Preliminary study on the Wicking and Antibacterial Properties of Herbal Finished Textile Fibres for the Development of Sanitary Napkins

Karthika, M[1*] & Sangeetha, K[2]
[1]Assistant Prof, Nehru Group of Institutions, Coimbatore.
[2]Head, Department of Textiles, Bharathiar University, Coimbatore.

Received: September 03, 2018 Accepted: October 17, 2018

ABSTRACT *Oral herbs used by the women during their menopause time in the olden days was selected and investigated for its antibacterial activity after finishing onto cotton and viscose fibres. The study was aimed to understand the wicking and antibacterial properties of the herbal extract finished fibres; so that the fibres shall be used for the development of sanitary napkins. Two different fibres like cotton and viscose was procured along with two medically significant herbs (Ipomoea digitata and Saraca asoca). The herbal extraction was carried out using a standard Soxhlet extraction method. The extracts were finished onto the fibres as herbal composites using a standard dyeing procedure. The mordant sodium chloride was added to impart permanent colour to the fibres. The surface change in the fibre if any was also determined under Scanning electron microscope. As expected for the antibacterial potential of the selected herbs in the study, the antibacterial activity of the herbal composite finished fibres were analyzed using standard EN ISO 20645 test method.*

Keywords: *Sanitary napkin, Cotton, Viscose, Medicinal herbs, EN ISO 20645*

The female hygiene products division is the important segment among medical textiles which needs to be treated well. Menstruation is a monthly occurrence that requires access to appropriate materials and facilities, without which, females suffer from poor menstrual hygiene which restricts their movement and self-confidence. Good menstrual hygiene is crucial for the health and dignity of girls and women. Sanitary napkin is an absorbent item worn by a woman while she is menstruating. The key property requirements of hygiene products are to absorb and retain menstrual fluid discharge which is a complex viscous mixture of water, salts and cells; barrier performance for containment and absorption without leakage, comfort and breathability, wicking and wetting behaviour, mechanical properties, sterilization stability, antimicrobial properties without skin irritant tendencies which are achieved by suitable raw material choices and design considerations (Jassal, 2011).

Menstruation is a process in which woman discharge blood and other material from the lining of the uterus at an interval of about 28 to 35 days from puberty until menopause. It causes serious problems to the women if not managed properly. This menstrual discharge can be absorbed by some absorbent material. The functional requirement of a feminine hygiene product is to absorb and retain the menstrual fluid so that back tracking of fluid does not happen and at the same time it should be odor free. Commercially available menstrual hygiene pads are made up of material which may seem innocuous but they are laced with dioxins, petrochemicals, artificial fragrances etc. These chemicals come in contact with sensitive skin tissue, can cause skin irritation. Cellulosic chlorine bleached pulp; rayon which is used to increase absorbency of pad contains dioxin leads to cervical cancer irregular growth in reproductive organs. Deodorants and synthetic material used in sanitary pads blocks dampness and heat which encourages yeast and bacterial growth. One of the major concerns of disposable pads is its non-biodegradability which increases generation of menstrual waste which ends up in leaking into nature and polluting rivers. Also it causes occupational hazard as the used pads are to be picked up by waste pickers by their bare hand (Anuradha Barman and Pooja M Katkar, 2017).

This problem can be elevated by developing the sanitary napkins fabricated with herbal extract finished cotton and viscose fibres. In this study an attempt has been made to develop the sanitary napkins of Cotton and viscose fibre finished with *Ipomoea digitata* (Valli flowers) and *Saraca asoca* (Asokam flowers) extracts as absorbent layer and antibacterial barrier layer.

Sanitary napkins may bring considerable troubles when they are not treated well. Bacteria feed and grow on fresh menstrual discharge while it is excreted from the body and absorbed by the sanitary products. For ordinary sanitary napkin used continuously for two hours, its surface may have bacteria numbering up to 10^7 per square centimeter and this contamination may seriously affect the health of the women. Therefore

the sanitary pads should be designed to restrict further bacteria growth and unnecessary odour (Davies, 2011).

