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Effect of *Aspergillus versicolor* Fungus Extract on Some Bacterial Species

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Abstract :-

Fungus *Aspergillus versicolor* is a subject of extensive study in biomicrobiology and pharmaceutical science owing to its ability to generate an array of biologically active secondary metabolites. Introducing this fungus into different strains of bacteria, it is known that the effect is mainly on its inhibition and antibacterial activity, as in its extracts present substances with anti-pathogenic microorganisms growth. *Aspergillus versicolor* is a filamentous fungus that produces a variety of secondary metabolites with potential inhibitory effects on *Pseudomonas aeruginosa* bacteria. Research indicates that certain compounds derived from A. versicolor show antibacterial activity against P. aeruginosa, including the inhibition of cell division and DNA-based metabolic interference. Other research suggests a multifaceted relationship between *Aspergillus versicolor* fungus and *Helicobacter pylori* bacteria, which includes both inhibitory effects from secondary metabolites and potential synergistic, carcinogenic, or concurrent associations.

Key word: *Aspergillus versicolor, Pseudomonas aeruginosa , Helicobacter pylori*

Introduction :-

Aspergillus versicolor is a common filamentous fungus belonging to the genus Aspergillus. This fungus is highly adaptable and can grow in diverse environments [1]. It is particularly known for producing potent mycotoxins and for its ability to color colonies in a variety of colors, hence its name "versicolor" (meaning "variable colors") [2]. A. versicolor is a widespread fungus (ubiquitous) in nature, found in soil, organic matter, decaying plant remains, and stored grains [3]. It is among the most prevalent moulds that contaminate homes and damp spaces. It grows well on drywall, carpets, wallpaper, and wood that has been subjected to prolonged moisture exposure and is a major contributor to “sick building syndrome."[4]

Fungi metabolize complex chemical compounds, which are normally isolated using organic solvents like ethyl acetate or the like or methanol [5]. These substances have natural anti-bacterial acting effect especially anthraquinones like aversin and its derivatives among others [6]. It has been found that these substances can pass through the wall of the bacterial cell and inhibit important enzymes inside the cell. Cyclic peptides such as the endophytic-derived penicopeptide A also show good antibacterial activity [7, 8]. Cyclic peptides such as penicopeptide A, which are derived from plant-associated strains, show strong anti-bacterial activity.

The inhibitory effect of Aspergillus versicolor (antibacterial)

The fungus Aspergillus versicolor produces a potent arsenal of biologically active compounds and secondary metabolites with antibacterial properties, most notably [9, 10]:

Sterigmatocystin: This is the direct chemical precursor of aflatoxin. This compound has the ability to induce oxidative stress and inhibit the growth of competing bacterial cells in the environment. Here is a detailed scientific analysis of the nature of this interaction and the shared biomechanisms between them [11].

Polyketides and anthraquinones: Several compounds (such as versicolorin derivatives and palitantin) have been isolated from this fungus and have demonstrated in laboratory tests the ability to penetrate the cell wall of Gram-negative bacteria and inhibit their viability [12].

Overcoming resistance compounds: Some strains of this fungus produce compounds such as aspergillomarasmine A, a natural inhibitor of metallo-β-lactamases, enzymes used by *Pseudomonas aeruginos*a to resist strong antibiotics such as carbenimets [13].

Pseudomonas aeruginosa :

Pseudomonas aeruginosa is one of the most important opportunistic, Gram-negative bacteria. It is classified globally as one of the most dangerous nosocomial pathogens due to its high resistance to antibiotics and its remarkable ability to adapt to various moist environments [14, 15]. These bacteria are characterized by the production of distinctive pigments and an aromatic scent resembling that of "grapes," "berries," or "popcorn" as a result of the production of the compound Aminoacetophenone [16, 17]. Bacteria possess an arsenal of virulence factors that enable them to colonize and destroy tissues [18, 19]:

- **Surface structures:**
- **Ciliates and flagella:** for adhesion to epithelial cells and movement.

Alginate (exopolysaccharide): a mucous substance that protects bacteria from phagocytosis and contributes to biofilm formation; it is very common in strains of cystic fibrosis patients.[20]

- **Exotoxins and enzymes:**

Exotoxin A: inhibits protein synthesis within host cells (similar to the mechanism of diphtheria toxin).

Elastase and proteases: enzymes that break down elastin and collagen, damaging tissues and blood vessels [21].

