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Analysis of Dietary Fiber of 66 Korean Varieties of Sprout Beans and Bean Sprouts

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Abstract

The present study was conducted to determine a high-fiber variety of sprout bean and bean sprout. Sixty-six varieties of Korean sprout beans and thirty varieties of Korean bean sprouts were analyzed for their total dietary fiber (TDF) using a combination of enzymatic and gravimetric methods adopted by AOAC. The average and range of the TDF contents of the 66 varieties of sprout beans were 21.73±2.43% and 16.60~29.2% (dry basis), respectively. The top five types of sprout beans with high TDF among the 66 samples were KLG10658 (29.2%), Dawonkong (28.46%), Sohokong (25.66%), Moohankong (25.465%) and Samnamkong (24.94%). The mean TDF content of sprout beans was relatively high in the variety with yellow seed coat color and a smaller seed size (<15 g/100 seeds) than the ones with other colors and of medium or large seed size. The average and range of the TDF content of the 30 varieties of bean sprouts were 24.48±3.9% and 18.3~33.38%, respectively. Dawonkong sprouts showed the highest TDF content (33.38%). The average TDF content of bean sprouts was 1.16 times higher than that of the corresponding seed beans. The TDF content of bean sprouts did not significantly change during the days of culture. The TDF content in the different parts of the bean sprout were high in the order of roots, hypocotyl and cotyledon.

Key words: total dietary fiber, sprout bean, bean sprout

INTRODUCTION

Soybean has recently received a great deal of attention due to the presence of various physiologically active functional materials, so called nutraceuticals, as well as their being an excellent source of high-quality protein and essential fatty acids. The nutraceuticals that have been reported to be present in beans are dietary fiber, oligosaccharides, isoflavones, phytic acid, trypsin inhibitor, saponins and other materials like vegetable sterol and phenol compounds (1,2). Among these nutraceuticals, dietary fiber has been implicated in reducing the risk of coronary heart disease (3,4) and colon cancer (5). Legumes are abundant in both soluble and insoluble dietary fibers. Pectins and gums are the major soluble fibers and cellulose is a major insoluble fiber in beans (6).

Bean sprouts are the most commonly-used vegetable in the Korean diet regardless of the season. Bean sprouts, therefore, may be a considerably significant source of dietary fiber in Korean meals. Bean sprouts are usually cultivated from small-sized beans (6.4~15.6 g, average of 12.2 g/100 seeds) which have yellow, green, or yellowish brown seed coat colors (7). Small-sized beans are favorable for cultivation due to their high rate of germination and high yield (8).

The domestic demand for sprout beans is approximately sixty-five thousand tons each year and is expected to increase continually due to expanded consumption in restaurants and institutional meal services. Domestic production of sprout bean, however, is rapidly decreasing like other types of beans because of it's high production costs. Accordingly, domestic demand for sprout beans is mostly met by imported foreign beans. If this trend continues, the basis for domestic production of sprout bean would be destroyed. We, therefore, need to find and develop a high-quality sprout bean variety which would differentiate it from the imported one.

Previously, we determined the contents of isoflavone for sixty-six varieties of Korean sprout beans and 30 varieties of bean sprouts (9) to find a high-isoflavone variety of sprout beans and bean sprouts. The purpose of this study is to determine the dietary fiber content for the same samples of beans and bean sprouts in order to select a high-fiber variety of sprout beans and bean sprouts. The changes in TDF content of bean sprouts during cultivation and TDF contents in different parts of bean sprout were also determined in the present study.

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MATERIALS AND METHODS

Sample preparation

Sixty-six varieties of sample sprout beans were kindly provided by the Department of Agronomy, Kyungpook National University, Daegu, Korea. Thirty varieties of sample beans including 14 high-isoflavone varieties (9) and 16 Korean improved lines were used for cultivation of bean sprout.

Fifty grams of each sample bean was dried for 4 hrs at 105°C in a dry oven and were ground to 45 mesh and stored in a tightly closed container until analysis was carried out.

Thirty varieties of bean sprout samples were prepared from the following cultivation procedure : Eighty grams of each variety of bean were soaked in water for 5 hrs and then cultivated in an automatic cultivator for 5 days under the conditions of a 10-minute spray of water (18°C) every 3 hrs. Cultivated bean sprouts were washed, had seed coats removed, drained and freeze-dried. Dried bean sprouts were ground to 45 mesh and defatted with petroleum ether as described in the AOAC procedure (10) and stored in a tightly closed container until analysis was carried out.

Total dietary fiber analysis

The TDF content of beans and bean sprout samples were determined using the total dietary fiber assay kit (Sigma Technical Bulletin No. TDFAB-3). This procedure for the determination of total dietary fiber is based on the method published in the 16th Edition of the Official Methods of Analysis of the Association of Official Analytical Chemists (AOAC) (10).

