

## Variation of 7S and 11S Seed Protein Concentrations in Different Food Types of Soybean Seed

Eun-Heui So<sup>\*†</sup>, Young-am Chae<sup>\*</sup>, Yong-Ho Kim<sup>\*\*</sup>, and Moo-Hee Yang<sup>\*\*\*</sup>

### ABSTRACT

Soybean varieties derived from Korea are classified into four groups on the basis of their food types such as soybeans for vegetable, sprout, sauce and paste and soybeans with colored seed coat. This study was carried out to know the differences in storage protein concentrations among these four groups. There were differences in storage protein concentrations among four groups. In 7S protein, the  $\alpha'$ - and  $\alpha$ -subunit concentrations did not vary among four groups, while a  $\beta$ -subunit concentration greatly varied. 7S protein concentration was the highest(40.6%) in soybean for sauce and paste and the lowest(37.7%) in soybean for vegetable, while 11S protein concentration was the highest (62.3%) in soybean for vegetable and the lowest (59.4%) in soybean for sauce and paste. In view of the fact that 11S protein has much higher sulfur containing amino acids than 7S protein, it was shown the soybeans for vegetable may have higher nutrition value than other groups.

**Keywords** : soybean, 7S protein, 11S protein, subunits ( $\alpha'$ -,  $\alpha$ -,  $\beta$ -).

Soybean(*Glycine max* L.) seed protein is a major source of edible plant protein in the world(Kitamura, 1995). Also, soybean has been used a various foods such as sauce and paste, soycurd, sprout and other uses in orient from ancient.

Although soybeans produce the highest seed protein yield among seed crops, its protein quality is limited due to low contents of the sulfur-containing amino acids, methionine and cystein. 7S( $\beta$ -conglycinin) and 11S(glycinin) globulins are two major storage proteins which amount to about 70% of total seed protein(Iibuchi & Imahori, 1978 ; Tsukada et al, 1986 ; Shotwell & Larkins, 1989). The functional properties and chemical components of the two globulins are quite different(Koshiyama, 1968). It is

known 11S globulin contains 3 to 4 times more methionine and cystein in unit protein than those of 7S globulin(Serretti et al, 1994). Also it was suggested that the increase of 11S globulin at the expense of 7S globulin would enhance the nutrition and improve the functionality of soybean proteins in food(De Lumen, 1990).

Recently, improvement of the soybean seed components has become to be expected to improve food-processing quality for the processed soybean products in Korea. This study, aiming at improving soybean seed quality, was carried out to know the differences in storage protein concentrations among soybean groups classified for uses.

### MATERIALS AND METHODS

#### Materials and Cultivation

Forty-eight soybean varieties and lines classified for uses were cultivated at National Crop Experiment Station(Suwon), Honam Agricultural Research and Extension Services(Iksan), and Youngnam Agricultural Research and Extension Services(Milyang) in 1997. The soybean groups classified are soybeans for vegetable(SV), soybeans for sprout (SS), soybeans for sauce and paste(SSP), and soybeans with colored seed coat (SCSC). A randomized complete block design(RC-BD) with four replications except SV(RCBD with three reps) was used in this experiment. The fertilizer was applied in the field(Suwon, Iksan, Milyang) at the ratio of N-P<sub>2</sub>O<sub>3</sub>-K<sub>2</sub>O = 4-7-6kg/ha. Soybeans were sown on May 22, June 17 and June 13 at Suwon, Iksan and Milyang, respectively, and harvested at October. In case SV, early maturing summer type, was harvested at August.

