17th INTERNATIONAL MARDIN ARTUKLU SCIENTIFIC RESEARCHES CONFERENCE

June 01-03, 2026 / Mardin, Türkiye

FULL TEXTS BOOK

EDITOR:
Dr. İlknur PORSUK DORU

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adapted by Mariam Rasulan

01.06.2026 | SESSION-3 | HALL-3

Ankara Local Time: 15:^{00}-17:^{00}

Meeting ID: 858 1117 0419	*Zoom Passcode: 171717*

HEAD OF SESSION: **Asst. Prof. Dr. Kanchi Ravi Padma**

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Gobeze Negash, HAILE	*Addis Ababa University*	EPIDEMIOLOGY AND ANTIMICROBIAL RESISTANCE OF ESCHERICHIA COLI AT THE HUMAN-ANIMAL-ENVIRONMENTAL INTERFACE IN ADDIS ABABA: A ONE HEALTH APPROACH

ANTIMICROBIAL INVESTIGATION OF MEDICINALLY IMPORTANT *COLEUS* SPECIES

Thenmozhi . M
Department of Biotechnology, School of Life Sciences, Vels Institute of Science, Technology and Advanced Studies (VISTAS), Pallavaram, Chennai-600 117, Tamil Nadu, India.
ORCID ID: 0000-0002-7957-6648

ABSTRACT
Plants having antimicrobial properties have been reported as an important natural source of bioactive compounds. One of such plants includes various species of Coleus from the family Lamiaceae. These are known for their medicinal uses in treatment of various ailments like digestive disorders, asthma, hypertension, heart diseases, and various cancers. This work was carried out to study the antimicrobial potential and genetic variability of three species of Coleus plants; *C. amboinicus, C. aromaticus,* and *C. forskohlii*. Plant extracts were obtained by using four different organic solvents; butanol, methanol, ethanol, and acetone. The antimicrobial activity was tested against various bacteria including *Escherichia coli, Bacillus sp., Staphylococcus sp., Proteus sp., and Pseudomonas sp.* by using agar diffusion technique. MIC analysis was also done for effective plant extracts. Out of all four solvents, butanol was found to be the most potent solvent showing maximum inhibition in *C. forskohlii*, exhibiting maximum inhibition against *E. coli* and *Proteus sp*. Moderate activity was noted in methanolic extracts whereas minimum inhibition occurred in ethanol and acetone extracts. It can be concluded from this study that Coleus plants, especially *C. forskohlii,* exhibit high levels of antimicrobial activity and could therefore serve as valuable sources for natural antimicrobial substances
Keywords: Antimicrobial properties, *C. aromaticus, C. forskohlii*, *C. amboinicus*, Medicinal plant

INTRODUCTION:
The fast development and spread of resistant microorganisms are among the threats to global public health, limiting the efficacy of antibiotics and requiring a search for new antimicrobial substances obtained from natural resources (WHO, 2023; Murray *et al.,* 2022). There are numerous medicinal plants containing such active secondary metabolites as phenolics, flavonoids, terpenoids, and alkaloids. Many of them have strong antimicrobial properties and have been used as the bases for new drugs (Huang *et al.,* 2022). Among medicinal plants, species of the genus Coleus (family Lamiaceae) have attracted considerable scientific interest due to their extensive ethnopharmacological applications. *Coleus amboinicus, Coleus aromaticus,* and *Coleus forskohlii* are among such plants that have been utilized for centuries to address respiratory problems, gastrointestinal problems, cardiovascular problems, and inflammation (Wadikar *et al.,* 2016). Previously, bioactive components exhibiting antimicrobial, antioxidant, anti-inflammatory, and anticancer activities have been identified through phytochemical analyses of Coleus spp. (Slusarczyk *et al.,* 2021: Stefanowicz-Hajduk *et al.,* 2025).
The rapid increase in antimicrobial resistance among pathogenic microorganisms has become a major global health concern, necessitating the search for alternative antimicrobial agents from natural sources. Medicinal plants have long served as reservoirs of bioactive compounds with therapeutic potential and continue to play a significant role in the discovery of novel antimicrobial molecules.

Among these, *Coleus aromaticus* (syn. *Plectranthus amboinicus*), a perennial aromatic herb belonging to the family Lamiaceae, has gained considerable attention due to its extensive traditional use and rich phytochemical composition (Bhavyashree *et al.,* 2025).

Coleus aromaticus, commonly known as Indian borage, is widely distributed throughout tropical and subtropical regions and is extensively cultivated in India for medicinal and culinary purposes. Traditionally, the plant has been used for the treatment of respiratory disorders, gastrointestinal ailments, fever, skin infections, and various inflammatory conditions. Recent pharmacological studies have validated several biological activities of the plant, including antioxidant, anti-inflammatory, antiviral, antidiabetic, anticancer, and antimicrobial effects (Bhavyashree *et al.,* 2025).

