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(Research Article)

To study the anti-microbial effect of groundnut shell extract when applied on cotton fabric

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Abstract

Antimicrobial textile products are becoming increasingly popular as consumers seek fresh-smelling, skin-friendly, and high-performance fabrics. By imbuing the fabric with antimicrobial properties, we can increase the comfort and hygiene factor, making it more pleasant to wear. Odors can be neutralized, and skin problems caused by microbial growth can be reduced, emphasizing the treated product's hygiene.

This research looks at extracting an antimicrobial finish from groundnut shells and applying it to cotton fabric. The hydrous (water) and solvent extraction processes were used for the extraction (methanol, ethanol). The Agar Diffusion Plate Method was used to test the antimicrobial efficacy of groundnut shell extract at different concentrations (20%, 40%, and 60%) with ethanol, methanol, and water. 20% methanolic extract for the *Escherichia coli*, the inhibition zone is greater than at other concentrations. For application, the fabric was desized and an iodine test was performed to check for the presence of starch before the finish was applied using the exhaustion and pad-dry-cure methods.

The results show that for *Escherichia coli*, the fabric treated with groundnut shell extract along with 12% citric acid performed better than the extract alone. Until the fifth wash, the fabric sample treated with extract and 12% citric acid showed a clear zone of inhibition. The clarity decreased after the sixth, seventh, and eighth washes.

Keywords: Antimicrobial finish; Groundnut shells; Textile; Exhaustion; Pad-dry-cure methods

1. Introduction

1.1. Antimicrobial Finishes

An antimicrobial finish is a type of textile treatment that prevents or inhibits the growth of microorganisms such as bacteria, fungi, and viruses. This finish can be used on a variety of textiles, such as clothing, bedding, and medical fabrics [1]. Antimicrobial finishes on textiles can help to reduce the spread of infections and illnesses, making them especially useful in healthcare settings, food processing plants, and other areas where hygiene is essential. Chemical treatments, nanotechnology, and natural agents such as silver ions or tea tree oil can all be used to create antimicrobial finishes [2]. The effectiveness of antimicrobial finishes varies depending on the microorganisms targeted and the finish's durability.

1.2. Groundnut

Groundnut, also known as peanut, is a legume grown primarily for its edible seeds. It originated in South America but is now grown throughout the world, including in Africa, Asia, and North America. Groundnuts are high in protein, healthy fats, vitamins, and minerals and are used in various recipes, including peanut butter, oil, and roasted snacks [3].

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Groundnuts have important cultural and economic significance in many countries, where they are an important cash crop and play an important role in local cuisine and traditions. It can also be used as a finish, as it shows many antimicrobial properties [4]. In the present scenario, groundnut shells are now significantly used by the fabric industry. A method of separating the fibre from the hulls was created.

Activated carbon was also prepared from peanut shells for its suitability for the absorptive removal of reactive black dye from an aqueous solution. Groundnut shells contain many bioactive and functional compounds like polyphenols, flavonoids, luteolin, and carotene [5]. Therefore, this study was done to determine the effectiveness of these compounds against the microbes present in the environment.

2. Methodology

The secondary data was collected from libraries, internet, journals, research papers, etc. Primary data has been collected in three phases. In phase 1 the extraction of antimicrobial finish from the groundnut shell has been done by two methods

- Hydrous extraction method
- Solvent extraction method

For hydrous water, the dried shell powder was taken and mixed in different concentrations (20%, 40%, and 60%), and for the solvent method, the dried shell powder was taken and mixed with the ethanol and methanol separately in different concentrations (20%, 40%, and 60%).

In phase 2 the application of the extracted antimicrobial finish on cotton fabric was done. The pre-treatment of the fabric was done by de-sizing of cambric fabric. In desizing of fabric, samples are soaked in 0.5% sulphuric acid solution (60-70c). The fabric samples are immersed for 15-20 minutes and then removed, squeezed, and rolled in the polythene sheets. They are kept in an oven maintained at 40 degrees Celsius for 4 hours, after which the fabric is rinsed, neutralized with 0.5% sodium carbonate solution, washed, and dried. Application of antimicrobials was done by using two methods:

- Exhaustion Method
- Pad- dry- cure Method

In phase 3, a laboratory test is conducted to evaluate the efficiency of an antimicrobial finish on cotton fabric. Escherichia coli was freshly revived

To test the effect of antimicrobial finishes on fabric, first, the minimum inhibitory concentration of the extract was determined. After that, the effective concentration of citric acid was determined. In this study, citric acid is used as a cross-linking agent to create a cross-linking bond between fabric and finish.