#### Sample Preparation and Electrophoresis

A sample of seeds was dried at 40°C for 48 hrs and was ground in a coffee mill. Each ground sample(0.05 g) was added to 1ml of a sample extraction buffer[0.05M-HCl(pH 8.0) ; 5M urea ; 0.2% SDS ; 0.1%  $\beta$ -mercaptoethanol](Nielsen, 1984). Seed storage proteins were obtained by centrifuge for 30 minutes (4°C, 15,000 rpm) after extracting in buffer for 30 minutes. The seed storage proteins were

\* Dept. of Agronomy, Coll. of Agric. & Life Sci., Seoul Nat'l Univ. Suwon 441-744, Korea. \*\* Dept. of Biological Resources, Soonchunhyang Univ., Asan 336-745, Korea. \*\*\* Dept. of Applied Biol & Sci., Sunmoon Univ., Asan 347-840, Korea. † Corresponding author:(E-mail):w5512370@chollian.net (Phone) +82-19-403-2121. Received 30 Sep., 1999.

separated by SDS-PAGE for 12 hours at a constant current of 30mA per gel. A resolving gel(12%) including 6M urea with a stacking gel(5%) was used. After electrophoresis, a gel was stained in a staining solution(0.5% Coomassie blue R-250 ; 40% methanol ; 10% acetic acid) and was destained in a destaining solution(40% methanol ; 10% acetic acid).

**Analysis of Data**

A gel was dried with gel dry film for 24 hours. Relative concentrations of 7S and 11S proteins were measured using a densitometer(scan 3+) and analyzed with SAS 6.12 using PROC GLM. Genotypic, locational, and their interaction effect were determined.

**RESULTS**

**Soybeans for vegetable**

For six soybean varieties for vegetable, a 7S protein concentration ranged from 36.6% to 39.3% and its mean was 37.7%. A  $\alpha'$ -subunit concentration ranged from 12.2% to 13.6% and its mean was 12.9%. A  $\alpha$ -subunit concentration ranged from 15.3% to 17.5% and its mean was 16.7%. A  $\beta$ -subunit concentration was the highest(17.5%) in "Milyang 83" and the lowest(16.7%) in "Hwaeomputkong". A  $\beta$ -subunit concentration ranged from 6.5% to 9.9% and its mean was 8.1%. A  $\beta$ -subunit concentration was the highest(9.9%) in "Milyang 82" and the lowest (6.5%) in "Suwon 196". A 11S protein concentration ranged from 60.7% to 63.4% and its mean was 62.3%. A ratio of 11S/7S protein concentration ranged from 1.6 to 1.7 and its mean was 1.7. There was no difference in a ratio of 11S/7S protein concentrations among six varieties(Table 1).

**Soybeans for sprout**

For sixteen soybean varieties for sprout, a 7S protein concentration ranged from 36.6% to 40.8% and its mean 39.2%. A 7S protein concentration was the highest(40.8%) in "Suwon 182" and the lowest (36.6%) in "Kwangankong". "Suwon 182" was the highest(40.8%) due to much higher  $\beta$ -subunit (12.4%) than other varieties, while "Kwangankong" was the lowest(36.6%) due to much lower(12.2%)  $\alpha'$ -subunit concentration than other varieties. Mean of a  $\alpha'$ -subunit concentration was 13.3%. A  $\alpha'$ -subunit concentration was the highest(14.0%) in "Iksan 14" and the lowest(12.2%) in "Kwangankong". Mean of a  $\alpha$ -subunit concentration was 15.4%. A  $\alpha$ -subunit concentration was the highest(16.4%) in "Iksan 13" and the lowest(14.0%) in "Milyang 85". Mean of a  $\beta$ -subunit concentration was 10.6%. A  $\beta$ -subunit concentration was the highest(12.4%) in "Suwon 182" and the lowest(8.9%) in "Jinju 1". A 11S protein concentration ranged from 59.2% to 63.4% and mean its mean was 60.8%. A 11S protein concentration was the highest(63.4%) in "Kwanankong" and the lowest(59.2%) in "Suwon 182". A ratio of 11S/7S protein concentration ranged from 1.5 to 1.7 and its mean was 1.6. "Kwangankong" was the highest(1.7) that was also the highest variety among all varieties(Table 2).