So, there is a need to develop a process of imparting antimicrobial agents to the textile substrate, where the properties of the resultant treated textiles are unaltered. Also it remains to be seen whether the stability or durability of antibacterial property of the herbal treated fabrics remains for long.

An increasing interest in the textile industry has been noticed in the functionalization based on environment friendly and biodegradable reagents which possess the necessary bioactive properties as substitute for toxic chemicals. There are many natural products, which show anti-bacterial properties like extracts from roots, stem, leaves, flowers, fruits and seeds of diverse species of plants. The objectives of the study are as follows:

1. To collect and extract the therapeutic compounds from the flowers of *Ipomoea digitata* (Valli flowers) and *Saraca asoca* (Asokam flowers).
2. To finish the extracts on cotton and viscose fibres and evaluate its antibacterial properties using a standard EN ISO 20645 test method.
3. To study topographically the finished fibres using SEM analysis
4. To determine the difference in wicking or absorbency behavior of the finished and plain fibres

Method

Procurement of cotton fibre and herbs

The absorbent cotton fibre and Viscose fibre (Pallava Textiles Pvt Ltd) was commercially procured from a fibre processing shop at Erode, India. Herbal powders of *Ipomoea digitata* (Valli poo) and *Saraca asoca* (Asokam Poo) were procured from an organic store at Coimbatore, India. All chemicals (Nice, Loba, Merck), and Media (Hi Media, TM Media) was purchased commercially from chemical suppliers, Coimbatore. The entire research work was done during the period of August 2018 to October 2018.

Extraction of herbs (Owis, 2010)

About 50g of each *Ipomoea digitata* and *Saraca asoca* powdered leaves were extracted with 125mL of ethanol using Soxhlet extraction apparatus for 3 to 6 hours. The extract was allowed to cool and stored at room temperature in liquid state prior to use. The extract was then used to dye the fibres and evaluated for its antibacterial activity.

Dyeing the fibre using herbal extracts (Owis, 2010)

The herbal extract was applied on to the fibres (cotton fibre) by immersing in a dye bath containing the herbal extract at liquor ratio of 1:50ml herbal solution for each gram of the fibre sample at room temperature without heating. Then at 100°C sodium chloride was added under closed dyeing system. Finally, the herbal dyes were rinsed in water and dried at 40°C for 30 min. Similarly, the above procedure was done for the viscose fibre separately.

Topographical studies of the fibres - Scanning Electron Microscopy (Haleem et al., 2014)

The topographical analysis of the finished fibres in comparison with the control (plain) fibre was investigated under scanning electron microscopy. The SEM analysis of the fibres was carried out to identify the difference in the fibre structures after the addition of herbal extract. The change in the fibre structure and fibre surface was comparatively investigated in the study. The samples were prepared for SEM using a suitable accelerating voltage (10 KV), vacuum (below 5 Pa) and magnification (X 3500). Metal coating was used as the conducting material to analyse the sample.

Antibacterial activity of the fibres (EN ISO 20645 test method)

Antibacterial activity of herbal dyed cotton fibre and viscose fibre was evaluated against two test organisms, *Escherichia coli*, *Staphylococcus aureus, Klebsiella* sp and *Pseudomonas* sp. (all cultures were procured from GRAM-POSITIVES, a diagnostic laboratory, Coimbatore). In this method the pre-measured size (2.0cm dia) of the test materials were tested from each preparation (*Ipomoea digitata* and *Saraca asoca*). Test materials were placed on the surface of Mueller-Hinton agar plate which had previously been seeded with an overnight broth culture of the test organisms and incubated at 37°C for 24 to 48 hours. Antibacterial activity was expressed as the diameter of the zone of inhibition or inhibition clear zone (ICZ).

