

Plant Derived Antimicrobial Agent Alternative To Antibiotics

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Abstract

Studies on the possible antimicrobial activity of plant-derived compounds, an unexplored source of antimicrobial chemotypes used in traditional medicine across various nations, have come to the attention of the pharmaceutical and scientific communities due to the rising prevalence of drug-resistant pathogens. This review's objective is to give current information about the potential of the most significant natural antibacterial substances produced from plant sources with a large range of secondary metabolites that can be used as substitute methods to regulate contagious illnesses. Natural plant products will be the main topic of this review since they are a good source of antibacterial compounds. especially effective against fungus and bacteria. Given that a large number of these substances, which have been utilized for are a source of novel medications and that.

Keywords: medicinal plant , plant derived antimicrobials, antimicrobial activity, traditional medicines

Introduction: Around the world, medicinal plants are used to make potent and effective medications. Due to the misuse of prescription medicines, antibiotic-resistant bacterial strains are created, rendering them ineffective the next time. As a result, specialists are looking for natural solutions safe antibiotic substitute. Medications made from natural plants are reasonably priced and kept at room temperature for an extended period of time. Complex herbal antibiotics that are utilized to eliminate bacteria, purify blood, strengthen the immune system, and improve the way certain organ systems work. They just eliminate microorganisms to correct the body's imbalances[1]. plant-derived antimicrobials are employed as an alternative to antibiotics Because they kill germs in a variety of ways[2]. Traditional medical systems make extensive use of plant materials, which are also the only resources available for treating many illnesses in many developing-nation communities. Eighty percent of people in several Asian and African nations depend on traditional medicine for their primary medical care, and over 100 nations have laws governing herbal remedies[3]. Throughout history, people have used plants as medicine all around the world. Herbs, herbal components, and products containing many plant parts or other plant parts are examples of medicinal plants. plant-based substances that have long been utilized to treat a variety of Numerous medical conditions[4].

Table 1

Some important plant products with numerous antimicrobial properties[6].

Sr. no.	Plant product	Scientific name	Antimicrobial compound	Potency against
1	Black pepper	<i>Piper nigrum</i>	Piperine	<i>Lactobacillus</i> , <i>Micrococcus</i> , different types of fungal species, etc
2	Cascara sagrada	<i>Rhamnus purshiana</i>	Tannins	Different types of fungal, Bacterial, and viral species
3	onion	<i>Allium cepa</i>	allicin	Different types of fungal and bacterial species
4	Thymus	<i>Thymus vulgaris</i>	Caffeic acid thymol etc.	Different types of fungal, Bacterial, and viral species.
5	Chamomile	<i>Matricaria chamomilla</i>	Anthemic acid	<i>M. tuberculosis</i> , <i>Staphylococcus. Aureus</i> etc
6	Eucalyptus	<i>Eucalyptus globulus</i>	Tannin	Different types of Bacterial, and Viral species.
7	Clove	<i>Syzygium aromaticum</i>	Eugenol	General
8	Oregon grape	<i>Mahonia aquifolias</i>	Berberine	Plasmodium Trypanosomes etc