The therapeutic potential of *C. aromaticus* is primarily attributed to its diverse phytochemical constituents, including phenolic acids, flavonoids, terpenoids, and essential oils. Major bioactive compounds such as thymol, carvacrol, eugenol, 1,8-cineole, rosmarinic acid, chlorogenic acid, and caffeic acid have been reported to possess broad-spectrum antimicrobial properties through mechanisms involving membrane disruption, enzyme inhibition, and oxidative stress induction in microbial cells (Kanjanapothi *et al.,* 2017). Previous studies have demonstrated inhibitory activity of *C. aromaticus* extracts and essential oils against both Gram-positive and Gram-negative bacteria, highlighting its potential as a source of natural antimicrobial agents (Bhat *et al.,* 2023; Singhal *et al.,* 2022).

Despite growing evidence supporting its antimicrobial efficacy, variations in extraction solvents and bacterial susceptibility necessitate further investigation to identify the most effective extraction systems and evaluate their antibacterial potential. Even though there is increasing scientific attention to the pharmacological activities of phytochemicals found in Coleus, few studies have been conducted comparing their antimicrobial effects using different extraction methods on different Coleus species. In this regard, the current study was designed to evaluate the bactericidal activity of three types of Coleus, namely *C. amboinicus, C. aromaticus,* and *C. forskohlii*, using butanol, methanol, ethanol, and acetone as extractants against selected bacteria using agar well diffusion technique. The results could help find plant sources of antimicrobial agents.

MATERIALS AND METHODS

Leaves of *C. amboinicus, C. aromaticus,* and *C. forskohlii* were harvested from Kanchipuram District, Tamil Nadu. The freshly harvested plant samples were cleaned by removing the leaves from the stems, washing with tap water, followed by distilled water washing.

Plant Extraction

The leaf samples were cut into small pieces and dried under shade for 14 days. The dried leaves were ground into a fine powder with the aid of an electric grinder. Twenty grams of powdered leaf samples were extracted by means of butanol, methanol, acetone, and ethanol in conical flasks of 250 mL each. The flasks were stoppered with cotton wool and aluminum foil to avoid loss of solvents and kept in a shaker for 24 hours (Ahmed *et al.,* 2026).

Bacterial inoculums preparation

The bacterial cultures employed in this experiment included Escherichia coli, Bacillus sp., Staphylococcus sp., Proteus sp., and Pseudomonas sp. The bacterial stock cultures were stored on nutrient agar (NA) slants at 4°C. In order to conduct the experiments for the determination of antimicrobial activities, bacterial cultures were grown in Mueller-Hinton broth. Active cultures were prepared by streaking a loopful from each bacterial stock culture onto test tubes filled with nutrient broth and incubating the samples at 37°C for 24 hours (Osuntokun *et al.,* 2021).

Agar Well diffusion method

The bacterial cultures used in the current experiment were *Escherichia coli, Bacillus sp., Staphylococcus sp., Proteus sp.,* and *Pseudomonas sp.* Stock cultures were maintained on Nutrient Agar (NA) slants stored at 4°C. The bacterial inoculum was made up from pure cultures as per protocol stated by Abdel-Moneim et al. (2022). The evaluation of antibacterial property of the plant extracts was performed using disc diffusion method on Mueller–Hinton Agar (MHA) medium as stated by Arullappan et al. 2009. Mueller-Hinton agar medium was poured onto Petri plates to allow it solidify. The prepared bacterial inoculum was spread evenly on the surface of the medium by the help of cotton swab wetted in bacterial suspension. The plant extracts were dissolved in dimethyl sulfoxide (DMSO), and then required concentration of extract solution and placed onto the inoculated agar plates in well. The Petri plates were kept in incubator at 37°C for 24 h.

RESULT AND DISCUSSION:

Antibacterial activities of various solvent extracts of *Coleus amboinicus, Coleus aromaticus,* and *Coleus forskohlii* were examined against selected bacteria using agar well diffusion technique. It was found that there existed differences in antibacterial activities based on the plant species and type of extraction solvent used. Of all the solvents investigated, butanol extracts exhibited the highest antibacterial activity (Table.1). *C. forskohlii* had the highest level of antibacterial activity towards all the bacterial strains tested. For instance, the highest zone of inhibition occurred in *E. coli* (2.0 cm) followed by *Proteus* sp. (1.6 cm). However, *Staphylococcus* sp. (1.2 cm), *Bacillus*. sp. (1.2 cm) and *Pseudomonas*. sp. (1.2 cm) were also inhibited by the butanol extract. Butanol extracts of *C. aromaticus* were moderately effective in inhibiting *E. coli* (1.4 cm), *Proteus* sp. (1.3 cm), S. sp. (1.1 cm) and both *Pseudomonas*. sp. and *Bacillus*. sp. (1.0 cm each). On the other hand, C. amboinicus extracts exhibited antibacterial activity to *E. coli* (1.6 cm), *Proteus* sp. (1.4 cm) and *Bacillus* sp. (1.1 cm). Methanol extracts showed relatively low levels of antibacterial activity where *C. forskohlii* extracts moderately inhibited *Proteus* sp. (1.7 cm), *Bacillus* sp. (1.6 cm) and *E. coli* (1.3 cm).

