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ANALYSIS OF LEAF PROTEIN CONCENTRATE (LPC) FROM GREEN FOLIAGES OF LEGUMINOUS CROP PLANTS

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ABSTRACT: In the present study analysis of Leaf Protein Concentrate (LPC) from green foliages of Leguminous crop plants It has been now well established that the process of Green Crop Fractionation (GCF) can be employed for the preparation of feed grade pressed crop residue (PCR) and food grade leaf protein concentrate (LPC). With GCFF the efficiency of utilizing plant nutrients increases. Out of the total proteins synthesized in leaf only 25 to 30% proteins are transported and stored in the grains. The remaining proteins are lost during transportation. Thus only 1/3 of the proteins synthesized by the leaves can be utilized for human consumption. In conclusion it can be said that for more efficient use of plant nutrients for human benefit, each and every plant or plant parts has to be used carefully.In this context the preparation of LPC from the leaves, instead of throwing them at random, will be a best alternative to make available more and more edible protein for human consumption.

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1.INTRODUCTION

There are several crop plants which are harvested either for roots or the tubers. Such crops are known as root crops or cole crops.The examples are Radish, Carrot, Beet root, Turnip, Knol-khol, Potato etc. After harvesting the main produce the leaves are discarded as by-product. Studies undertaken in this laboratory by Mungikar (1974), Tekale and Joshi (1976), Giri and Batra (1984), and Giri (1986) have shown that nutritionally superior quality of protein can be extracted from these by-product leaves, which increase the efficiency of using the crop. In addition to this, the by-product leaves of groundnut (Mungikar, 1974) can also be used for the production of leaf protein concentrate.

Several leguminous crop plants are harvested for their pods to use them as a source of vegetable. These include the pods of cowpea and *Dolichos.* In addition green pods of mung, gram and tur are harvested for their young grains which are eaten as either raw or after cooking. The pods of groundnut are uprooted when the leaves are still green. After separating the main produce in the form of pods from these crops, the green leaves are generally discarded and left unused. If these leafy materials are used for the extraction of leaf protein, additional edible protein can be made available for human consumption apart from that available in pods and the seeds inside them. By doing so, the efficiency of utilization of proteins from these crop plants can be increased. Bhagyawant *et al.,*(1998) made attempts to utilize by-product leaves of *Cicer arientinu* L. for the preparation of leaf protein concentrate (LPC) and pointed out the advantage in doing so. He pointed out that 13% additional edible protein can be extracted from the leaves of *C. arietinum* and made available for human consumption. Taking this in view an experiment was undertaken with six leguminous crops viz., Groundnut *(Arachis hypogaea* L.*),* Tur (*Cajanus Cajan* L.) millsp.), Gram (*Cicer arietinum* L.), *Dolichos*(Dolichos lablab. L.), Mung (*Phaseolus radiates* L.) and Cowpea (*Vigna unguiculata* (L) walp. The foliages of these crops along with tender pods were taken for the investigation to determine whether the proteins available in the foliage can be used to prepare LPC for gaining extra benefit.

2. MATERIALS AND METHODS

Fresh green foliages along with mature pods of groundnut, tur, gram, *Dolichos,* mung and cowpea were obtained from the fields nearby Aurangabad. The aboveground biomass of the plant was harvested except in case of groundnut wherein complete plant was uprooted. All crop plants were collected from the field during October 2005 to May 2006. One kg of green foliage, along with pods, harvested from the field, were immediately brought into the laboratory and washed thoroughly with water to remove soil and dust particles. The excess of water was blotted with blotter paper. The stem, leaf and pods were dried in oven at 95^{o} C till constant weight to determine dry matter (DM) content. A sample of fresh leaves was taken for the preparation of leaf protein concentrate (LPC) by heat coagulation method as described in Chapter III and the yield of LPC per unit weight of green leaves was recorded. The seeds were separated from the dry pods and the weights of dry seed as well as shells were recorded. The samples of dry steam, leaves, leaf protein concentrate prepared from leaves, shells and seeds were ground to fine powder and employed for the estimation of nitrogen by microKjeldahl method as described in Chapter III. The crude protein content in these parts was expressed as N x 6.25. The distribution of dry matter and crude protein in various parts of the crop plants was then calculated. The relative distribution was also worked out as per cent of dry weight or crude protein in the biomass.

