

# BIOACTIVE COMPOUNDS FROM MARINE ORGANISMS

With Emphasis on the Indian Ocean

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*Editors*

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# Bioactivity in Marine Algae

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Studies were conducted on 30 marine algal organisms collected from Mandapam, Tamil Nadu for their hemolytic and antimicrobial activities. The results indicate that these organisms, in general, show antibiosis against the Gram-negative microbes *Enteromorpha compressa*, *Cladophoropsis zoolingeri*, *Padina gymnospora*, *Sargassum wightii*, and *Gracilaria corticata* and against the Gram-positive cultures of *Bacillus*. Strong hemolytic activity was shown by *C. zoolingeri* and *Grateloupia lithophila*.

## INTRODUCTION

Marine algae have been reported to possess a wide range of bioactive properties (Hashimoto 1979, Baslow 1969, Hoppe, et al. 1979, Hoppe et al. 1984, Blunden et al. 1981, Cocamese et al. 1981, Ramamurthy et al. 1967, Mc Lachan 1964, Byrkholder and Sharma 1969, Conover and Sieburth 1964, Garber et al. 1958). Quite recently, Naqvi et al. (1980) studied the bioactivities of 25 species of marine algae and sea grasses collected mainly from the northwestern coast of India and a few from the coast of Tamil Nadu. There are still many marine algae that have not been studied. Presented here are the results of investigations on the antimicrobial activities of 30 marine algae of the Indian coast. The hemolytic activities of these algae have not been previously reported.

## MATERIALS AND METHODS

Thirty species of marine algae were collected from the Gulf of Mannar and Palk Bay, Mandapam, Tamil Nadu. Ethanol extracts of the organisms were examined for hemolytic activity on rabbit erythrocytes and for antimicrobial activity.

One gram of washed, air-dried, powdered algae was extracted with boiling ethanol, filtered, the ethanol extract evaporated, and the residue

**Table 1.** Algal species studied: collection sites and hemolytic activities.

No.	Algal Species	Collection Site	Hemolytic Activity
Chlorophyceae (green algae)			
1.	<i>Enteromorpha compressa</i> (Linnaeus) Greville	Rameswaram	—
2.	<i>Ulva lactuca</i> Linnaeus	Kilakarai	+
3.	<i>Ulva reticulata</i> Forsskal	Kilakarai	+
4.	<i>Chaetomorpha antennina</i> (Bory) Kuetzing	Pudumadam	+
5.	<i>Valoniopsis pachynema</i> (Metens) Boergesen	Kilakarai	+
6.	<i>Cladophoropsis zoolingeri</i> (Kuetzing) Boergesen	Seeniappa Dharga	+++
7.	<i>Bryopsis plumosa</i> (Hudson) Agardh	Pudumadam	+
8.	<i>Caulerpa peltata</i> (Turner) Lamouroux	Seeniappa Dharga	++
9.	<i>Caulerpa racemosa</i> , <i>V. macrophysa</i> (Kuetzing) Taylor	Thonithurai	—
10.	<i>Avrainvillea erecta</i> (Berkel) Gepp.	Hare Island	++
11.	<i>Halimeda gracilis</i> Harv. ex. J. Ag.	Pamban	++
Phaeophyceae (brown algae)			
12.	<i>Stoechospermum marginatum</i> (C. Agardh) Kuetzing	Pudumadam	++
13.	<i>Padina gymnospora</i> (Kuetzing) Vickers	Seeniappa Dharga	—
14.	<i>Cystoseira trinodis</i> (Forsskal) C. Agardh	Krusadi Island	+
15.	<i>Hormophysa trigueta</i> (Linnaeus) Kuetzing	Krusadi Island	+
16.	<i>Sargassum myriocystum</i> J. Agardh	Hare Island	—
17.	<i>Sargassum wightii</i> (Graville) J. Agardh	Pudumadam	+
18.	<i>Turbinaria conoides</i> (J. Agardh) Kuetzing	Thonithurai	++
Rhodophyceae (red algae)			
19.	<i>Gelidiella acerosa</i> (Forsskal) Feldmann et Hamel	Pudumadam	++
20.	<i>Amphiroa fragilissima</i> (Linnaeus) Lamouroux	Pamban	—
21.	<i>Cheilosporum spectabile</i> Harvey	Seeniappa Dharga	++
22.	<i>Jania rubens</i> (Linnaeus) Lamouroux	Kilakarai	+
23.	<i>Grateloupia lithophila</i> Boergesen	Pudumadam	++
24.	<i>Gracilaria corticata</i> J. Agardh	Pudumadam	+
25.	<i>Gracilaria crassa</i> (Harvey) J. Agardh	Pamban	+
26.	<i>Gracilaria edulis</i> (Gmel.) Silva	Hare Island	+
27.	<i>Hypnea musciformis</i> (Wulf) Lamouroux	Pudumadam	+
28.	<i>Centeroceras clavulatum</i> (C. Agardh) Mont.	Pudumadam	+
29.	<i>Acanthophora spicifera</i> (Vahl) Boergesen	Seeniappa Dharga	—
30.	<i>Laurencia papillosa</i> (Forsskal) Greville	Pudumadam	+

