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Nutritional composition and functionality of raw and germinated parole (*Vigna sp*) seed, a wild cowpea grown in hilly area of Bangladesh

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Abstract: The work was carried out on a cowpea variety locally called "parole" in Chittagong region to study its chemical composition and functionality. The proximate composition, mineral content and functional properties of flours from raw (control) and germinated *parole* (*Vigna sp.*) seeds were evaluated. Germination increased protein content and decreased ash, fibre, carbohydrate and mineral contents as compared to raw seed. The defatted kernel meal had higher content of K and S but considerably lower content of Ca. Germinated seed contained slightly lower content of minerals as compared to raw seed. Functional properties studied were water- and fat- absorption capacities, least gelation capacity and foaming capacity and stability. Germination increased water- and fat- absorption capacities significantly ($P < 0.05$). Germination improved the gel forming ability and foaming capacity but diminished the foaming stability of the flour. Thus, the study indicates that germination improves the functionality of *parole* flour and suggests its useful application in fabricated foods.
Key words: Proximate composition, Fibre, Functionality, Germination, Parole seed

Introduction

Cowpea is one of the most important protein sources in the diet of the people of tropical Africa. In Bangladesh, cowpea is cultivated mostly in the district of Dhaka, Noakhali, Tangail, Chittagong and Chittagong Hill Tracts. A cowpea variety grown almost exclusively in Chittagong Hill Tracts is called *Parole* (no resemblance of the variety named *Falone*). Cowpea can be used at all stages of growth as a vegetable crop. The tender green leaves are an important source of food in Africa. Green cowpea bean seeds are cooked as a fresh vegetable, can be dried for use as pulse or may be canned or frozen. It is highly nutritious crop with a seed protein of around 25% and protein digestibility higher than that of other legumes (Ologhobo and Fetuga, 1983). Therefore, the potential of expanding the production of cowpea in Bangladesh is quite high. More importantly it can be used as vegetables as well as pulse and it remains as fodder for animals. The tradition bound tribal people of Chittagong Hill Tracts grow it as pulse crop rather than vegetable crop. But it is not meant to imply that pods are not consumed as vegetable at any stage of its growth; only that the main purpose is to produce seeds for use as pulse. Parole is stable and has high yield potential compared to other pulses in Chittagong area. The functional properties of proteins have been defined as those physicochemical properties that affect the processing and behavior of proteins in food systems as judged by the quality attributes of the final product (Kinsella, 1976). Determination of the functional properties of proteins is desirable for the utilization of any new protein material. Modified proteins are known to have an entirely different functionality when compared with native ones and can be added in small amounts to food products for specific aspects (Wu and Inglett, 1974). On germination, protein quality of certain legumes improves (Bau and Derby, 1979). Protein modification that occurs during germination has been reported for mung bean (Rosario and Flores, 1981) and millet flour (Akubor and Obiegbuna, 1999). However, these data on this local cowpea variety are lacking. Therefore, the study was aimed to evaluate the proximate composition and functional properties of raw and germinated seed of this unconventional legume to see the suitability of its flour to be incorporated into human food products not only as protein supplements in diets but also as functional agents in a variety of formulated foods.

Materials and Methods

Materials: The research work was conducted on wild unconventional cowpea seeds locally called Parole. The seeds were collected from Chittagong market. Seeds were sun dried, cleaned and stored into plastic container and kept in a cool place until used for the chemical analysis.

Preparation of seed sample: Parole seeds are dehulled with forceps. After dehuling the seeds are dried by micro oven at 60 °C and placed into desiccator and cooled. Then the dried seeds are ground with a grinder to make fine powder.

Chemical analysis: The proximate analysis of whole seeds was determined in accordance with the method given in Association of Official Analytical Chemist (AOAC, 2000).

Minerals estimation

Materials: Parole whole seed and kernel flour was dried in an oven at 70°C and then placed into desiccator and cooled, which was then used for subsequent analysis.

Methods: The study was concerned with the analysis of essential minerals i.e. calcium, magnesium, potassium, phosphorus, copper, iron and zinc in locally grown (Chittagong hilly areas) cowpea variety "Parole". Ca, Mg, P, K were determined by Hunter method (Hunter, 1984) and Cu, Fe and Zn by wet oxidation methods as described by Jackson (1973).

