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REVIEW ARTICLE

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Drug resistant bacteria and antimicrobial activity of medicinal plants

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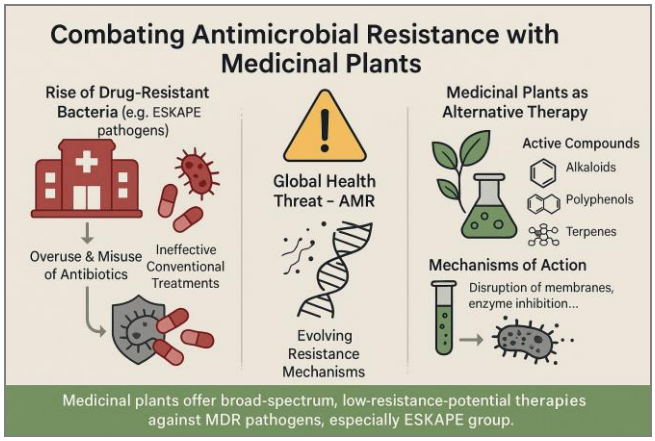
Abstract

The overuse/misuse of antimicrobial drugs caused emergence of antibiotics resistance. The medical science is facing this very urgent issue as World Health Organization (WHO) description. Thus, there is an urgent need to develop new antibiotics used against resistant bacterial isolates. This has directed researchers to discover new phytochemicals from medicinal plants to act against drug resistant microbes. Therefore, to get more perspective on using of phytochemicals as alternative medications to combat the issue of antibiotic resistance, to understand the mechanisms of actions in killing and inhibiting the microbes, this medical study is made.

Keywords: Drug resistant bacteria. Antimicrobial activity. Medicinal plants. Promising drugs.

Graphical Abstract



Introduction

The World Health Organization (WHO) has reported that 80% of the developing world still used medicinal plants as traditional medicines [1]. 20,000 species names of medicinal plants has recorded by WHO, these medicinal plants are considered as potential sources of new medications, 1340 plants are defined for their antimicrobial activity and 30,000 plant antimicrobial compounds are isolated [1].

The irregular, inappropriate, extensive and random uses of antimicrobial drugs have resulted in appearance of antibiotics resistance, making many current therapies ineffective [2-6]. The medical science is facing this very urgent issue as WHO description [7]. Thus, there is an urgent need to develop new antibiotics that are able to be used against resistant isolates. This has directed researchers to discover new phytochemicals from medicinal plants to act against drug resistant microbes [8].

Medicinal plant antimicrobial drugs can work alone or in combination with antimicrobial therapies for enhancing their antimicrobial activity against drug resistant pathogens [9]. Many medicinal plants is still unexplored their antimicrobial action, researchers are more working on the medicinal plants for exploring new and effective therapies [10].

Therefore, to get more perspective on the using of medicinal plant extracts as alternative medications to combat the issue of antibiotic resistance, to understand the mechanisms of action of phytochemicals which are responsible for medicinal plants activity against bacterial resistance were discussed in this medical study.

Antimicrobial activity of phytochemical compounds and their mechanisms of action

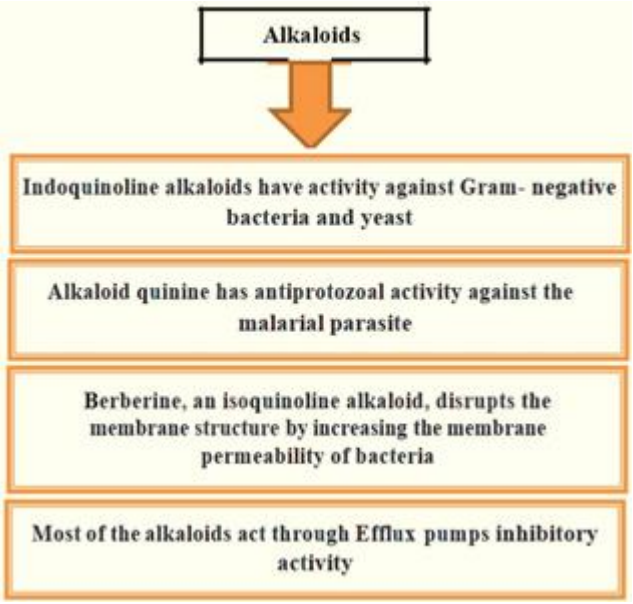
Medicinal plant extracts have various rates of antimicrobial activities in addition to that they have anti-inflammatory and some of them considered as antioxidant **[11]**. These medicinal plants antibacterial compounds have an important clinical value in inhibition the growth of protozoa, bacteria, viruses, and fungi **[12]**. Chemically complex compounds of medicinal plants have wide range effects with low chances of developing resistance and have less side effects than synthetic medications **[13]**.

