Determination of the Biomass and Phycocolloid Contents of some Marine Algae from Eritrea

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ABSTRACT. Specimens of five marine species of the brown (Cystoseira myrica, Sargassum torvum and Turbinaria ornata) and red (Gracilaria cortica and Gracilaria crassa) algae collected from the Red Sea coast of Eritrea were analyzed for their content of biomass and phycocolloids. Sargassum torvum was found to be the dominant species of a maximum biomass. Among the brown species, Turbinaria ornata was distinctive for its high content of alginic acid. Amount of agar did not fluctuate greatly in Gracilaria species.

Introduction

Marine algae provide a rich and adverse source of raw materials for the production of seaweed gums and polysaccharides. The major application of seaweeds is the extraction of alginic acid, alginate salts and agar. These extracts, which are called phycocolloids, have wide application in world industry (Round, 1973; Sharma, 1986; Durairatnum et al., 1990). Alginic acid occurs, naturally on the cell wall of most of brown algae. It is a complex carbohydrate polymer consisting of D-mannuronic acid and L-guluronic acid residues linked by 1-4 positions. The ratio of these two residues in the alginic acid polymer causes variation in the type of alginic acid produced (Othmex, 1954; Whistler, 1959; Saddington, 1969; Dawes, 1981). Alginic acid is capable of absorbing water 10 to 20 times its molecular weight (Tresslen & Lemon, 1951).

There is a belief that large quantities of seaweed species are available in tropical waters and the great demand for phycocolloids in the world market will help to develop industries in such areas (Durairatnum et al., 1990; Yarish &

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However, seaweeds of Eritrea have, to a large extent, escaped the attention of phycologists. Eritrea does not have a history of tradition of seaweed utilization. In this work, results of the studies on biomass, alginic acid and agar contents of some marine species from Eritrea are present.

**Materials and Methods**

**The Study Sites**

The selected sites for the study are Ghorgassum, Shaikh Saeed Island and Reisi medri. Khorgassum (15°37’N, 39°28’E) is located 12 km north of Massawa, the seaport of Eritrea. Sheikh Saeed island (15°35’N, 39°28’E) is located south of Massawa. Reisi Medri (15°36’N, 38°29’E) is located east of Massawa. The three sites share common characteristics. They have rocky intertidal area that can provide a suitable substratum for seaweeds attachment. However, they differ in wave action and possibly other environmental parameters that can affect algal growth.

Samples of *Sargassum torvum*, *Cystoseira myrica*, *Turbinaria ornata* (Phaeophyta), *Gracilaria cortica* and *Gracilaria crassa* (Rhodophyta) were collected from Shaikh Saeed island, Khorgassum and Reisi Medri on the Red Sea coast of Eritrea.

All plants were washed with seawater, freshwater, air-oven dried at 60°C for 12 hr and powdered mechanically.

Abundance was studied using a transect-quadrate method. The quadrate used was 1 meter square in area (1 m × 1 m), and it was laid at intervals of 10 meters. The wet and the dry weights of the seaweeds were measured. Statistical analysis was performed using three-way anova to determine the abundance of different species in terms of biomass, Table 1. The brown algae; *C. myrica*, *S. torvum* and *T. ornata* were examined for their alginic acid content. Two extraction methods were adopted in this work. On acidification, the resulting alginate salts were converted into alginic acid.

**Extraction of Alginic Acid**

*a – The Sodium Alginate Method: (Dawes, 1987)*

The dried ground samples (5 g each) were washed with acidulated water and digested with soda ash (150 ml) in a water bath for 20 minutes. The hot material was then filtered by suction. Concentrated hydrochloric acid (150 ml) was added portion wise with continuous stirring. The precipitated alginic acid was filtered through Buchner funnel, dried and weighed. It was qualitatively tested (Criddle & Ellis, 1976), Table 2.
**Table 1. Biomass content of the selected species of Eritrean marine algae.**

<table>
<thead>
<tr>
<th>Site</th>
<th>Parameter</th>
<th>January 1997</th>
<th></th>
<th>March 1998</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Red algae</td>
<td>Brown algae</td>
<td>Red algae</td>
<td>Brown algae</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Caracillaria crassa</td>
<td>Caracillaria Cortiea</td>
<td>Turbinaria ornata</td>
<td>Cystoseira myrica</td>
</tr>
<tr>
<td>Shaikh Saeed island</td>
<td>Tran length (m)</td>
<td>30</td>
<td>1106</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>No. of quard</td>
<td>03</td>
<td>–</td>
<td>03</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Wet weight</td>
<td>650</td>
<td>1106</td>
<td>187</td>
<td>7059</td>
</tr>
<tr>
<td>Khorgassum</td>
<td>Dry weight</td>
<td>141</td>
<td>118</td>
<td>29</td>
<td>962</td>
</tr>
<tr>
<td></td>
<td></td>
<td>–</td>
<td>–</td>
<td>30</td>
<td>–</td>
</tr>
<tr>
<td>Reisi Medri</td>
<td>Tran length (m)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>No. of quard</td>
<td>–</td>
<td>–</td>
<td>03</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Wet weight</td>
<td>–</td>
<td>–</td>
<td>1040</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Dry weight</td>
<td>–</td>
<td>–</td>
<td>128</td>
<td>–</td>
</tr>
</tbody>
</table>
The Calcium Alginate Method: (Dawes, 1981)

The dried ground samples (5 g each) were digested with sodium carbonate solution (5%, 100 ml), for 12 hr and filtered. Soluble sodium alginate in the filtrate was converted into calcium alginate by the addition of calcium chloride solution (5%). The isolated calcium alginate was dried and weighed, Table 2.

