

# STUDIES ON THE PROTEINS, PEPTIDES AND FREE AMINO-ACID CONTENTS IN SOME SPECIES OF *PADINA* FROM SOUTH-EASTERN COAST OF INDIA

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IN continuation of previous work,<sup>1</sup> the amino-acid constituents of the proteins, peptides and free state were studied in the three species of *Padina*: *P. distromatica* Hauck., *P. gymnospora* (Kuetz.) Vickers and *P. tetrastromatica* Hauck., to ascertain whether any variation occur in them. Algae were collected from the south-eastern coast of India in the months of February and March. These were preserved and analysed as described previously.<sup>1</sup>

The results are given in Tables I, II and III. The results of the protein hydrolysates are expressed as amount in grams per 16 g. of protein N, while those of the peptide hydrolysates and the free amino-acids, as micrograms per gram dry weight of the alga. The amino-acids which were not estimated quantitatively because of diffusion of the bands or interference of other compounds or minuteness of their qualities, are denoted by the "+", "++", etc., signs. An increasing number of these signs indicate relatively larger concentration of those amino-acids with the colour reagent used, the depth of colour being judged merely by visual colour comparison. Moreover, although hydroxyproline and tryptophan (specially in the protein hydrolysates) occurred in estimable amounts due to inadequacy of equipment these were not estimated in toto, and are indicated by the "+" signs. Leucine and isoleucine were estimated together and are referred to as "leucine(s)".

Of the twenty-two amino-acids detected in the protein hydrolysates (cf. the comments on the occurrence of  $\gamma$ -amino-butyric acid, homocystine and ornithine in the protein hydrolysates<sup>1</sup>) except homocystine, all were consistently found. Among these except hydroxyproline and tryptophan, all were consistently estimated. Although the qualitative composition of the amino-acids was similar in these species, significant variation in the amounts was observed in these constituents except aspartic acid, glutamic acid, histidine, homocystine (when estimated), leucine(s), lysine, tyrosine and valine; but the magnitude of these variations was varied for the individual amino-acids. Despite these changes, usually proline, aspartic acid, glutamic acid, leucine(s), phenylalanine, histidine and glycine occurred in large amounts while the others, in fairly

large quantities except  $\gamma$ -amino-butyric acid, homocystine, lysine and ornithine which were usually in poor concentrations.

Both qualitative and quantitative variations occurred in the peptide hydrolysates of these algae. Of the nineteen amino-acids recorded only  $\alpha$ -alanine, leucine(s), phenylalanine, proline, tyrosine and valine occurred consistently. All these were consistently estimated except phenylalanine and tyrosine. Although all the amino-acids were in poor amounts, comparatively, proline was consistently in large amount and in certain species (e.g., *P. gymnospora*) this had contributed a major portion of the peptides.

TABLE I

Comparative account of the protein hydrolysates in some species of *Padina* from south-eastern coast of India

(Calculated as amount in grams per 16 g. of protein N)

Compound	<i>Padina distromatica</i>	<i>Padina gymnospora</i>	<i>Padina tetrastromatica</i>
$\alpha$ -Alanine	4.89	4.66	3.89
$\gamma$ -Aminobutyric acid	0.92	0.78	0.57
Arginine	2.29	3.73	7.55
Aspartic acid	6.57	7.61	7.32
Cystine	4.13	3.73	2.63
Glutamic acid	7.19	8.99	6.75
Glycine	6.12	5.44	4.69
Histidine	6.42	6.06	5.72
Homocystine	..	0.93	0.92
Hydroxyproline	++	++	++
Leucine (s)	6.12	6.68	6.06
Lysine	1.68	1.55	1.49
Methionine	2.91	3.11	2.29
Ornithine	0.92	1.24	1.14
Phenylalanine	7.19	5.59	5.03
Proline	7.34	9.48	5.95
Serine	4.43	4.66	3.66
Threonine	5.05	4.97	3.66
Tryptophan	++	++	++
Tyrosine	3.82	2.95	2.97
Valine	3.06	2.64	2.63
Number detected	21	22	22
Number estimated	19	20	20
Amount in grams per 16 g. of protein N	81.05	77.80	74.90
Amount in grams per 100 g. of the dry alga	5.30	5.33	6.55
Protein N in grams per 100 g. of the dry alga	1.05	1.03	1.40
Per cent. recovery of protein N	69.73	72.91	72.18

