



Production Of Antiseptic Using Firetail (*Acalypha Amentacea*) And Evaluation Of Its Antibacterial Activity

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Abstract— This research focuses on the production of liquid antiseptic using Firetail (*Acalypha amentacea*) extract as a natural substitute for phenol, a common chemical disinfectant and evaluating its antibacterial activity. The study focuses on the formulation of a safer, eco-friendly antiseptic that retains strong antimicrobial properties. Firetail, known for its antibacterial and antifungal activity, was extracted using water and methanol and incorporated into a typical antiseptic formulation containing pine oil, isopropyl alcohol, texapon, and water. The product formed was evaluated for antimicrobial activity against *Klebsiella pneumoniae*, and *Staphylococcus aureus*. Results showed that the Firetail-based antiseptic demonstrated significant antibacterial effects against the tested pathogens. Methanol based extract showed 4.7 mm and 4.40 mm zones of inhibition against *Klebsiella pneumoniae*, and *Staphylococcus aureus*. Water extract of the plant recorded 2.90 mm and 1.90 mm zones of inhibition against *Klebsiella pneumoniae* and *Staphylococcus aureus* respectively. The formulation proved mild on skin and environmentally safe, suggesting that Firetail extract can effectively replace phenol in commercial antiseptic products. This work shows that locally sourced medicinal plants can be used in health-related formulations, reducing cost of purchasing chemicals and ensures environmental safety.

Keywords- Firetail leaves, Antiseptic, Antibacterial, Inhibitory zones.

I. INTRODUCTION

Acalypha amentacea, a member of the family Euphorbiaceae, is a fast-growing herbaceous shrub found extensively in tropical and subtropical regions, especially in Asia, Africa, and the Pacific Islands. It is one of the prominent species within the genus *Acalypha*, which includes over 450 species known for their ecological and medicinal importance (Oladeji, 2020). *A. amentacea* is locally utilized in traditional medicine systems for treating skin infections, wounds, gastrointestinal issues, and inflammation due to its rich phytochemical profile (Rajendran et al., 2019).

This plant is characterized by broad ovate leaves and elongated catkin-like inflorescences, which have earned it common names such as “copperleaf” or “firetail.” Although widely cultivated as an ornamental plant, it holds significant ethnopharmacological relevance. In several indigenous practices across Nigeria, India, and the Philippines, decoctions of *A. amentacea* leaves are applied externally or taken orally for their therapeutic effects (Okoli et al., 2018).

Phytochemical investigations have revealed the presence of bioactive constituents such as flavonoids, alkaloids, saponins, tannins, and phenolic compounds in the leaves and stem of *Acalypha amentacea*, which are responsible for its antimicrobial, anti-inflammatory, antioxidant, and wound-healing activities (Hossain et al., 2021).

The demand for effective, safe, and environmentally friendly antiseptics has led to increased interest in plant-based

alternatives to synthetic chemicals like phenol. Phenol, while widely used for its potent antimicrobial properties, poses health and environmental risks due to its corrosive nature and potential toxicity. Consequently, researchers are exploring natural compounds with antimicrobial efficacy to replace or reduce the reliance on synthetic agents in antiseptic formulations. Traditionally, it has been used in various cultures for treating infections and promoting wound healing. Phytochemical analyses have revealed that *A. amentacea* contains bioactive compounds such as flavonoids, phenolic acids, terpenoids, and phytosterols, which contribute to its antimicrobial and anti-inflammatory properties (de Araújo et al., 2021). These attributes make it a promising candidate for developing natural antiseptic formulations.

Several studies have investigated the antimicrobial properties of *A. amentacea*, for instance, de Araújo et al., (2021) evaluated the aqueous extract of fresh leaves and found significant antibacterial and antifungal activities, suggesting its potential as an antimicrobial agent. Similarly, Kannan et al. (2014) conducted preliminary phytochemical and antibacterial studies on leaf extracts of *A. amentacea*, reporting the presence of compounds like alkaloids, flavonoids, and phenols, which exhibited antibacterial activity against *Escherichia coli*.

