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Nutrient composition of selected newly bred and established mung bean varieties

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ABSTRACT

Seven newly bred and three established varieties of mung bean were analysed for proximate composition, minerals, anti-nutrients and *in vitro* mineral accessibility. They contained 18–23 g protein, 4.0–5.6 g crude fibre and 2.5–4.1 g ash per 100 g dry sample. Iron, zinc, calcium, sodium and potassium ranged from 3.4 to 4.6, 1.2 to 2.3, 79 to 115, 8.1 to 13.5 and 362 to 415 mg/100 g dry weight, respectively. Phytic acid and polyphenols averaged 769 and 325 mg/100 g dry weight, respectively. Varieties differed significantly in terms of nutrient and anti-nutrient contents. Phytic acid and polyphenols were negatively correlated with *in vitro* mineral accessibility and nutrient digestibility. Protein and starch digestibility ranged from 53 to 67 g/100 g dry weight and 20 to 29 mg maltose released/g dry weight, respectively. Average molar ratios of phytic acid to iron and zinc were 16.8 and 52.7, respectively. Differences in *in vitro* iron and zinc accessibility could not be explained by phytic acid to calcium nor magnesium molar ratios. However, the phytic acid amount in mung beans suffices to bind all minerals into indigestible complexes. The newly bred varieties have better agronomic yields but no better nutritional potential than the established varieties tested.

1. Introduction

Mung bean (*Vigna radiata* (L.) R. Wilczek) is an important legume in the diet of the majority of Indians, who consume it in different forms like dhals, sweets, snacks and savoury food products. Mung bean has a protein content comparable to that of chick pea (*Cicer arietinum*) but contains less anti-nutritional (Chitra, Vimala, Singh, & Geervani, 1995) and flatulence factors than soya bean (Abdullah, Baldwin, & Minor, 1984). Mung bean is rich in micronutrients and can be used to deliver minerals to malnourished populations if processed well to retain them in the diet. Mung bean varieties are grown in wide agro-climatic zones and have diverse agronomical, processing and nutritional characteristics (Bisht et al., 2005; Makeen, Abrahim, Jan, & Singh, 2007; Tomooka, 1991). The suitability of a particular variety for processing and consumption depends primarily on its quality characteristics, particularly physical properties and chemical composition.

The presence of anti-nutrients such as phytic acid (PA) and polyphenols was shown to reduce the digestibility (Binita & Khetarpaul, 1997) and bioavailability of nutrients present in mung bean (Dave, Yadav, & Tarafdar, 2008; Mubarak, 2005). There are several approaches to increase nutrient bioavailability and digestibility at the primary production level. The first is by breeding varieties with better abilities to acquire nutrients from the soil, and the second is to optimize agronomic practices like fertilisation. Furthermore it is also possible to use breeding techniques for increasing the concentration of mineral enhancers like ascorbic acid and for decreasing the concentration of nutrient inhibitors like phytic acid, polyphenols, etc. (Frossard, Bucher, Machler, Mozafar, & Hurrell, 2000).

Most of the mung bean breeding research in India has focused on high and stable yield, early and uniform maturity, resistance to pests, pathogens and drought (Singh & Ahlawat, 2005). These selection criteria may have produced varieties with altered nutritional composition of the grains. Moreover, breeding for improved nutritional composition is limited by the fact that some plant components that are undesirable from nutritional point of view are physiologically important for the plant itself. For instance, phytic acid is required for seed germination, but it is detrimental to micronutrient uptake in humans (Coelho, Santos, Tsai, & Vitorello, 2002).

To date, little effort has been made to evaluate the nutrient composition of new varieties of mung bean, which were bred for

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Table 1
Characteristics of the selected mung bean varieties.

Mung bean varieties		Level of resistance to mung bean yellow mosaic virus	Growing season	Yield (kg/hectare)	Crop duration (Days)
Established varieties	Asha	Tolerant	Autumn	1000	60
	Muskan	Resistant	Autumn	1000	80
	Satya	Resistant	Autumn	1300	66
Newly bred varieties	MH 124	Resistant	Autumn	1300	65
	MH 125[a]	Resistant	Autumn	1200	65
	MH 318	Resistant	Autumn/Summer	1500	58
	MH 421	Resistant	Autumn/Summer	1300	60
	MH 539	Resistant	Autumn/Summer	1400	60
	MH 560	Resistant	Autumn/Summer	1600	60
	MH 564	Resistant	Autumn/Summer	1500	60

[a] Notified for farmers' use in 2009.
Source: Kumar, pers. comm. (2010) Senior Scientist at CCS Haryana Agricultural University, Hisar (India).

their disease resistance and high yield, and established varieties with respect to their contribution to human nutrition. Therefore, in the present study, seven newly bred varieties and three established varieties of mung bean were investigated for nutritional quality.

