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Exploring the efficacy of homeopathic remedies as antimicrobials against multidrug-resistant *Klebsiella pneumoniae*: A revolutionary approach to combating antibiotic resistance

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Abstract

The primary goal of this study is to explore *in vitro* antibacterial activities of 3 homeopathic mother tinctures, *Calendula officinalis*, *Echinacea angustifolia*, and *Vitex negundo* against antibiotic-resistant bacteria using adequate control. These mother tinctures have been used clinically in treating localized skin infections. *Klebsiella Pneumoniae* sample collected was resistant to 36 antibiotics. This experiment demonstrates anti-bacterial activity of *Echinacea angustifolia* against the above-mentioned antibiotics resistant *Klebsiella Pneumoniae*.

Keywords: Homeopathy, multidrug resistant *Klebsiella*, antimicrobial activity, antibacterial activity

Introduction

Aim of this study's is to demonstrate *in vitro* effectiveness of homeopathy in treatment of bacterial infections, especially in cases when conventional antibiotics are ineffective owing to Multi Drug resistance. Antibiotic drug resistance is growing because of indiscriminate use of Antibiotics. Each year 1.27 million deaths are caused by bacterial pathogens resistant to the antibiotics available [1]. AMR (Antimicrobial Resistance) has a substantial negative macroeconomic and microeconomic impact on nations [2]. *Escherichia coli*, *Streptococcus pneumoniae*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* were each associated with about 500,000 deaths in 2019. [3] *K. pneumoniae* strains that can cause severe infections in healthy individuals and have been identified with increasing frequency in recent years are considered hyper virulent compared to classical strains because of their ability to infect both healthy and immunocompromised individuals and because of their increased tendency to produce invasive infections [4]. The time to address the antibiotic pipeline and access crisis is now [5]. Experiments have demonstrated anti-bacterial activity of *Calendula*, and *Vitex* against Azithromycin, Clarithromycin and Erythromycin resistant *Staphylococcus* [6].

Materials and Methods

Kirby-Bauer disk diffusion method

Klebsiella Pneumoniae Culture was grown on Brain Heart Infusion broth. After culture plates are prepared 5 mm sterile culture disk was impregnated with *Calendula* Mother, *Echinacea* and *Vitex negundo* Mother Tincture (each with drug strength 1/10) and was placed on. Antibiotic resistant *Klebsiella Pneumoniae* culture, incubated for 24 hours at 37 degree Celsius. Zones of inhibition are read after 24 hrs and 48 hrs. Discs impregnated with ethanol concentration corresponding to each tincture are kept as control for comparing zone of inhibition. Antibiotic sensitivity is also done.

Antibiotic Sensitivity Reports

(R-Resistant, S-Sensitive, IR-Intermediate)



Fig 1: *Calendula officinalis* has significant anti-inflammatory antioxidant wound healing anti-edematous antibacterial antifungal and antiviral effect [7].

Analysis of the MTT ((3-(4, 5-Dimethylthiazol-2-yl)-2, 5-Diphenyltetrazolium Bromide)) assay has revealed a strong antimicrobial potential of CA (*Calendula officinalis*)-GIExt, (glycolic extracts) comparable to chlorhexi-dine [8].



Fig 2: The ethanol extracts of *Vitex negundo* L. have the ability to inhibit the growth or to kill the concerned multi drug resistant bacterium and can be used for pharmaceutical and medicinal purpose [9].

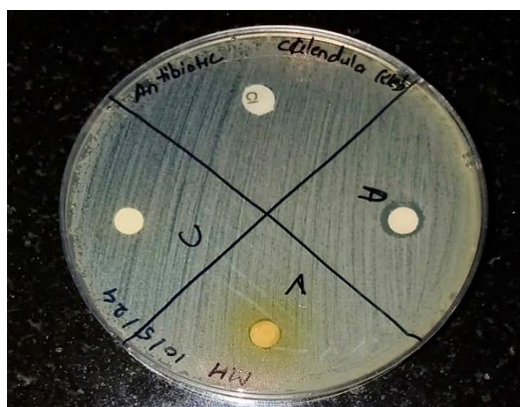
The traditional use of *V. negundo* as a broadspectrum anti-microbial agent against a wide range of microbes is recommended [10]



