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Chemical Composition of Seed in Medicinal Soybean Collected in Korea

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ABSTRACT

Production of medicinal soybean [*Glycine max* (L.) Merrill], characterized with black seed, white stripe at hilum border, yellow cotyledon and small seed, is increasing with increasing consumption. The objective of this study was to investigate the chemical composition of medicinal soybean seed and to provide basic information, for the characterization of these soybeans among genetic resources. Forty-four lines of medicinal soybeans collected from Korea and two control cultivars, 'Hwangkeumkong' (Yellow seed coat) and 'Geomjeongkong 1' (Black seed coat) were planted at the Research Farm of the College of Natural Resources, Korea University, located at Namyangju City on May 25, 1996. Seeds of these lines were harvested at full maturity and analyzed for protein, oil, sugar, starch and mineral contents. Mean protein and oil content of the medicinal line seeds were 42.6 and 16.1%, respectively, and those of the control cultivars were in the middle range for protein and oil content. However, sugar and starch content of the medicinal line seeds appeared to be in the lower range of the distributions compared to the control cultivars and were 10.0 and 1.68%, respectively. Mean P, K, Ca, and Mg contents of the seeds of medicinal soybean lines were 15.9, 21.5, 3.11, and 2.81 mg/g, respectively, indicating that these lines had higher P, K, and Mg and lower Ca contents when compared to the control cultivars. Mean Na and Fe contents were 671 and 224 mg/kg, respectively, showing lower Na and similar Fe contents. The observed results provided that chemical compositions of medicinal soybean were, on average, different from those of the general soybean cultivars.

Key word : *Glycine max*, medicinal soybean, protein content, oil content, sugar content, starch content, mineral contents.

Soybean seeds used for medicinal purpose have some common characteristics of black seed coat, white stripe at hilum border and very small seed weight with yellow cotyledon called 'Gynoonikong ('Seomoktae')' or 'Yakkong' (medicinal soybeans). These medicinal soybeans were originally named 'Yeodoo' or 'Heugsodoo' by Lee (1592), 'Yeodoo' or 'Wungheugdoo' by Hur (1613), and 'Yeodoo' ('Gynoonikong'), small black soybean or 'Wungheugdoo' by Hwang (1885). Chang (1988) has reported 'Yeodoo' or 'Gykong' ('Seomoktae') from ancient agricultural books.

These soybean seeds have been reported to have a common remedy effect on human diseases known as detoxification, even though the exact chemical components have not been proved yet (Chang, 1993; Chung & Shin, 1990; Lee, 1994). However many researchers have suggested that the chemical components in soybean seed, which have medicinal effects, may be saponins (Kim et al., 1994; Oakenfull, 1981; Proce et al., 1987), isoflavones (Holt, 1997; Kim, 1996; Kim et al., 1996; Molteni et al., 1995), and oligosaccharides (Choi et al., 1995). Recently the consumption of these medicinal soybeans is increasing very rapidly for a remedy against poison or for a functional food probably due to the increasing pollutions of air and water and foodstuff poisoning.

Chemical components of black soybean seeds collected in Korea were reported by Kim et al. (1993). The protein content of these black soybean seeds ranged from 34.1 to 48.0% (Kwon et al., 1972). Oil content ranged from 14.1 to 23.8% (Kwon et al., 1975). Total sugar content ranged from 8.3 to 12.1% (Kim et al., 1993). Smith & Circle (1978) have reported the mineral content of collected soybean seeds. Phosphorus (P) and potassium (K) content of these seeds ranged from 0.50 to 1.08% and from 0.81 to 2.39%, respectively. Other mineral elements such as calcium (Ca), magnesium (Mg), sodium (Na), and iron (Fe) also ranged with the minimum content. The objective of this study was to investigate the chemical composition of collected medicinal soybean seeds and to provide the basic information for the characterization of these soybeans among genetic resources.

MATERIALS AND METHODS

Seeds of medicinal soybeans [*Glycine max* (L.) Merrill] from Korea were planted at the Research Farm of the College of Natural Resources, Korea University, located at Namyangju City, Kyonggi Province. Forty-four lines of medicinal soybeans were grown with two control cultivars, Hwangkeumkong (Yellow seed coat) and Geomjeongkong 1 (Black seed coat). Seed characteristics are listed in Table 1. The planting date was 25 May 1996 and planting density was 60 × 15 cm with two seeds per station. Plot size was 1.8 m long with three rows. A randomized complete block design was used with the three replications. Seeds of the planted medicinal soybean lines were harvested at full maturity and dried at 70℃ for 48 hours.