**Soybeans for sauce and paste**

For fifteen soybean varieties for sauce and paste, a 7S protein concentration ranged from 38.7% to 42.5% and its mean was 40.6%. Mean of a  $\alpha'$ -subunit concentration ranged from 13.0% to 15.4% and its mean 14.0%. "Suwon 191" was the highest(15.4%), while "Hwangkeumkong" was the lowest(13.0%). A  $\alpha$ -subunit concentration ranged from 15.1% to 17.1% and its mean was 16.0%. "Milyang 67" was the high-

**Table 1. 7S( $\alpha'$ -,  $\alpha$ -,  $\beta$ -subunit) and 11S protein concentrations and a 11S/7S ratio in soybeans for vegetable averaged over three locations(Suwon, Iksan, Milyang).**

Variety	SSP <sup>#</sup>	Relative subunit concentrations of SSP					11S/7S ratio
		$\alpha'$	$\alpha$	$\beta$	7S	11S	
----- % -----							
Keunolkong	30.8	12.2 <sup>a+</sup>	16.4 <sup>b</sup>	8.6 <sup>b</sup>	37.2 <sup>ba</sup>	62.8 <sup>ba</sup>	1.7 <sup>a</sup>
Hwaeomputkong	33.2	13.6 <sup>a</sup>	15.3 <sup>c</sup>	7.8 <sup>cb</sup>	36.6 <sup>b</sup>	63.4 <sup>a</sup>	1.7 <sup>a</sup>
Suwon 196	29.2	13.6 <sup>a</sup>	17.2 <sup>ba</sup>	6.5 <sup>d</sup>	37.2 <sup>ba</sup>	62.8 <sup>ba</sup>	1.7 <sup>a</sup>
Milyang 81	26.9	13.3 <sup>a</sup>	17.0 <sup>ba</sup>	8.4 <sup>cb</sup>	38.7 <sup>ba</sup>	61.3 <sup>ba</sup>	1.6 <sup>a</sup>
Milyang 82	28.9	12.3 <sup>a</sup>	17.1 <sup>ba</sup>	9.9 <sup>a</sup>	39.3 <sup>a</sup>	60.7 <sup>b</sup>	1.6 <sup>a</sup>
Milyang 83	31.9	12.6 <sup>a</sup>	17.5 <sup>a</sup>	7.3 <sup>cd</sup>	37.4 <sup>ba</sup>	62.6 <sup>ba</sup>	1.7 <sup>a</sup>
Mean	30.2	12.9	16.7	8.1	37.7	62.3	1.7

<sup>\*</sup> Within columns, means followed by the same letter are not significantly different at p=0.05 according to Duncan's multiple range test.

<sup>#</sup> A sum of 7S and 11S proteins, indicating percentage(%) of total protein concentration in soybean seeds.

**Table 2. 7S( $\alpha'$ -,  $\alpha$ -,  $\beta$ -subunit) and 11S protein concentrations and a 11S/7S ratio in soybeans for sprout averaged over three locations(Suwon, Iksan, Milyang).**

