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Neem Leaves: A Natural Shield against Microbial Threats in Textiles

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ABSTRACT

The study explores the potential of natural plant extracts as antimicrobial agents for textile applications, addressing the increasing demand for hygienic textiles amidst growing awareness of microbial risks. By evaluating the antimicrobial activity of five plant extracts - *giloy, amaltas,* neem*, arjun*, and lemon, against various pathogenic microbes, the research identifies r as exhibiting the highest antimicrobial efficacy across Gram-negative and Gram-positive bacteria, unicellular fungi, and filamentous fungi. These findings pave the way for the development of environmentally friendly antimicrobial finishes for textiles, essential for mitigating microbial contamination, odour formation, and product deterioration. Antimicrobial assessment reveals that neem showed maximum zone of inhibition against *P. aeruginosa* (9.00, 12.00 and 16.50 mm), *S. aureus* (11.30, 13.00 and 15.30 mm), *Candida* (0.75, 1.20 and 1.30 mm) and *A. Awamori* (0.75, 1.3 and 0.4 mm) at 10, 15 and 20 mg/ml respectively. Hence, neem was selected as potential source exhibiting maximum antimicrobial properties for further application on cotton fabric in order to impart antimicrobial herbal finish for development of healthcare hygiene textile products. The investigation underscores the significance of natural bioactive agents in producing safe, non-toxic, and eco-friendly textile products, aligning with the growing demand for health and hygiene-conscious consumer choices.

Key words: *Plant extract, Antimicrobial efficacy, Hygiene, Textiles, Environment friendly*

Introduction

Worldwide interest is growing in eco-friendly antimicrobial compounds derived from natural ingredients for textile applications (Joshi *et al.*, 2009). Consumer awareness of the sanitary and potentially dangerous impacts of microbes is driving up demand for clothes with antimicrobial finishes. Numerous plant extracts with antibacterial qualities can be utilised as basic textile finishing agents or, to increase the extracts' durability and controlled release, as microcapsules. Antimicrobial consumption is rising daily due to the growing need for sanitary textiles (Chandrasekaran *et al.*, 2015). Recent years have seen a sharp increase in the demand for and growth of technical textiles because of the advancements being made to provide textiles new, valuable features. The current situation has seen a multiplication in the demand for cleanliness and health products due to the growing awareness of leading a healthy lifestyle. In order to preserve mummies, the ancient Egyptians used spices and plant extracts to apply antibacterial finishing to textiles. The manufacturing of clothing and fabrics that offer microbial protection has a lot of potential.

Microorganisms growing on textile materials cause a variety of unfavourable consequences for both the person and the textile (Joshi *et al.*, 2009).

These consequences frequently result in unpleasant odours, skin infections, allergic reactions, fabric stains and discolorations, and product degradation. Textiles serve as active agents in the spread of germs in addition to serving as substrates for microbial growth (Purwar and Joshi, 2004). The need for goods with antimicrobial qualities to prevent microbial contamination is rising as people become more conscious of the dangers of microbial infection. The majority of fabrics used in hospitals and hotels nowadays can spread diseases brought on by microorganisms, especially fungi and bacteria, and can also induce cross-infection (Gupta and Bhaumik, 2007).

This makes it necessary to produce garments that can have the requisite antimicrobial effect in order to prevent microbial growth, which has become increasingly crucial. Antimicrobial agents must be applied to textile materials to prevent the spread of pathogenic microorganisms, manage microbial infestation, stop microbial metabolism to prevent the development of odours, and shield textile products from stains, discolorations, and deterioration of quality (Babu and Ravindra, 2014).

The majority of commercial antimicrobial agents on the market today are synthetic and could not be good for the environment. Finished textiles using antimicrobial compounds may disrupt the skin's unique defence mechanism and immunological system. It is crucial that they abide by the rules set forth by international organisations like EPU. Effectiveness, selective action against unwanted microorganisms, non-toxicity, safety, biodegradability, and wash ability are requirements for active ingredients in antimicrobial finishing (Gao and Craston, 2008).

