CHEMICAL STUDIES ON MARINE ALGAE

XI. On the Tasty Ingredients of "ASAKUSANORI", *Porphyra tenera*

Kiichi MURATA, Mitsuzô TAKAGI and Mitsuo KURIYAMA
Faculty of Fisheries, Hokkaido University

Though various investigations[1)2)] have recently been carried out on the free amino acids occurring in marine algae, all of these analyses have been qualitative. "ASAKUSANORI" or *Porphyra tenera* is one of the nourishing algal foods commonly eaten with great relish. Nevertheless, its tasty ingredients have not been exactly described by any investigator. Recently, Tsuchiya and Suzuki[3)] have reported that glutamic acid, glycine and alanine are good tasty ingredients and especially alanine is a sweet one, on the whole, in *Porphyra tenera.*

In the present study, free amino acids participating as tasty ingredients of *Porphyra tenera* have been determined quantitatively by the technique of ion exchange perfected by Moore and Stein.[4)]

EXPERIMENTAL

Methods——"ASAKUSANORI", dried materials obtained from the open market were used. One gm of the dried materials was cut into small pieces and extracted by shaking occasionally with 100 ml of 70 per cent ethanol for 24 hours. After this treatment had been repeated three times, the extracts were mixed, concentrated in vacuo and filled up to 10 ml.

Total nitrogen and alcoholic extracted nitrogen were estimated by the micro-Kjeldahl procedure.

Aliquots corresponding to 4–5 mg of amino acids were used for determining free amino acids quantitatively by the technique of ion exchange used by Moore and Stein.

RESULTS

The contents of the total and alcoholic extracted nitrogen of *Porphyra tenera* are shown in Table 1. Though the date of collection is unknown because materials were

Table 1. Nitrogen forms of *Porphyra tenera*

Species	Date of collection	Total N	Alcoholic extracted N	Alcoholic extracted N / Total N
		per cent	*per cent*	*per cent*
Porphyra tenera	——	6.664	1.005	15.1

bought on the market, their total nitrogen content was 6.6 per cent. Thus the dried materials were found to be high in total nitrogen content and of good quality as samples

of "ASAKUSANORI". The alcoholic extracted nitrogen amounted to 1.0 per cent and its ratio to the total nitrogen was about 15.0 per cent.

The effluent curves obtained with the alcoholic extracts from the alga on a column of Dowex 50 resin are illustrated in Fig. 1. The distribution of the nitrogen of the

