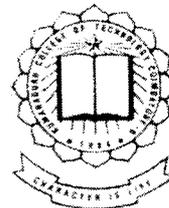




P- 3586



**APPLICATION OF AGRI PRODUCTS FOR THE
ABSORBANT CORE OF DISPOSABLE SANITARY
NAPKINS**

A PROJECT REPORT

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**(An Autonomous Institution affiliated to Anna University of Technology,
Coimbatore)**

APRIL 2011

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BONAFIDE CERTIFICATE

Certified that this project report

**“APPLICATION OF AGRI PRODUCTS FOR THE ABSORBANT CORE OF
DISPOSABLE SANITARY NAPKINS”**

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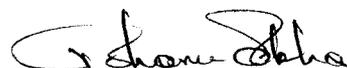
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INTERNAL EXAMINER



EXTERNAL EXAMINER

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ABSTRACT:

Medical textiles is one of the major growth areas within technical textiles and the use of textile materials for medical and healthcare products ranges from simple gauze or bandage materials to scaffolds for tissue culturing and a large variety of prostheses for permanent body. Meditech products include products like diapers, sanitary napkins, disposables, contact lens, artificial implants, etc. Feminine hygiene napkins or sanitary napkin is a hygiene absorbent product engineered to absorb and retain body fluid during menstruation cycles, without causing any leakage. The absorbent core of the sanitary napkin is made of wood pulp which is made by cutting numerous amounts of trees which lead to deforestation and is considered not to be eco friendly. With an environmental commitment the objective of the study has been focused towards finding an eco friendly alternative for the wood pulp in the absorbent core of the sanitary napkins.

In the first part of the study, 2 local brands of sanitary napkins prepared by SHGs have been compared and their parameters have been standardized to get the present scenario. In the second part of the study, five natural fibers were selected and they were cleaned, alkali treated and softened with cellulase enzyme, in order to prepare them for the web formation, suitable to be used for the absorbent core. Comparison between the properties of raw fibers and prepared fibers show that bio-softening has improved the performance of the raw fibers.

The sanitary napkins were prepared with various compositions of the prepared fibers and were evaluated for their absorbency and retention properties. Finally the napkin with 50% wood pulp and 50% bagasse combination has shown good results in absorbency as well as in retention properties which has been proved to be better than the napkin with 100% wood pulp. The combination has for sure enhanced the performance of wood pulp.

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INTRODUCTION

INTRODUCTION

MEDICAL TEXTILES

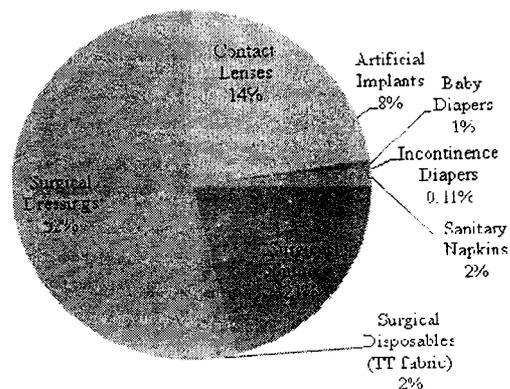
Medical textiles is one of the major growth areas within technical textiles and the use of textile materials for medical and healthcare products ranges from simple gauze or bandage materials to scaffolds for tissue culturing and a large variety of prostheses for permanent body implants.[1]

MEDITECH

Meditech products include textile materials used in hygiene, health and personal care as well as surgical applications. The Meditech products are available in woven, knitted and non-woven forms based on the area of application. Increasingly, synthetic fibre is being used in the production of these products. It includes products like diapers, sanitary napkins, disposables, contact lens, artificial implants, etc.

Technical textiles market under Meditech is estimated at US\$ 422.6 million in 2009-10. Surgical dressing alone accounts for over 50% of the total technical textile consumption across Meditech segment. Surgical sutures account for around 21% of the total.

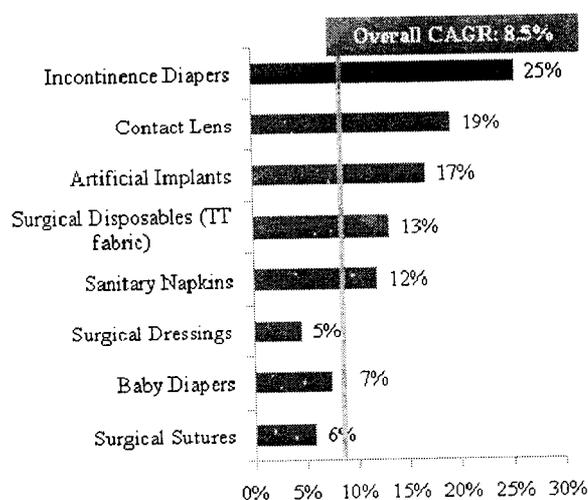
Figure 1: Value-wise share of various products in Indian Meditech market (2009-10)



The demand for Meditech products is dependent on the health and hygiene sector. The money spend on healthcare segment is steadily on the rise in India, predominantly by the private sector, which is expected to drive the demand for Meditech products.

In line with these developments, Indian Meditech industry is expected to achieve a growth of 8-9% year on year, over the next three years. The domestic consumption of technical textiles under Meditech is expected to increase from around US\$ 379.4 million in 2009-10 to around US\$ 488.2 million by 2012-13.

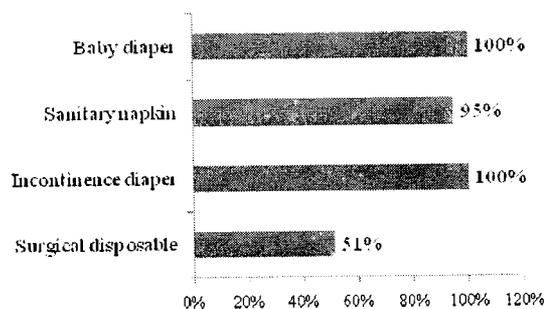
Figure 2: Value-wise CAGR for Meditech products (from 2009-10 to 2012-13)



INTERNATIONAL TRADE

Imports of technical textile component under Meditech constitute about 28% of domestic consumption under this segment, by value. Demand for products such as artificial implants, technical textile component of baby diapers and incontinence diapers is met by imports; the non-woven material required for medical applications (e.g. diapers) is primarily imported. Majority of imports are from Thailand, Singapore, Taiwan and China.

Figure 3: Volume-wise share of imports in the domestic consumption of Meditech products (2009-10)



By value around 12% of the technical textiles produced under Meditech in India are exported. Surgical sutures and surgical dressings are the key export products, with their exports constituting over 86% of the total exports under this segment. The key export markets are Bangladesh, the UK, Sri Lanka and Netherlands.

The ECTT report on technical textiles, the consumption of technical textiles in the country is expected to grow from Rs. 31,418.14Cr to Rs.44, 628 during the period from 2003-04 to 2007-08.

Further, as per an internal document prepared by the textile ministry, it is estimated that the technical textile market would grow to Rs.78, 060Cr. by 2014-15 with an annual growth rate of 14%. Till dated the Indian textile industry is barely able to support the country's demand. [2]

Feminine hygiene napkins or sanitary napkins is a hygiene absorbent product engineered to absorb and retain body fluid during menstruation cycles, without causing any leakage.

Key functions expected from a of sanitary napkin are absorbency, retention of menstrual fluid, leak proof, maintenance of aesthetic appearance, prevention of odour, comfortable to wear. They are either washable or disposables.

Disposables are widely used due to their maintenance free nature, cheaper unit price and better hygiene. They are categorized based on their absorbent capacity and design. The size of each and their content vary from market to market. Sanitary napkins consist of an absorbent pad sandwiched between two sheets of nonwoven fabric.

The average woman may have as many as 400 periods in their lifetime, and can use up to 15,000 tampons during this time. This is a very large number, and it is important to consider the health implications involved in this product. In INDIA the manufacturers do not point to the composition of chemicals that is present in these products. There are no government norms to regulate these issues. Creating awareness will caution the users not to buy these products.

The absorbent core of the sanitary napkin is made of wood pulp which is made by cutting numerous amounts of trees which lead to deforestation and is considered not to be eco friendly.

With an environmental commitment the objective of the study has been focused towards finding an eco friendly alternative for the wood pulp in the absorbent core of the sanitary napkins.

LITERATURE REVIEW

LITERATURE REVIEW

2.1 SANITARY PADS

A sanitary pad also known as sanitary napkin, menstrual pad, rag or maxi pad is a menstruation product used by females to absorb the blood flow during their menstruation / periods.

Sanitary Napkins or Sanitary pads is an absorbent pad of cotton, cellulose etc. worn by women during monthly menstruation or Sanitary Napkins are a disposable pad of absorbent material worn to absorb menstrual flow.

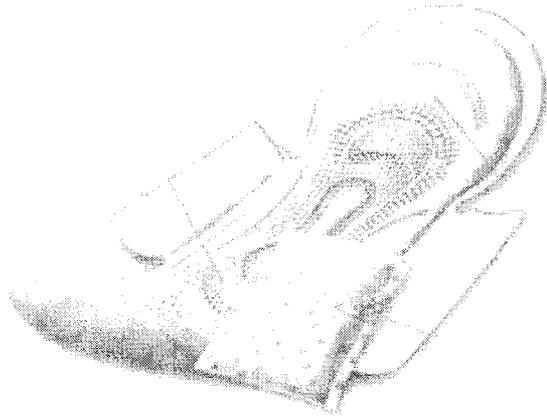


Figure 4: Sanitary napkin

FUNCTION

Sanitary napkins are designed to absorb and retain menstrual fluid discharges. When used they are applied inside an undergarment with a press-on adhesive fixing strip. Main functions/key elements of sanitary napkins are absorb and retain menstrual fluid, isolate fluids from the body, no leakage, no unaesthetic appearance, no odour, stay in place, comfortable to wear.^[3]

2.1.1. History of Sanitary Napkins / Sanitary Pads

Sanitary napkins known as sanitary pads, sanitary towels or maxi pads, sanitary napkins are an important part of the gynecological hygiene for every woman. A sanitary napkin is a form of a porous item that has the capability of absorbing the flow of menstrual flow. Menstruating women wear them during their periods. Some women also use sanitary napkins after vaginal surgeries, childbirth or abortion. Today, there are different varieties of disposable sanitary pads available in the market, ranging from ultra-thin panty liners to oversized maternity pads. From reusable 'rags' to disposable 'napkins', menstrual pads have indeed come a long way.

The 'Museum of Menstruation', located on the suburbs of Washington DC, offers some interesting insights. Some of the most common forms of protection were grass, rabbit skins, sponges, rags, menstrual aprons, homemade knitted pads or other kinds of absorbents. Disposable sanitary napkins/pads started to be available in the markets only around the year 1895.

Before disposable sanitary pads were created, reusable pads or cloth were widely used to collect menstrual blood. Women often used a variety of home-made menstrual pads which they crafted from various left craps, fabrics, grass, or other absorbent materials, to absorb menstrual blood. Even after disposable pads were commercially available, for several years they were too expensive for many women to afford. It took many years for disposable menstrual pads (sanitary napkins / sanitary pads) to become popular and affordable, but since then in most areas of the industrialized world their use became almost exclusive.

Disposable sanitary napkins/pads started used by nurses, nurses first came up with the idea of holding the flow of menstrual blood with the help of available wood pulp bandages in the hospital. The manufacturers of bandages borrowed the idea and produced sanitary pads made from handy products that were inexpensive enough to be disposed.

However, the prices of sanitary pads are very high, which made them exclusive toiletries of rich women.

The first sanitary pads were in the form of a cotton wool or similar stringy rectangular structure, sheathed with an absorbent liner. The sanitary pad was shaped in such way, that it could be easily attached to a special belt or girdle.

However, due to its inconvenience, the girdle gave way to an adhesive strip on the bottom of the pad for proper attachment to the undergarment. Belted sanitary napkins became outdated and stick-on pads became popular. The belted sanitary napkin quickly became unavailable after the mid-eighties.

The design of the sanitary napkins also changed through the 1980s to today. With earlier materials not being as absorbent and effective, and early pads being up to two centimeters thick, leaks were a major problem. The ergonomic designs changed over the years, for example, the Australian Libra brand initially had a pad that was wider at the front, tapering at the back to provide a more aesthetic appearance, the current variation now has a wide dovetail at the back, giving functionality a higher priority.

In this modern world, sanitary napkins are available in a wide variety of designed, the design of sanitary napkins taking into consideration both style, comfort and fashion. Some major innovations include quilting of the lining, introduction of 'wings', fragrant pads, introduction of panty liners and reduction of pad thickness.

Nowadays, most women even have their own standard sanitary brands. Besides, most brands come in very nominal prices, which have made sanitary napkins a commonplace household item. [4]

2.1.2. MARKET POTENTIAL AND GROWTH STATUS OF SANITARY NAPKINS

According to B. S. Pancholi and Dr. Sandeep R. Naik, A growth rate of over 18% to 20% is expected in India for the sanitary napkins market, which holds a huge potential and excellent profit margin for the manufacturers.

Today, the global market for absorbent hygiene products is over US\$ 50 bn (including wipes). The evolution of hygiene products in Europe and the North America has taken 4 to 5 generations. Feminine care was introduced over 100 years ago. Baby diapers were invented 60 years ago. Adult incontinence products appeared 30 years ago.

Feminine hygiene (lady napkins) is hygiene absorbent products engineered to absorb and retain body fluid without causing any leakage. The user should always feel dry and comfortable. It consists of an absorbent pad sandwiched between two sheets of nonwoven fabric.

There are 3 major types of products, viz, (a) Thick sanitary napkins. (b) Ultra thin sanitary napkins. (c) Panty liners being used in the market. The size of each and their content vary from market to market.

GLOBAL MARKET STATUS & POTENTIAL

The menstrual cycle starts for young women between the ages 11 - 17, frequently around 12-13 years. On average a woman experiences a period every 28th day, 12 - 13 times in a year. A menstrual period normally lasts 3 - 7 days. The loss of fluid in a period is on average half a cup or 65 - 80 ml. The menstrual pattern is influenced by giving birth and contraceptive methods. Menstruation lasts until menopause at the age 45 - 55. The feminine hygiene products market has evolved over more than 100 years to a more than US\$ 17 bn. [5]

MARKET STATUS & POTENTIAL IN INDIA

As regards consumption of total hygiene, absorbent products in India, total units consumed in 2007 in India were 2,829 million pieces. Baby diapers comprised 5% whereas adult incontinence 1% and feminine care share is 94%.

The total sales of absorbent hygiene products in India were US\$ 213 million in 2007, out of which adult incontinence share was 9%, baby diapers share was 18% whereas feminine care contributed 73%. [6]

Feminine Care (13% of FY98 revenues)

- P&G's *Whisper* dominates the Rs 1.8 bn sanitary napkins market. This segment is growing annually at 25-30%. The segment has low awareness and penetration levels (10-12% in urban areas). P&G competes with Johnson & Johnson (Stayfree, Carefree) and Kimberley Clarke-HLL (Kotex, Secure).[7]

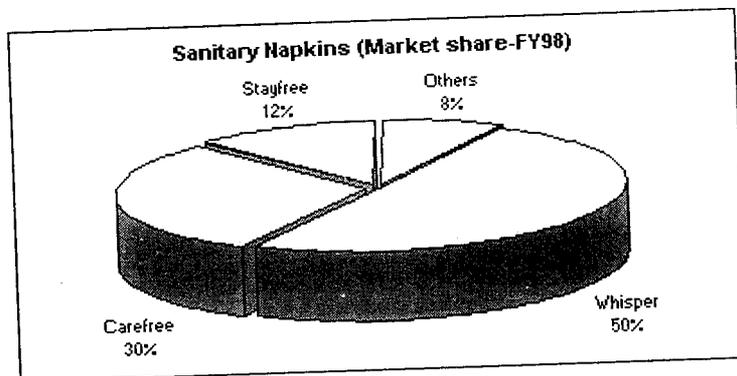


Figure 5: Pie chart for sanitary napkins market share

2.1.3. STRUCTURE AND COMPOSITION

The structure of typical samples is given below:

Raw material

Materials used in absorbent hygiene products:

- Permeable Top cover- Polypropylene
- Impermeable Bottom cover- Polyethylene
- Absorbent core - Pulp
- Absorbent core - Super absorbent
- Leak proof - Plastic film
- Adhesive- Super bond

2.1.4. FACTORS TO BE CONSIDERED IN SANITARY NAPKINS

- **Shape:** Product shape can be either flat or curved with/without wings to secure the pad in place and add additional leak protection. The pad can be rectangular, slender or curved in shape to fit your body better.
- **Size:** The size ranges from short and slender panty liners to large and extra large ones to hold different level of blood flow.
- **Design:** Some pads may feature extra features such as wings with adhesives that wrap around the sides of the panty and stick to help secure the pad in place and provide an additional side leak protection.
- **Fragrance:** Some pads come along with fragrance and deodorants added to them to cover the menstrual blood odor.
- **Packaging:** It is done either folded and single wrapped or packed flat and unwrapped. [8]

2.1.5. COMPONENTS OF SANITARY NAPKINS:

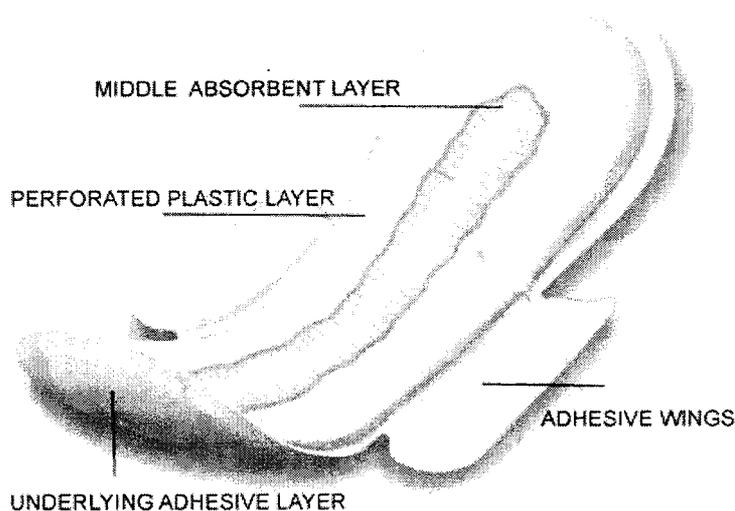
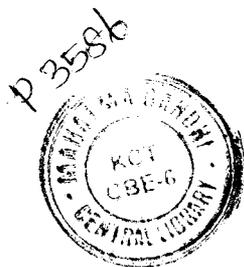


Figure 6: Components of sanitary napkin

The basic anatomy of a disposable sanitary pad comprises of an underlying layer, absorbent layer and a surface layer.

- The underlying layer is the back side of the napkin (adhesive or non-adhesive) that lies on the crotch of the panty.
- The middle layer also called the absorbent layer lies between the underlying layer and the surface layer. It is made of absorbent wood cellulose fibers. The absorbent panel consist polyacrylate gel which sucks up the liquid quickly, holds it in a suspension and prevents blood leakage.
- An additional top layer or the surface layer sits right against the skin. It is made of perforated plastic that keeps the skin dry and acts as a barrier between the skin and the absorbent panel.



2.1.6. TYPES OF SANITARY PADS:

There are 2 types of sanitary pads/ napkins that one can choose from: Disposable sanitary pads and reusable sanitary pads.

2.1.6.1. DISPOSABLE SANITARY PADS:

Disposable sanitary pads are disposed off once used. They are widely available. Disposable sanitary pads vary in design, functionality and comfort from manufacturer to manufacturer. There is a huge variety of sanitary pads available to suit the customer needs and pocket.

2.1.6.1.1. VARIATIONS IN DISPOSABLE SANITARY PADS:

Several types of sanitary pads or napkins are available for use during menstruation or periods. Many sanitary pads on the market offer various ranges of absorbencies, sizes and features.

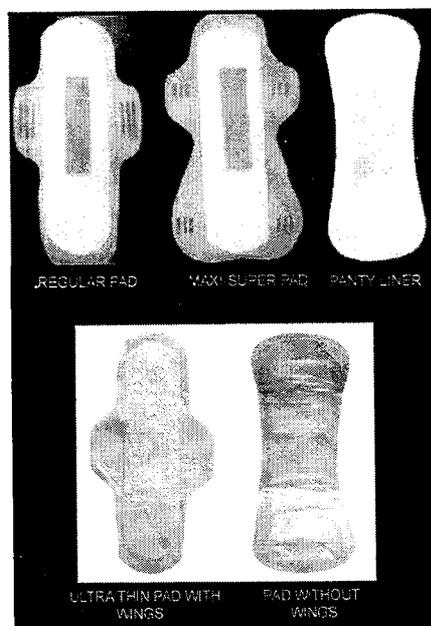


Figure 7: Types of sanitary napkins

Panty Liner

The panty liner is the lightest of all sanitary pads. They're usually worn as back-up protection for a tampon, or to absorb general vaginal discharge. They are also sometimes worn to protect against menstrual spotting between periods.

Ultra-Thin Pad

The Ultra-Thin pad is a very lightweight, super-thin pad. Most brands that offer ultra-thins claim market them to be as absorbent as regular sanitary pads, but less bulky. Other brands are designed for women who have light periods. Ultra-thin pads come in different lengths, including short, similar to a panty liner, and long, similar to a night pad.

Product designs, Ultra thin pad:

1. Topsheet - nonwoven or apertured film.
2. Transfer layer
3. Absorbent Layer
4. Absorbent Core
5. Backsheet film

Regular Pad

The regular pad offers a middle-range of absorbency and size. It's made for use by the majority of women, or for those who don't have excessively heavy or excessively light periods.

Super Maxi or Night Pad

The Super Maxi, sometimes marketed as a nighttime pad, is designed to absorb more than regular pads. They are also usually longer, so that the wearer is protected while lying down to sleep.

Maternity Pad

The maternity pad is often a little longer than a super maxi/night pad, and is designed to absorb bleeding that may occur after childbirth.

Nighttime Pad

These are little longer than the regular pads and are designed to offer more protection to the wearer when she is sleeping.

2.1.6. 2. NON-ADHESIVE DISPOSABLE SANITARY PADS

A non-adhesive disposable sanitary pad is the one that comes without an adhesive and needs to be placed directly on the crotch of the panty.

Another variation is the belted sanitary napkin. These pads come along with a special elastic belt or a girdle to be worn under the undergarment. The absorbent liners of the pad are extended on the front and the back so that they can fit into the loops of the belt. However, these pads are less comfortable to use.

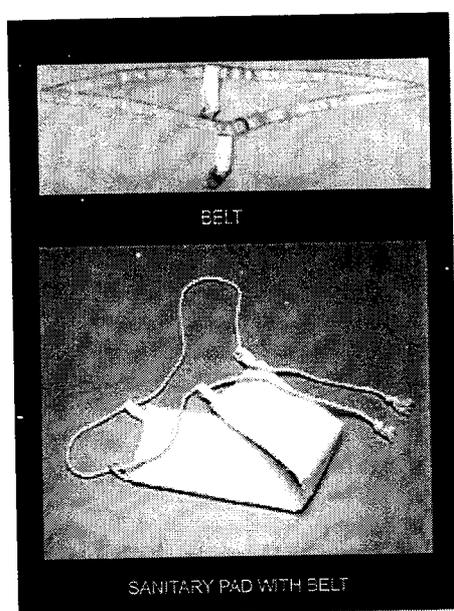


Figure 8: Sanitary napkin with belt

Disposable sanitary pads with adhesive:

- The underlying layer of an adhesive disposable sanitary pad consists of fabric adhering glue which is covered with a paper sticker. If the pad has wings, then the adhering glue and the paper sticker is present on the wings as well.
- The pads with adhesives help to safely secure the pad in place.

Advantages of using a disposable sanitary pad:

- Disposable sanitary pads are easier to use especially the ones with adhesives and wings.
- They help to be fresh and dry throughout the day.
- The ultra thin ones are the most comfortable ones as they are very thin and compact.
- They are more hygienic and safe.
- No fear of developing Toxic Shock Syndrome as in the case of using a tampon.
- Available in different varieties to suit different needs.
- Easier to be used by women of all age group. [9]

2.1.6.3. RE-USABLE SANITARY PADS:

Re-usable sanitary pads are not disposed off once used. Instead, they can be washed and re-used. Washable menstrual pads come in bright colors and are most often available online.

Washable / re-usable sanitary pads are made of different materials such as cotton, silk, hemp and terry cloth and offer a good absorbency. They are available in different sizes and absorbencies.

Reusable cotton pads usually consist of two parts: a removable liner and a liner holder. There are all in one reusable sanitary pads as well.

Advantages of using a washable / reusable sanitary pad:

- Washable sanitary pads are eco-friendly and bio-degradable.
- These can be reused many times before they wear out.
- They save on your pocket as you don't need to purchase new sets of pads every month.
- These are more comfortable to use and don't cause any sort of irritation as they are made of cotton.
- These are available in different variety to suit different needs. [10]

2.1.7. Sanitary Napkin with Anion (Negative Ion)

Anion (Negative Ion) on the Anion Sanitary Napkin able to suppresses the survival and multiplication of bacteria on the sanitary napkin. Anion in Sanitary Napkin release up to 5800 negative ions per cubic cm which has been proven in numerous scientific studies to protect against genital diseases, eliminating harmful bacteria, odor, enhance comfort and improve health.

