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Designing and development of functional products using herbal finished cotton fabric

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Abstract

The main objective of the study was to develop functional products using herbal finished cotton fabric. The cotton fabric was finished with medicinal property containing plant source *viz. neem (Azadirachta indica)* leaves extract. The herbal extract was applied to cotton fabric through pad-dry-cure technique using citric acid as cross linking agent. The cotton fabric finished with herbal *neem* extract was assessed for antimicrobial efficacy and 7 percent *neem* leaves extract showed 70.01 and 50.50 percent inhibition for *S.aureus* and *E.coli*, respectively. Nine products *viz.* diaper, baby night wear, bib, mittens, apron, mask, baby sheet, baby feeder cover and kitchen napkin were developed using the herbal finished cotton fabric. The developed products were found acceptable amongst the consumers indicated by the average weighted mean score of all the ranging from 2.64 to 2.78.

Keywords: Herbal extract, antimicrobial, functional products, acceptability

Introduction

Textile substrates provide an excellent medium for the adherence, transfer and propagation of infection-causing microbes. Inherent properties of textile fibres provide room for growth of micro-organisms. Structure of substrates and chemical processes may further enhance growth of microbes. Natural fibres are more liable to bacterial attack than synthetic fibres due to their porous and hydrophilic nature. The structure of natural fibers retains water and oxygen along with nutrients, in that way offering optimal environment for microbial growth. Due to direct contact, human body supplies warmth, humidity and nutrients which serve as a perfect environment and optimal conditions for bacterial growth. As garments are in direct contact with human body, the detrimental effects of microbes can be seen on the wearer and on the fabric itself. Micro-organism propagation can cause malodours, stains and loss of performance properties, contamination risk, strength reduction, quality loss etc. of the component fibres that could cause a product to be less effective in its intended use. Additionally, may promote skin contamination, inflammation in sensitive people. It is becoming increasingly important to maintain hygiene through the effective use of textile materials. (Haug, 2006 and Kavitha *et al.*, 2013) [3, 5]. Plants and plant products have been found traditionally to be used for healing of wounds, burn injuries, anti-fungal, anti-viral, anti-bacterial and anti-microbial activity against skin infections. Because of the excellent antimicrobial and eco-friendly properties exhibited by the plant extracts, these are used as textile finishing agents. Due to the environmental pollution and demand of consumers for eco-friendly products, it has become important to develop or find new hygiene products. Textile products having special properties are used for umpteen purposes, and one such product is herbal textiles (Shafei, 2018) [10].

Recently, there has been upsurge interest in apparel technology all over the world for much demanding functionality of the products like wrinkle resistance, water repellence, fire resistance and resistance to microbial invasion. With the increase in new antimicrobial textile finishes and the growing awareness about cleaner surroundings and healthy lifestyle there is a need to develop the process for imparting natural antimicrobial agents to the textile substrate, where the properties of the resultant treated textiles are unaltered. Considering the relatively lower incidence of adverse reactions of herbal products as compared to modern synthetic pharmaceuticals, coupled with their reduced cost, the antimicrobial herbal extracts of *neem* leaves were applied on cotton fabric for development of functional products.

Methodology

Preparation of fabric: For the preparation of cotton enzymatic desizing and scouring were done as per protocol of Waran, *et al.* (2013) and Rajendran *et al.* (2011) [8] respectively.

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The scoured fabric was further used for application with herbal finish. The fabric was immersed in the antimicrobial solution consisting of 7 percent *neem* (*Azadirachta indica*), extract, 6 percent (owf) cross linking agent with MLR 1:20 for 10 minutes maintaining temperature of 60⁰ C with occasional stirring. The extract impregnated fabric was passed between the rollers of the pneumatic padding mangle at a speed of 3m/min. at pneumatic pressure of 1 kg/cm². The finished fabric was shade dried and cured at 140°C for 3 minutes in hot air oven.

Selection of products: For selection of products an exhaustive list of apparels articles/ clothing accessories, medical textiles and home textiles/utility articles was prepared. Preferential choice index was developed and preferences of thirty experts were obtained on three point rating scale i.e. highly preferred, preferred and least preferred scoring 3, 2, and 1, respectively. Weighted mean scores were calculated and on the basis of scores obtained, rank was assigned to each article. Total nine articles i.e. top ranked three articles from each category were selected for development of products using herbal finished cotton fabric.