The methanolic extracts of *C. amboinicus* were found to be devoid of any antibacterial activity. The antibacterial activities of acetone extracts showed only very low inhibition against *Proteus* sp., recorded in *C. forskohlii* (1.4 cm). Ethanol extracts did not show any inhibition against the tested bacteria. In terms of the efficiency of solvent action on the tested bacteria, it could be said that the order is butanol > methanol > acetone > ethanol; while the antibacterial efficacy of the tested plants was: C. forskohlii > C. aromaticus > C. amboinicus.

The increased activity of butanol extracts against tested pathogens is probably due to efficient extraction of moderate polarity plant secondary metabolites, including phenolic substances, flavonoids, terpenoids, and components of essential oil. Plants from Coleus species are well-known for the presence of biologically active compounds such as thymol, carvacrol, eugenol, rosmarinic acid, and 1,8-cineole, known for their strong antimicrobial properties. The mechanisms of action include damage to cell membrane integrity, enzyme inhibition, suppression of cellular respiration processes, and oxidative stress in microbes (Bhavyashree *et al.,* 2025; Santos Filipe *et al.,* 2025). Increased antibacterial activity of *Coleus forskohlii* can be linked to its higher content of biologically active diterpenoids and phenolic metabolites known for their antimicrobial activity.

Table 1. Antimicrobial activity of *Coleus species*

Solvent	Plant sample	Zone Of Inhibition (cm)				
		E.coli	*Bacillus sp.,*	*Staphylococcus Sp.,*	*Proteus Sp.,*	*Pseudomonas Sp.,*
Butanol	*C. ambonicus*	1.6	1.1	-	1.4	-
	C.aromaticus	1.4	1.0	1.1	1.3	1
	C.forskholii	2.0	1.2	1.2	1.6	1.2
Methanol	*C.ambonicus*	-	-	-	-	-
	C.aromaticus	-	-	-	1.3	-
	C.forskholii	1.3	1.6	-	1.7	-
Acetone	*C.ambonicus*	-	-	-	-	-
	C.aromaticus	-	-	-	-	-
	C.forskholii	-	-	-	1.4	-
Ethanol	*C.ambonicus*	-	-	-	-	-
	C.aromaticus	-	-	-	-	-
	C.forskholii	-	-	-	-	-

It is worth noting that the inhibition of E. coli and Proteus sp. strains is particularly significant as Gram-negative bacteria contain an outer membrane, which makes them more resistant to antimicrobial compounds. Research has shown that the essential oils, especially thymol and carvacrol, can successfully pass through the membranes of bacteria and cause intracellular leakage, eventually leading to the death of the microorganisms (Aelenei *et al.,* 2016). The same observation was made in the study conducted by Khwaza et al. (2025), where Coleus extracts were characterized by their ability to exhibit broad-spectrum antimicrobial activity towards Gram-positive and Gram-negative bacteria. The moderate activity of the methanolic extracts means that methanol managed to extract some antimicrobial phytochemicals, although not as efficiently as butanol. Solvent polarity significantly affects phytochemical extraction.

The low levels of biological activity found in the acetone extract and the lack of any antibacterial properties in the ethanolic extract could be attributed to poor extraction of the specific antimicrobial components in the Coleus species under study. Differences in phytochemical content associated with changes in environmental factors such as geographic distribution, age of the plant, and methods of extraction have also been found to affect the efficacy of the medicinal plants against microbes (Kumar *et al.,* 2025). In addition, seasonal differences in the concentrations of thymol, carvacrol, and other volatile components are known to alter the antibacterial effects of Coleus oil extracts (Khwaza and Aderibigbe, 2025).

Generally, from the results obtained, there is enough evidence to suggest that there exist important antibacterial properties associated with various Coleus species. This especially holds true with regard to *Coleus forskohlii* which showed impressive results in terms of antibacterial activities, especially using the butanol extract form. With the rising trend of bacterial resistance against conventional antibiotic therapies, the search for other alternative sources of effective antimicrobial agents becomes even more essential.

SUMMARY AND CONCLUSION:

In the current research, the antibacterial potential of various extracts of *Coleus amboinicus, Coleus aromaticus,* and *Coleus forskohlii* was determined against selected bacterial pathogens using the agar well diffusion technique. The results showed significant differences between the tested plants and the different extract solvents in terms of antibacterial potential. Of all the solvent types used, butanol extracts possessed a greater degree of antibacterial potential, especially in the case of *Coleus forskohlii* that had the strongest inhibitory effect on the growth of E. coli and Proteus sp. Methanolic extracts had moderate antibacterial potential; however, acetone and ethanol extracts were minimally and maximally active against the studied bacteria, respectively. Based on their antibacterial efficacy, it can be stated that the following pattern was observed: butanol > methanol > acetone > ethanol, with regard to solvents, while in terms of plants, the order is: *C. forskohlii* > *C. aromaticus* > *C. amboinicus*. Therefore, Coleus species, particularly *C. forskohlii*, could be considered effective natural antibacterial resources.

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