EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Coden USA: EJBPBO
Volume: 13
Issue: 1
Year: 2026

EVALUATION OF PHYTOCHEMICAL AND ANTIMICROBIAL ACTIVITY OF *COCOS NUCIFERA* EMBRYO

Mr. Manjunath C. J.*, Mrs. Aparna Lakshmi I., Mr. Shivanand M. R., Chandrakala, Shreedevi Kori, Spoorthi, Spoorthy K. S., Veena Malipatil

Dept. of Pharmacology, N.E.T Pharmacy College, Raichur, Karnataka.

***Corresponding Author: Mr. Manjunath C. J.**

Dept. of Pharmacology, N.E.T Pharmacy College, Raichur, Karnataka.

DOI: https://doi.org/10.5281/zenodo.18150990

How to cite this Article: Mr. Manjunath C. J.*, Mrs. Aparna Lakshmi I., Mr. Shivanand M. R., Chandrakala, Shreedevi Kori, Spoorthi, Spoorthy K. S., Veena Malipatil. (2026). EVALUATION OF PHYTOCHEMICAL AND ANTIMICROBIAL ACTIVITY OF COCOS NUCIFERA EMBRYO. European Journal of Biomedical and Pharmaceutical Sciences, 13(1), 236–244.

Article Received on 05/12/2025 **Article Revised on 25/12/2025** **Article Published on 05/01/2026**

ABSTRACT

Aim: Antimicrobials are substances used to kill or inhibit the growth of bacteria, fungi, viruses, and protozoa. This activity plays a crucial role in preventing and controlling infections, ensuring public health, and preserving the quality and safety of pharmaceutical and food products. The coconut palm (Cocos nucifera) belongs to Arecaceae family and biologically active compounds such as flavonoids, terpenoids, saponins, alkaloids, glycosides, tannins, carbohydrates and proteins etc. which are essential for antimicrobial activity. *Cocos nucifera* embryo has been widely used in traditional treatments for numerous human diseases in many parts of the world of various ailments, including allergic reactions, headaches, dizziness, liver damage, Anaemia, Anxiety etc. However, no reports are published till today regarding embryo of *cocous nucifera* for In-vitro antimicrobial activity. Hence presence study is an attempt to explore its antimicrobial potency and to find phytochemical constituents. **Methods and materials:** The In-vitro antimicrobial activity was evaluated by using Broth micro dilution method. **Results:** Phytochemical investigation of *Cocos nucifera* embryo revealed that ethanolic extract contains flavonoids, terpenoids, saponins, alkaloids, glycosides, tannins, carbohydrates and proteins etc. The In-vitro results of Broth micro dilution method showed significant antimicrobial activity results revealed that the standard drug Ampicillin exhibited strong activity against both Gram-positive and Gram-negative bacteria, with a minimum inhibitory concentration (MIC) of 0.19 mg/ml against Staphylococcus aureus and 25 mg/ml against Escherichia coli. In comparison, the Cocos nucifera ethanol extract showed relatively moderate antimicrobial activity, with an MIC of 15 µl/ml against Staphylococcus aureus and 40 µl/ml against Escherichia coli. These findings indicate that Ampicillin is more potent, especially against Gram-positive bacteria. **Conclusion:** The findings suggest that the bioactive compounds in the plant extract could be developed for therapeutic applications.

KEYWORDS: *Cocos nucifera* embryo, antimicrobial activity, Ampicillin.

INTRODUCTION

Antimicrobials are substances used to kill or inhibit the growth of bacteria, fungi, viruses, and protozoa. This activity plays a crucial role in preventing and controlling infections, ensuring public health, and preserving the quality and safety of pharmaceutical and food products. Many herbal plants exhibit antimicrobial activity, potentially useful for treating infections, but some can also cause adverse effects, including allergic reactions, interactions with conventional medications, and toxicity, especially with improper use or high dosages. Despite centuries of searching for antimicrobial substances efficient drugs did not appear until the 19th century, when from extensive research, the domain of antimicrobials was achieved in the form of antibiotic, antifungal, and antiviral drugs.[1]

Although it is normally not linked to a single component but rather to a collection of metabolites, the secondary products found in plants are frequently responsible for the positive medical benefits of plant materials, including the antibacterial activity. It is unknown exactly how the

plant materials' active ingredients contribute to their antibacterial properties. Their ability to partition the lipids of the bacterial cell membrane and mitochondria, disrupting the cell structures and making them more permeable, is one of the hypothesized processes.[1] Death will result from significant bacterial cell leakage or the release of vital chemicals and ions. The mucosal membrane is astringently affected by tannins found in plant extracts.

Antibiotics

The compounds that are extracted from one microbe to eradicate another are known as antibiotics. To treat many bacterial infections, penicillin is utilized. Antibiotics work well to treat illnesses caused by bacteria, fungi, and parasites. The creation of synthetic components that function as antimicrobial agents against harmful bacteria has been aided by the advancement of chemical synthesis. These artificial ingredients are also known as antibiotics. At modest doses, synthetic components can destroy pathogenic germs. Amoxicillin and ampicillin are two examples. Arsphenamine, also known as salvarsan, is a synthetic substance that was created in 1908 by German bacteriologist Paul Ehrlich from an arsenic-based structure to treat syphilis. Then, in 1929, Alexander Fleming identified the fungus Penicillium notatum as the source of penicillin. A variety of bacterial infections can be treated using penicillin.