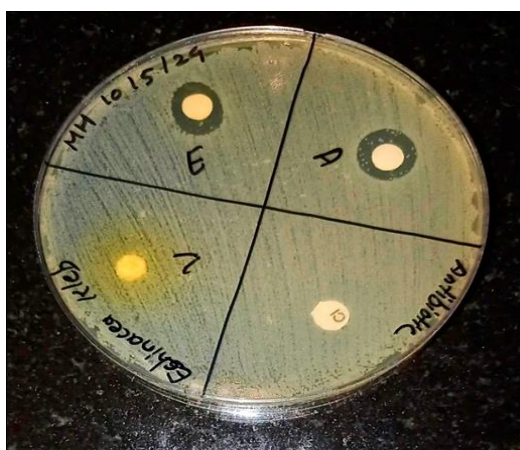
Fig 3: Studies have shown that essential oils from *E. angustifolia*, displayed inhibitory activity against *Coliform* Spp, *Pseudomonas* Spp, *Saccharomyces cerevisiae*,

Zygosaccharomyces bailii and *Lactobacillus plantarum* to varying degrees [11]. The combined use of *Echinacea* with Azithromycin produced favorable outcome than Azithromycin alone in pediatric patients with recurrent tonsillitis [12]

Cefazolin - R	Cefiderocol - R
Cefotaxime - R	Piperacillin - R
Ceftriaxone - R	Cefoperazone - R
Amoxicillin/ clavulanate - R	Cefixime - R
Ampicillin/Sulbactam- R	Cefpodoxime - R
Piperacillin/tazobactam - R	Cefprozil - R
Gentamicin - R	Netilmicin - R
Ciprofloxacin - R	Doxycycline - R
Levofloxacin - R	Minocycline - R
Trimetho/sulfamethox - R	Norfloxacin - R
Cefuroxime - R	Ofloxacin - R
Ticarcillin-clavulanate - R	Gatifloxacin - R
Cefepime - R	Cefdinir - R
Tobramycin - R	Cefaclor - R
Amikacin - R	Kanamycin - R
Cefoxitin - R	Ceftazoline - R
Tetracycline - R	Ceftazidime - R
Cefetamet - R	Ceftibuten- R
Ampicillin - IR	Imipenem - S
Meropenem - S	Azithromycin - S
Aztreonam - S	Doripenem - S
Nitrofurantoin - S	Nalidixic Acid - S
Fosfomycin - S	Chloramphenicol - S



E-Ethanol Control
AZ-Antibiotic
C- *Calendula officinalis*
V-*Vitex negundo*



E-Ethanol Control
AZ-Antibiotic
E- *Echinacea angustifolia*
V-*Vitex negundo*

Remedy Name	Zone of Inhibition measurement
<i>Calendula officinalis</i>	0 mm
<i>Echinacea angustifolia</i>	11 mm
<i>Vitex negundo</i>	0 mm
Ethanol Control	9.5 mm

Inference

Echinacea mother tincture demonstrated a zone of inhibition greater than the ethanol control in the subsequent research, which no other drug (Calendula, Vitex) did. This supports and validates the remedy's antibacterial qualities against bacteria that are Multidrug resistant.

Previous studies have demonstrated that encapsulation of *E. angustifolia* extract in nanoparticles enhanced its antimicrobial activity^[13].

Conclusion

In homeopathy, active chemical concentrations are frequently so low that they cannot be identified. This presents a considerable problem for standard methods of evaluating their effectiveness. It is impractical to directly compare homeopathic dilutions with antibiotics *in vitro*, as antibiotics are assessed in measurable milligram concentrations and analysed using standardised techniques such as disk diffusion assays. In contrast, due to the extreme dilution of homeopathic preparations, they cannot be subjected to similar quantitative evaluation. Therefore, homeopathic dilutions are compared with an equivalent volume of ethanol, which is present in the mother tincture, serving as a solvent-controlled reference for the experiment. The microbes in this investigation was resistant to 36 different antibiotics.

However, zones of inhibition indicated the sensitivity of *Echinacea angustifolia* for multidrug resistant bacteria. No zones of inhibition for Calendula and Vitex were observed. These findings demonstrate the effectiveness of *Echinacea angustifolia* in treating diseases that are resistant to Multidrug Resistant antibiotics.

Also *Echinacea angustifolia* might be a viable substitute for treating resistant infections, which calls for more research into its modes of action and therapeutic effectiveness.

Conflict of Interest

Not available

Financial Support

Not available

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