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DEVELOPMENT OF SANITARY NAPKIN BY FLAX CARDING WASTE AS ABSORBENT CORE WITH HERBAL AND ANTIMICROBIAL EFFICIENCY

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Abstract: The prizes of sanitary napkins must come under the purchase capacity of lower income group in developing countries like India. Due to unhygienic menstrual habits of using unsanitized cloth, husk, sand etc., a large number of women suffer from "reproductive tract infections" that is about 70% in India. To reduce the product cost, flax (Linum usitatissimum L.), carding waste fibre was used as absorbent core, which was found usable for this purpose. The core sheet was treated with methenolic extract of Alovera (Aloe barbadensis Miller) gel. The samples of treated fibers were tested as per standard test methods of AATCC and EN ISO to assess its antimicrobial efficacy against S. Aureus, a leading cause of human infections. The treated samples have been found to have sufficient antimicrobial potential against text bacterium. The developed napkin was tested as per IS: 5405. On the basis of results it meets all the requirements of test methods. Comfort related features of product were assessed through grading done by a group of college going girls, showed satisfactory results.

Keywords: Sanitary napkin, antibacterial, herbal, aloe vera.

Introduction

In the context of menstrual hygiene some kind of protection is necessary for every girl during menstruation. It is realized that there is a strong need for a hygienic product for menstrual protection worldwide. Increasing demand of suppressing production of solid waste in which Super Absorbent Polymers (SAP) is one of them has guided the future trend of producing more number of SAP free sanitary napkins. In the present study the traditional cotton filler is replaced with flax spinning waste, which is much cheap than pure cotton as well as highly absorbent.

The micro-organisms easily grow on surface where fabric is in the direct contact with body. In this sense sanitary napkin is prone to microbial infestation. *Staphylococcus aureus* is a leading cause of human infections and can survive best at human body temperature (37^{o}C). It

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may cause a variety of diseases including impetigo, cellulitis, food poisoning, toxic shock syndrome, necrotizing pneumonia, endocarditis, and sepsis (Voyich *et al,* 2005).

To avoid infections and diseases caused by these micro-organisms textile material, specially the sanitary napkin, need to have some antibacterial activity.

The Aloevera (*Aloe barbadensis Miller)* gel extracted antimicrobial finish is herbal, eco friendly, non irritant, and suitable for textiles. It has been found very effective against the growth of micro-organisms that is bacteria and fungi, as it does not support the growth of these micro-organisms.

Materials and Methods

Scouring and Bleaching: Scouring of flax fibres was done using non-ionic detergent and bleached with conventional peroxide bleaching.

Absorbency determination: Absorbency of flax spinning waste before and after bleaching was determined by the procedure described in a United States patent. A test basket made of metal wire of approximately 0.4 mm thickness and weighing not more than 3g was prepared. 1±0.05g of fibre sample, was placed in the basket and weighed. Basket was held on its sides approximately 12 mm above the surface of water at 25±1 degree, and dropped into the water. Time taken in seconds for complete submersion of test basket was determined. Basket was subsequently removed from water, allowed to drain for ten seconds in the same horizontal position then reweighed, and the weight of water absorbed was calculated.

Finish application: Aloevera is processed using hand filleted or whole leaf procedure. It carefully removes the gel while excluding the yellow sap of the leaf. The gel was crushed thoroughly and converted into solvent form.

Methanolic gel extract, in four different concentrations (100 %, 90%, 80% and 70% conc.) were applied to fibre in the presence of cross linking agent (citric acid). The fibres were immersed into the liquor, having different concentrations of aloe gel extract at optimized conditions. The samples were then dried at 80°C for several minutes to remove the moisture.

Evaluation of antibacterial activity

AATCC Test Method 147-2004 (Parallel streak method): Using a 4 mm inoculating loop, one loopful of the diluted inoculum was transferred to the surface of agar plates as per test method. Test specimen were placed onto inoculated agar plate transversely across the inoculums streaks and incubated for 18-24 hr at 37^0C, thereafter examined for interruption of growth along the streaks of inoculums beneath the specimen and for a clean zone of inhibition beyond its edge.