Wicking properties of the fibres (AATCC Test Method 197)

AATCC TM 197, Vertical Wicking of Textiles, is used to measure "the ability of vertically aligned fabric specimens to transport liquid along and/or through them" Wicking rate is a particularly important property that measures a fabric's ability to remove sweat/liquid from contact with the body. The wicking properties were analyzed comparatively for control (plain) fibre and test fibres (cotton and viscose). The wickability of the test fibres was evaluated by time for wetting. During the analysis, the fibre samples were conditioned in a standard atmosphere of 22ºC under 65% relative humidity for 24 hours. The pre-measured size (1.5cm x

10cm) of each test mounted on the glass slides was kept at immersed condition inside a reservoir containing artificial blood. The wicking height of the advancing liquid front as a function of time was recorded by visual observation after 5 minutes. Using a standard ruler scale, the colour of artificial blood absorbed on the fibre surface was measured for each sample and the values were recorded.

Results and discussion

The plants produce hundreds to thousands of diverse natural chemical compounds with different biological activities, which serve as plant defense mechanisms against predation by micro-organisms, insects or herbivores (Joshi *et.al*., 2009). The healing power of some of the plant materials has been used since ancient times. Recent developments on plant based bioactive agents have opened up new avenues in this area of research (Joshi *et.al.*, 2009).

Though, there is a vast resource of antimicrobial agents derived from plants, which can be used for imparting useful antimicrobial property to the textiles substrates, yet the utilization of plant based herbal products depends upon their bulk availability, extractability, antimicrobial efficacy, durability, non-allergenic reaction to skin, shelf life and cost.

Hence, in this present research two such plants were selected [*Ipomoea digitata* (Valli flowers) and *Saraca asoca* (Asokam flowers)] based on their ailment properties for menorrhagia. Genus Ipomoea represented by 650 species distributed worldwide. Recent research has shown that these and many other plants of this genus possess medicinal potential in various diseases. Species like *Ipomoea digitata* and *Ipomoea batatas* were reported to be used against menorrhagia (Deepa Srivastava, 2017).

Sanitary products treated naturally utilizing herbal extracts can help to stop spread of infections leading to superior protection, can lessen inflammation, can fight vaginal infections, keep unpleasant odour away and personal hygiene and enhance comfort of the wearer (Shanmugasundarama and Gowda, 2010). There are very few studies, wherein efforts have been made to exploit these ecofriendly bioactive natural products for textile application in a systematic way. So a need was perceived to impart antibacterial herbal finishes to the sanitary napkins as no related work has been reported in this sector. During the application of these extracts to the textile substrate, there may be the blocking of the active functional groups which are responsible for the antimicrobial activity, which may result in the loss of physical and other performance properties such as air permeability, stiffness of the treated textiles (Joshi *et.al.,* 2009).

Topographical studies of the fibres - Scanning Electron Microscopy

The scanning electron microscopic analysis of the control (plain) cotton fibre and finished cotton fibre was analysed to show the difference in the fibre structures due to addition of herbal extracts. The change in the structure of fibers surface is comparatively evident. In Fig-1, the structural morphology of the plain control cotton was presented. From the figure, it was evident that the fibres were wrinkled with harsh surface which may be caused due to absence of moisture content in the fibre. It was proven that the fibres always have the ability to hold atleast few percentage of moisture content due to the presence of carboxyl cellulose content and its functional groups (Elayarajah et al., 2013). This was evident from Fig-2 attributing the SEM analysis of cotton fibre structures. From the figure, it was evident that, the cotton fibres were swollen with few protruding microfibrils. Fiber swelling is due to the herbal extract concentration used during the herbal finishing (dyeing) process. Similar results were obtained for viscose fibre (Images not displayed)

Antibacterial activity of the fibres

The antibacterial activity of cotton and viscose finished (dyed) with the extracts of *Ipomoea digitata* (Valli flowers) and *Saraca asoca* (Asokam flowers) were evaluated against two significant organisms (*Escherichia coli*, *Staphylococcus aureus, Klebsiella* sp and *Pseudomonas* sp). During the analysis, the herbal extract finished cotton and viscose fibres showed good antibacterial inhibitory zones. The antibacterial activity of the herbal extract finished cotton and viscose fibres exhibiting the inhibitory zones measured in millimetre was tabulated in Table-1. In Fig-3, Fig-4, Fig-5 and Fig-6 the zone of inhibition observed was clearly evident against the respective test bacteria *Escherichia coli*, *Staphylococcus aureus, Klebsiella* sp and *Pseudomonas* sp.