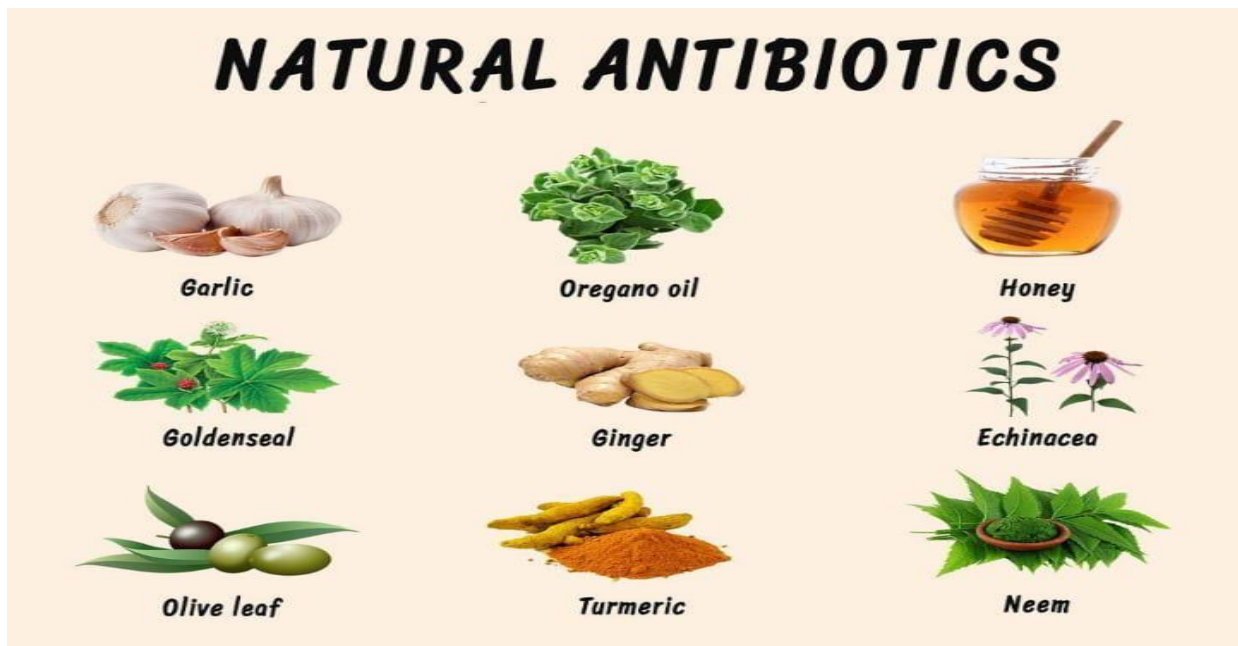


fig . 1

Garlic - Since Pasteur initially reported garlic's antibacterial property in 1958, other studies have shown how efficient and broad-spectrum its antimicrobial activity is against a variety of bacteria, viruses, parasites, protozoa, and fungus[7]. Commercial antibiotics are used as an alternate treatment for a variety of diseases because garlic is more effective and has less adverse reactions[8]. With good reason, garlic is regarded as one of nature's amazing medicinal plants. It can stop and eliminate fungus, bacteria[9].

At least 33 sulfur compounds, a number of enzymes, the minerals germanium, calcium, copper, iron, potassium, magnesium, selenium, and zinc, as well as vitamins A, B1, and C, fiber, and water, are all found in garlic. The 17 amino acids that are present in garlic include arginine, histidine, lysine, Aspartic acid, proline, glutamine, threonine, Alanine, cysteine, valine, methionine, isoleucine, glycine, Tryptophan, leucine, and phenylalanine[10].

Advantages -

-Allicin and other chemicals in garlic provide broad-spectrum antimicrobial activity against a variety of bacteria, fungi, and viruses[30].

-Garlic is a natural substance that provides an alternate for synthetic antibacterial agents, which may help lower the risk of antibiotic resistance [31].

Disadvantages –

- Garlic usage may be restricted for certain people due to gastrointestinal problems, allergic responses, or foul breath[34]

Oregano oil - *Origanum vulgare* is the primary representative species of the Lamiaceae family, which includes this herb. The plant's Greek name is the etymological source of the name *Origanum*. The term "origanon" comes from the words (ganos = brightness, beauty) and (oros = mountain), Given that oregano thrives in sunny

climates at elevations between 400 and 1,800 m locations[11]. The presence of their phenolic components, carvacrol and thymol, is linked to the great antibacterial properties of oregano and thyme essential oils[12]. When compared to sage, peppermint, chamomile, and hyssop, oregano oil showed a potent bacteriostatic and bactericidal action. oils, which only provide a bacteriostatic and weaker impact[13].

Advantages of Oregano Oil as an Antimicrobial Agent-

- Studies have demonstrated that oregano oil works well against a variety of bacteria, fungi, and viruses. Microbial cell membranes are disrupted by its active ingredients, which are mostly thymol and carvacrol.
- Oregano oil appeals to people looking for natural substitutes for synthetic antimicrobials because it is a natural substance, which may lower the likelihood of antibiotic resistance.
- By preventing the growth of spoilage organisms, its antimicrobial qualities can be used to increase the shelf life of food items.