For qualitative testing, we use the agar plate diffusion test, and at the end, we check the wash durability of the finish on the treated sample using a launderometer.

3. Results and discussion

Table 1 Determination of extraction Method and different concentration for groundnut shell Finish

S. No	**Herbal extract Concentration**	**Zone of Inhibition (Avg width of inhibition in mm)**		
		ethanol	**Methanol**	**Water**
		Escherichia coli	***Escherichia coli***	***Escherichia coli***
1.	20%	4	6.5	_
2.	40%	2.5	0.85	_
3.	60%	1.25	0.5	_
4.	Control	_	_	_

For determining the best extraction process and the effective concentration of the extract, we used the Agar Plate Diffusion Method AATCC147, where we used groundnut shell extract that was made by two methods, hydrous (using water) and solvent extraction (using ethanol and methanol) in different concentrations of groundnut shell powder (20%, 40%, and 60%). The width of inhibition zone (clear region produced on the agar surface, around the well with antimicrobial extract on the agar surface) was calculated. The clear region, which is an indication of the absence, or the effective inhibition, of microbial growth by the antimicrobial extract. The average width of the zone of inhibition on either side of the well was calculated

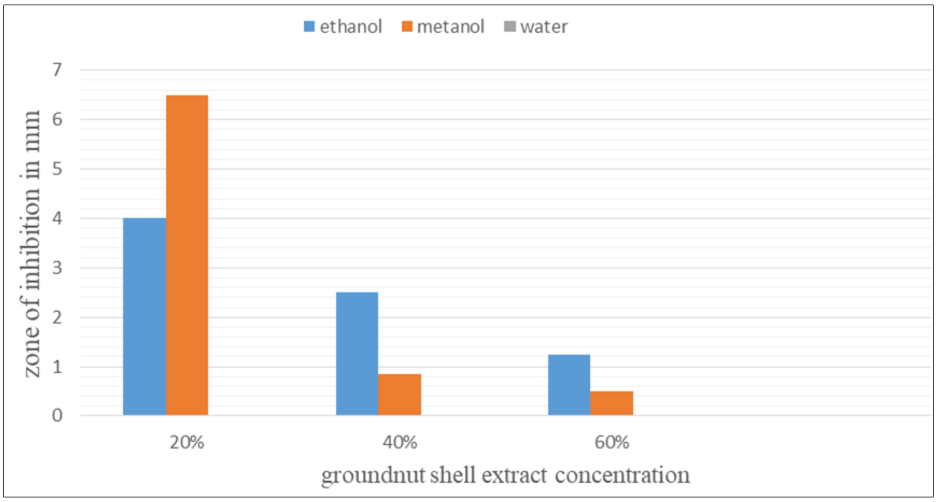

Figure 1 Antimicrobial Effect of different concentrations of extract (Methanol and ethanol) on E.coli

From Table 1. it can be observed that the ethanol with groundnut shell extract gave a range of widths for the inhibition zone of 1.25-4mm, with methanol, it gave a range 0.5-6mm and with water extract, it did not show any inhibition against the *Escherichia coli*. It was noted that 20% methanolic extract gave the highest value for the width of the inhibition zone at 6.5mm. Therefore, a 20% methanolic extract concentration was finalized for further study.

A control sample of water, ethanol, and methanol did not show any inhibition against *Escherichia coli* (Table 1.1).

3.1. Determining the best concentration of citric acid

For determining the best concentration of citric acid, the agar diffusion method was used. The different concentrations of citric acid (2%. 4%, 6%, 8%, and 10%) were added to the final concentration (20% methanolic extract for *Escherichia coli*).

Table 2 Determining the effect of different concentrations of citric acid based on the zone of inhibition.

