BIOCHEMICAL AND NUTRITIONAL STUDIES ON EAST PAKISTAN VEGETABLES

Part II.—Distribution of Protein and Non-Protein Nitrogen in Different Parts of Vegetables

H.N. De, Emdadul Haque Bhuiya and J.C. Debnath

Food and Fruit Research Division, East Regional Laboratories, Pakistan Council of Scientific and Industrial Research, Dacca

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The distribution of crude and true protein contents in different parts of fruity and leafy vegetables, like skin, flesh etc., have been evaluated by determination of total and non-protein nitrogen contents. The results show higher concentration of total nitrogen in the skin and leafy portions of the vegetables. The distribution of non-protein nitrogen reciprocally showed lesser contents in skin and leaves, and more in the fleshy portion and in the stem, with the ultimate result of more content of true protein in skin and leaves. The leaves of some plants like water hyacinth, jack fruit, banyan, banana etc. consumed by the bovine population were also similarly analysed and the results show high level of nearly 7.7 percent crude protein in jack fruit leaves with moisture content of 46 percent in constrast to low content of 1.8 percent in water hyacinth having moisture content of nearly 90 percent. The NPN contents in the leaves of these plants were also low like other leafy vegetables. The significance of these findings in the feasibility of bulk extraction of protein from the above sources has been discussed.

Introduction

The importance of vegetables in our dietaries, for the supply of vitamin C has already been discussed in the previous report by Qudrat-i-Khuda, De and Shariff.[1] Their role in the supply of protein cannot be ignored, as is evident from the reports of Chibnall,[2] Lugg,[3] Pirie,[4] and Steward and Thompson.[5] FAO[6] have also stressed on the importance of vegetables in the supply of protein to the poor rice-diets of Indo-Pakistan Subcontinent.

Vegetables also supply some non-protein nitrogenous constituents like amines, peptides and amino acids in free and bound form [7-12] and other constituents which may be well utilised in the human body. With this background information, it was considered desirable to study the distribution of protein nitrogen and non-protein nitrogen in the different vegetables as consumed in the dietaries of this region. Further, their distribution in the different parts of the vegetables like skin (epidermis) and flesh (mesocarp and endocarp) was also evaluated in order to determine how far the supply of the protein and non-protein nitrogen constituents will be affected by scrapping off the skin of some vegetables as practised in our meal preparation. Previous experiments on the distribution of ascorbic acid and anthocyanin in rat-tail radish, as reported by Qudrat-i-Khuda, De and Shariff,[13] have shown the maximum concentration of vitamin C on the skin, in association with the pigment, and the scrapping of the pigmented skin greatly affects the vitamin C supply. The food composition table compiled by McCance and Widdowson[14] shows decrease of the protein supply of the edible portion in contrast to the whole portion of the vegetables. It will be therefore worthwhile to study this section-wise distribution since the previous reports,[3-5,15] mainly refer to the results of the whole plant products.

In this series of experiments some of the leafy vegetables as banyan leaves, jackfruit leaves, water hyacinth etc., as consumed by the bovine population, as supplementary fodders, have also been investigated so as to ascertain the feasibility of bulk extraction of protein from these and other such sources, for consumption by the people of the developing countries as viewed by Pirie[16] and others.

Experimental

Some common vegetables (Group A) consumed by the people of this region were collected in their green stage and immediately segmented into different sections like skin (epidermis), upper fleshy portion (mesocarp) and the middle fleshy portion (endocarp) of the interior. Skin was carefully removed by scrapping with a glass edge and the upper fleshy portion just beneath the skin was then sliced out leaving the last middle portion of the flesh. In the case of bean the inner seeds were separately treated instead of middle fleshy portion. In the case of leafy vegetables (Group B) like *Amaranthus*, *Ipoemea aquatica*, etc., the whole products were analysed as these are consumed as such. The leaves of jack fruit tree, banyan tree etc. (Group C) were also analysed as such. The water hyacinth was separately estimated for leaves and stems.

The total nitrogen was determined from the whole sample according to the standard Kjeldahl method and the NPN by the micro-Kjeldahl method from their TCA filtrate. The moisture contents of the samples were also simultaneously determined according to the method described by A.O. A.C. The analytical values for the vegetables of fruit group (Group A) and those of leafy group (Group B) are shown in Table 1. The values for leaves consumed by bovine population are shown in Table 2 as Group C.

