

REVIEW ON EVALUATION OF ANTIMICROBIAL PROPERTIES OF *CHEBULA MYROBALAN*, *SEMECARPUS ANACARDIUM*, *TRIGONELLA FOENUM GRAECUM*, *STAR ANISE*, *OCIMUM TENUIFLORUM*Vrushali Hiranman Bande^{1*}, Ashu Anand Kuthe², Amol There¹ and Ankita Lonkar²

School of Pharmacy, G. H. Rasoni University Saikheda, Dist- Pandhurna, Madhya Pradesh, India- 480337.



*Corresponding Author: Vrushali Hiranman Bande

School of Pharmacy, G. H. Rasoni University Saikheda, Dist- Pandhurna, Madhya Pradesh, India- 480337.

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ABSTRACT

Increasing resistance of micro-organisms for pre-existing formulations and drugs create urge to find new drugs. Here we studied the background study, Pharmacology and phytochemical study with highlighting antimicrobial properties of individual drugs i.e. *Semecarpus anacardium*, *Trigonella foenum graecum*, *Chebula myrobalan*, *Star anise* and *Ocimum tenuiflorum* many from which are originated from India and Asia. Here, increasing trend of herbal drugs and plants in global market due to their higher frequency of therapeutic effect and minimum side-effects and toxicity are also discussed. They have various dominant pharmaceutical properties including anti-microbial property. These drugs show significant anti-microbial activity due to the presence of phytochemicals like alkaloids, flavonoids, saponins, tannins, steroids, etc.

KEYWORDS: Anti-microbial, *Semecarpus anacardium*, *Trigonella foenum graecum*, *Chebula myrobalan*, *Star anise*, *ocimum tenuiflorum*.

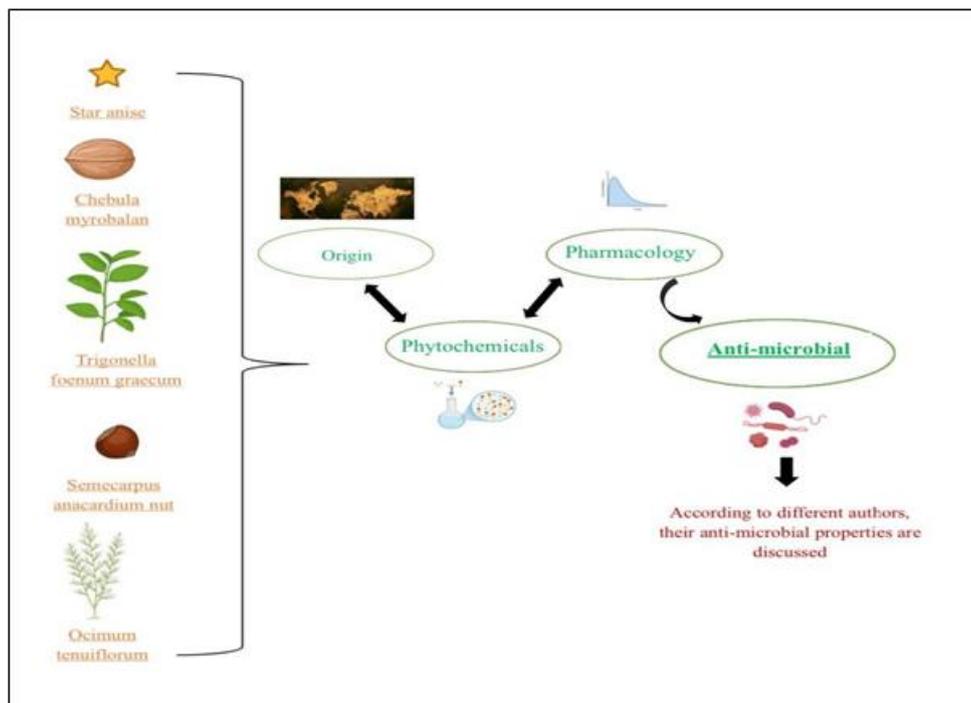
**GRAPHICAL
ABSTRACT**

Figure 1: Graphical Abstract.