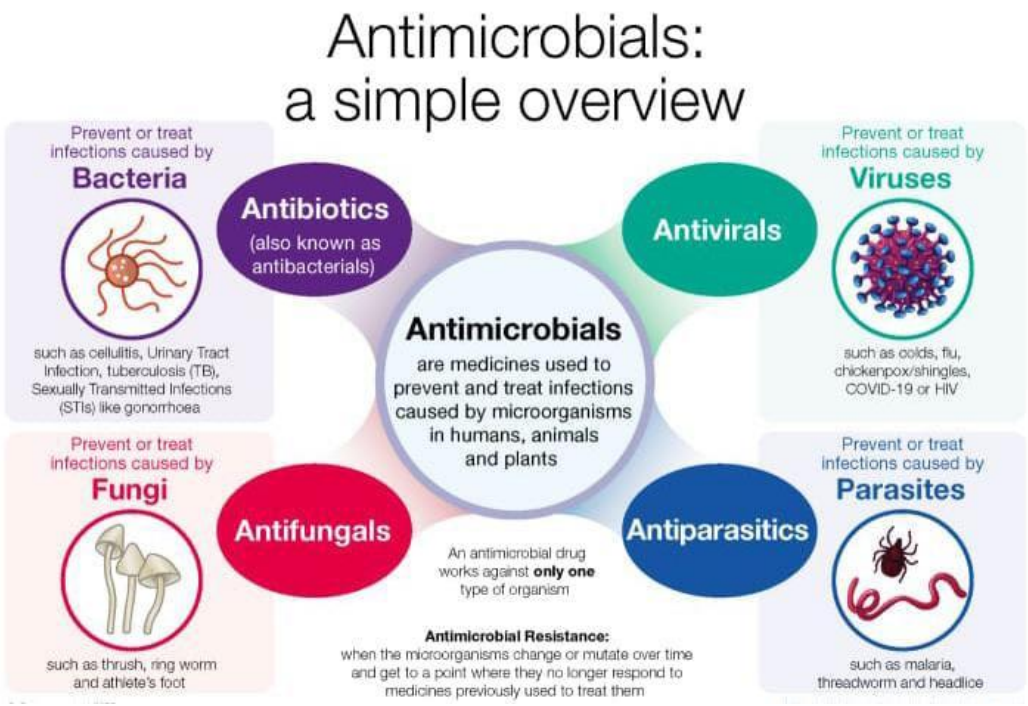

Fig. 1: Antimicrobial: a simple overview.

Antibiotics

Antibacterial activity is the property of certain substances to destroy or inhibit the growth of bacteria at the site of action without causing harm to surrounding tissues. Most modern antibacterial agents are derived from natural compounds that have been chemically modified. However, the frequent and often improper use of these agents has led to the common problem of bacterial resistance. This resistance usually develops through evolutionary processes, such as exposure to antibiotics, and can be inherited by subsequent generations.

Classification of Antibacterial Agents

1. Based on Mechanism of Action

a. Inhibitors of Cell Wall Synthesis: Prevent the formation of bacterial cell walls, leading to cell death. Examples: Penicillin, Cephalosporins.
b. Inhibitors of Protein Synthesis: Block bacterial ribosomes and disrupt protein production. Examples: Tetracycline, Erythromycin.
c. Inhibitors of Nucleic Acid: Interfere with DNA or RNA synthesis. Eg: Quinolones, Rifampicin.
d. Inhibitors of Metabolic Pathways: Block essential enzymatic reactions in bacteria. Examples: Sulfonamides, Trimethoprim.

2. Based on Spectrum of Activity

a. Broad-Spectrum Antibacterials: Effective against a wide variety of bacteria (both Gram positive and Gram-negative) Eg: Chloramphenicol
b. Narrow-Spectrum Antibacterials: Target specific groups of bacteria. Eg: Penicillin G.

3. Based on Effect on Bacteria

a. Bactericidal Agents – Kill bacteria directly. Eg: Aminoglycosides, Penicillin.

b. Bacteriostatic Agents – Inhibit bacterial growth, allowing the immune system to eliminate them. Eg: Tetracycline, Chloramphenicol.[2]

Common Side Effects of antibacterial are Nausea, indigestion, vomiting, diarrhea, bloating, appetite loss are frequent, pelvic pain, dizziness, rapid heartbeat. Rare and Severe Side Effects of Antibiotics are rapid heartbeat, rash, low blood pressure, seizures. Staining – Prolonged tetracycline use may permanently stain teeth, skin, nails, and bones, Kidney damage etc.[3]

Antiviral

Antiviral drugs are medications specifically designed to treat infections caused by viruses. While many of these drugs are formulated to act against particular viruses, some broad-spectrum antivirals can combat a wide variety of viral types. Generally, antiviral drugs are safe for human use and can be administered to manage viral infections. It is important to differentiate them from virucides—substances that destroy or deactivate viruses but are not classified as medications. Currently, the majority of available antiviral medications are developed to treat infections caused by HIV, herpes viruses, hepatitis B and C viruses, as well as influenza A and B strains.

