

Design and Development of Ecofriendly Herbal Armpit Liners Enhanced with Aromatic Oil Finishes

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ABSTRACT - Health and hygiene are the primary requirements for human beings to live comfortably and work with maximum efficiency. To protect the mankind from pathogen and to avoid cross infection a special finish like antimicrobial finish has become necessary. Hence there is significant development in investigation of eco-friendly, natural antimicrobial finish extracted from herbs for application on textile substrates. The study deals with design and development of herbal medical textiles arm pit liners by applying herbal essences and fragrance oil on textiles to safeguard the human from infections and uncomforted conditions. Nonwoven bamboo fabric inherently has antimicrobial property, used as absorbent skin touching layer. PLA (Poly lactic acid) is used has leak proof material. Vertical wicking, anti-bacterial test, skin irritation test was performed to analyze its efficacy towards nontoxicity. Subjective analyses were undertaken to measure the satisfaction level of the selected population on the product usage.

KEYWORDS: Textiles, Armpit liners, Antimicrobial, *Origanum majorana L.*, wicking, Fragrance.

I. INTRODUCTION

Consumers have become more aware of hygiene and potentially harmful effects of microorganisms, the demand for antimicrobial finished clothing is increasing. Antimicrobial textiles help to control the growth of microbes which helps in protecting the wearer from the risk of infection. The application of antimicrobial textile finishes at present is confined to specialty products in the medical, technical, industrial, home furnishing and apparel categories.

Underarm liners are an alternative to antiperspirants. The liners are applied directly to clothing. They contain absorbent material that wicks away moisture from sweat, keeping the axilla dry. Underarm liners were used more commonly before chemical antiperspirants, primarily by women, to preserve fine dresses from soiling. Sweat contains substances that stain yellow or fade dyes^[1]. Underarm liners are also known as underarm shields, underarm pads, sweat guards, dress shields, and petty protectors^[2].

Bamboo is an abundant natural resource, has several advantages, such as high growth speed, high strength with low density. The high specific strength of bamboo in comparison with its weight is derived by its fibers longitudinally aligned in its body. As this high specific

strength, natural bamboo fiber is called "Natural glass fiber"^[3]. Bamboo nonwoven fabric is a natural textile that has been growing in popularity in recent years, both for its quality and its environmental friendliness. Nonwoven bamboo fabric is made from the pulp of bamboo plant, which is actually a type of grass. The fastest growing grass species in the world, in fact, making them one of the most easily renewable natural resources we have a side from being more sustainable, nonwoven bamboo fabric is also light and strong, with excellent wicking properties^[4].

Marjoram is an important aromatic plant which is commonly used in cookery as a spice and condiment. It is a perennial herb in the mint family. Native to Mediterranean and parts of Asia and Africa, some ancient civilizations viewed the herb as a symbol of happiness. Marjoram volatile oil exhibit antifungal activity. It is both cultivated and collected from the wild for international markets^[5].

Jasmine oil used in aromatherapy massage was found to be particularly effective. Jasmine oil may be effective in treating and preventing infections when diluted and applied to the skin. Jasmine oil may have a cicatrizing effect and promote wound healing through the formation of scar tissue. It also worked as an antimicrobial agent against all

strains of candida and bacterial infections [7]. It has anti-inflammatory properties and can be useful in general skin care and the treatment of psoriasis. Another study published in the Journal of Health Research examined the effects of jasmine oil inhalation affected brain activity and mood states and the participants reported feeling more positive, energetic, and romantic [8].

The study investigates the antimicrobial functionality of nonwoven bamboo fabric finished using natural aqueous herbal solutions obtained by extraction from *Origanum marjorana* (marugu) and enhanced with fragrance oil (Jasmine) finish were tested for *Escherichia coli* microorganism typically known to grown on textiles, were used as test organisms for the antimicrobial study.

The herbal finished medicated fabrics were tested as per standards, ISO standards (Indian standard organization) and AATCC standards (American association of textile chemists and colorists). Standard test methods such as agar diffusion test method, and soil burial test as per (EN-ISO-17721) a have been carried out.