1. INTRODUCTION

Bacteria and virus are very small infection causing agents which cannot metabolize and replicate by themselves and depend on host cell for their nutritional requirement for metabolism and replication (Pingale, 2012). The skin acts as a crucial defense mechanism and guarding the body from microorganisms and topical infections. Different damages to skin like cuts, scrapes, abrasions and breached skin promotes microbial infection (Alves et al., 2024). To treat the infections by killing or inhibiting the growth of microorganisms, several antimicrobial agents are discovered. With time, microbial strains get evolved, adapted and develop resistance to several antimicrobial agents thus, evolution and search of new antimicrobial agents get important and misuse or overuse of antimicrobial drugs making it inferior (Cheng et al., 2016). (Pal & Shukla, 2003) states that, herbal drugs are generally used whole herb or part of herb in crude form contains various phytochemicals which helps to treat collectively and shows better results. Topical formulations offer advantages in both therapeutic and adverse effect point of view. Minor to moderate skin infections can be managed by topical formulations. Various forms of topical antimicrobial drugs are present like cream, gel, lotion, ointments, spray, etc. (Lipsky & Hoey, 2009).

Herbal medicines are those which are formulated from

any parts of plants like roots, stem, flowers, fruits, leaves, etc. for medicinal use (Chhetri et al., 1970). Herbal drugs over branded and generic drugs cause less toxicity to host cell and shows significant therapeutic effect. WHO states that above 80% of total population living in developing countries moving towards herbal and ayurvedic system for medication. Herbal drugs are gaining global attention due to their safety, effectiveness, therapeutic potency, less drug resistance along with minimum toxicity. (Prajakta N. Dongare et al., 2021) and over 60% of world population depends on plants and herbs for medicinal purpose (Sundaram et al., 2018). (Pandey et al., n.d.) states that essential oil, methanolic and ethanolic extract of herbs are reported to contain antimicrobial properties *Trigonella foenum-graecum*, *Chebula myrobalan*, *Star anise*, *Basil*, *Jatamansi* and *Semecarpus anacardium* are ayurvedic herbs from Indian origin showing significant antimicrobial activity.

2. Search Strategy

The information used in this review is obtained from google scholar (<https://scholar.google.com/>), pubmed (<https://pubmed.ncbi.nlm.nih.gov/>), science direct (<https://www.sciencedirect.com/>) with the help of keywords Anti-microbial, *Semecarpus anacardium*, *Trigonella foenum graecum*, *Chebula myrobalan*, *Star anise*, *ocimum tenuiflorum*, herbal drugs.

