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# DEVELOPMENT OF ANTIBACTERIAL AND ULTRAVIOLET PROTECTIVE CLOTHING BY THE APPLICATION OF MEDICINAL PLANTS EXTRACT

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## ABSTRACT

The increasing health concern has enhanced the utilization of technical products in every field of life from common household items to fabrics. Protection against UV is one of the main concerns of the modern world due to the potential health risk when skin is exposed to UV. Various chemicals have been utilized to enhance the UV protection of fabrics, but they are not green. The purpose of this research is to examine the properties of UV protective fabrics developed by using extract of different plants. Ethanol extract of dried leaves and seeds of three medicinal plants named Azadiarchta indica, Amaranthus viridis and Ricinus communis were applied on fabric to enhance the antimicrobial and UV blocking properties of the treated fabric as these plants are cheap and abundant in Pakistan. Azadiarchta indica and Amaranthus viridis showed good antibacterial and UV blocking. On the other hand, the extract of Ricinus communis showed excellent UV blocking but antibacterial effect was not good.

## KEYWORDS

Azadiarchta Indica, Amaranthus Viridis, Ricinus Communis , UV Protection, Antibacterial Activity.

## MATERIALS AND METHODS

In this research, a simple plain weave, 1/1 plain weave having construction 40*40/90*90 bleached cotton fabric (117 g/m2) was used. The machinery and equipment used in this study include Stentor Frame (Model No. VPM-250A) by Japan, Padder (Model No. VPM-250A) by Japan and UV–Visible Spectrophotometer (Model No. M550) by Spectronic CAMSPEC.

### Method

### Collection of Plant and Powder formation

Mature leaves and seeds of Amaranthus viridis, Ricinus Communis and Azadiarchta indica were collected from plant nursery at Faisalabad, Pakistan. Then all three plants were dried at room temperature in closed environment (25ºC and 60% RH). After drying the dried leaves and seeds of plants were grinded.

### Preparation of Plant Extract (Ethanol extraction method)

Plants extract was prepared in ethanol by taking 95 % ethanol and 100 g powder, suspended in 1000 ml of ethanol (95:5 ethanol: water) and allowed to stand solution under room temperature (25ºC) for 48 h using magnetic stirrer plate. After stirring, filter the solution by Whatman® filter paper number. Filtered solution was evaporated at temperature 75ºC on hotplate in vacuum and then, transferred the extract into the sterilized bottles for further use. Aqueous extracts are known to show green color regarding the

presence of chlorophyll compound but the advantage of using ethanol is that chlorophyll compound removes this compound to give colorless nature of extract.

For experiment, the solutions were prepared by using three concentrations (plant extract/ distilled water) 0.1, 0.27 and 0.6 g/150 ml of medicinal plants separately, which are Azadiarchta indica, Amaranthus viridis and Ricinus communis, respectively and about 2 mg dispersing agent was added to make homogenous solution by continuous stirring.

Fabric sample of 12"×8" was dipped in solution for 2 min and then padded the sample for evenly distribution of plant extract on fabric. After padding, the samples were dried at 100°C for 2 min. This process was repeated five times for the uniform penetration of solution. Then, samples were cured at 150°C for 1 min at Stenter machine.

## RESULTS AND DISCUSSION

Fabric samples were analysed for UV protection and antibacterial activity. The application of medicinal plant extract converts the conventional fabric into value-added textiles.

### Mean Ultraviolet Protection Factor

The present study has shown that the selected medicinal plants can play a major role in both UV protection of textiles and in preventing infection by providing antibacterial effect. The UV protection of cloths is measured in terms of ultraviolet protection factor (UPF) which is defined as the ratio of the average effective UV irradiance calculated for unprotected skin to the average UV irradiance calculated for skin protected by the fabric.

