Indian J. Genet., 68(3): 265-268 (2008)

Identification of soybean [*Glycine max* (L.) Merrill] genotypes with superior quality traits and their correlations with oil and protein

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(Received: June 2007; Revised: June 2008; Accepted: August 2008)

Abstract

Seventy four soybean genotypes of five different groups i.e. SL, PK, DS, Bragg and Pusa were analysed for physico-chemical and cooking quality. Oil correlates negatively with protein, cooking time and volume expansion after soaking. No *Kokroos* were found in any of the tested genotypes. Water absorption after soaking/cooking correlates positively with volume expansion. Genotypes of SL group exhibited superiority over other groups w.r.t. most of the quality traits and yield. Protein correlates negatively with yield (r = –0.16) and oil (r = –0.51).

Key words: Soybean, cooking quality, protein, oil, yield, correlation

Introduction

Soybean [*Glycine max* (L.) Merrill] is a wonder crop because of its nutritional value and versatile applications. It is used directly as food (dal, soypops), oil production, paustic atta/besan, soymilk, soy paneer and soy protein powder. It is useful in lowering cholesterol level, fighting cancer, controlling diabetes, improving immune system, protecting against Parkinson's disease etc. In India, soybean contributes about 10 per cent to the domestic edible oil pool and country earns substantial foreign exchange through export of soy- meal [1]. However, the presence of and nutritional factors exert a negative effect on the nutritional quality of protein [2]. It is an excellent source of protein (36-38%), unsaturated fat (18-20%) and fibre content. Soy protein is a complete protein and provides all eight essential amino acids in amounts needed for human health. Soy fat is highly unsaturated (24% mono- and 61% poly unsaturated) and is cholesterol free. The present investigation was undertaken to improve the quality characteristics like physico-chemical and cookability through breeding and selection. This information would be very useful to breeders intending to improve the quality of soybean.

Materials and methods

A set of seventy-four soybean genotypes comprising of five groups, *viz*., SL, PK, DS, Pusa and Bragg (Table 1) were procured from the Pulses Section of the Department of Plant Breeding, Genetics and Biotechnology, PAU Ludhiana during the crop season 2003.' The experiment was conducted in replicated trials in a randomized block design with three replications. The matured dry seeds were used for biochemical studies. The samples were cleaned and used for estimating the physico-chemical and cooking quality characteristics. The samples were ground in cyclotec (Tecator, Sweden) electric grinder and used for chemical analysis. Protein content (%) was determined by using Kjeldhal method of AOAC [3]. Physical and cooking quality parameters like 100-grain weight (g), 100-grain volume (ml), density (g/ml), water absorption (%), volume expansion (%), and, hard shelled grains (%) after soaking, cooking time (minutes), water absorption (%), volume expansion (%), solid dispersion (%) and *kokroos* (%) after cooking were determined by the methods of Santha *et al*. [4] and Shivshankar *et al*. [5]. Oil content was determined on NMR (Model No. 1) as reported by Alexander *et al*. [6]. Data on quality parameters and yield was subjected to statistical analysis by the method of Panse and Sukhatme [7].

Results and discussion

The main effects of genotypes were highly correlated for all grain quality variables tested. The physical, cooking and biochemical quality data means of 74 different genotypes is presented in Tables 2, 3 and Figs. 1 and 2. The correlations among different quality parameters and yield are presented in Table 5. Perusal of data revealed that SL group excelled with respect to 100-grain wt. (12.4g), 100-grain volume (11.0ml), density (1.2g/ml), volume expansion after soaking (175.0%),

Table 1. Distribution of genotypes among groups

Genotype groups	No. of genotypes	Genotypes included
SL	67	SL295, SL525, SL517, SL518, SL 633, SL 637, SL657, SL678, SL679, SL682, SL683, SL684, SL688, SL691, SL697,SL703, SL710, SL711, SL712, SL713, SL714, SL717, SL718, SL719, SL720, SL721, SL723, SL725, SL726, SL729, SL733, SL734, SL735, SL736, SL737, SL738, SL739, SL740, SL741, SL742, SL743, SL744, SL745, SL746, SL747, SL748, SL749, SL750, SL751, SL752, SL753, SL754, SL755, SL756, SL757, SL758, SL759, SL760, SL761, SL762, SL763, SL764, SL765, SL766, SL767, SL768, SL769
PK	3	PK1042, PK1347, PK416
DS	2	DS-98-14, DS-99-09
Pusa	1	Pusa 16
Bragg	1	Bragg