As per the literature review some reasons were hypothetically proved for the therapeutic potential of *Ipomoea digitata* and *Saraca asoca*. First reason was reported as the presence of significant compounds like β-sitosterol, taraxerol acetate, n-decanoic, cinnamic acids and operculinic acid A (Deepa Srivastava, 2017). The inhibitory zones indicated the antibacterial potential of these herbal compounds that are inherently present. Another reason was the cellulose content in the fibre which would significantly increase

the absorbency or wicking properties. This property was later discussed in the wicking behavioural tests of the fibres in comparison with the plain fibres. Due to more herbal dye absorbency, the fibres have exhibited more antibacterial activity. The increased concentration of herbal dyes absorbed by the fibres later gets released on to Nutrient agar surface. This would have shown more inhibitory zones against the test organisms.

Wicking properties of the fibres

The wicking properties were analyzed comparatively for plain fibres and finished fibres (cotton and viscose). The wickability of the test fibres was evaluated by time for wetting. During the analysis it was evident that the finished fibres showed similar wicking abilities when compared to that of the plain fibres. The results indicated that the existing herbal dye concentration did not inhibit the wicking or absorbency behavior of the finished fibres.

During the analysis, the fibre samples were conditioned in a standard atmosphere of 22ºC under 65% relative humidity for 24 hours. The pre-measured size (1.5cm x 10cm) of each test mounted on the glass slides was kept at immersed condition inside a reservoir containing artificial blood. A ruler was placed parallel to the sample strip to enhance the accuracy of the measurement. The wicking height of the advancing liquid front as a function of time was recorded by visual observation after 5 minutes. Using a standard ruler scale, the colour of artificial blood absorbed on the fibre surface was measured for each sample and the values were recorded (Table-2). The herbal dye finished fibres (cotton and viscose) exhibited similar level of blood absorbency when compared to that of control fibres. In Fig.-7 the absorbency in terms of time in minutes for wetting the fibres was illustrated.

Conclusion

In the preset study, two fibres were selected and tested for its ability to use it as a top absorbent layer for the development of eco-friendly sanitary napkin after finishing with two medical significant flower extracts (*Ipomoea digitata* and *Saraca asoca*). The flowers were selected based on their therapeutic potential use in the olden days by women during their menopause time. The extracts were used as oral drugs to cure the excess secretion of uterine fluids and related female genito-urinary problems like menorrhagia. The fibres like cotton and viscose were selected for this study. The extracts from flowers were taken and finished as dyeing agents on the selected fibres. The finished fibres were subjected to different laboratory studies like topographic SEM analysis, antibacterial activity and wicking properties. During the analysis, the antibacterial and wicking properties declare the significant role of the finished fibres for the development of eco-friendly sanitary napkins. Further optimization studies would also prove the ease of developing this sanitary napkin in the future.

References

1. AATCC Test Method 197. Wicking properties of Textile Materials. American Association of Textile Chemist and Colorist, AATCC technical Manual, 2011:159-165.
2. Anuradha Barman and Pooja M Katkar, Development of Eco-friendly Herbal Finished Sanitary Napkin, International Journal for Innovative Research in Science & Technology, 2017, 4(1): 183-189.
3. Bioactive agents Based on Natural Products. Indian Journal of Fibre and Textile Research. 34: 295-304.
4. Davies, A. M. 2011. Use of knitted spacer fabrics for hygiene applications. In McCarthy, B. J. (ed.) 2011. Textiles for Hygiene and Infection Control: pp 85-101, Cambridge: Woodhead Publishing Limited.
5. Deepa Srivastava. Medicinal plants of genus Ipomoea found in Uttar-Pradesh, India. Research Journal of Recent Sciences, 2017, 6(12): 12-22.
6. Elayarajah Balasubramanian, Venkatrajah Balasubramanian, Geethu Babu, Devika S , Rajendran R, Moist wound dressing fabrications: Carboxymethylation of antibacterial cotton gauze. Journal of Eng Fiber Fabr, 2013; 8 Suppl 4:78-87.
7. EN ISO 20645. Determination of antibacterial activity - Agar diffusion plate test. Technical Committee CEN/TC, 2004: 248.
8. Jassal, M. 2011. The design of novel hygiene textile products. In McCarthy, B. J. (ed.) 2011. Textiles for Hygiene and Infection Control: pp:85-101, Cambridge: Woodhead Publishing Limited.
9. Joshi, M., Ali, S. W. and Purwar, R. 2009. Ecofriendly Antimicrobial Finishing of Textiles using
10. Karolina Boruvkova, Jakub Wiener. Water absorption in carboxymethyl cellulose. AUTEX Res J, 2011; 11 Suppl 4:110-113.
11. Owis AS, An economical dyeing process for dyeing (cotton, polyester and cotton/polyester blend fabrics). J Tex Apparel Technol Manage, 2010; 6 Suppl 4:1-11.
12. Shanmugasundarama, O. L. and Gowda R. V. M. 2010. Development and characterization of bamboo and organic cotton fibre blend baby diapers. Indian Journal of Fibre and Textile Research.35(9): 201-205