TABLE II

Comparative account of peptide hydrolysates in some species of *Padina* from south-eastern coast of India

(Calculated as micrograms per gram dry weight of the alga)

Compound	<i>Padina distromatica</i>	<i>Padina gymnospora</i>	<i>Padina tetrastratica</i>
$\alpha$ -Alanine	.. 2.13	0.39	1.57
$\beta$ -Alanine	.. 1.15	..	..
$\gamma$ -Aminobutyric acid	.. ..	+	0.84
Arginine	.. ..	..	0.94
Aspartic acid	.. 0.71	..	1.35
Cysteic acid	.. ++	..	..
Cystine	.. 0.73	..	0.91
Glutamic acid	.. 0.78	..	1.20
Glycine	.. 2.16	..	..
Histidine	.. ++	..	++
Leucine (s)	.. 3.08	0.61	4.38
Lysine	.. ..	0.68	1.72
Ornithine	.. 1.65	..	..
Phenylalanine	.. 3.55	++	5.33
Proline	.. 6.63	12.91	3.06
Serine	.. 1.18	..	1.23
Tyrosine	.. 1.73	++	++
Valine	.. 2.04	0.72	3.33
Number detected	.. 16	9	15
Number estimated	.. 14	6	13
Amount estimated	.. 27.52	15.31	25.86

TABLE III

Comparative account of free amino-acids in some species of *Padina* from south-eastern coast of India

(Calculated as micrograms per gram dry weight of the alga)

Compound	<i>Padina distromatica</i>	<i>Padina gymnospora</i>	<i>Padina tetrastratica</i>
$\alpha$ -Alanine	.. 0.93	1.20	0.50
$\beta$ -Alanine	.. ..	..	++
Arginine	.. ..	++	++
Asparagine	.. ++	..	++
Aspartic acid	.. 1.40	0.35	1.20
Glutamic acid	.. 2.29	1.78	2.26
Glycine	.. +	..	++
Hydroxyproline	.. ++	..	..
Leucine (s)	.. 0.42	++	..
Proline	.. 3.83	5.61	++
Serine	.. +	..	++
Threonine	.. ..	..	++
Tryptophan	.. +++	+++	++
Tyrosine	.. +	++	++
Valine	.. 0.45	0.45	0.55
Number detected	.. 13	10	13
Number estimated	.. 7	6	4
Amount estimated	.. 9.32	9.39	4.51

All the amino-acids recorded in the protein hydrolysates were found either consistently or occasionally in the peptides except homocystine, hydroxyproline, methionine, threonine and tryptophan (since all the samples were analysed after acid hydrolysis, tryptophan in the samples might have been destroyed<sup>4</sup>). In addition,  $\beta$ -alanine and cysteic acid occurred in the peptide hydrolysates.

Free amino-acids also varied both in quality and quantity in these species. Of the sixteen amino-acids detected,  $\alpha$ -alanine, aspartic acid, glutamic acid, proline, tryptophan, tyrosine and valine occurred consistently. Of these  $\alpha$ -alanine, aspartic acid, glutamic acid and valine occurred consistently in estimable amounts; but none of these was in large quantity.

All the protein hydrolysates occurred consistently or occasionally in the free state except  $\gamma$ -aminobutyric acid, cystine, histidine, homocystine, lysine. In addition  $\beta$ -alanine and asparagine occurred occasionally.

As regards the total amount, the proteins were consistently most, while the free amino-acids, the least. Of the twenty-five amino-acids detected in the proteins, peptides and free state, in these algae,  $\alpha$ -alanine, proline, tyrosine and valine occurred consistently, while  $\alpha$ -alanine and valine were consistently estimated.

Dokhan<sup>1</sup> detected free and combined arginine in *Padina pavona*. Pillai<sup>5</sup> studied *P. australis* and estimated phenylalanine, leucine(s), tyrosine, valine, alanine, glycine, aspartic acid, glutamic acid, serine, threonine, arginine and histidine in the acid hydrolysates of both the mature and the young specimens. Lewis and Gonzalves<sup>3</sup> analysed the protein hydrolysates of *P. tetrastratica* and estimated all the above-mentioned amino-acids<sup>1,5</sup> except arginine, which was detected only. In addition, lysine, methionine and proline were estimated; ornithine and tryptophan were detected.

