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BIOLOGICAL CHARACTERISTICS OF MEDICINAL PLANT: A REVIEW ON ITS ANTIBACTERIAL ACTIVITIES

[1]Rehman M, [2]Ibrahim A., [3]Prakash S.

[1]Department of zoology, Aligarh Muslim University

[2]Interdisciplinary Biotechnology Unit, Aligarh Muslim University

[3]Department of Biotechnology, Integral University.

***Corresponding Author: Mohd Fazal Ur Rehman**

Email ID: mf.rehman5681@gmail.com

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ABSTRACT

For millions of years, plants were utilized to store food, to treat health conditions, and to cure infection like epidemics. Over the ages the awareness of their medicinal benefits has been conveyed within and amongst human cultures. Actually, data on various plants' antimicrobial activity, so far assumed empirical, have been clinically verified, along with the growing amount of studies on antimicrobial-resistant pathogenic microorganisms. Materials obtained from natural can potentially suppress bacterial growth in various circumstances and in the particular associated with disease treatment, numerous researches have been done to identify the chemical structure of these plant antimicrobial agents and the mechanisms engaged in bacterial inhibitory effect, whether separately or in conjunction with conventional antimicrobials. Thus, herbal medicines with focus on their antibacterial properties will be investigated in the present study.

Key words: Antimicrobial, growth, bacteria, herbal.

INTRODUCTION

The application of plants to prevent illness is as ancient as the human race. Famous findings on the usage and effectiveness of therapeutic plants contribute significantly to the revelation of their medical characteristic, so that they're being recommended if their chemical components are often not fully known. I the usage of therapeutic plants has strongly aided primary care throughout the globe, particularly in South American countries **[1].** It is projected that 250 - 500 thousand species of plants arise on the biosphere, and that humans and animals utilize just 1 - 10 per cent as food **[2, 3].** Brazilian people (80 percent) uses up just 37 percent of the available commercially drugs and rely nearly solely on medicines of biological source **[4].** Thus, phytotherapics reached the retail sector pledging a narrower and affordable manufacturing, since prerequisites to utilize therapeutic plants may not require standard quality concerning efficacy and safety comparison to the other kinds of medications **[5].** Communicable diseases, mainly in developing nations, represent a key reason of mortality and morbidity among the normal community. Hence, in recent times, drug makers have been focused on developing antibacterial drugs, particularly due to continuous introduction of conventional antimicrobial-resistant microorganisms. Evidently, species of bacteria display the biological ability to obtain and distribute tolerance to antimicrobials available today as there are regular reports of bacterial isolation that are known to be sensitive to routinely used drugs and have become multi-resistant to other medicines on the market **[6 , 7].** Subsequently, popular approaches applied by drug industry to provide the product with different antibacterial agents include modifying the chemical composition of the current drugs in way to produce them more effective or regain the activity reduced due to antibiotic resistance mechanism of bacteria **[8].**

From the other hand, given the looking for better antibiotics, that of medicinal plants must be highlighted since Brazil acquire such wonderful biodiversity among which a variety of plants were used for numerous applications and evaluated across the globe for centuries by various individuals.

Antimicrobial properties of medicinal plants

The antibacterial activities of Baccharis trimera Less. (carqueja) decoction on bacterial strains gram-positive (Streptococcus uberis and Staphylococcus aureus) and gram-negative (Escherichia coli and Salmonella gallinarum) have been tested and it has been noticed that the previous microbes are much more responsive to this herb than the latter, which supports previous research **[9].** Likewise, natural compounds utilised in Asia (Ruta graveolens) antibacterial assays demonstrated an inhibition ability toward B. cereus strains **[10].** A further article examines the inhibition effect of focus from 14 plant species in Brazil toward MRSA (methicillin-resistant Staphylococcus aureus) strains **[11].** The compounds that exhibited inhibition effect were the extract of ethanol from Punica granatum fruit (pomegranate). As for the prevalent yarrow (Achillea millefolium), its oil (obtained from leaves and stems) exhibits greater antibacterial activity than in its corresponding extracts (the chloroform-separated extract of methanol into not all dissolved parts). The oils inhibited Clostridium perfringes Streptococcus pneumoniae,and Candida albicans from developing and prevented slightly Mycobacterium smegmatis, Acinetobacter lwoffii and Candida krussei **[12].** A research assessed the impacts on bacteria present in dogs' oral cavity of certain extract solution of plant (aqueous and 40 per cent hydroalcoholic) (13). It considered the norm S. Aureus strain and isolated Streptococcus oralis and Streptococcus mitis strains were susceptible to garlic extracts (Allium sativum), 'espinheira santa' (Maytenus ilicifolia) and leaves of the guava tree (Psidium guajava).

