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Biochemical composition and oil characteristics of sunhemp seed, an unconventional legume in Bangladesh

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Abstract: Sunhemp (*Crotalaria juncea*) seed was analyzed for nutrient composition and oil characteristics. Nutrient composition of the whole seed and its three parts- testa, tegmen and kernel showed that most of the crude protein (62.94%) and oil (8.20%) were located in the kernel. Testa contained 44.44% crude fibre while the whole seed contained 13.77%. Whole seed contained 36.67% crude protein and 31.77% starch on dry basis. Distribution of nitrogen in the whole seed according to Osborne scheme showed that 28.77% of the total nitrogen was in the glutelin fraction followed by albumin (13.12%) and globulin (7.37%). In case of kernel the percent nitrogen extracted in the albumin fraction was 19.64% followed by globulin (12.57%) and prolamin (0.68%). The whole seed oil (5.33%) and kernel oil (7.16%) had a saponification value of 241.5 and 365.3, respectively. Iodine value of whole seed oil and kernel oil was, respectively 21.19 and 20.30, indicating the presence of unsaturated fatty acid in them. Carotene was also determined and found to contained 19.2 mg% in kernel. Whole seed contained 6.62% calcium and 0.44% phosphorous. Sunhemp seed was found to contain 35% gum which is almost wholly present in the tegmen. From the biochemical composition, it is concluded that there is a possibility of utilization of this unconventional legume as protein supplement.
Key words: Sunhemp, *Crotalaria juncea*, leguminosae, nutrient, seed

Introduction

Sunhemp (*Crotalaria juncea*) is a leguminous plant and locally called “Shon”. Like all leguminous crops, it has the unique capability of fixing atmospheric nitrogen through its root nodules. It is known as an important fibre yielding crop and ranks next to jute (Narayan, 1982). In Bangladesh, its agricultural use has been confined to green manuring for the improvement of soil fertility as well as to fodder (Alom *et al*., 1989).

Legumes as rich source of proteins have been used extensively in the diet of low income group people world wide and unconventional legumes are being added in the diet with the passes of time (Mortuza and Tzen, 2009). Therefore, the sunhemp plant should not be used only as fodder for livestock, its seed may also be used as an important indigenous feed ingredient for fish and poultry safely as there is no reports on the toxic effect of sunhemp plant when used as fodder for cattle in Bangladesh. In this context, sunhemp seed may have a potential impact on nutrition, and there is no documented scientific information available on the nutrient composition of locally produced sunhemp seed. The aim of this investigation was, therefore, to get the first hand idea of the nutritive value of locally available sunhemp seed.

Materials and Methods

Seed Collection: Seeds were collected from the Dairy Farm of the Bangladesh Agricultural University. For preparation of sample for chemical analysis, the collected seeds were sun dried, cleaned and stored in polythene bag until required for analysis. In dried condition the tightly adhering skin could not be removed manually or mechanically. The seeds were, therefore, soaked in water for 12-18 hours. As a result of swelling the seed skin burst and was removed manually. Although laborious, but in this way three clean fractions- testa, tegmen and kernel were obtained. Testa, tegmen and kernel were dried in an oven at 70-80°C, ground and redried. They were stored in desiccator until analyzed. Kernel and whole seed meal were partially defatted for the study of protein solubility.

Analytical Method: The proximate analysis [Moisture, crude protein (N x 5.85) crude fat, crude fibre and ash] of testa, tegmen and kernel was carried out according to the standard procedures given in Association of Official Analytical Chemists (AOAC, 1965). NFE was calculated by difference [100 – (crude protein + crude fat + crude fibre + ash)]. Non-protein nitrogen (NPN) was determined by trichloroacetic acid precipitation followed by determuration of nitrogen in aliquots of the filtrate by Kjeldahl method (AOAC, 1965). Starch was determined by multiplying the amount of glucose with 0.9. Distribution of nitrogen in the defatted flour was carried out according to the Osborne Scheme (Osborne and Brewer, 1977). Ca and P were determined by Hunter method (Hunter, 1984). Carotene was determined according to the procedure given by Ahmed and Scott (1962). Crude gum was estimated by filtation procedure**.** The percent oil content, saponification value, iodine number, free fatty acid value and peroxide value were estimated by the method of Chopra and Kanwar (1986). All the analysis were performed in triplicate and the mean values were recorded**.**

Results and Discussion

Nutrient composition of whole sun dried sunhemp seed and its various parts varied widely (Table 1). The whole seed contained 15.48% moisture and 36.67% crude protein. The kernel alone contained 62.94% crude protein while testa and tegmen contained relatively much less crude protein (4.71% and 2.12% respectively). The value obtained with kernel was much higher than the earlier reports (Reddy and Murty, 1972; Chowdhury *et al*., 1978)

Total crude fat content was found to be 6.30% indicating the seed contained appreciable quantity of oil. Of the three parts of the seed, kernel contained the highest amount of lipid (8.20%) followed by testa (1.20%) and tegmen (0.59%). However, our result with kernel was much higher than that of *Sesbania aculeata* seed (4.7-6.0%) reported by Roy and Gheyasuddin (1982).

Ash content of sunhemp whole seed was 6.82%, which is close to the value (7.8%) obtained by Reddy and Murty (1972) and higher than the value (3.3%) reported by Chowdhury *et al.* (1978).

Crude fibre content was found 13.77% in whole seed. However, testa contained the highest amount of crude

fibre (44.44%) while relatively much less amounts of crude fibre present in kernel (2.29%) and tegmen (2.65%). However, this value with kernel is much less than the previous report (8.1%) (Chowdhury *et al.*, 1978). Sunhemp whole seed contained 55.43% NFE. This value is higher than that of earlier findings of Reddy and Murty (1972). Thus it indicates that sunhemp seed is a good source of energy.