ADVANTAGES OF SANITARY NAPKIN WITH ANION (NEGATIVE ION)

a. Dry, air permeable, comfortable

Anion Sanitary Napkin has three main components:

i. The surface layer;

The surface layer of Anion Sanitary Napkin is made of thin silk and soft cotton materials to keep the delicate skin dry and comfortable.

ii. The absorbent layer

The middle layer of Anion Sanitary Napkin contains highly effective super strong absorbent agents that can turn the liquid discharge into a jelly-like state to eliminate the sticky feeling.

iii. The base layer

The base layer of Anion Sanitary Napkin is made of air permeable materials that allow diffusion of water molecules in the gaseous state to rapidly drive away moist air, thus effectively reducing moisture and heat between the napkin and the skin to maintain a dry and comfortable feeling.

b. Anti-bacterial and deodorization functions through purely physical processes

The padding in each Anion Sanitary Napkin is embedded with an Anion Chip that can release high density anion (Negative Ion) to help regulate body functions, such as antibacterial capabilities, deodorization, through purely physical processes. There is no side effect.

c. Use of highly effective and super strong absorption agents to meet physical needs

Anion Sanitary Napkin has an absorbent layer. This is made of highly effective and super strong absorption agents as well as leak-proof materials through a special high-tech process. When the liquid discharge comes into contact with the layer, it is absorbed such that there is no back flow or leakage. This will ensure a comfortable feeling and convenience in movement.

d. Compliance with national hygiene standards (China) and prevention of infection

‘Keeping dry, air permeability and cleanliness’ are three main principles of genital care. Production of healthcare sanitary products must strictly comply with the GB15979-2002 hygiene standard.

The main assurance measures taken include:

- (1) strict control over the hygiene standard of the raw materials for sanitary napkin.
- (2) using enclosed production plant of international advanced standard for fully automated sequential production with fully automated packaging.
- (3) Using advanced easy-to-open air-tight adhesive packaging to ensure the product is free from bacterial or fungal infection.

5. Patented Vaginitis Self Test Card provided free of charge can be used for genital health check.

SEVEN LAYERS OF PROTECTION FOR ANION SANITARY NAPKIN

- | | |
|---------------|---|
| First Layer | Premium soft cotton surface, double absorbency. |
| Second Layer | Exclusive patented “Negative Ion Chip” or “Anion Chip” |
| Third Layer | Sterilized and dirt free paper. |
| Forth Layer | Plant extract as premium water absorbents with strong liquid retention. |
| Fifth Layer | Sterilized and dirt free paper. |
| Sixth Layer | Breathable bottom layer that allow free-flow of air. |
| Seventh Layer | Easy to peel off, fold lines adhesive design (food grade gum). |

Eight Features Of Anion Sanitary Napkins

1. Reduce Stress
2. Treating Inflammation
3. Strengthening Immunity
4. Enhances Hormonal Balance
5. Removing Fatigue
6. Enhances Metabolism
7. Eradicate Odour
8. Eliminating Harmful Bacteria

The Negative Ion Chip (Anion Chip) in each piece of Anion Sanitary Napkin can release up to 5800-6070 Negative Ion (Anion) per cubic cm. The intensity of Negative Ion (Anions) released will effectively suppresses the survival and multiplication of bacteria on the sanitary napkin. [11]

2.1.8. THREATS OF SANITARY NAPKINS

The average woman may have as many as 400 periods in their lifetime, and can use up to 15,000 tampons during this time. This is a very large number, and it is important to consider the health implications involved in the products that women use to capture the blood during their periods. It is also interesting to note that the testing for the safety of these products is usually conducted by their manufacturer and not by an independent body.

2.1.8.1. DIOXIN

- Everyone likes the stuff which is sparkling white. We think that if the product is pure white it is clean.
- But the assumption is proved wrong in the case of tampons. The cotton that is received after harvesting is half white in colour.
- The manufacturers use a chemical called DIOXIN to bleach the cotton. Unless the tampon is specifically labeled as non-bleached you must assume it has undergone this process. Although the levels of dioxin in tampons are quite small (and the tampon companies will readily point this out) they are still dangerous as dioxin accumulates in the fat stores of the body and can add up to very dangerous residual levels over time.
- When we consider the average number of tampons used by a woman in her lifetime, we can start to imagine that the buildup of dioxin in the body tissue will actually be quite significant.

Dioxin is linked with the following effects in the body:

- Endometriosis
- Pelvic Inflammatory Disease
- Breast cancer
- Ovarian cancer
- Estrogen dominant conditions
- Birth defects in offspring
- Immune system damage
- Sarcoma, non-Hodgkin's lymphoma and Hodgkin's lymphoma
- Hormone dysfunction
- Miscarriage
- Impaired fertility
- Lowered concentration ability
- Diabetes
- Impaired thyroid function

2.1.8.2 WOOD PULP:

- Apart from cotton, Rayon is yet another synthetic polymer that is added to the tampons to enhance the absorbing capacity .Rayon also has dioxin in it.

2.1.8.3 PESTICIDES , HERBICIDES AND DEFOLIANTS

- These are the chemicals that are used to spray on the cotton crops. A chemical named FURAN stays on the cotton long after it has been harvested, which is a potential danger which might cause harm. These have been linked with the following effects in the body:
 - Birth defects of offspring
 - Low birth weight
 - Infertility
 - Hormonal disruption

- Thyroid malfunction
- Diabetes
- Endometriosis
- Depression

FRAGRANCES AND DEODARANTS

- These substances are added to the tampon product during processing. Although they can also enter the bloodstream in a similar way to the pesticides and dioxin, they can also have an effect locally in the vagina and cause allergies and skin reactions.

2.1.8.4 TOXIC SHOCK SYNDROME

- Toxic shock syndrome is not caused by the chemicals discussed above, but rather from an overgrowth of staphylococcus aureus bacteria in the vagina which causes a release of toxins and poisonous substances into the bloodstream. These toxins can cause a sudden fall in blood pressure and death. The presence of the tampon in the vagina for prolonged periods of time can encourage the growth of the staphylococcus bacteria, as can the use of synthetic fibers in tampons. The occurrence of these symptoms in conjunction with tampon use may be a sign of toxic shock syndrome:
 - Diarrhea
 - Vomiting
 - Sunburn-like rash
 - Dizziness
 - Confusion
 - Cold and clammy skin
 - Fever

- Sanitary pads are subject to the same considerations above in terms of the chemicals in the cotton used, the bleaching process, and the use of fragrances. Although they are in less contact with the internal vaginal wall they are still in contact with the external mucous membrane and chemicals on them can enter the bloodstream this way. Pads are also often made with a dry-weave plastic cover which can cause irritation and localized allergic reactions.[12]

2.1.9. SELECTION OF NATURAL CELLULOSIC FIBER FOR ABSORBENT CORE OF SANITARY NAPKIN:

The following figure displays the most abundant plant fibres.

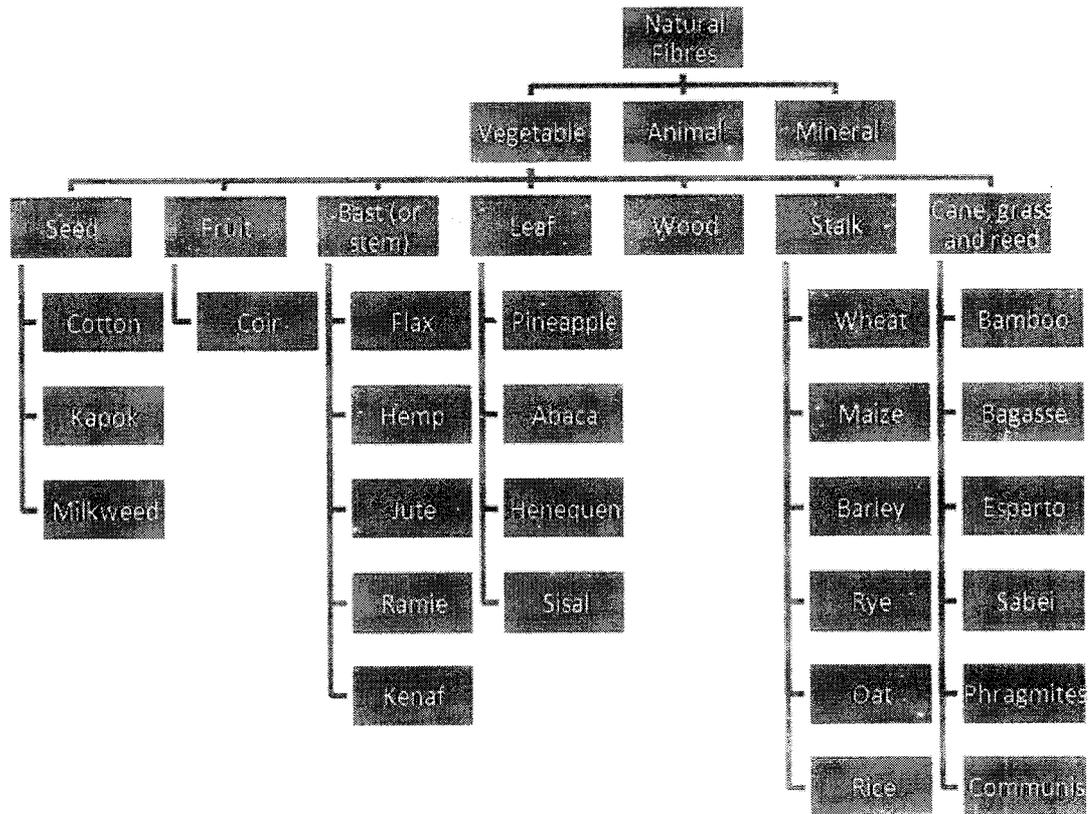


Figure 9: Abundant plant fibers

The material alternatives available for wood pulp will focus on natural cellulosic fibres. This choice in material allows for a reduction in cost, a greater likelihood of local availability and results in an eco-friendly product, if produced properly. [13]

Natural fibres are subdivided based on their origin-whether they are derived from plants, animals or minerals. The primary focus of this material analysis will be plant based fibres as they have a high moisture absorption. Also, these fibres will be more accessible as they are more likely to otherwise go to waste, whereas animal fibres such as fur, or mineral fibres such as asbestos, can be used for more profitable applications other than female hygienic pads.

Fibre	Moisture Content (wt%)
Cotton	7.85-8.5
Bagasse	49
Jute	12.5-13
Kenaf	10
Sisal	10-22
PALF (Pineapple)	11.8
Banana	10-12
Coir	8
Bamboo	5.72
Arecanut	8.46
Flax	8-12
Hemp	6.2-12
Ramie	7.5-12
Nettle	11-17
Abaca	5-10

Table 1: Moisture content of plant fibre

The above table demonstrates moisture content of common vegetable fibres. This value indicates the amount of water content the dried fibres will be able to absorb. A higher water content value indicates a higher absorption value and would therefore be beneficial when used in a hygienic pad.

Based on the data provided above, the moisture absorption level of most of the plant fibres are comparable to that of cotton fibres, which are most commonly used in hygienic pads. [14]

The cellulose is present in three types: α , β , and γ . The α cellulose is known as pure cellulose, whereas β and γ cellulose combined are called hemicellulose (Marthur, 1975). The hemicelluloses are chemically linked with cellulose molecules and together they are called as hollocellulose. The other main compound is lignin which is a high molecular weight substance.

Fiber	Cellulose (%)	Hemicellulose(%)	Lignin (%)
Sugar Cane	50.0	30.0	18.0
Kenaf	65.7	13.2	21.6
Ramie	68.6	13.1	0.6
Jute	64.4	12.1	18.8

Table 2: Composition of fibers (1)

Fibre Waxes	Cellulose	Hemicellulose	Lignin
Cotton	91.8	6.3	-
Flax (bast)	71.2	18.5	2.2
Hemp (bast)	78.3	5.4	2.9
Jute (bast)	71.5	13.3	13.1
Coir (brown)	35.6	15.4	32.7
Coir (white)	36.7	15.2	32.5
Coir pith	19.9	11.9	53.3
Sisal	73.1	13.3	11.0
Abaca	70.2	21.7	5.6

Table 3: Composition of fibers (2)

2.1. 10. ENZYMES IN TEXTILE PROCESSING

2.1.10.1. INTRODUCTION:

ENZYMES ARE PROTEINS

Enzymes are generally globular proteins and like other proteins consist of long linear chains of amino acids that fold to produce a three-dimensional product. Each unique amino acid sequence produces a specific structure, which has unique properties. Individual protein chains may sometimes group together to form a protein complex.

ENZYMES ARE BIOCATALYSTS

Enzymes are biocatalysts, and by their mere presence, and without being consumed in the process, enzymes can speed up chemical processes that would otherwise run very slowly. After the reaction is complete, the enzyme is released again, ready to

start another reaction. Most of the biocatalyst have limited stability and over a period of time they lose their activity and are not stable again. Usually most enzymes are used only once and discarded after their catalytic action.

NOMENCLATURE

The International Union of Biochemistry and Molecular Biology have developed a nomenclature for enzymes, the EC numbers where each enzyme is described by a sequence of four numbers preceded by "EC". The first number broadly classifies the enzyme based on its mechanism.

The top-level classification is

- EC 1 Oxidoreductases: catalyze oxidation/reduction reactions.
- EC 2 Transferases: transfer a functional group.
- EC 3 Hydrolases: catalyze the hydrolysis of various bonds.
- EC 4 Lyases: cleave various bonds by means other than hydrolysis and oxidation.
- EC 5 Isomerases: catalyze isomerization changes within a single molecule.
- EC 6 Ligases: join two molecules with covalent bonds.

At present, more than 2,000 enzymes have been isolated and characterized.

2.1.10.2. APPLICATIONS IN TEXTILES

Today enzymes have become an integral part of the textile processing. There are two well-established enzyme applications in the textile industry. Firstly, in the preparatory finishing area amylases are commonly used for desizing process and secondly, in the finishing area cellulases are used for softening, bio-stoning and reducing of pilling propensity for cotton goods.

However, there is little known about potential enzyme usage in other textile areas.

At present, applications of pectinases, lipases, proteases, catalases, xylanases etc., are used in textile processing. There are various applications which entail enzymes included fading of denim and non-denim, bio-scouring, bio-polishing, wool finishing, peroxide removal, decolourization of dyestuff, etc. Now the use of biocatalyst has become state of the art in the textile industry.

Research and development in this sector is primarily concentrating on:

- Optimizing and making routine the use of technical enzymes in processes that are already established in the textile industry today.
- Replacing established conventional processes with the aid of new types of enzymes, particularly from extremophile micro-organisms, under stringent conditions.
- Preparing enzyme-compatible dyestuff formulations, textile auxiliary agents and chemical mixtures.
- Producing new or improved textile product properties by enzymatic treatment.
- Providing biotechnological dyes and textile auxiliary agents, which are suitable for industrial use, and can possibly be synthesized insitu.

Most of the textile enzymes are those that catalyze the digestion or hydrolysis of certain large organic molecules like starch, cellulose, and protein. The enzymes actually attack these complex molecules, accelerating their digestion and yielding simpler substances. Since this process of digestion is referred to as hydrolysis, the enzymes that catalyze the process are considered to be hydrolyzing enzymes or hydrolases.

The hydrolyzing enzymes include:

1. Amylases, which catalyze the digestion of starch into small segments of multiple sugars and into individual soluble sugars.
2. Proteases or proteinase, which split up proteins into their component amino acid building blocks.

3. Lipases, which split up animal and vegetable fats and oils into their component part glycerol and fatty acids.
4. Cellulases (of various types) which break down the complex molecule of cellulose into more digestible components of single and multiple sugars.
5. Beta-glucanase or gumase, which digests one type of vegetable gum into sugars and / or dextrans.
6. Pectinase which digests pectin and similar carbohydrates of plant origin.

Amylase

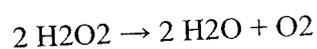
Amylase is present in human saliva; the pancreas also makes amylase. Plants and some bacteria also produce amylase. Amylases bring about complete removal of the size without any harmful effects on the fabric besides eco friendly behavior.

Pectinase

Pectinases hydrolyse pectin, a polysaccharide substrate that is found in the cell walls of plants into galacturonic acid and small sugars. Pectinases have an optimum temperature and pH at which they are most active

Catalase

Catalase has one of the highest turnover numbers of all enzymes; one molecule of catalase can convert millions of molecules of hydrogen peroxide to water and oxygen per second. Catalase is a common enzyme found in nearly all living organisms. Natural fabrics such as cotton are normally bleached with hydrogen peroxide before dyeing. Catalase enzyme is used to breakdown hydrogen peroxide bleaching liquor into water molecules and less reactive gaseous oxygen.



Compared with the traditional clean-up methods, the enzymatic process results in cleaner waste water or reduced water consumption, a reduction of energy and time. Reuse of the bleaching liquor after hydrogen peroxide bleaching is already possible today by using the enzyme catalase after bleaching. This enzyme destroys excess hydrogen peroxide, making use of the bleaching liquor for other finishing stages possible.

Cellulase:

Cellulases are produced chiefly by fungi, bacteria, and protozoans that catalyze the cellulolysis of cellulose. However, there are also cellulases produced by other types of organisms such as plants and animals. There are several different kinds of cellulases which differ structurally and mechanistically.

There are three types of reaction catalyzed by cellulases:

1. Breakage of the non-covalent interactions present in the crystalline structure of cellulose (endo-cellulase).
2. Hydrolysis of the individual cellulose fibers to break it into smaller sugars (exocellulase).
3. Hydrolysis of disaccharides and tetrasaccharides into glucose (beta-glucosidase).

Laccases:

They (EC 1.10.3.2) are copper-containing oxidase enzymes that are found in many plants, fungi, and microorganisms. The use of lignin degrading white-rot fungi has attracted increasing scientific attention as these organisms are able to degrade a wide range of recalcitrant organic compounds such as polycyclic aromatic hydrocarbons, chlorophenol, and various azo, heterocyclic and polymeric dyes. The major enzymes associated with the lignin degradation are laccase, lignin peroxidase, and manganese peroxidase. These enzymes can be used for textile dyeing/finishing, and many other industrial, environmental uses.

Lipase:

Lipases from fungi and bacteria serve important roles in human practices as ancient as yogurt and cheese fermentation. Though enzymes can easily digest protein stains, oily and fatty stains have always been troublesome to remove. The trend towards lower washing temperatures has made the removal of grease spots an even bigger problem. This applies particularly to materials made up of a blend of cotton and polyester.

The lipase is capable of removing fatty stains such as fats, butter, salad oil, sauces and the tough stains on collars and cuffs. Conventional preparation of cotton requires high amounts of alkaline chemicals and consequently, huge quantities of rinse water are generated.[15]

2.1.11. BIO-FINISHES FOR CELLULOSE

2.1.11.1. INTRODUCTION

Bio-finishing, also called bio-polishing, is a finishing process applied to cellulosic textiles that produces permanent effects by the use of enzymes. Bio-finishing removes protruding fibres and slubs from fabrics, significantly reduces pilling, softens fabric hand and provides a smooth fabric appearance, especially for knitwear and as a pretreatment for printing.

Second rate articles can obtain the high value eye appeal of first rate ones. In denim processing, bio-finishing can reduce or eliminate abrasive stones and the aggressive chlorine chemistry, achieving the desired 'worn' looks. Bio-finishing is not only useful for cotton but also for regenerated cellulose fabrics, especially for lyocell and microfibre articles.

By incorporating enzymes into detergents to remove protruding surface fibres, improved colour retention is achieved after multiple launderings. The disadvantages of bio-polishing are the formation of fibre dust, which has to be removed thoroughly, the reproducibility of the effect (which is dependent upon many parameters) and in the worst case, loss of tear strength. Enzymes are high molecular weight proteins produced by living organisms to catalyse the chemical reactions essential for the organism's survival.

They have complex three-dimensional structures composed of long chains of amino acids with molecular weights ranging from 10 000 to about 150 000 and occasionally to more than 1 000 000. These naturally occurring molecules provide a high degree of catalytic specificity unmatched by man-made catalysts. The enzyme and substrate form a 'lock and key' complex that requires the enzyme to have a specific molecular alignment in order to act as a catalyst.

The lock and key theory of Emil Fischer was broadened by Koshland Jr to the induced-fit theory of the enzyme-substrate-complex. Chemical reactions catalysed by enzymes can typically be carried out – as is most usual in nature – under mild aqueous conditions without the need for high temperatures, extreme pH values or chemical solvents.[16]

2.1.11.2. TYPE OF ENZYME USED IN TEXTILE AND EFFECTS:

Cellulases Bio-finishing, bio-polishing, anti-pilling, softness, smoothness, lustre improvement and stone-washed effects on denim Amylases Standard procedure for the removal of starch warp size Proteases In household washing agents better removal of protein containing soil or stains. Anti-felting of wool, accompanied by high loss of weight, tear strength and of the typical handle,2,3 degumming of silk with the problem of silk fibroin damage Lipases.

In detergents for the hydrolysis of lipids Pectinases Hydrolysis of pectins, for example in cotton preparation⁴ and retting of flax and hemp Catalases Catalyse the

decomposition of hydrogen peroxide, important before reactive dyeing or printing of peroxide bleached fabrics and yarn Peroxidases.

Used as an enzymatic rinse process after reactive dyeing, oxidative splitting of hydrolysed reactive dyes on the fibre and in the liquor, providing better wet fastness, decolourised waste water and potentially toxic decomposition compounds (aromatic nitro-compounds) Ligninases. Removal of burrs and other plant compounds from raw wool Collagenases Removal of residual skin parts in wool Esterases. In development: polyester finish, removal of oligomers Nitrilases In development: polyacrylonitrile preparation for better coloration.

Enzymes find commercial use in detergents, leather processing, baking, brewing, cheese manufacture, fruit juice processing, dairy production, animal feed, wine making and textiles. The names of the examples of textile-relevant enzymes follow the nomenclature of Duclaux from 1898, characterising an enzyme by the end-syllable 'ase', added to the name of the substrate that is split, synthesised or otherwise catalysed.

As with all catalysts, enzymes reduce the activation energy of a specific reaction. The discovery of large quantities of new enzyme systems afforded a more differentiated nomenclature, realised in 1964 by the International Union of Pure and Applied Chemistry (IUPAC) and the International Union for Biochemistry (IUB).

In the new enzyme classification (EC) the first number refers to one of the six main groups and the following numbers to subgroups, for example EC 3.4.5.6, where 3 stands for hydrolases.

Action of cellulase enzymes on cellulose Enzymes that hydrolyse cellulose are found in nature in both *Trichoderma* and *Humicola* fungi.⁶ The β (1–4) linkages between adjacent repeat units in the cellulose polymer chain are the sites that are vulnerable to catalytic hydrolysis by cellulases (Fig. 17.2). These enzymes are thus able to provide a food source for the organisms by producing glucose from cellulose.

Industrial production of cellulases involves large scale growth of fungal populations, followed by extraction of the enzyme. The extracted enzymes contain multiple components that work together to yield glucose from a cellulose polymer chain.⁷ At least four components have been identified as being important in providing efficient glucose production. Endo-glucanases hydrolyse cellulose at random locations along the polymer.

2.1.11.3. SCHEMATIC REPRESENTATION OF CELLULOSE FIBRE INTERNAL STRUCTURE:

Beta-glucanases hydrolyse cellulose polymers from the non-reducing end producing glucose and leaving a polymer chain with one less repeat unit. Cellobiohydrolases produce cellobiose (the glucose dimer) from polymer chains, and cellobiases convert cellobiose into glucose.

Numerous studies of the mechanism of cellulase interactions with cellulose have been reported.^{8–13} The generally accepted mechanism is adsorption of the endo-glucanase, beta-glucanase or cellobiohydrolase components onto the fibre surface followed by complex formation with the cellulose polymer chain and water.

After hydrolysis of the (1–4) bond, the enzyme desorbs and is available for further adsorption and reaction. Endo-glucanase effectively opens up more of the fibre structure to attack by beta-glucanase and cellobiohydrolase. These two components in turn produce water-soluble fragments from the exposed area. This synergistic action allows for rapid reduction in fibre strength.^[17]

2.1.11.4. CHEMISTRY OF ENZYME FINISHING

More than with other chemical reactions, the enzyme catalysed hydrolysis of cellulose is strongly influenced by factors such as pH, temperature, time and agitation. The optimal pH for a particular cellulase depends upon its origin. *Trichoderma*-based products (sometimes called 'acid cellulases') work best at pH 4.5–6, whereas cellulases from *Humicola* (often called 'neutral cellulases') are more effective at pH 6–6.5.

The reaction temperature is also critical since at low temperatures, the reaction rate is slower than desired, but very high temperatures can deactivate the enzyme by providing enough energy to alter its molecular alignments and thereby destroy its catalytic ability. Since enzymes are true catalysts and are not consumed during the chemical reaction, the hydrolysis reaction will continue until either the reaction conditions change or the cellulose is physically removed from the reaction mixture.

Mechanical agitation is important in order for the hydrolysis reaction to proceed efficiently. Recent work has demonstrated that the kinetics of the reaction are controlled by mass transfer effects. The adsorption–desorption mechanism of enzyme action depends on agitation to remove hydrolysis by-products and expose new fibre areas to attack. Because the enzyme's catalytic action is not reduced during the reaction, an effective method of ending the hydrolysis must be employed to prevent excessive fibre loss.

Since the molecule's physical alignments are crucial to its catalytic ability, procedures that alter the cellulase molecule's internal structure can be used to deactivate the catalysis and halt the hydrolysis. High temperatures (> 70 °C or 160 °F for at least 20 min or short drying at 120 °C or 248 °F), high pH (>10) and high electrolyte content as well as enzyme poisons can serve to terminate the reaction by distorting the enzyme's molecular shape.

Recent developments in enzyme manufacturing have led to commercial products that contain a preponderance of one cellulase component.⁶ These 'mono-component'

METHODOLOGY

enzymes are produced from modified *Humicola* strains and are primarily endo-glucanases active at pH 7–7.5 and are referred to as ‘alkaline cellulases’.