II. MATERIALS AND METHODS

2.1 Selection of Fabric Material

Bamboo nonwoven fabric was selected for its benefits like wicks away moisture to evaporate more efficiently than most other fabrics, helps in keeping skin dry and comfortable throughout the day. Also contains inbuilt Antibacterial and Anti-fungal Properties. It is a breathable ecofriendly fabric. Thus, Bamboo nonwoven spunlace fabric was selected and purchased from South Indian Textiles Association (SITRA), Coimbatore.



Fig 1: Nonwoven bamboo fabric

2.2 Selection and Collection of Herb and Fragrance Oil

Marjorana or marjoram is one of the oldest medicinal herbs used by the mankind. The medicinal herbs and its finishing on fabric ensure permanent effectiveness and compatibility to the human skin. The plant require for the study were collected from the Sular area of Coimbatore district. Fresh and disease-free leaves were collected, identified as dark green colour is shown in figure 2(a).



Fig 2(a): Marjoram leaves

Jasmine oil is an essential oil derived from the white flowers of the common jasmine plant, also known as *Jasminum officinale*. The flower is believed to originate from Iran, but can now also be found in tropical climates. It was selected for its fragrance and also for its phenolic compounds present which improves skin elasticity and tone, also acts as anti-aging and wrinkle serum. It is purchased from the Ukkadam, Coimbatore, shown in fig.2b.



Fig 2(b): Jasmine Oil

2.3 Extraction of Herbal Essence

The collected marjoram fresh leaves were grinded to a paste consistency, in the grinding machine alone with water (bour well water). Phenolic substances were extracted from the marjoram leaves through aqueous extraction method, by adding 50 gram of herbal paste in 150 ml of distilled water soaked for 6 hours (shown in fig 3a&b) and filtered with Wattman filter paper.



Fig 3: (a) Herbal plant grinded into pulp form (b) Finely grinded herbal paste

The selected herb was extracted with aqueous solution and made as composite with Jasmine oil at the measure of 5ml oil mixed with 100ml of herbal extract. Thus, the medicated fragrance essence was made for further process. (Shown in fig. 4)



Fig 4: Herbal aqueous extraction

2.4 Finishing on Fabric

The fabric samples were treated with herbal essence using citric acid as cross-linking agent. Aqueous extracts of Marjoram and Jasmine oil composite essence were applied on the fabric with the material liquor ratio of 1:2 using of 8% citric acid concentration. I.e., the nonwoven bamboo fabric was dipped in the herbal extract for 30 min and the sample were taken and dried at room temperature was cured at 120° F for 3 min. (shown in Fig. 5 a & b).



Fig 5: (a) Fabric dipped in herbal extract (b) Herbal finished fabric

2.5 Physical Test

2.5.1 Evaluation of Liquid Absorbency Capability by Vertical Wicking Test

The Vertical Wicking test measures how well fabric absorbs and transports moisture. The test dips a pre-marked fabric sample into water or a dyed solution in order measure how well it moves moisture from its source and up and through the fabric.

Test procedure

1. Cut 5 specimens in each direction, all measuring 200 mm X 25mm.
2. Fold each specimen end and secure it on a rod or pen using a needle or a clip. wicking test procedure
3. Place the rod over the opening of a glass bowl, so the specimen hangs in the bowl without touching the bottom.
4. Fill the bowl with water till the specimen is immersed 20mm in the water.
5. Leave the specimen for 30 minutes.
6. After 30 minutes measure how high the water has moved vertically, starting 20mm from the edge (The point which was the starting point for the wicking) as shown in fig 6 a & b. The average result from the 5 specimen was the final result.

Vertical Wicking Test



Fig 6(a): Wicking test for control fabric



Fig 6(b): Wicking test for herbal and oil finished fabric

2.6 Analysis of Antimicrobial Efficacy

Antimicrobial susceptibility tests are used to determine which specific antibiotics a particular bacteria or fungus is sensitive to. Most often, this testing complements a Gram stain and culture, the results of which are obtained much sooner. Antimicrobial susceptibility tests can guide the physician in drug choice and dosage for difficult-to-treat infections.

The fabric non-woven linen finished with composite extract were analyzed for their antibacterial testing using the standard McFarland test method against test organisms of gram-negative organism (*Escherichia coli*).

(a) Preparation of Inoculum

The inoculums for the experiment were prepared in fresh Nutrient broth from preserved slant culture. The inoculums were standardized by adjusting the turbidity of the culture to that of McFarland standards. The turbidity of the culture may be adjusted by the addition of sterile saline or broth (if excessive or by further incubation to get required turbidity. (Leonard Jarrett et.al.)