Disadvantages of Oregano Oil as an Antimicrobial Agent-

- Although studies have shown antibacterial activity in vitro, additional clinical research must be proven its efficacy in humans.
- When administered topically or in concentrated amounts, oregano oil may irritate some people's skin or trigger allergic reactions.
- Since overuse can have negative effects, working out a safe and appropriate dosage can be difficult[37,38,39].

Honey -It is a traditional medication that has been used to treat TB, eye conditions, throat infections, bronchial asthma, worm infestation, eczema, constipation, sores, and ulcers in addition to its nutritional value[14]. Honey has been used as an antibiotic to treat wounds and prevent infection since ancient times. Today, it is also used to treat burns, ulcers, chronic wounds, and skin sores. Its hydrogen peroxide content is what gives it its antibacterial properties. Infected wounds with resistant to methicillin Honey successfully treats *Staphylococcus aureus* by offering a protective covering. Characteristics of honey include hydrogen peroxide, glucose oxidase, and low water acidity.stop the growth of yeast and bacteria[15].

Advantages of Honey as an Antimicrobial Agent

- Honey is a natural source of antibacterial substances such as hydrogen peroxide, methylglyoxal, and many phenolic acids.
- Honey is useful in clinical settings for treating burns and chronic wounds since it effectively promotes wound healing and lowers infection.
- Honey has the ability to lower inflammation, which promotes healing in general.

Disadvantages of Honey as an Antimicrobial Agent-

- Depending on the floral source, processing method, and storage conditions, honey's antibacterial activity might vary greatly.
- Honey may contain *Clostridium botulinum* spores, which could be harmful, particularly to young children.

- Although honey has its uses, it shouldn't be used in place of traditional antimicrobial treatments for severe diseases.
- Certain ingredients in honey may cause allergic reactions in certain people[40,41,42,43].

Goldenseal - Because of its high antimicrobial properties, goldenseal rhizome extract has long been used to treat a range of skin disease. In multiple studies, the minimum inhibitory concentration (MIC) was used to determine the antibacterial activity. Extract from rhizomes shown antibacterial activity against *Escherichia coli*, *Pseudomonas aeruginosa*, *S. mutans*, *S. pyogenes*, *Streptococcus sanguis*, and *Staphylococcus aureus*. The alkaloids berberine, canadine, and canadoline were responsible for this[17,18].

Advantages –

- Goldenseal's main ingredient, berberine, has shown efficacy against a range of bacteria, fungus, and protozoa (44).
- According to some research, goldenseal may strengthen the immune system, which could help the body fight off illnesses (45).

Disadvantages –

- Although certain lab tests indicate antimicrobial action, there aren't enough reliable clinical trials to verify efficacy in people[46].
- Goldenseal may cause changes in the effectiveness of a number of medications, especially those that are processed by the liver (48).

Ginger - As a natural antibiotic, it is used. Ginger has antibacterial properties, helps reduce blood sugar, and helps with nausea and seasickness. Chemical components that provide superior antibacterial qualities include zingerone, gingerol, terpenoids, zerumbone, gingerdiol, shogaol, and flavonoids. by preventing the development of biofilms. Ginger can help the stomach's acid production return to normal, so the Bacterial activity When stomach acid is present, *H. pylori* bacteria thrive there. This can be prevented by ginger[19].

Advantages –

- : Ginger has antibacterial properties that protect against a range of diseases, such as viruses, fungus, and bacteria. Research has demonstrated its efficacy against common infections such as Salmonella and *E. coli*.
- Ginger is a natural product that is typically regarded as safe to use and consume, which makes it a better option than synthetic antimicrobials.

Disadvantage –

- Although ginger has antibacterial qualities, it might not be as effective as traditional antibiotics, particularly when it comes to germs that are resistant to them.
- Ginger usage may be restricted in some groups due to the possibility of allergies in some people.
- It might be difficult to standardize the antimicrobial usage of ginger because its active ingredients, such gingerol, can differ in concentration depending on how it is grown and processed[49,50].

Echinacea - The permanent medicinal herb *Echinacea purpurea* (Asteraceae) has significant anti- inflammatory and immunostimulatory properties. attributes, particularly the reduction of symptoms of a cold.