Development of products: Nine selected articles i.e. diaper, baby night wear, bib, gloves/ mittens, apron, mask, kitchen napkin, baby feeder cover and baby sheet were prepared using herbal finished cotton fabric as per the selected designs.

Assessment of developed products: Training-cum-demonstration was organized to impart technical know-how for extraction of plant extract, application of herbal finish and preparation of products using herbal finished fabrics. Two training-cum-demonstrations (one in each village) were organized for thirty rural women of Kirmara and Nangthala villages of Hisar district. An assessment index was developed to know the preferences of respondents regarding developed products on three point rating scale i.e. highly acceptable, acceptable and least acceptable scoring 3, 2, and 1, respectively. Weighted mean scores were calculated and on the basis of scores obtained, rank was assigned.

Results and Discussion:

The data presented in Table 1 and Fig.1 indicate that 7 percent concentration of *neem* leaves extract showed maximum turbidity (70.07%) against *S. aureus* and *E. coli* (50.50%).

Table 1: Minimum inhibitory concentration of *neem* leaves extract

Bacteria	Minimum Inhibitory Conc.(%)/ Percent Minimum Inhibition									
	1	2	3	4	5	6	7	8	9	10
<i>S. aureus</i>	02.65	08.71	48.90	54.79	56.81	61.23	70.07	61.48	64.77	62.12
<i>E. coli</i>	00.75	02.01	21.60	37.18	38.44	41.20	50.50	44.47	49.49	47.43

The results are also supported by (Chandra, 2017) according to whom fabric finishes are used to improve the Appearance – color, pattern, or shine; Change the texture of the fabric – embossing, brushing or smoothing; Improve the feel – softer, crisper, and firmer; Improve the drape – weighting; Improving wear qualities – crease resistance, stain resistance, bacterial resistance, flammability, waterproof etc.; Modify care requirements – easy wash, quicker drying times, colour fast, less shrinkage.

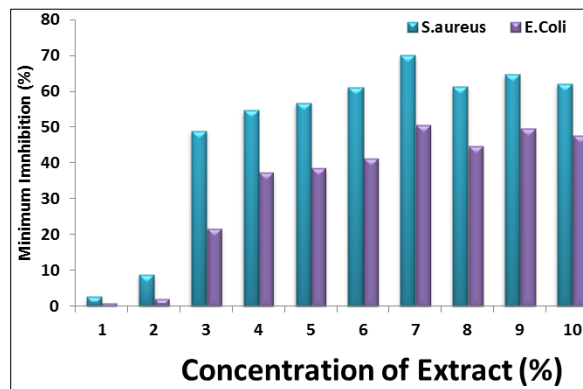


Fig 1: Minimum inhibitory concentration of *Neem* leaves extracts against *S. aureus* and *E. coli*

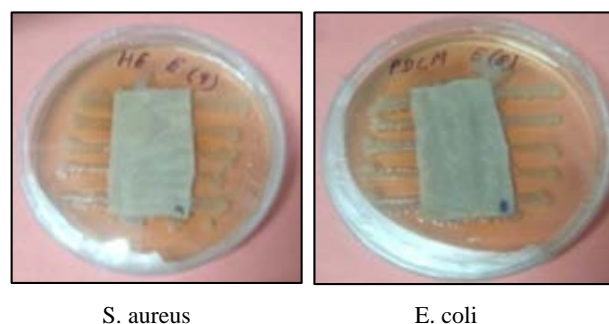


Plate 1: Bacterial growth at minimum inhibitory concentration of neem leaves extract

Selection of products: The preferences were sought for the products to be prepared from cotton fabric treated with *neem* (*Azadirachta indica*) leaves extracts. The data pertaining to preferences of experts for apparel/ clothing accessories articles in Fig. 2 highlight that diaper got I rank by scoring highest weighted mean score (WMS 2.86) followed by baby night wear (WMS 2.73) ranked II and bib (WMS 2.63) at rank III. The preferences of experts for rest of the products in descending order were baby bonnet (WMS 2.53), handkerchief (WMS 2.46), cap (WMS 2.40), socks (WMS 2.33), scarf (WMS 2.30) and T-shirt was the least preferred apparel article that scored 2.23 weighted mean score and ranked IX. The data presented in Fig. 3 elucidate that in medical textiles category as per experts’ preferences, gloves/ mittens were favoured most by scoring WMS 2.73 and ranked I followed by apron (WMS 2.70) ranked II and mask which obtained WMS 2.66 at rank III