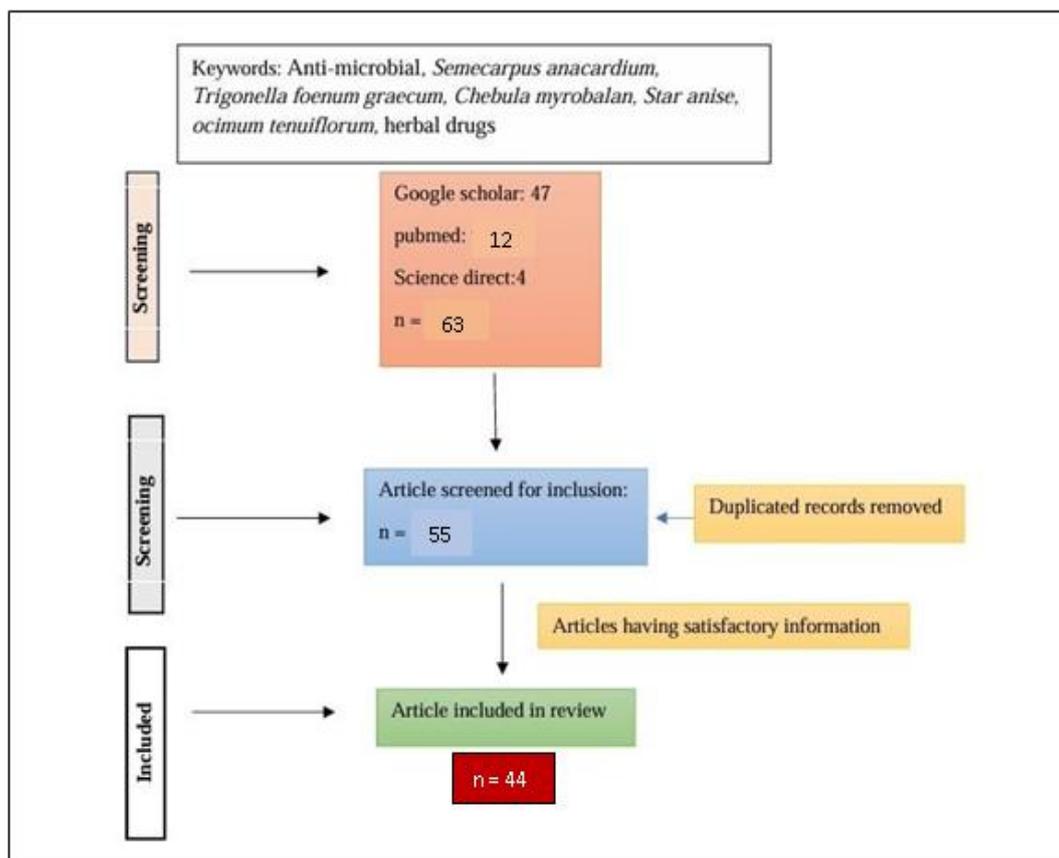


Figure 2: Research strategy.

3. *Chebula myrobalan*

- **Background:** *Chebula* is a ripped dried fruit found in India and Southeast Asia. It belongs to family Combretaceae. *Chebula* is also called as *black myrobalan* and *hirda*. *Chebula* is called as the ‘King of medicine’ due to its numerous medicinal properties in ayurveda. It is a medium to semi-large tree raises up to 25 meter and have subelliptic leaves but broader from there ends.(Manjunath et al., 2019). In Unani system of medicine, *Chebula* was known as a booster for brain, memory and vision(Sultan et al., 2023).
- **Pharmacology:** Dried fruits of *Chebula myrobalan* have been used for the treatment of asthma, vomiting, diarrhea, sore throat, gout, heart and bladder disease, etc. traditionally due to its antioxidant, antiulcer, antidiabetic, anticarcinogenic and wound healing

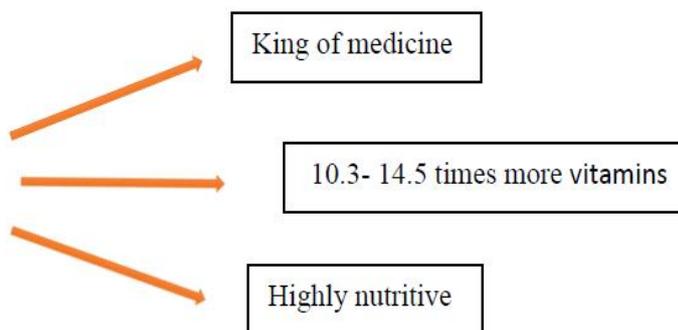


Figure 3: *Chebula Myrobalan*.

changes with geographical region. It contains triterpenoids, flavanols, glycoside and other phenolic compounds. It also contains minerals, vitamin C, proteins and amino acid(Nutritivssse Values of *Chebula Myrobalan*, n.d.).

- **Antimicrobial property of *Chebula myrobalan*:**

Tannins and 1,3,6-Trigalloylglucose present in aqueous extract of *T. Chebula* (Ou et al., 2024) are majorly responsible for its antimicrobial activity. Various antimicrobial activity of *Chebula* were reported including its inhibitory activity of *Helicobacter pylori*, bacteria which cause development of gastritis, ulcers and stomach cancer, *Xanthomonas campestris pv citri*, bacterium causes citrus cancer disease. It also prevents the proliferation of *Salmonella typhi* and intestinal bacteria (Bag et al., n.d.). Between ether, alcoholic and water extract of *Chebula*, ether extract shows prominent antimicrobial activity(Ashwini et al., 2011).