Samples of medicinal soybean lines were ground with a

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Table 1. Selection number, collected line name, and seed characteristics of Korean medicinal soybeans.

Selection number	Collected line name	Flower color†	Seed coat color†	Hilum color†	Seed coat texture	100-seed weight
						– g –
KU 1	Kapyong 1-1	P	B	B	shiny	11.0
KU 2	Kapyong 2-1	P	B	B	medium	11.5
KU 3	Kapyong 2-2	W	B	B	coarse	8.8
KU 4	Kangwon 1-1	P	B	B	very shiny	10.6
KU 5	Kangwon 1-2	W	B	B	very shiny	11.2
KU 6	Kangwon 1-1-1	W	B	B	shiny	10.0
KU 7	Kangwon 2-1	P	B	B	shiny	10.7
KU 8	Kangwon 2-3	P	B	B	shiny	9.3
KU 9	Kangwon 3-1	P	B	B	shiny	11.0
KU10	Kangwon 3-2	W	B	B	shiny	11.4
KU11	Kangwon 4-1	P	B	B	shiny	9.2
KU12	Kangwon 4-3	W	B	B	very shiny	10.6
KU13	Kangwon 5-1	P	B	B	very shiny	9.6
KU14	Kangwon 5-2	P	B	B	coarse	10.6
KU15	Kangwon 5-3	W	B	B	very shiny	11.3
KU16	Kangwon 6	P	B	B	shiny	10.1
KU17	Kangwon 7-1	P	B	B	medium	11.6
KU18	Kangwon 7-2	W	B	B	shiny	11.3
KU19	Kangwon 8-1	P	B	B	shiny	13.2
KU20	Kyonggi 2	P	B	B	shiny	13.2
KU21	Kyonggi 2-1-1	P	B	B	shiny	12.0
KU22	Kyonggi 2-1-2	W	B	B	medium	12.0
KU23	Kyongnam 2	P	B	B	shiny	11.6
KU24	Kyongsan 1	P	B	B	shiny	11.3
KU25	Kurye 1-2	W	B	B	shiny	11.6
KU26	Kurye 2-1	P	B	B	shiny	10.9
KU27	Kurye 2-2	W	B	B	shiny	11.7
KU28	Puan 1-2	W	B	B	shiny	11.2
KU29	Yangpyong 1	P	B	B	medium	10.8
KU30	Yangpyong 3	W	B	B	shiny	11.1
KU31	Yongchon 1-1	P	B	B	very shiny	10.5
KU32	Yongchon 1-2	W	B	B	shiny	12.0
KU33	Yongchon 2-2	W	B	B	shiny	11.7
KU34	Wonju 1	P	B	B	shiny	9.6
KU35	Jeonla	P	B	B	shiny	9.9
KU36	Chongyang	P	B	B	shiny	9.0
KU37	Chungnam 1-1	P	B	B	shiny	10.5
KU38	Hadong 1-2	W	B	B	shiny	11.7
KU39	Hadong 2-1	P	B	B	very shiny	10.7
KU40	Hongsong 1	P	B	B	coarse	14.7
KU41	Hongchon	P	B	B	shiny	12.3
KU42	Kangwon 4-1-1	P	B	B	shiny	9.6
KU43	Puan 2	P	B	B	very shiny	13.2
KU44	Yungdong 2	W	B	B	shiny	11.4
Con. 1	Hwangkeumkong	P	Y	Y	shiny	31.0
Con. 2	Geomjeongkong 1	W	B	B	medium	34.7

† B: Black, W: White, P: Purple, Y: Yellow.

Udy Cyclon mill (0.5 mm screen). The nitrogen content was measured by the boric acid modification micro-Kjeldahl method and multiplied factor 6.25 to obtain the protein content. Oil content was determined by the Soxhlet method. Sugar and starch contents were determined using the Anthrone method. Mineral contents of the samples were determined by the analytical methods of National Agricultural Science and Technology Institute (NASTI, 1988). Phosphorus (P) content was measured using the Bran Leubbe TRAAC800+ by molybdenium blue method with digestion solution followed H_2SO_4-H_2O_2 wet digestion. Potassium (K), calcium (Ca), magnesium (Mg), sodium (Na) and iron (Fe) contents were measured using ICP (GBC integra XL) after H_2SO_4-H_2O_2 wet digestion. Statistical data analysis was made with SAS package.