Determination of functional properties

Least gelation concentration (LGC) of the flours was determined (Coffman and Garcia, 1977; as modified by Sathe et al., 1982). Water absorption capacity (WAC) of the flours was measured using a modification of the centrifugation technique (Janicki and Walezek, 1954). Fat absorption capacity (FAC) of the flours was assessed by the procedure of Lin and Humbert (1974) as modified by Gruener and Ismond (1997).

Statistical analysis: Data were subjected to analysis of variance (ANOVA) and statistical comparisons between treatments were made by the Tukey honest significant difference (HSD) test using SPSS version 12.0 software for Windows (SPSS Inc. Chicago, IL, USA). The significance of observed differences was tested at $P < 0.05$.

Results and Discussion

Chemical composition: The protein content of raw parole seed was 25.37%. Protein content of other cowpea varieties grown in other countries shows more or less similar result. The protein content of eight cowpea varieties grown in Africa is 22.5% (Aletor and Aladetimi, 2006). The protein contents of other leguminous crops are also similar. Germination of parole seeds resulted in a significant ($P < 0.05$) increase in protein content as compared with the raw sample (Table 1), which was mainly due to the consumption of other components of seeds and the degradation of the high molecules of proteins to simple peptides during germination. This similar result was also observed in *Kalimatar*, an unconventional leguminous crop grown in Bangladesh (Mortuza and Tzen, 2011.) The flour from germinated seeds showed a slight decrease in lipid contents which might be due to the action of lipases during germination. Moreover, there was a slight decrease in total carbohydrates in germinated *parole*, which could be due to their consumption as a source of energy required for the germination process. Germinated *parole* showed noticeable decreases ($P < 0.05$) in the contents of Na and K (Table 2). These decreases might be due to the leaching of such minerals into soaking water. We noticed that the loss of Ca, P and Fe was less compared to that of Na and K with no obvious explanation. One plausible reason might be that there may be a lower loss of divalent minerals compared to that of the monovalent ones. Nonetheless, this level of minerals can still provide sufficient amounts to meet the human daily requirement (NRC, 1980).

Determination of functional properties

Least Gelation Concentration (LGC): The LGC value of flour from germinated *parole* seeds was 8% (Table 3). Compared to the raw one (10%), the germinated sample slightly improved the gel forming ability of the flour by decreasing the minimum concentration needed for the gel formation. This indicates that gelling may be produced more rapidly at higher protein concentrations. However, it should not be ruled out that the LGC is influenced by a physical competition for the water between the protein gelling and the starch gelatinization. Sathe *et al*. (1982) reported that the variation in the gelling properties of different legume flours is associated to the relative ratios of different constituents such as proteins, carbohydrates and lipids that make up the flours, suggesting that the interactions between such components may also have a significant role in gel formation. In this study, the high protein level of the seeds upon germination might have affected the relative ratios in the improvement of gel formation. The LGC value indicates that the germinated *parole* sample has a greater ability to form gel than other seed flours such as lupin (Sathe *et. al*., 1982), dark brown lima bean (Oshodi and Adeladun, 1993) and normal kidney bean (Kaur and Singh, 2007). The ability of proteins to form gels and to provide a structural matrix for holding water, flavors and sugars is useful in new foodstuff development, thereby providing an added dimension to protein functionality. This low LGC value of the flour from the germinated seeds may be an asset of *parole* in the production of curd, pudding or as an additive to other gel-forming materials in food products.

Table 1. Proximate composition (%) of flours from control and germinated seeds

Sample	%Crude protein	%Crude fat	%Crude fibre	%Ash	Carbohydrate
Control	25.37± 0.39a	1.7±0.15b	2.98±0.19b	6.76±0.15b	63.19
Germinated	26.83±0.28b	1.3±0.12a	2.49±0.21a	6.31±0.16a	63.07

Carbohydrate = 100 – (Crude protein + Crude fat + Crude fibre + Ash). Values are mean of triplicate determinations ± standard error. Means in column not sharing the same letter are significantly different ($P < 0.05$).

Table 2. Mineral composition (mg/100 g) of flours from control and germinated seeds

Sample	Na	K	Ca	P	S
Control	23.43±0.7b	1419.6±4.01b	150.55±2.55a	4.28±0.15a	317.6±o.26a
Germinated	19.01±0.5a	1141.9±3.41b	148.33±2.81b	3.53±0.11a	298.3±o.28a

Values are mean of triplicate determinations ± standard error. Means in column not sharing the same letter are significantly different ($P < 0.05$).

