ISSN: 2347-6567

International Journal of Allied Medical Sciences and Clinical Research (IJAMSCR)

IJAMSCR |Vol.14 | Issue 3| Jul - Sep 2026

www.ijamscr.com

DOI : https://doi.org/10.61096/ijamscr.v14.iss3.2026 .1307-1311

Review Article: Marine Algae in The Treatment of Skin Infections

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Published on:

24.07.2026
Published by:
Futuristic Publications
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Abstract: Marine algae are a diverse group of photosynthetic organisms with significant potential in treating skin infections due to their bioactive compounds. This review explores the antimicrobial properties of marine algae, their mechanisms of action against skin pathogens, and their application in developing novel therapeutic agents for skin infections

Keyword: Marine algae is naturally bio active compound act as a treatment for skin infection

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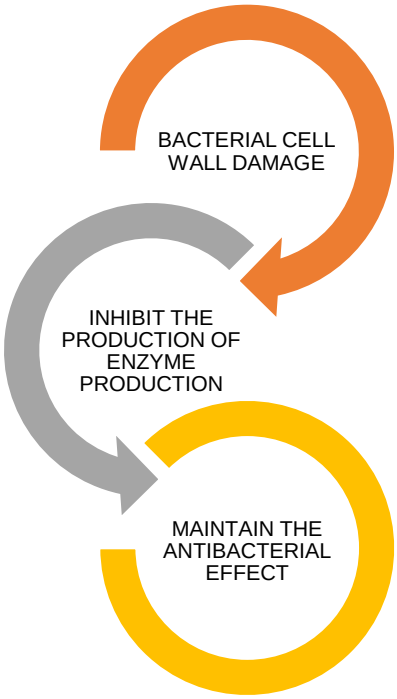
1. Introduction

Skin infections caused by bacteria, fungi, and viruses represent a major health concern worldwide. The rise of antibiotic resistance necessitates alternative treatment options. Marine algae, abundant in bioactive metabolites such as polysaccharides, polyphenols, and fatty acids, have gained attention for their relevant action . They contain antimicrobial, antiviral, anti-inflammatory, antioxidant, anticancer, and wound-healing compounds that have therapeutic applications as a properties relevant to skin health.



2. Bioactive Compounds in Marine Algae

Marine algae produce various secondary metabolites including phlorotannins, sulfated polysaccharides, carotenoids, and fatty acids. These compounds exhibit antimicrobial effects by disrupting microbial cell walls, inhibiting enzyme activity, and modulating immune responses. The diversity of these compounds varies among green (Chlorophyta), red (Rhodophyta), and brown (Phaeophyceae) algae. .Bioactive peptides and especially highlights some key issues, such as in silico proteolysis and quantitative structure-activity relationship studies, in vivo fate of bioactive peptides, and novel technologies in bioactive peptides studies and production



Marine algae contain a wide range of bioactive compounds with pharmaceutical potential.

The major bioactive compounds include:

1. Polysaccharides – Alginate, Agar, Carrageenan, Fucoidan, Ulvan
2. Polyphenols – Phlorotannins, Phenolic acids

3. Pigments – Fucoxanthin, Chlorophyll, β-Carotene, Astaxanthin, Phycocyanin, Phycoerythrin
4. Proteins and Bioactive Peptides
5. Lipids – Omega-3 fatty acids (EPA and DHA)
6. Terpenoids
7. Sterols – Fucosterol
8. Alkaloids
9. Flavonoids
10. Vitamins – Vitamins A, C, E, and B-complex
11. Minerals – Iodine, Calcium, Magnesium, Iron, Zinc, Potassium
12. Lectins

3 .Pharmaceutical activities

Antimicrobial
Antioxidant
Anti-inflammatory
Antiviral
Antifungal
Anticancer
Immunomodulatory
Wound-healing
Anti-diabetic

4. Mechanisms of Antimicrobial Action

Three of the compounds, cycloeudesmol, laurinterol, and debromolaurinterol, exhibited activity at concentrations approaching that of streptomycin. None of the compounds inhibited all of the organisms tested. There appeared to be selectivity for gram-positive microbes.

Cell Membrane Disruption: Certain algal extracts increase membrane permeability of pathogens, leading to cell lysis.



Enzyme Inhibition: Bioactive molecules inhibit enzymes essential for microbial survival and virulence.



Anti-Quorum Sensing: Some compounds interfere with microbial communication, reducing pathogenicity and biofilm formation.



Anti-inflammatory Effects: Algal metabolites reduce inflammation, promoting skin healing and reducing infection severity.

5. Marine Algae Against Common Skin Pathogens

Studies demonstrate efficacy of marine algal extracts against Staphylococcus aureus, Streptococcus pyogenes, Candida species, and dermatophytes. Brown algae, such as Ecklonia and Sargassum species, are particularly noted for strong antibacterial and antifungal activities.

Many algal extracts have broad-spectrum antimicrobial activity against bacteria, fungi, and some viruses.