Phospholipase C: damages the cell membrane (hemolysin).

Pyocyanin: inducer of oxidative stress in tissues..

P. aeruginosa is a major therapeutic challenge because of its multiple drug resistance mechanisms (MDR): [22, 23]

- Endogenous resistance - limited permeability of the outer membrane and presence of efflux pumps that pump out antibiotics from the cell.
- Acquired resistance: production of β-lactamases including AmpC and carbapenemases..
- Biofilm: Production of a viscous matrix that impedes the contact of antibiotics and the immu3ne system with bacterial cells.

***Pseudomonas aeruginosa* Antifungal Response**

P. aeruginosa is not an easy target; it possesses aggressive defensive and offensive mechanisms that make the relationship between them an antagonistic interaction: [24, 25]

Cyanide and Phenazine Secretion: The bacteria produce toxic compounds such as pyocyanin and cyanide, which cause cytotoxicity in surrounding fungi by destroying the respiratory chain in the fungal mitochondria.

Iron Starvation: The bacteria secrete very potent iron carriers (sideophores) such as pyoverdine, which draw iron ions from the medium and deprive the fungi of them, thus limiting the growth of the fungal mycelium [26] .

Activation of Silent Genes Through Co-culture

From a research and microbiological perspective, when Aspergillus versicolor is co-cultured with Pseudomonas aeruginosa in the same medium:

This intense competition leads to the activation of silent biosynthetic gene clusters in the fungi. This activation prompts the fungi to produce new alkaloids and polyketides that they would not have produced if they were growing alone (axenic culture), as a defense mechanism against bacterial attack. [27]

Helicobacter pylori :

Helicobacter pylori, previously known as Campylobacter pylori, is a gram-negative bacterium best known for its role in causing gastric ulcers in the human stomach [28]. Its helical body is thought to have evolved to penetrate the mucous lining of the stomach, helped by its flagella, and thereby establish infection[29]. Virulence factors in H. pylori (Helicobacter pylori) bacteria are the mechanisms and toxins that enable the bacteria to survive in the highly acidic environment of the stomach, penetrate its lining, evade the immune system, and cause diseases ranging from gastritis to ulcers. Key virulence factors include: [30, 31]

Urease: This is the bacteria's most important weapon, as it produces thi3s enzyme which breaks down urea in the stomach into ammonia and carbon dioxide. The ammonia neutralizes the acidity surrounding the bacteria, creating a safe alkaline environment that allows them to survive and colonize.

Vacuole cytotoxin (VacA): A toxin that creates holes and vacuoles within the cells of the gastric mucosa, leading to cell death and tissue destruction.

CagA: Acts as a "tumor protein" that is directly delivered into gastric cells by bacteria through a type IV secretion system leading to cell morphology changes, increased inflammation, and ultimately, tumor and gastric cancer formation.

Adhesins: e.g., BabA and OipA, are proteins that facilitate tight binding of the bacterial cells to the gastric mucosa, thus protecting them from intestinal peristalsis and the flow of gastric juices..

Flagella: The bacteria have flagella, which allow them to move quickly, burrow through the dense mucous layer of the stomach, and access the more protected epithelial cells.

Enzymes of protection (catalase and oxidase): These enzymes are employed to detoxify the oxidative hostile molecules produced by immune cells of the host, allowing the bacteria to escape the immunity of the host.

Other genes / antigens: such as the IceA and DupA genes, which are associated with more intense inflammation and the risk of ulcer or gastric atrophic development.

Respuesta antifungica a Helicobacter pylori

Investigation of the impact of the fungus *Aspergillus versicolor* on *Helicobacter pylori* is a part of microbiological research that deals with secondary metabolites and natural antibiotics of the filamentous fungi [32].

Laboratory studies show that these effects can be distilled into several main scientific statements:

- **Biologically Active and Antibacterial Compounds**

The fungus *A. versicolor* has been reported to possess the potential to produce various secondary minds [33]. Some of these molecules were found to be inhibitor or bactericide of Gram-negative bacteria, such as *H. pylori*. Among the most prominent of these chemical groups are:[34]

Anthraquinones: such as averufin and versicolorin, compounds that play a role in inhibiting bacterial cell growth.

Xanthones: such as sterigmatocystin (although its high hepatotoxicity and carcinogenicity preclude its therapeutic use, it possesses biological properties against competing microbes in the natural environment).