Phytochemical analyses using techniques like LC-MS/MS and GC-MS have identified various bioactive constituents in *A. amentacea* including flavonoids, terpenoids, and phytosterols. These compounds are known for their antimicrobial and

antioxidant activities, further supporting the plant's potential in antiseptic applications.

Antiseptics are antimicrobial substances applied to living tissues to reduce the possibility of infection, sepsis, or putrefaction. They are commonly used in healthcare settings for hand hygiene, wound cleaning, and preoperative skin preparation. The growing concern over antimicrobial resistance has renewed interest in optimizing the use of antiseptics (Boyce & Pittet, 2020).

Antiseptics act by disrupting microbial cell membranes, denaturing proteins, or oxidizing cellular components. For instance, alcohols dissolve lipid membranes, while iodine penetrates cells and disrupts protein synthesis (McDonnell & Russell, 2020).

Antiseptics are broadly classified based on their chemical nature:

Alcohols (e.g., ethanol, isopropanol): Effective against bacteria and enveloped viruses; widely used for hand sanitization (Kampf, 2021).

Chlorhexidine gluconate: A biguanide with broad-spectrum activity and persistent effects; commonly used in surgical settings (McDonnell & Russell, 2020).

Povidone-iodine (PVP-I): Iodophor effective against bacteria, fungi, and viruses; used in preoperative skin antisepsis (Chow et al., 2021).

Hydrogen peroxide: An oxidizing agent with moderate efficacy; often used for wound cleaning (Nwankwo et al., 2022).

Quaternary ammonium compounds (QACs): Surface-active agents with bactericidal properties; used in both healthcare and domestic settings (Vazquez-Muñoz et al., 2022).

Despite their effectiveness, the overuse of antiseptics raises concerns about microbial resistance. Some strains of *Staphylococcus aureus* and *Pseudomonas aeruginosa* have shown reduced susceptibility to chlorhexidine and QACs (Wand et al., 2021). Moreover, prolonged use may lead to skin irritation or allergies, especially with iodine-based products.

Recent research explores plant-derived antiseptics and nanoparticles as alternatives. Silver nanoparticles and essential oils (e.g., tea tree oil) have demonstrated promising antimicrobial properties with lower resistance potential (Vazquez-Muñoz et al., 2022). Moreover, enhanced delivery systems such as Nano-emulsions are being studied to improve antiseptic efficacy and reduce toxicity.

Despite these promising findings, there is a paucity of research focusing on the direct substitution of phenol with *A. amentacea*, extract in liquid antiseptic formulations. This study aims to bridge this gap by formulating a liquid antiseptic using *A. amentacea*, extract as a natural antimicrobial agent and evaluating its efficacy compared to traditional phenol-based antiseptics.

II. MATERIALS AND METHOD

A. RAW MATERIAL AND REAGENT FOR ANTISEPTIC PRODUCTION

1) Production Procedure Of Normal Liquid Antiseptic

Three litre (3 litres) of methanol and 125 ml of pine oil were introduced into a container and stirred for 10 minutes to trace. One hundred and twenty-five millilitres (125 ml) of Chloroxylenol was added with continuous stirring for additional 10 minutes. One hundred and twenty-five litres of phenol were gently introduced for additional 10 minutes of continuous stirring followed by additional 10 minutes of continuous stirring follows by addition of 250 g of texapon as the stirring continue for further 10 minutes. One litre of distilled water and colour to taste were added while stirring continue to attain homogeneous mixture.

Table 1: Measurement Table for the Production of Normal Liquid Antiseptic

Reagent	Quantity
Methanol	3 litres
Pine oil	125 ml
Phenol	125 ml
Chloroxylenol	125 ml
Texopone	250 g
Colour	Taste

2) Production Procedure Of Water Base Liquid Antiseptic

Three litre (3 litres) of methanol and 125 ml of pine oil were introduced into a container and stirred for 10 minutes to trace. One hundred and twenty-five mille litres (125 ml) of Chloroxylenol was added with continuous stirring for additional 10 minutes. One hundred and twenty-five litres of Firetail extract (Water as solvent) were gently introduced for additional 10 minutes of continuous stirring followed by additional 10 minutes of continuous stirring. This was followed by addition of 250 g of texapon as the stirring continue for further 10 minutes. One litre of distilled water and colour to taste were added while stirring continue to attain homogeneous mixture.