Classification of Antiviral Activity

1. Entry Inhibitors: Example: Enfuvirtide (used for HIV), Maraviroc.
2. Replication Inhibitors: These stop the virus from making copies of its genetic material (DNA or RNA). Eg: Acyclovir (for herpes), Remdesivir (for COVID-19).
3. Assembly Inhibitors – These interfere with the process of assembling new viral particles inside the host cell. Eg: Rifampin (used against poxviruses), protease inhibitors like Ritonavir (for HIV).
4. Release Inhibitors – These prevent the newly formed viruses from leaving the host cell to infect others. Eg: Oseltamivir (Tamiflu) and Zanamivir (used for influenza)
5. Broad-spectrum Antivirals – These act on multiple types of viruses, often at different stages of their life cycle. Eg: Ribavirin, Favipiravir, Nitazoxanide

   Antiviral drugs can cause some side effects like headache, nausea, tiredness, or stomach upset. In some people, they may affect the liver or kidneys. Serious problems are rare but possible with long use or high doses. It's important to use them under a doctor's advice.[4]

Antifungal

An antifungal agent is a medication designed to specifically target and remove fungal pathogens from a host while causing minimal harm to the host's own cells.

Classification of Fungal Infections (Mycoses)

Fungal infections, or mycoses, are generally categorized into 3 main types:

1. Superficial infections
2. Subcutaneous infections
3. Systemic infections.[5,6]

The development of antifungal drugs primarily focuses on targeting structural components such as mannans, glucans, and chitins, as well as specific enzymes involved in the ergosterol biosynthesis pathway, which is unique to fungal cells.[7]

Classification of antifungal agents

1. Azole derivatives

Mechanism: Inhibit lanosterol 14-α-demethylase → blocks ergosterol synthesis.

Eg: Fluconazole, Itraconazole, Ketoconazole, Voriconazole.[8]

2. Polyenes derivatives

Mechanism: Bind to ergosterol in the fungal membrane → form pores → cell leakage.

Eg: Amphotericin B, Nystatin.

3. Echinocandins derivatives

Mechanism: Inhibit β-1,3-D-glucan synthase → disrupt fungal cell wall synthesis. **Eg:** Caspofungin, Micafungin, Anidulafungin.

4. Pyrimidine Analogues

Mechanism: Inhibit DNA and RNA synthesis after conversion to 5-fluorouracil. **Eg:** Flucytosine.

5. Allylamines derivatives

Mechanism: Inhibit squalene epoxidase → disrupt ergosterol biosynthesis.

Eg: Terbinafine

The side effects of antifungal medications can vary depending on the specific drug, its dosage, and the type of fungal infection being treated. Common adverse effects may include abdominal pain, upset stomach, diarrhea, itchy skin, burning sensations, or skin rashes. In rare cases, antifungal drugs can lead to more serious complications, such as liver damage (jaundice), severe allergic reactions like anaphylaxis, or severe skin reactions involving blisters and peeling.[9,11]

Antiparasitic

Antiparasitic drugs are used to treat infections caused by parasites, including helminths, amoebas, ectoparasites, parasitic fungi, and protozoa. These medications work by either killing the parasites or stopping their growth, but they typically only act on a specific group of parasites. As a type of antimicrobial agent, antiparasitics are grouped alongside antibiotics, which fight bacteria, and antifungals, which combat fungal infections.

Classification of antiparasitic drugs

1. Nitazoxanide: effective against a variety of parasites
2. Antiprotozoals: Used for protozoan infections like sleeping sickness (Melarsoprol, Eflornithine),

vaginitis (Metronidazole), giardiasis (Tinidazole), and leishmaniasis (Miltefosine).

3. Antinematode: Mebendazole, Pyrantel pamoate, Thiabendazole, Diethylcarbamazine, Ivermectin, Fenbendazole – used for roundworm, hookworm, and filariasis.
4. Antiamoebics: Rifampin, Amphotericin B – treat amoebic infections.

Antiparasitic medications may lead to various side effects, which can vary based on the specific drug and how an individual responds to it. Frequently reported side effects include digestive disturbances, allergic reactions, headaches, dizziness, liver damage, nervous system effects, blood-related issues, vision disturbances, and feelings of tiredness or weakness. While most of these side effects are temporary and tend to subside once the treatment is stopped, some severe reactions might need medical intervention.[12]

Mechanism of action

Antimicrobial agents act by targeting vital structures or processes in microorganisms, leading to their death or inhibition of growth. They may inhibit cell wall synthesis (e.g., penicillins, cephalosporins, vancomycin) by blocking peptidoglycan cross-linking, disrupt cell membrane integrity (e.g., polymyxins, amphotericin B) causing leakage of cellular contents, or inhibit protein synthesis by binding to bacterial ribosomal subunits (30S inhibitors like tetracyclines and aminoglycosides; 50S inhibitors like macrolides and chloramphenicol). Others interfere with nucleic acid synthesis by inhibiting enzymes like DNA gyrase or RNA polymerase (e.g., quinolones, rifampin, metronidazole), while some block essential metabolic pathways such as folic acid synthesis (e.g., sulfonamides, trimethoprim). These mechanisms exploit structural and biochemical differences between microbes and human cells to achieve selective toxicity.[13]

