Technical Application Process for Eco- Friendly Cotton by Antimicrobial

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Abstract

Apparel textiles in service will adsorb metabolism perspiration from human body, thus prompting microbial propagation and leading to fiber degradation and splash. More seriously, this microbe gives rise to allergy and red swelling on human skin, which makes our body unwell. Staphylococcus aureus is one of common bacteria on human skin, but its excessive breeding on skin will bring red swelling and inflammation. In order to avoid this situation happening, we add antibacterial ingredients in textiles which were not harmful to human and cannot have negative effect on human. And this study aims at seeking for anti-staphylococcus aureus plants, trying to add ingredients from plants in textiles to discuss their antimicrobial change and investigating whether to be potential in textiles application. Phyllanthus Urinaria Linn (PUL) is common in tropical East Asia and can suppress the growth of bacteria regarding staphylococcus aureus, typhoid bacillus, pseudomonas aeruginosa etc. It is shown that when PUL was treated at 60^{o}C for 6 hours in 300 ml 95 % ethyl alcohols, extract rate was up to 12.53 %. And qualitative antimicrobial was effective between 12g/100ml and 0.09375g/100ml PUL extract liquor. And the fabric qualitative antimicrobial was obviously valid when extract concentration was above 0.75g/100 ml. Therefore, cotton treated by 1.5g/100ml PUL extract liquor had prominent antimicrobial effect.

Introduction

Microorganism reproduces, thus leading to fiber degradation or splash due to malodorant metabolites when fibre we wear adsorbs bacterium nutriments such as metabolism perspiration, sebum and dirt. To prevent cacosmia and fiber degradation or splash as a result of microorganism reproduction, antimicrobial agent was immersed into fibre to inhibit bacterial growth by deodoring and bactericidal finishing , which was called bactericidal finish [1]. Although silver which was previously considered as precious metal had been applied to inhibit bacterial growth, its application was restrained owing to its expensive price. So people have to look for cheap antibiotic textiles additive to protect textiles from microorganism erosion and wound infection. Generally, antimicrobial agent can be divided into organic agents which contains phenol, quaternary ammonium, biguanide, organic copper compounds and natural compounds, and inorganic agents which includes inorganic metals and metal salts [2]. Phyllanthus Urinaria Linn (PUL) belonging to euphorbiaceae or spurge family has strong inhibiting effect to staphylococcus aureus, shigella flexneri, and also has influence on hemolytic streptococcus, typhoid bacillus, pseudomonas aeruginosa [3]. In this study,

we used the PUL as experimental plant and extracted it with boiling method. And then the obtaining extract solution as antimicrobial agent was impregnated into cotton fabric, following discussion on the effect to antibiotic property of cotton fabric. Finally we estimated the PUL extract whether to be potential in textiles bactericidal finish.**Experimental**

PUL Extraction methods

Based on reference to previous researches, it is discovered that in polarity, non-polar and low polarity solutions, substance grams extracted from water and alcohol was at most, and inhibition zone test for qualitative antimicrobial in water and alcohol displays similar. But in these literatures, temperature and other experimental parameters were not referred. So in order to make differences, 20 g PUL powder was treated in different volume of solvents (300 ml，400 ml，500 ml)，heating temperature（25 ^{o}C，40 ^{o}C，60 ^{o}C）and heating time (3 hours, 6 hours, 9 hours), thus 27 samples with different parameters were prepared. The heating temperature was all lower than 60 ^{o}C because higher temperature might damage the medicine [4-5]. Mildew occurred in water extraction but didn't happen in alcohol. Considering the following antibacterial determination, we selected 95 % alcohol as extract solution. It is found that the optimal extraction parameter was 20 g PUL powers treated in 300 ml solution at 60 ^{o}C for 6 hours. In condition of 300 ml solvent, the extraction affected by solvent slightly but influenced by temperature and heating time greatly. And the extraction grams showed the most when PUL was extracted at 60 ^{o}C for 6 hours. Eight concentration configurations for collecting extract solution was shown in Tab .1 in order to antimicrobial testing.

Tab .1 PUL pharmaceuticals concentration

Sample no.	1	2	3	4	5	6	7	8	9
concentration (g/100ml)	12	6	3	1.5	0.75	0.375	0.188	0.093	0

PUL pharmaceuticals antibacterial qualitative tests

Bacterium fluid which contained 10 colonies in 1 ml soy broth was cultivated at 37 ^{o}C for 18-24 hours after uniform dispersion on trypticase soy broth by stirring. By measurements, firstly 0.1 ml bacteria fluid was dripped on solid medium, following plating count. And then no antibacterial papers (5mm diameter solid or rectangle) were pasted on solid medium. After dripping 1ml bacterium fluid on papers, they were keeping for 18-24 hours at 37 ^{o}C. Lately, zone of inhibition was measured to judge whether to have antibacterial property.