water absorption after cooking (141.6%), Volume expansion after cooking (222.6%), solid dispersion (42.2%) and yield (3889.0kg/ha). Water absorption after soaking was recorded highest in DS group (135.1%) while cooking time was recorded minimum in SL group (46 min) followed by PK group (55 minutes). *Kokroos* were not found in any genotype. One hundred grain weight varied from 7.9 g –12.4 g with mean value of 10.2 g. Three genotypes namely SL 739, SL 762 and DS-98-14 registered 100 grain weight more than 12g. One hundred grain volume ranged from 7.5 ml –11.0ml with mean value of 9.5ml. Twenty genotypes exhibited one hundred grain volume above 10ml. Water absorption after soaking ranged from 75.1 % to 135.1% with mean value of 115.3%. Three genotypes exhibited more than 130% water absorption after soaking. It was found maximum in DS-98-14. (135.13%) followed by PK1042 (131.5%) and PK1347 (130.8%). Twenty one genotypes had no hard grains after soaking.

Volume expansion after soaking varied from 90.5-175.0% with average value of 139.5%. Fourteen genotypes had more than 150% volume expansion after soaking. Cooking time was found less than 50 minutes in four genotypes namely SL 767 (46 minutes), SL 766, SL 768, SL 769 (50 minutes each). Cooking time varied from 46 minutes to 85 minutes with mean value of 65.1

Table 2. Physical and cooking quality characteristics of different soybean genotype groups

Genotype group	Statistics	100-grain wt. (g)	100-grain Vol. (ml)	Density (g/ml)	Water Abs (S) (%)	Vol. exp. (S) (%) (S)	Hard shelled grains (%)	Coking time (min) (%)	Water Abs. (C)	Vol. Exp. (C)	Solid Disp. (%)	Yield (kg/ha)
SL	Mean	10.2	9.5	1.1	114.3	139.1	4.4	65.3	99.4	130.7	19.8	2749.1
	Max.	12.4	11.0	1.2	127.5	175.0	36.0	85.0	141.6	222.6	42.2	3889.0
	Min.	7.9	7.5	1.0	75.1	90.5	0.0	46.0	9.8	50.1	4.5	1832.0
PK	Mean	10.1	9.7	1.0	127.9	138.5	0.7	61.7	114.3	132.6	12.6	2283.3
	Max.	10.6	10.0	1.1	131.5	155.6	2.0	65.0	141.4	177.8	19.3	2582.0
	Min.	9.8	9.0	1.0	121.3	130.0	0.0	55.0	94.7	90.0	7.3	2108.0
DS	Mean	11.1	10.0	1.1	131.1	159.6	2.0	62.5	123.2	151.0	27.7	2231.5
	Max.	12.2	11.0	1.1	135.1	163.6	2.0	65.0	177.2	211.1	36.1	2482.0
	Min.	10.1	9.0	1.1	127.2	155.6	2.0	60.0	69.2	90.9	19.3	1981.0
Bragg	Mean	10.0	9.0	1.1	113.1	133.3	6.0	68.0	55.6	77.78	18.0	2341.0
Pusa	Mean	9.6	9.0	1.0	115.8	133.3	1.0	65.0	56.13	55.56	15.3	2829.0
Overall	Mean	10.2	9.5	1.1	115.3	139.5	4.1	65.1	99.5	129.6	19.7	2711.8
	Max.	12.4	11.0	1.2	135.1	175.0	36.0	85.0	177.2	222.6	42.2	3889.0
	Min.	7.9	7.5	1.0	75.1	90.5	0.0	46.0	9.8	50.1	4.5	1832.0

S = soaking; C = cooking

Table 3. Biochemical characters of different soybean genotype groups

Genotype groups	No. of genotypes	Statistics	Protein (%)	Oil (%)
SL	67	Mean	36.5	20.5
		Max.	42.5	23.3
		Min.	26.2	16.3
PK	3	Mean	35.6	20.2
		Max.	38.5	22.5
		Min.	32.7	17.6
DS	2	Mean	35.3	22.4
		Max.	35.4	22.9
		Min.	35.2	22.0
Bragg	1	Mean	37.0	20.6
Pusa	1	Mean	32.0	19.1
Overall	74	Mean	36.4	20.5
		Max.	42.5	23.3
		Min.	26.2	16.3

minutes. Water absorption after cooking varied from 9.8 to 177.2% with average value of 99.5%. Nine genotypes exhibited more than 125% water absorption after cooking. Volume expansion after cooking ranged from 50.1-222.6% with mean value of 129.6%. Three genotypes namely SL 711 (222.6%), DS-99-09 (211.1%) and SL 517 (206.7%) showed more than 200% volume expansion after cooking. Only one genotype had more than 40% solid dispersion and five genotypes had solid dispersion between 30-40%. It is a very important consumer's quality parameter required for thickening of gravy.

