NOVEL TYPE OF ADULT DIAPER FROM NATURAL FIBERS

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ABSTRACT

The adult diaper are having some functional problems based on which the work has been focused in direction to make diapers more compact and using natural fiber like banana and hemp to enhance the comfort properties and making it eco friendly. The different combinations of banana and hemp fiber taken as core and treated with antimicrobial natural finish like neem. The performance has been checked for its functional and comfort properties. The result found satisfactory, the modification has been done to improve the performance. The novel idea related to smart diaper to sense wetting by incorporating conductive wire has been suggested.

Key Words: Natural fiber, Smart diaper, Moisture Management, Absorbency, Comfort aspects

1. INTRODUCTION

The construction of adult diapers is similar to baby diaper with a top sheet, distribution layer, absorbent core, back sheet, a cuff system and elastic leg gatherers. The inner layer of adult diaper facing towards the skin has to rapidly transfer liquid to the layer beneath it. The direct skin contact layer demands high degree of softness.The absorbing and distributing layer below transfers the liquid to the storage area [1]. The absorbent core layer consisting of a mixture of cellulose flakes and super absorbent polymer blocks and absorbs the liquid. The outer layer facing the clothing forms a moisture proof barrier. It therefore generally consists of a polyethylene film or a breathable nonwoven polyethylene composite are simultaneously gentle to the skin. Typical fiber here primarily includes cotton, rayon and cellulose, as well as synthetic fibers and various mixtures [2].

The absorbent hygiene products have become an indispensible feature of modern day living for all generations. Core of diaper is the main functional part of the product affecting its performance. The performance requirements of the diaper core material are absorption capacity, absorption rate and water retaining capacity. Core consists mainly of super absorbent polymer, which are non-biodegradable and cellulosic flakes. Thus this work has been focused on making core more effective, eco friendly by using natural fibers like banana and hemp in the core. Fibers are treated with natural neem finish for antibecterial properties. Smart diaper concept has been introduced by imparting conductive yarn to sense wetness.

2. PROBLEMS RELATED TO EXISTING PRODUCT

The problems arising with the products existing in the market are regarding their social, comfort, performance and environment aspects. It is socially accepted that the bladder control skills are acquired during childhood, and individuals suffering from incontinence face the stigmatization of their problem. Adult diapers are traditionally thick, visible and even noisy when user walk. This social stigma becomes a barrier for the person to use adult diapers especially in lower economic countries. The existing product does not offer great comfort as they have bulky structure because of the high amount of material used. Baggy structure doesn't fit properly and leads to friction and rashes. Moisture felt on the skin leads to bacterial infection. The commercial products mainly use super absorbent polymers (SAP) with Core

material, which perform well but they are non biodegradable and thus harms the environment. By making product more compact and thin, we can improve the comfort which will reduce the problem of rashes and reduce social stigmatization as wearing diaper will be less visible. Thus to make the product eco friendly, biodegradable and more comfortable natural fibers and its combination has been used in the novel type of adult diaper.

3. NOVEL CONCEPT

In this work novel concept of adult diaper using natural fibers has been introduced. Natural banana fiber and hemp fiber has been used to make the core of the adult diaper eliminating the super absorbent polymers making the product more biodegradable. A different combination of the layering of both the fibers has been tried in the core. To reduce bacterial infection these fibers were given natural antibacterial finish by using neem extract. The smart diaper concept has been introduced by incorporating conductive yarn with the help of integrated technology which able to sense and detect moisture level of diaper. This type of novel idea can offer assistance to patients, who are unable to have complete control over their bodily functions and having no senses. This type of modification in product can also help to serve the physiological needs of the patients and give solution for continence management [3], [4].

4 METERIALS AND METHODOLOGY

4.1 Materials

The diaper core has been prepared using banana and hemp fiber. The raw banana fiber has been collected from Navsari Agricultural University, Gujarat. A further fiber has softened by softening treatment as shown in figure1. Hemp fiber used in the core was cottonized procured from Boheco, Mumbai as shown in figure 2.The Spunbond-Spunbond (SS) nonwoven fabrics has been used as top and bottom sheets were procured from Ahlstrom, Mundra, Gujarat.

Figure 1. Banana Fibre

Figure 2. Hemp **F**iber

4.2 Experimental set up

The banana and hemp fibers core has been prepared by formation of web on card as shown in figure 3.The staple length of banana has been kept 4cm were opened up and feed to miniature card to prepare web. Similarly hemp fibers and of 50:50 banana/hemp has also been prepared. Six layers of web have been taken to make single core. The different combinations of layer have been prepared by compressed under hydraulic press machine under high pressure for 20 minutes along with top and bottom sheet.

