewable resource (starch). It is formed through condensation polymerisation, (Loss of water molecule)

History: produced first in 1954 but was only patented. Commercially produced in the 90's, growing in numbers. Developed by Scientists from ThyssenKrupp Uhde Polymer division.

Specific use: Plastic bag, plastic containers, garbage bags, food wrap, PLA fibre in textile, automotive industry

Production: Corn Starch – individual glucose hydrolysis – fermentation with bacteria or fungi – two lactic acid monomers – Condensation polymerisation reaction

3.1.4 Fabric used

3.1.4.1 Cotton:

Cotton is completely natural and does not contain any dangerous chemicals. Natural textiles, such as cotton, are highly breathable and allow for air movement. This is a fabric that may be worn in every season. It is a very breathable fabric, making it suitable for panties. Cotton fabric is an excellent choice for regular wear. These cotton panties are ideal for everyday usage in the summer and winter.

3.1.4.2 Modal

Modal fabric is made from highly refined beech-tree pulp. It is a natural and eco-friendly type of viscose that has just begun to appear as a cotton substitute due to its extremely soft, smooth texture and moisture absorbing characteristics. Depending on the fabric's manufacturing, modal can be more breathable than cotton.

3.1.4.3 Silk

This is yet another great fabric that will make your everyday trousers look more fascinating and exotic. It feels light and weightless on your skin and sits effortlessly on it. These panties allow you to engage in any activity without discomfort. These elegant silk panties are both functional and attractive. Silk is an excellent choice for both practicality and luxury since it allows air to flow, wicks moisture away from the skin and allows it to evaporate, and is naturally hypoallergenic, anti-fungal, and anti-bacterial.

3.2 Methods

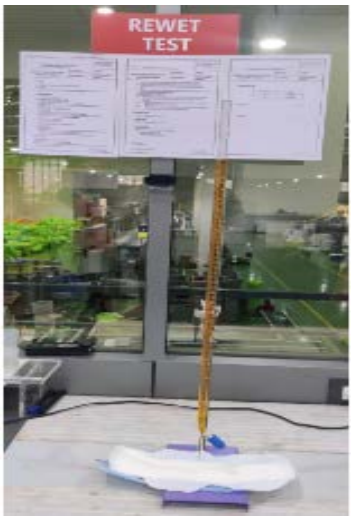
Off-line inspection performed for the measurements of the performance of the product Quality the company has established and specify the monitoring and measurement requirements (including acceptance criteria) for product /process characteristics and data generated is utilized for improved process. The test protocol has been designed on the basis of product specification including physical characteristics and performance of the product over the time of period.

Physical characteristics: Absorbency/strike through test with synthetic blood, Rewet test, Seal strength test, Peel adhesion test

The primed sanitary napkins after UV Sterilization were tested for the following properties.

2.2.1 Absorbency and Rewet Test

Check the expiration date of synthetic blood. Swirl the synthetic blood solution gently. Ensure no bubbles are formed. Calibrate the dispenser for 15ml amount = 15.35 +/- 0.05 gm. Place the pad on the stand with the body side up. Centre the surface of the funnel on the pad. Entire oblong surface of funnel must touch the specimen. Position the dispenser center to the funnel. Simultaneously start the timing device and begin dispensing the entire amount of synthetic blood into the funnel. Depress the liquid with constant flow. Do not move the funnel during all these activities. Stop the stopwatch when the liquid in the funnel reaches the end point and record the time. Remove the funnel from pad. Rinse the dispenser and the funnel with distilled water and pat dry with paper toweling after approximately one set of testing to prevent synthetic blood build up. [33]

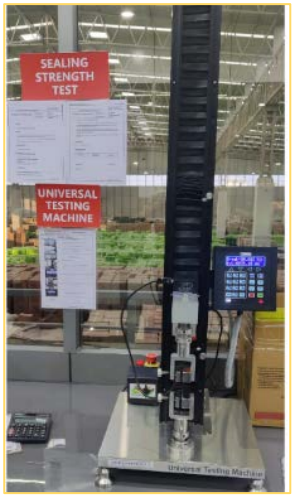


Use the same pad on which absorption test happened. Start the weighing scale. Wait until its showing Zero reading. Weigh three pieces of tissue in bi-fold condition. Note down the weight W1. Place the weighed tissue properly in the centre of the pad. Put the 5 kg metal block on centre of the tissue. Simultaneously start the stop watch. After 5 minutes, remove the metal block. Do it accurately. Weigh the tissue. Note down the weight W2. Calculate the difference W2-W1. Note down the rewet in grams.

