Enhancement of anti-microbial activity by natural finishes prepared from herbal spices and wastage peel of fruits applied on textile substrate

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Abstract: Fabrics with antibacterial assets have become essential to organize and manage the infestation by microbes, and to reduce the formation of odor. The fabrics with antimicrobial finishes are highly hygienic in all dimensions particular, when consumed by human beings. In order to evaluate antimicrobial activity, we have prepared natural and organic extracts from herbs and wastage of fruits like Pomegranate. The fabric samples were tested for antimicrobial activity against bacterial strains like Staphylococcus, E.coli, under qualitative analysis method AATCC 147. The results indicated that the cotton fabric show a better microbial resistance against the above-mentioned strains by both two natural finishes on untreated and treated substrate. As per qualitative analysis, the fabric treated with extract showed best reduction against Staphylococcus by analyzing antimicrobial activity.

Keywords. Textile fabrics, Natural Extract, Fruit peel, antibacterial activity, Staphylococcus Aureus, Escherichia coli.

1. Introduction
Antibacterial fabrics are important not only in medical applications but also in terms of daily life usage [1]. The cotton fabric has ability to use mostly on medical terms fabric so need anti-microbial finish for its cellulosic structure [2,3].

The application of antimicrobial finishing to textiles can prevent bacterial growth and antibacterial textile production has become increasingly prominent for hygienic and medical applications [4,5]. The environmental concerns with commercial anti-microbial finishes has silver chloride, benzimidaoles and Triclosan which very hygienic for human. Mostly anti-microbial products like socks and undergarments always contact with human body organs, so they must be abolish the hygiene factor [6].

Pakistan is an agriculture country and has increased growth rate of Pomegranatefruit, on seasonal life lot of peel have been generated. The peel of fruits is a rich source phenols, quinone’s, flavonoids, lectines, polyacetylenes which showed good antimicrobial activity. Many polymethoxylated flavones have several important bioactivities, which are very rare in other plants [7,8].

Pomegranate and herbal species is an important medicinal plant of the family Rutaceae. It is cultivated mainly for its alkaloids, which have anticancer activities and the antibacterial potential in crude extracts of different parts. flavonoids have a large spectrum of biological activity including antibacterial, antifungal, anti-diabetic, anticancer and antiviral activities, [8].
In addition the fiber of fruits also contains bioactive compounds, such as polyphenols, the most important being vitamin C (or ascorbic acid), and they certainly prevent and cure vitamin C deficiency—the cause of scurvy, [4]. Antimicrobial activity of the peel extract is directly concerned with the components that they contain [7]. The studies showed that essential oils, protopine and corydaline alkaloids, lactone, polyacetylenes, acyclic sesquiterpenes, hypericin and pseudohypericin compounds are effective toward various bacteria, [8].

The purpose of the present study was to determine the antimicrobial activity of fabrics functionalized with fruit extract (Pomegranate) and (Aloe Vera) against above bacteria’s. Since it is important to maintain the antibacterial activity of fabrics. Overall research methodology is shown at figure 1.

![Figure 1. Schematic Diagram of research methodology](image)

2. Material and methods
2.1 Preparation of Fabrics

The materials used for this research study are 100% cotton bleached fabric, obtained from (GulAhmed textile Karachi). The fabrics were passed through rinsing process in a washing machine at 40°C for 45-50 minutes using wetting agent, after washed fabric were tumble dried. The specification for fabric & water used is shown in Table 1 & 2.

| Fabric Composition | Weave type | Area weight (g/m²) | Warp yarn count (tex) | Weft yarn count (tex) | CIE Whiteness index (WI) | Absorbency (Sec) |
|--------------------|------------|-------------------|----------------------|----------------------|-------------------------|-----------------|
| Bleached 100% cotton | Plain | 170.0 | 45 | 40 | 80.5 | 1.0 |
| Bleached 100% cotton | Plain | 115.8 | 30 | 30 | 66.5 | 0.8 |
Table 2. Tested water specification

| The quality of water                                      |
|-----------------------------------------------------------|
| pH                         | 7.0  |
| Total hardness (ppm)     | 45.0 |
| Total dissolve solids (ppm)| 142.0|

2.2 Preparation of natural extract

2.2.1. Fruit

Fruit collected from local market must sure are fresh and not effected bacteria before then it will change the properties of microbes during application and testing. Fruit were washed with the help of tap water followed by sterilized distilled water, air dried and peeled off further the peels were dried in sun, packed in envelops for drying in hot air oven at 60°C for 3 days and used as raw material for the extraction of antimicrobial compounds [9,10].