Variety	SSP <sup>#</sup>	Relative subunit concentrations of SSP					
		$\alpha'$	$\alpha$	$\beta$	7S	11S	11S/7S ratio
----- % -----							
Kwangankong	28.3	12.2 <sup>c+</sup>	14.5 <sup>de</sup>	9.9 <sup>ted</sup>	36.6 <sup>e</sup>	63.4 <sup>a</sup>	1.7 <sup>a</sup>
Suwon 182	25.4	13.6 <sup>ba</sup>	14.9 <sup>dec</sup>	12.4 <sup>a</sup>	40.8 <sup>a</sup>	59.2 <sup>e</sup>	1.5 <sup>e</sup>
Suwon 184	27.1	12.8 <sup>bac</sup>	15.4 <sup>bdac</sup>	11.7 <sup>ba</sup>	39.8 <sup>bac</sup>	60.2 <sup>edc</sup>	1.5 <sup>edc</sup>
Suwon 187	25.9	13.6 <sup>ba</sup>	15.6 <sup>bdac</sup>	10.1 <sup>edc</sup>	39.3 <sup>bdac</sup>	60.7 <sup>ebdc</sup>	1.6 <sup>bedc</sup>
Suwon 188	26.7	13.8 <sup>ba</sup>	15.6 <sup>bdac</sup>	10.9 <sup>bdc</sup>	40.2 <sup>ba</sup>	59.8 <sup>ed</sup>	1.5 <sup>ec</sup>
Suwon 189	25.5	12.9 <sup>bac</sup>	15.1 <sup>bdc</sup>	11.6 <sup>ba</sup>	39.6 <sup>bac</sup>	60.4 <sup>edc</sup>	1.5 <sup>edc</sup>
Milyang 64	26.3	13.1 <sup>bac</sup>	15.6 <sup>bdac</sup>	11.3 <sup>bac</sup>	40.0 <sup>bac</sup>	60.0 <sup>edc</sup>	1.5 <sup>edc</sup>
Milyang 73	26.5	14.0 <sup>a</sup>	16.2 <sup>ba</sup>	10.3 <sup>dec</sup>	40.5 <sup>ba</sup>	59.5 <sup>ed</sup>	1.5 <sup>ed</sup>
Milyang 84	28.6	13.6 <sup>ba</sup>	15.4 <sup>bdac</sup>	9.8 <sup>fed</sup>	38.7 <sup>bdac</sup>	61.3 <sup>bedc</sup>	1.6 <sup>bedc</sup>
Milyang 85	28.6	12.7 <sup>bc</sup>	14.0 <sup>c</sup>	12.1 <sup>a</sup>	38.8 <sup>bdac</sup>	61.2 <sup>bdac</sup>	1.6 <sup>bedc</sup>
Iksan 9	28.8	12.9 <sup>bac</sup>	15.3 <sup>bdc</sup>	10.4 <sup>edc</sup>	38.5 <sup>edc</sup>	61.5 <sup>bdc</sup>	1.6 <sup>bdc</sup>
Iksan 10	29.3	12.9 <sup>bac</sup>	15.7 <sup>bdc</sup>	9.5 <sup>ef</sup>	38.0 <sup>edc</sup>	62.1 <sup>bac</sup>	1.7 <sup>bac</sup>
Iksan 13	29.4	13.7 <sup>ba</sup>	16.4 <sup>a</sup>	9.5 <sup>ef</sup>	39.6 <sup>bac</sup>	60.4 <sup>edc</sup>	1.5 <sup>edc</sup>
Iksan 14	31.0	14.0 <sup>a</sup>	15.7 <sup>bac</sup>	10.3 <sup>edc</sup>	40.1 <sup>bac</sup>	59.9 <sup>edc</sup>	1.5 <sup>ed</sup>
Iksan 15	31.6	13.0 <sup>bac</sup>	15.6 <sup>bdac</sup>	10.7 <sup>bedc</sup>	39.3 <sup>bdac</sup>	60.7 <sup>bedc</sup>	1.6 <sup>bedc</sup>
Jinju 1	27.9	13.4 <sup>bac</sup>	15.1 <sup>bdc</sup>	8.9 <sup>f</sup>	37.4 <sup>de</sup>	62.6 <sup>ba</sup>	1.7 <sup>ba</sup>
Mean	27.9	13.3	15.4	10.6	39.2	60.8	1.6

\* Within columns, means followed by the same letter are not significantly different at p=0.05 according to Duncan's multiple range test.

# A sum of 7S and 11S proteins, indicating percentage(%) of total protein concentration in soybean seeds.

**Table 3. 7S( $\alpha'$ -,  $\alpha$ -,  $\beta$ -subunit) and 11S protein concentrations and a 11S/7S ratio in soybeans for sauce and paste averaged over three locations(Suwon, Iksan, Milyang).**