The other products preferred in declining trend were head cover (WMS 2.60), hospital bed sheets (WMS 2.53), trolley cover (WMS 2.43), bandage (WMS 2.36) and face wipes (WMS 2.33). The least preferred product in medical textile category was OT dress which with WMS 2.00 ranked IX.

The data depicted in Fig. 4 reveal that from home textiles/utility articles category, kitchen napkin scored highest with weighted mean score 2.86 and ranked I followed by baby feeder cover (WMS 2.80) ranked II and baby sheet ranked III by scoring WMS 2.73. The other articles obtained descending order of preferences as cushion cover (WMS 2.60), pillow cover (WMS 2.50), mats (WMS 2.46), mattress (WMS 2.36), baby quilt cover (WMS 2.30) and sofa cover was the least preferred home textile article that scored 2.20 weighted mean score and ranked IX.

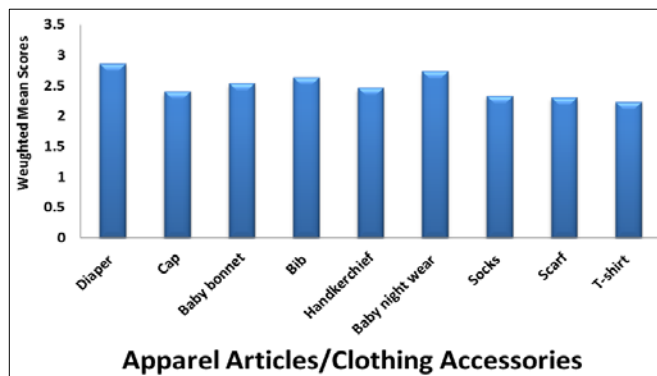


Fig 2: Preferential choices for apparel articles/clothing accessories of herbal finished cotton fabric

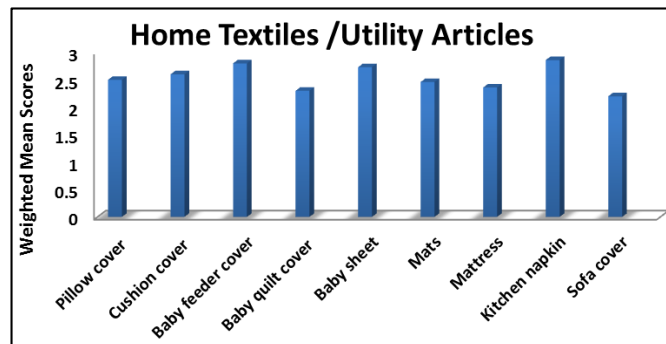


Fig 4: Preferential choices for home textile/ utility articles of herbal cotton finished fabric

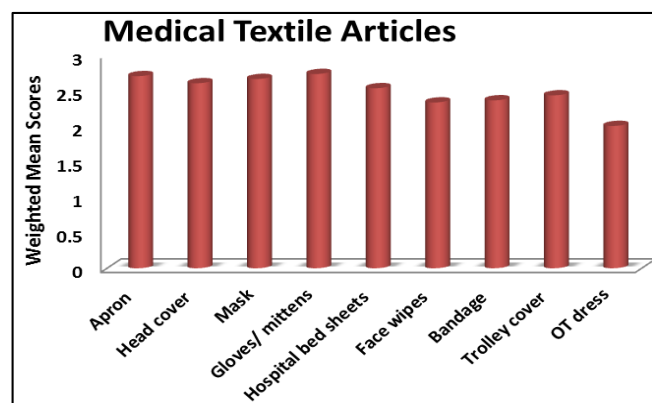


Fig 3: Preferential choices for medical textile articles of herbal finished cotton fabric

Development of products using herbal treated cotton fabric: Total nine products i.e. three from each category were selected as per the preferences of experts from the listed products of apparels, medical textiles and home textile/utility articles for product development using herbal finished cotton fabric. The products selected from apparel category were diaper, baby night wear and bib, from medical textiles category were gloves/ mittens, apron and mask and from home textile/utility articles were kitchen napkin, baby feeder cover and baby sheet. Kumar and Srinivasan, 2017 [6] also stated that herbal clothing can help reduce exposure to allergens and other irritants and give a comfortable feeling. Herbal textile is often used in making bed coverings, undergarments, towels, meditation clothes, sleepwear, and other such garments that stay close to human skin so that all its benefits could be absorbed through the skin.