The plant's biological functions include antiviral, antibacterial, and antioxidant. There have been reports of antibiotic activity in earlier experimental research. Distinct secondary metabolite groups of the plants like caffeic acid and alkaloids, polysaccharides, derivatives, and glycoproteins. The idea behind glycoproteins is that they both pharmacologically and physiologically active[20].

Advantages –

-Echinacea could improve the body's protection against infections. According to certain research, it may lessen the length and intensity of respiratory infections and colds.

- Antimicrobial Properties: Studies show that some germs and viruses can be inhibited by Echinacea. Alkaloids and echinacoside are two examples of compounds that might contribute to this effect.

-For people seeking natural cures, echinacea provides a plant-based choice that appeals to those searching for substitutes for synthetic drugs.

Disadvantages-

-: People who are allergic to plants in the Asteraceae family are particularly susceptible to allergic reactions.

- Echinacea may only be effective in treating minor infections and cannot be used in place of traditional medicines to treat serious illnesses[51,52,53].

Olive leaf –olive leaf (*Olea europaea*) contains a high concentration of phenolic chemicals, especially oleuropein, its antibacterial qualities have been investigated. Olive leaf extracts have been shown to have antibacterial activity against a variety of diseases, including fungus and bacteria. extracts from olive leaves can stop the growth of a number of bacteria, such as *Escherichia coli* and *Staphylococcus aureus*. Oleuropein is thought to be responsible for the antibacterial actions since it breaks down the membranes of bacteria. Extracts from olive leaves have shown promise in combatting fungus like *Candida albicans*. It is thought that the phenolic chemicals that prevent the production of fungal cell walls are the source of the antifungal effects[21,60,61].

Advantages –

- Bacteria, viruses, and fungus are just a few of the microbes that olive leaf extract has been shown to be effective against. According to studies, it can stop the growth of bacteria that are Gram-positive and Gram-negative, including *Salmonella* species, *Staphylococcus aureus*, and *Escherichia coli*[32].

-The polyphenolic chemicals, particularly oleuropein, interfere with vital enzyme functions and rupture microbial cell membranes to produce strong antibiotic activity. As a result, bacterial growth is inhibited, perhaps preventing illnesses[33].

- With comparatively low toxicity, olive leaf extract is regarded as a natural antimicrobial substance. Because of this, it's a desirable substitute for synthetic antibiotics, particularly given the rise in antibiotic resistance. Utilizing olive leaf extract may lessen the need for traditional antibiotics and lessen the negative effects that come with them[35].

Disadvantages –

-Depending on the extraction technique, concentration, and particular formulation, olive leaf extract's antimicrobial properties can change. Because of this discrepancy, standardizing its application for therapeutic or clinical settings may be challenging.

-Large-scale clinical trials to verify the effectiveness and safety of olive leaf extract in treating infections in humans are still lacking, despite encouraging research on its antimicrobial properties.

- High dosages of olive leaf extract may cause adverse effects like nausea, diarrhea, or liver damage in some people, even though moderate amounts are usually thought to be safe[36, 16, 47].

Turmeric -It has been proved that turmeric has potent anti-inflammatory and antioxidant properties. Still, using dosages of turmeric to produce the same therapeutic effect should be precise every day, and using a large dosage in once. In general, turmeric is a dependable culinary ingredient as long as Healthy persons do not consume a lot, and there have no negative consequences[22]. It is a well-known Indian spice with flavor and antibacterial qualities. Turmeric's key ingredient, curcumin, which is extracted from the rhizome of *C. longa*, plays a crucial part in the treatment of stomach inflammations and urinary tract infections (UTIs). antimicrobial properties[23].

Advantages-

- Turmeric has antibacterial properties that protect against a range of diseases, such as viruses, fungus, and bacteria. Research has shown its efficacy against strains of *Staphylococcus aureus* and *E. coli*.
- Turmeric is a natural product that is generally regarded as safe for the majority of individuals to use in culinary quantities. In contrast, synthetic antimicrobial drugs have the potential to cause adverse consequences.

Disadvantages-

- Curcumin is difficult for the body to absorb due to its limited bioavailability. This restricts its efficacy unless it is combined with additional ingredients that improve absorption.
- When taking significant amounts of turmeric, some people may have gastrointestinal problems or allergic reactions. [54,55,56].