Figure 3. web formation on miniature card

Further Banana fiber has been treated with neem extract. The neem leaves were taken and washed properly with water to remove the contaminations on the surface of leaves. These washed leaves pat dried with absorbent cloth and excess moisture from the surface is removed. These leaves were then oven dried at 150°C for 2 minutes and crushed into fine powder. The 10gm of neem powder and 100ml of methanol were stirred and mixed for 60 minutes and then filtered with filter paper. The filtered solution of 20% neem extract was mixed with water to get miscible solution. The prepared web was sprayed with the above solution and allowed to dry at room temperature. The web color change has been observed before and after neem treatment as shown in figure 4.

Figure 4. Banana web before and after neem extract treatment

4.3 Performance Check

The sample preparation has been done using an acrylic sheet template of 80x12cm having five circular holes each of diameter 4cm and having distance between two circles 7cm [5]. Specific sizes of circular samples were cut from the web. These samples were used for testing thickness and absorption test. The saline water has been prepared adding 9 gm of NaCl in 1litre water.

The water absorption % was found taking first dry weight of sample.The samples has been dipped in saline water for 10 seconds and then left for 5 minutes outside so water can be drain. After 5 minutes weight of wet sample has been taken. The % absorption calculated using given formula (1).

$$\text{Water absorption } (\%) = \frac{(\text{wet sample weight} - \text{dry sample weight}) \times 100}{\text{wet sample weight}} \quad \ldots\ldots\ldots(1)$$

To find holding capacity further sample has been kept under weight of 2 kg for 5 minutes so that unabsorbed water can remove and again sample weight has been taken after compression. The % holding capacity calculated using given formula (2). Experiment has been repeated for all the samples and data was recorded.

$$\text{Holding Capacity (\%)} = \frac{(\text{wet sample weight after compression} - \text{dry sample weight}) \times 100}{\text{wet sample weight after compression}} \quad \ldots.(2)$$

Antibacterial property of samples was examined by zone of inhibition and viable count method, according to test method AATCC 100-1998. The antibacterial activity was checked against both gram positive bacteria S. aureus (ATCC 25923) and gram negative bacteria E. coli (ATCC 35218) obtained from an overnight culture were suspended in nutrient broth. The 200 ml was spread on Muller Hinton Agar (MHA) plates to obtain a semi-confluent growth. The samples were then placed on the inoculated medium and the plates were kept for incubation for 24 hours at 37°C. The inhibition zones were then observed [6].

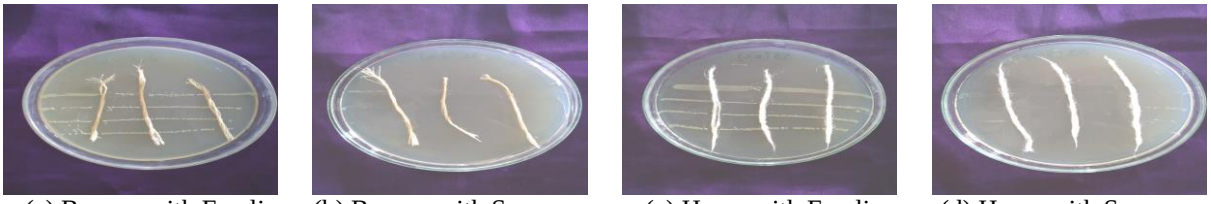
5. RESULT AND DISSCUTION

The different core samples has been prepared along with top and bottom sheets and checked for its performance like % absorbency, % holding and antimicrobial properties. The four samples were prepared with six layers of different combination of banana and hemp fibers as shown in Table1.

Table 1. Core layer combinations and its properties

Sample	Thickness (mm)	Absorbency (%)	Holding (%)	No. of layers/ layer material	Layer combination
Commercial sample	6.02	94.80	69.16	Combination of pulp and SAP	
C_B	9.03	87.50	83.02	6/ banana	
C_H	7.15	85.44	83.33	6/ hemp	
$C_{BH:B:BH}$	9.90	90.35	87.31	2/Banana hemp 2/Banana 2/Banana hemp	
$C_{BH:B:H}$	9.80	87.43	83.81	1/Banana hemp 4/Banana 1/Hemp	

The thickness of total composition has been found around 9.5 mm except the 100% hemp that gives lower thickness 7.15mm. The cottonized hemp is more bulky but lighter in weight as compared to banana fibers. The absorbency of banana fiber is high because of its structural composition due to absorbent cellulose contains good percentage of alpha cellulose which increases its absorbency as compared to other natural fibers. The antimicrobial performance of banana and hemp has been checked as shown in figure 5 (a) to (d). The results show that the banana and hemp have good resistance to the bacteria S.aureus (figure 5(b) and (d)) and less resistance for bacteria E.cloi (figure 5(a) and (c)). The eruptions in diaper area are more prone to have bacterial infections cause by S.aureus, which is responsible for skin allergies [7].