RESULTS AND DISCUSSION

Seeds of medicinal soybeans were analyzed for protein, oil, sugar, and starch contents as shown in Table 2. The protein content of the forty-four medicinal soybean lines ranged from 38.5 to 46.1% and those of two control cultivars, Hwangkeumkong and Geomjeongkong 1 were 42.1 and 40.7%, respectively, indicating that the protein contents of the control cultivars were in the middle range of the medicinal soybeans (Table 3). This protein content distribution of medicinal soybean lines was within the range of those of the black soybean seeds reported by Kim et al. (1993). Oil contents of the lines ranged from 14.2 to 19.3% and those of the control cultivars were 17. 0 and 17.8%, respectively. The oil content like the protein content was also within the range of those of black soybean seeds (Kim et al., 1993).

Sugar content of medicinal soybean lines ranged from 8.9 to 11.3% and those of the control cultivars were 12.5 and 11.7% (Table 2). Thus, the sugar content of medicinal soybean seeds was generally lower than that of the control cultivars as in Table 3. Starch content of the lines ranged from 1.12 to 2.32%, and those of the control cultivars were 4.09 and 3.61%, respectively. The distribution pattern of starch content of the lines was similar to the sugar content distribution (Table 3). The results indicated that sugar and starch contents of medicinal soybean seeds were lower than those of the generally cultivated cultivars. On the other hand, total sugar content of black soybean seeds were reported to range from 8.3 to 12.1% (Kim et al., 1993).

Seeds of medicinal soybean lines were measured for phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), and iron (Fe) contents as shown in Table 4. P contents of forty-four lines of medicinal soybeans ranged from 13.5 to 18.8 mg/g, and those of two control cultivars, Hwangkeumkong and Geomjeongkong 1 were 14.6 and 14.5 mg/g, respectively. Based on the distribution pattern (Table 5) medicinal soybean lines showed higher P content than did the control cultivars. K content of the lines also appeared to have

Table 2. Protein, oil, sugar, and starch contents in seeds of collected medicinal soybean lines cultivated at Namyangju area in 1996.

Collected line name	Protein content	Oil content	Sugar content	Starch content
	.....	(%)	.....	
Kapyong 1-1	41.4	15.7	10.2	1.57
Kapyong 2-1	41.3	18.0	11.1	1.34
Kapyong 2-2	43.2	14.2	10.4	1.51
Kangwon 1-1	42.9	15.0	10.2	1.95
Kangwon 1-2	43.3	16.0	9.9	1.19
Kangwon 1-1-1	42.4	15.3	10.5	1.91
Kangwon 2-1	42.4	15.0	10.1	1.65
Kangwon 2-3	41.9	14.5	9.9	1.12
Kangwon 3-1	39.5	16.8	9.4	1.25
Kangwon 3-2	40.9	16.9	10.2	1.94
Kangwon 4-1	41.9	14.5	10.4	2.26
Kangwon 4-3	41.8	16.7	9.0	2.29
Kangwon 5-1	41.9	16.0	9.7	1.68
Kangwon 5-2	40.9	15.5	9.8	1.27
Kangwon 5-3	42.6	15.6	9.1	1.54
Kangwon 6	42.2	15.9	9.8	2.32
Kangwon 7-1	38.7	17.9	11.2	2.03
Kangwon 7-2	44.6	15.2	9.9	1.63
Kangwon 8-1	46.1	15.8	10.2	1.71
Kyonggi 2	39.4	19.3	10.8	1.68
Kyonggi 2-1-1	41.6	19.2	11.1	2.07
Kyonggi 2-1-2	39.8	15.8	9.9	1.35
Kyongnam 2	43.6	15.8	9.7	1.66
Kyongsan 1	42.4	15.7	9.6	1.35
Kurye 1-2	40.7	16.0	9.6	1.63
Kurye 2-1	38.5	18.5	10.7	2.16
Kurye 2-2	44.3	16.5	9.7	1.84
Puan 1-2	42.1	15.8	9.7	2.12
Yangpyong 1	44.2	14.9	9.3	2.15
Yangpyong 3	44.2	15.8	9.8	1.73
Yongchon 1-1	42.6	16.1	9.4	1.45
Yongchon 1-2	44.2	15.1	10.0	1.44
Yongchon 2-2	44.8	14.4	8.9	1.41
Wonju 1	44.7	15.7	10.1	1.78
Jeonla	44.8	15.6	9.6	1.76
Chongyang	41.7	16.4	10.3	1.44
Chungnam 1-1	43.3	16.1	9.7	1.43
Hadong 1-2	43.8	15.6	9.5	1.67
Hadong 2-1	45.3	15.6	9.6	1.40
Hongsong 1	46.1	15.7	10.7	1.49
Hongchon	42.8	18.0	11.3	1.13
Kangwon 4-1-1	42.6	16.0	10.1	2.13
Puan 2	41.1	17.4	10.5	1.54
Yungdong 2	45.0	16.5	10.3	2.03
Mean of medicinal soybeans	42.6	16.1	10.0	1.68
Hwangkeumkong	42.1	17.0	12.5	4.09
Geomjeongkong 1	40.7	17.8	11.7	3.61
$LSD_{0.05}$	0.7	0.4	0.3	0.17