4. *Semecarpus anacardium nut*

- **Background:** *Semecarpus anacardium* Belongs to the family *Anacardiaceae* is a plant found in Himalayan, sub-Himalayan and topical and central region of India. It is also called as *bhilwa*, *biba*, *bhallatak* and *making nut*. Name of the drug is derived from Greek word where *Semecarpus* means

properties(Wadkar & Pinjari, n.d.). Also, ayurvedic formulations of *Chebula* were prepared for the treatment of various infectious diseases pyorrhea, bacterial and fungal infections. *Chebula myrobalan* fruit possess laxative, tonic, anti-spasmodic, ophthalmic, hemorrhoids, dental care like loose or bleeding gum, ulcerated oral cavity, analgesic, sore throat, digestive aid, liver stimulant, stomachic, gastrointestinal prokinetic, etc. properties(Bag et al., 2013).

- **Phytochemicals:** It is studied that; it contains 10.3 times more vitamin C and 14.5 times more vitamins as compared to apples thus it is one for the biggest source of dietary supplements. *Chebula* consists of almost 32% tannin of 14 different hydrolysable components including gallic acid, chebulic acid, chebulanin, etc. concentration of tannins.

“making” and *anacardium* means heart shaped collectively.



Figure 4: *Semecarpus Anacardium*.

called as “heart shaped making nut”. It is well known in ayurveda and siddha system of medicine due to its high medicinal properties(Semalty et al., 2010a). Various secondary metabolites are present in leaves, shoot, fruits and other parts of *Anacardium* species which are responsible for its nutraceutical, medicinal and biological properties(Salehi et al., 2020).

- **Pharmacology:** It has various pharmacological properties in Ayurveda and Siddha system of medicine including anti-arthritis, anti-inflammatory,

anti-oxidant, antimicrobial, anti-reproductive, CNS stimulant, anti-cancer, hypoglycemic and hair growth promoter. Beside therapeutic activity, *Semecarpus anacardium* has several side effects including irritation and itching of skin and eyes. Thus, in ayurveda, to resolve such problems, extract of makingnut was taken with milk (Semalty et al., 2010b).

- **Phytochemicals:** Chemicals identified in the nuts of *Semecarpus anacardium* are biflavanoids, phenolic compounds, bflawanols, sterols, glycosides and catechol derivatives are major components of it also amino acid, vitamins, minerals, etc. are present which are responsible for various pharmacological activities (Purushothaman et al., n.d.). Ethanolic extract of leaves of S.A. contain alkaloid, carbohydrate, fats and oils, tannins, phenols, flavonoid, cardiac glycoside which may be responsible for its different therapeutic activities (Bahir et al., n.d.).
- **Antimicrobial activity of *Semecarpus anacardium*:** Phenolic compounds and catechol derivatives present in *Semecarpus anacardium* are responsible for antimicrobial activity in which catechol derivative I and IV shows more potent antimicrobial activity than II and III (Sundaram et al., 2022). Extract of *Semecarpus anacardium* nut with petroleum ether and acetone gives antimicrobial



Figure 5: *Trigonella foenum Graecum*.

anorexia treating properties. Now, it is also found by the researchers and scientists that, it possesses antidiabetic, cholesterol lowering characters, anti-hyperthyroidism, anti-cancer, antioxidant, antimicrobial, anti-allergic, anti-inflammatory, antipyretic and anti-helminthic properties due to its diverse chemical constituents such as diosgenin, trigonenin, neotigogenin, triterpenoids, trigonelline, choline, amino acid, flavonoids and various phenolic compounds (Paul & Pal, n.d.; Yadav & Baquer, 2014)