Many countries are approved the synthetic antimicrobial drugs, but many researchers attract the natural compounds of medicinal plant their attention as natural medications, the discovery of new natural bioactive compounds of the medicinal plants which can fight against resistant pathogens **[14]**. The phytochemicals have therapeutic value; secondary plant metabolism is produced secondary metabolites products that are used for medicinal purposes **[15]**. The antimicrobial activity and mechanisms of action the natural compounds of medicinal plants are described below **[15, 16]**.

Alkaloids

Have antimicrobial effects, antispasmodic, and analgesic, alkaloids mechanisms of action are detailed in Figure 1 **[1,17]**.

Figure 1. Alkaloids mechanisms of action.

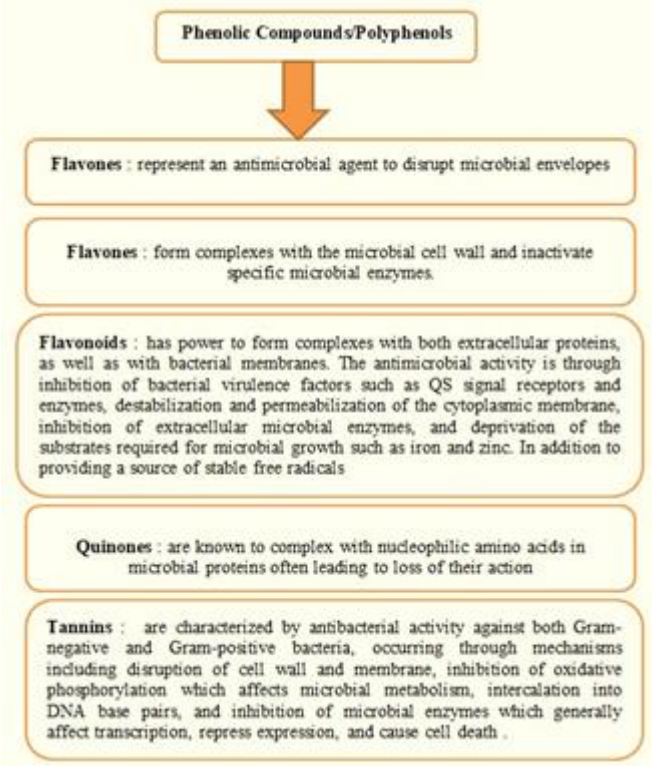


Source: **[1,17]**.

Phenolic Compounds/Polyphenols

Involve: tannins, flavonoids, quinones, flavanols and flavones with various mechanisms of action towards various pathogens as mentioned bellow in Figure 2. **[1,18]**.

Figure 2. Phenolic compounds/Polyphenols mechanisms of action.

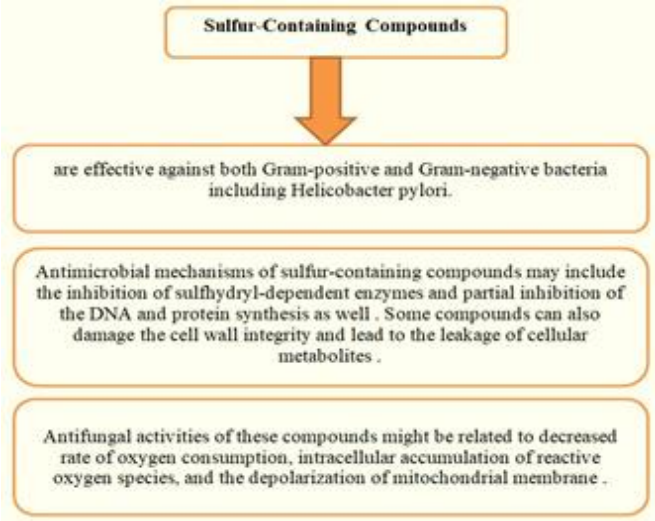


Source: **[1,18]**.

Sulfur-Containing Compounds

The compounds are isothiocyanates, ajoene, and allicin, their mechanisms of action are mentioned in Figure 3 **[1,19]**.

Figure 3. Sulfur-Containing Compounds mechanisms of action.