Results

Total Nitrogen and Crude Protein.—The results presented in Table 1 show the crude protein contents (N$\times$6.25) of some of the common fruity vegetables (whole product) of Group A, varied from 0.50 to 1.32 percent. Section wise analysis showed the skin as the richest with the values ranging 1.71 to 2.28 percent. Fleshy portions reversibly were much poorer in this respect. In the case of papaya, its skin showed the highest content of the crude protein to the extent of 3.59 percent. Its fleshy portion and the whole fruit were likewise richer, in crude protein, than the other vegetables studied. This high crude protein content in papaya (green) is perhaps due to the presence of large quantity of white milky exudate (latex) in which sufficient quantity of papain is accumulated. However, in every vegetable studied, it was noted that the crude protein concentration is richer in the skin with gradual diminution towards the interior fleshy portion. The leafy vegetables of Group B contained more protein than the fruity vegetables of Group A—higher values were noted in the leaves of *Ipoemea aquatica* and *Colocasia macrohiza.*

Regarding distribution of crude protein in the leaves consumed by the bovine population (Table 2) jack fruit leaves showed the maximum level of nearly 7.72 percent with low moisture content of only 46 percent, and water hyacinth leaves showed minimum value of 2.12 percent at a higher water content of 84 percent. The leaves from other plants like banyan tree, etc. also possess moderate quantities of crude protein in ordinary condition.

Non-Protein Nitrogen and True Protein Nitrogen.—The determination of the total non-protein nitrogen contents of the above samples indicate the ratios of the NPN to the protein nitrogen ranging from 0.36 to 0.88 in the case of skin and 1.61 to 2.90 in the case of the fleshy portion of the vegetables of Group A. For leaves of vegetables of Group B and leaves of water hyacinth, jack fruit, banyan tree, etc. of Group C, the above ratio ranged from 0.44 to 1.23. The stem of Amaranthus and water hyacinth showed a higher ratio of nearly 2. These observations of comparatively lower NPN in the case of skin and leaves reflect more concentration of true protein in these sections ranging from 0.42 to 5.51 percent in contrast to lower range of 0.15 to 0.85 percent in the fleshy portions, in Barbati seed and in the stems as evident from the Tables 1 and 2.

This high level of true protein in the skin and leaves may be corelated with high enzymatic activities in these tissues for the performance of some vital metabolic functions involved in respiratory and photosynthetic mechanisms. The previous report from these laboratories by Qudrat-i-Khuda, De and Khan[17], that the dehydrogenase enzymes which are involved in the ripening of banana are concentrated on their peel, and similar findings[18] in the case of mango ripening lend support to the above possibility. This is also substantiated by the findings of Wildman and Bonner[19] on the presence of phosphatase and some dehydrogenases in the cytoplasmic proteins of spinach isolated by them in two separate fractions. A large volume of other work reviewed by different authors[3-5,20,21] that the chlorophyll by itself is 40-50 percent protein in nature and constitutes 35 to 40 percent of the total leaf protein, give a strong evidence of the importance of skin of the fruity vegetables and of leaves in the supply of large quantity of protein of high biological activity.

Discussion

The results of these investigations show that the vegetables grown in this region may supply some quantity of protein, the amount of which depends on the nature of the vegetables. This protein is concentrated mostly on the skin which is generally scrapped off in the preparation of the meal.

Comparatively the skin contains less NPN fractions than the fleshy portions and the stems of radish and water hyacinth, for which its true portein content is higher. In the leaves also there is low content of NPN fractions. These NPN fractions play an important role in the bulk extraction of protein. Because of lower true protein and higher NPN contents the bulk extraction of protein from water hyacinth, which is a great menace to our crop, specially the rice crop, will not be a practicable venture. The leaves of other plants like jack fruit, banyan tree etc. may be suited for such bulk protein extraction. But how far these extracted proteins would economically compete with the other sources of protein like fish etc., which are easily available in this region, and how far these will be acceptable to the people of this region in preference to fish, meat etc., are some of the main issues which require a thorough investigation.

TABLE I.— DISTRIBUTION OF TOTAL NITROGEN (TN), NON-PROTEIN NITROGEN (NPN) AND PROTEIN NITROGEN (PN) IN VARIOUS PARTS OF VEGETABLES OF HUMAN DIETARIES.