Table 2: Measurement Table for the Production of Firetail Extract (water as solvent) Liquid Antiseptic

Reagent	Quantity
Methanol	3 litres
Pine oil	125 ml
Firetail Extract (Water as solvent)	125 ml
Chloroxylenol	125 ml
Texopone	250 g
Colour	Taste

3) **Production Procedure Of Firetail Extract (Methanol As Solvent) Liquid Antiseptic**

Three litre (3 litres) of methanol and 125ml of pine oil were introduced into a container and stirred for 10 minutes to trace. one hundred and twenty-five mille litres (125 ml) of Chloroxylenol was added with continuous stirring for additional 10 minutes. One hundred and twenty-five litres of Firetail extract (Methanol as solvent) were gently also introduced for additional 10 minutes of continuous stirring followed by additional 10 minutes of continuous stirring. It was follows by addition of 250 g of texapon as the stirring continue for further 10 minutes. One litre of distilled water and colour to taste were added while stirring continue to attain homogeneous mixture.

Table 3: Measurement Table for the production of Methanol Base Liquid Antiseptic

Reagent	Quantity
Methanol	3 litres
Pine oil	125 ml
Firetail Extract (Methanol as solvent)	125 ml
Chloroxylenol	125 ml
Texopone	250 g
Colour	Taste

B. **PREPARATION OF ANTISEPTIC PRIOR TO ANTIBACTERIAL DETERMINATION**

A series of concentrations were prepared for the newly produced antiseptic from the A. amentacea leaves extract. Five (5) fold serial dilutions were prepared using five sterile test tubes. 10 ml of concentrated antiseptic was transferred in to the first tube then followed by 7.5 ml in to the second tube, diluted with 2.5 ml of water, 5.0 ml of antiseptic was transferred in to third test tube and diluted with 5.0 ml of water, to the fourth set; 2.5 ml of antiseptic was transferred and diluted with 7.5 ml of water and in to the last set; 1.2 ml of antiseptic was transferred and diluted with 8.5 ml of water giving a concentration of 100 % v/v, 75 % v/v, 50 % v/v, 25 % v/v and 12.5 % v/v, respectively (Dazzo, 2005).

1) **Determination Of Antibacterial Activity Of The New Product (Antiseptic)**

The inoculum was prepared by standardizing the test organisms in Nutrient broth and the turbidity of the bacterial suspension was compared with 0.5 MacFarland Standard. Antibacterial activity of the antiseptic was evaluated against the test organisms using the agar well diffusion method (Balouri et al., 2016). Mueller-Hinton agar plates were seeded with the suspension (diluted cultures) of the test bacteria and five wells were bored using a sterile cork borer of about 0.5 mm diameter. Different concentrations of the antiseptic were then made and 0.1mL from each concentration was placed aseptically into the wells on the seeded plates with the help of sterile pipette. The plates were incubated at 37o C for 24 hours. The resulting zones of inhibition were measured and values for each test organism recorded. Dettol was used as positive control.

2) **Determination Of Minimum Inhibitory Concentration (Mic)**

Nutrient broth was prepared and sterilized, then 5 mL of medium was dispensed into sterile test tubes and allowed to cool. After cooling, equal volume of the different concentrations of the antiseptic was then added to each test tube containing the media. 0.1 ml sterile suspension of the test organisms was inoculated into the medium. The tubes were then incubated at 37°C for 24 hours, after which they were examined for the presence or absence of turbidity which is an indication of growth or inhibition. The MIC was taken as the lowest concentration that prevented the growth of the test organisms (CLSI, 2023).

3) **Determination Of Minimum Bactericidal Concentration (Mbc)**

A loopful of the content of each tube in the MIC determination above, which did not show any visible growth after the period of incubation was streaked unto freshly prepared and solidified Nutrient agar and then incubated at 37°C for 24 hours after which it was observed for visible growth. The lowest concentration of the subculture with no growth was considered as minimum bactericidal concentration (CLSI, 2023).