Figure 3: Absorption and rewet test

2.2.2 Peel adhesion

Peel adhesion test is used to determine the peel strength of pad with cotton fabric. Peel adhesion measures the force required to remove a pressure sensitive adhesive from a cotton fabric or its own backing material as per D1876 standard test method. The sample was tested on Universal Testing Machine with sample size of 2 inch x 5 inch.

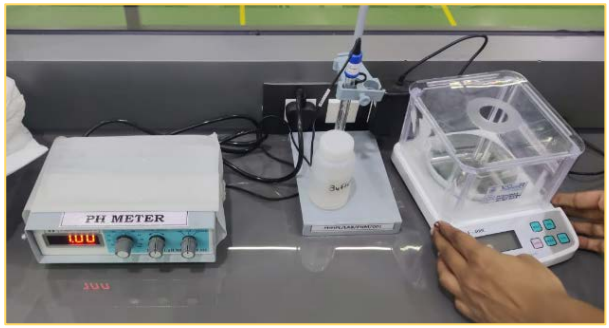


2.2.3 Seal strength

Purpose: This test is used to determine the maximum strength (peak load) of the seam of the feminine care pads. Seal strength is the tensile strength of the seal at ambient temperature, which was tested as per ASTM F88. It is the maximum force required to separate the two layers of a seal under particular conditions. The sample was tested on Universal Testing Machine with sample size of 1 inch x 2 inch.

Figure 4: Peel Adhesion tester (Universal Testing Machine)

2.2.4 pH test



Sanitary napkins should have neutral pH values; they should neither be acidic nor alkaline. For that, they are tested to determine their pH value. Testing sanitary napkins on these parameters according to IS 5405:2019 test, it can ensure purpose without leaking and without causing any discomfort. [17]

Figure 5: pH tester

4. Results and Discussion

The use of textiles in the medical, applied healthcare, and hygiene industries is a significant and expanding component of the textile industry.

“Sanitary Napkins” is known as sanitary pads, sanitary pads, sanitary towels, or maxi pads, which form an important part of the gynaecological hygiene of every woman. Sanitary Napkins are absorbent disposable single-use products designed to receive, absorb, and retain menstrual fluid and isolate them from the rest of the body. It is worn externally, between the vulva and a woman's undergarment. It is a form of a porous item that has the capability of soaking the flow of blood. Hence, menstruating women wear them during their periods. Some women also prefer using them while recovering from vaginal surgeries, childbirth, or abortion. Sanitary napkins are made by inserting an absorbent pad between fabric sheets. The technical textile component of the sanitary napkin is the non-woven fabric which prevents leakage of menstrual discharge.

3.1 Absorption and Rewet test

Table 2: Absorption and Rewet test

Sr. No	Type of Sanitary Napkins	Sample Code	Absorbency (ml)	Absorbency rate (Sec)	Rewet (gm)
A	Corn PLA Sanitary	P240	15ml	12.0	2.5
			15ml	21.0	3.4
		P290	15ml	13.5	1.5
			15ml	21.3	4.1
			15ml	33.8	5.3
B	Organic Cotton	B240	15ml	11.4	3.4
			15ml	20.8	4.1
		B290	15ml	12.1	2.8
			15ml	19.3	3.9
			15ml	25.0	6.2
C	Mulberry silk	M240	15ml	15.0	2.8
			15ml	22.0	3.5
		M290	15ml	14.5	2.4
			15ml	24	6.4
			15ml	28	6.8
D	Soft Comfort	S240	15ml	17	1.52
			15ml	22.6	5.19
		S290	15ml	15.6	1.16
			15ml	22	3.31