The use of various enzymes is in the early stages of development but their innovative applications are increasing and spreading rapidly into all areas of textile processing. Enzyme producing companies constantly improve their products for more flexible application conditions and a more wide-spread use. The textile industry can greatly benefit from the expanded use of these enzymes as nontoxic, environmentally friendly compounds if their effects on the textile substrate and the basic mechanisms involved are better understood.[18]

3. METHODOLOGY:

3.1. OBJECTIVE:

- To standardize the testing procedure and properties of sanitary napkins manufactured by local SHGs.
- To find eco-friendly alternative fibers for the absorbent core of sanitary napkins.

3.2. METHODS AND MATERIALS:

3.2.1. STANDARDIZE THE TESTING PROCEDURE AND PROPERTIES OF SANITARY NAPKINS MANUFACTURED BY LOCAL SHGS.

3.2.1.1 To analyze 2 local brands of sanitary napkins manufactured by SHGs for dimensional and performance properties.

3.2.1.2 Standardization of procedures and parameters

3.2.2. TO FIND ECO-FRIENDLY ALTERNATIVE FIBERS FOR THE ABSORBENT CORE OF SANITARY NAPKINS

3.2.2.1 Selection and procurement of fibres

3.2.2.2. Optimizing the preparation procedure for fibers

3.2.2.3 Final optimized process

3.2.1. STANDARDIZE THE TESTING PROCEDURE AND PROPERTIES OF SANITARY NAPKINS MANUFACTURED BY LOCAL SHGS.

3.2.1.1 To analyze 2 local brands of sanitary napkins manufactured by SHGs for dimensional and performance properties.

The performance of 2 local brands of sanitary napkins (100 Nos. of pad in each brand), both with wood pulp as core has been compared in terms of:

3.2.1.1.1 DIMENSIONAL PROPERTIES AND WEIGHT OF WHOLE PAD & INDIVIDUAL COMPONENTS

3.2.1.1.1.1. THICKNESS

PRINCIPLE:

The nonwoven fabric of cover stock/top cover of the napkin is kept between 2 smooth parallel plates with a constant pressure. The distance between the plates is measured accurately by a dial indicator.

INSTRUMENT USED:

Thickness tester

STANDARD:

ASTM D 5729 (07.02)

PREPARATION OF SAMPLES:

Take a sample of fabric measuring 6" x 6".

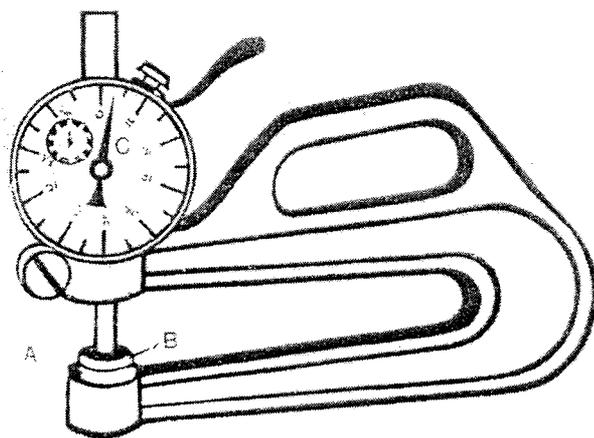


Figure 10: Thickness tester

A – Anvil

B – Presser foot

C - Pointer

PROCEDURE:

Clean the circular pressure foot and the anvil (base plate). Set the gauge dial to zero. Keep the sample below the presser foot without wrinkles. The presser foot is lowered on to the sample slowly at a uniform rate. The thickness of the fabric is noted from the dial then the movement of the pointer has stopped. Repeat the process taking 5 readings at different points of the sample and find out the average thickness of the fabric.

3.2.1.1.1.2. STIFFNESS:

Fabric stiffness indicates the resistance of the fabric to bending and it is a key factor in the study of handle and drape. The Cantilever test is the preferred method because it is simpler to carry out.

INSTRUMENT USED:

Shirley stiffness tester

STANDARD:

PREPARATION OF TEST SPECIMEN:

The sample is conditioned in the standard testing atmosphere and using the template, specimens are cut to the size of 6 inches X 1 inch.

PROCEDURE:

The test is carried out in the standard testing atmosphere. The tester is set on a table so that the horizontal platform and the index lines are at eye level.

The specimen is placed on the platform with the template at the top of it so that the leading edges coincide. Both are slowly pushed forward until the leading edges of the specimen and the template project beyond the edge of the platform. With the eye in a position so that the index lines coincide, the sliding of the specimen is stopped when it cuts both index lines.

If the specimen has a tendency to twist, the reference point at the centre of the leading edge is taken. For the specimens which twist more than 45°, this method should not be used. Then the bending length can be read from the scale opposite a datum line engraved on the side of the platform.

Four readings are taken from each specimen, with each side u, first at one end and then the other. Mean values for the bending length in warp and weft ways are calculated and the flexural rigidity and the bending modulus are determined.

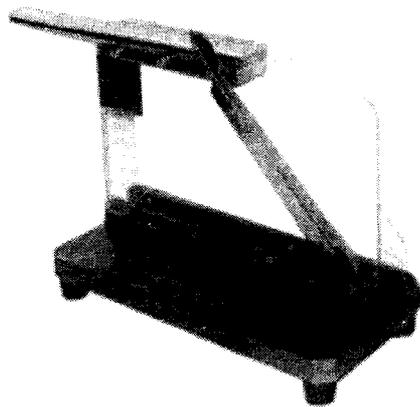


Figure 11: Shirley stiffness tester

3.2.1.1.1.3 DETERMINATION OF GSM:

STANDARD:

ASTM D 2646 (07.02)

PREPARARION OF TEST SPECIMEN:

Prepare a sample of sample size 1X1 cm.

PROCEDURE:

Cut 20 samples. Weigh the samples. Multiply the reading by 10,000 to get the GSM of the sample.

3.2.1.1.2 ABSORBENCY AND LIQUID RETENTION OF THE WHOLE PAD

RECIPE FOR STANDARD LIQUID:

Methyl paraben = 4g

Arabic gum = 740g

Glycerin = 1470ml

Methyl blue = 9g

Time = 24hrs

Add 6 liters of water to 10 liter of stainless steel or glass vessel. Add methyl paraben, Arabic gum and stir until dissolved. Add water to make it 8.05 liters and allow it to stand for 24 hrs. Filter it and add methyl blue, glycerin and 840 ml of water. Total volume of liquid is 9.21 liter approximately. Mix it and leave the solution for 24 hrs.

3.2.1.1.2.1. ABSORBENCY TEST:

STANDARD:

IS:5405-1980 A-1.2

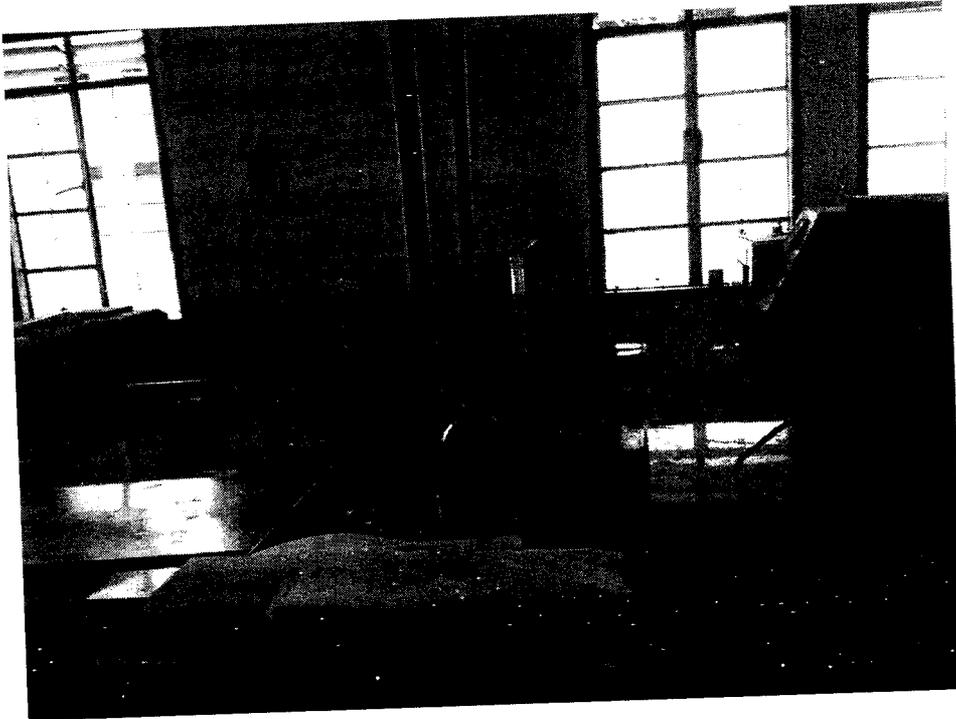


Figure 12: Absorbency test apparatus

PROCEDURE:

Weigh the dry weight of the napkin and lay it on a flat level glass plate, so that the underside of the napkin is visible. Using the burette, drip the test liquid at the rate of 15ml per min on the center of sanitary napkins, from a height of 1-2mm approx away from the burette. Immediately after noting down the end point of the absorption capacity of the pad (which is noted through the leaking of the pad on the sides), the dripping of the test liquid is stopped. Then total amount of liquid allowed to drip is noted down based on the burette readings and the values are tabulated.

3.2.1.1.2.2. ABSORBATION CAPACITY OF THE WHOLE PAD, SAP AND WOOD PULP:

STANDARD:

US patent (5,419,955)

MA001-1-Diapers-worldwide.com

PROCEDURE:

- ✓ The initial weight of the whole pad is noted down.
- ✓ The whole is submerged in the water for 20 minutes.
- ✓ At the exact moment the 20 minutes is over remove the whole pad from the standard test fluid, keep it in a horizontal position and allow the fluid to drain out.
- ✓ Immediately weigh the pad and record its weight.
- ✓ Repeat the process for two more readings.
- ✓ Weight of the wet pad is subtracted from the weight of the dry pad. This is its absorption capacity.

3.2.1.1.3. STRENGTH OF THE COVER STOCK:

3.2.1.1.3.1. TEARING STRENGTH OF THE COVER STOCK

STANDARD:

ASTM D 5735-95

PROCEDURE:

Make a template of paper board with size 18cmX7.5 cm. Make the slit in the middle along the lengthwise grain upto 7.5cm. Using this template cut 20 samples. Prepare the instron instrument to test the samples.

Prepare the test apparatus and calibrate the machine. Secure the specimen in the clamp with the slit edge of each tongue centered. Start the machine and record the tearing

force on the recording device. After, the crosshead has moved to produce approximately 6mm of fabric tear record the single peak force or multiple peak force. Stop the crosshead motion after the fabric has torn completely. Return the crosshead to the starting point. The data are automatically computer-processed and calculations are contained in the associated software.

Perform the test and record the chart and tabulated readings.

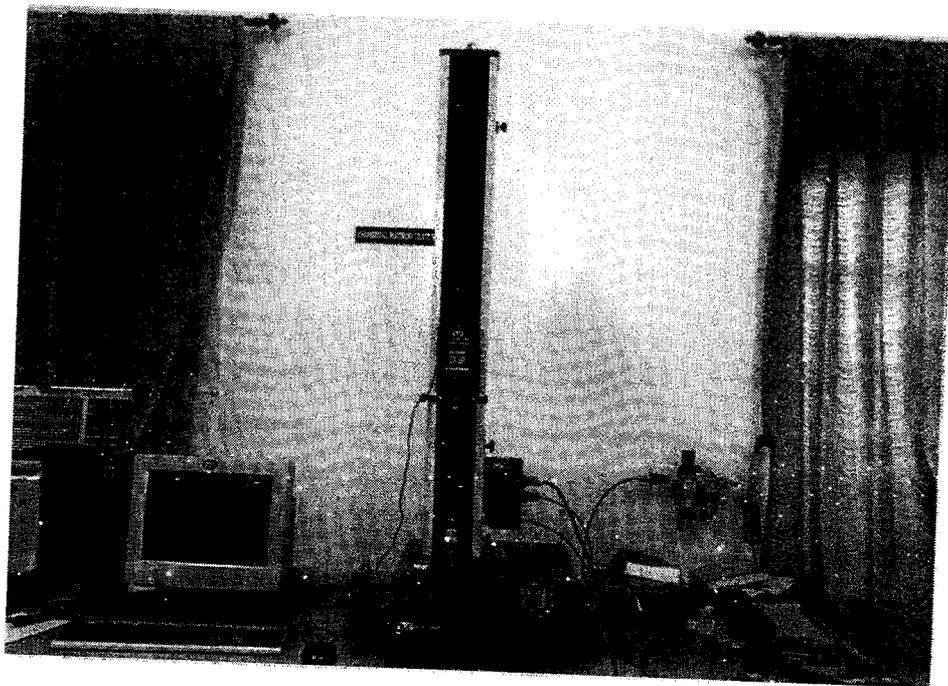


Figure 13: Instron instrument

3.2.1.1.3.2 PEEL BOND STRENGTH OF THE ADHESIVE

INSTRUMENT USED:

Instron instrument

STANDARD:

ASTM D 2724

PREPARATION OF TEST SAMPLE:

Make a template of size 18cmX7.5cm. Using this template cut 20 samples in the fabric. Prepare the Instron instrument to test the samples.

3.2.1.1.3.3 PEEL BOND STRENGTH BETWEEN PAD AND STICKER PAPER:

Prepare the test apparatus and calibrate the machine for conducting the peel bond strength testing in 90 degrees method. Fix the adhesive paper in the top jaw and napkin in the bottom jaws of Instron instrument. Start the machine and record the peel bond strength on the recording device for a distance of 120 cms (equal to the length of the adhesive in the pad). Return the crosshead to the starting point. The data are automatically computer-processed and calculations are contained in the associated software. Perform the test and record the chart and tabulated readings.

3.2.1.1.3.4 PEEL BOND STRENGTH BETWEEN PAD AND FABRIC:

Similar procedure is followed to measure the peel bond strength between pad and fabric (cut samples)

3.2.1.1.4 LEAK FACTOR AND DRYNESS FACTOR

STANDARD:

Modified IS:5405-1980 5.1

PROCEDURE:

Lay the sanitary napkin on a flat level glass plate, so that the underside of the napkins is visible. Using the burette, drip the 30ml of test liquid at the rate of 15ml per min on the center of sanitary napkins, from a height of 1-2mm approx away from the

burette. After the napkin has absorbed the full amount of liquid, keep a blotting paper of known initial weight one on the top and one at the bottom of the pad and place a standard weight of 1kgf for 1 min on the portion where the fluid was absorbed. At the end of loading time remove the blotting papers from the top and bottom of the pad and find out the final weights of the blotting papers.

3.2.1.1.5. PH & DISPOSABILITY OF THE ABSORBENT CORE.

STANDARD:

IS:1390-1961

PREPARATION OF THE AQUEOUS EXTRACT

Prepare the extract at room temperature as follows:

Place each test sample and 100 ml of extracting solution water into a stoppered flask. Agitate the flask for a short period by hand to ensure that the textile material is properly wetted out. Then shake it mechanically for 2 h±5 min. Record the temperature of the extracting solution used.

MEASUREMENT OF THE PH OF THE AQUEOUS EXTRACT USING PH METER

Calibrate the pH-meter at the temperature of the extract to be measured Decant the extract into a beaker. Immediately immerse the electrode to a depth of at least 10 mm and stir gently with a rod until the pH-value stabilizes. And note down the value.

MEASUREMENT OF THE PH OF THE AQUEOUS EXTRACT USING PH PAPER

Decant the extract into a beaker. Immediately immerse the strip of pH paper in to the solution to a depth of 1cm for 30 seconds and compare the color change of pH paper with pH scale (Figure 13) to find out the pH value.

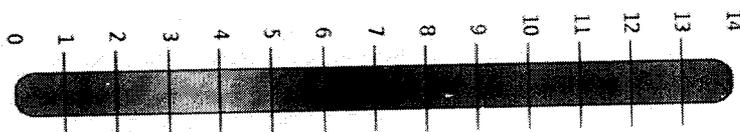


Figure 14: PH scale

3.2.1.1.6. DISPOSABILITY TEST:

STANDARD:

IS 5405-1989 5.2

PROCEDURE:

Separate the wood pulp from the rest of the napkin components and stir it in 5 liters of water. Find out the time taken for disintegration of wood pulp in water using stop watch. Make sure it dissolves completely within 5 min.

3.2.1.2 STANDARDIZATION OF PROCEDURES AND PARAMETERS

3.2.1.1 Standards for all the measured parameters of the sanitary napkins have been set based on the best performance.

The following tests for the sanitary napkins have been standardized:

- Peel bond (pad to sticker paper and pad to cloth) (Refer 3.2.1.1.3.4)

- Absorbency index (a formula was derived based on the absorption% of the fibre and gel combination used for absorbent core)
- Leak factor and dryness factor (Refer 3.2.1.1.4)
- Absorption capacity for the whole pad, super absorbent gel and wood pulp. (Refer 3.2.1.1.2)

3.2.2. TO FIND ECO-FRIENDLY ALTERNATIVE FIBERS FOR THE ABSORBENT CORE OF SANITARY NAPKINS:

3.2.2.1 SELECTION AND PROCUREMENT OF FIBRES:

MOISTURE REGAIN AND MOISTURE CONTENT:

S.No	Properties	FIBRES							
		JT	KNF	ARNT	BG	CP	WP	Sisal	Coir
1	Moisture regain (%)	9.05	9.2	9.24	9.4	16.28	6.85	10-22	8
2	Moisture content (%)	8.3	8.44	8.46	8.63	14	6.41	87.25%	17

Table 4: Moisture content and regain of fibres

The selection of fibres is done based on the analysis and comparison of the moisture regain and moisture content of the fibres with the wood pulp which is shown in the above table.

PROCUREMENT OF FIBRES:

- Jute and kenaf fibres were procured from Salem which was extracted for the purpose of producing ropes.
- Arecanut fibres were procured from Kerala, the waste removed from the removal of beetle nut.
- Coir pith is collected from the waste of the coir and sugarcane industry.

- Bagasse was the waste collected from the sugarcane juice extraction vendors.

3.2.2.2. OPTIMIZING THE PREPARATION PROCEDURE FOR FIBERS.

After procurement of the fibers, they are subjected to either/combination of the following treatments:

- Cleaning with eco friendly materials
- Alkali treatment
- Softening of fibers through Bio process method

The optimization of fiber processing was first done with jute fibers.

3.2.2.2.1. CLEANING:

For cleaning organic cleaning agents called Chebulic myrobalan (kadukkai) and Sapindus (puchkai) were used. They were used as a traditional method of cleaning. Organic cleaning products have major health and environmental advantages.[19]

CLEANING WITH CHEBULIC MYROBALAN POWDER:

RECIPE:

Fibre – 10g/l

Chebulic myrobalan Powder- 10g/l

M:L ratio- 1: 0.1

Temperature- 60°C

Time- till boiling

Chebulic myrobalan is added to the water and stirred until dissolved. Add the fibers to the dissolved solution and heat it until it boils. Remove the fiber from the solution and rinse it well with cold water.

CLEANING WITH SAPINDUS POWDER:

RECIPE:

Fibre – 10g/l

Sapindus- 10g/l

M:L ratio- 1: 0.1

Temperature- 60°c

Time- till boiling

Seed is separated from the sapindus. It is added to the water and heated. The sapindus is squeezed and removed from the water. Add the fibres to the solution and heat it until it boils. Remove the fiber from the solution and rinse it well with cold water.

The sample of 5gms of juter fibers cleaned with Chebulic myrobalan and sapindus were subjected to FTIR test and subjective handling. The test results inferred that kadukkai had a better result of cleaning than sapindus. But kadukkai resulted in deposition of Chebulic myrobalan precipitate on the fibers along with yellow tint in the fiber. Hence sapindus was selected for cleaning the fibers.

3.2.2.2.2. ALKALI TREATMENT:

It is characteristic of the glucosidic linkage of the cellulose molecule that it is highly resistant to alkalies. At normal temperature weak solutions of caustic soda have no effect on cellulose. But on boiling in a 1 % solution of caustic soda, a small part of cellulose passes into solution. As the alkali concentration increases, the cellulose solubility becomes considerably higher.

In concentrated solutions of caustic soda (over 10 per cent) at normal temperatures, the fibre swells, becomes elastic, and contracts in length.

RECIPE:

NaOH flakes- 10%

pH-12

PROCEDURE:

The sample of 5gms of jute, baggage, coir fibres were treated separately with 3%, 5 %,and 10% NaOH at a temperature of 100 °C for 60 mins. The pH is maintained at 12 during the boiling. Later the fibers were neutralized with few drops of acetic acid and fibers were removed and rinsed thoroughly. Out of the 3 concentrations, 10% treatment was found to be effective giving better handle of fibers.

3.2.2.2.3. ENZYMATIC SOFTENING (USING BAGASSE-CELLULASE ENZYME)

a) BUFFER PREPARATION TO EXTRACT THE ENZYME:

RECIPE:

Potassium dihydrogen phosphate – 31.2g for 1000ml

Hydrogen potassium phosphate-37.6 for 1200ml

Potassium dihydrogen phosphate – 39ml

Hydrogen potassium phosphate- 51ml

(making up 100ml on the whole for 1g of bagasse)

PROCEDURE:

To extract the cellulase enzymes cut the bagasse into small pieces and drop it in the above solution. (Bagasse 10g/l).

Store the solution in a cool place for 24hours for the enzyme to be extracted.

SOFTENING PROCESS:

RECIPE:

pH – 7

time – 5 hours

Temperature- Room temperature

PROCEDURE:

The prepared buffer solution which contains cellulase enzymes is filtered to get the enzyme solution.

Then the cleaned fibre is treated with the enzyme solution for 5 hours at the pH level of 7.[20]

3.2.2.2.4 ENZYME ACITIVITY TEST:

RECIPE:

3 test tubes

T1- Enzyme + DNS standard solution

T2- DNS standard solution

T3- Starch +enzyme+ DNS standard solution

Starch, enzyme -10 ml

DNS coloring agent-2 ml

PROCEDURE:

Take 4 test tubes and name the as T1, T2 and T3. Add enzyme + DNS standard solution in T2. In T3 test tube add DNS standard solution and in the last test tube T4 add starch, enzyme and DNS standard solution. Starch and enzymes are taken 10ml each. DNS is taken 2ml each. Then these test tubes are heated to a temperature of 100°C for 10min. The color change of the solution is noted and the corresponding inference is noted down.[20]

3.2.2.3 FINAL OPTIMIZED PROCESS:

- Cleaning with sapindus
- Alkali treatment with 10% NaoH
- Softening process with cellulase enzyme

The above procedures were followed for the other fibres for bulk processing as follows (70gms of fibers):

Jute:

Jute fibre is not a soft fibres by nature. So, was cleaned , treated with NaOH and softened with cellulase enzymes.

Aricanut:

For aricanut the fibres are cleaned and treated with NaOH. Softening was not done.

Coir

The coir pith has was cleaned, treated with NaOH and softened with cellulase enzymes.

Coir pith

For coir pith, the fibres are cleaned. As coir pith is in dust form so the further processes were neglected.

Sisal

The sisal was cleaned, treated with NaOH and softened with cellulase enzymes.

Kenaf

Kenaf fibre is cleaned, treated with NaOH and softened with cellulase enzymes.

Bagasse

Bagasse was cleaned, treated with NaOH and softened with cellulose enzymes, but it was found to be still hard, so the raw bagasse was ground into powder form and used.

3.2.2.4. TESTS CONDUCTED FOR FIBRES AT RAW STAGE AND PROCESSED STAGE:

Moisture content, moisture regain, FTIR, Immersion time and absorption capacity.

3.2.2.4.1 MOISTURE CONTENT, MOISTURE REGAIN:

STANDARD:

ASTM D 2495-01

DESICCATOR PROCEDURE:

When an oven with a built-in balance is not available, or when maximum precision is required, specimens may be weighed after cooling in a desiccator. This procedure takes much more time, but the moisture content or moisture regain may be determined within ± 0.3 percentage point at the 95 % probability level. However, unless the specimens are truly representative of the material and are taken under conditions that prevent any change in moisture content during sampling, the desiccator procedure may not give any more accurate information as to the moisture content or moisture regain of the material sampled than does the oven-balance procedure.

Since cotton containing at least 2 % moisture will not change more rapidly than 0.1 %/min during exposure to air at ordinary temperatures and humidities, it is permissible, and often more convenient, to open the container and weigh the specimen directly on the balance pan to the nearest 0.01 g.

Close the weighing can or weighing bottle while it is still in the oven, then transfer the closed container to desiccator and cover the desiccator. Two or three times while the specimen and container are cooling, uncover the desiccator raise the cover of the container slightly for a moment to equalize the air pressure, and replace the cover on the

desiccator {Note 6). When the container and specimen have cooled to room temperature, weigh them to the nearest 0.01 g. Return the container and specimen to the oven, uncover, and repeat the drying, cooling, and weighing at the intervals specified in 9.4.1.1 or 9.4.1.2 until the change in mass between two successive weighing is less than 0.1 % of the specimen mass. Record the final mass and the mass of the empty container.

3.2.2.4.2 FTIR PRINCIPLE

To identify a component of certain compounds, they are exposed to high energy such as Infrared Radiation (IR). The reaction results to emission of energy showing the reactions of the molecules, which are automatically plotted to a graph by one of the programs embedded in spectroscopic instruments. Using the generated graph, organic chemists analyze the plot and detect distinctive peaks that can be attributed to the components of the compound.

For instance, a graph shows two distinctive peaks, and after analyzing the plot, you found out that one peak corresponds to Hydrogen (H) and the other is Oxygen (O₂); thus, you can safely say that it is H₂O or water molecule. Molecules that react with IR always exhibit the same distinguishing peak of energy so they can easily be identified from the graph.

