CHEMICAL STUDIES ON THE GREEN ALGA *MONOSTROMA* *NITIDUM* WITTROCK—III.

Inorganic Components of the Alga and Its Mucilage

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The inorganic components of algae or their mucilages have been reported on the following species, *Gelidium amansii*¹⁾, *Chondrus ocellatus*, *Iridea laminarioides*²⁾, *Gloiopeltis furcata*³⁾, *Porphyra tenera*⁴⁾, *Enteromorpha compressa* and *Ulva pertusa*⁵⁾.

The present study was carried out on the mineral constituents of *Monostroma nitidum* and of its mucilage. The results revealed that the inorganic component of mucilage consists mainly of sodium, potassium, magnesium, and sulphur, and the sulphur presents as ethereal sulphate.

Experimental

1. Materials

The fronds of *M. nitidum*, collected at Itsukaichi, Hiroshima Prefecture, on March 20th (Sample A) and April 20th (Sample B), 1961, were washed with distilled water and air-dried. Prior to analyses of the inorganic components, they were finely ground.

Preparation of Mucilage: From 300 grams of air-dried Sample A, the mucilage was extracted with 15 liters of distilled water for 24 hours at room temperature (25 to 30°C.) with occasional stirring. The extract was filtered, and then condensed to about 200 ml. *in vacuo*. To precipitate the mucilage, 10 volumes of 95 per cent methanol were added to the condensed extract. The mucilage, collected by filtration, was dissolved in a small amount of hot water. From the solution, the mucilage was reprecipitated with 95 per cent methanol. The procedure was repeated five times. Finally, the mucilage was washed successively with absolute ethanol and diethyl ether, and dried *in vacuo*. The product thus obtained was light tan in colour. The yield of mucilage was 40 grams (moisture 12.15%, N 0.15%).

2. Analytical Methods

An aliquot portion of the material was ashed at 500°C. in an electric muffle. The ash was subjected to analyses of the following elements.

Na: Triple acetate method with zinc uranyl acetate⁶⁾.

K: Gravimetric method with sodium tetraphenyl boron⁷⁾.

Ca: Volumetric calcium oxalate method⁶⁾.

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Mg: This element was precipitated as magnesium ammonium phosphate⁶⁾ from the filtrate of calcium determination. The phosphorus in the precipitated magnesium ammonium phosphate was determined colorimetrically by the molybdenum blue method⁶⁾. Then the magnesium content in the precipitate was calculated from the phosphorus value found.

Mn: Colorimetric potassium periodate method⁶⁾.

Fe: Colorimetric *o*-phenanthroline method⁶⁾.

Al: MOROSHIMA's spectrophotometric method⁹⁾.

Si: Gravimetric silicon dioxide method⁶⁾.

P: Colorimetric molybdenum blue method⁶⁾.

S: Gravimetric barium sulphate method.

In the cases mentioned above, the colorimetric works were done by Shimadzu spectrophotometer QB-50.

Total sulphur in the mucilage was determined as barium sulphate after oxidation and fixation of the sulphur with magnesium nitrate⁸⁾. The determination of ethereal sulphate sulphur in the mucilage was carried out on the hydrolysate by the gravimetric method, after hydrolysis with 2.5 per cent hydrochloric acid for 5 hours.

Results and Discussion

The inorganic components of *M. nitidum* and its mucilage are listed in Table 1.

Table 1. The inorganic components of *Monostroma nitidum* and its mucilage.

	Sample A		Mucilage from Sample A		Sample B	
Crude ash	19.68*	—	28.24**	—	17.51*	—
Na	3.63	18.45***	4.81	17.03***	2.82	16.11***
K	1.74	8.84	2.07	7.33	2.37	13.54
Ca	0.51	2.59	0.81	2.87	0.33	1.88
Mg	1.43	7.27	1.39	4.92	1.38	7.88
Fe	0.027	0.14	0.031	0.11	0.052	0.30
Al	0.019	0.098	0.024	0.085	0.054	0.31
Mn	0.0068	0.034	0.017	0.060	0.0078	0.044
P	0.13	0.66	0.57	2.02	0.22	1.26
Si	0.15	0.76	0.095	0.34	0.37	2.11
S	3.99	20.27	6.65	23.55	3.23	18.45
Total S	—	—	9.79	—	—	—
Ethereal						
Sulphate	—	—	9.82	—	—	—
S						

* % on moisture free basis.

** % on moisture and nitrogen free basis.

*** % on ash.

Sample A was collected on March 20th, and Sample B on April 20th, 1961.

MITA⁵⁾ reported that the main components in the ashes of mucilages of *E. compressa* and *U. pertusa* are magnesium, sodium, and sulphur. On the other hand, the author's data in Table 1 indicated that the inorganic component of mucilage of *M. nitidum* consists mainly of sodium, potassium, magnesium, and sulphur. In comparison with the mucilages of *E. compressa* and *U. pertusa*, the author's preparation is remarkable for its high content of ash, sodium, potassium, calcium, phosphorus and sulphur, and for the presence of manganese, which has not been recognized by MITA. The difference of the contents of ash, sodium, calcium and sulphur in Sample A and Sample B is owing probably to the seasonal variation of algal constituents.

The mucilage does not contain free sulphuric residue, since sulphate ion could not be detected until the mucilage was hydrolyzed with hydrochloric acid. It is noteworthy that there is a remarkable agreement between total sulphur content and ethereal sulphate sulphur content in the mucilage as seen Table 1. This concordant estimation of the sulphur values indicates that all the sulphur in the mucilage presents as ethereal sulphate.

From the results, it can be concluded that the mucilage of *M. nitidum* is composed mainly of sodium, potassium and magnesium salts of sulphated polysaccharide¹⁰⁾.

Summary

The inorganic constituents of *Monostroma nitidum* and its mucilage were studied quantitatively. The analytical results showed that sodium, potassium, magnesium and sulphur are rich in the minerals of them, and that the sulphur in the mucilage presents as ethereal sulphate.

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