Assessment of Antimicrobial Properties of Chili Seed Oil and Anise Seed Oil against bacterial and fungal strains.

Jay Vishwakarma[1], Rahul Bisen[2], Aaju Goswami[3], Naveen Kumar[4], Paramjeet Kumar[5], Abhishek Kumar Shah[6]

[1]*Assistant Professor, NRI Institute of Pharmaceutical Sciences*

[2,3,4,5,6]*UG Scholar, NRI Institute of Pharmaceutical Sciences*

Abstract- **Antimicrobial resistance is a growing global health concern, prompting exploration of alternative therapies such as plant-derived essential oils. This study evaluated and compared the antimicrobial activity of chili seed oil and anise seed oil against *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans* using the agar well diffusion method. Both oils inhibited all tested pathogens, with anise seed oil demonstrating consistently larger zones of inhibition. These results highlight the potential of anise and chili seed oils as natural antimicrobial agents for possible pharmaceutical or cosmetic applications.**

Keywords: Chili seed oil, Anise seed oil, antimicrobial activity, Zone of inhibition, Essential oils, Natural preservatives.

I. INTRODUCTION

Antimicrobial resistance is a major public health crisis afflicting the world today calling for urgent action [1][2]. The declining effectiveness of traditional antibiotics has led researchers worldwide to develop alternative treatments. This includes essential oils from plants, which possess a broad range of activities and are structurally more complex than conventional antibiotic molecules. At end point is relatively little chance either for resistance to develop or in the case that new types of resistance are generated, to perpetuate [3].

Chili (Capsicum spp.) seed oil contains potent bioactive constituents such as capsaicin, flavonoids, tocopherols, and polyunsaturated fatty acids, which have shown antimicrobial and anti-inflammatory properties [4]. Similarly, anise seed oil (Pimpinella anisum L.), traditionally used in herbal remedies and culinary practices, contains major components like anethole, limonene, and estragole, which exhibit pharmacological actions including antibacterial, antifungal, and antioxidant effects [5].

The present research study assess and compare the antimicrobial activity of chili seed oil and anise seed oil against selected Gram-positive, Gram-negative, and fungal pathogens namely *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans* using standardized in vitro methods to comparatively access the individual efficacies and provides a scientific foundation for their potential use in pharmaceutical or cosmetic formulation.

II. MATERIAL AND METHODOLOGY

2.1 Materials

a. Essential oils: Cold-pressed chili seed oil and steam-distilled anise seed oil were used for study.
b. Test organisms:
   1. Gram-positive bacteria: *Staphylococcus aureus*
   2. Gram-negative bacteria: *Escherichia coli*
   3. Fungal strain: *Candida albicans*
c. Culture media: Mueller-Hinton Agar (MHA) for bacteria, Sabouraud Dextrose Agar (SDA) for fungi
d. Solvent: DMSO

2.2 Methods

2.2.1 Preparation of Culture Media

Mueller-Hinton agar [6] and Sabouraud Dextrose Agar [7] were prepared and were sterilized using autoclave.

2.2.2 Agar Well Diffusion Method

Mueller-Hinton agar and Sabouraud Dextrose Agar plates were inoculated with bacterial (*Staphylococcus*

aureus and Escherichia coli) and fungal strain (*Candida albicans)* respectively. The Wells were made in inoculated agar plates, and 100 µL of each oil (diluted 1:1 in DMSO) was added to each well. The plates were incubated at 37°C for 24 hours (bacteria) and 48 hours at 28°C (fungi).

III. RESULTS AND DISCUSSION

3.1 Zone of Inhibition (Agar Well Diffusion Method)

The antimicrobial strength of essential oils was compared using respective zone of inhibition.

Table 1: Zones of Inhibition (mm) for Chili Seed Oil and Anise Seed Oil

Microorganism	Chili Seed Oil (mm)	Anise Seed Oil (mm)
Staphylococcus aureus	14 ± 1.2	18 ± 1.0
Escherichia coli	10 ± 0.9	13 ± 1.1
Candida albicans	12 ± 1.0	16 ± 1.2

3.2 Discussion

The present study demonstrates that both chili seed oil and anise seed oil possess notable antimicrobial activity against *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans*. Anise seed oil consistently exhibited greater zones of inhibition compared to chili seed oil across all tested organisms, suggesting superior efficacy. This enhanced activity may be attributed to its major bioactive components, such as anethole and limonene, which are known for their strong antimicrobial properties [8][9].