Table 3. Distribution of forty-four collected lines at each range of protein, oil, sugar, and starch contents in medicinal soybean seeds cultivated at Namyangju area in 1996.

Division	Range values (%)				
	Number of lines or cultivars				
Protein	38.5~40.0	40.1~41.5	41.6~43.0	43.1~44.5	44.6~46.1
Collected lines	5	6	16	9	8
Hwangkeumkong			1		
Geomjeongkong 1		1			
Oil	14.1~15.0	15.1~16.0	16.1~17.0	17.1~18.0	18.1~19.5
Collected lines	7	22	8	4	3
Hwangkeumkong			1		
Geomjeongkong 1				1	
Sugar	8.0~8.9	9.0~9.9	10.0~10.9	11.0~11.9	12.0~12.9
Collected lines	1	22	17	4	
Hwangkeumkong					1
Geomjeongkong 1				1	
Starch	1.10~1.69	1.70~2.29	2.30~2.89	2.90~3.49	3.50~4.09
Collected lines	26	17	1		
Hwangkeumkong					1
Geomjeongkong 1					1

Table 4. Mineral element contents in seeds of collected medicinal soybean lines cultivated at Namyangju area in 1996.

Collected line name	P	K	Ca	Mg	Na	Fe	Collected line name	P	K	Ca	Mg	Na	Fe
	····· mg/g ·····				··· mg/kg ···								
Kapyong 1-1	13.5	21.7	3.70	2.81	814	260	Kurye 1-2	17.0	21.9	3.08	2.86	592	180
Kapyong 2-1	15.9	21.2	3.37	2.65	589	150	Kurye 2-1	18.5	23.4	2.78	2.78	717	191
Kapyong 2-2	14.5	20.4	4.21	2.96	925	336	Kurye 2-2	18.1	21.3	3.01	2.76	733	259
Kangwon 1-1	15.0	21.0	3.76	2.83	955	337	Puan 1-2	15.9	20.5	3.18	2.74	595	157
Kangwon 1-2	17.7	20.3	3.67	2.85	780	243	Yangpyong 1	15.3	21.8	2.93	2.82	614	157
Kangwon 1-1-1	15.6	20.4	2.70	2.74	415	188	Yangpyong 3	13.9	19.8	3.27	2.72	432	170
Kangwon 2-1	17.5	22.8	3.22	3.02	837	212	Yongchon 1-1	18.8	22.5	3.13	2.79	650	180
Kangwon 2-3	14.5	20.5	3.04	2.88	314	199	Yongchon 1-2	13.7	20.6	2.66	2.85	420	466
Kangwon 3-1	15.0	22.1	2.99	2.84	574	153	Yongchon 2-2	17.8	20.6	3.41	2.82	772	203
Kangwon 3-2	15.0	20.4	2.82	2.71	301	157	Wonju 1	18.5	21.9	3.67	2.97	745	178
Kangwon 4-1	16.6	21.5	3.01	2.79	764	205	Jeonla	15.0	23.2	3.02	2.94	643	157
Kangwon 4-3	17.1	21.4	3.43	2.82	771	266	Chongyang	15.6	22.4	3.26	2.81	661	191
Kangwon 5-1	16.1	19.9	3.92	2.82	884	193	Chungnam 1-1	14.6	22.3	3.39	3.05	647	196
Kangwon 5-2	17.3	21.8	3.38	3.00	776	542	Hadong 1-2	16.9	22.1	3.36	2.85	786	157
Kangwon 5-3	17.3	21.0	2.80	2.92	742	232	Hadong 2-1	16.3	23.5	2.73	2.85	791	357
Kangwon 6	16.5	21.2	3.53	2.73	757	237	Hongsong 1	17.5	21.7	3.41	2.84	686	178
Kangwon 7-1	14.3	23.2	2.66	2.85	654	224	Hongchon	13.5	22.8	3.08	2.93	630	177
Kangwon 7-2	15.4	22.0	3.09	2.87	665	200	Kangwon 4-1-1	18.0	21.7	2.72	2.65	828	229
Kangwon 8-1	15.2	20.3	2.75	2.77	646	168	Puan 2	15.4	22.4	2.37	2.41	642	204
Kyonggi 2	15.9	21.9	2.92	2.88	649	168	Yungdong 2	14.1	19.1	3.03	2.67	354	185
Kyonggi 2-1-1	15.0	22.3	2.59	2.76	705	433	Mean of medicinal soybeans	15.9	21.5	3.11	2.81	671	224
Kyonggi 2-1-2	15.8	20.7	2.85	2.76	936	209	Hwangkeumkong	14.6	18.7	3.62	2.62	867	217
Kyongnam 2	14.8	21.6	2.46	2.66	573	191	Geomjeongkong 1	14.5	20.5	3.55	2.51	913	298
Kyongsan 1	14.2	22.0	2.41	2.74	563	198	$LSD_{0.05}$	0.2	0.1	0.02	0.12	12	15

