IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A Review Article On Bio Active Compounds In Citrus Fruits

P. HARSHITHA

Department of MSc Microbiology

Siddhartha Women's Degree & PG College,

Kukatpally, Hyderabad.

Abstract:

Because of their flavor, nutritional content, and health-promoting qualities, citrus fruits (genus citrus) are grown and consumed all over the world. The main types of bioactive substances found in citrus, such as flavonoids, limonoids, carotenoids, phenolic acids, vitamin C, essential oils, and dietary fibers (pectin), are summarized in this article.

Natural phytochemicals called flavonoids provide therapeutic benefits and help prevent a number of diseases. These phytochemicals are primarily present in citrus fruits, but they are also present in seeds, cereals, tea, coffee, wine, and chocolate. The primary bioactive ingredients in citrus fruits are flavonoids, which have several health benefits, particularly antidiabetic ones.

Citrus flavonoids are extremely bioactive substances that have antibacterial, antioxidant, neuroprotective, and anticancer properties, among other health advantages.

Bioactive phenolic chemicals found in citrus peels provide a number of health benefits, such as anti-inflammatory, anti-hypertensive, antibacterial, and antidiabetic properties.

Additionally, the wound-causing microbes (S. aureus, E. coli, streptococcus pyogenes, and E. faecalis) are affected by bioactive substances such as flavonoids, phenolic acids, essential oils, limonoids, and vitamins.

Introduction:

Oranges, mandarins, lemons, limes, grapefruits, and their hybrids are some of the most significant crops in the world. They belong to the *Rutaceae* family and are a varied collection of fruits with a tart flavor and high vitamin C content. Citrus fruit tissues (peel, albedo, pulp, juice, and seeds) contain a wide variety of phytochemicals with evidence of advantageous biological actions in addition to macronutrients and vitamins. Scientific data associating diets high in citrus to a lower incidence of chronic diseases and growing consumer desire for functional foods and natural substitutes for synthetic additives have sparked interest in citrus bioactive.. PubMed [1]

Native to subtropical and tropical regions of Asia (from India to North China), the genus Citrus contains a wide variety of trees and shrubs, with 16 species (according to *Swingle's* classification) or 156 species (according to *Tanaka's* classification).Around the world, 100 million tons of citrus fruits are produced each year, of which 60 million tons are consumed domestically, 10 million are exported, and 30 million are utilized in industrial processes. The production of oranges, lemons, limes, pomelos, grapefruit, mandarins, and their hybrids dominates the market.

Hesperidin was found via groundbreaking biochemistry research in the nineteenth century, marking the first identification of flavonoids in the citrus genus. A variety of citrus fruits, including pomelos, oranges, mandarins, lemons, limes, bergamots, and grapefruits, contain flavonoids. Citrus fruits are a part of a healthy diet because of their high nutritional content, appealing sensory qualities, and affordable pricing, citrus fruits are a good addition to any diet. Because of their distinctive flavor and high nutritional content (vitamin C, dietary fiber, and bioactive chemicals), citrus fruits are grown and consumed in large quantities worldwide. [2]

Major Classes of Bioactive Compounds in Citrus Fruits

Class of Compound

- Flavonoids
- Phenolic acids
- Carotenoids
- Essential oils
- Vitamins
- Limonoids

Flavonoids:

Bioactive substances with antibacterial, anti-inflammatory, and antioxidant qualities include flavones (like apigenin and diosmetin) and flavanones (like hesperidin and naringenin). The peels and seeds contain large amounts of these chemicals, which are frequently glycosylated to sugar molecules, affecting their solubility and bioavailability**.**

Impact on Microorganisms that Cause Wounds:

Harm bacterial membranes, prevent DNA replication, and prevent the formation of biofilms.PMC [3]

Phenolic acids:

Numerous phenolic acids, including ferulic, p-coumaric, and caffeic acids, are present in citrus fruits; these acids are mostly concentrated in the peels, but they are also present in the pulp and juice.

These substances function as antioxidants, and the amount of each varies greatly according on the fruit is ripeness, kind, and portion.

Their use in citrus fruits enhances the fruit is general health-promoting qualities and may lower the likelihood of developing chronic illnesses.

Impact on the microbe that causes wounds:

- Interferewith the integrity of the bacterial cell wall and disrupt enzyme activity.PubMed [4]

Essential Oils:

Citrus fruits contain rich, fragrant liquids called essential oils that are mostly taken from the fruit is peel. The monoterpene limonene, which gives most citrus oils their distinctively fresh aroma, is the main constituent. Because of their pleasant scent and a variety of bioactive qualities, such as antibacterial and antifungal activities, citrus essential oils are prized in a variety of industries, from food to cosmetics.

Impact on bacteria that cause wounds:

Breach the microbial cell wall, release the contents of the cell, and prevent quorum sensing.[5]

Carotenoids:

Citrus fruits contain pigments called carotenoids, which give them their vivid hues—yellow, orange, and red—and add to their nutritional content. Carotenoids, which are categorized as carotenes (such as beta-carotene and beta-cryptoxanthin) and xanthophylls (such as lutein and violaxanthin), are primarily found in citrus fruits. These qualities strengthen the immune system and function as antioxidants.