Four 1-g samples of each material were weighed into tall form beakers. Fifty mL of pH 6.0 phosphate buffer and 0.1 mL of α-amylase (Sigma A-3306) were added to each beaker and mixed well. Each beaker was covered with aluminum foil and placed in a boiling water bath with gentle agitation and incubated for 15 minutes after the internal temperature of the beakers reached at 95°C and then was allowed to cool to room temperature. The pH of the solutions was adjusted to 7.5±0.2 by adding 10 mL of 0.275 N NaOH to each beaker and 0.1 mL of protease (Sigma P-3910) solution (50 mg/mL phosphate buffer) was pipetted into each beaker. The beaker was placed in 60°C water bath and incubated for 30 minutes after the internal temperature of the beakers reached at 60°C and then allowed to cool to room temperature. The pH of the solutions was adjusted to between pH 4.0 and 4.6 by adding 10 mL of 0.325 M HCl to each beaker and 0.1 mL amyloglucosidase (Sigma A-9913) was added to each beaker. After each beaker was incubated in 60°C water bath for 30 minutes, 4 volumes of 95% ethanol was added and solutions were set overnight at room temperature to allow complete precipitation.

Each enzyme digest was filtered through a fritted crucible containing dried Celite (Sigma C-8656) while suction was applied. The residue was washed with three 20 mL portions of 78% ethanol, two 10 mL portions of 95% ethanol, and two 10 mL portions of acetone, successively. The crucibles containing the residue were dried overnight in a 105°C air oven, and cooled in a desiccator and weighed. The residues from two samples and two blanks were analyzed for protein by the micro-Kjeldahl method (11) using 6.25 as the factor to convert nitrogen determined in the analysis to protein. The residues from the other two samples and two blanks were ashed for 5 hr at 525°C, cooled in a desiccator, and weighed. Total dietary fiber is the weight of the residue less the weight of the protein and ash. Blanks were run through the entire procedure along with samples to measure any contributions from reagents to residue weight. Samples and blanks were run in quadruplicate so that duplicate protein and ash values were available for improved accuracy. The TDF value was expressed as a percentage of the dry weight of the samples.

The TDF content of the sample was calculated by the following equations:

Blank (g) = Blank residue weight (g) - Blank protein weight (g) - Blank ash weight (g)

TDF (%) = [Sample residue (g) - Sample protein (g) - Sample ash (g) - Blank (g)] / Sample (g)] × 100

RESULTS AND DISCUSSION

TDF content of sprout beans

The TDF content of sixty-six varieties of sprout beans based on dry weight is shown in Table 1. The amount of the TDF of 66 varieties of sprout beans ranged from 16.60% in Saebyul bean to 29.2% in KLG10658, with an average of 21.73±2.43%. The top five varieties with the highest TDF contents among the 66 samples were KLG10658 (29.15%), Dawonkong (28.46%), Sohokong (25.66%), Moohankong (25.46%) and Samnamkong (24.94%).

The TDF content of 30 varieties of medium-sized sprout beans were compared, based on seed coat color (Table 2). The mean TDF content of the varieties with yellow, black, green, brown and mixed color seed coat showed 21.51±0.64%, 21.36±0.56%, 21.56±0.64%, 21.31±1.1% and 20.83±0.32%, respectively. There was no significant difference in the TDF values by the different color seed coats. Twenty varieties of beans with yellow color seed coat were divided into three groups based on the seed size (small size : <15 g/100 seeds, medium size : 16~24 g/100 seeds, large size : >25 g/100 seeds) and

Table 1. The TDF contents of 66 varieties of sprout beans

Sprout beans	TDF[1] (% dry basis)	Sprout beans	TDF (% dry basis)
Namhaekong	25.27	KLG10066	21.97
Dawonkong	28.46	KLG10097	20.18
Doremikong	19.60	KLG10617	20.86
Myungjoonamoolkong	24.29	KLG10844	19.99
Bookwangkong	20.12	KLG10845	20.03
Somyungkong	16.60	KLG10847	24.22
Sobaiknamoolkong	23.29	KLG11118	23.29
Sowonkong	21.29	KLG10003	18.94
Sohokong	20.91	KLG10017	21.07
Saebyulkong	25.66	KLG10044	21.21
Iksannamoolkong	25.85	KLG10055	23.43
Eunhakong	18.26	KLG10099	22.94
Poongsannamoolkong	16.86	KLG10605	20.95
Paldokong	18.57	KLG10635	20.96
Pureunkong	17.94	KLG10022	24.58
Hannamkong	19.58	KLG10600	22.09
KLG10621	20.35	Hannamkong	24.37
KLG10783	22.19	Dankyungkong	21.51
KLG10850	19.83	Duyookong	22.96
KLG10995	21.99	Manleekong	22.99
KLG11078	19.89	Moohankong	25.46
KLG10062	20.13	Baikoonkong	22.54
KLG10618	22.32	Sinpaldalkong	22.48
KLG10614	21.86	Jangsookong	22.03
KLG10851	21.09	KLG10373	20.61
KLG10855	19.27	KLG10377	20.80
KLG10873	20.18	KLG10642	19.90
KLG10925	21.17	KLG10647	21.47
KLG10970	21.20	Namchunkong	21.05
KLG11051	21.03	Samnamkong	24.94
KLG10650	20.18	Jinpumkong	20.36
KLG10658	29.15	Keunolkong	22.40
KLG10841	26.67	Hwanggumkong	19.74
Total mean±SD		21.73±2.43	