The creation of safe, non-toxic, skin- and environmentally-friendly bioactive textile products is made possible by natural bioactive compounds with antimicrobial capabilities, which have gained significant importance in the bio-functionalization of textile fibres. Phenolics and polyphenols (simple phenols, phenolic acids, quinines, flavonoids, flavones, flavonols, tannins, and coumarins), terpenoids, essential oils, alkaloids, lactins, polypeptides, and polyacetylenes are among the antimicrobial substances that are primarily extracted from plants (Babu and Ravindra, 2014). These substances have both antioxidant and antibacterial properties.

The current research sets out on a major quest. Finding and carefully assessing a few plant sources that are well-known for their strong antibacterial qualities is its main goal. These plant selections—*giloy, amaltas*, neem, *arjun*, and lemon—have the potential to serve as the cornerstones of an innovative method of producing healthcare textiles. Its goal is to thoroughly evaluate these plant extracts ability to combat a variety of harmful microbes through antimicrobial activity.

Materials and Methods

Through a series of experiments, the investigators have discerned a critical indicator of antimicrobial activity known as the "zone of inhibition." This metric was applied to evaluate the effectiveness of the selected plant extracts against various pathogenic microbes. These microbes encompass a wide range, spanning Gram-negative and Gram-positive bacteria, unicellular fungi, and filamentous fungi, thereby ensuring a comprehensive assessment of antimicrobial potential. The following steps are included:

Collection and selection of plant material: Five plant sources having antimicrobial properties i.e. *giloy, amaltas, neem, arjun* and lemon were identified.

Assessment of antimicrobial activity of selected plants extracts against pathogenic microbes: The antimicrobial activity of the selected plant materials (*giloy, amaltas, neem, arjun and* lemon) was used for the determination of zone of inhibition against *Pseudomonas aeruginosa* (Gram negative bacteria), *Staphylococcus aureus* (Gram positive bacteria), *Candida* (Unicellular fungi) and *Aspergillus awamori* (Filamentous fungi).

Selection of plant source: One plant source out of five identified plant sources exhibiting maximum antimicrobial properties was selected for further application on cotton fabric in order to impart antimicrobial herbal finish for development of healthcare hygiene textile products.

Results and Discussion

Selection of plant source showing maximum antimicrobial activity: Five plants extracts i.e. *giloy, amaltas, neem, arjun* and lemon were used for assessment of antimicrobial activity against pathogenic microbes (Table 1 and 2).

The antimicrobial activity of plant extracts (*giloy, amaltas, neem, arjun* and lemon) was calculated in terms of zone of inhibition. The data from the Table 2 reveal that 9.00, 12.00 and 16.50 mm zone of inhibition was observed for *neem* leaves extract, 8.20, 11.80 and 14.00 mm for lemon leaves extract, 8.20, 11.30 and 10.00 mm for *arjun* bark extract, 6.00, 7.00 and 8.00 mm for *giloy* leaves extract and 6.00, 6.00 and 7.00 mm for *amaltas* leaves extract at 10, 15 and 20 mg/ml respectively against *P. aeruginosa* (Gram negative bacteria).

The antimicrobial activity (zone of inhibition values) noticed against *S. aureus* (Gram positive bacteria) in case of *neem* leaves extract was 11.30, 13.00 and 15.30 mm, for lemon leaves extract 10, 12.30 and 14.90 mm, for *arjun* bark extract 9.00, 12.00 and 14.20 mm, for *amaltas* 8.00, 10.00 and 13.00 mm and for giloy 7.20, 8.30 and 10.00 mm at 10, 15 and 20 mg/ml, extract concentration respectively.