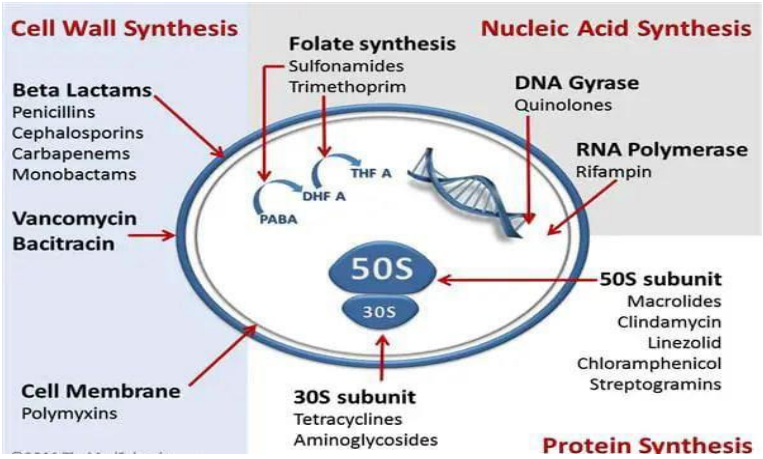

Fig. 2: Mechanism of action.

Some common side effects of antimicrobial activity of drugs include

- Allergic reactions
- Nausea, Diarrhea
- Headache
- Anaphylaxis
- Anemia
- Nephrotoxicity
- Confusion
- Anxiety
- Seizures
- Hepatotoxicity
- Fever
- Abdominal pain
- Dizziness
- Leukopenia
- Photosensitivity
- Teeth discolouration
- Skin dryness
- Paradoxical infection risk
- Redness and irritation
- Bone marrow suppression
- Cytoxicty risk
- Liver strain
- Drug interactions
- Weight gain

The need for this study is justified by the growing crisis of antimicrobial resistance, the slow pace of new antibiotic development, and the vast untapped potential of natural products as sources of novel antimicrobial agents. Scientific exploration of natural remedies, supported by modern research tools and traditional knowledge, offers a promising and sustainable strategy to combat drug-resistant infections.

For thousands of years, medicinal plants have been used as traditional treatments for numerous human diseases in many parts of the world. The natural products derived from medicinal plants have proven to be an abundant source of biologically active compounds making them effective source for alternative medicines. Numerous traditional medicinal plants have been evaluated for their potential application in the prevention or treatment of diseases particularly those of microbial origin.[14]

Therefore, evaluating antimicrobial properties especially from natural and plant-based sources is essential to combat infectious address antibiotic resistance and support the global need for safe and effective therapeutic agents.

Many herbs and spices are known for their antimicrobial properties, with some showing strong activity against various bacteria.

Examples include thyme, oregano, rosemary, sage, basil, cinnamon, clove, and allspice.

Their antimicrobial effects are often attributed to the presence of specific bioactive compounds. Garlic (Allium sativum), Green tea, Pomegranate (Punica granatum), Yarrow (Achillea millifolium), Clove (Caryophyllus aromaticus), Mangifera indica (Mango), Ricinus communis (Castor oil plant), Indian gooseberry (Amla).[1] These culinary herbs and spices have long been valued for their flavor and preservation qualities, but their antimicrobial effects are now well-documented. Such effects are primarily attributed to specific bioactive compounds—particularly essential oils, phenolic acids, flavonoids, and terpenoids—which can inhibit bacterial, fungal, and sometimes even viral growth.

Other notable antimicrobial plants include garlic (Allium sativum), known for its sulfur-containing compound allicin; green tea (Camellia sinensis), rich in catechins like epigallocatechin gallate (EGCG); pomegranate (Punica granatum), containing ellagitannins and punicalagins; yarrow (Achillea millefolium), with sesquiterpene lactones; mango (Mangifera indica), possessing mangiferin and phenolic acids; castor oil plant (Ricinus communis), which contains ricin and ricinoleic acid; and Indian gooseberry or amla (Phyllanthus emblica), a potent source of vitamin C and polyphenols. Together, these botanicals demonstrate a broad spectrum of antimicrobial action, making them useful in food preservation, herbal medicine, and natural health products.

The coconut palm (Cocos nucifera) belongs to Arecaceae family, is a highly nutritious plant, offering a range of essential nutrients. Coconut water is a natural source of electrolytes such as potassium, magnesium, and chlorides, while the flesh provides dietary fiber, manganese, calcium, riboflavin, and vitamin C. It is also rich in lauric acid, a saturated fatty acid known for its potential antibacterial effects. The coconut embryo contains an abundance of phytochemicals, including phenolic compounds, flavonoids, amino acids, and essential fatty acids, which are responsible for its notable antioxidant, antimicrobial, anti-inflammatory, and cytoprotective activities. These components aid in shielding cells from oxidative stress, combating microbial threats, and supporting tissue repair and overall cellular health. In addition to its nutritional benefits, traditional medicinal practices have long utilized various parts of the coconut, particularly the embryo, for treating infections, aiding wound healing, and boosting immunity. Furthermore, the presence of secondary metabolites such as flavonoids, alkaloids, and saponins enhances its value, making Cocos nucifera a significant resource for the food, cosmetic, and pharmaceutical industries.