Name of the vegetable		Section of the vegetable	Moisture	TN	Crude protein TNx6.25	NPN	PN	Actual protein PNx6.25	Ratio of NPN:PN
Botanical	Local								
Group A									
Luffa acutangula	Jhinga	W	93.91	0.121	0.76	—	—	—	—
		S	87.49	0.274	1.71	0.123	0.151	0.94	0.81
		UF	94.22	0.178	1.11	0.112	0.056	0.41	1.70
		MF	94.74	0.084	0.52	—	—	—	—
Trichosanthes dioica, Rozle	Patal	W	92.45	0.162	1.01	—	—	—	—
		S	83.68	0.294	1.84	0.102	.192	1.2	0.57
		UF	94.56	0.208	1.30	0.136	.072	0.45	1.89
		MF	95.12	0.144	0.90	—	—	—	—
Solanum Melongenala	Brinjal	W	89.88	0.177	1.10	—	—	—	—
		S	85.46	0.365	2.28	0.172	0.193	1.20	0.88
		UF	87.48	0.204	1.28	0.140	0.064	0.40	2.18
		MF	87.64	0.136	0.85	—	—	—	—
Raphanus Sativus	Radish	W	94.28	0.108	0.67	—	—	—	—
		S	88.42	0.276	1.72	0.098	0.178	1.11	0.55
		UF	90.24	0.082	0.51	0.061	0.021	0.15	2.90
		MF	92.56	0.076	0.47	—	—	—	—
Cucumis sativus	Cucum-ber	W	93.46	0.080	0.50	—	—	—	—
		S	89.58	0.163	1.02	0.058	0.105	0.65	0.55
		UF	90.25	0.102	0.62	0.064	0.038	0.23	1.61
		MF	92.39	0.072	0.45	—	—	—	—
Trichosanthes anguina	Chich-inga	W	88.46	0.134	0.84	—	—	—	—
		S	84.68	0.262	1.64	0.084	0.178	1.11	0.47
		UF	85.66	0.156	0.97	0.108	0.048	0.30	2.25
		MF	86.29	0.115	0.72	—	—	—	—
Casica Papaya	Papaya	W	90.56	0.211	1.32	—	—	—	—
		S	85.28	0.574	3.59	0.152	0.422	2.64	0.36
		UF	88.36	0.229	1.43	0.146	0.082	0.51	1.78
		MF	89.26	0.155	0.97	—	—	—	—
Vigna catiaug	Barbati	W	88.48	0.113	0.71	—	—	—	—
		S	84.56	0.196	1.29	0.074	0.122	0.76	0.60
		Seed	86.75	0.089	0.58	0.056	0.033	0.20	1.70
Group B									
Amaranthus	Data	W	92.24	0.134	0.84	—	—	—	—
		Leaf	84.38	0.214	1.33	0.082	0.122	0.76	0.67
		Stem	90.67	0.168	1.05	0.114	0.054	0.34	2.11
Raphanus Sativus	Radish vegetable	W	90.36	0.130	0.81	—	—	—	—
		Leaf	86.52	0.152	0.95	0.084	0.068	0.42	1.23
		Stem	89.14	0.115	0.72	0.072	0.043	0.27	1.63
Ipoemca acquatica Forsk	Kalmi Sak	W	93.45	0.358	2.24	—	—	—	—
		Leaf	88.59	0.516	3.22	0.242	0.274	1.71	0.88
		Stem	90.72	0.457	2.84	0.321	0.136	0.85	1.36
Colocasia macrohiza	Kachu	Leaf	82.34	0.630	3.94	0.245	0.385	2.40	0.63

The data represent the values in g/100 g. wet basis.
W—Whole product, S—Skin, UF—Upper fleshy portion
MF—Middle fleshy portion

Table 2.— Distribution of Total Nitrogen (TN), Non-Protein Nitrogen (NPN) and Protein Nitrogen (PN) in Plants Consumed By Bovine Population.

Name of the vegetable: Botanical	Name of the vegetable: Local	Section of the vegetable	Moisture	TN	Crude protein TNx6.25	NPN	PN	Actual protein (PNx6.25)	Ratio of NPN:PN
				Group C					
Eichhenia crassipes solms.	Water Hyacinth	Leaf	84.83	0.339	2.12	0.154	0.185	1.16	0.83
		Stem	89.24	0.205	1.28	0.138	0.067	0.42	2.06
Artocarous integrifolis L.	Jack fruit	Leaf	46.07	1.235	7.72	0.384	0.851	5.51	0.45
Ficus religiosis L.	Ashwatha	Leaf	52.10	0.987	6.17	0.423	0.564	3.52	0.75
Ficus benghalessis L.	Bat (Banyan)	Leaf	64.24	0.612	3.82	0.186	0.426	2.66	0.44
Musa balbisiana	Banana	Leaf	75.72	0.706	4.41	0.312	0.394	2.46	0.79

The data indicates the values in g./100 g., wet basis.

Regarding the importance of vegetables in protein nutrition it may be viewed that the consumption of 200 g. of vegetables, as has been recommended by FAO, will supply a few g. of protein on an average. The quantity may be however negligible against the requirement of nearly 50 to 60 g. per day, but this small quantity of vegetable protein is very important because of its richness with respect to some essential amino acids like lysine, tryptophane, total sulphur containing amino acids, which will make up the deficiencies of the protein of fish, rice and pulse, for the above amino acids, respectively. Hegsted *et al.*[22] in their work on vegetable diets in human nutrition have rightly asserted that, "The proteins of fruits and vegetables which are usually not considered to be of importance in protein nutrition may be an important supplement in the cereal proteins."

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