			15ml	27	6.3
E	Dry Comfort	D240	15ml	25.6	0.7
			15ml	40.6	3.13
		D290	15ml	20.4	0.34
			15ml	31.8	1.69
			15ml	41.2	2.3

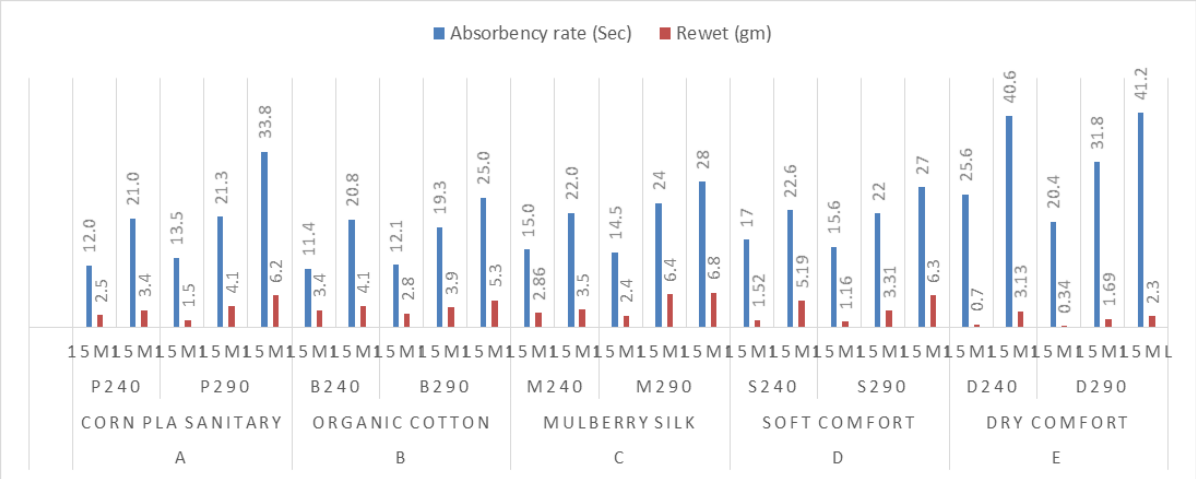


Figure 6: Absorption and Rewet test

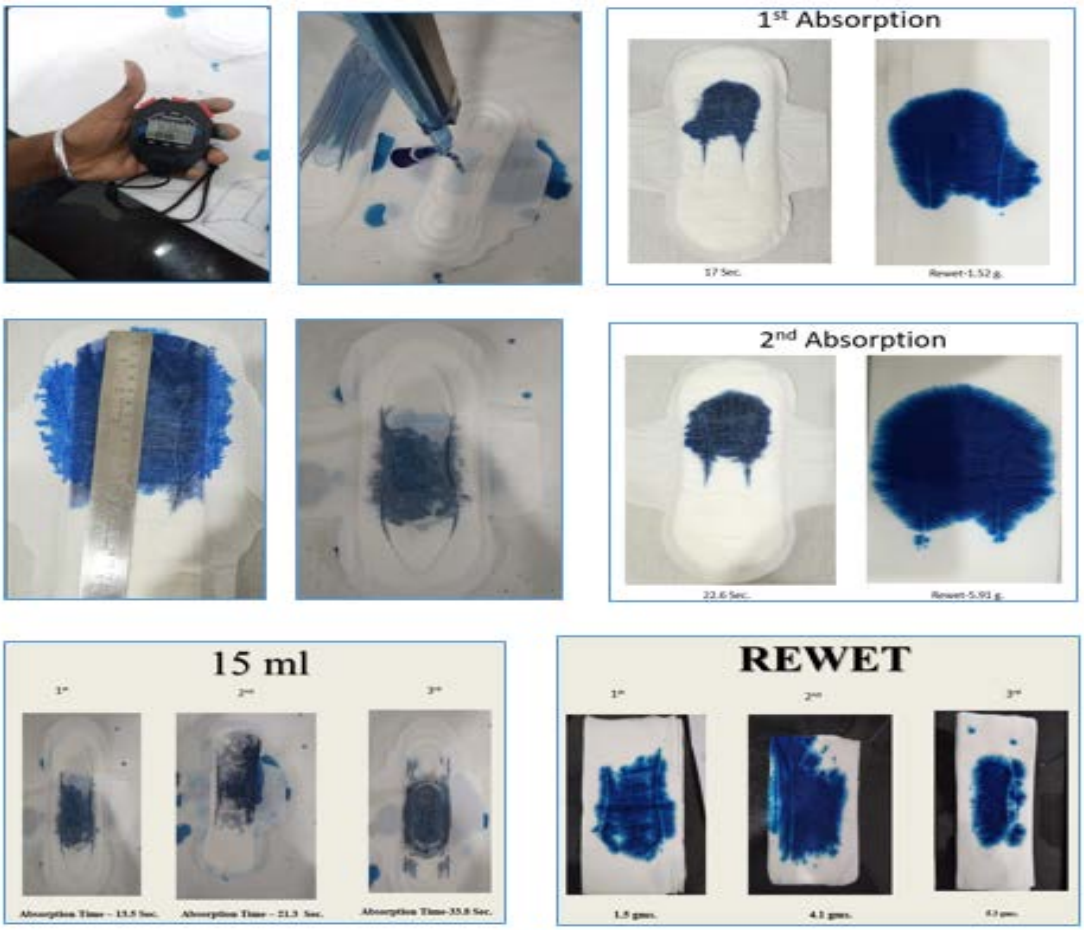


Figure 7: Absorption and rewet test images for the sanitary napkins

IS: 5405/ 1980 Absorption test method used. The sanitary napkins shall absorb 30 ml of coloured water or test fluid when flowed on to the centre of the napkin (at the rate of 15 ml per minute) and it shall not show up at the bottom or sides of the sanitary napkin, when tested according to Appendix A.

Utilizing wood pulp fibre as cake material mixed with SAP for soft comfort and dry comfort, and using wood pulp fibre as cake material combined with corn starch for Corn PLA, Organic Cotton, and Mulberry silk top sheet materials, all types of napkins were produced.

In table number 2, I've added the code name, alphabet number, and associated napkins. The time it took for various sanitary napkins to absorbed fluid ranged from 1 second to 40 seconds. The new napkins (A, B, and C types), which were produced from napkins, took the lowest amount of time—10 seconds—compared to the old napkins (D & E), which were constructed of soft comfort and dry comfort.

The top layer of the napkins is another crucial element that affects absorbency. D-Soft Comfort napkins' top sheet was spun bond. Nonwoven E-Dry Comfort napkins had top sheets made of perforated poly plastic, whereas all other napkins had top sheets made of A-Corn PLA, B-Organic Cotton, and C-Mulberry Silk.

In comparison to A, B, and C, Corn PLA, Organic Cotton, and Mulberry silk top sheet, old-made napkins D and E (soft comfort and dry comfort) have a good rewet value. This is because fluff pulp was mixed with SAP in earlier samples A and B, but corn starch was mixed with fluff pulp in more recent samples (A, B, and C). The product samples A, B, and C had a slightly slower absorption rate than samples D and E. In favour of the biodegradable samples, this is a favourable indicator. When compared to the D and E, the rewet testing results for the A, B, and C are better.

As depicted in figures 6 and 7, the sample B (Organic cotton top sheet) has a very quick rate of absorption and a low rewet value.