Table-1:Anti-bacterial activity of herbal (flower) extract finished fibres

S. No.	Fibres	Zone of Inhibition (in mm)	
		Cotton (finished)	*Viscose (finished)*
1	*Escherichia coli*	19	18
2	*Staphylococcus aureus*	17	16
3	*Klebsiella* sp	17	17
4	*Pseudomonas* sp	22	18

Std: Ciprofloxacin drug was used a standard drug (average inhibitory zone recorded - 21.5mm)

Table-2: Wicking properties of herbal (flower) extract finished fibres

S. No.	Fibres	Wicking height in centimeters	
		Control	Finished
1	Cotton	4.8	4.5
2	Viscose	4.7	4.9

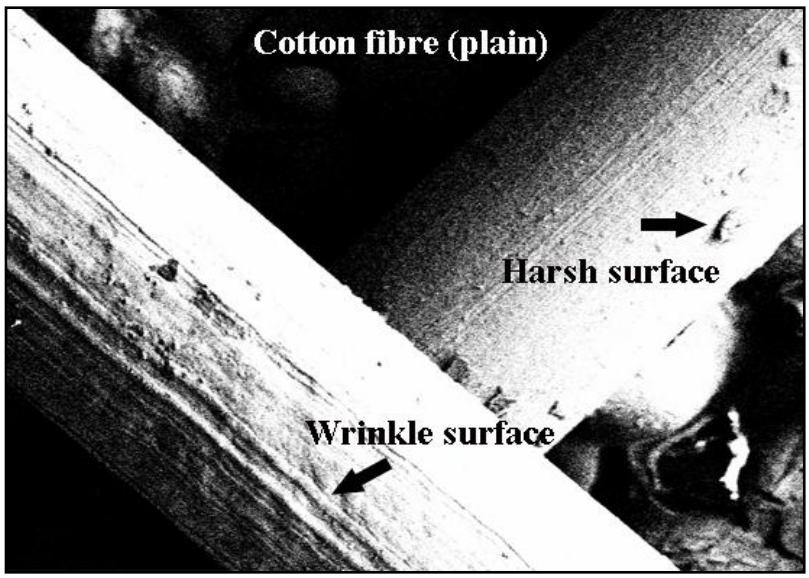

Fig-1: SEM analysis of (control-plain) cotton fibre