BASIC COMPONENT AND WORKING OF FTIR

The unique part of an FTIR spectrometer is the interferometer. A Michelson type plane mirror interferometer is displayed. Infrared radiation from the source is collected and collimated (made parallel) before it strikes the beamsplitter. The beamsplitter ideally transmits one half of the radiation, and reflects the other half. Both transmitted and reflected beams strike mirrors, which reflect the two beams back to the beamsplitter. Thus, one half of the infrared radiation that finally goes to the sample gas has first been reflected from the beamsplitter to the moving mirror, and then back to the beamsplitter. The other half of the infrared radiation going to the sample has first gone through the beamsplitter and then reflected from the fixed mirror back to the beamsplitter. When

these two optical paths are reunited, interference occurs at the beamsplitter because of the optical path difference caused by the scanning of the moving mirror.

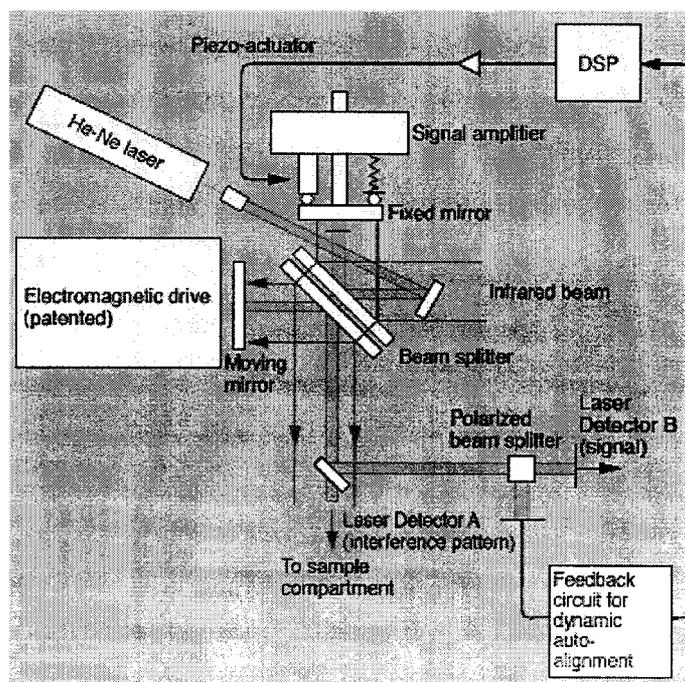


Figure 15: FTIR principle

The surface chemistries of the treated fibres were evaluated by using a Shimadzu FTIR with equipment. Scans were run at resolution of 4cm^{-1} . The sample recording of the fibres consisted of 100 scans recorded in absorbance wavelength from 4000 to 400cm^{-1} .

3.2.2.4.3 IMMERSION TEST METHOD:

STANDARD:

US patent (5,419,955)

PRINCIPLE:

- The test fibre is placed in a nylon mesh and tied with a thread and allowed to immerse in water under its own weight.

- The time required for complete wetting of the fibre is measured, the mass of water absorbed then being determines after a sated immersion time followed by a given draining time, under specified conditions.

PROCEDURE:

- 1 gram of fibre is taken and placed in the nylon mesh and tied with a thread of known length.
- Place the nylon mesh packed with the fiber in a glass beaker.
- Start to record the time from the stop watch.
- Observe the wetting of the fibre to determine the moment that complete wetting occurs.
- Stop the timer and record the time required for complete wetting of the fibre.

3.2.2.4.4 ABSORPTION CAPACITY:

STANDARD:

MA001-1-Diapers-worldwide.com

PROCEDURE:

- This can be continued from the immersion test.
- After the exact moment that the complete wetting of the sample is achieved, allow the nylon mesh packed with fiber to remain submerged in the water for 20 minutes.
- At the exact moment the 20 minutes is over remove the nylon mesh from the water, keep it in a horizontal position and allow the water to drain out.
- Immediately weigh the nylon mesh packed with the fiber and record its weight.
- Repeat the process for two more readings.
- Weight of the wet fiber and subtract from it the weight of the dry fiber. This is its absorption capacity.

3.2.3. TO PREPARE SANITARY NAPKINS FROM THE PREPARED FIBERS AND FINDING ITS SUITABILITY AS AN ABSORBENT CORE.

3.2.3.1 WEB PREPARATION:

Using the above methods and processes the fibres are made into an applicable to be made as an absorbent core in the sanitary napkins.

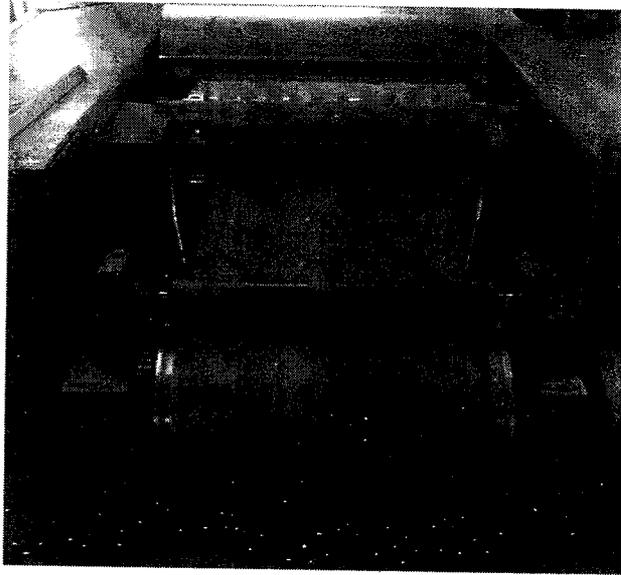


Figure 16: Mini carding machine

The softened fibers are converted into a web. The webs are made from mini carding machine. The fibers selected for web formations are jute, aricanut and kenaf. These prepared webs are used directly for the absorbent core in the sanitary napkins. The bagasse and coir pith are made into a web by compression method.

3.2.3.2 TESTING WETTING TIME OF THE WEB:

Wettability or wetting is the actual process when a liquid spreads on a solid substrate or material. Wettability can be estimated by determining the contact angle or calculating the spreading coefficient. Wetting or spreading of a liquid on a solid surface or material depends on the solid surface properties as well as the liquid used.

3.2.3.2 SANITARY NAPKIN PREPARATION:

The top cover and leak proof are made from polypropylene and polyethylene. The dimensions for the napkins are taken from the standardized readings. The full pad is prepared using the sealing machines according to the standardized measurements.

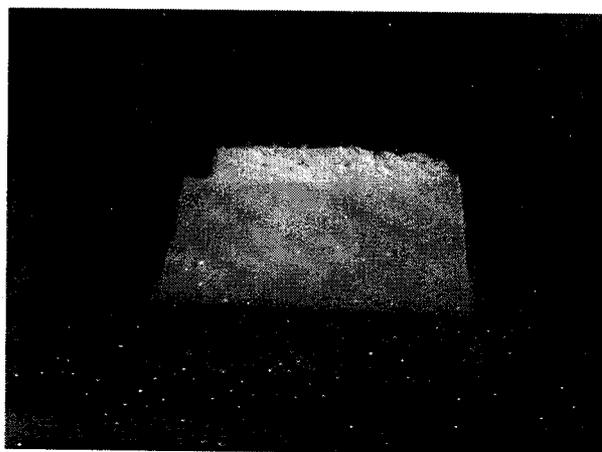


Figure 17: Napkin components

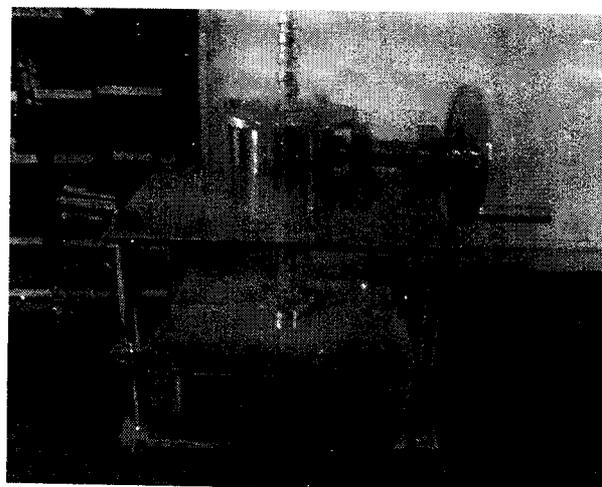


Figure 18: Compressing machine

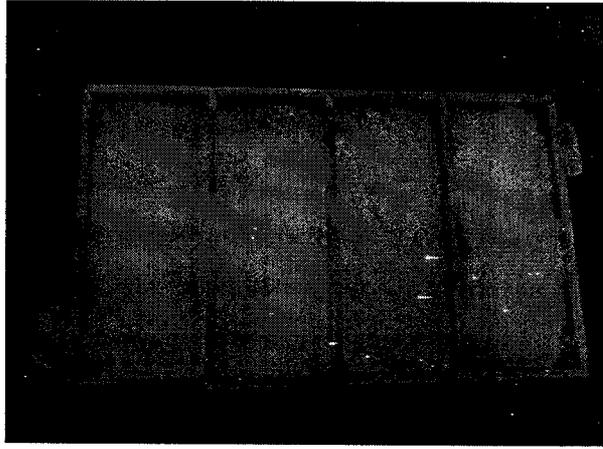


Figure 19: Template

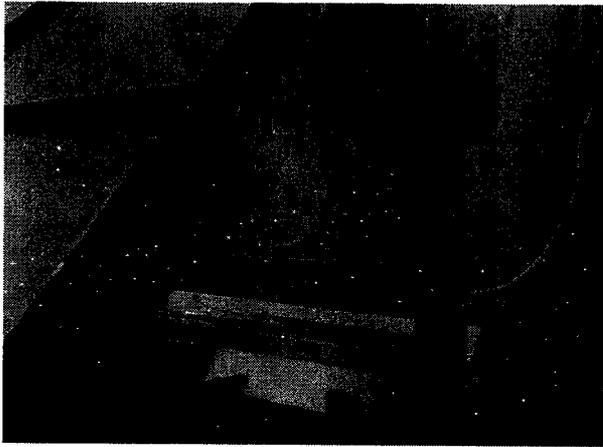


Figure 20: Fusing machine

3.2.3.2.1 VARIETIES OF SANITARY NAPKINS:

Varieties of sanitary napkins were made which varied in the composition of the absorbent core and with the following specifications:

1. Stock cover / top cover(Permeable Non-woven) GSM- 16 GSM,
Dimension -200 mm X 350 mm
2. Leak proof material dimensions (polyethylene sheet)-90 mm X 190 mm

Fibre composition in the absorbent core	Abbreviation	Weight of absorbent core
Jute	JT	12.8
Kenaf	KNF	12.42
Aricanut	ARNT	11.61
Bagasse	BG	12.13
Coir pith	CP	12.15
Wood pulp	WP	9.59
Jute 50% and wood pulp 50%	WP / JT	10.2
Kenaf 50% and wood pulp 50%	WP / KNF	9.95
Arecanut 50% and wood pulp 50%	WP / ARNT	10.03
Coir pith 50% and wood pulp 50%	WP / CP	16.87
Bagasse 50% and wood pulp 50%	WP / BG	15

Table 5: Different fiber composition in the absorbent core

The prepared sanitary napkins were tested for their absorbency and retention properties.

3.2.3.3 TESTS CARRIED OUT FOR THE PREPARED SANITARY NAPKINS:

Each variety of the prepared sanitary napkins has been tested for the following:

- Absorbancy test(Refer 3.2.1.1.2)
- Leak factor and dryness factor (Refer 3.2.1.1.4)
- Retention test (Refer 3.2.1.1.2) [21]

RESULT AND DISCUSSION

RESULTS AND DISCUSSIONS:

4.1 Analysis of 2 local brands of sanitary napkins manufactured by SHGs for dimensional and performance properties.

Table 7: Dimensional and absorbency test results for GANDHIGHGRAM- Batch no 2

Whole Pad											Individual Parts										
Dimensional Tests					Absorbency tests					Sticker Paper			Top Cover				Wood Pulp		Leak Proof		
S. no	Length in cm	Width in cm	Thickness in mm	Weight in grams	Moisture %	Dryness factor	Leak factor	Weight in gms	Thickness in mm	Thickness in mm	Thickness in mm	Weight in gms	GSM	Bending Rigidity	Weight in gms	Weight in gms	Thickness in mm	GSM			
1	21.6	7	7.05	13.87	276.53	2.25	1.05	0.61	0.05	0.12	1.48	0.16	0.16	33.275	10.93	0.44	0.18	24			
2	20.8	6.7	7.55	13.8	277.25	4.17	5.81	0.61	0.06	0.16	1.28	0.16	0.16	43.2	11.03	0.44	0.19	24			
3	22.2	7	7.55	14.91	230.40	4.17	8.00	0.51	0.05	0.1	1.42	0.16	0.16	31.4928	12.37	0.42	0.2	28			
4	20.8	8.2	5.97	13.69	285.87	15.69	0.00	0.63	0.06	0.1	1.46	0.16	0.16	33.275	11.04	0.35	0.2	24			
5	20.4	7.3	7.63	14.27	323.50	17.31	0.00	0.58	0.05	0.12	1.51	0.16	0.16	31.4928	11.49	0.42	0.2	28			
6	21.7	6.8	6.71	14.97	258.32	8.97	0.00	0.58	0.05	0.12	1.37	0.16	0.16	28.1216	12.17	0.42	0.17	24			
7	21.5	6.7	6.23	14.77	267.11	13.64	1.22	0.5	0.05	0.12	1.6	0.16	0.16	31.4928	11.94	0.42	0.16	24			
8	21.3	7.1	6.6	13.21	250.19	7.61	1.11	0.62	0.05	0.12	1.5	0.16	0.16	31.4928	10.34	0.42	0.19	24			
9	20.8	7.4	8.54	13.39	247.40	2.38	0.00	0.47	0.07	0.11	1.34	0.16	0.16	35.1232	11.1	0.45	0.21	24			
10	20.5	7.1	6.95	12.85	253.90	17.72	0.00	0.52	0.05	0.14	1.35	0.16	0.16	35.1232	10.28	0.44	0.17	28			
11	20.8	7	7.05	13.8	285.87	15.69	0.00	0.58	0.06	0.12	1.48	0.16	0.16	35.1232	10.93	0.44	0.18	24			
12	22.2	0.7	7.55	13.87	230.40	4.17	8.00	0.5	0.07	0.16	1.4	0.16	0.16	28.1216	11.03	0.44	0.19	22			
13	20.8	8.2	7.55	14.91	258.32	8.97	0.00	0.51	0.06	0.1	1.53	0.16	0.16	31.4928	12.37	0.42	0.2	24			
14	21.7	7.3	5.97	13.96	276.53	2.25	1.05	0.61	0.05	0.1	1.56	0.16	0.16	28.1216	11.04	0.44	0.2	25			
15	21.5	6.7	7.3	14.27	250.19	7.61	1.11	0.47	0.05	0.12	1.25	0.16	0.16	25	11.49	0.45	0.17	26			
16	21.3	7.1	6.71	14.77	253.90	17.72	0.00	0.52	0.06	0.12	1.25	0.16	0.16	28.1216	12.17	0.42	0.16	28			
17	20.4	7.4	6.23	14.27	247.40	2.38	0.00	0.58	0.07	0.12	1.45	0.16	0.16	31.4928	11.94	0.35	0.19	26			
18	20.5	6.7	6.6	12.85	277.25	4.17	5.81	0.63	0.08	0.14	1.3	0.16	0.16	28.1216	10.34	0.44	0.17	24			
19	21.6	6.8	8.54	13.39	323.50	17.31	0.00	0.61	0.07	0.11	1.6	0.16	0.16	31.4928	11.1	0.35	0.19	24			
20	22.2	7.5	7.05	13.8	267.11	13.64	1.22	0.47	0.06	0.14	1.56	0.16	0.16	31.4928	10.28	0.35	0.21	24			
Avg	21.2	6.83	7.06	13.98	267.05	9.39	1.72	0.55	0.05	0.12	1.43	0.16	0.16	31.6335	11.26	0.41	0.18	24.95			
SD	0.61	1.51	0.73	0.66	25.12	6.05	2.75	0.06	0.01	0.02	0.11	0.00	0.00	3.84	0.70	0.04	0.02	1.76			
CV	2.87	22.6	10.3	4.72	9.40	64.44	160.1	10.4	15.9	14.7	7.87	0.00	0.00	12.1686	6.19	8.52	8.39	7.06			

Table 8: Dimensional and absorbency test results for GANDHIGRAM- Batch no 3

S. no		Whole Pad										Individual Parts																	
		Dimensional Tests					Absorbency tests					Sticker Paper					Top Cover Pulp					Wood					Leak Proof		
Length in cm	Width in mm	Thickness in mm	Weight in grams	Moisture %	Dryness factor	Leak factor	Weight in grams	Thickness in mm	Thickness in mm	Weight in grams	GSM	Bending rigidity	Weight in grams	Weight in grams	Thickness in mm	GSM	Bending rigidity	Weight in grams	Weight in grams	Thickness in mm	GSM	Bending rigidity	Weight in grams	Weight in grams	Thickness in mm	GSM			
1	21.2	8	7.04	16.72	290.90	14.81	0	0.5	0.06	0.12	1.22	16	12.8	13.74	0.41	16	12.8	13.74	0.41	0.14	20								
2	22.4	7.8	6.3	13.09	198.75	13.85	3.61	0.51	0.06	0.11	1.3	16	43.2	10.29	0.5	16	43.2	10.29	0.5	0.22	28								
3	20	7	6.13	12.42	274.63	9.72	1.82	0.541	0.06	0.13	1.29	16	0.819	9.73	0.39	16	0.819	9.73	0.39	0.18	28								
4	21.2	8	6.55	13.55	186.11	-1.59	0.00	0.77	0.05	0.12	2.12	16	22.11	9.54	0.47	16	22.11	9.54	0.47	0.21	28								
5	20.8	7.5	6.7	12.54	211.83	27.42	0.00	0.62	0.06	0.14	1.51	16	25	9.15	0.45	16	25	9.15	0.45	0.19	28								
6	20.7	7.9	6.46	13.17	246.34	22.39	0.00	0.53	0.06	0.12	1.61	16	35.12	10.19	0.41	16	35.12	10.19	0.41	0.19	28								
7	21.2	7.7	6.35	13.45	174.34	14.86	1.59	0.59	0.05	0.1	1.78	16	35.12	10.05	0.46	16	35.12	10.05	0.46	0.21	28								
8	21	8	5.39	13.56	209.78	23.73	0.00	0.46	0.05	0.1	1.46	16	31.49	10.62	0.4	16	31.49	10.62	0.4	0.18	24								
9	21	8.3	5.3	13.16	213.46	15.63	1.69	0.47	0.05	0.13	1.9	16	35.12	9.54	0.38	16	35.12	9.54	0.38	0.18	28								
10	22	7.7	4.36	11.99	219.72	17.72	1.59	0.48	0.05	0.1	1.46	16	39.02	9.14	0.41	16	39.02	9.14	0.41	0.18	28								
11	22.4	7.7	6.55	12.54	211.83	27.42	0.00	0.53	0.05	0.14	1.6	16	8	10.19	0.41	16	8	10.19	0.41	0.17	28								
12	22.4	7.7	7	13.17	186.11	-1.59	0.00	0.62	0.05	0.117	1.5	16	0.819	9.73	0.39	16	0.819	9.73	0.39	0.15	26.8								
13	22.1	7.9	7.5	12.42	209.78	23.73	0.00	0.77	0.05	0.17	1.6	16	22.11	9.54	0.47	16	22.11	9.54	0.47	0.14	28								
14	22.6	8.1	5.75	13.09	246.34	22.39	0.00	0.59	0.05	0.18	1.8	16	25	9.15	0.41	16	25	9.15	0.41	0.23	27								
15	21.1	7.8	4.76	16.72	219.72	17.72	1.59	0.46	0.05	0.14	1.8	16	28.12	10.19	0.38	16	28.12	10.19	0.38	0.19	28								
16	21.5	7.1	6.13	13.45	274.63	9.72	1.82	0.47	0.05	0.16	1.87	16	31.49	9.15	0.4	16	31.49	9.15	0.4	0.14	28								
17	22.4	8.1	5	13.17	174.34	14.86	1.59	0.54	0.06	0.15	1.46	16	39.02	10.19	0.47	16	39.02	10.19	0.47	0.22	27								
18	21.6	7.8	7.14	12.4	213.46	15.63	1.69	0.51	0.05	0.16	1.56	16	35.12	10.15	0.5	16	35.12	10.15	0.5	0.17	27								
19	20.8	8	6.3	12.54	198.75	13.85	3.61	0.48	0.06	0.17	1.75	16	25	10.29	0.41	16	25	10.29	0.41	0.18	26								
20	20.7	7	5.39	11.99	246.34	22.39	0.00	0.52	0.05	0.18	1.8	16	31.49	9.15	0.43	16	31.49	9.15	0.43	0.23	27								
Avg	21.4	7.7	8.88	13.25	220.36	16.23	1.03	0.54	0.05	0.13	1.62	16	26.54	9.98	0.42	16	26.54	9.98	0.42	0.19	27.0								
SD	0.74	0.3	12.1	1.28	33.14	8.01	1.20	0.09	0.00	0.03	0.23	0	11.93	1.00	0.04	0	11.93	1.00	0.04	0.03	1.93								
CV	3.46	4.6	137	9.67	15.04	49.33	116.43	16.54	8.99	19.36	14.2	0	44.97	10.04	9.01	0	44.97	10.04	9.01	15.54	7.14								

Table 7: Dimensional and absorbency test results for GANDHIGRAM Batch No 4

Whole Pad																			
S. no	Dimensional Tests				Absorbency Tests			Sticker Paper			Top Cover				Wood Pulp			Leak Proof	
	Length in cm	Width in cm	Thickness in mm	Weight in grams	Moisture %	Dryness factor	Leak factor	Weight in gms	Thickness in mm	Thickness in mm	Weight in gms	GSM	Bending Rigidity	Weight in gms	Weight in gms	Thickness in mm	Weight in gms	Thickness in mm	GSM
1	20.2	7.5	5.22	12.8	222.32	16.67	0	0.42	0.05	0.1	1.52	16	35.1232	10.13	0.34	0.16	0.34	0.16	40
2	19.9	7.4	6.25	13.15	300.94	4.35	1.67	0.3	0.05	0.11	1.54	18	41.66843	10.65	0.38	0.18	0.38	0.18	28
3	21	7.4	6.78	12.87	243.38	1.54	1.45	0.43	0.05	0.13	1.6	16	35.1232	11.02	0.36	0.2	0.36	0.2	24
4	20.3	7.4	6.42	14.7	329.84	6.06	0.00	0.4	0.05	0.1	1.28	16	39.0224	12.2	0.39	0.16	0.39	0.16	28
5	20.8	7.3	6.41	14.41	281.45	13.43	2.90	0.4	0.05	0.11	1.55	16	31.4928	11.79	0.36	0.17	0.36	0.17	32
6	21.8	7.4	7.23	16.04	313.90	21.88	0.00	0.39	0.05	0.11	1.47	18	33.49733	13.42	0.38	0.15	0.38	0.15	40
7	21.4	7.4	7.2	15.86	282.90	9.23	0.00	0.42	0.06	0.1	1.46	18	35.4294	13.23	0.39	0.15	0.39	0.15	25
8	21	7.3	5.95	14.42	340.30	3.23	0.00	0.4	0.07	0.1	1.51	18	43.9002	11.83	0.38	0.16	0.38	0.16	28
9	20.8	7.2	5.79	12.82	310.26	10.14	0.00	0.39	0.07	0.1	1.42	18	35.4294	10.36	0.39	0.18	0.39	0.18	30
10	21.5	7.4	7.22	15.57	238.86	16.42	1.45	0.43	0.05	0.12	1.52	18	35.4294	12.83	0.42	0.16	0.42	0.16	30
11	21.4	7.4	5.95	15.57	281.45	13.43	2.90	0.4	0.06	0.12	1.54	18	0.6174	11.79	0.36	0.16	0.36	0.16	30
12	21.8	7.3	6.41	15.48	243.38	3.08	1.45	0.39	0.07	0.1	1.52	16	33.275	12.2	0.39	0.16	0.39	0.16	28
13	20.3	7.4	6.42	13.15	329.84	6.06	0.00	0.39	0.05	0.11	1.28	16	12.8	11.02	0.38	0.16	0.38	0.16	28
14	20.8	7.4	7.2	12.5	310.26	10.14	0.00	0.37	0.05	0.12	1.6	15	29.5245	13.42	0.38	0.16	0.38	0.16	28
15	19.9	7.2	6.42	12.8	300.94	4.35	1.67	0.36	0.07	0.12	1.47	15	26.364	11.83	0.39	0.15	0.39	0.15	30
16	20.2	7.3	6.78	13.5	238.86	16.42	1.45	0.41	0.07	0.12	1.51	16	12.8	10.36	0.42	0.15	0.42	0.15	30
17	21	7.5	6.25	15.27	313.90	21.88	0.00	0.44	0.05	0.12	1.55	16	28.1216	12.83	0.36	0.15	0.36	0.15	30
18	21.5	7.4	5.95	12.82	222.32	16.67	0.00	0.38	0.08	0.11	1.42	16	33.275	13.23	0.38	0.17	0.38	0.17	28
19	20.8	7.4	5.95	13.4	340.30	3.23	0.00	0.35	0.07	0.11	1.28	17	35.35469	11.79	0.34	0.17	0.34	0.17	28
20	20.3	7.4	7.2	14.41	282.90	9.23	0.00	0.34	0.06	0.11	1.6	17	29.8792	11.07	0.39	0.17	0.39	0.17	28
Avg	20.83	7.37	6.45	14.07	286.42	10.37	0.75	0.39	0.05	0.11	1.48	16.7	30.40636	11.85	0.37	0.16	0.37	0.16	29.6
SD	0.60	0.08	0.57	1.22	39.18	6.41	1.02	0.03	0.01	0.01	0.10	1.080	10.47551	1.07	0.02	0.01	0.02	0.01	3.93
CV	2.89	1.09	8.81	8.70	13.68	61.84	136.14	8.69	17.30	8.22	6.83	6.472	34.4517	9.03	5.61	7.76	5.61	7.76	13.3