Likewise, the chamomile had antibacterial properties toward Staphylococcus aureus. Responsible for the investigation are the natural antioxidants current in its methanolic extracts (14). It also was noted that the leaf extracts from the artichoke (Cynara scolymus) and the ethanolIC extracts (80 percent) from both artichoke and "macela" (Achyrocline satureioides) reduced the development of Bacillus cereus, B. Pseudomonas aeruginosa subtilis and S. Aurores **[14].**

Terpene compounds (eugenol, geraniol, thymol, and carvacrol) extracted from essential oils from native plants in Argentina showed inhibitory effects on MRSA **[15].**

In another research, essential oils from 28 plants were evaluated toward ETEC (enterotoxigenic *E. coli*) and EPEC (enteropathogenic *E. coli*) serotypes, and the findings show that palmarosa (Cymbopogon martinii), a very common plant in Brazil, has a broad range of action toward 3 ETEC and EPEC serotypes, whereas Java citronella grass (Cymbopogon winterianus) hindered 1 EPEC . The composition accountable for the biological monitoring differed among 100 and 500 µg / mL, while still at greater quantities other plants triggered suppression only. Researches of 70 percent antibacterial activities of methanolic extracts from *Mikania glomerata* ("guaco"), P. guajava (guava), *Baccharis trimera* ("carqueja"), *Mentha piperita* (peppermint) and Cymbopogon citratus (lemongrass). The plants of sativum (garlic), *Syzygium aromaticum* (clove) and Zingiber officinale (ginger) in natura all demonstrates a few action toward S. aureus, but the most active compounds were those from clove at the intensity of 0.36 mg / mL and guava at 0.56 mg / mL **[16,17].**

In a survey performed in a native people, it was confirmed that the companies attempt leaf extract from *Vernonia polyanthes* ("assa-peixe"), *Aristolochia triangularis* ("cipó mil-homens"), *Tabebuia avellanedae* (purple trumpet tree) and Stryphnodendron adstringens ("barbatimão") had a significant antibacterial impact so a local rum-like beverage (with an ethanol content of 30) had a significant antimycobacterial impact **[18].**

In addition, the outcomes of a latest research defined Vernonia polyanthes extract have potent inhibitory activity against Leishmania strains **[19].** Under same circumstances, even so, its concentrates had no antifungal action. Likewise, a 10-µL dosage of Baccharis dracunculifolia oil ("alecrim-do-campo") inhibited the development of P. aeruginosa , *S.aureus ,E.Coli* in antibacterial tests, **[20].**

The oils from Pelargonium graveolens (geranium) show low MIC value (minimum inhibitory concentration) against B. Cereus (0.36 mg / mL), *B. subitilis* (0.72 mg / mL) and *S. aureus* (0.72 mg / mL), so although *Origanum vulgare* (oregano) oils as well demonstrate MIC (antimicrobial activity) against the same microbes, in relation to E. Coli; furthermore, a dosage of 0.35 mg / mL for inhibiting *B . Subitilis* is needed in the latter while the other bacteria require 0.70 mg / mL to be inhibited **[21].**

In a further research, oils from rosemary (R. officinalis), clove (*Caryophyllus aromaticus L.*), ginger (*Z. officinalis*), lemongrass (*C. citratus*), peppermint (*M. piperita*) and cinnamon (*Cinnamomum zeilanicum Blume*) were evaluated toward and ***E.coli*** and S. aureus *strains.* The oils exhibited a few antibacterial properties; essential ginger oil was perhaps the most effective toward S. The aureus were the most efficient toward *E. Coli* while cinnamon and clove did at 0.09% v / v **[22].** *C. Candida krusei* and the *albicans* **[36].**

Depending on the above data, it can be concluded that the publication on publication on measuring antibacterial activities of plant materials is wide, such as an growing number of papers per annum. Consequently, integrating so many lots of studies on the antimicrobial action of plant products into the present review is difficult; a multidisciplinary approach to this theme is increasingly needed.

