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Design and Development of Ecofriendly UV-Protective Gloves

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ABSTRACT

UV rays and relevant skin diseases are a major problem among the wide population. UV rays affect our skin harshly, mainly while traveling exposed to the sun. Overexposure to the sun is the primary cause of most skin cancers. Acute exposure to UV rays causes immediate skin discoloration. To unfold these issues, the contemplated work aims at reducing skin diseases and skin exposure to the rays, with natural oils incorporated in developed natural fibered fabric hand gloves for UV protection. The knitted bamboo and woven banana fabrics are used for a better wearing experience. Natural oils such as almond oil (*Prunus Amygdalus Dulcis*), Sesame oil (*Sesamum indicum L.*), Red raspberry oil (*Rubus idaeus L.*), and Lemon grass (*Cymbopogon citratus*) for incorporated into the fabric. UPF testing, Anti-microbial tests, and Anti-bacterial tests are carried out.

Keywords: *Prunus Amygdalus Dulcis, Sesamum indicum L, Rubus idaeus L, Cymbopogon citratus,* UV-rays, Bamboo knit, Banana fabric, Skin cancer, Natural oil, Hand Gloves.

1. INTRODUCTION

Materials comprised of fibers, thin threads, or filaments, whether natural or synthetic are known as textiles. They are created utilizing both natural and synthetic fibers, such as Nomex, Kevlar, Spandex, and Twaron, which have increased practical qualities, such as greater tenacity, good insulation, improved thermal resistance, etc. A crucial subset of technological textiles is protective textiles or Pro-Tech. This fabric offers numerous defense mechanisms, including heat resistance, bulletproofness, ballistic protection, chemical protection, temperature protection, etc [1,2].

In this study, the Protech product is developed to ensure the effect and reduction of sunburns, pigmentation, aging, skin inflammation, and many other skin diseases from UV radiation [3]. According to the WHO report, 300,000 NMSCs occur often and are linked to previous sunburns and chronic sun exposure[4]. Only natural materials and plant-based oils were used in the design, development, and finishing of this product, it is user-friendly and has no negative effects on the skin while being used.

Bamboo and banana materials were chosen to create the gloves for their unique properties hypoallergenic and kind to sensitive skin [5]. These are comfortable and breathable, and the knit fabric was selected for its ability to provide flexibility and comfort when driving[6]. Essential oils including sesame seed oil, almond seed oil, red raspberry seed oil, and lemon grass oil for fragrance are utilized to deliver skin-nourishing characteristics and UV radiation finishing. Regarding the health of the human

and environment, only the seeds are extracted in this initiative [7,8,9].

Standard tests were carried out for quality assessment of the product, FTIR (Fourier Transform Infrared Spectroscopy), anti-fungal using *Candida albicans*, anti-bacterial using *E.Coli*, and UPF testing (ultraviolet protection factor) tests have been conducted on the created items.

2. MATERIALS AND METHODS

2.1 Selection of Fabric (Knitted Bamboo)

The selected fabric is a knitted white bamboo material. This knitted bamboo has the properties of elasticity, absorbency and so more. This fabric is sourced from the Tirupur locality. They have various advantages in protective textiles and can be used for developing various other projects.

Fig1: Knitted bamboo fabric (single jersey)

2.2 Selection of Natural Herbal Oil

2.2.1 *Prunus Amygdalus Dulcis* (Almond Oil)

The selected natural oil almond essential oil, is sourced from the commercial market for its properties. These play a major role in treating skin diseases, and using these regularly will have an expected result on the skin.

Fig 2: *Prunus Amygdalus Dulcis* (Almond oil)

2.2.2 *Sesamum indicum L. (*Sesame Oil)

The selected natural oil sesame oil, is sourced from the commercial market for its properties. These play a major role in treating skin diseases, and using these regularly will have an expected result on the skin.

Fig 3*: Sesamum indicum L.* (sesame oil)

2.2.3 *Rubus idaeus L,(*Red raspberry seed oil)

The selected natural oil red raspberry seed oil, is sourced from the commercial market for its properties. These play a major role in treating skin diseases, and using these regularly will have an expected result on the skin.

Fig 4: *Rubus idaeus L, (*Red raspberry oil)

2.2.4 *Cymbopogon citratus (*Lemon grass oil)

The selected natural oil lemon grass oil, is sourced from the commercial market for its properties. These have various nutritive values and a strong and pleasant smell so this product includes this to get a pleasant smell.