All the amino-acids recorded by the above workers<sup>1,3,5</sup> are estimated here in the protein hydrolysates except tryptophan, which is detected only. In addition,  $\gamma$ -aminobutyric acid, cystine and homocystine are estimated, while hydroxyproline is detected.

Lewis and Gonzalves<sup>2</sup> studied the free amino-acid contents of *P. tetrastratica* and estimated  $\alpha$ -alanine, aspartic acid, glycine and valine; in addition, cystine, glutamic acid, leucine(s), ornithine, proline, serine, threonine and tryptophan were detected.

All the amino-acids mentioned above<sup>2</sup> are either estimated or detected here in the free state except cystine and ornithine. In addition,



$\beta$ -alanine, arginine, hydroxyproline and tyrosine are detected.

The algæ studied here are comparatively poorer in the proteins and free amino-acids than those reported earlier.<sup>2,3</sup> This might have been due to the variations in the habitat of the specimens studied. However, the record of some additional ones made here, is most likely due to the improved methods of analysis employed in the present investigation. Since the identical species, viz., *P. tetrastomatica* investigated earlier<sup>2,3</sup> as well as in this investigation, differed in amount of proteins and free amino-acids, it seems a study of these variations in the different species of the same genus, as well as under varied ecological conditions, is necessary in order to evaluate the importance of the data

in the taxonomical and nutritional studies of any algal specimen.

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5. Pillai, V. K., *Proc. Indian Acad. Sci.*, 1957, **45 B**, 43.

## SYMPOSIUM ON FERRO-ALLOY INDUSTRY

**M**ETALLURGICAL partnership of special and alloy steels with the ferro-alloys started more than a century ago when Robert Mushet happened to add manganese to the then newly invented Bessemer-Kelly process of pneumatic steel-making, providing thereby the solution to a major cri-de-cœur in the metallurgy of steel. Since the turn of the last century considerable developments have taken place in the research and production technology of ferro-alloys which have led to the phenomenal growth of ferro-alloy industry in different parts of the world. These developments in ferro-alloy's production technology have, however, been exceedingly slow in their impact in India.

In order to focus attention on the latest technological trends and research developments in the production of ferro-alloys, a symposium on 'Ferro-Alloy Industry in India' was organised by the National Metallurgical Laboratory from February 12 to 15, 1962, to exchange technical know-how with the leading scientists, and metallurgists from different parts of the world in the context of the interrelated problems facing the industry and its growth along scientific and economic lines. The Symposium drew a large gathering of top-ranking scientists and technologists from all over the world besides a large number of distinguished delegates from India.

The Symposium was inaugurated by Prof. M. S. Thacker, Director-General, Scientific

and Industrial Research; Sir Jehangir Ghandy, Chairman of the Executive Council, National Metallurgical Laboratory, presided, and Dr. B. R. Nijhawan, Director, National Metallurgical Laboratory, welcomed the distinguished delegates.

Twenty-nine technical papers covering the various aspects of research and development work on ferro-alloys and their production and properties were presented and discussed in six technical sessions. The subjects covered relate to (i) survey of raw materials, sampling methods and role of research; (ii) extraction and production technology; (iii) scope for development of ferro-alloy industry, utilisation of by-products and methods of standardisation; (iv) physico-chemical principles involved in the ferro-alloy production; and (v) general aspects of ferro-alloy technology.

The National Metallurgical Laboratory Technical Journal for February 1962 (Vol. IV, No. 1) is a Symposium Number and contains besides the abstracts of all the papers presented at the Symposium, the following technical papers in greater detail: "Some Aspects of the Sampling and Analysis of Ferro-Alloys" by G. M. Holmes; "The Extraction of Vanadium from Titanium Iron Ores" by A. G. Robiette; "Some Applications of Rapid Metallurgy to the Manufacture of Ferro-Alloys" by R. Perrin and A. Greffe; "Electrolytic Manganese in a Non-Diaphragm Cell" by G. Bjorling and N. G. Elfstrom.