Marine algae are considered promising alternatives or adjuncts to conventional antibiotics, particularly in the context of antimicrobial resistance.

These compounds are being incorporated into topical creams, gels, ointments, wound dressings, and cosmetic formulations for managing skin infections.

1. Against Staphylococcus aureus (including MRSA)

- Inhibits bacterial growth and biofilm formation.
- Damages the bacterial cell membrane, causing leakage of cellular contents.
- Bioactive compounds: Phlorotannins, fucoidan, fucoxanthin.

2. Against Streptococcus pyogenes

- Inhibits bacterial cell wall synthesis and growth.
- Reduces inflammation associated with skin infections.
- Bioactive compounds: Phlorotannins, sulfated polysaccharides.

3. Against Pseudomonas aeruginosa

- Prevents biofilm formation.
- Disrupts bacterial membranes and reduces virulence.
- Bioactive compounds: Fucoidan, alginate-derived compounds, terpenoids.

4. Against Cutibacterium acnes

- Suppresses bacterial growth responsible for acne.
- Reduces inflammation and oxidative stress in acne lesions.
- Bioactive compounds: Fucoxanthin, phlorotannins, flavonoids.

5. Against Candida albicans

- Inhibits fungal cell membrane integrity and fungal growth.
- Prevents fungal adhesion and biofilm formation.
- Bioactive compounds: Lectins, terpenoids, sulfated polysaccharides.

6. Against Dermatophytes (Trichophyton spp. and Microsporum spp.)

- Inhibits fungal spore germination and mycelial growth.
- Effective against ringworm and other superficial fungal infections.
- Bioactive compounds: Phenolic compounds, terpenoids, fatty acids.

7. Against Herpes Simplex Virus (HSV-1 and HSV-2)

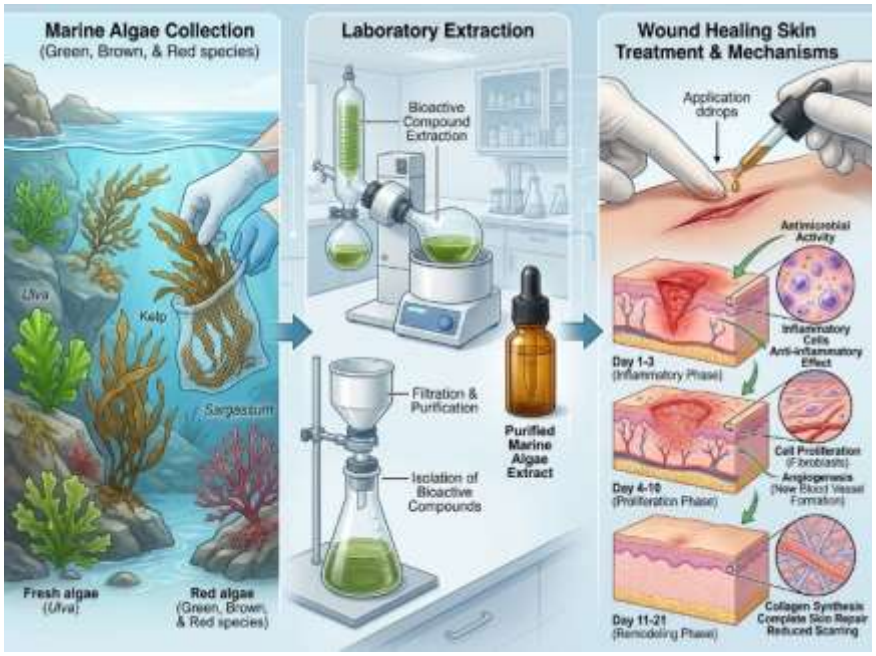
- Sulfated polysaccharides prevent viral attachment and entry into host cells.
- May reduce viral replication.
- Bioactive compounds: Carrageenan, fucoidan.

6. Applications in Skin Infection Treatment

Topical Formulations: Incorporation of algal extracts in creams, gels, and ointments enhances antimicrobial efficacy and skin regeneration.

Wound Healing: Sulfated polysaccharides from algae promote wound closure and tissue repair alongside infection control.

Cosmeceuticals: Algal bioactives serve as natural preservatives and active ingredients in skincare products targeting infected or inflamed skin.



7. Challenges and Future Directions

Standardization of extraction methods and identification of active compounds remain critical. More clinical trials are needed to validate safety and efficacy. Advances in nanotechnology and drug delivery systems may improve bioavailability and targeted application of marine algal compounds for skin infections.

8. Conclusion

Marine algae represent a promising natural source of antimicrobial compounds for treating skin infections because of their antibacterial, antifungal, antiviral, anti-inflammatory, antioxidant, and wound-healing properties. However, challenges such as variability in bioactive compounds, lack of clinical evidence, formulation difficulties, and regulatory barriers must be addressed. Future research should focus on standardized production methods, advanced drug delivery systems, comprehensive clinical trials, and sustainable cultivation to enable the successful translation of marine algae into safe and effective treatments for skin infections.

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