Butanolides and cyclic peptides: Some strains (especially those isolated from marine environments or as endophytes) produce peptide derivatives that inhibit bacterial reproduction by penetrating their cell wall or plasma membrane.

- **Proposed Mechanisms of Action**

When organic extracts (such as ethyl acetate extract) of A. versicolor were tested against H. pylori, the inhibition mechanisms centered around [35] [36]:

Urease Inhibition: H. pylori bacteria rely on the enzyme urease to survive the harsh acidity of the stomach by converting urea to ammonia. Some fungal extracts act as competitive or non-competitive inhibitors of this enzyme, thus depriving the bacteria of their acidic defenses.

Membrane Disruption: Fungal metabolites increase the permeability of the bacterial cell membrane, causing leakage of vital cellular components and bacterial cell death.

Influence on Virulence Factors: Some compounds may impair the bacteria's ability to adhere to epithelial cells or inhibit the expression of certain virulence-related genes.

- **Biological Challenges and Limitations**

Although some extracts of this fungus have shown inhibitory effects against bacteria in laboratory dishes, there are strict limitations preventing their direct application in human medicine [37, 38]:

High Toxicity: Aspergillus versicolor is a major producer of Sterigmatocystin, a mutant aflatoxin precursor that is highly toxic to the liver and kidneys; therefore, its crude extracts cannot be used as oral treatments.

Isolation and biorne; The nowadays study research priorities are to isolate only safe (nontoxic) compounds from the fungus or, alternatively, to chemically modify them in order to obtain potentia3l antibiotic candidates having high efficiency against H. pylori strains resistant to the conventional antibiotics (i.e. clarithromycin and metronidazole).

Conclusion :-

Aspergillus fungi secrete secondary metabolites (organic compounds and mycotoxins) that act as natural antibiotics, targeting and weakening bacteria. In contrast, *Pseudomonas aeruginosa* bacteria produce secondary compounds that inhibit fungal growth (such as pyoverdine and phenazines) [39]. Their simultaneous presence within the human body or the environment leads to different immune responses; secretions from Pseudomonas bacteria stimulate oxidative stress within fungal cells, while their co-occurrence exacerbates the severity of respiratory diseases and increases bacterial resistance to antibiotics [40]. Some fungal extracts have shown efficacy in inhibiting the growth of H. pylori bacteria, known to cause stomach ulcers, opening the door to exploring new drug sources (such as extracted compounds) to combat antibiotic-resistant bacteria [41]. Despite the stabilizing effect, this fungus is not used therapeutically; it is classified as an environmental allergen and produces mycotoxins such as strygatomsteine, meaning that its benefit is limited to isolating pure and pharmacologically safe chemicals [42].

ETHICAL APPROVAL

The research protocol was approved by the Ethical Research Committee of the Kirkuk Health Authority. We declare that the Helsinki Declaration had been followed in the study.

INFORMED CONSENT

Participants were aware of the purpose of the study and provided informed consent prior to the participations.

Conflict of interest: No conflict of interest

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Data Availability: The data available on request

All authors reviewed the results and approved the final version of the manuscript.

References

1- Géry A, Séguin V, Eldin de Pécoulas P, Bonhomme J, Garon D. Aspergilli series Versicolores: importance of species identification in the clinical setting. Critical Reviews in Microbiology. 2023 Jul 4;49(4):485-98.

2- Abdel-Azeem AM, Abdel-Azeem MA, Abdul-Hadi SY, Darwish AG. Aspergillus: Biodiversity, ecological significances, and industrial applications. InRecent advancement in white biotechnology through fungi: volume 1: diversity and enzymes perspectives 2019 Mar 9 (pp. 121-179). Cham: Springer International Publishing.

3- Kaur J, Singh AP, Singh AP, Kaur R. White-rot fungus: An updated review. International Journal of Pharmaceutics and Drug Analysis. 2021 Sep;9(3):202-17.

4- Loukou E, Jensen NF, Rohde L, Andersen B. Damp buildings: associated fungi and how to find them. Journal of Fungi. 2024 Jan 27;10(2):108.

5- Eloff JN, Angeh IE, McGaw LJ. Solvent-solvent fractionation can increase the antifungal activity of a Melianthus comosus (Melianthaceae) acetone leaf extract to yield a potentially useful commercial antifungal product. Industrial Crops and Products. 2017 Dec 30;110:103-12.