However, no reports are published till today regarding embryo of *cocous nucifera* for In-vitro antimicrobial activity. Hence presence study is an attempt to explore its antimicrobial potency and to find phytochemical constituents.

PLANT PROFILE
Botanical name: Cocos nucifera
Synonyms: Cocos palm or coconut tree
Family: Arecaceae
Domain: Eukarya
Kingdom: Plantae
Phylum: Magnoliphy
Class: liliopsidia
Order: Arecales
Family: Arecaceae
Genus: Cocos
Species: Cocos nucifera[15]

Vernacular names
English: coconut
Hindi: Nariyal
Telugu: Kobbari
Kannada: Tenginakaayi
Tamil: Thengai

Morphology description

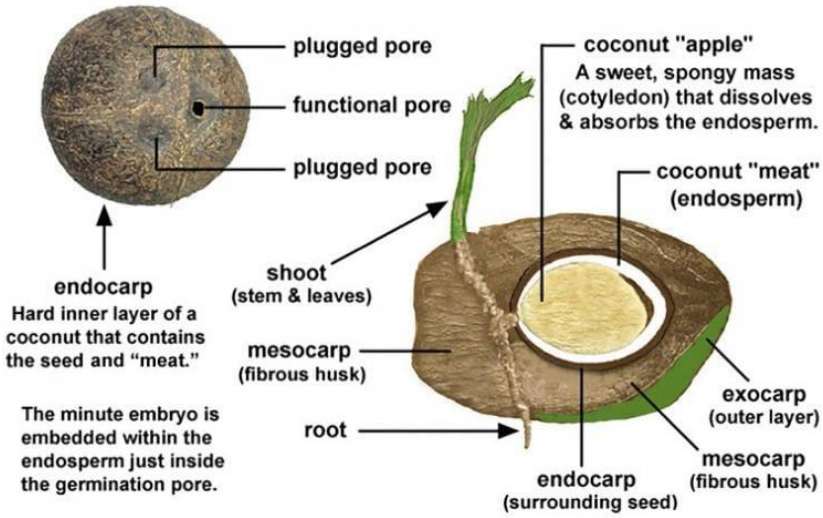

Fig. 3: Morphology description of Germinated coconut.

Fruit structure

Exocarp: The outermost layer, typically thin and smooth, often greenish-brown.

Mesocarp: The thick, fibrous layer surrounding the endocarp, commonly known as the husk.

Endocarp: The hard, stony shell that encloses the seed.

Seed Structure

Testa: A thin, brown coat that adheres to the endocarp.

Endosperm: The white, fleshy part of the coconut (coconut meat) and the liquid endosperm (coconut water).

Odor: Fresh coconut has a mild, sweet, and nutty aroma due to volatile fatty acids and aromatic compounds present in the kernel.

Taste: The kernel is mildly sweet, nutty, and creamy.

Size of coconut

Height: typically, 20–30 m tall.

Colour: Fruit (Coconut):

Exocarp (outer skin): Green, yellow, orange.

Mesocarp (husk): Fibrous, light brown to coir-colored when dry.

Endocarp (hard shell): Dark brown.

Endosperm (kernel): White.

MATERIALS AND METHODS

Collection of plant material Collected a fresh samples of *Cocos nucifera* from a local market and authenticated the plant material.

Preparation of plant extract

Cotyledons were separated from the shell, sliced into pieces (0.5 cm3) and then subjected to extraction. Solvent extraction of cotyledons was performed by the Soxhlet extraction method, using the solvent ethanol. Soxhlet apparatus was used for hot percolation method, with the cotyledons solvent ratio being 1:10 w/v. The temperature was set at the 70 ℃ and the apparatus was operated for 5-6 cycles. The extraction obtained through hot percolation method was concentrated to obtain the crude extract. The crude extract was diluted with respective solvent for further analysis.[16]

Preliminary phytochemical screening

Standard screening test of the Ethanolic extract of *Cocos nucifera* embryo was carried out for various phytoconstituents. The crude extract was screened for the presence or absence of secondary metabolites using standard procedures.

In vitro methods

The crude extracts obtained was subjected to in vitro antimicrobial activity by following method.

The minimum inhibitory concentration (MIC) of the test samples was determined using the microbroth dilution method in 96-well microtiter plates. The bacterial strains were cultured overnight on Mueller–Hinton Agar (MHA) at 37 °C, and well-isolated colonies were suspended in sterile normal saline. The turbidity of the suspension was adjusted to a 0.5 McFarland standard (≈ 1.2×10^8 CFU/mL).

The test samples were prepared at 100% concentration, and 100 µL was added to the first well of each row. Mueller–Hinton Broth (MHB, pH 5.9) was dispensed (50 µL) into the remaining wells. Two-fold serial dilutions were performed across the plate by transferring 50 µL sequentially to obtain decreasing concentrations. Subsequently, 50 µL of the bacterial inoculum was added to each well, except the negative control, maintaining a final volume of 100 µL per well. Wells containing only inoculated broth served as the positive control, while wells containing broth alone served as the negative control. The plates were sealed with perforated seals and incubated at 37 °C for 24 h. After incubation, the wells were visually inspected for turbidity. The lowest

concentration of the test sample showing no visible bacterial growth was recorded as the MIC.