2.3 Dispersion of prepared finish and application parameters

2.3.1. Direct application methods

We took 1g, 5g, and 10g of each fruit waste powder (Pomegranate) & (Aloe Vera) in 1000 ml separate measuring cylinders. Then added 100 ml water in each measuring cylinders. And shake each cylinder continuously for 10 minutes. After 10 minutes we observed that finish was not completely soluble in water. After 30 minutes the finish was more soluble. But still some particle left which abolish by filter.

Table 3. Finishes application parameters for natural fruits extract.

| Extract source                  | Finishing Concentration% | Pickup % | Processing temp & time |
|---------------------------------|--------------------------|----------|------------------------|
| Pomegranate & Aloe Vera Rind    | 1g, 5g, 10g /100 ml      | 80       | 60°C, 10 min           |
|                                 |                          |          | 150°C, 3min            |

Figure 2. (a) Fruit peel extracts solution. (c) Fruit solution treated sample
2.4 AATCC Test Method 147-2004 (Parallel streak method)
Using a 4 mm inoculating loop, one loop full of the diluted inoculums was transferred to the surface of TSA plates by making five streaks approximately 60 mm in length, spaced 10 mm apart covering the central area of a standard Petri plates without refilling of loop. Test specimens were cut with a rectangular die (25x50 mm) and were placed to inoculate TSA transversely across the five inoculums streaks. Petri plates were incubated for 18 – 24 hr at 37°C. Incubated plates were examined for interruption of growth along the streaks of inoculums beneath the specimen and for a clean zone of inhibition along a streak on either side of the test specimen was calculated using the following equation:

\[ W = \frac{T - D}{2} \]

Where, \( W \) is width of clear zone of inhibition in mm, \( T \) is total diameter test specimen and clear zone in mm, \( D \) is diameter of the test specimen in m³.

3. Results & Discussion
To test activity of antimicrobial, we have above fruit finish sources and check on four types of bacteria activity on different conditions,

a. Extract concentration,

Binders are the mechanism used to keep the color on the fabric when using pigments for printing textiles. The choice of binders will always depend upon the final fastness requirements as well as the cost requirements of the process. Almost all the binders used in textile pigment printing are the addition polymerization products. The binder film in pigment print is a three-dimensional structure, the third dimension is rather less important than the other two. The binder is a film-forming substance made up of long chain macromolecules, which when applied to the textile together with the pigment, produces a three-dimensionally network. The links are formed during some suitable fixing process, which usually consists of dry heat and change in \( \text{pH} \) value, bringing about either self-cross linking or reaction with other suitable cross-linking agents. Elasticity and improved adhesion of the film to the substrate is achieved by cross linking. The cross-linking reaction must produce covalent bonds, which are insensitive to hydrolyzing agents (washing liquor, perspiration, industrial atmosphere). The reaction should be activated in dry hot air by curing process. Its formation takes place in two stages: flocculation (or coagulation) and coalescence. During the first stage of film formation, water and surfactants are removed from the binder by;

\[ \text{Binder-CH-ORHO-Cellulose} \rightarrow \text{Binder-CH-O-Cellulose + ROH} \]

On the above-mentioned results lemon show the better result in all bacteria (Gram positive & Gram negative) for the reason of this unsaturated fatty acids compose 64.1% of total linoleic acid (21.71%) Compounds have anti-oxidant & anti-microbial activity. Lemon (citrus compositions), as results lemon shows the good number of microbial reduction and will be used as competitive as such commercial anti-microbial finishes in field of finishing. After noticeable for washing results on recent textile industry development and issues, we had selected the Quantitative test by agar nutrients EN-ISO-20645-2004 which also show inhibition zone both test are use same number of standardized microbes, we had tested all fruit extract concentration and show the common results (Table 5, 6, 7) show the result on highest extract concentration.