Table 1. The nutrient composition of sunhemp whole seed and its different fractions (testa, tegmen and kernel)

Sample	Moisture %	DM %	Crude Protein %	Crude Fat %	Crude Fibre %	Ash %	NFE	Starch %	% Ca	% P	NPN %
Testa	15.85	84.15	4.71	1.20	44.44	5.58	62.88	24.97	11.88	0.84	0.62
Tegmen	4.007	95.93	2.12	0.59	2.65	1.92	96.93	50.98	6.33	0.08	0.58
Kernel	12.73	87.27	62.94	8.20	2.29	4.69	36.45	11.68	5.50	0.52	0.76
Whole seed	15.48	84.52	36.67	6.30	13.77	6.82	55.43	31.77	6.62	0.55	0.35

DM=Dry Matter; NPN= Non-protein Nitrogen; NFE, nitrogen free extract calculated as 100- % (crude protein + crude fat + ash + crude fibre)

The whole seed contained 31.77% starch which is lower than the value of Chowdhury *et al.* (1978). The highest amount of starch was found in tegmen (50.98%) followed by testa (24.97%) and kernel (11.68%). The non-protein nitrogen content was the highest in kernel (0.76%) followed by testa (0.62%) and tegmen (0.58%). Testa contained the highest amount of calcium (11.88 mg %) while the kernel contained the least amount (5.5 mg %). Testa contained the highest amount of phosphorus (0.84 mg %) while the tegmen contained the least (0.08 mg %). Similar trend in calcium and phosphorous content was reported earlier (Reddy and Murty, 1972).

Table 2. Distribution of nitrogen of Sunhemp (*Crotalaria juncea*) defatted whole seed and defatted kernel in various solvents according to Osborn scheme (dry basis)

Parameters	Defatted whole seed	Defatted kernel
% Total nitrogen (TN)	5.56	10.18
% Albumin nitrogen	0.73	2.02
% Albumin nitrogen of TN	13.12	19.64
% Globulin nitrogen	0.41	1.33
% Globulin nitrogen of TN	7.37	13.06
Total contribution of albumin and globulin	20.49	32.70
% Prolamin nitrogen	0.00	0.07
% Prolamin nitrogen of TN	0.00	0.68
% Glutelin nitrogen	1.60	1.28
% Glutelin nitrogen of TN	28.77	12.57
% Non-extractable nitrogen	2.78	4.58
% Non-extractable nitrogen of TN		44.99

The results of distribution of nitrogen in sunhemp whole seed according to the Osborne scheme is in agreement with that of Roy and Gheyasuddin (1982) found in *Sesbania aculeata* seed. The defatted whole sunnhemp seed contained 13% albumin fraction of the total nitrogen (Table 2). This value is much lower than the value obtained in *Sesbania aculeata* whole seed (Roy and Gheyasuddin, 1982). Globulin fraction was found to be 7.37% of total nitrogen which was slightly lower than the value obtained by them in *Sesbania aculeata* whole seed (8.69). Prolamin fraction was found nil in sunhemp whole seed while they found 5.20% prolamin nitrogen in *Sesbania aculeata* seed. Glutelin fraction in sunhemp whole seed was 28.77% of total nitrogen which was much higher than the value (17.36) obtained in *Sesbania aculeata* seed. Non-extractable nitrogen fraction value (50.01) obtained in this study was much higher than the value (27.78) obtained in *Sesbania aculeata* seed.

Table 3. Some characteristic parameters of the oil extracted from sunhemp whole seed and kernel

Parameters	Values	
	Whole seed oil	Kernel oil
Saponification value	214.5	356.30
Peroxide value	5.70	5.03
Iodine value	21.19	20.30
Free fatty acid value	0.80	1.01

Saponification number which is an index of the average chain length of the fatty acid was found to be 214.5 and 356.3 in whole sunhemp seed oil and kernel oil, respectively. This difference between saponification values of whole seed oil and kernel oil of sunhemp might be due to the presence of some longer C-chain fatty acids in testa and tegmen. Iodine values obtained in the present study indicated that almost similar pattern of unsaturated fatty acids was present in both whole seed and kernel oil. Data obtained on saponification values and iodine values in the present study were found to be much higher than the values 135.47 and 97.07, respectively obtained by Roy and Gheyasuddin (1982) in *Sesbania* seed oil. The free fatty acid value was quite low showing that the lipase action

was not considerable in the seed and that peroxidation with the subsequent rupture of chain had not produced any significant amount of acid in the oil, which was evident from low peroxide value (5.70 in whole seed and 5.03 in kernel oil) obtained in this study.

As the sunhemp seed kernel was yellow, the kernel expectedly contained sufficient amount of carotene (19.2 mg %). The whole sunhemp seed contained 35% gum which was higher than the value found in *Sesbania* seed (26%) (Huq, 1983). For extraction of gum at a commercial scale, it is imperative that a suitable mechanical method be developed so that the three fractions can be separated on mass scale. Extraction of gum from the whole seed is obviously undesirable as it will lead to loss of kernel which incidentally contains 62.94% protein, 8.20% lipid and only 2.29% crude fibre (Table 1). As a matter of fact, the kernel alone will be much better as a feed ingredient, not only because it has high percentage of protein but also because it is free from testa and tegmen both of which, in all probability are much less digestible. Besides, it is quite likely that kernel meal with proper treatment can be used even in human diet and as a source of important protein isolate for incorporation in cereal based food. From the discussion, it is obvious that an important strategy in the utilization of sunhemp seed for various end uses, a method to separate three parts of the seeds must be worked out.

In conclusion it can be said that sunhemp seed contains high percentage of protein and significant amount of oil. The seed offers a possibility for production of protein isolate for incorporation in food and feed stuffs.

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