Table 10: Dimensional and absorbency test results for GANDHIGRAM-Batch no 5

S. no	Whole Pad										Individual Parts																			
	Dimensional Tests					Absorbency Tests					Sticker Paper					Top Cover					Wood Pulp					Leak Proof				
	Length in cm	Width in cm	Thickness in mm	Weight in grams	Moisture %	Dryness factor	Leak factor	Weight in grams	Thickness in mm	Leak factor	Weight in grams	Thickness in mm	Weight in grams	Thickness in mm	GSM	Bending rigidity	Weight in grams	Thickness in mm	Weight in grams	Thickness in mm	GSM	Bending rigidity	Weight in grams	Thickness in mm	Weight in grams	Thickness in mm	GSM			
1	22.8	7.5	4.41	10.94	219.62	6.25	0	0.42	0.05	1.48	1.48	1.48	9.89	0.34	0.18	40														
2	20.8	7.4	5.25	11.92	220.30	8.33	1.54	0.39	0.05	1.54	1.54	10.65	0.38	0.16	25															
3	22	7.4	5.49	13.05	219.74	0	2.74	0.43	0.05	1.41	1.41	10.82	0.36	0.2	28															
4	20.6	7.4	5.52	12.82	169.13	12.5	10.45	0.4	0.06	1.3	1.3	12.2	0.39	0.17	35															
5	20.5	7.3	7.29	14.08	229.54	9.52	0.00	0.4	0.06	1.55	1.55	11.79	0.36	0.19	30															
6	21.2	7.4	6.81	14.33	223.32	13.43	1.59	0.39	0.05	1.52	1.52	13.42	0.38	0.17	35															
7	21	7.4	6.46	14.42	224.56	18.46	0.00	0.42	0.06	1.46	1.46	13.23	0.39	0.18	25															
8	21.3	7.3	5.66	13.48	233.66	16.18	0.00	0.44	0.06	1.44	1.44	11.83	0.38	0.2	27															
9	21.7	7.2	4.3	11.57	230.99	14.08	0.00	0.39	0.06	1.42	1.42	10.36	0.39	0.18	34															
10	21	7.4	5.33	12.36	223.67	15.38	1.37	0.43	0.06	1.38	1.38	12.83	0.42	0.19	35															
11	21.4	7.4	5.95	15.57	230.99	14.08	0.00	0.4	0.06	1.54	1.54	11.07	0.36	0.17	35															
12	21.8	7.3	6.41	15.48	223.32	13.43	1.59	0.39	0.06	1.52	1.52	29.88	12.2	0.39	0.18	34														
13	20.3	7.4	6.42	13.15	233.66	16.18	0.00	0.39	0.06	1.28	1.28	11.02	0.38	0.18	37															
14	20.8	7.4	7.2	12.5	220.30	8.33	1.54	0.37	0.06	1.6	1.6	13.42	0.38	0.17	35															
15	19.9	7.2	6.42	12.8	229.54	12.70	0.00	0.36	0.05	1.47	1.47	11.83	0.39	0.19	25															
16	20.2	7.3	6.78	13.5	219.62	6.25	0.00	0.41	0.06	1.51	1.51	10.36	0.42	0.16	26															
17	21	7.5	6.25	15.27	224.56	18.46	0.00	0.44	0.05	1.55	1.55	12.83	0.36	0.17	28															
18	21.5	7.4	5.95	12.82	219.74	0.00	2.74	0.38	0.06	1.42	1.42	13.23	0.38	0.19	35															
19	20.8	7.4	5.95	13.4	223.45	15.38	1.37	0.35	0.05	1.28	1.28	11.79	0.34	0.17	27															
20	20.3	7.4	7.2	14.41	179.75	12.50	10.45	0.34	0.06	1.6	1.6	11.07	0.39	0.15	36															
Avg	21.04	7.37	6.05	13.39	219.97	11.57	1.77	0.39	0.05	1.46	1.46	11.79	0.37	0.17	31.60															
SD	0.70	0.08	0.85	1.27	16.37	5.32	3.11	0.03	0.00	0.10	0.10	1.11	0.02	0.01	4.77															
CV	3.31	1.09	13.97	9.48	7.44	46.00	176.13	7.13	8.66	6.67	6.67	9.44	5.61	7.51	15.10															

Table 11: Test results for Ghandhigram peel bond and tensile strength- batch 1

S no	Peel bond						Tensile Strength			Disposability in secs	pH
	Sticker			Fabric			Maximum load(N)	Extension at maximum load(mm)	Tenacity at maximum load(gf/tex)		
	Load at maximum peel extension	Extension at maximum (mm)	Time at maximum peel extension(sec)	Load at maximum peel extension	Extension at maximum (mm)	Time at maxi peel extension(sec)					
1	0.59506	292.17	58.434	0.3084	258.57	51.716	6.02	93.002	6.14495	83	Neutral
2	0.5367	263.02	52.606	0.5598	243.43	48.686	6.77	167.49	6.9094	87	Neutral
3	0.58612	213.73	42.748	0.504	293.41	58.684	6.60	173.49	6.73726	86	Neutral
4	0.59236	208.18	41.638	0.521	311.77	62.356	5.34	132.99	5.44783	84	Neutral
5	0.43912	174.65	34.932	0.8486	275.52	55.106	5.36	173.49	5.46782	83	Neutral
6	0.37448	232.86	46.574	0.6801	281.38	56.278	4.53	124.08	4.62607	82	Neutral
7	0.63767	173.9	34.62	0.8274	294.90	58.982	3.77	101.99	3.85082	89	Neutral
8	0.66917	231.62	46.324	1.008	302.86	60.574	4.95	195.01	5.05768	88	Neutral
9	0.49454	277.48	55.496	0.8704	298.64	59.73	4.20	159.49	4.28383	88	Neutral
10	0.57423	185.72	52.678	0.8567	284.64	58.95	5.77	64	4.66796	88	Neutral
11	0.5367	263.02	52.606	0.5598	243.43	48.686	6.77	167.49	6.9094	86	Neutral
12	0.66917	231.62	46.324	1.008	302.86	60.574	4.95	195.01	5.05768	86	Neutral
13	0.59236	208.18	41.638	0.521	311.77	62.356	5.34	132.99	5.44783	84	Neutral
14	0.37448	232.86	46.574	0.6801	281.38	56.278	4.53	124.08	4.62607	84	Neutral
15	0.59506	292.17	58.434	0.3084	258.57	51.716	6.02	93.002	6.14495	85	Neutral
16	0.49454	277.48	55.496	0.8704	298.64	59.73	4.20	159.49	4.28383	85	Neutral
17	0.43912	174.65	34.932	0.8486	275.52	55.106	5.36	173.49	5.46782	82	Neutral
18	0.63767	173.9	34.62	0.8274	294.90	58.982	3.77	101.99	3.85082	82	Neutral
19	0.57423	185.72	52.678	0.8567	284.64	58.95	5.77	64	4.66796	83	Neutral
20	0.58612	213.73	42.748	0.504	293.41	58.684	6.60	173.49	6.73726	87	Neutral
g	0.549945	225.33	46.605	0.6984	284.52	57.1062	5.33	138.5032	5.319362	85.1	
	0.085999	39.893	7.8191	0.2075	19.795	4.006479	0.94	40.14296	5.278083	85.20	
	15.63775	17.704	16.777	29.711	6.9574	7.01584	17.6	28.98342	5.196517	85.11	

Table 12: Test results for Gandhigram peel bond and tensile strength- batch 2

S no	Peel bond						Tensile Strength			Disposability in secs	pH
	Sticker			Fabric			Maximum load(N)	Extension at maximum load(mm)	Tenacity at maximum load(gf/tex)		
	Load at maximum peel extension	Extension at maximum (mm)	Time at maximum peel extension(sec)	Load at maximum peel extension	Extension at maximum (mm)	Time at maxi peel extension(sec)					
1	0.453	120	24.002	0.438	120	24.002	6.02	93	6.144	89	Neutral
2	0.48	120	24.002	0.786	120	24.002	6.77	167.49	6.909	87	Neutral
3	0.453	120	24.002	0.438	120	24.002	6.07	173.49	6.737	85	Neutral
4	0.46	120	24.002	0.465	120	24.002	5.34	132.99	5.477	89	Neutral
5	0.372	120	24.002	0.467	120	24.002	5.36	173.49	5.467	87	Neutral
6	0.353	120	24.002	0.456	120	24.002	4.53	124	4.62	86	Neutral
7	0.439	120	24.002	0.497	120	24.002	3.77	101.99	3.85	85	Neutral
8	0.46	120	24.002	0.465	120	24.002	4.95	195	5.057	84	Neutral
9	0.46	120	24.002	0.465	120	24.002	4.20	159.49	4.283	82	Neutral
10	0.381	120	24.002	0.444	120	24.002	4.57	64	4.667	83	Neutral
11	0.48	120	24.002	0.786	120	24.002	4.53	124	4.62	85	Neutral
12	0.444	120	24.002	0.519	120	24.002	3.77	101.99	3.85	89	Neutral
13	0.439	120	24.002	0.497	120	24.002	6.02	93	6.144	87	Neutral
14	0.427	120	24.002	0.431	120	24.002	3.77	101.99	3.85	88	Neutral
15	0.355	120	24.002	0.452	120	24.002	4.53	124	4.62	89	Neutral
16	0.48	120	24.002	0.786	120	24.002	4.20	159.49	4.283	86	Neutral
17	0.3353	120	24.002	0.386	120	24.002	5.34	132.99	5.477	89	Neutral
18	0.444	120	24.002	0.519	120	24.002	6.07	173.49	6.737	85	Neutral
19	0.453	120	24.002	0.438	120	24.002	6.02	93	6.144	89	Neutral
20	0.48	120	24.002	0.786	120	24.002	6.77	167.49	6.909	87	Neutral
avg	0.453	120	24.002	0.438	120	24.002	6.07	173.49	6.737	85	
sd	0.46	120	24.002	0.465	120	24.002	5.34	132.99	5.477	89	
cv	0.372	120	24.002	0.467	120	24.002	5.36	173.49	5.467	87	

Table 13: Test results for Gandhigram peel bond and tensile strength- batch 3

S no	Peel bond						Tensile Strength			Disposability in secs	pH
	Sticker			Fabric			Maximum load(N)	Extension at maximum load(mm)	Tenacity at maximum load(gf/tex)		
	Load at maximum peel extension	Extension at maximum (mm)	Time at maximum peel extension(sec)	Load at maximum peel extension	Extension at maximum (mm)	Time at maxi peel extension(sec)					
1	0.393	232.47	46.496	0.541	276.22	55.246	4.30	96.5	4.389	89	Neutral
2	0.511	276.22	45.792	0.38	269.58	53.918	5.36	85.999	5.468	84	Neutral
3	0.286	228.95	43.558	0.694	279.82	55.964	4.29	148.99	4.383	85	Neutral
4	0.464	217.78	40.716	0.681	297.78	59.558	4.24	63.99	4.329	85	Neutral
5	0.577	23.58	49.934	0.737	290.99	58.1998	5.21	119.99	5.316	85	Neutral
6	0.416	249.66	36.044	0.562	263.89	52.778	4.37	211.49	4.456	87	Neutral
7	0.377	180.22	33.184	0.671	286.62	57.324	5.71	64.999	5.829	81	Neutral
8	0.835	165.91	44.918	0.655	259.28	51.856	4.37	62.499	4.462	82	Neutral
9	0.773	224.58	51.402	0.686	276.38	55.278	4.86	207	4.959	83	Neutral
10	0.144	275	30.824	0.47	196.85	39.372	5.53	149.99	5.463	89	Neutral
11	0.416	249.66	36.044	0.562	263.89	52.778	4.37	211.49	4.456	90	Neutral
12	0.511	276.22	45.792	0.38	269.58	53.918	5.36	85.999	5.468	90	Neutral
13	0.464	217.78	40.716	0.681	297.78	59.558	4.24	63.99	4.329	90	Neutral
14	0.577	23.58	49.934	0.737	290.99	58.1998	5.21	119.99	5.316	85	Neutral
15	0.577	23.58	49.934	0.737	290.99	58.1998	5.21	119.99	5.316	86	Neutral
16	0.393	232.47	46.496	0.541	276.22	55.246	4.30	96.5	4.389	90	Neutral
17	0.773	224.58	51.402	0.686	276.38	55.278	4.86	207	4.959	82	Neutral
18	0.773	224.58	51.402	0.686	276.38	55.278	4.86	207	4.959	86	Neutral
19	0.511	276.22	45.792	0.38	269.58	53.918	5.36	85.999	5.468	82	Neutral
20	0.377	180.22	33.184	0.671	286.62	57.324	5.71	64.999	5.829	85	Neutral
avg	0.5074	200.16	43.678	0.6069	274.79	54.95957	4.88	123.7202	4.97715	85.8	
sd	0.177001	82.300	6.676	0.1223	21.515	4.303146	0.53	56.71461	0.535538	3.019	
cv	34.88395	41.116	15.284	20.164	7.8298	7.829657	10.9	45.84103	10.75994	3.518	

Table 14: Test results for Gandhigram peel bond and tensile strength- batch 4

S no	Peel bond						Tensile Strength			Disposability in secs	pH
	Sticker			Fabric			Maximum load(N)	Extension at maximum load(mm)	Tenacity at maximum load(gf/tex)		
	Load at maximum peel extension	Extension at maximum (mm)	Time at maximum peel extension(sec)	Load at maximum peel extension	Extension at maximum (mm)	Time at maxi peel extension(sec)					
1	0.3353	120	24.002	0.386	120	24.002	4.38	218.99	4.46	84	Neutral
2	0.444	120	24.002	0.519	120	24.002	4.86	104.99	4.95	86	Neutral
3	0.301	120	24.002	0.416	120	24.002	5.43	79.5	5.54	85	Neutral
4	0.37	120	24.002	0.578	120	24.002	5.13	159	5.23	82	Neutral
5	0.395	120	24.002	0.516	120	24.002	5.20	175.49	5.3	89	Neutral
6	0.388	120	24.002	0.406	120	24.002	4.97	194.5	5.07	87	Neutral
7	0.353	120	24.002	0.456	120	24.002	5.76	139.5	5.87	81	Neutral
8	0.322	120	24.002	0.395	120	24.002	4.58	217.39	4.67	83	Neutral
9	0.381	120	24.002	0.325	120	24.002	5.05	140.99	5.14	90	Neutral
10	0.427	120	24.002	0.431	120	24.002	4.05	231.99	4.68	90	Neutral
11	0.353	120	24.002	0.456	120	24.002	5.76	139.5	5.87	85	Neutral
12	0.301	120	24.002	0.416	120	24.002	5.43	79.5	5.54	86	Neutral
13	0.3353	120	24.002	0.386	120	24.002	4.38	218.99	4.46	87	Neutral
14	0.395	120	24.002	0.516	120	24.002	5.20	175.49	5.3	88	Neutral
15	0.381	120	24.002	0.325	120	24.002	5.05	140.99	5.14	84	Neutral
16	0.427	120	24.002	0.431	120	24.002	4.05	231.99	4.68	82	Neutral
17	0.388	120	24.002	0.406	120	24.002	4.97	194.5	5.07	83	Neutral
18	0.444	120	24.002	0.519	120	24.002	4.86	104.99	4.95	89	Neutral
19	0.37	120	24.002	0.578	120	24.002	5.13	159	5.23	85	Neutral
20	0.353	120	24.002	0.456	120	24.002	5.76	139.5	5.87	85	Neutral
avg	0.37318	120	24.002	0.4458	120	24.002	5.00	162.3395	5.151	85.55	
sd	0.042605			0.0725			0.51	48.3232	0.437371	2.704	
cv	11.41681			16.283			10.2	29.76675	8.490999	3.161	

Table 15: Test results for Gandhigram peel bond and tensile strength- batch 5

S no	Peel bond						Tensile Strength			Disposability in secs	pH
	Sticker			Fabric			Maximum load(N)	Extension at maximum load(mm)	Tenacity at maximum load(gf/tex)		
	Load at maximum peel extension	Extension at maximum (mm)	Time at maximum peel extension(sec)	Load at maximum peel extension	Extension at maximum (mm)	Time at maxi peel extension(sec)					
1	0.439	120	24.002	0.497	120	24.002	4.99	92.5	5.09	89	Neutral
2	0.355	120	24.002	0.452	120	24.002	5.14	113.49	5.24	89	Neutral
3	0.372	120	24.002	0.467	120	24.002	4.19	153.5	4.27	85	Neutral
4	0.48	120	24.002	0.786	120	24.002	4.58	158.49	4.67	86	Neutral
5	0.369	120	24.002	0.41	120	24.002	4.98	93.49	5.08	82	Neutral
6	0.39	120	24.002	0.326	120	24.002	4.13	55.49	4.21	83	Neutral
7	0.453	120	24.002	0.438	120	24.002	3.58	163.99	3.65	87	Neutral
8	0.506	120	24.002	0.476	120	24.002	5.51	84	5.62	84	Neutral
9	0.381	120	24.002	0.444	120	24.002	5.59	79.5	6.01	81	Neutral
10	0.46	120	24.002	0.465	120	24.002	4.34	88.99	4.42	90	Neutral
11	0.506	120	24.002	0.476	120	24.002	5.51	84	5.62	86	Neutral
12	0.48	120	24.002	0.786	120	24.002	4.58	158.49	4.67	89	Neutral
13	0.439	120	24.002	0.497	120	24.002	4.99	92.5	5.09	89	Neutral
14	0.381	120	24.002	0.444	120	24.002	5.59	79.5	6.01	90	Neutral
15	0.46	120	24.002	0.465	120	24.002	4.34	88.99	4.42	90	Neutral
16	0.372	120	24.002	0.467	120	24.002	4.19	153.5	4.27	84	Neutral
17	0.439	120	24.002	0.497	120	24.002	4.99	92.5	5.09	86	Neutral
18	0.453	120	24.002	0.438	120	24.002	3.58	163.99	3.65	85	Neutral
19	0.355	120	24.002	0.452	120	24.002	5.14	113.49	5.24	87	Neutral
20	0.39	120	24.002	0.326	120	24.002	4.13	55.49	4.21	86	Neutral
avg	0.424	120	24.002	0.4804	120	24.002	4.70	108.2945	4.8265	86.4	
sd	0.050593			0.1144			0.63	36.64369	0.695945	2.741	
cv	11.93239			23.826			13.4	33.83707	14.41925	3.173	

Table 16: Dimensional and absorbency test results for RAASI- Batch No 1

Whole Pad													Individual Parts																
S. no	Dimensional Tests						Absorbency Tests						Sticker Paper			Top Cover						Wood Pulp			Leak Proof				
	Length in cm	Width in cm	Thickness in mm	Weight in grams	Moisture %	Dryness factor	Leak factor	Weight in grams	Thickness in mm	Weight in grams	Thickness in mm	Weight in grams	GSM	Bending rigidity	Weight in grams	Thickness in mm	Weight in grams	GSM	Weight in grams	Thickness in mm	Weight in grams	GSM	Weight in grams	Thickness in mm	Weight in grams	Thickness in mm	Weight in grams	GSM	
1	21	7.1	6.1	11.72	295.28	9.52	0	0.47	0.05	0.15	0.649	16.8	4.04	9.3	0.09	1.16	NA	NA	0.09	1.16	0.09	NA	1.16	0.09	NA	0.09	1.16	0.09	NA
2	20.9	6.8	6.9	11.9	288.11	21.21	0	0.46	0.06	0.14	0.663	18.4	4.43	9.402	0.08	1.3	NA	NA	0.08	1.3	0.08	NA	1.3	0.08	NA	0.08	1.3	0.08	NA
3	20.4	9	7.2	11.98	290.97	8.77	1.61	0.47	0.05	0.13	0.687	17.2	5.24	9.56	0.08	1.18	NA	NA	0.08	1.18	0.08	NA	1.18	0.08	NA	0.08	1.18	0.08	NA
4	20.5	6.4	6.7	11.9	267.94	8.06	11.86	0.46	0.05	0.13	0.706	17.6	4.23	9.527	0.08	1.111	NA	NA	0.08	1.111	0.08	NA	1.111	0.08	NA	0.08	1.111	0.08	NA
5	20.5	7	6.4	12.17	247.27	10.17	6.56	0.46	0.05	0.12	0.686	16	6.19	9.178	0.08	1.587	NA	NA	0.08	1.587	0.08	NA	1.587	0.08	NA	0.08	1.587	0.08	NA
6	20.7	7	7	11.84	295.28	9.52	0.00	0.47	0.06	0.11	0.645	17.6	6.68	9.225	0.07	1.416	NA	NA	0.07	1.416	0.07	NA	1.416	0.07	NA	0.07	1.416	0.07	NA
7	20.8	6.9	6.7	11.73	263.76	22.03	1.69	0.46	0.05	0.12	0.672	16	4.88	9.849	0.08	1.066	NA	NA	0.08	1.066	0.08	NA	1.066	0.08	NA	0.08	1.066	0.08	NA
8	21	7.1	7.2	10.1	258.33	17.31	1.47	0.46	0.06	0.12	0.667	16.8	6.63	9.193	0.07	1.358	NA	NA	0.07	1.358	0.07	NA	1.358	0.07	NA	0.07	1.358	0.07	NA
9	20.5	7	6.9	11.09	263.60	18.75	1.49	0.4	0.06	0.12	0.66	18.4	4.43	9.52	0.07	1.132	NA	NA	0.07	1.132	0.07	NA	1.132	0.07	NA	0.07	1.132	0.07	NA
10	20.7	6.8	7.2	11.7	276.37	14.29	4.92	0.47	0.05	0.13	0.67	16	3.85	9.17	0.08	1.145	NA	NA	0.08	1.145	0.08	NA	1.145	0.08	NA	0.08	1.145	0.08	NA
11	20.9	7	6.9	11.68	267.94	8.06	11.86	0.46	0.06	0.14	0.64	17.2	3.78	9.25	0.08	1.129	NA	NA	0.08	1.129	0.08	NA	1.129	0.08	NA	0.08	1.129	0.08	NA
12	20.7	6.9	7.2	11.78	295.28	9.52	0.00	0.46	0.05	0.12	0.68	16.8	3.52	9.46	0.09	1.12	NA	NA	0.09	1.12	0.09	NA	1.12	0.09	NA	0.09	1.12	0.09	NA
13	21	6.9	6.8	11.86	263.76	22.03	1.69	0.47	0.06	0.15	0.69	16	4.88	9.67	0.07	1.17	NA	NA	0.07	1.17	0.07	NA	1.17	0.07	NA	0.07	1.17	0.07	NA
14	20.8	7	7	11.58	258.33	17.31	1.47	0.4	0.05	0.12	0.66	17.6	4.23	9.57	0.08	1.28	NA	NA	0.08	1.28	0.08	NA	1.28	0.08	NA	0.08	1.28	0.08	NA
15	20.5	6.8	6.9	11.68	288.11	21.21	0.00	0.47	0.06	0.12	0.702	16	3.85	9.89	0.16	1.16	NA	NA	0.16	1.16	0.16	NA	1.16	0.16	NA	0.16	1.16	0.16	NA
16	20.6	6.8	7	11.72	290.97	8.77	1.61	0.46	0.05	0.13	0.72	16	3.85	9.23	0.07	1.32	NA	NA	0.07	1.32	0.07	NA	1.32	0.07	NA	0.07	1.32	0.07	NA
Avg	20.7	6.9																											
2	0	6.88	11.65	275.71	14.16	2.89	0.46	0.05	0.13	0.67	16.9	4.67	9.44	1.23	0.08	NA	NA	0.08	1.23	0.08	NA	1.23	0.08	NA	0.08	1.23	0.08	NA	
SD	0.20	0.1	0.30	0.47	16.10	5.64	3.94	0.02	0.01	0.01	0.02	0.86	1.02	0.23	0.14	0.01	NA	NA	0.01	0.14	0.01	NA	0.14	0.01	NA	0.01	0.14	0.01	NA
7	2.4																												
3	0.98	3	4.38	4.05	5.84	39.83	136.19	5.08	9.42	9.11	3.36	5.08	21.86	2.47	11.30	8.81	NA	NA	8.81	11.30	8.81	NA	11.30	8.81	NA	8.81	11.30	8.81	NA