In all three concentrations resist the bacteria and show the good anti-microbial activity. But lack of information is that its only show the resist zone not mentions the specific number. Due to upgradation of finishing, we need to improve the testing and need specific number, so we have to choose a different test
related to exactly numbers. AATCC- 100-2004 has shown the results in number by scientific machine, limited germs and test the both un-wash & wash sample. But limitation of colony counter device, and we know the high extract factor we chose only 10gm related samples and check the anti-microbial activity. If we discuss the concentration and the number of cycles we follow the domestic washing rules on laundry detergent which mostly used in commercial and home laundering, so we gradually increase the washing cycles up to 20 and check the results which show the increase cycle mean decrease in anti-microbial activity. The best results show the high concentration from all extract, but due to cost affected we need to use the concentration as per our need our as per demand of finishing.

**Table 4.** Results of Antimicrobial Activity by AATCC-147-2004 (Qualitative)

| Fabrics                        | S. Aureus (AATCC 6538) | E.coli (AATCC4352) |
|--------------------------------|------------------------|--------------------|
| Fruit Extract Treated Swatches | 3.41±0.04mm<sup>a</sup> | 0 mm and No growth of microbe<sup>b</sup> |
| Untreated Swatches (Control Sample) | 0mm and No growth reduction | 0 mm and No growth reduction |

**Figure – 3.** (a). Anti-microbial Activity by agar streak Test, (b). Control Sample

**4. Conclusion**
The binding of cotton fabric using plant natural products was found to exhibit anti-bacterial properties. The fruits rind of fruit as an efficient waste biomass, exhibit efficient anti-microbial agent for the preparation of anti-microbial finish of medical cloths Pomegranate and herbal species extract shown better anti-microbial activity against all microbes. The choice of binders will always depend upon the final fastness requirements.
as well as the cost requirements of the process. Almost all the binders used in textile are addition polymerization products. The binder film in pigment print is a three-dimensional structure, the third dimension is rather less important than the other two. The alkaline cross linking agent proved to be better in performance as compared to the acidic binder with third dimension. But as we mention our subject title that we need to use natural finishes so we try to keep away the formaldehyde binders or other acrylic binders which can be cause the natural extract worst and our product and work can be gone to astray way so we chose the sodium bi carbonate and the acetic acid which both need to fix the dyes on cotton fabric when contact with different dyes alos these both chemical are not harmful and gradually used in industrial way. Both chemical exhaust after unknown time as product will be eco-friendly. Our work on improvement of antimicrobial activity achieved by natural way.

References
[1] T., Ramachandran. Antimicrobial Textile an overview. *Journal of the Institution of Engineers*. (2004). 84(2): 42–47.
[2] Jantas. R., &Górna., K. Antibacterial finishing of cotton fabrics. *Fibers and Textiles in Eastern Europe*. (2006). 14(1): 55
[3] Gouda., M. Enhancing flame-resistance and antibacterial properties of cotton fabric. *Journal of Industrial Textiles*. (2006). 36(2):167-177
[4] Jakimiak. B., Röhm-Rodowald. E., Staniszewska. M., Cieślak M., Malinowska. G., &Kaleta., A. *Microbiological assessment of efficiency of antibacterial modified textiles.*
[5] Roczniki Państwowego Zakła-du-Higieny. (2006). 57(2): 84-177.
[6] Renaud. F., N. R. Dore. J., &Freney. H., J. Evaluation of antibacterial properties of a textile product with antimicrobial finish in a hospital environment. *Journal of Industrial Textiles*. (2006). 36(1): 89-94.
[7] Uddin., F. Environment concern in Antimicrobial finishing of Textiles. *International Journal of Textile Science*. (2014). 15-20.
[8] Mahesh. S., Manjunatha. R. A. H., &Vijaya. K., G. Studies on antimicrobial textile finishes using certain plant natural products. *International conference on advances in biotechnology and pharmaceutical sciences Bangkok*. (2011). 253-258.
[9] Ahmad. M. M., Z. Salim-ur-Rehman., F. M. Iqbal-Anjum., & J.I., Sultan. Genetic variability to essential oil composition in four citrus Fruit Species. *Pak, J. Bot*. (2006). 319-324.
[10] AATCC Test Method 100 (2004). Antibacterial finishes on textile materials: Assessment of AATCC Technical Manual, American Association of Textile Chemists and Colorists, *Research Triangle Park, NC*. 150-151
[11] ENISO 20645:2004. Determination of antibacterial activity-agar diffusion plate test. *Technical Committee CEN/TC 248*. (2004)