6- Qun T, Zhou T, Hao J, Wang C, Zhang K, Xu J, Wang X, Zhou W. Antibacterial activities of anthraquinones: Structure–activity relationships and action mechanisms. RSC Medicinal Chemistry. 2023;14(8):1446-71.

7- Yount NY, Yeaman MR. Peptide antimicrobials: cell wall as a bacterial target. Annals of the New York Academy of sciences. 2013 Jan;1277(1):127-38.

8- Mohamed GA, Ibrahim SR, Asfour HZ. Antimicrobial metabolites from the endophytic fungus Aspergillus versicolor. Phytochemistry Letters. 2020 Feb 1;35:152-5.

9- Wang H, Xi Y, Zhang S, Wang Y, Xiao J, Cheng Z, Zhang Z. Recent Advances of Secondary Metabolites From Marine-Derived Aspergillus versicolor: Chemical Diversity and Bioactivities (2015–2024). Chemistry & Biodiversity. 2025 Dec;22(12):e02414.

10- Conrado R, Gomes TC, Roque GS, De Souza AO. Overview of bioactive fungal secondary metabolites: cytotoxic and antimicrobial compounds. Antibiotics. 2022 Nov 11;11(11):1604.

11- Raimondi F, Singh G, Betts MJ, Apic G, Vukotic R, Andreone P, Stein L, Russell RB. Insights into cancer severity from biomolecular interaction mechanisms. Scientific reports. 2016 Oct 4;6(1):34490.

12- Yang LJ, Peng XY, Zhang YH, Liu ZQ, Li X, Gu YC, Shao CL, Han Z, Wang CY. Antimicrobial and antioxidant polyketides from a deep-sea-derived fungus Aspergillus versicolor SH0105. Marine drugs. 2020 Dec 11;18(12):636.

13- Zahir I. Aspergillomarasmine, a promising adjuvant to overcome antibiotic resistance. Journal of Biology and Biomedical Research (ISSN: 3009-5522). 2025 Sep 19;2(1):177-81.

14- Diggle SP, Whiteley M. Microbe Profile: Pseudomonas aeruginosa: opportunistic pathogen and lab rat. Microbiology. 2020 Jan;166(1):30-3.

15- Nimer NA. Nosocomial infection and antibiotic-resistant threat in the Middle East. Infection and drug resistance. 2022 Jan 1:631-9.

16- Mele MA, Kang HM, Lee YT, Islam MZ. Grape terpenoids: Flavor importance, genetic regulation, and future potential. Critical Reviews in Food Science and Nutrition. 2021 May 15;61(9):1429-47.

17- Buican BC, Luchian CE, Colibaba LC, Niculaua M, Bordean ME, Kallithraka S, Cotea VV. Aroma Compounds from Grape Pomace: Investigation of Key Winemaking Factors for Future Extraction Applications—A Review. Horticulturae. 2025 Mar 10;11(3):302.

18- Sharma AK, Dhasmana N, Dubey N, Kumar N, Gangwal A, Gupta M, Singh Y. Bacterial virulence factors: secreted for survival. Indian journal of microbiology. 2017 Mar;57(1):1-0.

19- Abdulateef SA, Owaif HA, Hussein MH. Importance of virulence factors in bacterial pathogenicity: a review. International Journal of Medical Science and Clinical Research Studies. 2023 Apr 22;3(4):765-9.

20- Chung J, Eisha S, Park S, Morris AJ, Martin I. How three self-secreted biofilm exopolysaccharides of Pseudomonas aeruginosa, Psl, Pel, and alginate, can each be exploited for

antibiotic adjuvant effects in cystic fibrosis lung infection. International Journal of Molecular Sciences. 2023 May 13;24(10):8709.

21- Heinz A. Elastases and elastokines: elastin degradation and its significance in health and disease. Critical reviews in biochemistry and molecular biology. 2020 May 3;55(3):252-73.

22- Kunz Coyne AJ, El Ghali A, Holger D, Rebold N, Rybak MJ. Therapeutic strategies for emerging multidrug-resistant Pseudomonas aeruginosa. Infectious diseases and therapy. 2022 Apr;11(2):661-82.

23- Alharbi MS, Moursi SA, Alshammari A, Aboras R, Rakha E, Hossain A, Alshubrumi S, Alnazha K, Khaja AS, Saleem M. Multidrug-resistant Pseudomonas aeruginosa: Pathogenesis, resistance mechanisms, and novel therapeutic strategies. Virulence. 2025 Dec 31;16(1):2580160.