Water Absorption Capacity (WAC): Germination resulted in an increase of the WAC of *parole* seeds (Table 4). Previous finding also shows that the WAC of green gram is improved upon germination (Rosario and Flores, 1981). The increase of WAC on germination could be due to an increase in protein content and changes in the quality of the proteins upon germination and also a breakdown of polysaccharide molecules; hence the sites for interaction with water and holding water would be increased. The WAC value of flour from germinated *parole* seeds is similar to those of other legumes such as soybean (130%) (Lin and Humbert, 1974), dehulled lima bean (135%) (Oshodi and Adeladun, 1993) and lupin seed (120%) and fluted pumpkin seed (85%) (Fagbemi and Oshodi, 1991). WAC is considered as an essential function of protein in viscous foods such as soups, gravies, doughs and baked products; and thus flour from germinated *parole* may be useful in these food formulations.

Fat Absorption Capacity (FAC): Germination resulted in an increase of the FAC of *parole* seeds (Table 4). Previous finding also shows that the FAC of millet flour is improved upon germination (Akubor and Obiegbuna, 1999). As the binding of oils depends on the surface availability of hydrophobic amino acids (Sosulski *et al*., 1976), the enhancement in FAC of germinated seeds could be due to an increase in the availability of these amino acids by unmasking the non-polar residues from the interior protein molecules. The FAC value of flour from the germinated *parole* seeds is higher than to that of green gram (84%) (Singh, 2001). Fat acts as a flavor retainer and increases the mouth feels of food. Therefore, higher FAC values are desirable in ground meat formulations, meat replacers and extenders, pancakes, baked goods and soups where oil-holding capacity is of prime importance. Thus, the flour from germinated *parole* seeds may be useful in the above mentioned food formulations.

Table 3. Gelation properties of flours from control and germinated seeds

Sample	flour concentration (% w/v)								
	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0
Control	-	-	±	±	+	+	+	+	+
Germinated	-	±	±	+	+	+	+	+	+

- not gelled; ± slightly gelled but slipped; + gelled. Symbols in column not the same are significantly different ($P < 0.05$). Same result found in all 3 replications.

Table 4. Functional properties of flours from control and germinated seeds

Sample	WAC (%)	FAC (%)	Volume of foam (ml) after time (h)				
			0	0.5	1	2	4
Control	84.88±1.3a	83.45± 1.5a	121± 1.6a	112± 1.3a	108± 1.1a	104± 1.0a	102± 0.9a
Germinated	107.3± 1.3b	101.32±1.6b	132± 1.2b	116± 1.3a	107± 1.2a	103± 0.7a	101± 0.8a

WAC= Water absorption capacity; FAC= Fat absorption capacity, values are mean (rounded off to next digit) of triplicate determinations ± standard error. Means in column not sharing the same letter are significantly different ($P < 0.05$).

Foaming capacity (FC) and foaming stability (FS): The germinated flour had a better whipping property, while its foam was less stable than that of the raw one. We noticed that most of the foams formed collapsed within the first 30 min after whipping; foams tended to become stable with the passing of time (Table 4). Germination increased the FC value from 20% (raw seeds) to 32% (germinated seeds) but diminished the FS value from 13% (raw seeds) to 7% (germinated seeds) (data not shown in table). The findings are in agreement with that reported for millet flour (Akubor and Obiegbuna, 1999). Diwakar *et al.* (1996) also reported an increase of FC in horse gram due to germination. Germination may have caused surface denaturation of the proteins and reduced the surface tension of the molecules, which gave good foamability. However, our result is in agreement with the previous finding which states that FS is related to the amount of native protein that gives higher FS than the denatured protein (Lin and Humbert, 1974). Kinsella (1981) also proposed that the conformational changes taking place during germination of proteins may have an effect on the foam stability of the legume flours. The FC and FS are important properties in food product such as breads, cakes, crackers, meringues, ice creams and several other bakery items to maintain their texture and structure during or after processing. The FC value (32%) of flour from germinated *parole* seeds is lower than those of soybean (66%) and sunflower (60%) (Lin and Humbert, 1974) and pigeon pea (68%) (Oshodi and Ekperigin, 1989) and comparable to those of great northern bean (32%) (Sathe *et al*., 1982) and lima bean (28.2%) (Oshodi and Adeladun, 1993). The FS value (7%) is comparable to sunflower (9%) (Lin & Humbert, 1974) and fluted pumpkin (5%) (Fagbemi and Oshodi, 1991). Therefore, the flour from germinated *parole* may be more useful compared to the just-mentioned legumes in use in the above mentioned food products.

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