The results align with previous research indicating the effectiveness of essential oils as alternative antimicrobial agents, particularly against antibiotic-resistant pathogens [10][11]. The broad-spectrum activity observed in both oils supports their potential use in pharmaceutical and cosmetic formulations aimed at infection control. However, further studies are needed to clarify their mechanisms of action, optimal concentrations, and safety profiles for practical applications. Overall, our findings reinforce the promise of plant-based essential oils as complementary strategies in combating microbial resistance.

IV. CONCLUSION

This study demonstrates that both chili seed oil and anise seed oil possess significant antimicrobial activity against *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans*, with anise seed oil consistently exhibiting larger zones of inhibition across all tested organisms. The superior efficacy of anise seed oil may be attributed to its rich content of bioactive compounds such as anethole and limonene, which are known for their potent antimicrobial properties. These findings suggest that both oils, particularly anise seed oil, hold promise as natural antimicrobial agents that could be incorporated into pharmaceutical or cosmetic formulations to help combat microbial infections and address the growing challenge of antimicrobial resistance. However, further research is necessary to elucidate their mechanisms of action, determine optimal usage concentrations, and establish safety profiles for practical applications. Overall, this research supports the potential of plant-derived essential oils as effective alternatives or adjuncts to conventional antimicrobial agents in the ongoing fight against resistant pathogens.

REFERENCE

[1] Chinemerem Nwobodo D, Ugwu MC, Oliseloke Anie C, Al-Ouqaili MTS, Chinedu Ikem J, Victor Chigozie U, Saki M. Antibiotic resistance: The challenges and some emerging strategies for tackling a global menace. J Clin Lab Anal. 2022 Sep;36(9):e24655.

[2] Vishwakarma, J., Kumar, S., Sondhiya, M., Singh, A., Kumar, V., Rai, B., & Rathi, J. C. (2025, June). Comparative study of antimicrobial properties of oregano, clove and neem oil using the disc diffusion method. *International Journal of Modern Pharmaceutical Research*

[3] Swamy MK, Akhtar MS, Sinniah UR. Antimicrobial Properties of Plant Essential Oils against Human Pathogens and Their Mode of Action: An Updated Review. Evid Based Complement Alternat Med. 2016;2016:3012462.

[4] Echave, J., Pereira, A. G., Carpena, M., Prieto, M. Á., & Simal-Gándara, J. (2020). *Capsicum seeds as a source of bioactive compounds: Biological properties, extraction systems, and industrial application*. In Capsicum. IntechOpen.

[5] Gülçin, İ., Oktay, M., Kireçci, E., & Küfrevioğlu, Ö. İ. (2003). Screening of antioxidant and antimicrobial activities of anise (*Pimpinella*

anisum L.) seed extracts. *Food Chemistry, 83*(3), 371–382.

[6] Vishwakarma, J., Sahu, S., Deshmukh, J., Maria, M., Kushwaha, K., Ahirwar, M., & Rathi, J. C. (2025). Antimicrobial efficacy of eucalyptus, cinnamon, and oregano essential oils: A comparative study. *World Journal of Pharmaceutical and Medical Research*.

[7] Aryal, S. (2022, August 10). *Sabouraud dextrose agar (SDA) – Composition, principle, uses, preparation and colony morphology*. MicrobiologyInfo.

[8] Dumitrescu E, Muselin F, Tîrziu E, Folescu M, Dumitrescu CS, Orboi DM, Cristina RT. *Pimpinella anisum* L. Essential Oil a Valuable Antibacterial and Antifungal Alternative.

[9] Radaelli M, da Silva BP, Weidlich L, Hoehne L, Flach A, da Costa LA, Ethur EM. Antimicrobial activities of six essential oils commonly used as condiments in Brazil against Clostridium perfringens. Braz J Microbiol. 2016

[10] Shojaii A, Abdollahi Fard M. Review of Pharmacological Properties and Chemical Constituents of Pimpinella anisum. ISRN Pharm. 2012;2012:510795.

[11] Morrine, A. O., Zen-Zi, W., Weih, G. B., Grant, A. H., Kamal, D., & Baumler, D. J. (2018). Comparative analysis of capsaicin in twenty nine varieties of unexplored *Capsicum* and its antimicrobial activity against bacterial and fungal pathogens. *Journal of Medicinal Plants Research, 12*(29), 544–556.