MECHANISMS OF NATURAL PRODUCTS ANTIMICROBIAL ACTIVITY

For safety toward aggressor entities, many other plants comprise so many substances with antibacterial properties, especially microbes. There is antiseptic activity of active ingredients present in certain plant species; for eg,clove has isoeugenol and eugenol, thyme has carvacrol and thymol, and oregano has carvacrol and terpinenol-4. In certain instances, water soluble terpenes from essences have greater antimicrobial potency than the others **[23].** Key properties essential for essential oils' antibacterial activities involve hydrophobic compounds that enable the involvement of lipids from the bacterial cell membrane, disrupting cell structures and making them more permeable **[24].**

Chemical substances from plant oils also function on proteins from cytoplasmic membranes **[24].** Cyclic hydrocarbons work on the enzyme believed to be in the plasma membranes and enclosed by lipid molecules, ATPases. Furthermore, lipid hydrocarbons can distort the connection between protein and lipid, and the direct interaction of lipophilic compounds with hydrophobic protein parts is also possible **[25]**. Some essential oils increase the development of pseudo-mycelia, proving they can respond on enzymes responsible for the synthesis of bacterial structural components **[25].**

A few substances are described below with their modes of action on microorganisms.

Thymol and Carvacrol

The thymol structure is close to those of carvacrol; nevertheless, the position of the -OH group in the phenolic ring is differing. Both compounds tend to create the permeable membrane **[26].** Their structure breaks down gram –ve bacteria's external membrane, releasing lipopolysaccharides (LPS), and boosting the permeation of the plasma membranes to ATP. This activity does not impact the existence of Mgcl2, proposing a chelating process of different cations on the outer membrane **[26].**

Allyl chain-substituted guaiacol (Eugenol):

Various amounts of eugenol may impede protease and amylase development by B. cereus. Besides that, cell wall deterioration and cell lysis also were noted **[27].**

p-Cymene

This hydrophobic compound is a precursor of carvacrol and induces stronger swelling of the plasma membranes relative to carvacrol **[27].**

Carvone

Carvone disappears pH gradient and cellular membranes ability if evaluated at greater concentrations than its mic (minimal inhibitory concentration) . The development of E. Coli, Streptococcus thermophilus and Lactococcus lactis can reduce by carvone intensity, indicating that they act by disrupting the cell's general metabolic status **[26].**

Cinnamaldehyde

Cinnamaldehyde inhibits *E. Coli* and salmonella Typhimurium development at comparable amounts to thymol and carvacrol. It does not, nevertheless, deteriorate the cellular membranes, nor degrade the intracellular ATP **[27].** The group carbonyl has affinity with protein , avoiding the operation of amino acid decarboxylase on *E. aerogenes* **[27].**

Finally, Table 1 covers the key mechanisms of action of plant antimicrobials according to the groups already described.

Table 1: key mechanisms of action of plant antimicrobials according to the groups already described.

	Compound	Action of mechanisms
1	Falxatin	Disulfide bridge formation
2	Mannose specific agglutinin	Block of viral fusion
3	Piperine	Intercalation into cell-wall or DNA
4	Berberine	Intercalation into cell-wall or DNA
5	Capsaicin	Membrane disruption
6	Warfarin	Interaction with eukaryotic dna
7	Ellagitannin	Protein Binding ,Adhesion binding Enzyme inhibition ,Complex with cell wall
8	Abyssinone	HIV reverse transcription inhibition
9	crysin	Adhesion Binding
10	Epicatechine	Membrane disruption
11	Catechol	Substrate Deprivation