dissolved in 10 ml of phosphate-buffered saline at pH 7. Hemolytic activity bioassays were conducted as described by Rao et al. (1985) using rabbit blood erythrocytes. Antimicrobial activity was examined on cultures of *Vibrio alginolyticus*, *V. parahaemolyticus*, *Bacillus*, *Staphylococcus aureus*, and *Salmonella typhi*.

## RESULTS AND DISCUSSION

The species of marine algae, with their place of collection, and the results of the hemolytic activity bioassays are given in table 1. The results of the antimicrobial bioassays are presented in table 2.

Table 2. Antimicrobial activities of algae.

No. Algal Species	<i>Vibrio al-</i> <i>ginolyticus</i>	<i>Vibrio</i> <i>parahaem-</i> <i>olyticus</i>	<i>Bacillus</i>	<i>Staphy-</i> <i>lococcus</i> <i>aureus</i>	<i>Salmonella</i> <i>typhi</i>
Chlorophyceae (green algae)					
1. <i>Enteromorpha compressa</i>	+	+	+	—	—
2. <i>Ulva lactuca</i>	+++	—	—	—	—
3. <i>Ulva reticulata</i>	+	++	—	—	—
4. <i>Chaetomorpha antennina</i>	++	—	—	+	—
5. <i>Valoniopsis pachynema</i>	+	++	—	++	—
6. <i>Cladophoropsis zoolingeri</i>	++	—	+	+	—
7. <i>Bryopsis plumosa</i>	+	+	—	—	—
8. <i>Caulerpa peltata</i>	+++	—	—	+++	—
9. <i>Caulerpa racemosa</i>	+	—	—	—	—
10. <i>Avrainvillea erecta</i>	—	+++	—	—	—
11. <i>Halimeda gracilis</i>	—	+	—	+	—
Phaeophyceae (brown algae)					
12. <i>Stoechospermum marginatum</i>	++	+	—	+++	—
13. <i>Padina gymnospora</i>	—	—	+	—	—
14. <i>Cytoseira trinodis</i>	+	+	—	—	—
15. <i>Hormophysa triquetra</i>	—	+	—	—	—
16. <i>Sargassum myriocystum</i>	—	—	—	—	—
17. <i>Sargassum wightii</i>	—	—	+	—	—
18. <i>Turbinaria conoides</i>	+	—	—	—	—
Rhodophyceae (red algae)					
19. <i>Gelidiella acerosa</i>	+++	+	—	+++	—
20. <i>Amphiroa fragilissima</i>	—	—	—	+	—
21. <i>Cheilosporum spectabile</i>	—	+	—	+	—
22. <i>Jania rubens</i>	+	+	—	—	—
23. <i>Grateloupia lithophila</i>	—	—	—	—	—
24. <i>Gracilaria corticata</i>	+	—	+	++	—
25. <i>Gracilaria crassa</i>	—	+++	—	—	—
26. <i>Gracilaria edulis</i>	—	—	—	—	—
27. <i>Hypnea musciformis</i>	—	+	—	—	—
28. <i>Centeroceras clavulatum</i>	—	—	—	—	—
29. <i>Acanthophora spicifera</i>	+	—	—	—	—
30. <i>Laurencia papillosa</i>	+	—	—	—	—