24- Gellatly SL, Hancock RE. Pseudomonas aeruginosa: new insights into pathogenesis and host defenses. Pathogens and disease. 2013 Apr 1;67(3):159-73.

25- Qin S, Xiao W, Zhou C, Pu Q, Deng X, Lan L, Liang H, Song X, Wu M. Pseudomonas aeruginosa: pathogenesis, virulence factors, antibiotic resistance, interaction with host, technology advances and emerging therapeutics. Signal transduction and targeted therapy. 2022 Jun 25;7(1):199.

26- Kuemmerli R. Iron acquisition strategies in pseudomonads: mechanisms, ecology, and evolution. Biometals. 2023 Aug;36(4):777-97.

27- Alanzi A, Elhawary EA, Ashour ML, Moussa AY. Aspergillus co-cultures: A recent insight into their secondary metabolites and microbial interactions. Archives of Pharmacal Research. 2023 Apr 1;46(4).

28- Reyes VE. Helicobacter pylori and its role in gastric cancer. Microorganisms. 2023 May 17;11(5):1312.

29- Paul J. Gastrointestinal tract infections. InDisease causing microbes 2024 Jan 3 (pp. 149-215). Cham: Springer International Publishing.

30- Ansari S, Yamaoka Y. Helicobacter pylori virulence factors exploiting gastric colonization and its pathogenicity. Toxins. 2019 Nov 19;11(11):677.

31- Baj J, Forma A, Sitarz M, Portincasa P, Garruti G, Krasowska D, Maciejewski R. Helicobacter pylori virulence factors—mechanisms of bacterial pathogenicity in the gastric microenvironment. Cells. 2020 Dec 25;10(1):27.

32- Padhi S, Sharma S, Sarkar P, Masi M, Cimmino A, Rai AK. A Comprehensive Review of Plant and Microbial Natural Compounds as Sources of Potential Helicobacter pylori-Inhibiting Agents. BioTech. 2025 Nov 26;14(4):94.

33- Miao FP, Li XD, Liu XH, Cichewicz RH, Ji NY. Secondary metabolites from an algicolous Aspergillus versicolor strain. Marine drugs. 2012 Jan;10(1):131-9.

34- Breijyeh Z, Jubeh B, Karaman R. Resistance of gram-negative bacteria to current antibacterial agents and approaches to resolve it. Molecules. 2020 Mar 16;25(6):1340.

35- Cardos IA, Danila C, Yahya G, Seleem NM, Mosbah RA, Shaldam MA, Vicas SI, Metwally K, Cavalu SD. Targeting Helicobacter pylori enzymes using Viscum album L. extract: in silico molecular docking and in vitro study. Frontiers in Cellular and Infection Microbiology. 2025;15:1690969.

36- Ying J, Zhou Z, Tang J, Zhang H. Establishing links between biosynthetic gene clusters in fungi and their secondary metabolites: A case study of Aspergillus. Bioresource Technology. 2026 Apr 5:134535.

37- Hafidh RR, Abdulamir AS, Vern LS, Bakar FA, Abas F, Jahanshiri F, Sekawi Z. Inhibition of growth of highly resistant bacterial and fungal pathogens by a natural product. The open microbiology journal. 2011 Aug 16;5:96.

38- Yuan B. What personalized medicine humans need and way to it——also on the practical significance and Scientific Limitations of Precision Medicine. Pharmacogenomics and Personalized Medicine. 2022 Dec 31:927-42.

39- Bastos RW, Akiyama D, Dos Reis TF, Colabardini AC, Luperini RS, de Castro PA, Baldini RL, Fill T, Goldman GH. Secondary metabolites produced during Aspergillus fumigatus and Pseudomonas aeruginosa biofilm formation. MBio. 2022 Aug 30;13(4):e01850-22.

40- Cumming E, Peters C. Immune response to infection. Anaesthesia & Intensive Care Medicine. 2024 Jun 1;25(6):439-43.

41- da Silva RM. Evaluation of the antimicrobial potential of natural extracts on Helicobacter Pylori (Master's thesis, Universidade de Coimbra (Portugal)).

42- Singh K, Kumari A. Mycotoxins and mycotoxicoses. Singapore:: Springer; 2022 May 17.