Variety	SSP <sup>#</sup>	Relative subunit concentrations of SSP					
		$\alpha'$	$\alpha$	$\beta$	7S	11S	11S/7S ratio
----- % -----							
Mallikong	31.3	13.1 <sup>ed+</sup>	15.8 <sup>ba</sup>	13.6 <sup>a</sup>	42.5 <sup>a</sup>	57.5 <sup>c</sup>	1.4 <sup>c</sup>
Hwangkeumkong	33.9	13.0 <sup>e</sup>	15.8 <sup>ba</sup>	11.7 <sup>b</sup>	40.5 <sup>bac</sup>	59.5 <sup>bac</sup>	1.5 <sup>bac</sup>
Suwon 181	32.4	13.6 <sup>edc</sup>	15.7 <sup>ba</sup>	10.9 <sup>cb</sup>	40.2 <sup>bc</sup>	59.8 <sup>ba</sup>	1.5 <sup>ba</sup>
Suwon 185	34.4	13.2 <sup>ed</sup>	15.1 <sup>b</sup>	10.4 <sup>cd</sup>	38.7 <sup>c</sup>	61.3 <sup>a</sup>	1.6 <sup>a</sup>
Suwon 190	34.0	14.1 <sup>bedc</sup>	15.9 <sup>ba</sup>	11.0 <sup>cb</sup>	40.9 <sup>bac</sup>	59.1 <sup>bac</sup>	1.5 <sup>bac</sup>
Suwon 191	29.0	15.4 <sup>a</sup>	16.9 <sup>a</sup>	9.9 <sup>cde</sup>	42.2 <sup>ba</sup>	57.8 <sup>bc</sup>	1.4 <sup>bc</sup>
Suwon 192	33.9	14.5 <sup>bac</sup>	16.3 <sup>ba</sup>	9.4 <sup>de</sup>	40.2 <sup>bc</sup>	59.8 <sup>ba</sup>	1.5 <sup>ba</sup>
Milyang 67	29.7	14.8 <sup>ba</sup>	17.1 <sup>a</sup>	9.9 <sup>cde</sup>	41.8 <sup>ba</sup>	58.2 <sup>bc</sup>	1.4 <sup>bc</sup>
Milyang 76	32.3	14.2 <sup>bdc</sup>	16.9 <sup>a</sup>	9.9 <sup>cde</sup>	41.0 <sup>bac</sup>	59.0 <sup>bac</sup>	1.4 <sup>bc</sup>
Milyang 86	33.9	14.9 <sup>ba</sup>	16.7 <sup>a</sup>	9.1 <sup>e</sup>	40.7 <sup>bac</sup>	59.3 <sup>bac</sup>	1.5 <sup>bac</sup>
Milyang 87	34.7	14.2 <sup>bedc</sup>	15.1 <sup>b</sup>	10.8 <sup>cb</sup>	40.1 <sup>bc</sup>	59.9 <sup>ba</sup>	1.5 <sup>ba</sup>
Iksan 11	34.5	13.8 <sup>bedc</sup>	15.9 <sup>ba</sup>	10.2 <sup>cde</sup>	39.9 <sup>bc</sup>	60.1 <sup>ba</sup>	1.5 <sup>ba</sup>
Iksan 12	29.2	14.2 <sup>bdc</sup>	16.3 <sup>ba</sup>	10.2 <sup>cde</sup>	40.7 <sup>bac</sup>	59.3 <sup>bac</sup>	1.5 <sup>bac</sup>
Iksan 16	31.4	13.5 <sup>edc</sup>	15.1 <sup>b</sup>	10.9 <sup>b</sup>	40.5 <sup>bac</sup>	59.5 <sup>bac</sup>	1.5 <sup>bac</sup>
Iksan 17	32.4	13.4 <sup>edc</sup>	15.1 <sup>b</sup>	10.4 <sup>cd</sup>	38.9 <sup>c</sup>	61.1 <sup>a</sup>	1.6 <sup>a</sup>
Mean	32.5	14.0	16.0	10.6	40.6	59.4	1.5

\* Within columns, means followed by the same letter are not significantly different at p=0.05 according to Duncan's multiple range test.