[1]Total dietary fiber.

Table 2. The TDF contents of sprout beans classified by seed coat color and seed size

Varieties		TDF[1] (% dry basis)
Seed coat color (medium size)	Yellow (n=7)	21.51±0.64[2)NS]
	Black (n=7)	21.36±0.56
	Green (n=7)	21.56±0.64
	Brown (n=2)	21.23±1.10
	Mixed (n=7)	20.83±0.32
Seed size[3] (yellow color)	Small (n=4)	25.13±1.91[a4)]
	Medium (n=7)	22.86±0.48[ab]
	Large (n=9)	21.26±0.53[b]

[1]Total dietary fiber.
[2]Mean±SE.
[3]Small: <15 g/100 seeds, medium: 16~24 g/100 seeds, large: >25 g/100 seeds.
[4]Different superscripts in the same column indicate significant difference ($p<0.05$) between groups by Duncan's multiple comparison test.
[NS]Not significantly different among groups ($p<0.05$).

the TDF contents of the groups were compared. The small-size variety showed a significantly higher amount of TDF (25.13±1.91%) compared with the medium (22.86±0.48%) and larger-sized ones (21.26±0.53%). There was a correlation that the smaller the size of sprout beans, the higher the amount of the TDF.

Kim et al. (12) reported that the TDF content of Korean black and yellow soybeans were 24.84%, and 23.95%, respectively. Other reported TDF values for Korean soybean were 23.25%. (13) and 25.40% (14). Nishimune et al. (15) reported that Japanese soybeans contained 19.40% of TDF. From the reported data, the TDF content of Korean soybeans appeared to be in the range of 23~26% and is higher than the Japanese one. The TDF values of the sample sprout beans determined in the present study were shown to be in a wider range (16.6~29.2%) than that of the regular soybeans.

TDF contents of bean sprouts

The TDF contents of thirty sample bean sprouts including 14 high-isoflavone varieties (9) and 16 Korean improved lines are shown in Table 3. The range and av-

Table 3. The TDF contents of 30 varieties of bean sprouts and comparison of TDF content in sprout beans and bean sprouts

Varieties		TDF[1] (% dry basis)		
		Bean sprout	Sprout bean	BS/S[2]
High-isoflavone lines (≥1500 mg/kg isoflvone)	KLG10650	27.98	20.18	1.39
	KLG11118	22.76	23.29	0.98
	KLG10099	18.03	22.94	0.79
	KLG10022	23.39	24.58	0.95
	KLG10600	23.87	22.09	1.08
	KLG10621	25.24	20.35	1.24
	KLG10783	25.37	22.19	1.14
	KLG10850	20.12	19.83	1.01
	KLG10995	26.12	21.99	1.19
	KLG11078	24.27	19.89	1.22
	KLG10618	21.72	22.32	0.97
	KLG10855	24.84	19.27	1.29
	KLG10873	26.35	20.18	1.31
	KLG11051	25.01	21.03	1.19
16 Korean improved lines	Namhaekong	22.08	25.27	0.91
	Dawonkong	33.38	28.46	1.17
	Doremikong	19.77	19.60	1.01
	Myungjoonamoolkong	27.19	24.29	1.12
	Bookwangkong	26.51	20.12	1.32
	Somyungkong	25.35	23.29	1.09
	Sobaiknamoolkong	30.59	21.29	1.44
	Sowonkong	23.09	20.91	1.11
	Sohokong	24.01	25.66	0.93
	Saebyulkong	23.93	16.60	1.44
	Iksannamoolkong	30.71	18.26	1.65
	Eunhakong	22.91	25.85	0.88
	Poongsannamoolkong	24.71	17.94	1.38
	Paldokong	24.38	16.86	1.44
	Pureunkong	21.86	18.57	1.18
	Hannamkong	18.77	19.58	0.96
Total mean±SD		24.48±3.9	21.42±2.81	1.16±0.20

[1]Total dietary fiber.
[2]BS/S: the ratio of bean sprout TDF to sprout bean TDF in dry basis.

erage TDF content of the samples were 18.03~33.38% and 24.48±3.9%, respectively.