2. Materials and methods

2.1. Sampling

The mung bean varieties used for the study (Table 1) were grown using identical agronomic practices (e.g. fertilizer, irrigation) by the Department of Plant Breeding, CCS Haryana Agricultural University, Hisar, India. Raw, fully mature, disease-free mung bean grains were cleaned of extraneous matter, broken grains and weed grains, dust and other foreign materials, mixed well and ground to fine powder in an electric grinder (Cyclotec M/s Tecator, Hoganas, Sweden) and passed through a 0.5 mm sieve. Powders were stored in sealed air-tight plastic containers in a refrigerator at 5 °C until analysis.

Pepsin, pancreatin, pancreatic amylase and bile were obtained from Sigma–Aldrich Co. USA. All other reagents used for the analyses were of analytical grade and glassware was acid (1 g/100 mL HCl) washed.

2.2. Selection and description of mung bean varieties

Ten mung bean varieties were selected, namely seven newly bred at CCS Haryana Agricultural University and three established in Haryana state in India.

2.3. Analytical methods

2.3.1. Proximate composition

The following AOAC methods (1990) were used to determine proximate composition: drying at 105 °C for 24 h for moisture (AOAC 925.10), incineration at 550 °C for ash (AOAC 923.03), defatting in Soxhlet apparatus using hexane for crude lipids (AOAC 920.39), digestion with NaOH and H_2SO_4 for crude fibre (AOAC 962.09) and microKjeldahl method for crude protein (AOAC 960.52). For conversion of Nitrogen to crude protein, a conversion factor of 6.25 was used. The carbohydrate content was estimated by difference of protein, fibre, ash, fat and 100. Energy was calculated using Atwater energy conversion factors of 4.0, 4.0 and 9.0 kJ/g, for protein, carbohydrate and fat, respectively. Proximate composition was determined using dried samples. Values are presented as g/100 g on dry weight basis.

2.3.2. Mineral composition

Calcium, iron and zinc contents were determined by first digesting 1 g of sample using 25 ml diacid mixture ($HNO_3/HClO_4$: 5/1, v/v) after which the digested solution was filtered through Whatman no. 42 filter paper. Volume of the solution was made up to 50 ml and then the mineral content was determined by Atomic Absorption Spectrophotometer 2380, Perkin–Elmer (Waltham, USA) using the method of Lindsey and Norwell (1969).

2.3.3. In vitro protein and starch digestibility

In vitro protein digestibility was determined by the method of Mertz, Kirleis, and Axtell (1983). The method involved treatment of 250 mg sample with 20 ml pepsin reagent (0.1 mol/L KH_2PO_4 (pH 2.0) containing 0.2 g/100 mL pepsin) and then incubating at 37 °C for 3 h with constant shaking. The digested protein was then separated by sedimenting residual protein with 5 ml of 50 g/100 mL trichloroacetic acid and centrifugation at 16,770 × *g* for 10 min. The Nitrogen content of the supernatant containing digested protein was determined by the microKjeldahl method (AOAC, 1990).

In vitro starch digestibility was assessed by using pancreatic amylase. Twenty-five milligram of the defatted sample was dispersed in 1 ml 0.2 mol/L phosphate buffer (pH 6.9). Half a millilitre of pancreatic amylase was added and then the suspension was incubated at 37 °C for 2 h. After incubation, 3 ml of 3, 5-dinitrosalicyclic acid reagent was quickly added and then heated for 5 min in a boiling water bath. Next, the mixture was cooled and distilled water was added to get 25 ml. This solution was filtered and liberated maltose was measured colorimetrically at 550 nm. Maltose was used as standard and the values are expressed as mg of maltose liberated per gram of sample (Singh, Kherdekar, & Jambunathan, 1982).

2.3.4. In vitro mineral accessibility

In vitro iron accessibility was determined by digesting the sample with a single enzyme method as described by Rao and Prabhavathi (1978). This method is convenient, requires a minimum of chemicals, and is well suited for comparative purposes. Obviously, it does not necessarily predict exactly what will happen in-vivo, but neither do the more sophisticated in-vitro approaches.

The method involved incubation of 2 g of powdered sample with 25 ml 0.5 g/100 mL pepsin in 0.1 mol equi/L HCl solution in a water bath of 37 °C for 90 min, after adjusting the pH to 1.3 using HCl. The mixture was then centrifuged at 1000 × *g* for 45 min and the supernatant was filtered through Whatman no. 44 filter paper. Iron in the filtrate was determined according to the AOAC (1995) method by treating with 1 ml hydroxylamine hydrochloride solution and 5 ml acetate buffer solution and then reacted with α, α′ dipyridyl to yield colour which was read at 510 nm.