EN ISO 20645:2004 (Determination of antibacterial activity-agar diffusion plate test): Specimen is placed on inoculated agar with the test bacteria, and incubated for 18-24 hr at 37^0C. The level of antibacterial activity was assessed by examining the extent of bacterial growth in the contact zone between the agar and the test specimen.

AATCC 30-1993: Antifungal activity, assessment on textile materials: mildew and rot resistance of textiles (Humidity jar method): 500 ml sterile conical flasks containing of PD broth were prepared. The test samples were transferred aseptically into the conical flasks and kept at room temperature for three days. Then the growth of fungi in the conical flask was observed after three days.

Development of Prototype (IS: 5405-1980)

Absorbent filler: The filler material used in the study was flax spinning waste. It was given finishes such as scouring, bleaching making it free from lumps, oil, spots, dirt or foreign material. Anti microbial finish was subsequently applied on fibres to make it microbe free.

Covering: The fabric used was good quality cotton/rayon non-woven fabric with sufficient porosity to permit the assembled pad to meet the absorbency requirement and a lower non absorbent sheet.

Size: The prototype, developed was a regular type tab less sanitary napkin of 15±2 mm thickness, 200±20 mm length and 60 to 75 mm width (tab less napkin).

Sheet Formation: The fibres, free from lumps oil and foreign matter, were opened, parallelized and laid on a flat surface at the uniform thickness of 15±2 mm in the form of a uniform sheet. A vertical sheet of 200±20 mm length (regular type), and 60 to 75 mm width was cut from the fibre sheet without any wrinkle or distortion.

Layer Placement: The filler sheet was placed in the covering in such a way that it does not promote lump formation with the effect of sudden pressure. An adhesive coating was given at the bottom to hold the napkin in position. The sanitary napkin has a non-absorbent barrier on one side. The developed sanitary napkins were autoclaved to remove any type of microorganism.

Results and Discussion

Absorbency Determination: Flax fibres were assessed for their absorbency and results in Table 1 indicate that absorbency of bleached flax was significantly more in comparison to that of unbleached flax fibres. Higher absorbency of bleached flax may be attributed to swelling of bleached fibres.

Table.1. Determination of absorbency of fibre samples before and after bleaching

S. No.	Flax fibres	Average Weight of water absorbed (g/g)
1.	Unbleached	14.663
2.	Bleached	20.797

Evaluation of antibacterial activity

AATCC Test Method 147-2004 (Parallel streak method): The width of a zone of inhibition along a streak on either side of the test specimen was measured and value of W is calculated using the equations, given in test method. Here, mean W value is given.

Table 2. Width of zone of inhibition of gel treated samples

S. No.	Concentration (%)	Aloe gel treated samples		Commercial product's filler	Test control
		AATCC 147 (Mean W value in mm)	EN-ISO (Mean H value in mm)		
1.	100	7.75	7.25	Not detected	Not detected
2.	90	6.38	6.75		
3.	80	5.38	6.63		
4.	70	4	4.8		

Absence of bacterial colonies under the specimen in the contact area is considered as an acceptable antibacterial activity. Thus, the results are found to having very effective antibacterial activity against *S. aureus* (Table 2).

EN ISO 20645: 2004 (agar diffusion plate test): Inhibition zones were calculated using the equations in the H value. Inhibition zones >1-0 mm and no growth under samples were accepted as effective. Thus, all the samples were found very much effective against *S. aureus* even at 70% aloevera gel finish application (Table 2).