Fig 5: *Cymbopogon citratus (*Lemon grass oil)

2.3 Application of selected composite oils on fabrics (spraying method)

In this, the traditional method of spraying and shadow drying is opted for finishing the fabric. The spray method is utilized as a classic finishing technique for fabric. The natural essential oils are mixed in a 3:3:3 ratio, and the fragrance oil is mixed in a 3:2 ratio after the gloves have been developed, drafted, and stitched to the desired measurement. Once the oils have been combined in the spray bottle, The gloves must be sprayed with the oil mixture. The gloves must then be left to completely dry and allow the fibers to absorb the oil molecules for two days.

3. Pattern Drafting

a) First, the approximate measurement must be taken
b) Then followed by drafting a pattern on a pattern sheet using the measurements
c) Then place the pattern sheet on the fabric and then the fabric can be cut
d) The fabric must be on fold and the pattern is cut-2,4 pieces of fabric will be acquired

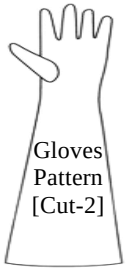

Fig 6: Glove pattern

3.1. Sewing

a) The first step is to place the wrong side of 2 fabrics facing each other.
b) Then the stitching must be made along the seam line with a single lock machine.
c) All the ends should be stitched, leaving a small gap to turn it inside out.
d) After joining the glove, it's turned inside out to get the right side of the glove.
e) Then the glove is finished by overlocking.
f) The same is followed for the other pair of gloves.

Fig 7: Sewing

3.2 Developed Final product

Fig 6: Back and front view of the gloves (a)Developed product (b)During wearing

4. Costing

S.NO	Particulars	Cost of product (Research purpose)	Cost of 10nos for commercial production
1.	Cost of the fabric	Rs. 1500	Rs. 1000
2.	Cost of the essential oil	Rs. 950	Rs. 800
3.	Cost of Manufacturing	Rs. 350	Rs. 200
4.	Cost of Testing	Rs.1800	Same as above
	Total	4600/10 pieces	3800
	Cost per piece	460/piece	380/piece

5. Evaluation of the Herbal Treated Fabric

5.1 FTIR Analysis

The FTIR analysis method uses infrared light to scan test samples and observe chemical properties. FTIR Scanning Microscope. FTIR is widely used in many industries and is used for the analysis of both organic and inorganic compounds. It can confirm the composition of both solids, liquids, and gases. FTIR is mainly used for The identification of unknown compounds.

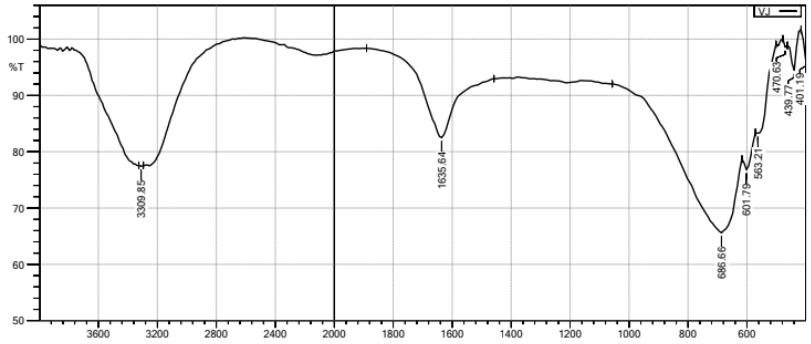

Fig:7 FTIR analysis of Herbal-treated bamboo fabric

5.2 Analysis of Antimicrobial Efficacy

Antimicrobial susceptibility tests determine which specific antibiotics articular 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. Results are commonly reported as the minimal inhibitory concentration (MIC).

Anti-Bacterial Analysis

Preparation of the bacterial inoculum

Stock cultures were maintained at 4° C on slopes of nutrient agar and potato dextrose agar. Active cultures for experiments were prepared by transferring a loop full of cells from stock cultures to test tubes of 50ml nutrient broth bacterial cultures were incubated with agitation for 24 hours and at 37°c on a shaking incubator and fungal cultures were incubated at 27°c for 3-5 days. Each suspension of the test organism was subsequently stroked out on nutrient agar media and potato dextrose agar. Bacterial cultures were then incubated at 37°c for 24 hours and fungal incubated at 27°c for 3-5 days. A single colony was transferred to nutrient agar media slants were incubated at 37°c for 24 hours and potato dextrose slants were incubated at 27°c for 3-5 days. These stock cultures were kept at 4°c. For use in experiments, a loop of each test organism was transferred into 50ml nutrient broth and incubated separately at 37°c for 18-20 hours for bacterial culture.

5.3 UPF-Testing (Ultraviolet Protection Factor)

Ultraviolet Protection Factor (UPF) measures the UV protection capability of the fabric/garments covering protection against both UVA and UVB. The UPF standard was created in 1998 by AATCC, based on original guidelines established in Australia in 1994. The testing standard for sun-protective fabrics in the United States is the AATCC Test Method 183, which tests both wet and dry fabric. A minimum UPF of 30 is needed to qualify for the Skin Cancer Foundation's Seal of Recommendation. UPF 30 to UPF 49 is considered very good protection, and UPF 50+ rates as excellent protection Standards also require that clothing made of different fabrics, or different colors of the same fabric, have each area tested separately. The garment must be labeled according to the lowest level of protection they provide.