(b) Preparation of Sterile Swabs and Forceps

Cotton wool swab on wooden applicator or plastics were prepared and sterilized by autoclaving or dry heat (only for wooden swabs) by packing the swabs in culture tubes, papers or tins etc. Sterilize forceps by dipping in alcohol and burning off the alcohol.

(c) Experiment Procedure

The standardized inoculums is inoculated in the plates prepared earlier (aseptically) by dipping a sterile in the

inoculums removing the excess of inoculums by passing by pressing and rotating the swab firmly against the side of the culture tube above the level of the liquid and finally streaking the swab all over the surface of the medium 3 times rotating the plate through an angle of 60° C after each application. Finally pass the swab round the edge of the agar surface. Leave the inoculums to dry at room temperature with the lid closed.

Each Petri dish, the fabric sample such as control and finished fabric(µg) are placed in the plate with the help of sterile forceps. Then Petri dishes are placed in the refrigerator at 4° C or at room temperature for 1 hour for diffusion. Incubate at 37 ° C for 24 hours. Observe the zone of inhibition produced by different samples as shown in fig 7 a & b. Measure it using a scale and record the average of two diameters of each zone of inhibition.

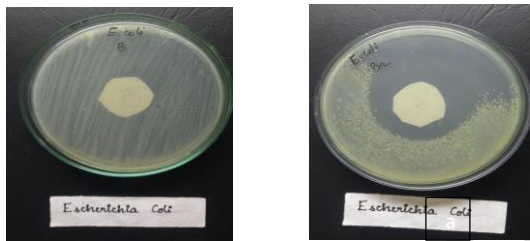


Fig 7: (a) Assessment of Antibacterial Activity in control and (b) Herbal Finished Fabric

2.7 Skin Patch Test

Composite herbal extracts were finished on to bamboo nonwoven fabric and its biocompatible properties were assessed by skin-irritation test. Herbal treated separately by patching on the skin surface of selected human subject (women) of age group 20-30.

Procedure

- Non hairy skin part of the subject was selected.
- The surface of the skin was cleaned with moisture sterile cotton swabs.
- The patches of the fabric sample were plastered on the cleaned skin.
- The area of patching was observed for symptoms related to contact dermatitis allergy like erythema and oedema.
- Observation was made up to 24 hours and time may extend for the observation of symptoms such as reddishness, rashes and irritation.

Evaluation

After the contact time, the fabric patches were removed and observed for the following reaction.

(NIR) - No irritation reaction

(IR) - Irritation reaction

Thus, the results are observed and discussed under results and discussion.

2.5 Design and Development of Product

- Armpit pads are disposable pads that stick to your clothing (under arm pits) to absorb excess sweat.
- It containing three layers. First layer was nonwoven bamboo fabric finished with composite herbal essence and fragrance oil.
- Second layer was disposable and degradable poly lactic acid (PLA) sheet. This is the biodegradable eco-friendly layer.
- The third layer is the Adhesive paper strip for the product to stick on garment.

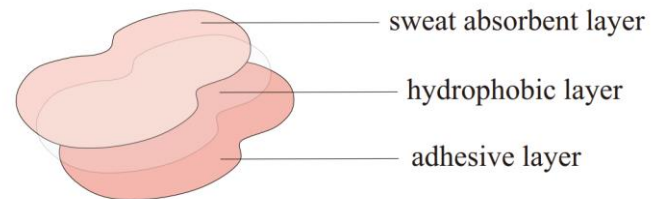
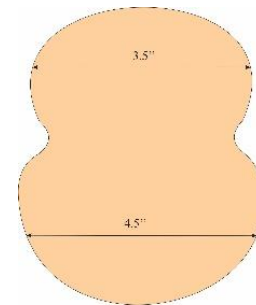