Among 30 kinds of bean sprouts, Dawon bean sprouts showed the highest content of TDF (33.38%). The other varieties with high TDF value were Iksannamool bean sprouts (30.71%), Sobaiknamool bean sprouts (30.59%), KLG10650 bean sprouts (27.98%), and Myungjoonamool bean sprouts (27.19%). The average TDF content of the sample bean sprouts was lower than the value of 31.69% reported by Hwang et al. (16).

The TDF contents of bean sprouts were compared with those of the corresponding bean samples. The average TDF content (24.48±3.9%) of bean sprouts was 1.16 times higher than that of the corresponding beans (21.42±2.8%). This result is supported by other finding (17) that the dietary fiber content of bean sprout increased during the cultivation period.

Changes in TDF content of bean sprouts during cultivation

Five varieties of beans (KLG10621, KLG10873, KLG 11078, KLG10783, KLG11051) were randomely selected from the high-isoflavone varieties (9) and were cultivated for 6 days. The time-course changes in the average TDF content of bean sprouts during a 6-day cultivation period is shown in Table 4 and Fig. 1. The mean TDF value was highest on the first day of cultivation and significantly

Table 4. Changes in the TDF content of bean sprouts during the days of cultivation

Cultivation period (day)	TDF[1] (% dry basis)
1	24.83±1.27[2)a3)]
2	20.99±1.44[b]
3	21.79±0.46[ab]
4	20.30±0.53[b]
5	22.37±1.01[ab]
6	22.23±1.26[ab]

[1]Total dietary fiber.
[2]Mean±SE (n=5).
[3]Different superscripts in the same column indicate significant difference ($p<0.05$) between groups by Duncan's multiple comparison test.

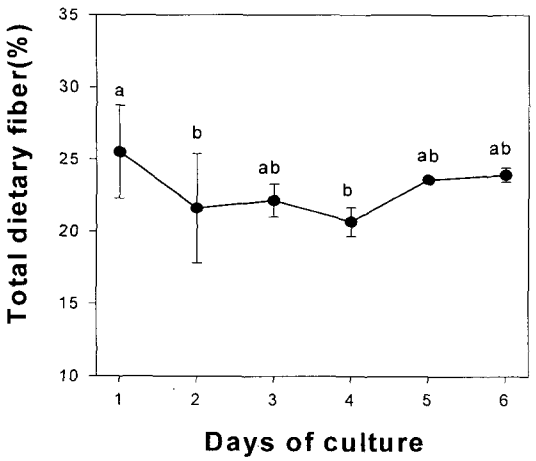

Fig. 1. Changes in the total dietary fiber content of bean sprouts during the days of cultivation. Values are means (n=5) with their standard errors represented by vertical bars. Different letters indicate a significant difference between groups by Duncan's multiple comparison test ($p<0.05$).

Table 5. Mean TDF content in different parts of bean sprout

Parts of bean sprout	TDF[1)] (% dry basis)
Cotyledon	24.31±1.51[2)a3)]
Hypocotyl	25.81±0.16[a]
Root	30.40±0.42[b]

[1)]Total dietary fiber.
[2)]Mean±SE (n=5).
[3)]Different superscripts in the same column indicate significant difference ($p<0.05$) between groups by Duncan's multiple comparison test.

decreased on the 2nd day. A slight increase was recorded from the 5th day. Overall, the dietary fiber content of bean sprouts seems to be maintained at a relatively constant level during cultivation.

TDF contents in different parts of bean sprout

Table 5 shows the mean TDF values in different parts of bean sprouts. The mean TDF content was significantly high in root parts (30.40±0.42%) compared with hypocotyl (25.81±0.16%) and cotyledon (24.31±1.51%) parts in dry basis.

CONCLUSION

Sixty-six varieties of Korean sprout beans and thirty varieties of Korean bean sprouts were determined for their total dietary fiber (TDF). The average and range of the TDF contents of the 66 sample sprout beans were 21.73 ±2.43% and 16.60~29.2% in dry basis, respectively. The top five types of sprout beans with high TDF content were KLG10658 (29.2%), Dawonkong (28.46%), Sohokong (25.66%), Moohankong (25.46%) and Samnamkong (24.94%). The average and range of the TDF content of the 30 sample bean sprouts were 24.48±3.9% and 18.3~33.38% in dry basis, respectively. Dawonkong sprouts showed the highest TDF content (33.38%). The TDF content of bean sprouts did not significantly change during the days of culture. The TDF contents in the different parts of the bean sprout were high in the order of roots, hypocotyl and cotyledon.

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