3.2 Peeling Adhesion Test:

Table 3: Peel Adhesion test

Sr. No	Type of Sanitary Napkins	CODE	Peel Adhesion (gf)	
			Front	Back
A	Corn PLA Sanitary	P240	120	126
		P290	140	134
B	Organic Cotton	B240	145	156
		B290	154	143
C	Mulberry silk	M240	163	168
		M290	158	154
D	Soft Comfort	S240	135	129
		S290	127	126
E	Dry Comfort	D240	129	131
		D290	120	119

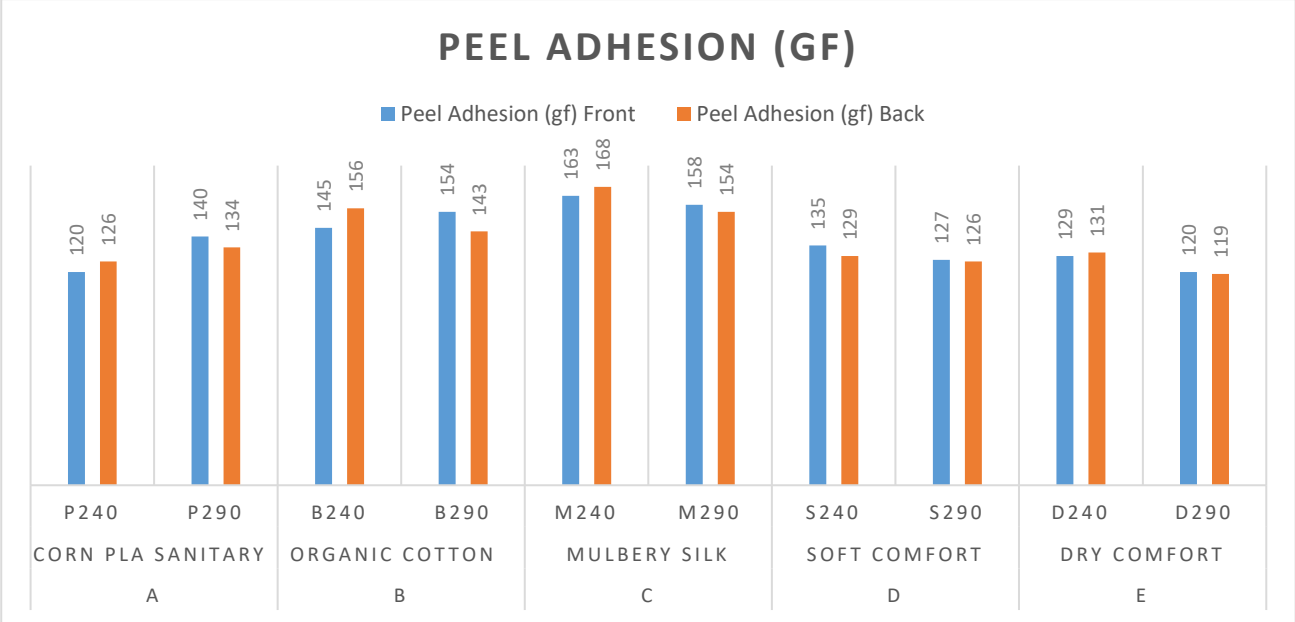


Figure 8: Peel Adhesion test

Results for the peel adhesion for several types of sanitary napkins are displayed in table 3 The peel adhesion test is used to calculate the force needed to separate two components that are adhered together. Bond strength, another name for the test result, is typically expressed as gf (force to de-bond). 1) Quality control, where the glued component must meet a minimum bond strength value, can be accomplished with the peel adhesion test. Determine the ideal pressure and temperature for adhesive curing in order to get the highest bond strength. 3. Determine how temperature, humidity, and other external factors may affect the bond strength.

According to industry standards, 80 gf to 200 gf are needed for the peel adhesion value of sanitary napkins. We analysed all of the product samples, including A, B, C, D, and E. According to figure 8, which is a graphic representation of the Peel Adhesion test findings for samples A, B, C, D, and E, test results range from 120gf to 170gf.