Fig: a) Armpit liner measurement, b) Layer details of Armpit liner

III. RESULTS AND DISCUSSIONS

3.1 Liquid Absorption Test (Vertical Wicking)

Table 1: Evaluation of Liquid Absorption-Vertical Wicking test

S.No	Fabrics	Vertical Wicking (Cms)
1	Control	14
2	Herbal Finished	11.5

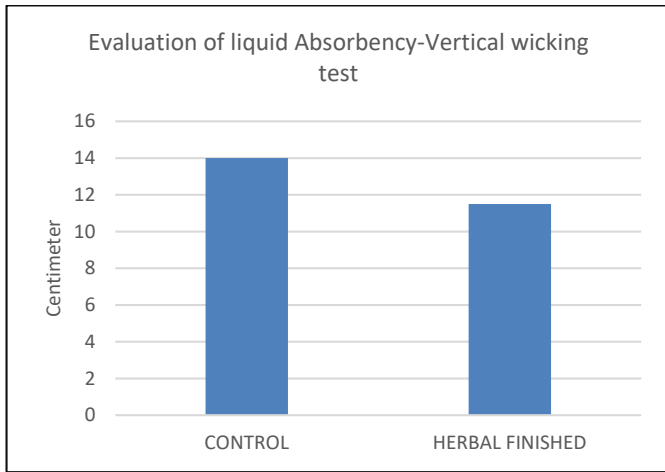


Fig 8: Vertical wicking test on unfinished and finished nonwoven bamboo fabric

The above table and figure confirm the wick-ability of the herbal finished and unfinished nonwoven bamboo fabric. In this the control (unfinished) nonwoven bamboo fabric wicks vertically up to 14cms due to the high liquid contact angle and the herbal finished fabric wicks vertically up to 11.5cms shows the herbal components coated on the fibre strand slows down the liquid absorbency to a least when compared to the control one.

3.2 Analysis of Antibacterial Activity

Table 2: Analysis of Antibacterial Activity of Herbal Finished Fabric

S.NO	Fabrics Bamboo (Nonwoven)	Antibacterial Activity (<i>Escherichia coli</i>) Zone Of Inhibition in mm
1	Control	26
2	Herbal Finished	45

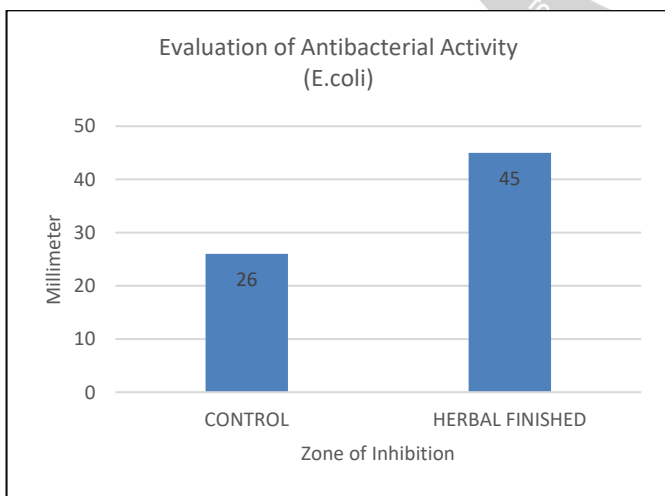


Fig 9: Evaluation of Antibacterial Activity on unfinished and finished nonwoven bamboo fabric

The above table and figure demonstrate the analysis of antibacterial activity present in the herbal finished and control nonwoven bamboo fabric. In this the control nonwoven bamboo fabric pertained 26mm of zone of

inhibition due to its inbuilt antibacterial efficacy. The herbal finished nonwoven bamboo fabric shows excellent zone of inhibition as 45mm, which confirms that it can perform as antibacterial herbal fabric for hygiene product development.

3.3 Costing

Fiber cost: Rs.150/-
 Fabrication cost: Rs.150/-
 Manufacturing cost: Rs.150/-
 Testing cost: Rs.200/-
 Total cost: Rs.650/50 pieces
 The cost per pieces is Rs.13/- depends on the cost of sample production.

*It may get vary during bulk production.

3.4 Anti-Inflammatory Skin Irritation Studies of Herbal Composite Finished Fabric



Fig 10: Skin irritation studies of herbal and oil finished fabric

Table 3: Skin irritation studies of herbal and oil finished fabric

Subject Type.	Fabric sample	Irritation End point
Female (20-35 age group)	Herbal finished bamboo (Nonwoven spunlace)	NIR

NIR - No Irritation after incubation period

During the analysis, no such irritant end points were detected for human subject skin patched with the finished fabric samples.