S.no	Plates [extract (e) + % citric acid	zone of inhibition (avg width of inhibition in mm)
		Coli
1	2%	1.5
2	4%	1.7
3	6%	2.1
4	8%	2.5
5	10%	4.2
6	12%	6
7	Control 12%	—

With the help of a qualitative assessment method, the concentration of citric acid was determined. After the incubation of the agar plates which had the finish with different conc. Of citric acid was examined.

In *Escherichia coli*, it was observed that as we increased the concentration of citric acid in the extract, the zone of inhibition also increased. Thus, we finalized 12% of citric acid, which gives the incubation zone width of 6 mm. also, the control sample of 12% citric acid does not give any result; therefore, it can prove that the extract with citric acid gives a satisfactory result.

The treated fabric sample was tested with the help of qualitative assessment (Agar plate diffusion Method) against *Escherichia coli*. The result was found out are as follows:

- The treated fabric sample (groundnut shell extract 20% methanol for *Escherichia coli* with 12% citric acid) showed a clear zone of inhibition which means the antibacterial effect of the finishes was seen.
- The treated fabric sample (groundnut shell extract 20% methanol for *Escherichia coli*) also showed a clear zone of inhibition.

Therefore, it can be concluded that the finish prepared from groundnut shell extract and 12% citric acid showed good antibacterial activity on the fabric.

3.2. Testing the wash durability of the finish on the treated sample using a launderometer

Table 3 Determining the effect of groundnut extract on cotton fabric before and after washing based on the zone of inhibition

S.NO	**Stage of washing (zone of inhibition)**	**Groundnut shell extract with methanol**	**Ground nut shell extract with methanol and citric acid**
		Escherichia coli	*Escherichia coli*
1	Before washing	++	++
2	1 wash	++	++
3	2 wash	++	++
4	3 wash	+	++
5	4 wash	+	++
6	5 wash	+	++
7	6 wash	_	+
8	7 wash	_	+
9	8 wash	_	+
10	9 wash	_	_
11	10 wash	_	_

The fabric sample treated with finish without citric acid showed clear zone of inhibition till 2ndwash. After 3rd 4th and 5th wash, the clarity was reduced but a zone of inhibition was still present. After the 6th to 10th washes, the growth of bacteria was seen.

The fabric sample treated with finish with 12% citric acid showed a clear zone of inhibition till the 5th wash. After the 6th 7th and 8th washes, the clarity reduced, but a zone of inhibition was still present. After the 9th and 10th washes, the growth of bacteria was seen.

4. Conclusion

Due to the emergence of the antibiotic resistance of pathogenic bacteria, an antimicrobial compound extracted from herbs and plants have also been extensively studied as an alternative therapeutic strategy to combat microbial growth in textiles.

The study was done on the woven cotton fabric, which was treated with an extract prepared from a groundnut shell. To carry out this study, the antimicrobial finish was extracted from the groundnut shell by using a hydrous (water) and solvent (methanol, ethanol) process. The extracted finish was applied to the cotton fabric, and a qualitative assessment (Agar diffusion method AATCC147) was done to check the effect of the antimicrobial finish. The wash ability of the finish was also determined.

It was found that 20% methanolic extract gave the highest value for the width of the inhibition zone, 6.5 mm, against E.coli, and also that 12% citric acid, which was used as a linking agent, showed a good inhibition zone against E.coli. Finally, the treated sample was tested with the help of qualitative assessment (Agar Diffusion Method, AATCC147). The antimicrobial effect was evaluated based on the clarity of the zone of inhibition which was beneath the fabric. It was seen that the fabric sample treated with an optimized finish and citric acid gave a clear zone of inhibition.

The wash fastness of the treated fabric was also seen after ten washes. The washing of all the finished samples was done in a launderometer and evaluated with the help of qualitative assessment (Agar Diffusion Method, AATCC147). It was found that treated fabric with a finish and citric acid showed a clear zone of inhibition, and the finish lasted for five washes. Zone of inhibition was present until eight.

Hence, it can be concluded that cotton fabric that has been treated with ground nut shell extract along with citric acid shows an antimicrobial effect against *Escherichia coli*.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest.

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