3.RESULTS AND DISCUSSION

The above ground biomass harvested for each crop was green, bearing mature pods suitable for consumption as vegetables, either whole or after separating the seeds. The pods were removed and the leaves were separated from the stem portion. In case of groundnut the above ground biomass was taken for the preparation of LPC, as the pods were underground. The patter of distribution of dry matter (DM), and crude protein (CP) in each plant parts was as follows :

Groundnut

One kg of groundnut (*Arachis hypogaea* L.) biomass along with the underground part contained 86.5 g stem portion, 94.3 g leaf portion, 25 g shell and 47.5 g seeds. Thus stem and leaf portions contributed 34.1 and 37.2% dry matter while the seeds contributed 18.7% dry matter leaving behind 9.9% dry matter in the shell. The nitrogen(N) content in the dry matter of seeds was highest (3.33%) followed by that in leaves (3.0%) and stem portion (1.0%). When the leaves were employed to prepare leaf protein concentrate (LPC), it yielded 14.1 g LPC dry matter (DM) containing 5.41% nitrogen (N) in the dry matter (DM). thus the LPC was with 33.8% crude protein. Preparation of LPC can thus make available 14.1 g of edible food grade product apart from 47.5 g seeds. Thus an additional 5.6% dry matter can be made available for human consumption in the form of LPC. The efficiency of using dry matter from this crop as edible food thus increased from 18.7 to 24.3%. when the distribution of crude protein got distributed in stem, shells, and seeds the proportion of 15.2, 7.2, and 27.8% respectively. Thus out of the total protein content in the biomass of groundnut, about 50% was in leaf and 28% in the seeds. After preparing LPC from the leaves additional 13.4% protein got incorporated intothe LPC making available 41.2% of total protein available for human consumption. Thus with GCF the efficiency of protein utilization can be increased by 13.4% The above ground biomass harvested for each crop was green, bearing mature pods suitable for consumption as vegetables, either whole or after separating the seeds. The pods were removed and the leaves were separated from the stem portion. In case of groundnut the above ground biomass was taken for the preparation of LPC, as the pods were underground.

Tur

Tur (*Cajanus canjan* (L.) Millsp.) is a popular pulse crop of this region which is normally cultivated as an intercropping along with a *Sorghum.* When one kg of green above ground biomass along with pods was harvested, it contained 120 g dry matter(DM) in stem, 114.0 g in leaf, and 126 g in the pods. Thus the distribution of DM was almost similar in all the three fractions i.e. stem, leaf and pod. The nitrogen content in the leaves was high (3.85%) followed by that in the seeds (3.41%), shell (1.75%) and the stem (1.16%). When the leaves were fractionated it yielded 3.90 g leaf protein concentrate (LPC) as an additional food product for human consumption. Out of total crude protein in the biomass, 46.7% was present in the leaves while 25.0% was available in the seeds. With GCF and preparation of LPC, additional 7.1% protein could be made available, which increased the efficiently

of utilization of protein could be made available, which increased the efficiently of utilization of protein from 25.0 to 32.1%.

Gram

Gram (*Cicer arietinum* L.) is one of the most important leguminous cash crop of this region, cultivated widely during winter. When 1 kg of above ground biomass of gram was harvested along with pods and dried, it was observed that 32% of total dry matter was in leaves while 56% was in the pods. The weight of DM was equally distributed among the seeds and shells. When LPC was prepared from the leaves it contributed to additional 12.6% edible DM. the nitrogen content in the seeds was highest (3.5%) followed by that in leaf (3.0%), shell (1.5%), and stem (1.08%). The LPC was with 3.83% nitrogen i.e. 20% crude protein. Out of the total nitrogen in above ground biomass of gram 38.8% was available in leaves while 38.7% in the seeds. After preparing LPC from leaves, additional 19.6% protein could be made available, which increased the efficiency of using protein from 38.7 to 58.3%.

Dolichos

Dolichos (*Dolichos lablab* L.) is a common leguminous vegetable crop cultivated along with sugarcane in this region. The distribution of dry matter in above ground foliage of *Dolichos* indicated that 50% of dry matter was present in the stem portion, the leaves contributed to 28.8% DM while the seeds only 5.3%. when the leaves were subjected for the preparation of LPC additional, 5.0% LPC was available, which increased the amount of edible dry matter from 5.3% from the seeds to 10.2% along with LPC. The seeds of *Dolichos* were rich in nitrogen content (5.16% of DM), followed by the nitrogen content in the leaves (3.16%), shell (2.5%) and stem (1.25%). The LPC prepared from green leaves was a rich source of protein containing 25.88% crude protein on dry matter basis. The leaves contributed 55.0% of total protein content in the biomass, of which nearly 25.88% could be extracted in the LPC which increased the availability of edible protein in the seed from 16.46% to 42.34% when seeds protein in the seed from 16.46% to 42.34% when seeds and LPC were considered as a source of protein.

Mung

The performance of both varieties of mung was almost similar. The local variety of Mung (*Phaseolus radiates* L.) and *P. radiates* L. var. Kopargaon, were used for present investigation to study the distribution of dry matter DM and crude protein (CP). Out of the total dry matter in the foliage maximum DM accumulation was reported in the leaves while the seeds contributed 23.2 to 24.6% of total DM in the above ground biomass. As experienced with *Dolichos*, the seeds of mung were with maximum nitrogen content (5.0%) followed by that in leaves, shell, and its preparation increased efficiency of using protein by 10 to 12%.