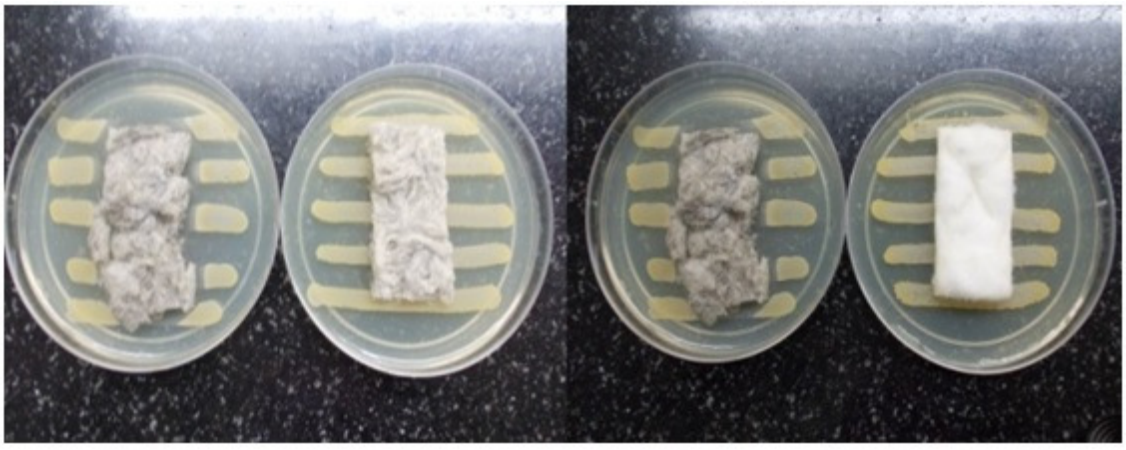

Figure 1. Presence of inhibition zone on plates with gel treated samples (left in each image), test control and commercial product's filler (AATCC 147: 2004)

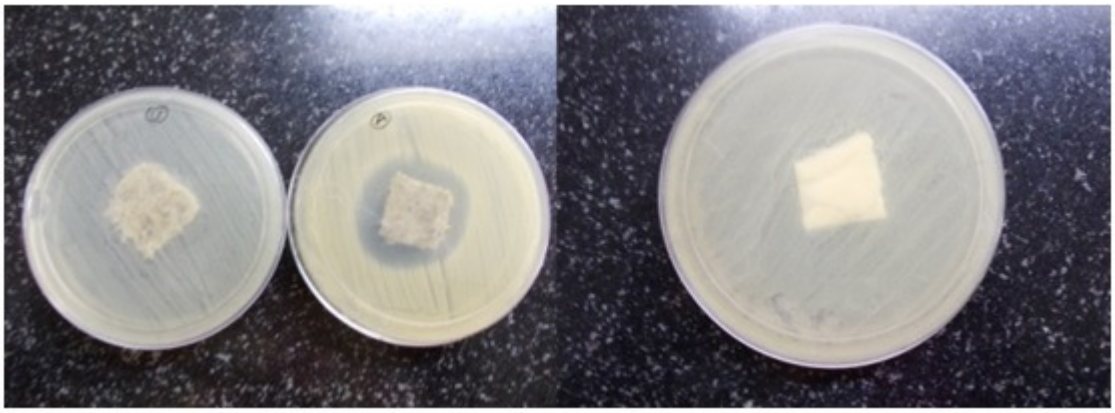

Figure 2. Presence of inhibition zone on plates with gel treated samples (left in each image), test control and commercial product's filler (EN ISO 20645: 2004)

Anti Fungal Activity (AATCC 30-1993: Antifungal activity, Assessment of textile material: mildew and rot resistance of textile material): No growth of fungi was found after three days in the flask containing gel treated samples. This indicates that the gel treated samples possess desirable anti fungal activity. Growth of fungi was found in the flasks of test control (Fig) and commercial product's filler after three days (Fig). Results confirm that the sanitary napkins treated with aloevera gel has sufficient antifungal properties and are safer to use than the available commercial napkins and untreated napkins.