3.3 Seal Strength

Table 4: Seal Strength

Sr. No	Type of Sanitary Napkins	Code	Seal Strength - gms			
			Front	Back	Right side	Left Side
A	Corn PLA Sanitary	P240	368	399	376	380
		P290	244	270	255	264
B	Organic Cotton	B240	222	269	256	275
		B290	227	282	277	267
C	Mulberry silk	M240	475	508	480	505

		M290	508	510	503	514
D	Soft Comfort	S240	594.	578	425	440
		S290	642.	610	458	414
E	Dry Comfort	D240	519	535	460.	401
		D290	528	498	421	429

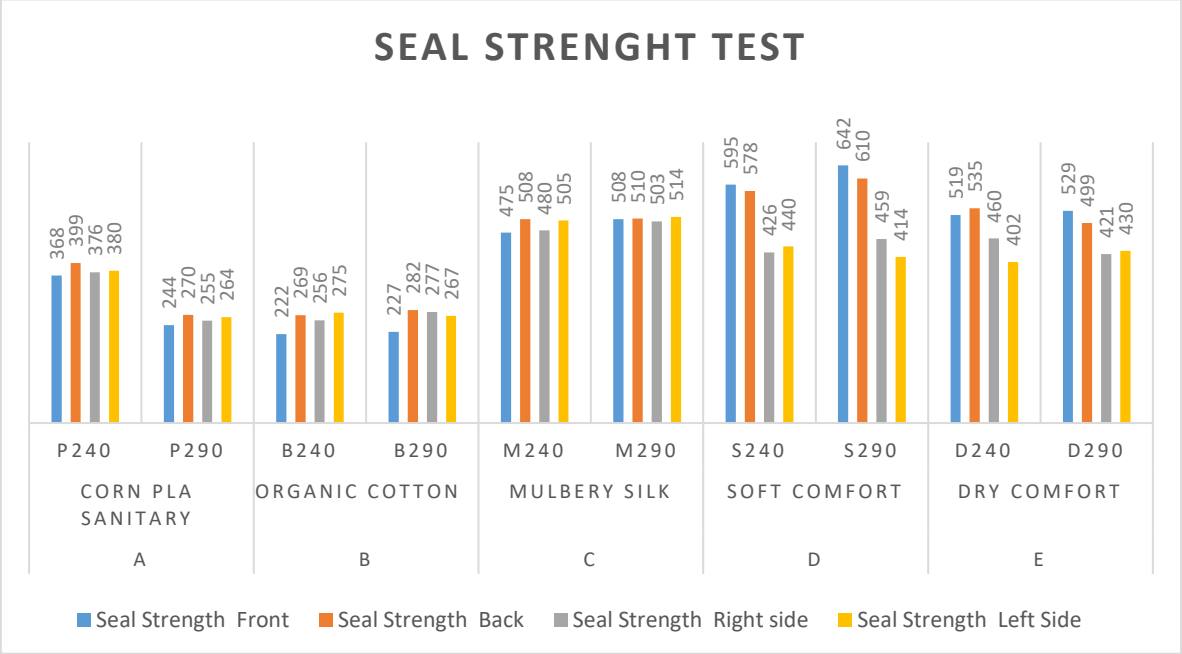


Figure 9: Seal Strength test

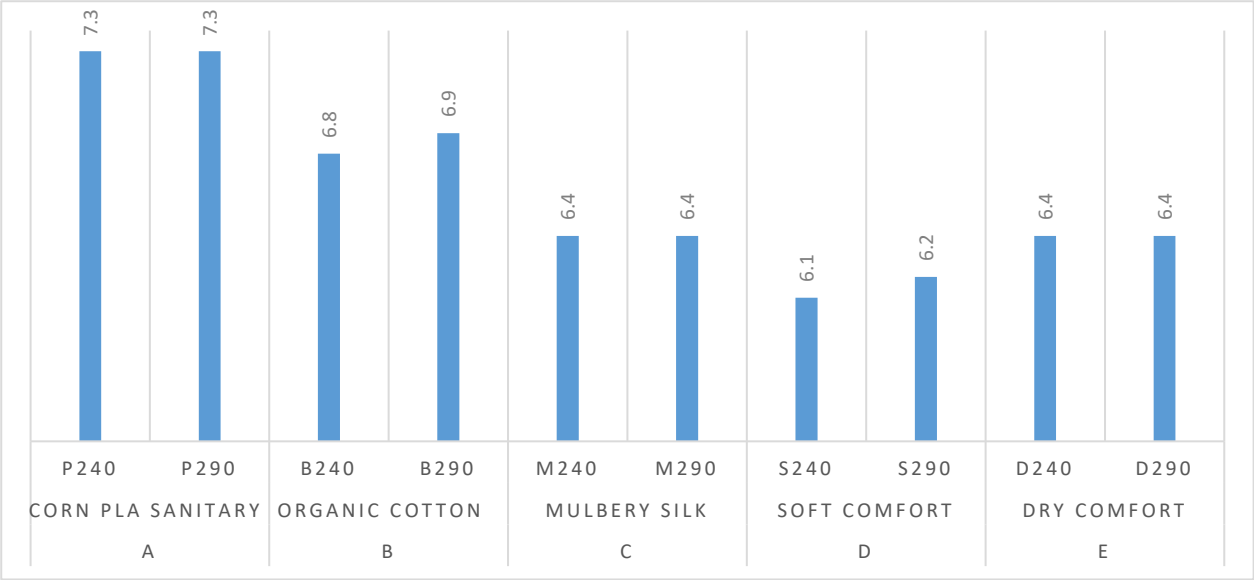
According to table 4, which displays the Seal Strength results for samples A, B, C, D, and E. The peak load (maximum strength) of the seam on the feminine care pads is ascertained by this test. The force necessary to separate the two layers is calculated using the seal strength test. According to industry standards, sanitary napkins must have a seal strength value of greater than 300 gf. We analysed all of the product samples, including A, B, C, D, and E. Figure 9 illustrates the testing findings, which range from 255gf to 505gf.

3.4 pH Test

Table 6: pH Test

Sr. No	Type of Sanitary Napkins	CODE	PH Test
A	Corn PLA Sanitary	P240	7.3
		P290	7.3
B	Organic Cotton	B240	6.8
		B290	6.9
C	Mulberry silk	M240	6.4

		M290	6.4
D	Soft Comfort	S240	6.1
		S290	6.2
E	Dry Comfort	D240	6.4
		D290	6.4



4.1.1

Figure 11: pH test

The pH of the absorbent substance must be between 6 and 8.5 when tested using the technique, and the sanitary napkin must be free of any acidic or alkali materials. According to table 6, the pH of all the napkins ranged from 6.1 to 7.3. As a result, every sanitary napkin complied with the permissible pH range, which is 6 to 8.5. As demonstrated in