ANTINUTRITIONAL FACTORS AND ANTIOXIDATIVE ACTIVITY OF IMPROVED COMMON BEAN CULTIVARS

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Introduction

Common bean (*Phaseolus vulgaris* L.), a member of the Fabaceae family is one of the five cultivated species of the genus *Phaseolae*, namely; *P. coccinueus*, *P. lunatus*, *P. acutifolius* and *P. polyanthus*. Biochemical composition of these species is very similar in relation to protein content (22.3%), crude fiber (6.0%) and carbohydrates (52.4%) (Bressani and Blanco, 1991). Common bean plays an important role in the diet of many Latin American countries and contributes between 20 to 40% of the total source of proteins, vitamins and minerals. However, one of the most important nutritional problems of dry beans is low protein digestibility. Among the main factors influencing low digestibility are oligosaccharides that cause flatulence, phytic acid that interacts with proteins producing insoluble compounds (Knuckles et al., 1985), trypsin inhibitors (protease inhibitors), proanthocyanidins or tannins (plant polyphenols) which precipitate proteins. Recently, the antioxidant capacity of polyphenols (flavonoids and tannins) have been recognized (Decker. 1995). The objective of this study was to assess the variability among improved commercial bean cultivars for antinutritional factors and the antioxidative activity of low molecular weight phenolic compounds.

Materials and Methods

The study included a group of 16 common bean cultivars of different seed classes, namely; black-seeded (N), pinto (P), cream or bayo type (B), azufrado (Az), flor de mayo (FM), and Perry Marrow (white), which was used as control. Measured variables included seed weight and seed coat content (%). Cotyledon flour was prepared for each bean cultivar, seed coat was manually separated from the grain and the cotyledons were grinded and screened using a 100-mesh. Total sugar content was determined following the ethanol-sulfuric acid method (Barampana and Simard, 1994). Amount of phytic acid was determined using the spectrophotometric method (Haug and Lantzsch, 1983). Trypsin inhibition induced on the bean flour was determined following the method described by Savelkoul *et al.* (1992). Seed coat tannin content was estimated using Price (1978) method, which uses vainillin as a reactant. Antioxidant activity of tannins obtained from the seed coat was evaluated following the tiocianate (emulsion) method (Kasuga, 1995) and a thin layer chromatography (free oil) method (Masuda, 1994).

Results and Discussion

The study included small, medium and large seeded cultivars. The extent of 100 seed weight and seed coat content ranged from 25.8 to 51.2 g and from 5.8 to 11.9% respectively. N. Altiplano and Perry Marrow were strongly different cultivars for these variables (Table 1). Seed coat color did not display a clear relationship with sugar (oligosaccharides) and tannin content. Thus, the highest amount of sugars (ranging from 54.2 to 57.6 mg/g) were found on contrasting cultivars as FM M38 (pink speckled on cream background), N. Altiplano, Az. Regional 87 (sulfur/yellow), Bayo Victoria (cream), and Az. Peruano 87. In general, flor de mayo cultivars had the highest tannin content as catechin equivalent. In contrast, black beans tended to inhibit

trypsin in a higher proportion (up to 50.3%) than other seed classes, particularly Mayocoba (21.9%) and Az. Peruano 87 (21.7%). FM M38 was the exception since this cultivar had the highest trypsin inhibition (57.1%) among all genotypes studied.

Genetic variation was revealed for the amount of phytic acid per gram of cotyledon. The results demonstrated differences among cultivars (Table 1). The sulfur/yellow seeded cultivars tended to possess the highest content (Mayocoba, 2.16 mg/g) similar to black-seeded cultivars N. Durango and N. Sahuatoba. Perry Marrow, the white-seeded control, had an intermediate value (1.51 mg/g) similar to some pinto and bayo (cream) cultivars. An interesting cultivar is Bayo Durango, which had the lowest (0.98 mg/g) amount of phytic acid. This cultivar has a light cream seed coat color but it carries a dominant allele in the *P* locus evidenced by the purple color of its flowers, hypocotyls, stems and leaf veins (Leakey, 1988). When the antioxidative activity was assessed, P. Mestizo and N. Altiplano showed better results for oxidation induction times and slowing down lipidic oxidation. Cultivars in the flor de mayo class scored high in the lipidic oxidation test as a direct relationship with their tannin content.