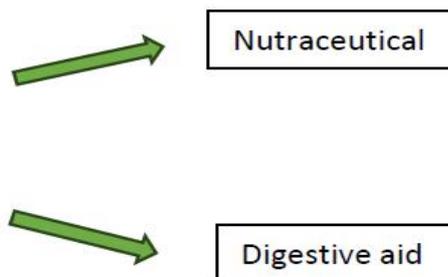
- **Antimicrobial properties of *Trigonella foenum graecum***

It is found that, *Fenugreek* seed extract contains number of medicinally important compounds like polysaccharides galactomannan, volatile oils, alkaloids, flavonoids,

activity against multiple bacteria and fungi. Petroleum ether extract showed inhibitory activity against *Escherichia coli* with zone of inhibition of 19mm, *Salmonella typhi* with ZOI of 26mm, *Micrococcus luteus* with 23mm, *Bacillus subtilis* with 14mm and *klebsiella pneumonia* with 22mm of ZOI (Bagewadi, n.d.).

5. *Trigonella foenum graecum*

- **Background:** *Trigonella foenum graecum* also known as *Fenugreek* belongs to the family *Fabaceae* is one of the ancient plants having various medicinal properties generally used as food for its nutraceutical and medicinal values. *Trigonella foenum graecum* is originated from Mediterranean region and south east Asia and now it is cultivated in Africa, Europe, North and South America and Australia although India is the largest cultivator of *Fenugreek* in the world (Visuvanathan et al., 2022).
- **Pharmacology and phytochemicals:** Traditionally, *Fenugreek* was used for its wound healing properties, swollen glands, lactation enhancer, treating arthritis, dropsy, heart disease, gastric stimulant, spleen and liver enlargement, kidney ailment and against.



saponins and fatty acid due to which, *Trigonella foenum graecum* shows activity against various gram-positive and gram-negative bacteria. Extraction of *Fenugreek* from Pakistani region with water and ethanol gives direct dose response relationship with different concentration of extract whereas the ethanolic extract of *Fenugreek* cultivated in India with ethanol failed to demonstrate antimicrobial activity against *Bacillus subtilis*, *Escherichia coli* and *Saccharomyces cerevisiae*. (Paul & Pal, n.d.). It described that antimicrobial activity of *Trigonella foenum graecum* varies with the region of cultivation. According to (*Antibacterial and Antifungal Activity of Trigonella Foenum*, n.d.), aqueous extract of *Trigonella foenum graecum* shows 12.22mm zone of inhibition against *S. marcescens* 11.33mm against *B. cereus*, 9.33mm against *P. aeruginosa* and 10.50mm

against *E. coli* while, hexane extract shows 9.44mm of zone of inhibition against *S. marcescens* and methanolic extract shows 10mm (*S. marcescens*), 11.50mm (*B. cereus*), 9.50 (*P. aeruginosa*), 9.33 (*E. coli*) respectively.

6. *Star anise*

- **General:** *Star anise* is one of the important plant belongs to the family Magnoliaceae (Zou et al., 2023) in traditional Chinese system of medicine also cultivated in North America, Atlantic and subregional areas of Asia. It is also called as *Illicium verum*. The fruit of *Star anise* has pungent, strong and slightly sweet taste and is aromatic in nature.
- **Phytochemicals:** It contain 2.5-3.5 % volatile component in fresh fruit and the principle

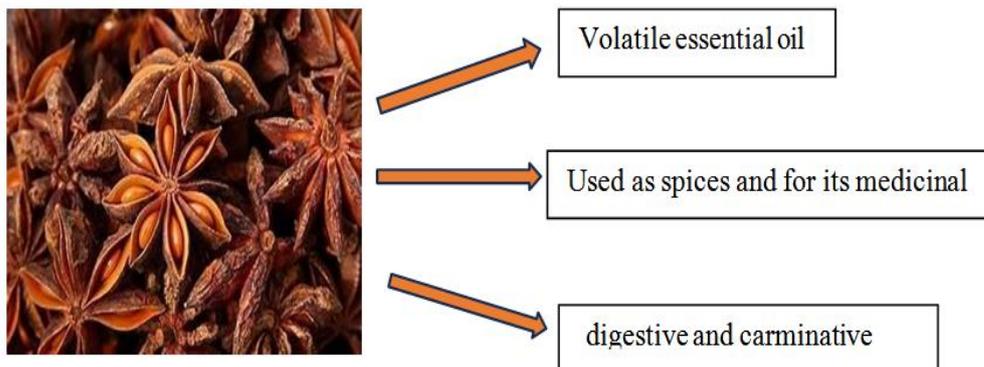


Figure 6: Star anise.