(a) Banana with E.coli (b) Banana with S.aureus (c) Hemp with E.coli (d) Hemp with S.aureus

Figure 5. Antibacterial Test

The samples have been checked for absorbency and holding power, then compared with the commercial sample. It has been clearly indicated in figure 6 that C_B (100% banana fiber sample) have higher absorbency% then C_H (100% hemp fiber sample), while holding% was observed to be almost same for both the samples. It has been observed while testing that liquid transfer property of cottonized hemp fiber web has been found very low compared to banana fiber web. The cottonized hemp having very soft in feel and voluminous property due to which it does not transfers the liquid immediately. Hence we have concluded that hemp fiber layer is not suitable for the top layer of core combinations. Thus in other two combinations banana hemp mixed web has been taken as a top layers. It has been clearly indicated in figure 6 that sample $C_{BH:\,B:\,BH}$ having higher % absorbency and % holding then sample $C_{BH:\,B:\,H}$. These results were obtained when samples completely dipped in the solution but when solution transfer properties were observed it has been found that banana hemp mix web transfers the solution better than 100% hemp but less compare to100% banana web.

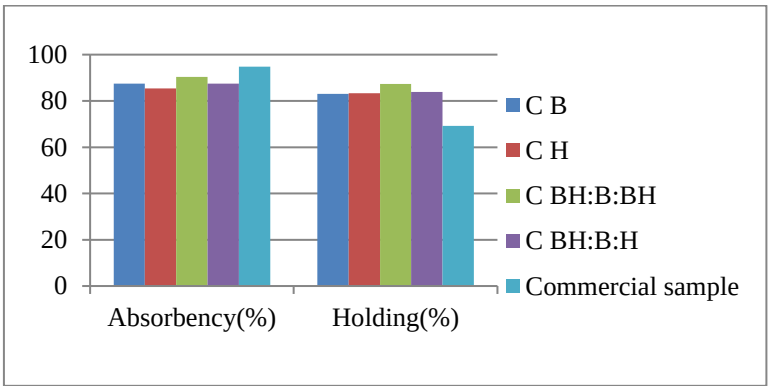


Figure 6. Performance Properties of Core

Out of the four samples $C_{BH:\,B:\,H}$ has been found more suitable as banana/hemp layer on the top gives softness and comfort along with good transfer property. The middle layers of banana fiber helps in transferring the liquid and give the good absorbency. The hemp fiber has been placed in last layer to avoid leakage as complete transfer of liquid will not taking place. When compared with commercial sample as shown in figure 6 the % absorbency was less but % holding was observed to be high of sample $C_{BH:\,B:\,H}$. The number of combination has been also prepared using Spun-Meltblown-Spun (SMS) nonwoven fabrics in top and bottom sheet and core combination to optimize the mix of fibers.

6. DESIGN MODEL OF NOVEL ADULT DIPER

The design of adult diaper consists of three parts: Top sheet, Core and Bottom sheet as shown in figure 7. The top sheet consists of a layer of SS nonwoven followed by layers of web in core and lastly bottom sheet which consists of a non-permeable sheet sandwiched between two layers of SS nonwoven.The inner layer of nonwoven in bottom sheet has been incorporated with conductive yarn by stitching.

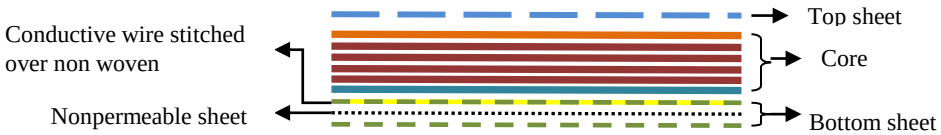


Figure7. Novel Design of Adult Diaper

This conductive yarn can be incorporate with sensor to sense wetness. All these layers were stitched together from the sides to make a sample.

7. CONCLUSION

This study has purpose to make adult diaper using natural fibers with effective properties. It has been found that sample $C_{BH:\,B:\,H}$ shows good performance test results with absorbency and holding capacity and can be used as a core for medium flow incontinence patients. Further to improve its performance and make it useable for heavy incontinence diapers 0.5g of SAPs can be added. Hereby in the sample conductive yarn has been incorporated, which can be inter phase with appropriate sensors to the sense wetness for novel type of smart diaper.

8. REFERENCES

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Dr Hireni Mankodi is working as Associate Professor in the Textile Engineering, Faculty of Technology and Engineering, The M.S. University of Baroda, India since last 28 years. She has been awarded FTA from All India Textile Association, Career Award for Young Teacher by AICTE and FIE from Institution of Engineers. She was nominated as visiting Scholar under UGC-TEC agreement in 2012 and visited Mauritius for 1 month under this scheme. Recently she has completed MRP Project on textile composite from GUJCOST. She has published over 25 research paper in International journal,16 review papers 12 papers presented in National seminars and 36 papers+3 posters in International Conference at different places. The one chapter on Development in Hybrid Yarns published in Book entitled "Specialist Yarn and Fabric Structures: Developments and Applications". Her expertise in Technical Textile and research areas include medical textiles, hybrid yarns, Electronic controls in textile machineries and Design consideration for Smart Garments. She is member of 7 professional associations.