Bacterial viability in the MIC assay was confirmed using the MTT reduction assay. After incubation, 40 µL of MTT solution (0.2 mg/mL) was added to each well of the 96-well microtiter plate. The plate was then incubated at room temperature for 30 minutes in the dark.

Following incubation, the wells were observed for colour development. The absence of colour change, indicating no reduction of MTT to formazan, was considered as evidence of bacterial growth inhibition. The lowest concentration of the test sample that showed no colour change was recorded as the confirmed MIC value.

RESULTS

PRELIMINARY PHYTOCHEMICAL SCREENING

The ethanolic extract gave positive results for alkaloids, carbohydrates, flavonoids, glycosides, saponins, proteins and tannins.

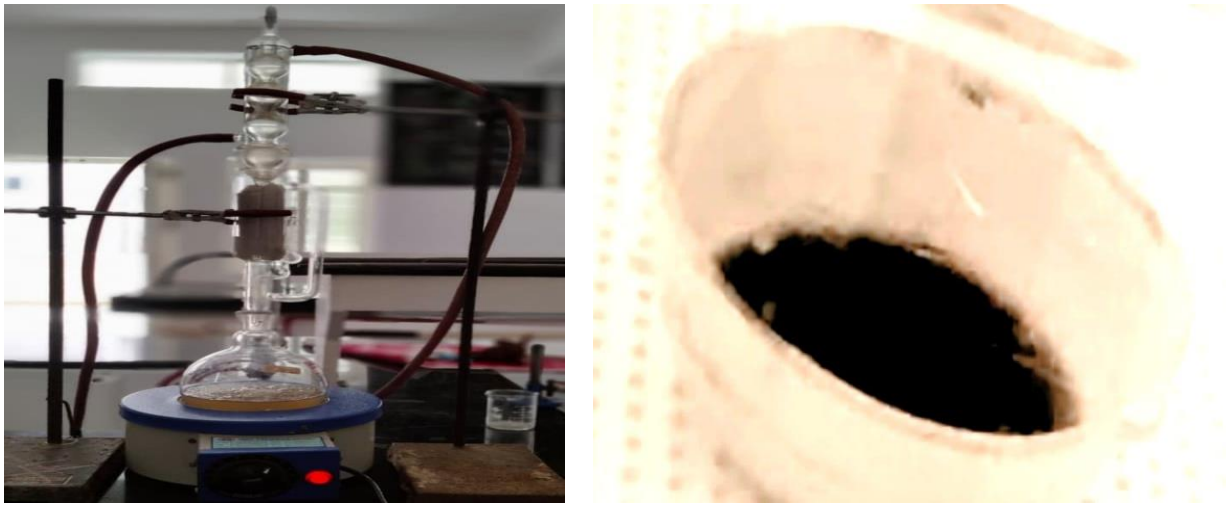

Fig. no. 4: Soxhlet Extraction Ethanolic extract obtained after extraction.

Table no. 1: Antimicrobial activity - Minimum inhibition concentration of *C. nucifera* Embryo Ethanolic extract.

Bacterial type	MIC-*C. nucifera* Embryo Ethanolic (µl/mL)	MIC- Ampicillin (µl/mL)
Gram-positive	15	0.19
Gram-negative	40	25

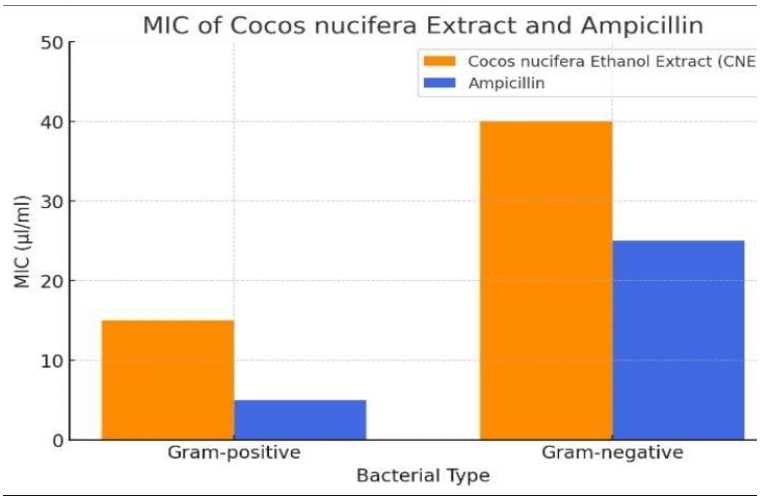

Fig. no. 5: Antimicrobial activity – Graphical data of Minimum inhibition concentration of *C. nucifera* Embryo Ethanolic extract.

The antimicrobial assay results revealed that the standard drug Ampicillin exhibited strong activity against both Gram-positive and Gram-negative bacteria, with a minimum inhibitory concentration (MIC) of 0.19 mg/ml against Staphylococcus aureus and 25 mg/ml against Escherichia coli. In comparison, the Cocos nucifera ethanol extract showed relatively moderate antimicrobial activity, with an MIC of 15 µl/ml against Staphylococcus aureus and 40 µl/ml against Escherichia coli. These findings indicate that Ampicillin is more potent,

especially against Gram-positive bacteria, while the Cocos nucifera extract demonstrated noticeable but less pronounced antimicrobial potential, suggesting its possible role as a natural antimicrobial agent with broader but weaker activity compared to the standard antibiotic.