Neem -The purpose of the study was to ascertain the neem leaf extract's antibacterial properties. The neem leaf alcoholic extract that exhibits Antimicrobial properties relative to a the gentamycin standard. The alcoholic extract of Neem exhibits the highest level of bacillus inhibition. *pseudomonas aeruginosa*, *pumillus*, and *Aureus Staphylococcus*. The Neem Extract's Action additionally proven to be beneficial in preventing the formation of *S. sobrinus* is a carcinogenic bacteria[24].

The objective of the study is to determine when a neem leaf acetone extract has greater antibacterial efficacy against gram-negative bacteria (*E. Coli*). Opposite to the extract of chloroform for the *C.E.* bacterium exhibits more potent antibacterial action against *B. cereus*, *S. pneumonia*, *S. aureus*, and *S. subtilis* which are bacteria that are gram positive. The outcome indicates that to include a variety of bioactive substances that have strong antibacterial properties and discovered that It has strong anti-cancer cytotoxic properties[25].

Advantages-

- Neem has the ability to fight a variety of pathogens, such as viruses, fungus, and bacteria. Because of this, it can be used to treat a variety of infections.
- Neem is thought to be more environmentally friendly than synthetic antimicrobials because it is a plant- derived component, which lowers the likelihood of antibiotic resistance.
- In comparison to traditional antibiotics, neem is generally thought to be safe for topical application and to have fewer adverse effects.

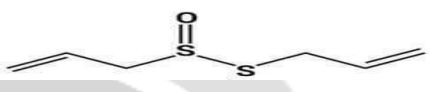
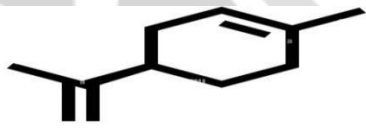
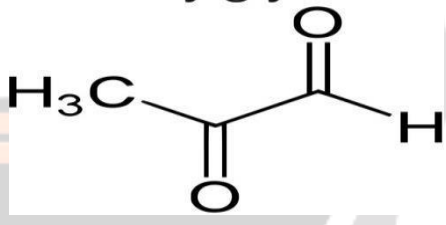
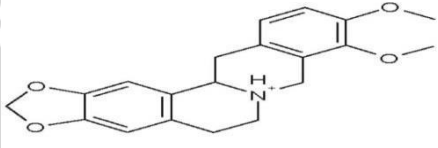
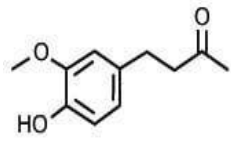
Disadvantages-

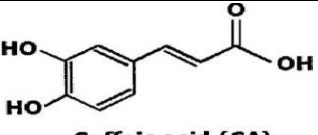
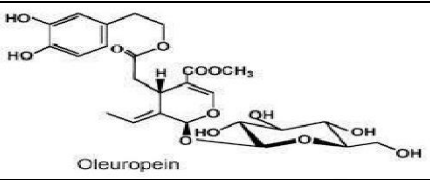
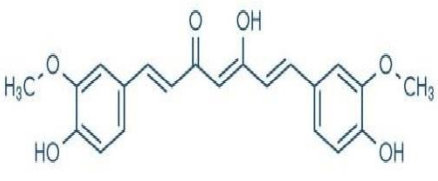
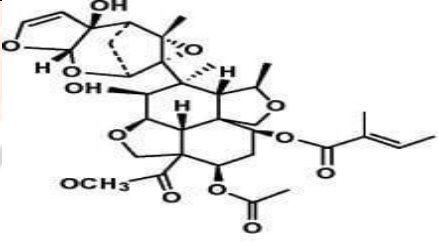
- Neem may cause allergic reactions in certain people, which could result in skin irritations or other adverse effects.

- Depending on the formulation and administration technique, it might be challenging to determine the optimal dose for antibacterial action.

- Neem may not be adequate as a stand-alone treatment for serious illnesses, requiring the use of traditional antibiotics. [57,58,59].