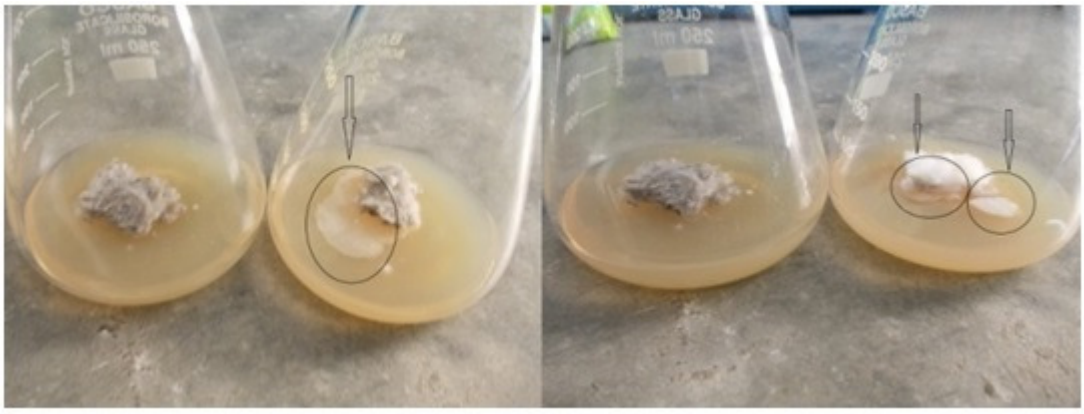

Figure 3. Growth of fungi in on test control and commercial product's filler (shown by arrows) and in gel treated samples (left, in both images), AATCC 30:1993

Testing of Developed Napkin (IS: 5405-1980)

Thickness: The average thickness was found about 15.74 mm which is within the limit of thickness as per test method. The stock height of 10 napkins was also measured and found about 157.40 mm.

Absorbency and ability to Withstand Pressure after Absorption: The routine test was done which is used for tab less napkin as per test method. After the napkin had absorbed full

amount of fluid and the pressure was given, the back and sides of napkin was observed for any fluid showing up.

The average time taken for absorbing the 20 ml water was 48.4 seconds and the napkin did not show any leakage of fluid on back and sides.

Figure 4. The prototype, showing no Fluid at back sides

Figure 5. Disintegrated filler sheet in water

Disposability: A disposable sanitary napkin with outer covering removed was immersed in 15 lt. of water and stirred. The pad was disintegrated in 1 minute and 35 seconds (it should not be more than 5 minutes).

Physical features of prototype: Comfort related features of sanitary napkin specimen like softness, flexibility and softness were assessed through grading done by a group of college girls, working woman and housewives. Maximum evaluators rated it between 7 to 9 out of 10 points.

Conclusion

In the present study, the short fibres of flax, waste fibres from the spinning mill, were found highly absorbent, natural cellulosic composition, short length, low cost etc.

As a preprocessing, scouring and bleaching was done to clean, increase the absorbency and to lighten the color of fibres. Today eco-friendly finishes on textiles are very much admirable and gaining popularity in the context of non harmful effect for nature. 70% aloegel extract on filling mat and service site of sanitary napkin has given satisfactory antimicrobial and antifungal potential

According to AATCC-147: 2004 test and EN ISO: 20645: 2004, AATCC-30: 1993. The napkin was then prepared and was evaluated for different parameters, given in test method IS: 1505-1980, like size, shape, thickness, absorbency to withstand pressure after absorption, disposability. The results found, meet all the requirements of these parameters. Comfort related features of sanitary napkin specimen like softness, flexibility and softness were

assessed through grading done by a group of college girls, working woman and housewives. Maximum evaluators rated from 7 to 9 out of 10.

The developed product may found its place among the commercial available counterpart products in women sanitary market. In order to develop low cost sanitary napkins this paper will form a strong platform for the application of spinning waste of some more natural fibres which is available in plenty in textile industry in various forms.

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