Neem leaves extract showed 0.75, 1.20 and 1.30 mm zone of inhibition and lemon leaves extract showed 0.42, 0.30 and 0.75 mm zone of inhibition against *Candida* (Unicellular fungi) at 10, 15 and 20 mg/ml extract concentration respectively. Zone of inhibition of 0.41, 0.67 and 0.40 mm was observed for *arjun* bark extract, 0.41, 0.75 and 0.34 mm for *giloy* leaves extract and 0.42, 0.40 and 0.40 mm zone of inhibition for *amaltas* leaves extract at 10, 15 and 20 mg/ml extract concentration respectively, was recorded against *Candida* (Unicellular fungi).

The data in the table revealed that *neem* leaves extract showed 0.75, 1.3 and 0.4 mm zone of inhibition while lemon leaves extract showed 1.20, 0.75 and 0.74 mm zone of inhibition, *arjun* bark extract showed 0.40, 0.40 and 1.20 mm, *giloy* leaves extract 0.40, 0.30 and 1.30 mm and *amaltas* leaves extract showed 0.67, 0.20 and 0.40 mm zone of inhibition at 10, 15 and 20 mg/ml respectively, against *A. awamori* (Filamentous fungi). The finding was in

Table 1. Identified plant sources

S. No.	Local name	Botanical name	Family	Part used
1.	*Giloy*	*Tinospora cordifolia*	*Myrtle*	Leaves
2.	*Amaltas*	*Cassia fistula*	*Fabaceae*	Leaves
3.	*Neem*	*Azadirachta indica*	*Meliaceae*	Leaves
4.	*Arjun*	*Terminalia arjuna*	*Combretaceae*	Bark
5.	Lemon	*Citrus limon*	*Rutaceae*	Leaves

Table 2. Antimicrobial activity of identified plant extracts against microorganisms

Microorganisms	Extracts	Concentration of plant extract(mg/ml) and Zone of inhibition (mm)		
		10 mg	15 mg	20 mg
P. aeruginosa (Gram negative bacteria)	Control	No inhibition		
	Giloy leaves	6.00	7.00	8.00
	Amaltas leaves	6.00	6.00	7.00
	Neem leaves	9.00	12.00	16.50
	Arjun bark	8.20	11.30	10.00
	Lemon leaves	8.20	11.80	14.00
S. aureus (Gram positive bacteria)	*Giloy* leaves	7.20	8.30	10.00
	Amaltas leaves	8.00	10.00	13.00
	Neem leaves	11.30	13.00	15.30
	Arjun bark	9.00	12.00	14.20
	Lemon leaves	10.00	12.30	14.90
Candida (Unicellular fungi)	*Giloy* leaves	0.41	0.75	0.34
	Amaltas leaves	0.42	0.40	0.40
	Neem leaves	0.75	1.20	1.30
	Arjun bark	0.41	0.67	0.40
	Lemon leaves	0.42	0.30	0.75
A. awamori (Filamentous fungi)	*Giloy* leaves	0.40	0.30	1.30
	Amaltas leaves	0.67	0.20	0.40
	Neem leaves	0.75	1.30	0.40
	Arjun bark	0.40	0.40	1.20
	Lemon leaves	1.20	0.75	0.74

compliance with the results of Vastrad and Byadgi (2018) which showed that an increase in concentration of extract (5%, 10% and 100%) increased the zone of inhibition against the microorganisms. The results are also supported by the findings of Nageswari *et al*. (2016) who reported increase in zone of inhibition for increased concentrations (10, 20, 30, 40 and 50 mg/ml) of aqueous extracts of different plants.

Conclusion

The outcomes of these experiments have unveiled a compelling narrative. Among the selected plant extracts, neem leaves extract has emerged as the standout performer, demonstrating consistent and robust antimicrobial activity against the entire spectrum of tested microorganisms. Hence, neem was selected as potential source exhibiting maximum antimicrobial properties for further application on cotton fabric in order to impart antimicrobial herbal finish for development of healthcare hygiene textile products. Such textiles, fortified with neem's natural antimicrobial properties, have the potential to not only enhance infection control measures but also contribute significantly to overall public health.

Conflict of Interest- Authors declare no conflict of interest.

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