Table 2. Amounts of alginic acid and agar in some marine algae of Eritrea (Data are means of 6 determinations).

<table>
<thead>
<tr>
<th>Algae species</th>
<th>Alginic acid</th>
<th>Agar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sodium alginate method</td>
<td>Calcium alginate method</td>
</tr>
<tr>
<td>Sargassum torvum</td>
<td>1.75 g (35%)</td>
<td>3.22 g (64.5%)</td>
</tr>
<tr>
<td>Cystoseira myrica</td>
<td>0.69 g (13.8%)</td>
<td>3.31 g (66.2%)</td>
</tr>
<tr>
<td>Turbinaria ornate</td>
<td>1.52 g (30.4%)</td>
<td>3.68 g (73.6%)</td>
</tr>
<tr>
<td>Ciracilaria crassa</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Ciracilaria cortica</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

**Extraction of Agar**

The two species of *Gracilaria* were examined for their agar content. Extraction of agar was conducted as described by Pickering *et al.* (1990). The dried seaweeds (10 g each) were washed with distilled water, extracted with sodium hydroxide solution (5%) at autoclave (120°C) for 3 min. and filtered. The filtrates were allowed to gel. The gels were dissolved in water and oven dried at 60°C, Table 2.

**Results and Discussion**

The biomass of *Cystoseira myrica*, *Sargassum torvum* and *Turbinaria ornata* (Phaeophyta), *Gracilaria cortica* and *Gracilaria crassa* (Phadophyta) growing on the Red Sea coast of Eritrea has revealed clear variation in their abundance (Table 1). It was observed that, *Sargassum* formed dense strands, a criteria that have been reported for tropical species of *Sargassum* (Dawes, 1987). It could also be seen that *Sargassum* was also found to be the dominant species in all sites, particularly in Khorgassum site. *Cystoseira* has an even gradient distribution within the three sites. *Turbinaria* was completely absent in Khorgassum, but was the dominant species in Reisi medri. Comparatively, red algae have shown minimum distribution within the three sites. They are completely absent in Reisi Medri. In Shaikh Saeed Island, *Gracilaria crassa* was the only red algal...
species to be detected; but with the lowest abundance compared to brown algal species found on the same site. Both species, *Gracelaria crassa* and *G. cortica* are found in good abundance during the two sampling periods in Khorgassum (Table 1).

The biomass of *Cystoseira* and *Sargassum* species of Shaikh Saeed Island and Khorgassum (Table 1), are statistically different. The site effect could be due to physico-chemical differences (Lapointe & Tenore, 1981; El-Naggar, 1994), or to the extent of site exposure to wave action (McQuaid & Brach, 1984). No significant difference was revealed in biomass between the two sampling methods. This could be due to the reason that the Red Sea seaweeds are in their active growth period during low water temperature (October-April). The slight reduction in the biomass of *Sargassum* was attributed to the observed reduction of drifted piles. This is usually appearing at the end of the active growth period (Table 1). It could be observed that significant interactions occur between site and species. Interactions between site, period and species are of no statistical importance.

Utilizing the sodium alginate and calcium alginate extraction methods, the percentage yield of alginic acid in *Turbinaria ornata*, 30.4%, 73.6% was found to be the highest, compared to *Sargassum torvum*, 35%, 64% and *Cystoseira myrica* 13.6%, 66.2% respectively. Comparatively, the calcium alginate method gave higher percentage yield of alginic acid, (64.4%-73.6%) than the sodium alginate method (13.6%-35.0%) depending on the species. The results also confirm the findings that *Sargassum* was found to be the best alginic acid producing marine algal species in tropical waters (Dawes, 1987).

The agar content, in the red algae, *Gracilaria crassa* and *G. cortica*, does not fluctuate much and was found to be 15.8% and 17.7% respectively.

Since the Eritrean seaweed resources are still untouched, calls on an intensive study and wise utilization of such resources should be put into focus and consideration. It could be recommended that there is a need for a general biomass study of seaweed resources to determine the maximum sustainable yield and also to study the possible means of artificial propagation, processing methods in relation to seasonality. Such studies would synchronize with other ongoing efforts, on neighboring countries, to unveiling the Red Sea rich resources.

**Acknowledgement**

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References


تعيین الكتلة ومحتوى الغروات النباتية لبعض الطحالب البحرية من أريتريا

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المستخلص: تمت دراسة وتعيين محتوى الكتلة الحيوية ومحتوى الغروات النباتية لعينات خمس فصائل طحالب جمعت من ساحل البحر الأحمر بأريتريا. شملت الدراسة الطحالب البنية (مينيركيا، سيروجاسوم تورفوم و تيربيناريا أورناتا) والحمراء (جراميلاريا كورتيكا، و جراميلاريا كراسا). تبين أن سيروجاسوم هي الفصلية السائدة بعد أعلى من الكتلة الحيوية. كشفت الدراسة أن تيربيناريا أورناتا تميزت بمحتواها العالي من حمض الجينيك. كمية الأجار لم تبدد كثيراً في فصائل الجراميلاريا.

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