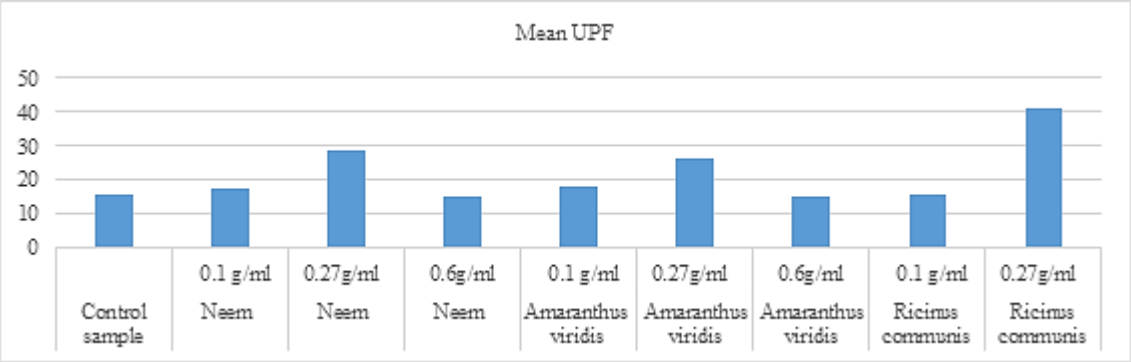


**Figure 1. Mean UPF of different plants extracts.**

The mean UPF of treated samples is shown in Figure1. From the results at lower concentration the value of UPF is approximately same for all these three plants. The effect of increase in plant extract on fabric is significant. The UPF increases and exceeds the threshold of 40 which is the minimum requirement for clothing. It is obvious from above results that application of plant extract increases the ultraviolet protection factor. By increasing the concentration of extract, the value of UPF also increased. It is since many antioxidants are present in the extract of plants which absorb UV radiations that contributes to the UPF. Ricinus communis showed the best result of UPF among other plants i.e., at concentration of 0.6 g/ml. From the above results it was clear that a small amount of these medicinal plants gave excellent results, and these are green and cheaper to use due to their nontoxicity and abundance in nature as compared to synthetic UV protective agents.

### UVA and UVB Blocking

The extract of selected plants gave good ultraviolet protection to fabrics by absorbing the UV radiations so that they are unable to damage the substrate. The results of UV blocking are shown in Figure 2.

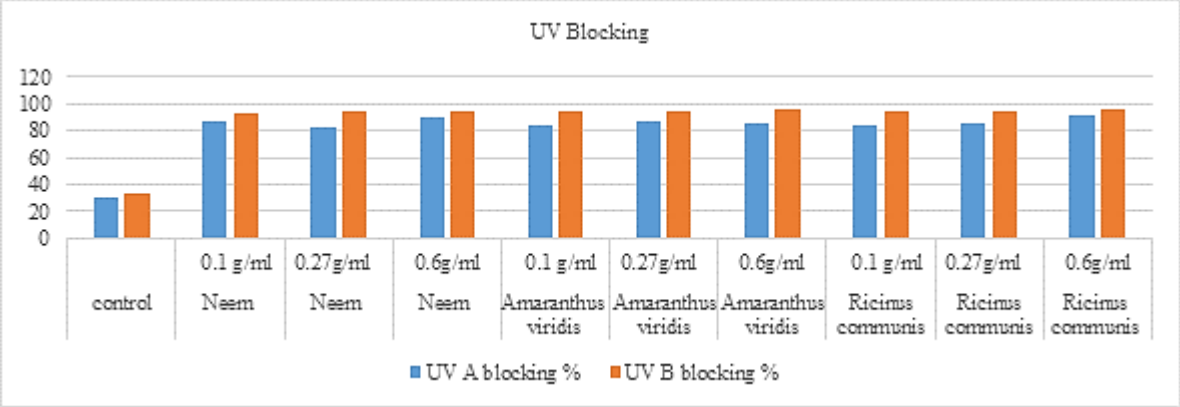


**Figure 2. UV blocking percentage.**

The above results depicted that a very small amount of extract give excellent results by absorbing the harmful radiations in UVA and UVB regions. From the results obtained it was found that fabric samples treated with Amaranthus viridis gives best blocking in UVB region which is more dangerous. These blocking properties may be attributed to the presence of flavonoids and phenolic compounds (i.e., glycosides, tannins, alkaloids, flavonoids, reducing sugars, steroids and carbohydrates) in the extract of plants. These compounds provide shielding effect against the harmful effects of UV and their mechanism of action is the activity of hydroxyl groups of these phenolic compounds possess strong scavenging activity for different free radicals.

### Antibacterial activity

*In vitro* antibacterial activity was examined for treated samples. Antibacterial activity of plants extracts against two pathogenic bacteria (*S. aureus and E. coli*) was investigated by following standard test method AATCC- 147. Results of test are shown in Table 1. Untreated cotton samples show clear growth of microbes throughout the sample with no zone of inhibition.

Samples treated with plants extract showed resistance against bacterial growth and display excellent antibacterial activity. Zone of inhibition showed by treated samples for Gram-negative bacterial strain i.e., *Escherichia coli* was larger than Gram-positive bacterial strain i.e., *Staphylococcus aureus* as clearly presented by Table 1. Diameter of inhibition zone was measured for all samples against Escherichia coli and Staphylococcus aureus.