Table 17: Dimensional and absorbency test results for RAASI-Batch no 2

S. no	Whole Pad				Individual Parts													
	Dimensional Tests				Absorbency Tests			Sticker Paper		Top Cover			Wood Pulp		Leak Proof			
	Length in cm	Width in cm	Thickness in mm	Weight in grams	Moisture %	Dryness factor	Leak factor	Weight in gms	Thickness in mm	Thickness in mm	Weight in mm	GSM	Bending rigidity	Weight in gms	Weight in gms	Weight in gms	Thickness in mm	GSM
1	21	7.3	6.9	12.46	283.45	1.56	0	0.42	0.05	0.12	0.73	18.8	9.24	10	1.205	0.06	NA	NA
2	20.4	7.3	7.2	11.84	276.15	1.37	0	0.46	0.06	0.11	0.75	18.4	6.21	9.45	1.09	0.07	NA	NA
3	20.6	7.5	6.2	12.64	269.72	2.74	0	0.46	0.06	0.11	0.72	18.8	7.70	10.04	1.35	0.08	NA	NA
4	20.3	6.7	6.8	12.61	249.50	3.03	1.52	0.463	0.05	0.1	0.64	17.2	8.01	9.48	1.93	0.06	NA	NA
5	19.8	7	7.1	11.3	248.45	2.82	0.00	0.468	0.05	0.09	0.61	16.8	7.55	9.28	0.95	0.05	NA	NA
6	19.7	7	7.2	11.22	274.77	19.12	3.39	0.476	0.06	0.1	0.6	18.8	8.14	8.9	1.18	0.06	NA	NA
7	20.4	7.2	7.4	12.02	248.45	2.82	0.00	0.464	0.05	0.1	0.65	18	7.94	9.51	1.23	0.06	NA	NA
8	20.9	7	6.9	11.9	251.12	13.24	0.00	0.465	0.06	0.1	0.66	16.8	8.11	9.75	1.07	0.08	NA	NA
9	20.9	7	7.1	12.32	251.27	14.08	1.61	0.45	0.06	0.12	0.69	19.2	9.77	9.59	0.98	0.065	NA	NA
10	5	7.2	7.2	11.98	262.12	16.92	0.00	0.47	0.06	0.11	0.72	18.8	8.91	9.68	0.97	0.06	NA	NA
11	20.9	7	6.8	12.23	269.72	2.74	0.00	0.46	0.06	0.12	0.75	19.2	9.94	9.89	1.03	0.07	NA	NA
12	19.8	7	7.2	11.86	276.15	1.37	0.00	0.462	0.05	0.12	0.69	18.8	10.08	9.67	1.09	0.06	NA	NA
13	20	7.3	7.2	12.23	249.50	3.03	1.52	0.47	0.05	0.12	0.65	19.2	9.27	9.89	0.98	0.08	NA	NA
14	20.2	7	6.8	11.63	283.45	1.56	0.00	0.45	0.06	0.13	0.6	18.4	8.72	10.1	0.9	0.05	NA	NA
15	20.3	7.2	7.2	12.32	251.12	13.24	0.00	0.47	0.06	0.11	0.69	19.2	9.10	9.13	0.9	0.06	NA	NA
16	20.5	7.3	7.3	12.54	248.45	2.82	0.00	0.46	0.05	0.12	0.7	19.6	9.97	9.89	1.02	0.07	NA	NA
Avg	20.3	7.1	7.0	12.07	262.09	6.40	0.50	0.46	0.06	0.11	0.68	18.8	8.66658	9.64	1.12	0.06	NA	NA
SD	0.42	0.1	0.2	0.43	13.71	6.38	0.99	0.01	0.01	0.01	0.05	0.87	1.0721	0.34	0.25	0.01	NA	NA
CV	2.04	2.7	4.1	3.59	5.23	99.62	196.84	2.79	9.21	9.78	7.39	4.70	12.3713	3.51	22.43	14.79	NA	NA

Table 18: Dimensional and absorbency test results for RAASI- Batch No 3

S. no	Whole Pad						Individual Parts										
	Dimensional Tests			Absorbency Tests			Sticker Paper			Top Cover				Leak Proof			
	Length in cm	Width in cm	Thickness in mm	Weight in grams	Moisture %	Dryness factor	Leak factor	Weight in grams	Thickness in mm	Thickness in mm	Weight in grams	Weight in mm	GSM	Bending rigidity	Weight in grams	Weight in mm	GSM
1	20.6	7	7.3	12.1	256.83	9.09	0	0.42	0.05	0.1	0.64	17	6.96	9.2	1.2	0.05	NA
2	20.7	7.2	7.2	11.48	295.00	3.28	0	0.46	0.06	0.11	0.68	17	9.91	9.13	1.21	0.05	NA
3	19.8	7.3	7.3	11.88	280.36	4.11	0	0.46	0.05	0.11	0.64	18	8.84	9.68	1.037	0.05	NA
4	20.2																
4	1	7	7.12	13.47	251.22	5.80	0	0.463	0.05	0.09	0.61	18	7.37	10.2	1.29	0.06	NA
5	19.6	7.3	7.9	11.85	272.26	4.00	1.23	0.468	0.05	0.11	0.61	17	6.96	8.99	1.73	0.06	NA
6	20	7.4	7.12	11.69	267.99	16.42	0.00	0.476	0.06	0.11	0.60	18	8.84	9.23	1.508	0.05	NA
7	20.2	7.1	6.83	11.571	271.86	12.16	1.22	0.464	0.05	0.09	0.61	18	7.37	9.82	1.6	0.05	NA
8	20.8	7.3	7.3	12.38	255.17	14.49	0.00	0.465	0.06	0.07	0.63	18	10.50	9.53	1.53	0.05	NA
9	20.2	7.4	7.2	11.8	260.55	27.50	0.00	0.45	0.06	0.09	0.64	16	7.86	9.5	1.32	0.05	NA
10	19.8	7.1	7.5	12.23	258.47	12.50	1.39	0.47	0.05	0.09	0.64	18	10.50	9.3	1.58	0.06	NA
11	20.3	7.2	7.2	11.89	280.36	4.11	0.00	0.46	0.06	0.12	0.62	18	8.84	9.6	1.62	0.06	NA
12	20.2	7.2	7.3	12.32	256.83	9.09	0.00	0.462	0.05	0.12	0.62	18	8.84	9.62	1.23	0.05	NA
13	19.8	7.2	7.5	12.13	260.55	27.50	0.00	0.47	0.06	0.11	0.63	18	10.50	9.8	1.32	0.06	NA
14	20.3	7.2	7.2	12.36	251.22	5.80	0.00	0.45	0.05	0.09	0.65	17	6.96	9.58	1.78	0.06	NA
15	20.2	7.1	7.5	12.23	272.26	4.00	1.23	0.47	0.06	0.11	0.66	16	7.86	9.67	1.67	0.05	NA
16	19.8	7.2	7.3	12.32	295.00	3.28	0.00	0.46	0.05	0.09	0.62	18	10.50	9.58	1.54	0.06	NA
Avg	20.1	7.2	7.30	12.11	267.87	10.20	0.32	0.46	0.05	0.10	0.63	17.5	8.66	9.53	1.45	0.05	NA
SD	0.35	0.1	0.23	0.46	14.13	7.97	0.57	0.01	0.01	0.01	0.02	0.73	1.38	0.30	0.22	0.01	NA
CV	1.72	1.6	3.18	3.83	5.27	78.18	179.2	2.79	9.42	13.80	3.11	4.17	15.89	3.17	15.14	9.42	NA

Table 19: Dimensional and absorbency test results for RAASI-Batch no 4

Whole Pad																		
INDIVIDUAL PARTS																		
Dimensional Tests					Absorbency Tests				Sticker Paper			Top Cover			Wood Pulp		LEAK PROOF	
S. no	Length in cm	Width in cm	Thickness in mm	Weight in grams	Moisture %	Dryness factor	Leak factor	Weight in grams	Thickness in mm	Thickness in mm	Weight in mm	GSM	Bending rigidity	Weight in grams	Weight in grams	Thickness in mm	GSM	
1	21.1	12.91	7.5	12.91	282.91	6.45	0	0.42	0.05	0.1	0.75	18.8	6.35	9.72	1.22	0.05	NA	
2	20.2	11.68	7.5	11.68	264.43	1.41	0	0.46	0.06	0.09	0.68	17.6	6.94	9.28	1.11	0.05	NA	
3	19.8	12.91	7.8	12.91	259.79	1.33	0	0.46	0.05	0.09	0.69	18.4	8.57	9.73	1.2	0.05	NA	
4	22.0																	
4	1	12.85	7.2	11.75	276.29	4.35	1.45	0.463	0.05	0.09	0.73	16.8	3.52	9.35	1.17	0.06	NA	
5	21.7	11.56	7.6	11.63	261.95	18.92	1.69	0.468	0.05	0.1	0.7	16.8	6.63	9.52	1.18	0.06	NA	
6	20.9	12.45	7.3	11.92	266.61	24.62	1.49	0.476	0.06	0.09	0.62	17.2	6.91	9.54	1.19	0.05	NA	
7	21.6	12.65	7.2	12.59	266.64	19.35	1.54	0.464	0.05	0.1	0.59	18	7.65	9.75	1.25	0.05	NA	
8	21.5	11.56	7.6	12.86	256.02	15.63	1.30	0.465	0.06	0.09	0.71	18.4	7.40	9.6	1.11	0.05	NA	
9	20.9	11.6	7.3	12.59	274.91	11.11	0.00	0.45	0.06	0.09								
10	21.7	11.8	7.6	12.32	275.16	15.94	0.00	0.47	0.05	0.09	0.72	18.8	8.14	9.72	1.2	0.06	NA	
11	21.6	12.3	7.2	11.98	264.43	1.41	0.00	0.46	0.06	0.1	0.73	18.4	7.26	9.55	1.16	0.06	NA	
12	21.2	11.8	7	12.65	266.64	19.35	1.54	0.462	0.05	0.1	0.69	18.4	7.82	9.67	1.19	0.05	NA	
13	20.9	12.5	7.5	12.32	261.95	18.92	1.69	0.47	0.06	0.1	0.72	17.2	6.91	9.83	1.23	0.06	NA	
14	21.6	12.6	7.3	12.32	261.95	18.92	1.69	0.45	0.05	0.09	0.73	18.8	7.28	9.45	1.19	0.06	NA	
15	21.3	12.3	7.6	12.45	282.91	6.45	0.00	0.47	0.06	0.1	0.69	18.8	7.99	9.67	1.23	0.05	NA	
16	21.2	12.1	7.7	11.98	259.79	1.33	0.00	0.46	0.05	0.09	0.73	18.4	7.97	9.68	1.19	0.06	NA	
Avg	21.2	12.22	7.43	12.30	267.65	11.59	0.78	0.46	0.05	0.09	0.70	18.1	7.15	9.61	1.19	0.05	NA	
SD	0.58	0.50	0.22	0.44	8.28	8.205	0.81	0.01	0.01	0.01	0.04	0.74	1.14	0.15	0.04	0.01	NA	
CV	2.72	4.08	2.98	3.55	3.10	70.778	104.03	2.79	9.42	5.33	6.07	4.07	15.9	1.57	3.23	20	NA	

Table 21: Test results for Raasi peel bond and tensile strength- batch 1

S no	Peel bond						Tensile Strength			Disposability in secs	pH
	Sticker			Fabric			Maximum load(N)	Extension at maximum load(mm)	Tenacity at maximum load(gf/tex)		
	Load at maximum peel extension	Extension at maximum (mm)	Time at maximum peel extension(sec)	Load at maximum peel extension	Extension at maximum (mm)	Time at maxi peel extension(sec)					
1	0.907	120.00	24.00	0.574	120.00	24.002	5.60	93.499	5.716	85	Neutral
2	1.27	120.00	24.00	0.431	120.00	24.00	5.19	134.49	6.312	89	Neutral
3	0.989	120.00	24.00	0.453	120.00	24.00	6.75	96.99	4.88	86	Neutral
4	0.496	120.00	24.00	0.623	120.00	24.00	5.86	81.99	5.98	85	Neutral
5	0.428	120.00	24.00	0.392	120.00	24.00	5.42	98.76	5.00	85	Neutral
6	0.584	120.00	24.00	0.632	120.00	24.00	6.54	90.13	5.876	86	Neutral
7	0.699	120.00	24.00	0.510	120.00	24.00	4.97	94.788	4.91	84	Neutral
8	0.815	120.00	24.00	0.616	120.00	24.00	5.48	94.89	4.91	85	Neutral
9	0.428	120.00	24.00	0.621	120.00	24.00	5.00	99.59	6-12	86	Neutral
10	0.567	120.00	24.00	0.457	120.00	24.00	5.43	88.91	5.87	87	Neutral
11	0.476	120.00	24.00	0.567	120.00	24.00	4.97	94.788	4.91	89	Neutral
12	0.428	120.00	24.00	0.392	120.00	24.00	5.42	98.76	5.00	86	Neutral
13	0.907	120.00	24.00	0.574	120.00	24.002	5.60	93.499	5.716	84	Neutral
14	0.584	120.00	24.00	0.632	120.00	24.00	6.54	90.13	5.876	87	Neutral
15	1.27	120.00	24.00	0.431	120.00	24.00	5.19	134.49	6.312	85	Neutral
16	0.496	120.00	24.00	0.623	120.00	24.00	5.86	81.99	5.98	89	Neutral
avg	0.709	120	24	0.533	120	24.00025	5.61	97.98088	2549.328		
sd	0.28646233	0	0	0.0924	0	0.000683	0.56	15.18267	10175.11	86.4	
cv	40.4037137	0	0	17.346	0	0.002846	10.0	15.49555	399.1292	2.741	
										3.173	

Table 22: Test results for Raasi peel bond and tensile strength- batch 2

Peel bond							Tensile Strength			Disposability in secs	pH
S no	Sticker			Fabric			Maximum load(N)	Extension at maximum load(mm)	Tenacity at maximum load(gf/tex)		
	Load at maximum peel extension	Extension at maximum (mm)	Time at maximum peel extension(sec)	Load at maximum peel extension	Extension at maximum (mm)	Time at maxi peel extension(sec)					
1	0.48244	120.00	24.00	0.545	120.00	24.00	5.14	113.49	5.24	89	Neutral
2	0.66053	120.00	24.00	1.17	120.00	24.00	6.13	96.49	6.25	92	Neutral
3	0.7647	120.00	24.00	0.839	120.00	24.00	6.94	138.50	7.08	85	Neutral
4	0.80899	120.00	24.00	0.808	120.00	24.00	6.78	115.00	6.92	87	Neutral
5	0.688	120.00	24.00	1.193	120.00	24.00	5.78	111.56	3.68	89	Neutral
6	0.988	120.00	24.00	0.833	120.00	24.00	6.13	102.58	5.97	90	Neutral
7	0.724	120.00	24.00	0.738	120.00	24.00	6.54	114.79	6.32	90	Neutral
8	0.768	120.00	24.00	0.847	120.00	24.00	5.96	109.56	7.41	91	Neutral
9	0.688	120.00	24.00	0.912	120.00	24.00	5.87	97.52	5.24	85	Neutral
10	0.712	120.00	24.00	1.12	120.00	24.00	5.98	114.68	5.24	86	Neutral
11	0.812	120.00	24.00	0.789	120.00	24.00	5.78	118.39	7.01	87	Neutral
12	0.768	120.00	24.00	0.847	120.00	24.00	5.96	109.56	7.41	85	Neutral
13	0.688	120.00	24.00	0.912	120.00	24.00	5.87	97.52	5.24	84	Neutral
14	0.80899	120.00	24.00	0.808	120.00	24.00	6.78	115.00	6.92	86	Neutral
15	0.7647	120.00	24.00	0.839	120.00	24.00	6.94	138.50	7.08	86	Neutral
16	0.66053	120.00	24.00	1.17	120.00	24.00	6.13	96.49	6.25	87	Neutral
avg	0.73668	120	24	0.8981	120	24	6.17	111.8519	6.20375	85.1	
sd	0.105495	0	0	0.1787	0	0	0.50	12.862	1.041754	85.20	
cv	14.32038	0	0	19.904	0	0	8.10	11.49914	16.79233	85.11	

Table 23: Test results for Raasi peel bond and tensile strength- batch 3

Peel bond							Tensile Strength			Disposability in secs	pH
S no	Sticker			Fabric			Maximum load(N)	Extension at maximum load(mm)	Tenacity at maximum load(gf/tex)		
	Load at maximum peel extension	Extension at maximum (mm)	Time at maximum peel extension(sec)	Load at maximum peel extension	Extension at maximum (mm)	Time at maxi peel extension(sec)					
1	0.71757	120	24	0.7175	120	24	5.17	105.99	5.28	89	Neutral
2	0.55472	120	24	0.5547	120	24	5.28	100.49	5.391	85	Neutral
3	0.48205	120	24	0.4820	120	24	7.72	183.99	7.88	86	Neutral
4	0.46865	120	24	0.4686	120	24	6.51	111.99	6.641	87	Neutral
5	0.57428	120	24	0.5742	120	24	6.32	164.68	6.781	82	Neutral
6	0.72708	120	24	0.7270	120	24	7.12	134.41	7.145	90	Neutral
7	0.94669	120	24	0.9466	120	24	5.63	148.16	5.671	89	Neutral
8	0.4092	120	24	0.7625	120	24	6.23	132.18	5.255	90	Neutral
9	0.8997	120	24	0.4686	120	24	7.56	168.15	6.854	85	Neutral
10	0.49794	120	24	0.5547	120	24	6.82	148.99	7.142	86	Neutral
11	0.79893	120	24	0.7175	120	24	6.53	142.89	5.61	90	Neutral
12	0.51144	120	24	0.4820	120	24	7.16	168.25	7.23	86	Neutral
13	0.62977	120	24	0.4686	120	24	5.89	123.45	6.89	87	Neutral
14	0.52256	120	24	0.7270	120	24	6.32	146.75	5.92	86	Neutral
15	0.85538	120	24	0.5742	120	24	5.58	189.27	5.13	84	Neutral
16	0.71757	120	24	0.7175	120	24	5.17	105.99	5.28	83	Neutral
avg	0.644596	120	24	0.6215	120	24	6.31	142.2269	6.25625	86.56	
sd	0.167771	0	0	0.1409	0	0	0.82	27.93979	0.899647	2.502	
cv	26.02725	0	0	22.677	0	0	12.9	19.64452	14.37997	2.890	

Table 24: Test results for Raasi peel bond and tensile strength- batch 4

Peel bond							Tensile Strength			Disposability in secs	pH
S no	Sticker			Fabric			Maximum load(N)	Extension at maximum load(mm)	Tenacity at maximum load(gf/tex)		
	Load at maximum peel extension	Extension at maximum (mm)	Time at maximum peel extension(sec)	Load at maximum peel extension	Extension at maximum (mm)	Time at maxi peel extension(sec)					
1	0.36208	120	24	0.3649	120	24	6.34	94.499	6.4751	85	Neutral
2	0.8997	120	24	0.6223	120	24	8.24	203.5	8.408	86	Neutral
3	0.49794	120	24	0.5051	120	24	5.03	122.2	5.132	83	Neutral
4	0.79893	120	24	0.8253	120	24	7.40	127.3	4.23	84	Neutral
5	0.51144	120	24	0.5778	120	24	8.46	118.57	6.45	89	Neutral
6	0.62977	120	24	0.4882	120	24	6.10	112.35	7.23	87	Neutral
7	0.52256	120	24	0.6414	120	24	7.20	127.5	5.124	89	Neutral
8	0.85538	120	24	0.8153	120	24	5.97	132.85	8.152	87	Neutral
9	0.5846	120	24	0.9745	120	24	6.30	122.97	7.231	84	Neutral
10	0.74856	120	24	0.5678	120	24	7.00	100.2	6.325	89	Neutral
11	0.52256	120	24	0.6414	120	24	7.20	127.5	5.124	87	Neutral
12	0.51144	120	24	0.5778	120	24	8.46	118.57	6.45	90	Neutral
13	0.8997	120	24	0.6223	120	24	8.24	203.5	8.408	91	Neutral
14	0.36208	120	24	0.3649	120	24	6.34	94.499	6.4751	86	Neutral
15	0.49794	120	24	0.5051	120	24	5.03	122.2	5.132	85	Neutral
16	0.79893	120	24	0.8253	120	24	7.40	127.3	4.23	89	Neutral
avg	0.625226	120	24	0.6200	120	24	6.92	128.4693	6.286013	86.93	
sd	0.182344	0	0	0.1691	0	0	1.11	31.5751	1.371542	2.379	
cv	29.16456	0	0.7048	27.282	0	4.640912	455.9587	1.067603	37.85549	2.737	

Table 25: Test results for Raasi peel bond and tensile strength- batch 5

Peel bond							Tensile Strength			Disposability in secs	pH
S no	Sticker			Fabric			Maximum load(N)	Extension at maximum load(mm)	Tenacity at maximum load(gf/tex)		
	Load at maximum peel extension	Extension at maximum (mm)	Time at maximum peel extension(sec)	Load at maximum peel extension	Extension at maximum (mm)	Time at maxi peel extension(sec)					
1	0.80124	120	24	0.8397	120	24	6.04	139.49	6.159	83	Neutral
2	0.81691	120	24	0.5202	120	24	8.90	171.5	9.081	87	Neutral
3	0.46215	120	24	0.5217	120	24	7.19	143.99	7.341	86	Neutral
4	0.74194	120	24	0.7419	120	24	7.23	148.08	7.564	84	Neutral
5	0.58797	120	24	0.5879	120	24	6.38	138.09	6.057	83	Neutral
6	0.98389	120	24	0.6872	120	24	5.68	135.89	5.081	82	Neutral
7	0.94913	120	24	0.7193	120	24	6.00	139.85	6.981	89	Neutral
8	0.55372	120	24	0.6988	120	24	8.00	170.65	8.765	88	Neutral
9	0.55624	120	24	0.7234	120	24	7.56	146.87	7.564	89	Neutral
10	0.49862	120	24	0.7236	120	24	6.52	138.09	6.321	87	Neutral
11	0.98389	120	24	0.6872	120	24	5.68	135.89	5.081	89	Neutral
12	0.94913	120	24	0.7193	120	24	6.00	139.85	6.981	87	Neutral
13	0.46215	120	24	0.5217	120	24	7.19	143.99	7.341	84	Neutral
14	0.46215	120	24	0.5217	120	24	7.19	143.99	7.341	89	Neutral
15	0.94913	120	24	0.7193	120	24	6.00	139.85	6.981	89	Neutral
16	0.55372	120	24	0.6988	120	24	8.00	170.65	8.765	90	Neutral
avg	0.700716	120	24	0.6528	120	24	6.90	147.1487	7.149667	86.86	
sd	0.215322	0	0	0.097958	0	0	0.95773	12.54571	1.178887	2.629956	
cv	30.72883	0	0	15.005	0	0	13.86573	8.525877	16.4887	3.027577	

Table 26: Average dimensional and absorbency test results for GANDHIGRAM

S. no	Whole Pad				Individual Parts														
	Dimensional Tests				Absorbency Tests			Sticker Paper			Top Cover			Wood Pulp			Leak Proof		
	Length in cm	Width in cm	Thickness in mm	Weight in grams	Moisture %	Dryness factor (ml)	Leak factor (ml)	Weight in gms	Thickness in mm	Thickness in mm	Weight in mm	GSM	Bending rigidity (mg.cm)	Weight in gms	Bending rigidity (mg.cm)	Weight in gms	Thickness in mm	GSM	
Batch 1	20.42	7.36	6.82	13.47	256.20	13.31	2.86	0.50	0.06	0.13	1.44	16	32.9424	11.14	0.39	0.21	24.45		
Batch 2	21.23	6.83	7.06	13.98	267.05	9.39	1.72	0.55	0.05	0.12	1.43	0.16	31.6335	11.26	0.41	0.18	24.95		
Batch 3	21.45	7.75	8.88	13.25	220.36	16.23	1.03	0.54	0.05	0.13	1.62	16	26.54	9.98	0.42	0.19	27.04		
Batch4	20.83	7.37	6.45	14.07	286.42	10.37	0.75	0.39	0.05	0.11	1.48	16.7	30.40636	11.85	0.37	0.16	29.6		
Batch5	21.04	7.37	6.05	13.39	219.97	11.57	1.77	0.39	0.05	1.46	1.46	16.85	27.72	11.79	0.37	0.17	31.60		
AVG	20.99	7.33	7.052	13.63	250	12.17	1.626	0.474	0.052	0.39	1.48	13.14	29.84845	20.994	7.33	7.052	13.632		

Table 27: Average dimensional and absorbency test results for RAASI

S. no	Whole Pad				Individual Parts														
	Dimensional Tests				Absorbency Tests			Sticker Paper			Top Cover			Wood Pulp			Leak Proof		
	Length in cm	Width in cm	Thickness in mm	Weight in grams	Moisture %	Dryness factor	Leak factor	Weight in gms	Thickness in mm	Thickness in mm	Weight in mm	GSM	Bending rigidity (mg.cm)	Weight in gms	Bending rigidity (mg.cm)	Weight in gms	Thickness in mm	GSM	
Batch 1	20.72	6.90	6.88	11.65	275.71	14.16	2.89	0.46	0.05	0.13	0.67	16.9	4.67	9.44	1.23	0.08	NA		
Batch 2	20.38	7.13	7.03	12.07	262.09	6.40	0.50	0.46	0.06	0.11	0.68	18.8	8.66	9.64	1.12	0.06	NA		
Batch 3	20.16	7.20	7.30	12.11	267.87	10.20	0.32	0.46	0.05	0.10	0.63	17.5	8.66	9.53	1.45	0.05	NA		
Batch4	21.20	12.2	7.43	12.30	267.65	11.59	0.78	0.46	0.05	0.09	0.70	18.1	7.15	9.61	1.19	0.05	NA		
Batch5	21.16	6.67	7.08	12.12	274.52	11.97	0.46	0.46	0.05	0.09	0.68	17.67	7.14	9.48	1.37	0.05	NA		
AVG	20.724	8.02	7.14	12.05	269.56	8	0.99	0.46	0.052	0.10	0.672	17.794	7.256	20.72	8.02	7.14	NA		

Table 28: Average test results for GHANDHIGRAM peel bond and tensile strength

S.no	Peel bond						Tensile Strength				Disposability in secs	pH
	Sticker			Fabric			Maximum load(N)	Extension at maximum load(mm)	Tenacity at maximum load(gf/tex)			
	Load at maximum peel extension (N)	Extension at maximum (mm)	Time at maximum peel extension(se)	Load at maximum peel extension(N)	Extension at maximum (mm)	Time at maximum peel extension(se)						
Batch 1	0.549945	225.33	46.605	0.6984	284.52	57.1062	5.33	138.5032	5.319362	85.1	Neutral	
Batch 2	0.453	120	24.002	0.438	120	24.002	6.07	173.49	6.737	85	Neutral	
Batch 3	0.5074	200.16	43.678	0.6069	274.79	54.95957	4.88	123.7202	4.97715	85.8	Neutral	
Batch4	0.37318	120	24.002	0.4458	120	24.002	5.00	162.3395	5.151	85.55	Neutral	
Batch5	0.424	120	24.002	0.4804	120	24.002	4.70	108.2945	4.8265	86.4	Neutral	
AVG	0.461505	157.098	32.4578	0.5339	183.862	36.81435	5.196	141.2695	5.402202	85.57	Neutral	