Fabric antibacterial qualitative tests

According to AATCC 147, needle holder with bacteria solutions in the solid medium lined for five parallels with 6 cm long, 4 cm wide and 1 cm spacing. Then 2.5 cm × 5 cm strip cloth treated by PUL extract bridged and stuck on the surface of above five lines. After 37^{o}C cultivation for 18-24 hours, the zone of inhibition and lines covered by cloth was observed if they grew bacterial, aiming at evaluating whether to be effective to antibiosis.

Results and discussion

Extraction rate

As shown in prepared experiment, the highest extract rate for PUL appeared to treat for 6 hours at 60 ^{o}C in 300 ml alcohol solution. Grams of extraction substance after 16 times treatment was weighing as extraction rate, and data was presented in Tab .2. The experimental material we used grows in nature whose ingredient was influenced by origin, collecting time, water and geography, so it is difficult to achieve uniformity of extract rate. In this experiment, the mean extract rate we obtained was 12.54 %. Referring to previous study, 0.288 g phyllanthusiin was produced by using 1g PUL and 95 % alcohol extract solvent[25].Moreover, for previous flavonoids extraction, the extract rate reach 1.27 % using 95 % alcohol [26]. From these literatures, it can be seen that extraction rate we got in this experiment results is higher because of different extraction methods. In previous literatures, extraction analysis was mostly done by High Performance Liquid Chromatography(HPLC), but in this study we used simple boiling method which resulted in the increase of extraction impurities, which is the main reason for huge gap between two of them.

Tab .2 PUL extraction rate using 95 % alcohol

Extraction no.	Mean mass (g)	Mean extraction mass (g)	Mean extraction rate (%)
1-5	21.0266	2.9576	14.0608
6-10	20.4636	2.2428	10.9646
11-16	20.0052	2.5160	12.5766
Mean	20.4985	2.5721	12.5337

Extract liquor qualitative test

The purpose of extract qualitative test is to measure the pharmaceuticals concentration of inhibiting bacteria growth. In our experiment, alcohol was used for PUL extract. And the extract substance we collected was dissolved in deionized water to measure the effective concentrations of antibacterial effect. Eight kinds of pharmaceuticals concentration for test were shown in Table 1..

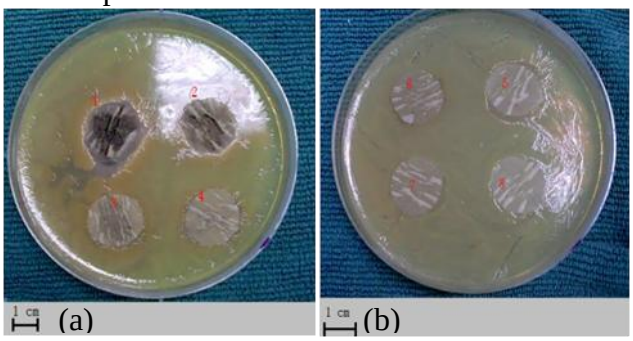

Fig. 1(a) Pharmaceuticals qualitative test for groups 1 to 4, (b) qualitative test for groups 5 to 8

From Fig.1, it is observed that sample groups 1 ~ 8 (12 g / 100ml ~ 0.09375 g / 100 ml) produced inhibition zone. And light colorless area namely inhibition zone appeared in the peripheral paper disk, which means that bacteria have encountered pharmaceuticals solution on paper and diffused to periphery. That was because pharmaceuticals had ingredient of restraining staphylococcus aureus growth for instance organic acids and flavonoids. It is also demonstrated that pharmaceuticals concentration in the range of 12 kg/100ml ~0.09375 kg/100ml was effective to antibacterial property.

Fabric qualitative tests

According to AATCC 147 pharmaceuticals qualitative test, solutions in groups of 1 ~ 8 (12 g /100ml ~ 0.09375 g / 100ml) were effective. To confirm whether the cloth immersing extraction solution achieves the expected effect, the cloth impregnated was tested.