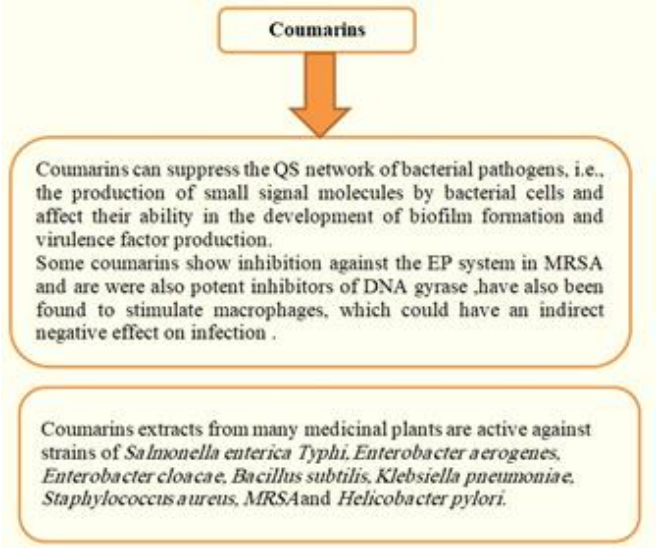


Source: **[1,19]**.

Coumarins

Are phenolic substances with antibacterial activity, their mechanisms of action are mentioned in Figure 4 **[1,20]**.

Figure 4. Coumarins mechanisms of action.

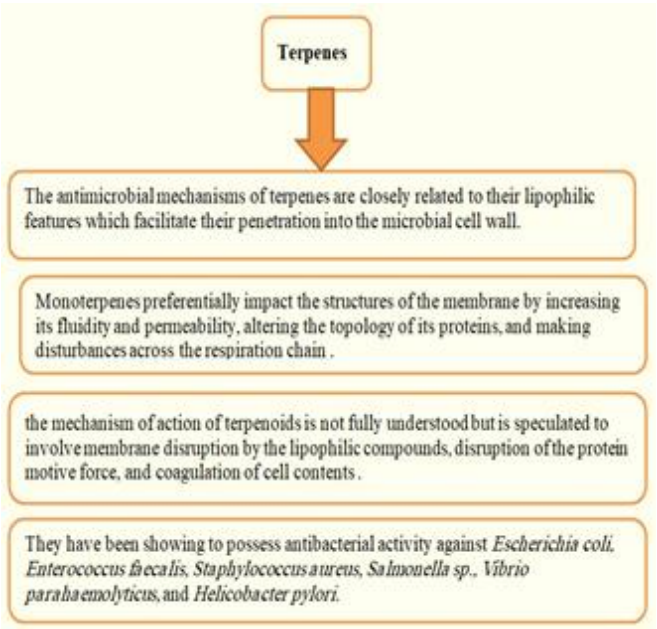


Source: **[1,20]**.

Terpenes

Their derivatives contain usually oxygen and called as terpenoids, their mechanisms of action are mentioned in Figure 5 **[1,21]**.

Figure 5. Terpenes mechanisms of action.



Source: **[1,21]**.

'ESKAPE' Pathogens and Medicinal Plants

At the last four decades, the uncontrolled\over used of antibiotics has led to increase the global health crisis, that called by antimicrobial resistance. The microbes which are caused global lethal threating in healthcare settings are called by 'superbugs' because of their multiple, extensive or Pan Drug resistance **[1]**. *Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumanni, Pseudomonas aeruginosa,* and *Enterobacter* species are named (ESKAPE bacteria) by the Infectious Disease Society of America, they are considered as very dangerous bacterial group because of their virulence factors and their high rate resistance towards various kinds of antimicrobial drugs **[22-25]**.

These ESKAPE pathogens caused intense need to discover novel antimicrobial agents. Phytochemicals are considered as promising curative effects against ESKAPE infections **[22,26]**. *Martynia annua*, *Cynodon dactylon* etc. are considered as broadspectrum activity medicinal plant against one or two ESKAPE pathogens **[27]**. *Aloe vera* and *Cynodon dactylon* etc. have the ability to prevent AMR **[28]**.

Limitations

Various studies from various countries are used plant extracts for treating infections of ESKAPE, but more researches are in need to unify all information into a commercial antimicrobial drug.

Conclusion

The antimicrobial activity of medicinal plant is considered as a new hope against dangerous threats of increasing the rate of antimicrobial resistance over the world. Therefore, high priority should be given for making new studies to discover new bioactive compounds from medicinal plants with therapeutic effects are considered as urgent needs, which have yet to be adequately explored. It is very important to conduct in vitro and in vivo tests to ensure that the selection of the compounds is right (nontoxic and active antimicrobial plant-derived compounds).

CRediT

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Conflict of Interest

The authors declare no conflict of interest.

Similarity Check

It was applied by Ithenticate[@].

Application of Artificial Intelligence (AI)

Not applicable.

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It was performed.

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