Table 29: Average test results for RAASI peel bond and tensile strength

S.no	Peel bond						Tensile Strength				Disposability in secs	pH
	Sticker			Fabric			Maximum load(N)	Extension at maximum load(mm)	Tenacity at maximum load(gf/tex)			
	Load at maximum peel extension (N)	Extension at maximum (mm)	Time at maximum peel extension (sec)	Load at maximum peel extension (N)	Extension at maximum (mm)	Time at maximum peel extension (sec)						
Batch 1	0.709	120	24	0.533	120	24.00025	5.61	97.98088	2549.328	86.4	Neutral	
Batch 2	0.73668	120	24	0.8981	120	24	6.17	111.8519	6.20375	85.1	Neutral	
Batch 3	0.644596	120	24	0.6215	120	24	6.31	142.2269	6.25625	86.56	Neutral	
Batch4	0.625226	120	24	0.6200	120	24	6.92	128.4693	6.286013	86.93	Neutral	
Batch5	0.700716	120	24	0.6528	120	24	6.90	147.1487	7.149667	86.86	Neutral	
AVG	0.683244	120	24	0.6650	120	24.00005	6.382	125.5355	515.0447	86.37	Neutral	

4.1.1 ABSORPTION CAPACITY OF THE WHOLE PAD, SAP AND WOOD PULP:

Table 30: GANDHIGRAM- WHOLE PAD ABSORBANCY CAPACITY TEST

S. no	Initial wt	Final wt of the napkin	Absorbancy %
1	12.15	185.34	1425.43
2	14.2	203.49	1333.03
3	13.83	195.31	1312.22
4	14.24	207.19	1354.99
5	13.92	197.37	1317.89
Avg	13.605	197.8325	1356.42

Table 31: RAASI- WHOLE PAD ABSORBANCY CAPACITY TEST

S. no	Initial wt	Final wt of the napkin	Absorbancy %
1	10.19	153.74	1408.734053
2	11.34	162.39	1332.010582
3	10.29	155.89	1414.965986
4	10.82	159.56	1374.676525
5	10.89	160.21	1371.166208
Avg	10.706	158.358	1380.310671

Table 32: WOOD PULP-ABSORBANCY CAPACITY TEST

S. no	Initial wt of wood pulp along with bag	weight of bag	Final weight of the wood pulp along with bag	final weight of the bag	Initial weight of the wood pulp	final weight of the wood pulp	Absorbancy %
1	1.14	0.16	19.62	1.98	0.98	17.64	1700
2	1.15	0.16	20.01	1.98	0.99	18.03	1721.212
3	1.14	0.16	13.34	1.98	0.98	11.36	1059.184
4	1.16	0.16	18.83	1.98	1	16.85	1585
5	1.14	0.16	19.2	1.98	0.98	17.22	1657.143
Avg	1.146	0.16	18.2	1.98	0.986	16.22	1544.508

Table 33: GEL- ABSORBANCY CAPACITY TEST							
S. no	Initial wt of gel along with bag	weight of bag	Final weight of the gel along with bag	final weight of the bag	Initial weight of the gel	final weight of the gel	Absorbancy %
1	1.89	0.89	33.61	11.01	1	22.6	2160
2	1.87	0.89	29.34	11.01	0.98	18.33	1770.408
3	1.89	0.89	34.53	11.01	1	23.52	2252
4	1.87	0.89	29.34	11.01	0.98	18.33	1770.408
5	1.89	0.89	34.53	11.01	1	23.52	2252
avg	1.882	0.89	32.27	11.01	0.992	21.26	2040.963

4.1.2 OBSERVATIONS AND RECOMMENDATIONS:

Adhesive strength:

The adhesive strength of the pad to sticker paper of the GANDHIGRAM brand was found to be bad whereas in RAASI brand was good but the adhesives were unevenly disturbed.

SAP (Super Absorbent Polymer):

Due to the presence of SAP in GANDHIGRAM brand the absorption capacity of the whole pad was found to be good whereas the lack of SAP in RAASI brand resulted in low absorption capacity of whole pad.

Leak proof:

The absorbancy of the RAASI brand sanitary pads were found to be better than GANDHIGRAM as the leak proof was made of polyethylene and the later from polyethylene.

RECOMMENDATION:

GANDHIGRAM:

- ✓ Better results could be achieved if polyethylene is used instead of polypropylene as the leak proof material.
- ✓ Better adhesive could be used for sticker paper.

RASSI:

- ✓ Wood pulp orientation could be still more even.
- ✓ The adhesive applied at the back of the napkins could be still more evenly spread.
- ✓ SAP can be used to improve the absorbency capacity of the napkin.

4.2 STANDARDIZED DIMENSIONAL PARAMETERS OF NAPKIN PAD AND ITS COMPONENTS:

- 1) The Length(mm) - 200 mm
- 2) The width(mm) - 60– 75mm
- 3) Thickness(mm) – 7-8 mm
- 4) Over all Weight - 14 gms
- 5) Sticker paper thickness (mm) - 0.05 mm
- 6) Stock cover / top cover(Permeable Non-woven) GSM- 15 – 17 GSM
- 7) Stock cover / top cover(Permeable Non-woven) Bending rigidity(gm.cm) – 19-20 mg.cm
- 8) Stock cover / top cover(Permeable Non-woven) thickness(mm)0. 11 – 0.12mm
- 9) Tearing strength of Stock cover / top cover(Permeable Non-woven) – 5-6 gf/text
- 10) Woodpulp (Absorbant core) weight (gm)- 11 – 11.5 gms
- 11) Gel (SAP) weight 0.2 – 0.3 gms
- 12) Leak proof GSM - 9 GSM(Polyethylene)
- 13) Leak proof material dimensions- 74 to 90 mm X 190 mm
- 14) Peel bond strength of adhesives Area of Gum: Length = 12 cms, width =5 cm

Bond strength of adhesive = 0.7 - 0.8N,
gum : water = 1:2 and 2 strokes through screens

- 15) Maximum Absorbency of the whole pad = 270% over the weight of the pad ,
maximum absorbing 35 ml of test fluid with a density of 1203 gms/ml
- 16) Ability to with stand the pressure = 0 to- 0.01 ml
- 17) Dryness factor (%) = 0.07to 0.1 ml
- 18) pH of the absorbent core(wood pulp) - neutral
- 19) Disposability of absorbent core (wood pulp) – 85 – 90 secs.
- 20) Wood pulp : Super absorbent polymer (gel) ratio

21) Absorbency index:

The fixed or expected amount of moisture absorption of a pad with over all weight of 14 grams is = 270% (over the weight of the absorbent core)

$$\text{Weight of absorbent core} = 0.2 (x) + 11.06 (y) = 11.26 \text{ gram}$$

Where x = weight of super absorbent and y = weight of wood pulp when 1.5% of gel on the weight of the absorbent core is used.

$$\text{Absorbency of absorbent core} = X + Y = Z$$

Where X= Gel absorbency %, Y = Wood pulp absorbency % and Z = absorbency of absorbent core

$$0.1 \text{ gms of gel absorbency \%} = 69\%$$

$$1 \text{ gram of wood pulp absorbency \%} = 12\%$$

4.3 TESTS FOR PRESENCE OF ENZYME:



Figure 21: DNS Solution

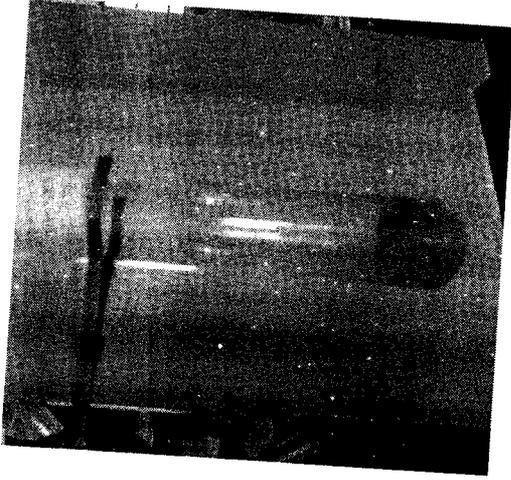


Figure 22: Starch, DNS sol and enzyme

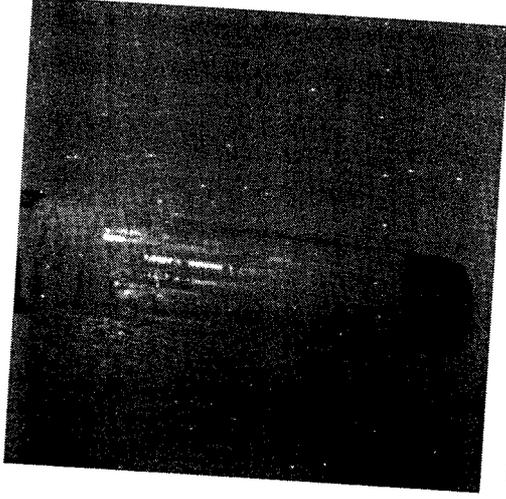


Figure 23: Enzyme, DNS solution

When comparing the sample the T3 specimen (fig.23) shows a slight change in color from yellow to yellowish orange proving the presence of cellulose enzyme which happens due to the alcohol which releases during the degradation of cellulose by cellulase and this alcohol combines with DNS to create the change in color.

4.4. IESI RESULTS FOR FIBRES AT RAW STAGE AND PROCESSED STAGE:
4.4.1.1 FTIR results of jute (optimization results)

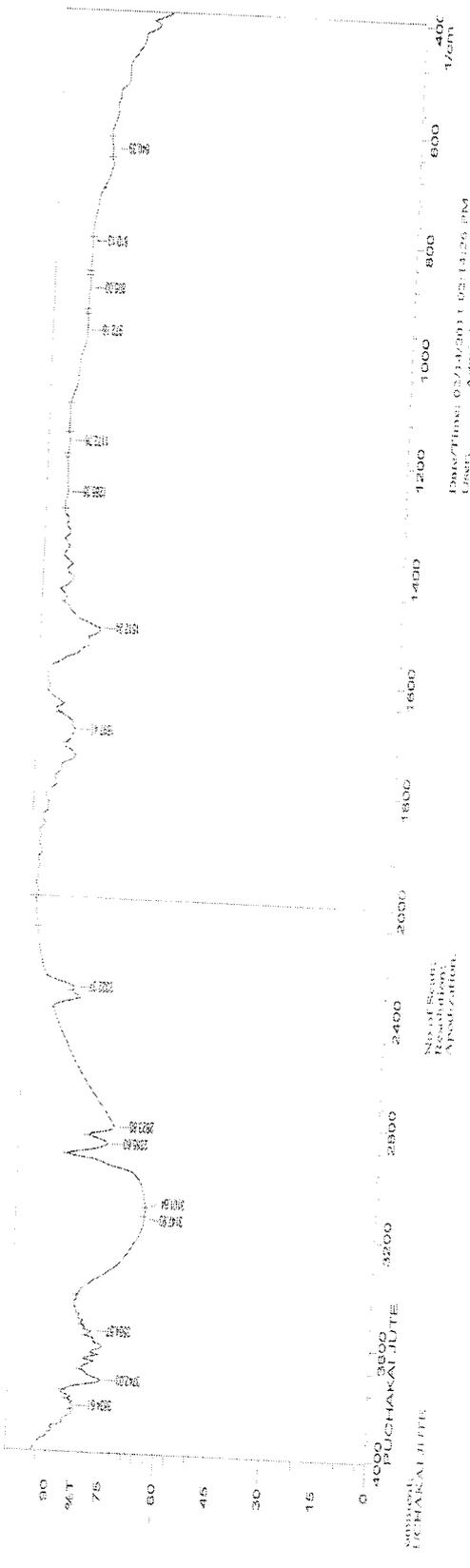


Figure 24: Sapanidius cleaned jute

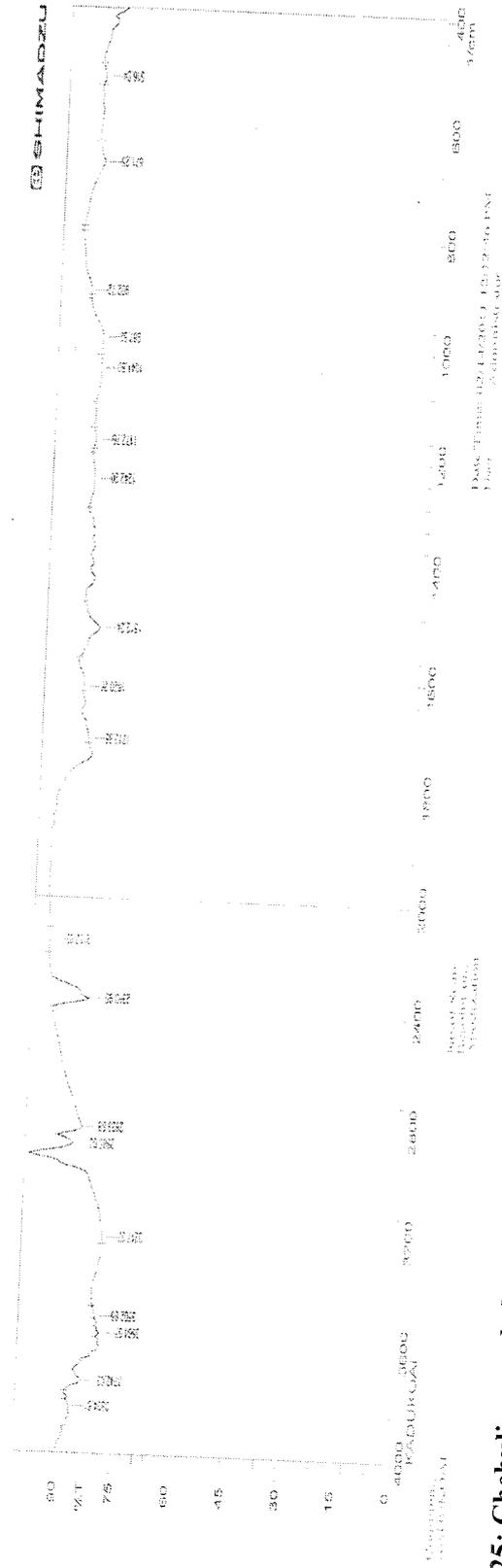


Figure 25: Chebulic myrobalan cleaned jute

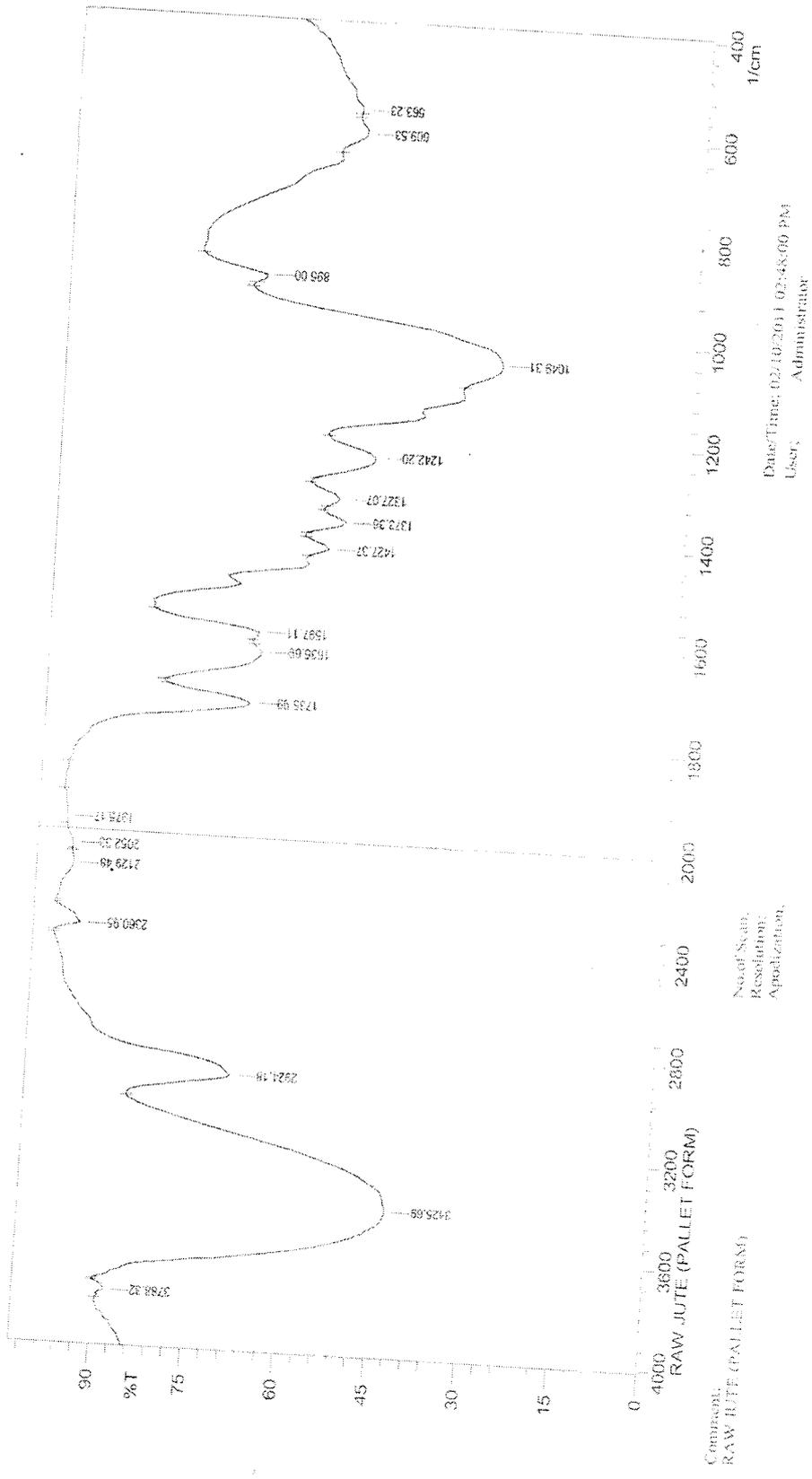


Figure 26: Raw jute

Infrared Spectroscopy: The surface chemistries of the treated fibers were evaluated by using a Shimadzu Fourier transform infrared spectrometer (FTIR). Scans were run at a resolution of 4 cm^{-1} . The sample of jute fiber cleaned with Sapindus seeds and Chebulic myrobalan separately, in finely grinded powder form were exposed to Infra red radiations.

When analyzing the Fourier Transform Infrared (FTIR) graphs of jute fibers, characteristic spectrum shows the presence of 2 significant peaks, viz; the absorption between 3300 to 3500 showing the presence of alcohol and phenyl groups and absorption between 1000 to 1100 showing the presence of secondary alcohols and esters. At these wavelengths, when observing the spectrum of the Sapindus seeds cleaned jute fiber and Chebulic myrobalan cleaned jute fiber, these peaks are absent and the absorption around these wavelengths have been reduced indicating the absence of substances and proves that the fibers have been cleaned. Out of the 2 samples Chebulic myrobalan cleaned jute fibers, had presence of yellow tint and deposition of precipitates. So Sapindus seeds were selected to be best suitable for cleaning jute fibers.

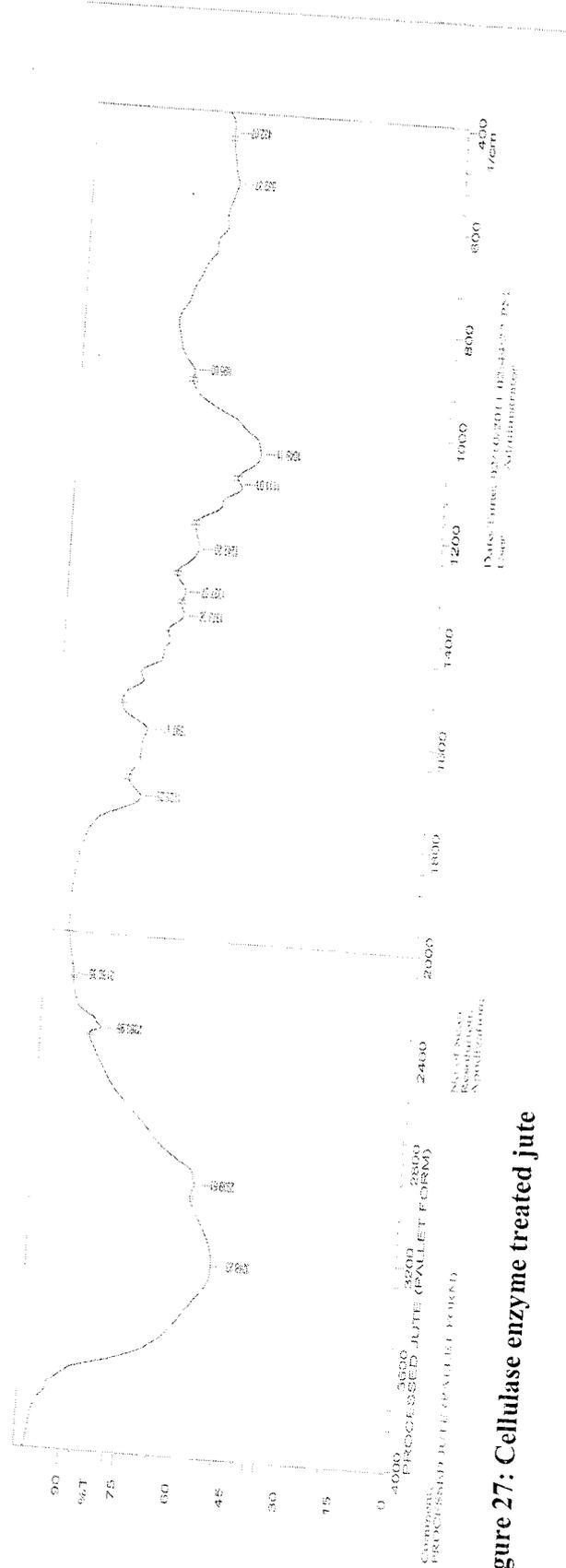


Figure 27: Cellulase enzyme treated jute

Infrared Spectroscopy: The surface chemistries of the treated fibers were evaluated by using a Shimadzu Fourier transform infrared spectrometer (FTIR). Scans were run at a resolution of 4 cm^{-1} . The sample recording of jute fiber treated with cellulase enzyme extracted from bagasse were exposed to Infra red radiations.

When analyzing the Fourier Transform Infrared (FTIR) graphs of jute fibers, characteristic spectrum shows the presence of 2 significant peaks, *Viz*; the absorption between 3300 to 3500 showing the presence of alcohol and phenyl groups and absorption between 1000 to 1100 showing the presence of secondary alcohols and esters. At these wavelengths, when observing the spectrum of the cellulase softened jute fiber, these peaks have been reduced and the absorption around these wavelengths have been reduced indicating the degradation of cellulose fibers by cellulase and proves that the fibers have been softened. Though a very slight degradation has been observed, there was considerable softness in the subjective handling of the fibers. So cellulase softening procedure was selected for softening jute fibers.

4.4.1.2 RESULTS FOR THE TESTS MADE FOR FIBRE:

Table 34: Results for fiber moisture regain, moisture content, immersion time and absorption capacity

S.No	Properties	Fibres								
		JT		KNF		ARNT		BG	CP	WP
		Raw	Softd	Raw	Softd	Raw	Softd			
1	Moisture regain (%)	9.05	9.58	9.2	9.79	9.24	11.58	9.4	16.28	6.85
2	Moisture content (%)	8.3	8.74	8.44	8.92	8.46	10.38	8.63	14	6.41
3	Immersion time (Sec)	496	80	1133	97	200	115	13	70	25
4	Absorption capacity (%)	236.8	286.4	303.2	336	268	306.4	298.4	226.8	341.33

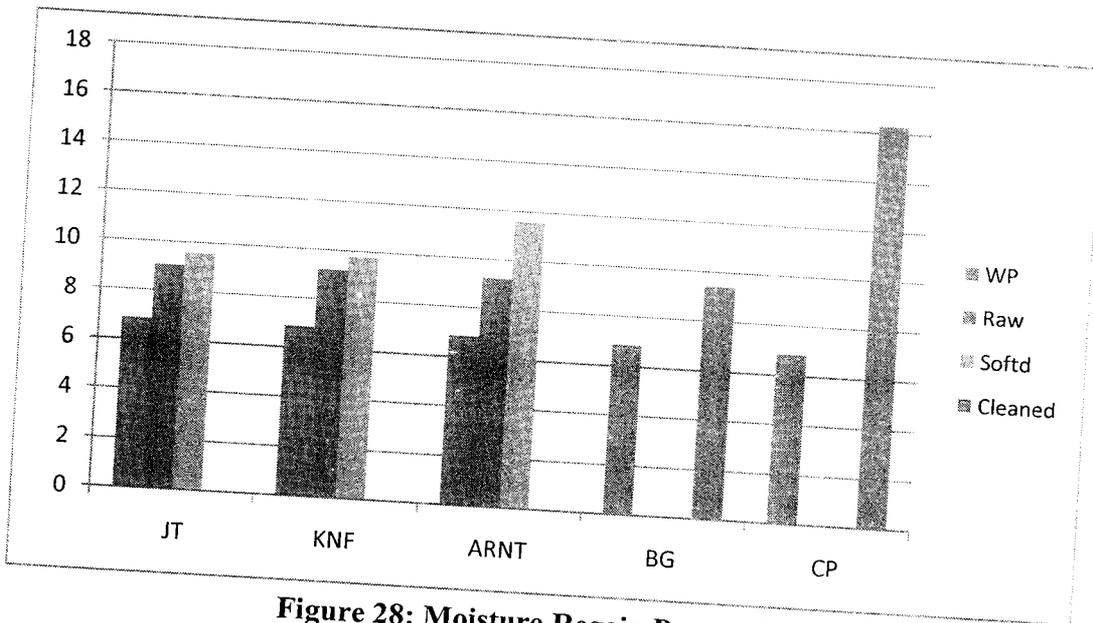


Figure 28: Moisture Regain Properties

- ✦ It is evident that moisture regain% of all fibre selected is higher than WP
- ✦ It is also inferred that there is increase in the regain% in the softened fibres compared to the raw fibres.
- ✦ The softening process for BG and CP is not applicable, so the primary process- cleaning is done for these fibres.