Figure 11, both of the napkins that were created using soft comfort materials—spun bond nonwoven and perforated poly plastic—and the dry comfort materials—organic cotton and mulberry silk top sheets—also fell within the permitted range and had pH levels that were almost identical.

5. Conclusion

Various types of period underwear, including those made from Corn PLA, organic cotton, mulberry silk, as well as materials that provide soft comfort and dry comfort, have been successfully produced using cotton, silk, and Modal. All of these samples are created using readily accessible natural materials. All the samples have shown improvement in terms of absorption, rewet return, leakage resistance, and pH value.

Among all the samples, the top sheet made of organic cotton, wood pulp fibre, and corn starch mix has demonstrated a remarkable ability to absorb quickly. The top sheet made of mulberry silk with wood pulp fibre has demonstrated the lowest rewetting rate, indicating its superior performance. Based on the results, it can be concluded that the Corn PLA and Organic cotton top sheet exhibited superior peel adhesion strength compared to the other samples.

All samples have been tested for seal strength according to the standards. Period underwear typically have a pH value ranging from 6 to 8.5 pH. It is clear that women require menstrual hygiene products. It is important to raise awareness about organic Period Underwear among the society, as the current level of awareness is less than 15%. This could potentially be a viable long-term solution for the environment. The Period Underwear samples are made from natural biodegradable materials, making them hygienic and decompose more quickly than synthetic alternatives.