Protein content varied from 26.2-42.5% with mean value of 36.4% (Table 4). It was found highest in SL group followed by PK group. It was found more than 40% in eleven genotypes (Fig. 1) while 39 genotypes had protein from 35.1-40%. It was negatively correlated with oil content (r = –0.51), yield (r = –0.16) but positively correlated with volume expansion after soaking (r = 0.24) as given in Table 4. It was maximum in SL 723 (42.5%) followed by SL 737 (41.6 %). Oil content ranged from 16.3-23.3% with average value of 20.5 % (Table 4). Similar results were also reported by Sharma *et al.* [8] with respect to protein content (31.9-38.9%) and oil content (19.7-21.7%). Manjaya *et al.* [9] determined oil content in 55 genotypes which ranged from 13.19-20.72%. It was found highest in SL group genotypes followed by DS and PK group genotypes. SL 748 exhibited highest oil content (23.3%), followed by SL756 (23.1%). Forty-six genotypes recorded more than 20% oil content. It was negatively correlated with cooking time

Table 4. Correlations amongst quality characters and yield

Parameters	r
100-grain wt(g) vs 100-grain volume (ml)	0.95
Density (g) vs 100-grain wt (g)	0.39
Volume expansion (%) vs water absorption (%)	0.36
Hard shelled (%) vs volume expansion (%) (S)	-0.29
Volume expansion (%) (C) vs water absorption (%)	0.57
Protein (%) vs volume expansion (%) (S)	0.24
Oil (%) vs volume expansion (%) (S)	–0.21
Protein(%) vs yield (Kg/ha)	–0.16
Oil (%) vs protein (%)	–0.51
Oil (%) vs cooking time (minutes)	–0.27

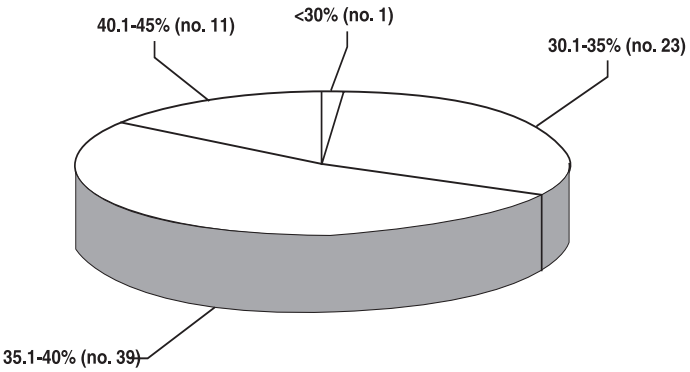

Fig. 1. Protein (%) in different genotypes of soybean

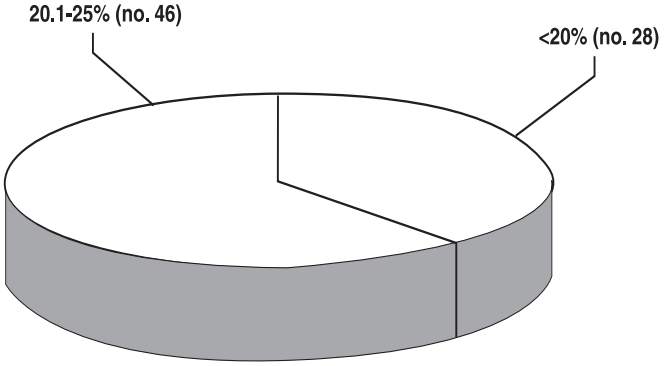

Fig. 2. Oil (%) in different genotypes of soybean

(r = –0.27), volume expansion after soaking (r = –0.21). Yield varied from 1832-3889 kg/ha with mean value of 2711.8 kg/ha. SL 752 had maximum yield (3889 kg/ha) followed by SL 733 (3622 kg/ha). Twenty-four genotypes had yield of more than 2700 kg/ha.

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