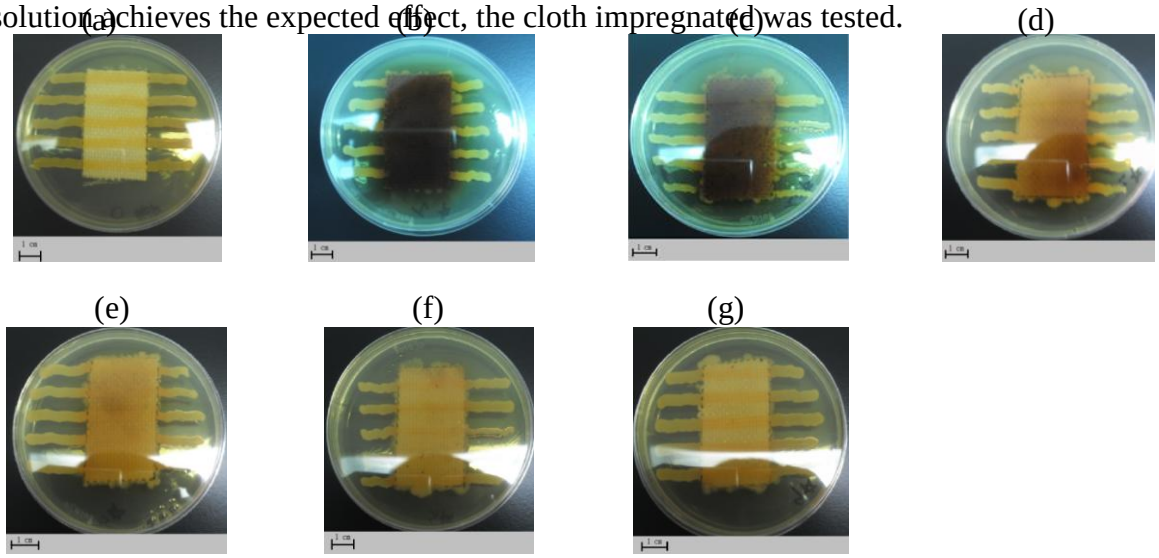

Fig.2 qualitative test for fabric treated with different concentrations (a) without handling,(b) no.1 group (12 g/ 100ml), (c) no.3 group (6 g / 100ml) ,(d) no.4 group (3 g / 100ml) ,(e)no. 4 group (1.5 g / 100ml), (f) no. 5 group (0.75 g/ 100ml), (g) no. 6 group (0.375 g / 100ml).

As shown in figure 2 (a), for fabric without handling staphylococcus aureus bacteria directly grew through cloth leaving obvious stripe below cloth, which demonstrated no antibacterial effect.

Fig.2 (a) shows the control (0g/100ml) after culturing. Staphylococcus aureus directly grew through cloth leaving obvious stripes under the cloth, which demonstrated no antibacterial effect. Fig.2(b) displays the cotton cloth in extract concentration of 12 g/100ml. It is found that Staphylococcus aureus could not grow. That means that 12 g/100ml is effective antibacterial concentration. Fig.2(c) presents no bacteria on the cloth at 6 g/100ml, which also means effective antibacterial effect. From Fig. 2 (d), it shows the situation at concentration of 3 g/ 100ml. By observation of medium and cloth color, it is clear that the bacteria concentration on the cloth declined. Even in such concentration, it was still effective to bacteria inhibiting; thus there was no bacteria under the cloth. In the concentration of 1.5 g/100ml, it is found that effective antibacterial effect happened as indicated in Fig. 2(e). In Fig.2 (g), it can be seen that bacteria was partly through the cloth, and partly not in 0.75 g/100ml pharmaceuticals. So it is determined that minimal inhibitory concentration (MIC) was higher or lower than 0.75 g/100ml and likely ineffective. As shown in fig. 2 (g) at 0.375 g / 100ml, bacteria evidently grew through the cloth; therefore, it was identified as invalid in this concentration.

It was known that pharmaceuticals solution above 0.75 g / 100ml was significantly effective, but it had no effect below 0.75 g / 100ml. From the results, it is determined that the sample concentration of no.1 ~ 4 groups was valid, but no. 6 ~ 8 groups was obviously invalid. No. 5 group was hard to judge as shown in fig.2(f), and it may be between valid and invalid effect.

Conclusion

The PUL extract liquor and the antibiotic fabric were both successfully developed in this study. When PUL was treated at 60oC for 6 hours in 300ml 95 % alcohol, the extract rate achieved 12.53 %. At qualitative tests for PUL pharmaceuticals solution, the extraction concentration was chosen between 12 g/100ml and 0.09375 g/100ml. Although in this study we didn't verify the minimal inhibitory concentration of 0.03125 g/ml as reference reported, we determined the effective antibiotic effect in concentration of above 0.09375 g/100ml.

When cotton cloth was treated under pressure of 1kg/cm2 at 25～28oC between 12g/100ml and 0.09375g/100ml, it is found that bacteria grew through cloth at 0.375 g/100ml but it was absent at above 0.75 g/100ml. The result shows that when cotton cloth was treated at 1.5 g/100ml in 300ml 95% alcohol for 6 hours, it had better antibacterial effect. In the following study, we will add PUL extract liquor in textiles, and discuss on their mechanical properties and qualitative antibiosis in order to increase its application in textile potential.

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