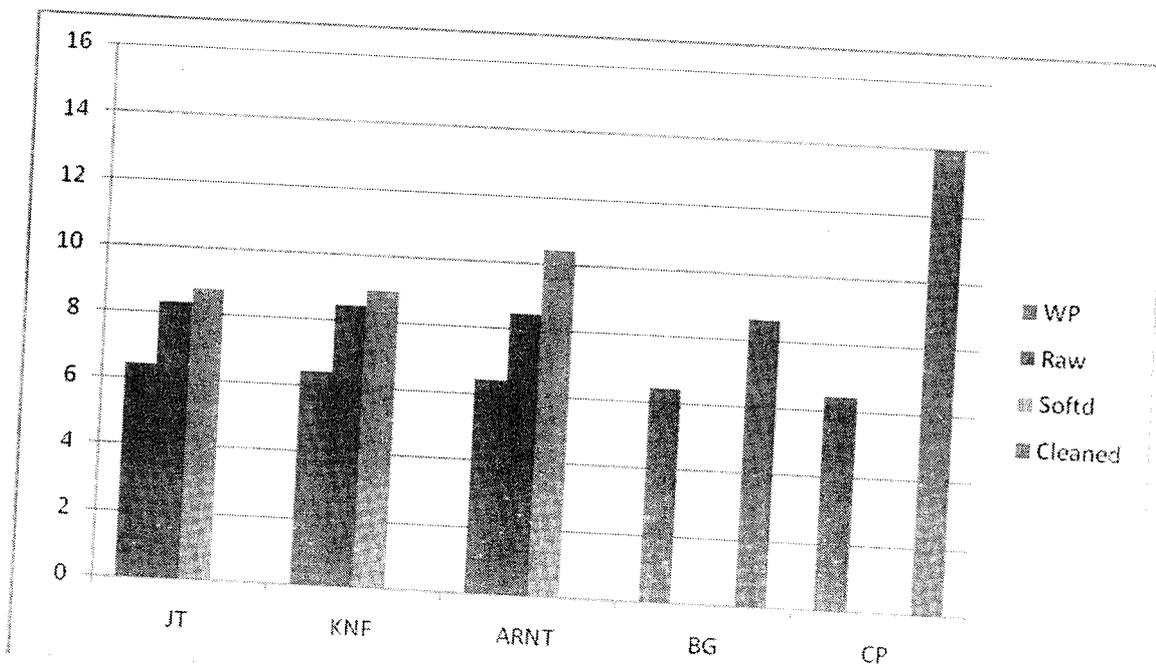


Figure 29: Moisture Content

- ✦ It is evident that moisture content% of all fibre selected is higher than WP
- ✦ It is also inferred that there is increase in the moisture content % in the softened fibres compared to the raw fibres.
- ✦ The softening process for BG and CP is not applicable, so the primary process- cleaning is done for these fibres.

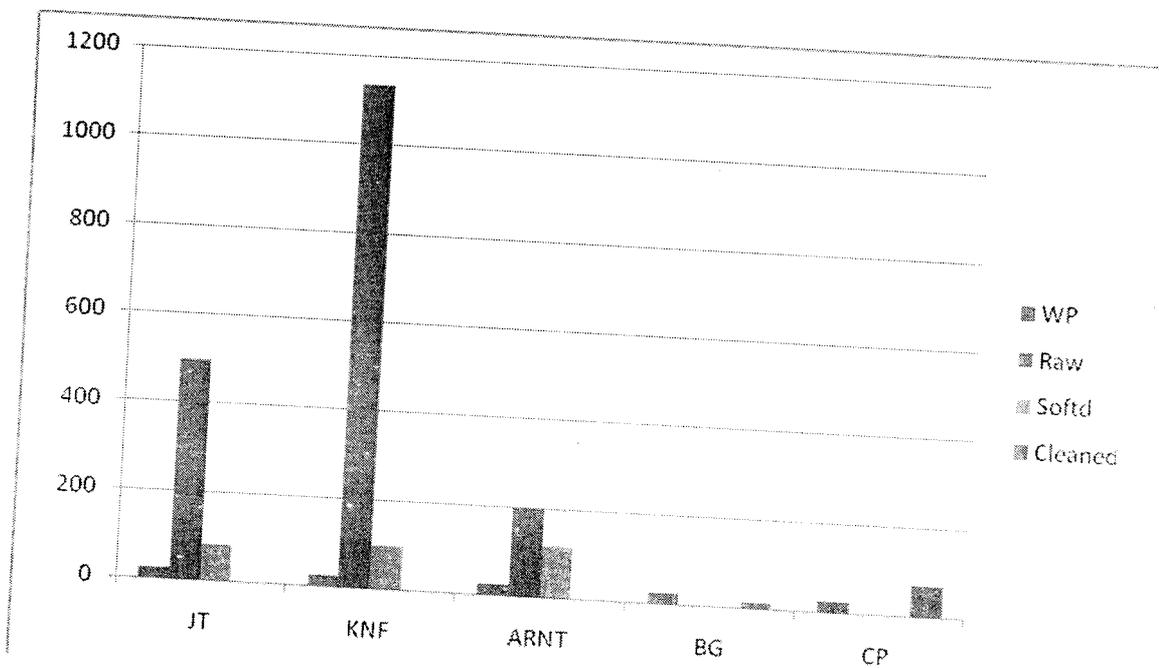


Figure 30: Immersion time

- ✦ The immersion time of raw fibre is much higher than the WP.
- ✦ When the softened fibre is compared with the raw fibres the immersion time is comparatively low but still it is higher than the WP.
- ✦ This is because, all the samples were in fibre state and WP is in the pulp form.

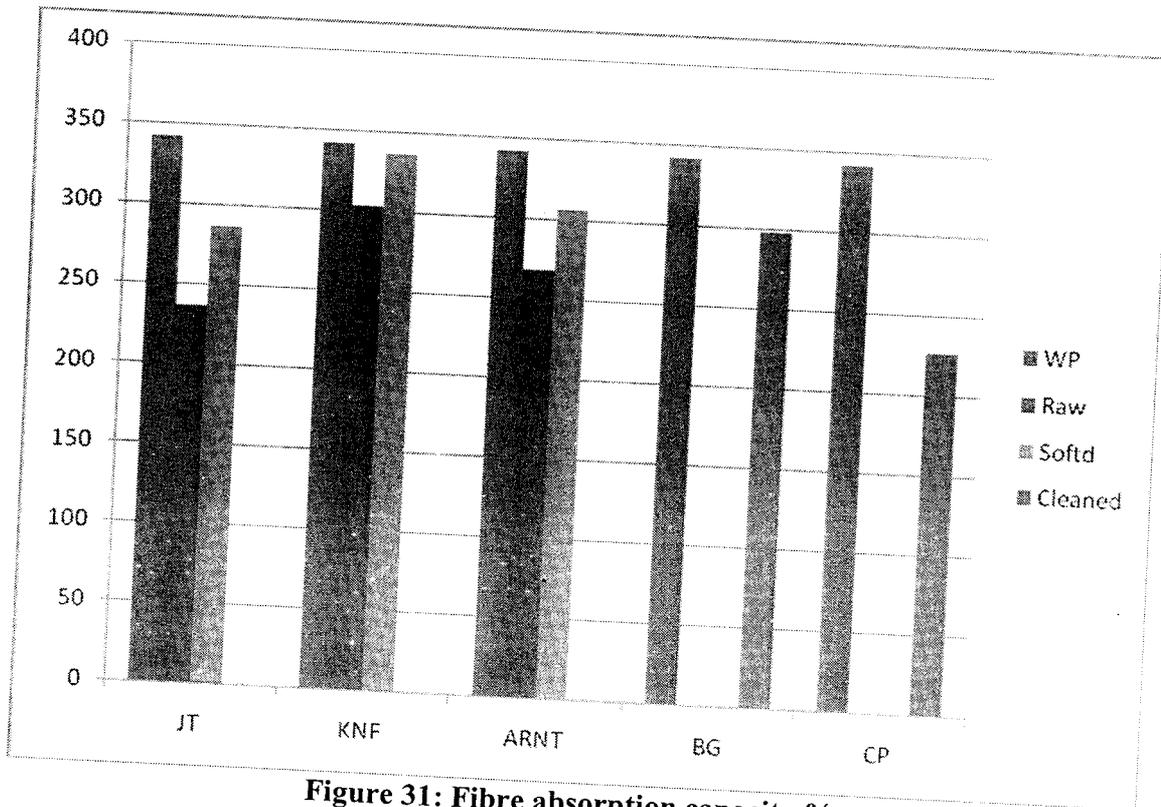


Figure 31: Fibre absorption capacity %

- ✦ It is observed that WP have more absorption capacity% than all the samples.
- ✦ But between the raw and softened fibres there is comparable difference i.e the absorption capacity% has increased in softened fibres than the raw fibres.

1.5 TESTS CARRIED OUT IN THE WEB STAGE:

Table 35: Wetting test results for web

S.No	Fibers	Wetting time (sec)
1	JT	3
2	KNF	10
3	ARNT	272
4	BG	2
5	CP	2
6	WP	2

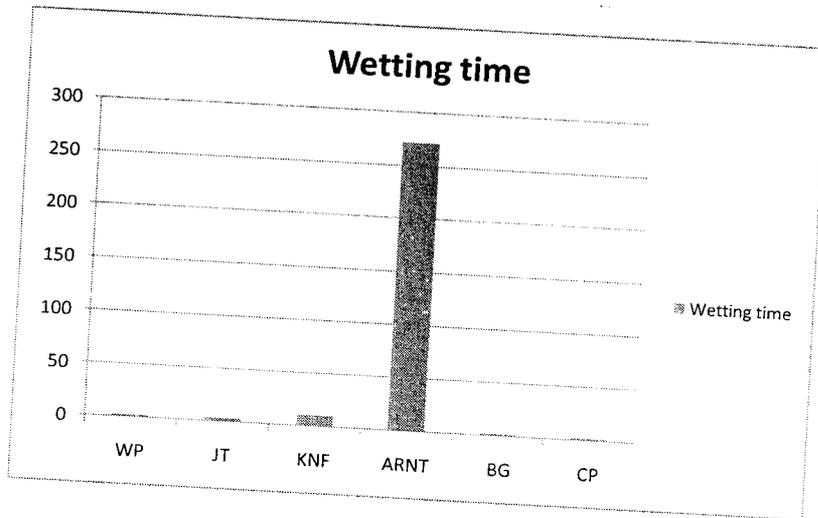


Figure 32: Wetting time

- ✦ The wetting time for arecanut is high when compared to other fibers.
- ✦ The wetting time of bagasse and coirpith is nearly equal to the wetting time of wood pulp.

4.6 TESTS CARRIED OUT FOR THE PREPARED SANITARY NAPKINS:

Table 36: Absorbency% for prepared sanitary napkins

S.No	Napkins	Absorbency %	Absorbed quantity (ml)
1	WP	750.92	96
2	JT	345.36	41.5
3	KNF	Not applicable	Not applicable
4	ARNT	Not applicable	Not applicable
5	BG	528.57	70
6	CP	162.71	13
7	WP / JT	469.87	46.35
8	WP / KNF	663.36	55.75
9	WP / ARNT	678.36	68.42
10	WP / BG	753.33	100
11	WP / CP	610.26	75

Table 37: Retention%, leak factor, dryness factor for the prepared sanitary napkins

S.No	Napkin	Retention %	Leak factor	Dryness factor
1	WP	730.20	22.03	107.21
2	JT	339.01	50	58.97
3	KNF	Not applicable	Not applicable	Not applicable
4	ARNT	Not applicable	Not applicable	Not applicable
5	BG	524.5	0	43.75
6	CP	160.35	3.07	15.38
7	WP / JT	462.82	16.39	89.06
8	WP / KNF	656.85	0	179.10
9	WP / ARNT	652.69	98.24	170.17
10	WP / BG	749.44	0	107.46
11	WP / CP	604.74	1.69	87.77

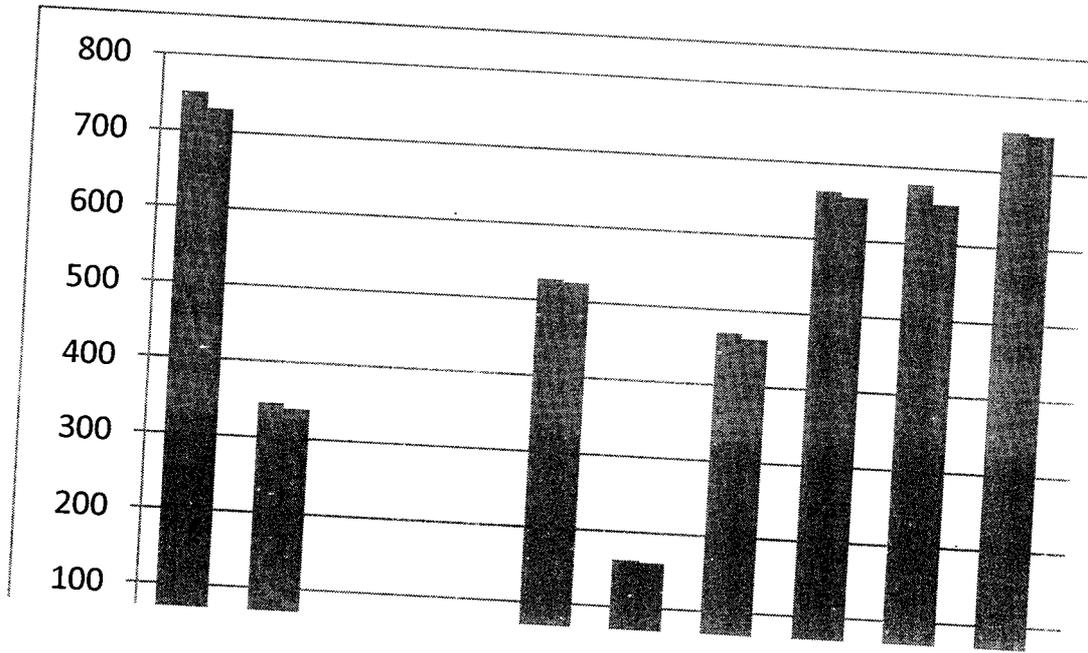


Figure 33: Relation between absorbency and retention % for the prepared sanitary napkins

- ✦ The test fluid dripped into 100% KNF and ARNT napkin has stripped out from the top surface. This is because the very low strike through rate for these fibers. The high wetting and immersion time would be the possible reason for this low strike through rate.
- ✦ On the other side the absorption capacity for these fibers is higher than JT and is nearly equal to WP.
- ✦ Because of this reason when the napkin is prepared with WP/KNF and WP/ARNT, the absorbency% is found to be higher (assisted by WP) and found higher than JT and WP/JT.

Table 38: Projected values for Absorbency % of prepared sanitary napkins with addition of 1.5% Super absorbent polymer over the weight of the absorbent core

S.No	Napkin	Weight of absorbent core			Projected absorbency %
		Total	Fiber	Gel	
1	WP	9.59			
2	JT	12.8	9.44	0.14385	820.5819
3	KNF	12.42	12.60	0.192	365.728
4	ARNT	11.61	12.23	0.1863	128.547
5	BG	12.13	11.43	0.17415	120.1635
6	CP	12.15	11.94	0.18195	646.187
7	WP / JT	10.2	11.94	0.21	280.32
8	WP / KNF	9.95	10.04	0.153	568.392
9	WP / ARNT	10.03	9.80	0.14925	926.4819
10	WP / BG	16.87	9.87	0.15045	771.9951
11	WP / CP	15	16.61	0.25305	759.2119
			14.77	0.225	756.3561

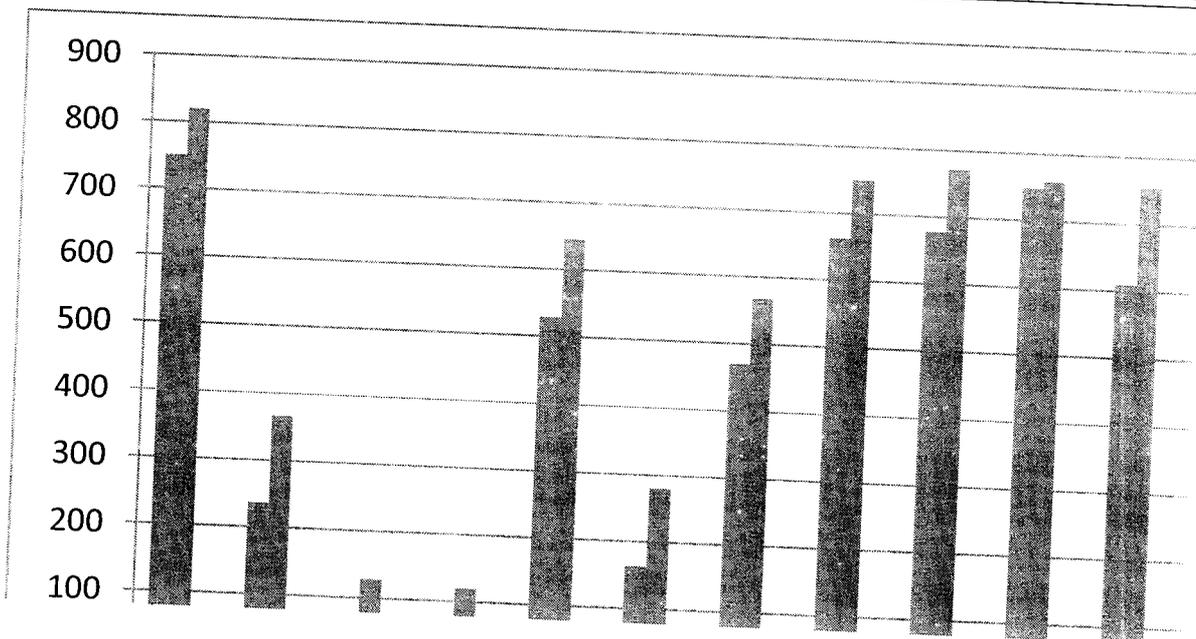


Figure 34: Projected values for Absorbency % of prepared sanitary napkins with addition of 1.5% Super absorbent polymer over the weight of the absorbent core

✦ The absorbency % of the fibers is increased with the addition of gel..

Table 39: Performance of fibers with respect to the performance of the WP

S.No	Napkin	Absorbency %	% difference	Rank	Retention %	% difference	Rank
1	WP	750.92	Ref value	2	730.20	Ref value	2
2	JT	345.36	-54.0084163	9	339.01	-53.572994	8
3	KNF	Not applicable	Not applicable	-	Not applicable	Not applicable	-
4	ARNT	Not applicable	Not applicable	-	Not applicable	Not applicable	-
5	BG	528.57	-29.6103446	6	524.5	-28.170364	6
6	CP	162.71	-78.3319129	8	160.35	-78.040263	9
7	WP / JT	469.87	-37.4274224	7	462.82	-36.617365	7
8	WP / KNF	663.36	-11.6603633	4	656.85	-10.045193	3
9	WP / ARNT	678.36	-9.66281362	3	652.69	-10.6149	4
10	WP / BG	753.33	0.320939647	1	749.44	2.63489455	1
11	WP / CP	610.26	-18.7316891	5	604.74	-17.181594	5

- ✦ From the table 4.5.3 and figure 5.2 it observed that absorbency and retention properties of WP/BG is higher than the WP and other fibers.
- ✦ The difference between absorbency and retention % is less in all the selected fibers and their combinations when compared to WP.
- ✦ WP/ARNT have lower retention property value when compared to other combinations
- ✦ Ranking is given to the absorbent core based on its performance with respect to the performance of the WP.

4.7 COSTING:

Table 40: Overall cost of sanitary napkin

Elements	Cleaning	NaOH	Softening	Cost of cover stock and leak proof	CMT	Fiber	
						Jute	Kenaf
Per kg	15	144	200	44	88	80	70
Per napkin	0.17	1.62	2.25	0.50	1	0.56	0.78

Table 41: Cost of sanitary napkins for various fiber and its combinations

S no	Fiber Combination	Per Pad
1	WP	2.01
2	JT	6.86
3	KNF	7.08
4	ARNT	3.67
5	BG	2.27
6	CP	2.27
7	WP/JT	4.43
8	WP/KNF	4.54
9	WP/ARNT	2.83
10	WP/BG	2.13
11	WP/CT	2.13

CONCLUSION

CONCLUSION

- ✓ Procedures and parameters have been standardized for the sanitary napkins prepared by SHGs.
- ✓ Absorbency index has been formulated.
- ✓ Recommendations and suggestions to improve the quality of the analyzed 2 brands have been furnished.
- ✓ An alternate organic cleaning material instead of detergents has been suggested to improve the eco-friendliness of the final product.
- ✓ Processing methods has been optimized for the various selected fibres.
- ✓ Processing of fibers has improved its moisture regain , moisture content% and absorbency capacity. And also the immersion time is also found to be decreased with the processing.
- ✓ In the web stage, the wetting time of bagasse and coirpith is nearly equal to the wetting time of wood pulp. Arecanut wetting time is found to be higher than all the other fiber webs.
- ✓ In the napkin stage :
 - The absorbency % of the combination of WP/BG is found to be higher than other fiber in which coir pith is found to be least.
 - The difference between absorbency and retention % is lower in all the fibers and their combinations when compared to WP.
 - When comparing all the fibers and their combinations WP/BG has shown better results in both absorbency and retention %.
 - The projected absorbency % of the napkin with the addition of 1.5% gel shown considerable increase in the absorbency% . This can increase the absorbency performance of the fibres in the sanitary napkins.
- ✓ The sanitary napkins made with 100% jute has shown higher strike through when compared to other sanitary napkins with 100% fibers.
- ✓ The volume of liquid lost by the sanitary napkin s while testing for retention % has been observed and this has been very less in WP/KNF and very high in WP/ARNT.

- ✓ The wetting time for coir pith is very high but still it has a very high retention.
- ✓ Bagasse has shown good absorbency and retention% and with the WP combination (WP/BG) absorbency and retention % is higher even than 100% WP napkin.
- ✓ The cost of the prepared sanitary napkins with the BG and CP and its combination WP/BG and WP/CP is found to be nearly equal to cost of WP .When it is done in bulk the cost can be further reduced than WP.
- ✓ The above mentioned points proves these fibers would be a better alternative for WP

**SUGGESTION FOR
THE FEATURE**

FURTHER SCOPE OF THE PROJECT:

- ✓ All the selected fibers could be transformed into pulp stage and used as the absorbent core of the sanitary napkin.
- ✓ In this project, we have softened the fibres but not de-lignified. De-lignification of the fibers could be done to improve the absorbency.
- ✓ To increase the integrity of coir pith and bagasse alternate methods of web formation could be done.
- ✓ Natural SAP could be combined with these natural fibers and study of the performance could be taken for the research work.
- ✓ Plant fibers with higher moisture content could be taken for similar study.

REFERENCES

REFERENCE:

- 1: <http://www.docstoc.com/docs/33824599/Domestic-technical-textiles-Indu>
- 2: <http://www.docstoc.com/docs/33824599/Domestic-technical-textiles-Indu>
<http://technotex.gov.in>
- 3: http://www.anion-sanitary-napkin.com/sanitary_napkin.html
- 4: http://www.anion-sanitary-napkin.com/sanitary_napkin.html
- 5: <http://www.fibre2fashion.com/industry-article/16/1501/manufacturing-market-potential-of-sanitary-napkins1.asp> (Manufacturing & Market Potential of Sanitary Napkins, By : B. S. Pancholi, Dr. Sandeep R. Naik)
- 6: <http://www.indiantextilejournal.com/articles/FAdetails.asp?id=1567>
- 7: <http://www.equitymaster.com/p-detail.asp?date=1/5/99&story=1>
- 8: <http://www.glamcheck.com/fashion/2010/05/19/what-are-sanitary-pads-types/>
- 9: <http://www.glamcheck.com/fashion/2010/05/19/what-are-sanitary-pads-types/>
- 10: <http://www.glamcheck.com/fashion/2010/05/19/what-are-reusable-sanitary-pads/>
- 11: <http://winalitepro.webs.com/>
- 12: http://www.theherbaladvisor.com/Systems_and_Functions_26/Tampon_and_Sanitary_Product_Fact_Sheet_5_printer.shtml
- 13: http://www.appropedia.org/Banana_Tree_Fibre_Female_Hygienic_Pads
- 14: http://www.appropedia.org/Banana_Tree_Fibre_Female_Hygienic_Pads
- 15: <http://www.ptj.com.pk/Web-2010/04-10/Muhammad-Ayaz-Shaikh.htm>
- 16: <http://www.indiantextilejournal.com/articles/FAdetails.asp?id=3085>
- 17: <http://books.google.co.in>
- 18: <http://www.google.co.in/>
- 19: <http://www.safemenopausesolutions.com/organic-cleaning-products.html>

20. Sadasivam.S and Manikam.A.: 1996 : Bio Chemical method second edition new age international pvt ltd. New Delhi : PP: 7, 8, 187

21. ASTM Standard books.