Plate 2: Developed Products of Herbal Finished Fabric

Opinion of consumers regarding developed products: The developed products were got evaluated from the thirty consumers on different parameters like ‘treatment of cotton fabric with *neem* leaves extract improve its antibacterial properties’, ‘selected products require to impart antibacterial herbal finish’, ‘with negligible cost, the finishing treatment

provide health benefits in terms of bacterial resistance’, ‘it’s easy to impart finish at home’, ‘designs of the products are appropriate as per end use’, ‘developed products are useful and attractive’, ‘developed products are acceptable as per trend’ and ‘would like to purchase this type of product’. All the parameters were assessed on three point rating scale. The

results related to assessment of developed products are given in Fig. 4

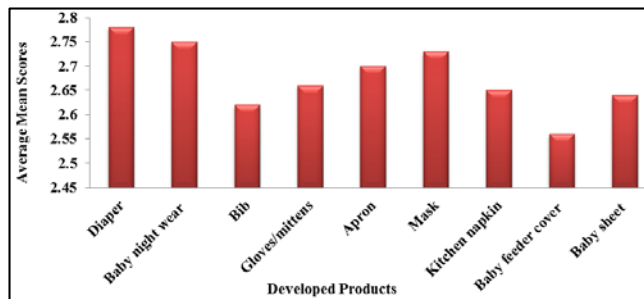


Fig 4: Opinion of consumers regarding developed products of herbal finished fabric

The data in the Fig. 4 highlight that consumers had very high opinion about developed products of herbal finished fabric as weighted mean score values were above 2.33 indicating that consumers strongly agreed for each parameter of assessment. The average weighted mean score of all the products ranged from 2.64 to 2.78 highlighting that all the developed articles were very well accepted by consumers. It is thus concluded that the respondents had very high opinion regarding the developed products in terms of 'treatment of cotton fabric with *neem* leaves extract improve its antibacterial properties', 'selected products require to impart antibacterial herbal finish', 'with negligible cost the finishing treatment provide health benefits in terms of bacterial resistance', 'it's easy to impart finish at home', 'designs of the products are appropriate as per end use', 'developed products are useful and attractive', 'developed products are acceptable as per trend' and 'would like to purchase this type of product'.

Anonymous, 2015 ^[1] reported that herbal clothing helps to stand like a guard against harmful toxins about to enter the body through the skin, hence are beneficial for health. Due to their beneficial properties herbal textiles are mainly used in making sleepwear, undergarments, bed coverings, towels, meditation clothing etc. that remain close to the skin absorbing all the benefits it gives out. Herbal textiles are also used in home textile products like mattresses, coir mats, door mats, bath towels, bed spreads and carpets.

Malarvizhi, 2015 ^[7] applied aloe vera extract for finishing of upper layer of baby diapers' fabric. The antibacterial skin touching layer proved to be safe, laying a foundation to reduce health problems like nappy rashes, red patches, itching sensation on the baby's skin. The results of this research can be a right solution for production of modern health and hygiene care products. Babel and Mishra, 2018 ^[2] also found that the regular and large size sanitary napkins developed with application of neem extract on filler fibre were found acceptable amongst 81.11 and 81.55 percent users, respectively.

Conclusion

Today the world is moving towards the eco-friendly era. This research work has given a new idea for utilization of *neem* leaves extract onto the fabric using pad-dry-cure method and finished fabric can be used for development of various products requiring antibacterial properties. Since *neem* leaves are abundantly available, the scope for utilization and commercialization of extract to impart antibacterial finish in textiles is high. Further, the raw materials i.e. fabric and extract are from natural sources, having economic and

environmental benefits. The products developed from herbal finished cotton fabric were highly preferred by the consumers as they had very high opinion about developed products.

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