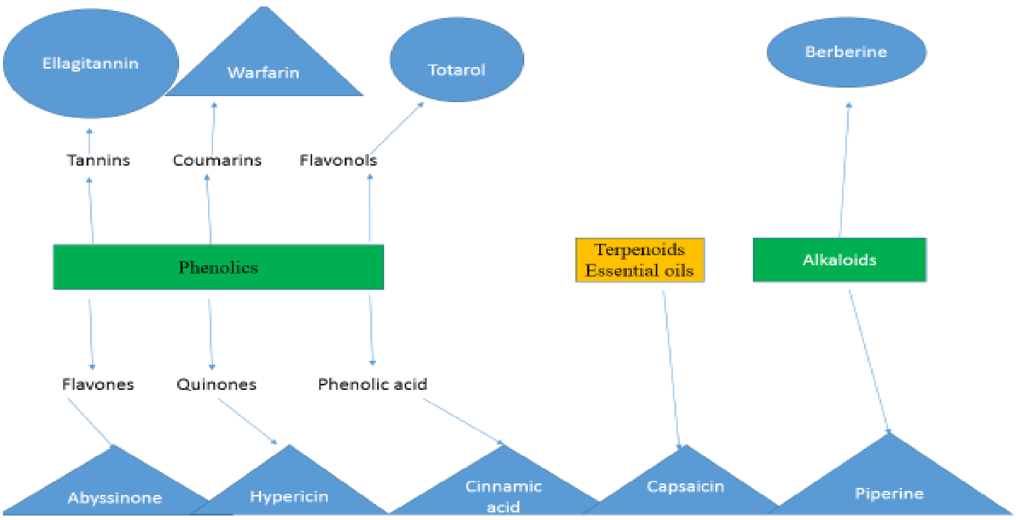

Figure 1: chemical compound and their examples that show antimicrobial activity.

Interaction between antimicrobial drugs and natural products

A synergy between traditional antibiotics and product made from plant extracts has been confirmed in relation to the antibacterial activity of essential oils and plant extracts. Possible associations are commonly found between drugs, which has inspired researchers to examine these scenarios. It must be stressed, nevertheless, that associations between synthetic and biological drugs rely on many factors, namely pharmacokinetics and the doses used, because in vitro established formulations do not have the same impact on behavior **[28].** However, the literature includes multiple research on this specific topic. Synergism tests toward MRSA and E. Coli between penicillin and terpenes showed a synergic activity resulting from the mixture of penicillin and carvone while an antagonistic impact between penicillin and thymol was observed against MRSA stresses. Relating to E. Coli, synergy between penicillin, eugenol, and thymol was present; nevertheless, myrcene and terpene revealed only an inhibitory action **[29].** Also tested was the synergic activity between plant extracts-clove, jambul (Syzygium cumini), pomegranate and thyme- and other antibacterial drugs. Extract of Garlic disclosed a few impacts on Klebsiella pneumoniae if coupled with ampicillin while extract of Clove and tetracycline combined to inhibit growth of Proteus sp. These leaf extract had antibacterial effect, even toward antibiotic-resistant microbes, thus going to act either individually or in combination with antibiotics used in standard treatments **[30].** Probst **[31]** documented the antibacterial activity of essential oils toward S: clove (C. aromaticus), ginger (Z. officinale), peppermint (M. piperita) and cinnamon (C. zeylanicum). Aurores and *E. Coli.* Besides that, when evaluated against S. Aurreus, the encounters between these plants and ethanol extracts of propolis, ginger, and mint were synergistic against *E. coli* only showed synergy with cloves **[32].** Synergistic effect between combinations including one of eight natural products and one of 13 antibacterial agents was found in another research on the connections between biological products and medicines.

Synergistic effect between combinations including one of eight natural products and one of 13 antibacterial agents was found in another research on the connections between biological products and medicines. The Kirby and Bauer method tested against strains synergism between the essential oils of cinnamon (*C. zeylanicum*), lemon grass (*C. citratus*), peppermint (*M. piperita*), ginger (Z. officinale), clove (C. aromaticus) and rosemary *(R. officinalis*), and eight antimicrobial drugs (chloramphenicol, gentamicin, cefepime, tetracycline, sulfazotrim, cephalothin, ciprofloxacin, and rifampicin).

S,aurores and E. Coli. among lemon grass and the 8 drugs evaluated accompanied by mint and 7 drugs (except for cefepime against S. aureus) were the highest level of synergism **[33].**

Conclusion:

A few communities have utilized plants since prehistoric times to control a significant lot of illnesses, such as infectious diseases. myriad research have been carried out on the pharmacology of medicinal herbs, even though they involve a possible source for the development of new medications and may enhance the efficacy of conventional antimicrobials, which will likely reduce quality and efficiency of treatment. Nevertheless, during antibiotic therapy, some plants can have antagonistic effects. A significant factor is the quest for new substances with antimicrobial activity and synergism with antimicrobial medicines presently available, as bacteria that are immune to traditional antibiotics are progressively frequent; thus, medicinal plants are an option for the treatment of infections.

Different studies have shown the antibacterial function of plants in the form of both essential oils and extracts. This property can thus be a successful alliance in the development of new drugs designed to fight the growing amount of bacteria strains which become insensitive to standard antibiotics. Therefore, considering that the research on antibacterial action testing of plant foods is wide-ranging, such as a growing amount of reports each year, it is very difficult to relate the numerous articles on the antibacterial activity of such materials in this review article on such a highly complex topic that needs a comprehensive approach.

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