Table 5. Distribution of forty-four collected lines at each range of phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), and iron (Fe) contents in medicinal soybean seeds cultivated at Namyangju area in 1996.

Division	Range values (%)				
	Number of lines or cultivars				
P	13.4~14.5	14.6~15.7	15.8~16.9	17.0~18.1	18.2~19.3
Collected lines	9	13	9	10	3
Hwangkeumkong		1			
Geomjeongkong 1	1				
K	18.6~19.5	19.6~20.5	20.6~21.5	21.6~22.5	22.6~23.5
Collected lines	1	9	10	18	6
Hwangkeumkong	1				
Geomjeongkong 1		1			
Ca	2.00~2.49	2.50~2.99	3.00~3.49	3.50~3.99	4.00~4.49
Collected lines	3	14	20	6	1
Hwangkeumkong				1	
Geomjeongkong 1				1	
Mg	2.40~2.54	2.55~2.69	2.70~2.84	2.85~2.99	3.00~3.14
Collected lines	1	4	21	15	3
Hwangkeumkong		1			
Geomjeongkong 1	1				
Na	300~439	440~579	580~719	720~859	860~999
Collected lines	6	3	17	14	4
Hwangkeumkong					1
Geomjeongkong 1					1
Fe	150~229	230~309	310~389	390~469	470~549
Collected lines	32	6	3	2	1
Hwangkeumkong	1				
Geomjeongkong 1		1			

a similar pattern to P content. K content ranged from 19.1 to 23.5 mg/g, and those of the controls were 18.7 and 20.5 mg/g (Table 4 and 5). These higher P and K contents of medicinal soybean lines were in the maximum range in collected as soybean seeds reported by Smith & Circle (1978).

Ca content of the medicinal soybean lines ranged from 2.37 to 4.21 mg/g, and the mean was 3.11. Also those of the control cultivars were 3.62 and 3.55 mg/g, respectively, indicating that many medicinal soybean seeds had lower Ca contents than did the control cultivars. Mg content of the medicinal soybean lines ranged from 2.41 to 3.05 mg/g and those of the controls were 2.62 and 2.51 mg/g, respectively, indicating that medicinal soybean seeds had higher Mg contents than did the control cultivars (Table 4 and 5).

Sodium (Na) content of the medicinal soybean lines ranged from 301 to 955 mg/kg and those of the control cultivars were 867 and 913 mg/kg, respectively (Table 4). These results indicated that medicinal soybean seeds in general, had lower Na contents when compared to the control cultivars (Table 5). Fe content of the medicinal soybean lines ranged from 150 to 542 mg/kg and those of the controls were 217 and 298 mg/kg, respectively. However, most of the lines had lower levels of Fe content than of the control cultivars (Table 5).

Based on these results, seeds of medicinal soybean lines, when compared to the control cultivars, had similar protein, similar oil, and lower sugar, and lower starch content. Seeds of the medicinal soybean lines also had higher P, K, and Mg, lower Ca and Na, and similar Fe content. Thus, it could be concluded that chemical composition of medicinal soybeans were different from those of the general soybean cultivars. Further research of these medicinal soybeans is needed to investigae saponins, isoflavones, oligosaccharides, and other components.

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