- **Pharmacology:** It possesses numerous Functional properties like antioxidant, antimicrobial, hypoglycemic, hypolipidemic, estrogenic, antidiabetic, anticancer properties due to which, the use of raw star anise fruit and its essential oil is encouraging for safe use in pharmaceutical as well as food industry. Microbes are developing resistance to several preexisting anti-microbial drugs thus the urge to find new antimicrobial agents is necessary (Shahrajabian et al., 2019).
- **Antimicrobial activity of Star anise:** Shikimic acid extracted from Star anise is used in the formulation of Tamiflu, which is the drug used to treat influenza. Traditionally, the oil of Star anise was used to treat flatulence, spasmodic pain and colic. *Star anise* shows inhibitory activity against various bacteria including *S. aureus*, *L. monocytogenes* (Gram positive bacteria) *E. coli* and *S. arizonae* (Gram-negative bacteria) (Alhaji et al., 2019a). Whether the methanolic extract shows inhibitory activity against multidrug-resistant bacteria *Acinetobacter baumannii* (Salem et al., 2021a). Volatile oil of Star anise is found to be operative for growth controlling activity against *F. moniliforme* and *Aspergillus niger*. Extract of Star anise with acetone is found to be significantly effective against *Aspergillus flavus*, *Staphylococcus aureus* and *Bacillus*.

On the other hand, it shows significant anti-fungal

component in *Star anise* essential oil is trans-anethole, paramethoxyphenyl propene that occupies 85-90 % of the total weight (Zhang et al., 2024). Fruits of some related species are poisonous in nature thus care and precaution is necessary to avoid toxicity. It is used as both medicine and food as spices. It is enriched in oil mainly anethol.

It contains various bioactive compounds and also various phenols including shikimic acid, gallic acid, flavonoids like quercetin, kaempferol, antioxidants, preservatives. It is given that temperature and solvent type used for extraction affects bioactive compounds (Sabry et al., 2021).

activity against *Candida albicans*, *C. parapsilosis*, *C. tropicalis*, *C. pseudotropicalis* and *C. krusei*. It also possesses growth inhibitory properties against dermatophyte species including *Trichophyton rubrum*, *T. mentagrophytes*, *Microsporum canis* and *M. gypseum*. Methanolic extract of *Star anise* shows potent antibacterial activity against *A. fumigatus* (Alhaji et al., 2019b), *A. baumannii* and *Staphylococcus aureus* (Salem et al., 2021b).

According to (Kosalec et al., 2005), *Star anise* shows antifungal activity against all fungi inspected with zone of inhibition from 20-29 mm. fungus used including *T. mentagrophytes* (29mm), *Candida albicans*, *C. tropicalis*, *C. pseudotropicalis* and *C. krusei* (10-12mm), *C. albicans* (12mm), and all fungi demonstrated shows sensitivity from essential oil of *Star anise* in which, *Microsporum gypseum* (21mm), *Trichophyton mentagrophytes* (25mm), *T. rubrum* (25mm), and *M. canis* has 27mm which is the zone of inhibition.