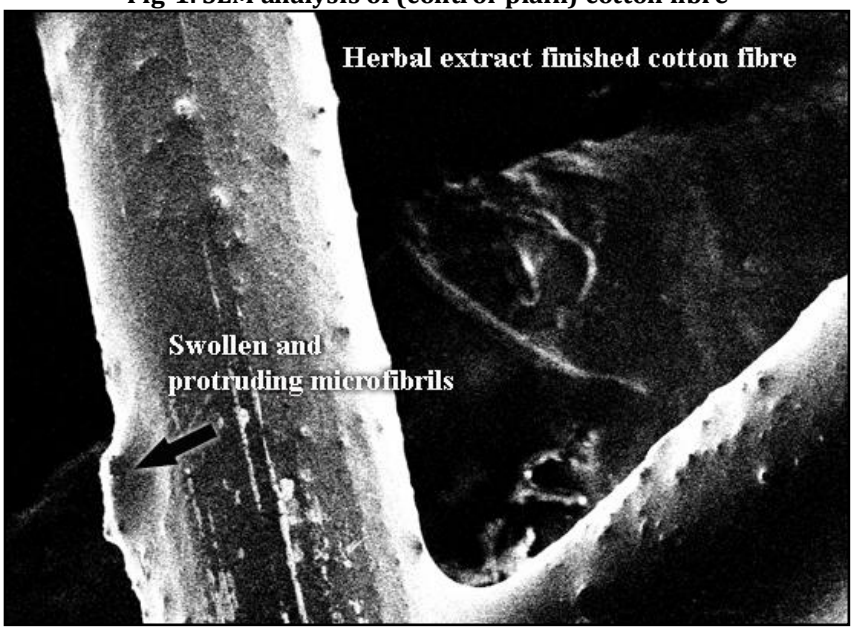

Fig-2: SEM analysis of herbal extract finished cotton fibre

Fig-3: Antibacterial activity of finsihed cotton and viscose against *Escherichia coli*

Fig-4: Antibacterial activity of finsihed cotton and viscose against *Staphylococcus aureus*

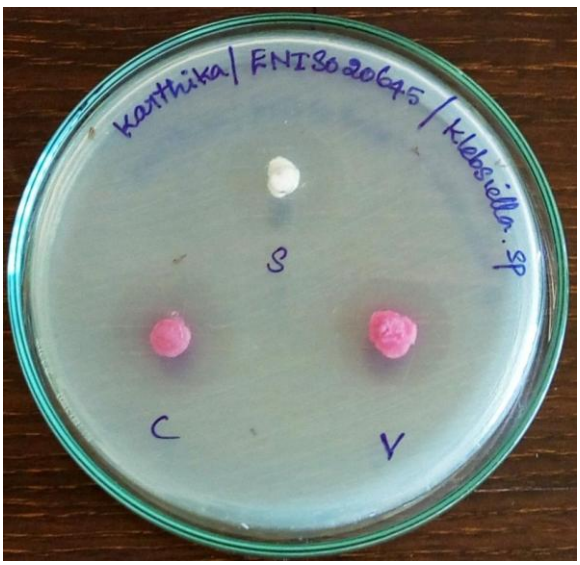

Fig-5: Antibacterial activity of finsihed cotton and viscose against *Klebsiella* sp

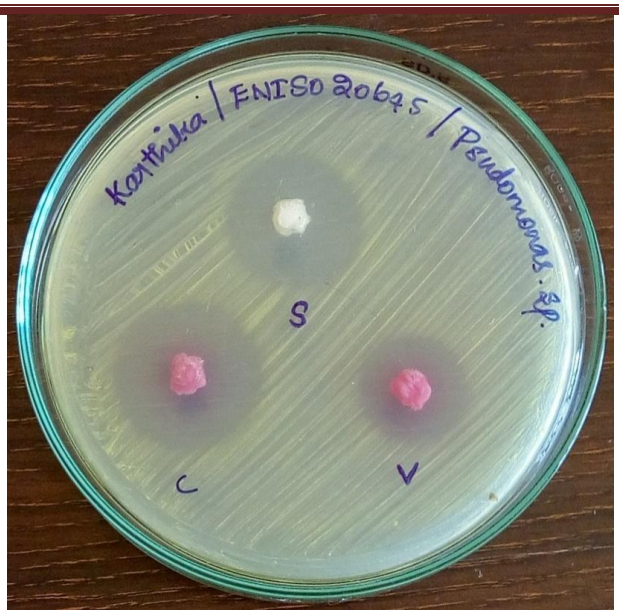

Fig-6: Antibacterial activity of finsihed cotton and viscose against *Pseudomonas* sp

Cotton Viscose

Fig-7: Wicking properties of cotton and viscose fibres