3.5 Visual and Wear Ability Evaluation of Developed Herbal Armpit Liners

Table 4: Awareness and Acceptability Analysis in percentage

S.NO	QUESTIONS	YES	NO
1	Aware of herbal armpit pad	84	16
2	Interest in buying	90	10
3	Soft and flexible	80	20
4	Colour acceptable	84	16
5	Cost is affordable	80	20

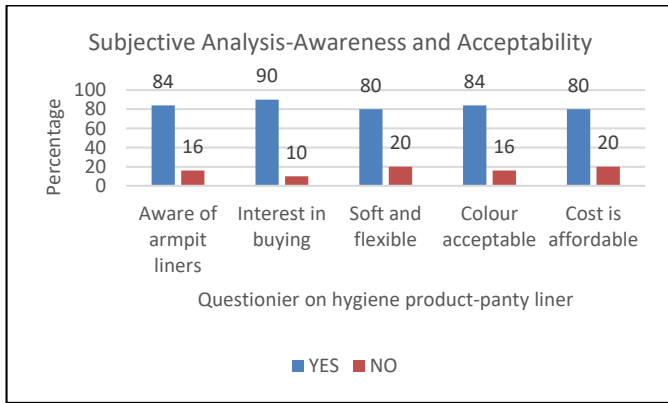


Fig 11. Awareness and Acceptability for product

The above table and figure shows, that the product pertains good score on subjective evaluation consider for awareness and acceptability among the selected population of 30nos. 84% of women are aware of the armpit liners, 90% of population shows interest in buying the herbal hygiene product, 80% of women satisfied with the product softness and flexibility. Colour of the liners were accepted by 84% of the people. 80% of the consumer felt that the cost is affordable.

Table 5: Evaluation Grade for satisfaction level in percentage

S.NO	QUESTION	GOOD	FAIR	POOR
1	Thickness	76	23	0
2	Comfort	86	11	3
3	Overall satisfaction	90	10	0

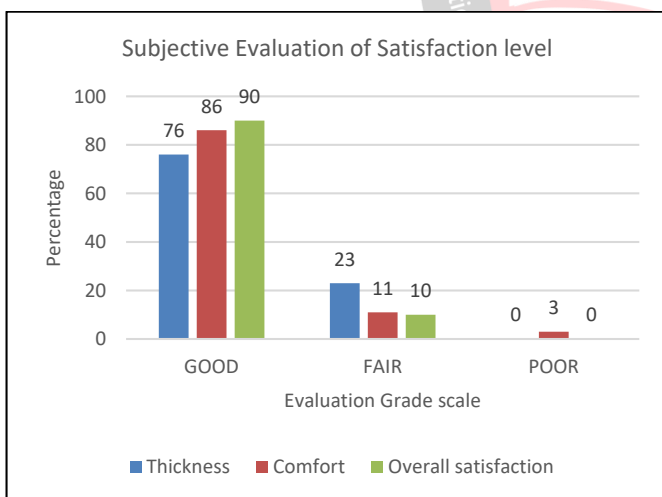


Fig 4. Evaluation Grade for satisfaction level for product

The table and figure demonstrate that the product yields good overall satisfaction among the people evaluated during visual and wear ability study. Among them 76%, 86% and 90% of women graded the product thickness, comfort and overall satisfaction is good. 23%, 11% and 10% of user graded the product as fair. Only 3% of user graded as they need some changes.



Fig 7: End Product-Arm pit liner

IV. SUMMARY AND CONCLUSION

Bamboo fiber products are the new kings of the green and environmentally friendly retail market. It has the great potential to report its share along with organic cotton. The pertained good result on fabric wicking test concludes that the herbal finished fabric has the ability to absorb sweat that secret under arm pits. The chemical free antibacterial herbal finish helps the user from avoid bacterial infections and other toxic effects during the moist skin condition by sweat. The aromatic oil finish will keep skin healthy and control the bad odour during sweating and exhibits pleasant aroma during the convention keep the users mind in relaxing mode. All other standard testing and result pertains very good result which are reflects in gaining excellent overall satisfaction grade among the selected population during visual and wearability test. Thus, the developed ecofriendly herbal armpit liners are designed with antibacterial and completely compostable natural absorbent and leak proof layers. To finish, the study concludes to deals and gratify with the environmental awareness of consumer, new green living trend, and the consumer look out for ecofriendly and organic products.

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