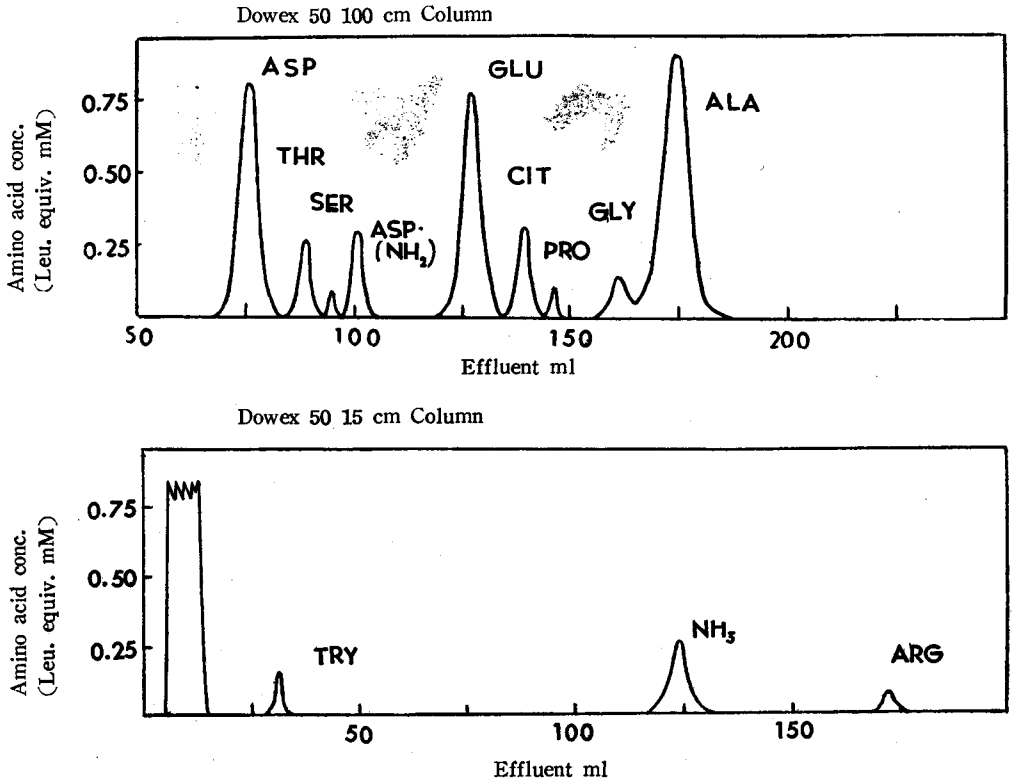

Fig. 1. Section of effluent curves obtained with alcoholic extracts of *Porphyra tenera* on a column of Dowex 50 resin

free amino acids in the alga calculated from Fig. 1 is reported in Table 2 as mg percentage of the dried materials.

It may be considered that the distribution of free amino acids in the alcoholic extracts of *Porphyra tenera* differs according to the harvesting time and locality. Therefore, the results reported in Table 2 represent only one instance of the alcoholic extract constituents of *Porphyra tenera*.

Nevertheless, the presence of aspartic acid, threonine, serine, glutamic acid, glycine, alanine and asparagine in the free state appeared to be very similar to Tsuchiya and Suzuki's results with the exception of absence of proline, tryptophan, arginine and citrulline.

According to the same authors, an amount of alanine corresponding to about ten

Table 2. The contents of free amino acids occurring in alcoholic extracts of *Porphyra tenera*

Amino acid	Author's result	Tsuchiya and Suzuki's result
	mg per cent	*mg per cent*
Aspartic acid	817.2	++
Threonine	154.7	++
Serine	40.4	+
Asparagine	214.4	+
Glutamic acid	768.2	+++
Citrulline	240.9	
Proline	111.8	
Glycine	89.1	20− 101
Alanine	942.7	20−1177
Tryptophan	132.5	
Arginine	56.5	−
Ammonia	48.3	

foldthat of glycine was contained in the alcoholic extracts of *Porphyra tenera*. Likewisely, large amounts of alanine, aspartic acid and glutamic acid were found to be present in the alcoholic extracts of *Porphyra tenera* in the present experiment. The contents of citrulline, asparagine, threonine, tryptophan and proline come next in amount to the above amino acids, and that of glycine, arginine and serine are minimum among the free amino acids occurring in *Porphyra tenera*.

DISCUSSION

Valine, methionine, isoleucine, leucine, tyrosine, phenylalanine, histidine, lysine and ornithine are not able to be determined in the alcoholic extracts of *Porphyra tenera* by this technique. Accordingly, provided that these amino acids are contained in the free state in the alga, it may be affirmed without hesitation that their contents are only to a barely appreciable degree. Fowden[5] has confirmed the presence of asparagine, glutamire and citrulline in *Chlorella vulgaris*, fresh water alga. Coulson[1] has reported that the marine algae examined differ from fresh water ones and land plants in that they not only show a preference for peptides but these amides excluding citrulline now under consideration seem to be absent.

The present research, however, has proved that asparagine and citrulline are present in the alcoholic extracts of *Porphyra tenera*. Smith and Young[6] have recognized exceptionally the presence of citrulline and ornithine in *Chondrus crispus*, marine red alga. Further investigations should be performed in future to ascertain whether these amides and amino acids are present or not in other marine algae, such as green, or brown as well as red ones.

SUMMARY

The distribution of the free amino acids occurring in the alcoholic extracts of *Porphyra tenera* has been determined quantitatively by Moore and Stein's technique of ion exchange. The results obtained are as follows: aspartic acid 817.2 mg per cent; threonine 154.7; serine 40.4; asparagine 214.4; glutamic acid 768.2; citrulline 240.9; proline 111.8; glycine 89.1; alanine 942.7; tryptophan 132.5; arginine 56.5; and ammonia 48.3 mg per cent to the dried materials.

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