**Table 1. Zone of inhibitions of treated samples.**

| Concentration | Neem Zone of inhibition (mm) | | Amaranthus viridis Zone of inhibition (mm) | | Ricinus communis Zone of inhibition (mm) | |
|---|---|---|---|---|---|---|
| | Staphylococcus | E.coli | Staphylococcus | E.coli | Staphylococcus | E.coli |
| 0.1 | 0.5 | 1 | 0.1 | 0.5 | 0 | 0.1 |
| 0.27 | 0.7 | 1.8 | 0.5 | 1.3 | 0 | 0.5 |
| 0.6 | 1.7 | 2 | 1.2 | 1.5 | 0.1 | 0.7 |

From the treated samples, neem treated samples showed excellent antibacterial activity against both Gram-negative bacterial strain i.e., *Escherichia coli* and Gram-positive bacterial strain i.e., *Staphylococcus aureus* as shown in Figure 3-4. This is due to the presence of certain active photochemical compounds as well as the antibacterial compounds that have been reported earlier to be extracted by methanol extraction. As the concentration of extract increased, the diameter of zone of inhibition is also increased which could be due to the more amount of antibacterial agents in extract. Antimicrobial activity of the Ricinus communis was not significant against *E. coli* and *S. aureus*

(Figure 5). Amaranthus viridis showed slight difference between the pattern of antimicrobial activity against *S.aureus* and *E. coli*.

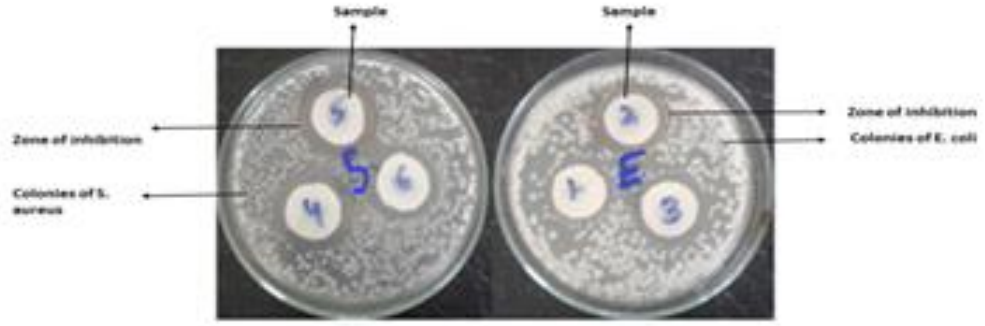


**Figure 3. Antibacterial results of samples treated with Neem extract.**

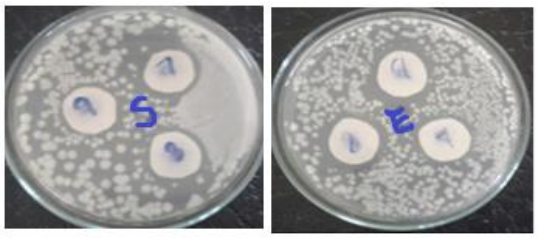


**Figure 4. Antibacterial results of samples treated with Amaranthus extract.**

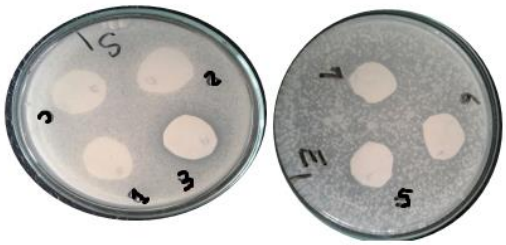

**Figure 5. Antibacterial results of samples treated with Ricinus communis.**

## CONCLUSION

In this study, different plants extracts were used to impart the functional properties to conventional cotton fabrics. These extracts can be used as an antibacterial and UV blocking finishing. Three types of plants extract were used and among these plants neem give best results as an antibacterial agent. Whereas Ricinus communis showed excellent results in terms of ultraviolet protection. Fabrics developed by using these medicinal plants extract can be used as protective clothing and in outdoor applications. This finishing process is economic and nontoxic due to natural sources as compared to synthetic chemical finishes. The selected plant extracts showed good effect on fabric regarding antibacterial and UV-protection aspects, but in-depth studies are yet to be followed to evaluate the identity of the effective compounds responsible for the UV protection and antibacterial activity of treated cotton fabric.

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