Cowpea

Cowpea (*Vigna unguiculata* (L.) Walp.) is a popular vegetable crop of this region. The young pods of cowpea are used as a vegetable. The leaves of cowpea contributed 45.7% of total dry matter in the foliage, while the pods contributed 20% of dry matter in the foliage. The seeds of cowpea were rich in nitrogen content (4.83%) followed by leaf (3.5%), shell (2.41%) and stem (1.58%). The LPC prepared from leaves was with 45% crude protein content which contributed 25.4% of additional edible protein and increased the efficiency of protein utilization from 15.4 to 40.8%.

4. CONCLUSION

The results obtained with the six leguminous crops under investigation as described above and presented in the table 1, clearly indicate that the protein rich green foliage of these crop plants should not be ignored after removing the pods. Instead of treating those leaves as a by-product and waste material, these could be employed to prepare leaf protein concentrate (LPC). Thus edible protein in the form of LPC, in addition to that available in the seeds, will be useful for human consumption. This practice will not only make use of green leaves to provide LPC but it will also increase the overall efficiency of using proteins synthesis by the plants, after using seeds as a conventional and LPC as a non-conventional source of protein in human diet. The protein intake thus will increase to a great extent. In addition, the tender stem portion as well as pressed crop residue (PCR) left after the preparation of LPC can be successfully used in animal nutrition. The shells can be used either in animal nutrition or as a fuel after complete drying. One more additional product will be liberated in this process which is called as deproteinized juice (DPJ) left after leaf protein extraction from the leaf juice. This product can be successfully used as a source of manure, or as a medium for growing useful microorganism to produce various metabolites like enzymes, toxins, alcohol, antibiotics, single cell protein (SCP) etc. In conclusion it can be said that for more efficient use of plant nutrients for human benefit, each and every plant or plant parts has to be used carefully. In this context the preparation of LPC from the leaves, instead of throwing them at random, will be a best alternative to make available more and more edible protein for human consumption. This will not only increase the efficiency of protein utilization but will also provide a cheap source of protein to overcome protein deficiency and malnutrition.

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Table 1: Distribution of Dry Matter and Protein (gm) in various parts of 1kg leguminous plants

Plant		Stem	Leaf		Shell	Seed	Seed + LPC
			whole	LPC			
Groundnut	DM	86.5(34.1)	94.3(37.2)	14.1(5.6)	25.00(09.9)	47.5(18.7)	61.6(24.3)
	N%	1.00	3.00	5.41	1.66	3.33	--
	*CP	5.40(15.2)	17.68(49.8)	4.75(13.4)	2.56(07.2)	9.87(27.8)	14.62(41.2)
Tur	DM	120.0(33.3)	114.0(31.7)	10.7(03.0)	62.0(17.2)	64.0(17.8)	74.7(32.1)
	N%	1.16	3.58	5.83	1.75	3.41	----
	*CP	8.68(15.9)	25.50(46.7)	3.90(07.1)	6.75(12.4)	13.62(25.0)	17.52()32.1
Gram	DM	35.0(11.7)	96.3(32.1)	38.0(12.6)	87.0(29.0)	82.0(27.3)	120.0(39.9)
	N%	1.08	3.00	3.83	1.50	3.50	---
	*CP	2.31(05.0)	18.00()38.8	9.10(19.6)	8.12(17.5)	17.93(38.7)	27.03(58.3)
Dolichos	DM	141.0(49.8)	81.8(28.8)	14.0(04.9)	46.0(16.2)	15.0(05.3)	29.0(10.2)
	N%	1.25	3.16	8.66	2.5	5.16	---
	*CP	1.10(3.76)	16.12(55.18)	7.56(25.88)	7.18(24.58)	4.81(16.46)	12.37(42.34)
Mung	DM	52.0(21.3)	98.0(4.00)	11.83(04.8)	38.0(15.5)	56.8(23.2)	68.6(28.0)
	N%	1.25	3.16	6.75	1.75	5.00	--
	*CP	4.06(09.0)	19.31(42.7)	4.99(11.0)	4.12(09.1)	17.75(39.2)	22.74(50.2)
Mung var.	DM	50.5(17.2)	121.4(41.3)	12.2(04.2)	49.80(16.9)	72.5(24.6)	84.7(28.8)
Kopergaon	N%	1.66	3.00	6.25	2.25	5.00	--
	*CP	5.18(09.0)	22.75(39.5)	4.76(8.27)	7.00(12.2)	22.62(39.3)	27.4(47.6)
Cowpea	DM	59.0(33.7)	80.0(45.7)	17.4(09.9)	20.0(11.4)	16.0(09.1)	33.4(19.0)
	N%	1.58	3.50	7.25	2.41	4.83	---
	*CP	5.81(18.7)	17.50(56.2)	7.90(25.4)	3.00(09.6)	4.81(15.4)	12.71(40.8)