TABLE 2: HERBAL SOURCES WITH ANTIMICROBIAL ACTIVITY

Botanical name (Common name)	Family	Part used	Geographical source	Chemical Constituents	Activity
<i>Allium sativum</i> (Garlic)	Amaryllidaceae	Bulb	Central Asia, particularly Iran and Turkmenistan. It spread to Mediterranean regions and India	<p>Allicin</p> 	Antimicrobial
<i>Origanum vulgare</i> Oregano oil	Lamiaceae	Leaves	Mediterranean regions, particularly Greece and Italy.	 <p>limonene</p>	antimicrobial
Honey	Apidae	Nectar and pollen collected by honey bees from flowering plant	Worldwide, sourced from various flower types.	<p>Methylglyoxal</p> 	antimicrobial
<i>Hydrastis canadensis</i> Goldenseal	Ranunculaceae	Root and rhizome	Native to North America, particularly in the eastern United States.	 <p>Canadine</p>	antimicrobial
Ginger	Zingiberaceae	Rhizome	Native to Southeast Asia, particularly in countries like India and China. It is cultivated in tropical and subtropical regions worldwide.	 <p>Zingerone</p>	antimicrobial

<i>Echinacea purpurea</i> Echinacea	Asteraceae	Roots and aerial parts	Native to North America, particularly the Great Plains.	 <p>Caffeic acid (CA)</p>	antimicrobial
<i>Olea europaea</i> Olive leaf	Oleaceae	Leaves	Mediterranean regions,	 <p>Oleuropein</p>	antimicrobial
Turmeric	zingiberaceae	Rhizome	Believed to have originated in Southeast Asia, especially in India. It thrives in tropical climates and is extensively grown in India, which is the largest producer.	 <p>curcumin</p>	antimicrobial
<i>Azadirachta indica</i> Neem	Meliaceae	Leaves, bark, seeds	Native to the Indian subcontinent and parts of Southeast Asia.	 <p>Azadirachtin</p>	antimicrobial