Impact on microorganisms that cause wounds:

enhances immune function, lowers oxidative stress at the wound site, and provides indirect antimicrobial assistance. [6]

Vitamins:

Although citrus fruits are well known for being a great source of vitamin C, they also include additional B vitamins, such as riboflavin (B2) and thiamin (B1). They are also high in antioxidants including flavonoids and carotenoids, as well as vitamins A and E. These vitamins stimulate the immune system and promote collagen formation. Vitamin C promotes wound healing and stops bacteria from growing. [7]

Limonoids:

Citrus fruits, such as oranges, lemons, and grapefruits, contain limonoids, which are bitter-testing substances, mostly in the seeds and peel. Citrus juices gradually lose their bitterness due to these bioactive triterpenoids, which have a furan ring. Numerous advantageous qualities, such as antioxidant, anti-inflammatory, antiviral, and anticancer activities, are being investigated for limonoids.

• It prevents oxidative damage to pathogens and the growth and pathogenicity of bacteria.

Wound causing microorganisms controlled by *Citrus fruits*

These substances can stop or lessen the development of germs that cause wounds, preventing infections and accelerating the healing process. Examples include the Gram-positive bacteria Staphylococcus aureus.

Gram-negative Pseudomonas aeruginosa bacteria

The gram-negative bacteria Escherichia coli and the fungus yeast Candida albicans

Enterococcus faecalis is a bacterium that is Gram positive.

Enterococcus faecalis:

The human gastrointestinal tract is frequently home to the facultative anaerobic, Gram-positive bacterium Enterococcus faecalis. However, when HPV penetrates sterile bodily places or wounds, it turns opportunistic.

Clinical Significance

One of the main causes of wound infections, particularly surgical site infections and diabetic foot ulcers, is Enterococcus faecalis.

• Infections of burn wounds

• Traumatic wounds infected

Role of Citrus Fruits Against *Enterococcus faecalis*

Bioactive antimicrobial substances found in citrus fruits have the ability to either suppress or eradicate E. faecalis.

Among these are flavonoids, phenolic acids, essential oils, limonoids, vitamins, and organic acids.

Antimicrobial Mechanisms Against E. faecalis

1. Disruption of the cell wall and membrane

- Cell lysis results from the breakdown of peptidoglycan layers by citrus essential oils (limonene, citral).

2. Preventing the Formation of Biofilms

- In infected wounds, E. faecalis creates biofilms.
- Quorum sensing genes (fsrB, geIE) involved in biofilm formation are inhibited by citrus flavonoids such as quercetin and naringenin.
- stops wounds from being colonized.

3. Inhibition of DNA and Protein Synthesis

- Flavonoids prevent replication by binding to DNA gyrase and topoisomerase IV.

4. Inhibition of enzymes

- By inhibiting ATPase enzymes, phenolic acids lower the amount of energy produced by bacteria.

5. Reduction of PH

- Citric acid inhibits the growth of E. faecalis by lowering the pH of the immediate lesion.[8]

Conclusion:

In conclusion, citrus fruits have anti-inflammatory and natural antibacterial qualities that effectively combat wound-causing pathogens such as streptococcus pyogenes, E. coli, S. aureus, and E. faecalis.

Their bioactive chemicals are important in natural wound care products and antimicrobial therapies because they have a strong capacity to fight off wound-causing microorganisms and aid in tissue healing.

Antimicrobial, antiviral, anticancer, anti-inflammatory, and antioxidant qualities are found in these bioactive substances, which include flavonoids, limonoids, carotenoids, phenolic acids, vitamin C, essential oils, and dietary fibers (pectin).

References:

- Xu, Y., He, P., He, B., Chen,Z. "Bioactive flavonoids metabolites in citrus species: their potential health benefits and medical potentials." *Frontiers in Pharmacology*, 2025. DOI: 10.3389/fphar.2025.1552171. PubMed
- Gandhi GR, Vasconcelos ABS, Wu DT, Li HB, Antony PJ, Li H, Geng F, Gurgel RQ, Narain N, Gan RY. Citrus Flavonoids as Promising Phytochemicals Targeting Diabetes and Related Complications: A Systematic Review of In Vitro and In Vivo Studies. Nutrients. 2020 Sep 23;12(10):2907. doi: 10.3390/nu12102907. PMID: 32977511; PMCID: PMC7598193.
- Saini, R. K., et al. (2022). *Bioactive Compounds of Citrus Fruits.***PubMed Central**. PMC
- Singh B, et al. *Phenolic composition, antioxidant potential and health benefits of citrus peel.* Food Research International. 2020. PubMed
- **Fisher, K., & Phillips, C. A.** (2008). Potential antimicrobial uses of essential oils in food: is citrus the answer? *Trends in Food Science & Technology, 19*(3), 156–164. https://doi.org/10.1016/j.tifs.2007.11.006
- Edge, R., MC Garvey, D. J., & Truscott, T. G. (2010). **The carotenoids as antioxidants—A review.***Journal of Photochemistry and Photobiology B: Biology*, 70(1), 123–130. https://doi.org/10.1016/S1011-1344(02)00117-7
- Carr, A. C., &Maggini, S. (2017). **Vitamin C and immune function.***Nutrients*, 9(11), 1211. https://doi.org/10.3390/nu9111211
- Mubarak, Z., et al. (2018). The Acid Tolerance Response and pH Adaptation of Enterococcus faecalis in Citrus Extracts. *Frontiers in Microbiology*, 7, 287. https://doi.org/10.3389/fmicb.2018.00287