Table 1. Antinutritional factors and antioxidative activity of improved common bean cultivars.

Cultivar Name[a]	Seed[b] size (g)	Seed Coat (%)	Sugar[c] Content (mg/g)	Phytic Acid (mg/g)	Trypsin Inhibition (%)	Tannin[d] content (mg/g)	Induction[e] time (min)	Lipidic[f] oxidation %
N. Durango	36.3	10.2	53.2	1.84	45.4	47.1	38.0	65.8
N. Sahuatoba	23.6	11.8	51.9	1.87	50.3	72.6	27.5	68.3
N. Altiplano	25.8	11.9	56.0	1.43	43.4	65.3	35.0	38.5
P. Mestizo	40.5	9.2	47.0	1.44	22.4	112.9	35.3	21.9
P. Bayacora	38.4	8.7	46.5	1.75	33.6	85.4	30.2	15.5
P. Villa	34.0	9.5	48.3	1.18	41.9	94.6	21.6	28.4
B. Durango	47.1	10.3	52.3	0.98	42.5	60.0	24.1	37.4
B. Victoria	38.2	11.7	54.6	1.54	39.7	115.4	20.0	36.7
B. Madero	42.3	11.6	51.5	1.69	40.3	77.3	20.3	63.3
FM Bajío	27.8	10.0	38.3	1.59	34.6	105.0	31.4	25.2
FM M38	26.9	9.6	57.6	1.07	57.1	110.0	30.3	30.0
Mayocoba	35.1	9.5	51.4	2.16	21.9	12.7	13.5	45.6
Az. Regional 87	32.8	8.0	55.1	1.87	32.8	13.5	6.0	76.9
Az. Peruano 87	37.2	8.6	54.2	1.83	21.7	8.7	4.8	46.9
Az. Namiquipa	36.5	8.2	43.1	1.04	40.7	5.9	10.0	61.2
Perry Marrow	51.2	5.8	48.1	1.51	42.3	3.5	0.0	63.3

a= N (negro, black), P (pinto), B (bayo, cream), FM (flor de mayo, pink speckled on cream background), Az.(azufrado, yellow/sulfur); b = 100 seeds wt.; c = mg of oligosaccharides per g of cotyledon; d = mg of catechin equivalents per g of seed coat; e = linoleic acid oxidation time under UV; f = % of oxidation respect to linoleic acid (tiocianate method).

References

Bressani, R.; Blanco, A. 1991. *Instituto de Nutrición de Centro América y Panamá (INCAP)*, **41**: 39-51.
Barampama and Simard. 1994. *J. of Food Sci.* **59**: 833-837
Decker, E.A. 1995. *Nutr. Rev.* **53**: 49-58.
Haug, W.; Lantzsch, H.J. 1983. *J. Sci. Food Agric.* **34**: 1423-1426.
Kasuga, A.; Yasuo, A.; Tatsuyuki, S. 1995. *J. of Food Sci.* **60**: 1113-1115.
Knuckles, B.E.; Kuzmicky, D.D.; Betschart, A.A. 1985. *J. Food Sci.* **50**: 1080-1082.
Leakey, C.L.A. 1988. Genetic resources of *Phaseolus* beans. Kluwer, Dordrecht, Netherlands. p. 245-237
Masuda,T.; Jitoe, A. 1994. *J. Agr. Food Chem.* **42**: 1850-1856.
Price L.; Hagerman, E. 1978. *J. Agric Food Chem.* **26**:459-462
Savelkoul, F.H.M.G.; Van Der Poel, A.F.B.; Tamminga, S. 1992. *Plant Foods Hum. Nutr.* **42**: 71.