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INTRODUCTION

Elimination of flatulence is a challenging practical problem associated with consumption of legumes. The problem is compounded by the variability in susceptibility among individuals. Rackis (1981) established that the oligosaccharides-verbascose, stachyose and raffinose are major causes of flatulence. They escape digestion and are fermented by intestinal micro floral to form excessive amounts of carbon dioxide and hydrogen. Little has been done to develop bean varieties that combine agronomic superiority with nutritional quality, fast cooking and low flatulence levels in eastern Africa. The objectives of this study were to: (i) determine if there is genotypic variation in concentration of oligosaccharides associated with flatulence in commercial bean varieties, recently released biofortified bean and advanced breeding lines, and (ii) the effect of cooking on oligosaccharide concentration.

MATERIALS AND METHODS

Study materials were 10 commercial dry bean varieties and seven recently released biofortified cultivars representing the Andean and Mesoamerican gene pools and the major market classes grown in east, central and southern Africa. Verbascose, stachyose and raffinose were extracted twice from ground raw and cooked bean milks using a 3:7 v/v methanol-water mixture and quantified on a high performance chromatography system using analytical grade standard reagents. The oligosaccharides sugars were quantified using a high performance liquid chromatography (Chromatography Systems model 750, Shimadzu, USA) with a differential refractometer. The precipitated material was removed by centrifugation and the supernatant filtered prior to analysis. The column used (250mm*4.6mm i.d) was packed with spherisorb-5-amino, as a slurry in propan-2-ol. Sample injection valve, model 7120 was used. The eluting solvent was acetonitrile/water (67:33, v/v) with a flow rate of 2.0 ml min^{-1} at a temperature of 40^0C. Quantification was carried out by peak area comparisons of sample and standards of known concentration (Pinthong et al, 1980). Standards were obtained from SIGMA-Aldrich, USA. Data was analyzed using Genstat statistical software (v15).

RESULTS AND DISCUSSION

There were significant differences in total oligosaccharide, raffinose and stachyose concentration among the genotypes (Table 1). However, differences in verbascose concentration were not significant. Cooking significantly reduced concentration of total oligosaccharides, raffinose and stachyose. Total oligosaccharide concentration varied from 4.1 % (*Kenya Almasi*) to 5.89% (*Kenya Madini*) with a mean of 4.96%. Raffinose concentration varied from 0.40% (KCB13-08) to 0.05% (GLP2). Stachyose concentration varied from 2.3% (*Kenya Almasi*) to 4.2% (*Kenya Madini*). Most genotypes showed only traces of verbascose except KCB13-05 (0.028%), KCB 13-06 (0.47%), *Kenya Majano* (0.049%) and GLP 1004 (0.15%). Mex 142, which is known to be low in flatulence causing factors, had total oligosaccharide concentration

of 5.43. Except for *Kenya Afya*, most of the genotypes with higher levels of oligosaccharides were red mottled, small red and red kidneys. However, there were coloured genotypes with low oligosaccharide concentration. This implied that ability to induce flatulence may be a genotype specific trait, which may not be associated with grain colour or size. Flatulence in the study genotypes was largely due raffinose and stachyose. The results indicated that there is adequate variation for oligosaccharide concentration to facilitate selection for low flatulence beans of diverse market classes, which can promote consumption of dry beans.

Table 1. Cooking time and grain oligosaccharide concentration of new biofortified bush bean varieties and commercial varieties.

Variety	**Cooking time (minutes)**	**Total oligosaccharide (%)**		**Raffinose (%)**		**Stachyose (%)**		**Verbascose (%)**	
		Raw	Cooked	Raw	Cooked	Raw	Cooked	Raw	Cooked
Kenya Maua	44.9	5.030	4.848	0.1885	0.0670	3.342	3.281	0.0000	0.0000
Kenya Afya	26.5	6.938	4.143	0.1840	0.0945	5.254	2.549	0.0000	0.0000
Kenya Madini	40.9	6.835	4.953	0.3395	0.1240	4.995	3.329	0.0000	0.0000
Kenya Almasi	26.6	4.307	4.577	0.1995	0.0810	2.607	2.996	0.0000	0.0000
Kenya Cheupe	26.5	4.362	4.579	0.2935	0.2355	2.569	2.843	0.0000	0.0000
Kenya Majano	36.3	4.845	5.706	0.0770	0.0830	3.171	4.123	0.0970	0.0000
Rosecoco Madini	40.0	4.307	4.577	0.1995	0.0810	2.607	2.996	0.0000	0.0000
Checks									
Mex 142	47.3	5.716	5.147	0.2030	0.1810	4.013	3.466	0.0000	0.0000
GLP1004	71.1	4.356	4.797	0.1870	0.1200	2.369	3.177	0.3000	0.0000
GLP 2	67.1	4.394	4.753	0.0485	0.0815	2.846	3.172	0.0000	0.0000
GLP 24	70.9	4.551	5.235	0.0810	0.1025	2.970	3.633	0.0000	0.0000
GLP 585	81.3	5.157	4.761	0.1225	0.1265	3.534	3.135	0.0000	0.0000
GLP 92	57.0	3.971	4.760	0.1790	0.1425	2.292	3.117	0.0000	0.0000
KAT B1	48.0	5.308	4.659	0.1205	0.0905	2.887	3.447	0.0000	0.0000
KAT 69	56.7	5.371	5.879	0.0530	0.0690	3.818	4.310	0.0000	0.0000
KAT 56	105.9	4.922	4.826	0.0875	0.0870	3.335	3.240	0.0000	0.0000
KAT B9	100.5	4.878	4.474	0.1260	0.0900	3.252	2.885	0.0000	0.0000
Mean		5.132	4.788	0.2404	0.1169	3.375	3.171	0.0161	0.0000
$LSD_{0.05}$		0.0868		0.00728		0.0838		0.01817	
CV(%)		14.5		0.7		0.1		0.00732	

CONCLUSIONS: Results of this study indicate that there was considerable genetic variation in flatulence causing factors in the genotypes studied. Cooked samples of six of the new varieties had low oligosaccharide concentration compared with industry standard, Mex 142 and most of the commercial varieties. Raffinose and stachyose were the main oligosaccharides in these varieties, with only traces of verbascose. In addition, *Kenya Cheupe* showed excellent canning characteristics. Dissemination and utilization of the new bean varieties can increase productivity, incomes, reduce micronutrient malnutrition, save time and costs of cooking, reduce incidence of flatulence, promote value addition and consumption in eastern Africa.

REFERENCES: Rackis, J.J. 1981. Flatulence caused by soya and its control through processing. JAOCS (1981): 503-509