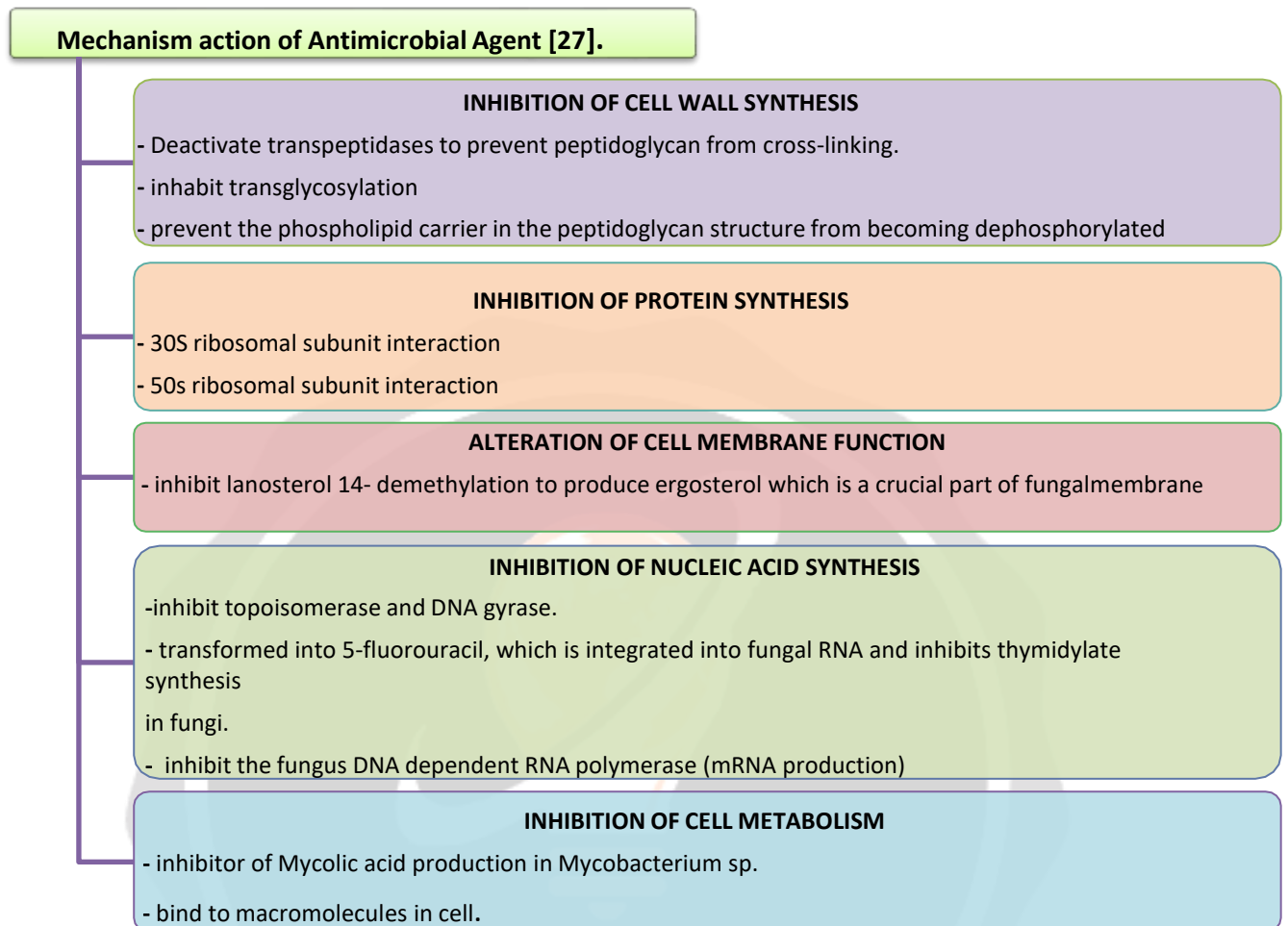
MODE OF ACTION OF CRUDE DRUG

Several crude drugs include antimicrobial qualities. The active ingredients in crude medications, like as turmeric, ginger, and garlic, work against bacteria in a similar way by reduces or stops the creation of biofilms, making it as sensitive as herbal antibacterial medications. The Clove and chemical ingredients have similar pharmacological actions by obstructing the creation of genetic components, such as protein and DNA, and stops the growth of germs[26].

NEEDS OF HERBAL ANTIMICROBIALS

Antibiotics used to treat any bacterial infection have numerous negative effects by interfering with the body's normal processes and killing beneficial bacteria. By substituting natural antimicrobial agents, these undesirable side effects of antibiotics can be totally eliminated or reduced. Antibiotics made from herbs work by not just antibacterial, but also strengthening the body's defenses against microorganisms in the future. infections. Generally speaking, natural antibiotics do not cause medication resistance, which is frequently observed in

Both natural and pharmaceutically manufactured antibiotics lack the bactericidal activity against helpful microorganisms that reside in our bodies and provide us with several benefits[26].



Benefits of plant derived antimicrobials over antibiotics

- They don't show side effects often associated with use of Synthetic chemicals.
- No report of antimicrobial resistance has been Documented to these phytochemical(plant derived Antimicrobials) because they have multiple mechanism of Action.
- Affordability of these compounds.
- The marked antimicrobial effect, nontoxic nature and Affordability of these compounds potentiate their use as Growth promoters in livestock and poultry industry, effective Antimicrobial and disinfectants in food industry, component of Herbal therapy in veterinary medicine and source for Development of novel antibiotics in pharmaceuticals[28].

THE RISKS OF NATURAL ANTIMICROBIAL AGENT

Naturally occurring substances are not always considered safe.

All that matters are the dosages and concentrations of the drug's active components. High concentrations of garlic may increase bleeding risk, hence it is not advised for anyone undergoing surgery or using bloodthinners.

There are several With their effectiveness against bacteria, phytochemicals are no longer sold as commercial antibiotics.

Thus, In order to properly recognize the therapeutic properties, safety, and efficacy of plants, research on them is necessary. Outcomes, making herbal remedies an alternative for modern medications[29].

Conclusion- Drug resistance is a serious issue that is getting more harmful every day in this 21st century. We must realize that the fight against these pathogenic microbes is never going to be won. conclusion, but we can overcome them by modifying our approach and by utilizing active components derived from plants that have survived microorganisms for many years. Presently, following the discovery of antibiotic-resistant microorganisms, Antimicrobial research has been the subject of numerous investigations. medicinal herbs' action. The desire to extract medications from therapeutic herbs would aid in resolving the issue of antibiotic-resistant now or in the future. With any luck, the Medicinal plant-based antibacterial research could be advantageous.

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