The antimicrobial evaluation of the tested samples, namely Ampicillin (standard antibiotic) and Cocos nucifera ethanol extract, provides important insights into their relative effectiveness against Gram-positive and Gram-negative bacterial strains. Ampicillin demonstrated a very strong inhibitory effect on Staphylococcus aureus (Gram-positive), with a minimum inhibitory concentration (MIC) as low as 0.19 mg/ml, indicating its high potency at very minimal concentrations. Against Escherichia coli (Gram-negative), the MIC value was 25 mg/ml, which, although higher than that for Gram-positive bacteria, still reflects significant antimicrobial activity.

In contrast, the Cocos nucifera ethanol extract exhibited moderate antimicrobial activity. The MIC against Staphylococcus aureus was found to be 15 µl/ml, which is considerably higher compared to Ampicillin, suggesting that larger amounts of the extract are required to inhibit bacterial growth effectively. Similarly, the extract showed activity against Escherichia coli with an MIC value of 40 µl/ml, which again highlights a lower potency compared to the standard antibiotic. However, despite its comparatively weaker action, the results confirm that *Cocos nucifera* embryo does possess measurable antibacterial properties against both Gram-positive and Gram-negative organisms.

Overall, while Ampicillin remains superior in terms of potency and effectiveness, the antimicrobial activity observed in Cocos nucifera extract suggests its potential as a natural antimicrobial agent. Such plant-based extracts may serve as complementary or alternative therapeutic options, particularly in the search for new antimicrobial compounds, given the growing concern of antibiotic resistance. Further purification, characterization, and dose standardization of the extract could enhance its efficacy and open pathways for its possible application in pharmaceutical or nutraceutical formulations.

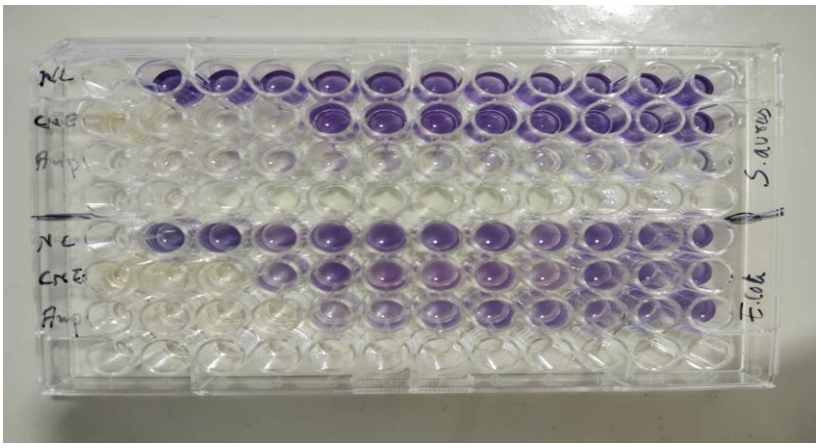

Fig. 6: Antimicrobial activity - Minimum inhibition concentration of *C. nucifera* Embryo Ethanolic extract.

DISCUSSION

Antimicrobials are substances used to kill or inhibit the growth of bacteria, fungi, viruses, and protozoa. This activity plays a crucial role in preventing and controlling infections, ensuring public health, and preserving the quality and safety of pharmaceutical and food product. Despite centuries of searching for antimicrobial substances efficient drugs did not appear until the 19th century, when from extensive research, the domain of antimicrobials was achieved in the form of antibiotic, antifungal, and antiviral drugs.[1] The common side effects of antimicrobial agents are Nausea, Diarrhea, Anaphylaxis, Anemia, Bone marrow suppression, Liver strain, renal obstruction etc.

The need for this study is justified by the growing crisis of antimicrobial resistance, the slow pace of new antibiotic development, and the vast untapped potential of natural products as sources of novel antimicrobial agents. Scientific exploration of natural remedies, supported by modern research tools and traditional knowledge, offers a promising and sustainable strategy to combat drug-resistant infections.

Numerous traditional medicinal plants have been evaluated for their potential application in the prevention or treatment of diseases particularly those of microbial origin. Therefore, evaluating antimicrobial properties especially from natural and plant-based sources is essential to combat infectious address antibiotic resistance and support the global need for safe and effective therapeutic agents. Many herbs and spices are known for their antimicrobial properties, with some showing strong activity against various bacteria. Examples include thyme, oregano, rosemary, sage, basil, cinnamon, clove, and allspice.[1,17]

The coconut embryo contains an abundance of phytochemicals, including phenolic compounds, flavonoids, amino acids, essential fatty acids, carbohydrates, proteins, saponins, alkaloids, glycosides, tannins, steroids, terpenoids etc.

