ANTIMICROBIAL ACTIVITY OF MACROALGAE FROM KWAZULU-NATAL, SOUTH AFRICA, AND THE ISOLATION OF A BIOACTIVE COMPOUND FROM *OSMUNDARIA SERRATA* (RHODOPHYTA)

by
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Abstract

The rhodophytes or red seaweeds are an ancient group of organisms that are related to plants. Like terrestrial plants, they use secondary compounds to protect themselves from microbial infection and grazing by herbivores. However, unlike terrestrial plants, they produce mostly halogenated secondary compounds and rarely alkaloids. *Osmundaria serrata* (Rhodophyta) is found along the eastern South African coast and the Maldive Islands. Its descriptive common name is "red spirals" and the species is adapted to live in habitats with high wave action. Extracts from this seaweed had previously shown to have antimicrobial activity, but ecologically irrelevant microbes were used to test the extracts. In this study, ten bacteria were isolated from the surface of *O. serrata* and its habitat, and identified. Mostly aerobic and Gram-negative bacteria were isolated (*Halomonas* and *Pseudomonas* species) along with facultatively anaerobic forms (*Vibrio* spp.) and a Gram-positive (*Marinococcus* sp.). These were used in bioassays to compare the activity of extracts made from *O. serrata* and other seaweeds that occur in the same habitat. Marine bacteria are the initial colonisers in biofilm formation and subsequent fouling of surfaces in marine environments. The study of these bacteria in relation to their macroalgal hosts may help to control biofouling of surfaces that cause economic losses worldwide.

A comparison was made between using agar dilution and microtitre methods for testing the antibacterial activity of an *O. serrata* extract. The microtitre method was found to be more sensitive than the agar dilution method. Possibly because some of the bacteria on the petri plates (in the agar dilution method) were not in direct contact with the toxicant in the growth medium, but were in direct contact in the liquid medium of the wells in the microtitre plates.

The extract from *O. serrata* was the most active of the thirteen species of macroalgae collected from the same habitat and tested for antibacterial activity. Deformities in bacteria were observed in response to the *O. serrata* extract. Increased capsule production and blebbing of the outer membranes were observed by transmission electron microscopy (negative staining).

Lanosol diethyl ether was isolated from *O. serrata* and tested for antibacterial activity. Lanosol is produced mainly by the rhodophytes, but it is also found in other macroalgae and fungi in lower concentrations. The compound inhibited the test bacteria with average MIC's of 0.27 ± 0.07 mg.ml^{-1} (bacteriostatic) and 0.69 ± 0.15 mg.ml^{-1} (bactericidal).

Different forms of biofilm were observed by scanning electron microscopy on the thirteen species of macroalgae. These ranged from a very little biofilm covering on the calcified reds to complex communities on the other macroalgae. The treatment with OsO_4 vapour before fixation in glutaraldehyde preserved the biofilm structure better than no treatment and indicated that lipids are important in maintaining biofilm structure.

Since a complex biofilm community was seen on the surface of *O. serrata*, it is unlikely that lanosol functions as an antifouling agent. This chemical seems to multifunctional with antimicrobial and feeding deterrent activities.

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Dedication

This thesis is dedicated to **Mrs. Swanepoel-Engelbrecht**,
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Publications

The following articles are in preparation for publication based on the research derived from this study:

1. Barreto, M. and J.J.M. Meyer, 2003. The antibacterial activity of extracts from selected macroalgae from KwaZulu-Natal, South Africa. [Incorporating Chapters 2, 4 and 5.]
2. Barreto, M. and J.J.M. Meyer, 2003. Isolation and antimicrobial activity of the ethyl ether derivative of lanosol, from Osmundaria serrata (Rhodophyta) [Chapter 6]
3. Barreto, M. and J.J.M. Meyer, 2003. A seaweed is more than the sum of its parts: SEM visualisation of biofilms on some seaweeds from KwaZulu-Natal, South Africa [Chapter 7]

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