6. RESULTS AND DISCUSSIONS

6.1 FTIR Analysis

Table 1: Analysis of FTIR for the herbal components

S.NO	Numbers	Functional Groups
1	3309.85	O-H stretching vibration presence of alcohols, phenols
2	1635.64	-c=c-stretching vibration presence of alkenes
3	686.66	CH out of plane aromatic band

The given Sample heaving 8 Peaks are present. Peaks represent the active sites or active components that are preset in the given herbal oil extract. The functional group 3309.85 represents the stretching vibration presence of alcohols and phenols;1635.64 represents -c=c stretching vibration presence of alkenes;686.66 represents CH out of plane aromatic band. The presence of active components is responsible for antimicrobial properties.

6.2 Evaluation of Antimicrobial Efficacy

Table2: Evaluation of Anti-microbial Activity

Organisms	Bacteria (*E.Coli*)	Fungus (*Candida albicans*)
Control	0	0
Oil treated	2.5 cm	2.0 cm

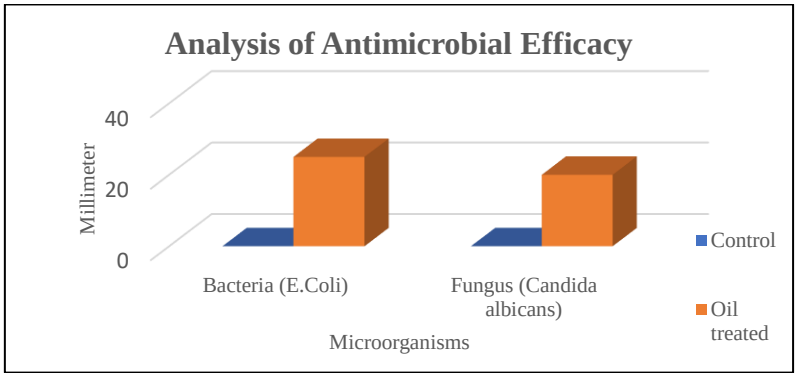

Fig 8: Analysis of Anti-microbial Efficacy

The above table and Fig 8 demonstrate that the controlled fabric shows no activity against the bacteria and fungus. However the herbal treated fabric shows a 2.5cm zone of inhibition against bacteria E.Coli and a 2.0cm zone of inhibition against *Candida albicans* fungus. As a result, the treated fabric has good results as having antimicrobial properties.

6.3 Analysis of Ultraviolet Protection Factor (UPF)

Table 3: UV-protection activity

Test	% of UV protection
Control	55
Oil treated	80

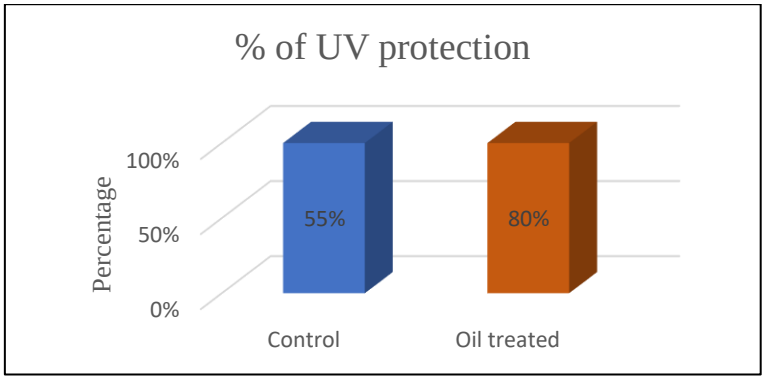

Fig 9: UV-protection percentage

The above table and figure shows the Ultraviolet Protection Factor measures the UV protection capability of the fabric pertains 55 percentage by the control fabric and 80percentage of UV protection capability by the herbal oil treated fabric. This is due to the presence of oil molecules and its active components in the fibre structure.

7. CONCLUSION

The above-demonstrated graph and tables represent that the expected result is obtained and these can be used and it's is safe on the skin. The above-accomplished product can be developed into various other products. Hand gloves are essential for many facets of our lives since they provide comfort, protection, and functionality in a wide range of situations and pursuits. Gloves serve as a barrier against damage, pollution, and hostile surroundings in a variety of settings, including the medical field, laboratories, industrial operations, and even recreational activities like driving and sports. They ensure the wearer's safety and dexterity by coming in a variety of materials and designs suited to particular requirements.

Declaration by Authors

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