7. *Ocimum tenuiflorum*

- **General:** *Ocimum tenuiflorum* also called as *Ocimum sanctum* holy basil, *Tulsi* (Varghese et al., 2024) is one of the oldest plants from Lamiaceae Family is an annual herb having numerous pharmaceutical and medical properties. *Ocimum tenuiflorum* is innate to India (Pingale, 2012) but is found and cultivated in tropical, subtropical and Central and Southern America,

African and Asian countries (Gajula et al., 2009). *Tulsi* has tremendously known for its therapeutic properties in Ayurveda and it called as DashemaniShwasaharni which means antiasthmatic and Kaphaghna which means expectorant or suppressant (Singh et al., 2013). According

to (Kasmara et al., 2024), every element of *Ocimum tenuiflorum* has medicinal properties and is given in Charak Samitha and Susruta Samitha. In Ayurveda, it is also called as lifesaving herb and hailed as 'elixir of life'.

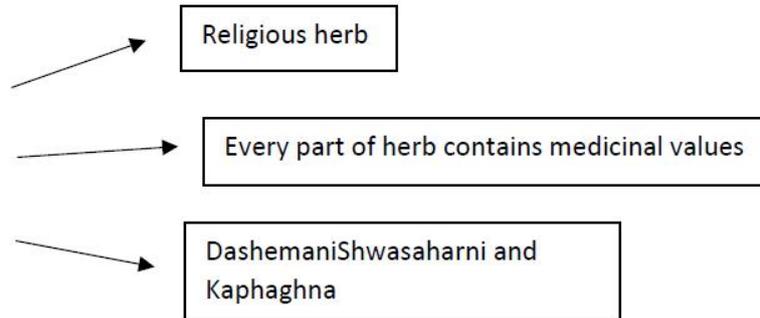


Figure 7: *Ocimum tenuiflorum*.

- **Pharmacology and Phytochemicals:** Major components of *Ocimum tenuiflorum* are methyl eugenol, beta caryophyllene, tenuiflorum, linalool. Leaves and flowers of *Ocimum tenuiflorum* have carminative, galactagogue, stomachic and anti-spasmodic properties along with its pathological activities including headache, coughs, diarrhea, constipation and antimicrobial properties (Gajula et al., 2009).
- **Antimicrobial activity of *Ocimum tenuiflorum*:** Methanolic extract of *Ocimum tenuiflorum* shows more potent activity than aqueous and organic extract. *Ocimum tenuiflorum* shows significant activity against Escherichia Coli, Salmonella typhi, Pseudomonas pyocyanus, Vibrio Cholerae, Shigella dysenteriae and Proteus Vulgaris for regulated contact duration. Whereas Salmonella typhi was pointedly restricted from every extract of *Ocimum tenuiflorum* (Pingale, 2012).

Based on the study of (Naik et al., n.d.), *Ocimum tenuiflorum* extract shows superior antimicrobial activity against gram negative bacteria when measured against positive gram bacteria. They give that, methanolic extract shows antimicrobial activity against *E. coli* with zone of inhibition 7mm, *Pseudomonas putida* and *Klebsiellapneumoniae* shows 5mm zone of inhibition respectively. Silver nanoparticles shows robust dose dependent antimicrobial activity on both gram positive and negative bacteria on average zone of inhibition of 14.31 + - 2.5 (Singhal et al., 2011).

As per (Balakumar et al., 2011), extract of *Ocimum tenuiflorum* leaves with alcohol, hexane, benzene, chloroform, ethyl acetate, methanol and aqueous fraction shows significant antifungal activity against all microbes used including *Trichophyton mentagrophytes*,

Trichophyton rubrum, *Microsporium gypseum*, *Microsporium nanus* and *Epidermophyton floccosum*.

8. CONCLUSION

This review transferred the benefits and advantages of herbal and ancient drugs over branded and chemical-based drugs by highlighting their background, origin, pharmacology, phytochemicals study and anti-microbial properties of multiple herbal drugs. All the discussed findings gives that herbs like *Semecarpus anacardium*, *Trigonella foenum graecum*, *Chebula myrobalan*, *Star anise*, *ocimum tenuiflorum* possesses significant anti-microbial activity against various microbes but the standardization is still a concern. While herbal medicines getting demand in medicinal market, further studies on their therapeutic dosage, long term safety, etc. should be taken in consideration for worldwide acceptance.

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