The antimicrobial evaluation of the tested samples, namely Ampicillin (standard antibiotic) and Cocos nucifera ethanol extract, provides important insights into their relative effectiveness against Gram-positive and Gram-negative bacterial strains. Ampicillin demonstrated a very strong inhibitory effect on Staphylococcus aureus (Gram-positive), with a minimum inhibitory concentration (MIC) as low as 0.19 mg/ml, indicating its high potency at very minimal concentrations. Against Escherichia coli (Gram-negative), the MIC value was 25 mg/ml, which, although higher than that for Gram-positive bacteria, still reflects significant antimicrobial activity. In contrast, the Cocos nucifera ethanol extract exhibited moderate antimicrobial activity. The MIC against Staphylococcus aureus was found to be 15 µl/ml, which is considerably higher compared to Ampicillin, suggesting that larger amounts of the extract are required to inhibit bacterial growth effectively. Similarly, the extract showed activity against Escherichia coli with an MIC value of 40 µl/ml, which again highlights a lower potency compared to the standard antibiotic. However, despite its comparatively weaker action, the results confirm that *Cocos nucifera* embryo does possess measurable antibacterial properties against both Gram-positive and Gram-negative organisms. Overall, the antimicrobial activity observed in *Cocos nucifera* embryo extract suggests its potential as a natural antimicrobial agent.

CONCLUSION

In conclusion, the Invitro antimicrobial study of the ethanolic extract of *cocos nucifera* embryo demonstrated significant activity, attributed to the presence Flavonoids, saponins, Alkaloids, Glycosides etc. The ethanolic extract exhibited notable antimicrobial activity Invitro showed effective against both Gram-positive [S. aureus] and Gram-negative [E. coli] bacteria. The extract demonstrated stronger inhibition towards Gram positive stains as reflected by the lower MIC value of around 15mg/ml were as higher concentration [approximately 40 mg/ml] were required to suppress gram positive bacteria likely due to the structural complexity of their outer membrane. Although its efficacy was comparatively lower than standard antibiotic Ampicillin. These findings suggest that the bioactive compounds in the plant could be developed for therapeutics application targeting antimicrobial condition. Further in-depth studies including Invivo models are recommended to confirm its efficacy and elucidate the underlying mechanisms.

REFERENCE

1. Cowan MM. Plant products as antimicrobial agents. Clin Microbiol Rev., Oct. 1999; 12(4): 564–82.
2. Tripathi KD. Essentials of Medical Pharmacology. 8th ed. New Delhi: Jaypee Brothers Medical Publishers, 2018.
3. Kohanski MA, Dwyer DJ, Collins JJ. How antibiotics kill bacteria: from targets to networks. Nat Rev Microbiol, 2010; 8(6): 423-35.
4. De Clercq E, Li G. Approved antiviral drugs over the past 50 years. Clin Microbiol Rev., 2016; 29(3): 695-747.
5. Gupta AK, Ryder JE, Nicol K, Cooper EA. Superficial fungal infections: an update on pityriasis versicolor, seborrheic dermatitis, tinea capitis, and onychomycosis. Clin Dermatol, 2003; 21(5): 417-25.
6. Bonifaz A, Vázquez-González D, Perusquía-Ortiz AM. Subcutaneous mycoses: chromoblastomycosis, sporotrichosis and mycetoma. J Dtsch Dermatol Ges., 2010; 8(8): 619-28.
7. Campbell-Falck D, Thomas T, Falck TM, Tutuo N, Clem K. The intravenous use of coconut water. Am J Emerg Med., 2000; 18(1): 108–11.
8. Sanglard D, Coste AT. Activity of isavuconazole and other azoles against Candida clinical isolates and yeast model systems with known azole resistance mechanisms. Antimicrob Agents Chemother, 2016; 60(1): 229-38.
9. Shapiro RS, Robbins N, Cowen LE. Regulatory circuitry governing fungal development, drug resistance, and disease. Microbiol Mol Biol Rev., 2011; 75(2): 213-67.
10. Ghannoum MA, Rice LB. Antifungal agents: mode of action, mechanisms of resistance, and correlation of these mechanisms with bacterial resistance. Clin Microbiol Rev., 1999; 12(4): 501-17.
11. Lemke A, Kiderlen AF, Kayser O. Amphotericin B. Appl Microbiol Biotechnol, 2005; 68(2): 151-62.
12. Katzung BG, Trevor AJ. Basic & Clinical Pharmacology. 15th ed. New York: McGraw-Hill Education, 2021; 865-870.
13. Darby EM, Trampari E, Siasat P, Gaya MS, Alav I, Webber MA, Blair JMA. Molecular mechanisms of antibiotic resistance revisited. Nat Rev Microbiol, 2023; 21(5): 280-95.
14. Jenkinson HF, Lamont RJ.microbial communities in sickness and in health. Trends Microbiol, 2005; 13: 589–95.
15. Lima EBG, Sousa CNS, Meneses LN, Ximenes NC, Santos Júnior MA, Vasconcelos GS, et al. Cocos nucifera (L.) (Arecaceae): A phytochemical and pharmacological review. Braz J Med Biol Res., 2015; 48(11): 953–64.
16. De Clercq E, Li G. Approved antiviral drugs over the past 50 years. Clin Microbiol Rev., 2016; 29(3): 695-747.
17. Daniele C, et al. Antimicrobial and antiviral activities of polyphenolic fractions from Cocos nucifera husk fiber. J Ethnopharmacol, 2002; 79(1): 1-4.