It is seen from the tables that the algal species generally exhibit both hemolytic and antimicrobial activities. Only one test organism, *Sargassum myriocystum*, was totally inactive. Of the 30 species examined, six species, *Enteromorpha compressa*, *Caulerpa racemosa*, *Cystoseira trinodis*, *Sargassum myriocystum*, *Amphiroa fragillissima*, and *Acanthophora spicifera*, had no hemolytic action on the red blood cells of rabbits. None of the 30 species studied showed any action on *Salmonella typhi*. There was antibiosis against Gram-negative microbes. *Enteromorpha compressa*, *Cladophoropsis zoolingeri*, *Padina gymnospora*, *Sargassum wightii*, and *Gracilaria corticata* were active against the Gram-positive culture of *Bacillus*. The algae that exhibited both hemolytic and antimicrobial activities for both Gram-negative and Gram-positive cultures were *C. zoolingeri*, *P. gymnospora*, *S. wightii*, and *G. corticata*. Two of these, *P. gymnospora* and *S. wightii*, were only active against the Gram-positive *Bacillus* and hemolytic activity.

Further studies on these bioactive algal species are under progress to determine more about their active substances, their nature, and other details.

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#### LITERATURE CITED

- Baslow, M.H. 1969. *Marine Pharmacology*. The Williams & Wilkins Co. Ltd., Baltimore, Maryland.
- Bird, C.J., and M.A. Ragan. 1984. *11th International Seaweed Symposium*, 1983. Dr. W. Junk Publishers, Dordrecht, Bosten, Lancaster.
- Blunden, G., C.J. Barwell, K.J. Fidgen, and K. Jenners. 1981. A survey of British marine algae for antiinfluenza virus activity. *Botanica Marina* 14(5): 267-272.
- Burkholder, P.R., and G.M. Sharma. 1969. Antimicrobial agents from the sea. *Lloydia* 32: 466-483.
- Cocamese, S., R. Azzolena, G. Furnari, M. Cormaci, and S. Grasso. 1981. Antimicrobial and antiviral activities of some marine algae from eastern Sicily. *Botanica Marina* 24(7): 365-367.
- Conover, J.T., and J.Mc. N. Sieburth. 1964. Effects of *Sargassum* distribution on its epibiota and antibacterial activity. *Botanica Marina* 6: 147-157.

- Garber, P., J.D. Dutcher, E.G. Adams, and J.R. Sherman. 1958. Protective effects of seaweed extracts for chicken embryos infected with influenza B or mumps virus. *Proc. Soc. Exp. Biol. Med.* 99: 590-593.
- Hashimoto, Y. 1979. *Marine Toxins and other Bioactive Marine Metabolites*. Japan Scientific Societies Press, Tokyo, Japan.
- Hoppe, H.A., T. Levring, and Y. Tanaka. 1979. *Marine Algae in Pharmaceutical Science*. Walter de Gruyter, Berlin/New York.
- Hoppe, H.A., and T. Levring. 1982. *Marine Algae in Pharmaceutical Science*. Vol. 2. Walter de Gruyter, Berlin/New York.
- McLachan, J., and Craigie, T.S. 1964. Algal inhibition by yellow ultraviolet-absorbing substances from *Fucus vesiculosus*. *Can. J. Bot.* 42: 287-297.
- Naqvi, S.W.A., S.Y. Kamat Solimabi, L. Fernandes, C.V.G. Reddy, D.S. Bhakuni, and B.N. Dhawan. 1980. Screening of some marine plants from the Indian coast for biological activity. *Botanica Marina* 24(1): 51-55.
- Ramamurthy, V.D., and S. Krishnamurthy. 1967. The antibacterial properties of marine blue-green algae *Trichodmium erythraeum* (Ehr). *Curr. Sci.* 36: 524-525.
- Rao, D.S., D.B. James, K.G. Girijavallabhan, S. Muthusamy, and M. Najmuddin. 1985. Biototoxicity in echinoderms. *J. Mar. Biol. Assoc. India* 27(1,2): 88-96.