III. RESULTS AND DISCUSSION

A. **EXPERIMENTAL RESULTS**

Table 4: Antibacterial Activity of Antiseptic (Methanol and Water based) on *Klebsiella pneumoniae*

	Concentration (100 % v/v) of the Antiseptic					
	100	75	50	25	12.5	CA
Zone of inhibition (mm)						
Methanol based	4.70	4.00	3.00	2.50	1.90	3.90
Water based	2.90	1.60	1.20	0.00	0.00	3.90

Key: Control = Commercial antiseptic (CA)

Table 5: Antibacterial Activity of Antiseptic (Methanol and Water based) on *Staphylococcus aureus*

	Concentration (100 % v/v) of the Antiseptic					
	100	75	50	25	12.5	CA
Zone of inhibition (mm)						
Methanol	4.40	3.70	3.20	2.10	0.00	3.90
Water	1.90	1.60	1.20	0.00	0.00	3.90

Key: Control = Commercial antiseptic (CA)

Table 6: Minimum Inhibitory Concentration (MIC) of Antiseptic (Methanol and Water based) on *Klebsiella pneumoniae*

Antiseptic	Minimum Inhibitory Concentration (100 % v/v)				
	100	75	50	25	12.5
Methanol	-	-	-	-	+
Water	-	-	+	+	+

Key: - means no growth + means growth

Table 7: Minimum Inhibitory Concentration (MIC) of Antiseptic (Methanol and Water based) on *Staphylococcus aureus*

Antiseptic	Minimum Inhibitory Concentration (100 % v/v)				
	100	75	50	25	12.5
Methanol	-	-	+	+	+
Water	-	-	-	+	+

Key: - means no growth + means growth

Table 8: Minimum Bactericidal Concentration (MBC) of Antiseptic (Methanol and Water based) on *Klebsiella pneumoniae*

Antiseptic	Minimum Inhibitory Concentration (100 % v/v)				
	100	75	50	25	12.5
Methanol	-	-	+	+	+
Water	-	-	-	-	+

Key: - means no growth + means growth

Table 9: Minimum Bactericidal Concentration (MBC) of Antiseptic (Methanol and Water based) *Staphylococcus aureus*

Antiseptic	Minimum Inhibitory Concentration (100 % v/v)				
	100	75	50	25	12.5
Methanol	-	+	+	+	+
Water	-	-	-	+	+

Key: - means no growth + means growth

IV. DISCUSSION

There is a noticeable antibacterial activity of the methanol and water-based antiseptic formulated from firetail (*Acalypha amentacea*) leaves extracts with 4.7 mm and 4.40 mm zones of inhibition for methanol based against *Klebsiella pneumoniae* and *Staphylococcus aureus* respectively. Water based antiseptic had 2.90 mm and 1.90 mm as zones of inhibition against the tested organisms. According to Onyema & Okafor (2024), the higher activity noticed in the methanol based compared to water based may be attributed to better solubility and extraction efficiency of non-polar and moderately polar compounds in methanol. The variation in antibacterial between the bacterial species could be attributed to differences in cell wall components, activity of permeate molecules, or other

intrinsic resistance mechanisms that serve as adaptive mechanism for survival in adverse conditions.

Furthermore, de Araújo et al. (2021) evaluated the aqueous extract of fresh leaves of firetail (*Acalypha amentacea*) and found significant antimicrobial activities, suggesting its potential as an antimicrobial agent. This singular observation is in agreement with the current study. It clearly indicates that the methanol and water-based extracts of these leaves can serve as substitute for phenol in the production process of commercial antiseptic as phenol may be harsh or toxic on the skin surface. However, the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) of methanol and water-based extracts of firetail leave evaluation showed moderate values against the test organisms as seen in Tables of result (6, 7, 8 & 9). This observation does not align with the work of Dawoud et al. (2013). This may be due to the choice of solvent, the nature of the product and the strains of the target or tested organisms.

V. CONCLUSION

The formulation of antiseptic using firetail (*Acalypha amentacea*) demonstrated antibacterial potential against some pathogens. It is mild on skin and environmentally safe, giving credence to the fact that Firetail extract can effectively replace phenol in commercial antiseptic products. In this study, there is a promotion of the use of locally available medicinal plants in health-related formulations, supporting sustainability, reducing chemical toxicity and enhances biodegradability.

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