# A sum of 7S and 11S proteins, indicating percentage(%) of total protein concentration in soybean seeds.

est(17.1%), while "Suwon 185" was the lowest(15.1%). A  $\beta$ -subunit concentration ranged from 9.1% to 13.6% and its mean was 10.6%. "Mallikong" was the highest(13.6%) and "Milyaing 86" was the lowest (9.1%). A 11S protein concentration ranged from 57.5% to 61.3% and its mean was 59.4%. A ratio of 11S/7S protein concentration ranged from 1.4 to 1.6 and its mean 1.5(Table 3).

**Soybeans with colored seed coat**

For twelve soybean varieties with colored seed coat, a 7S protein concentration ranged from 37.3% to 44.1% and its mean was 40.0%. A  $\alpha'$ -subunit concentration ranged from 11.4% to 14.1% and its mean 12.8%. A  $\alpha$ -subunit concentration ranged from 14.5% to 17.9% and its mean was 16.2%. "Milyang 88" was the highest(17.9%) that was also the highest variety among all soybean varieties, while "Suwon 195" was the lowest(14.5%). A  $\beta$ -subunit concentration ranged from 8.9% to 15.0% and its mean was 11.1%. "Suwon 195" was the highest(15.0%) that was the highest variety among all soybean varieties, while "Suwon 193" was the lowest(8.9%). A 11S protein concentration ranged from 55.9% to 62.7% and its mean was 59.9%. A ratio of 11S/7S protein concentration ranged from 1.3 to 1.7 and its mean 1.6(Table 4).

**DISCUSSIONS**

**Variation between the 4 groups**

Variation in 7S( $\alpha'$ -,  $\alpha$ -,  $\beta$ -subunits) and 11S proteins concentration and a ratio of 11S/7S protein concentration of each four soybean groups were analyzed over three locations(Suwon, Iksan, Milyang). There were highly significant genotypic and locational effects and interaction effects between genotype and location on 7S and 11S proteins(Table 5).

There were differences in 7S( $\alpha'$ -,  $\alpha$ -,  $\beta$ -subunit) and 11S protein concentration among four groups. A 7S protein concentration among four groups ranged from 37.7% to 40.6%. A 7S protein concentration was the highest(40.6%) in soybeans for sauce and paste due to much higher  $\alpha'$ -subunit concentration(14.0%) than other groups. A  $\alpha'$ -subunit concentration ranged from 12.8% to 14.0%. Soybean for sauce and paste was the highest(14.0%) and soybean with colored seed coat was the lowest(12.8%). A  $\alpha$ -subunit concentration ranged from 15.4% to 16.7%. Soybean for vegetable was the highest(16.7%) and soybean for sprout was the lowest(15.4%). A  $\beta$ -subunit concentration ranged from 8.1% to 11.1%. Soybean with colored seed coat was the highest (11.1%) and soybean for vegetable was the lowest (8.1%). In 7S protein, the  $\alpha'$ - and  $\alpha$ -subunit concentrations did not vary among the four groups, while  $\beta$ -subunit concentration greatly varied. Especially, it was reported  $\beta$ -subunit has probability of cholesterol-lowering polypeptide(Han, 1990). Therefore, soybeans with colored seed coat have much higher  $\beta$ -subunit concentration, it may have probability of funtional effect. 11S protein concentration among four

**Table 4. 7S( $\alpha'$ -,  $\alpha$ -,  $\beta$ -subunit) and 11S protein concentrations and a 11S/7S ratio in soybeans with colored seed coat averaged over three locations(Suwon, Iksan, Milyang).**

Varieties	SSP <sup>#</sup>	Relative subunit concentrations of SSP					
		$\alpha'$	$\alpha$	$\beta$	7S	11S	11S/7S ratio
----- % -----							
Geomgjeongkong 1	30.3	12.1 <sup>rde+</sup>	15.3 <sup>dec</sup>	11.5 <sup>cd</sup>	38.8 <sup>cbd</sup>	61.2 <sup>bac</sup>	1.6 <sup>bac</sup>
Hwangkeumkong	33.0	12.4 <sup>fdec</sup>	15.8 <sup>dec</sup>	11.1 <sup>d</sup>	39.3 <sup>cbd</sup>	60.7 <sup>bac</sup>	1.6 <sup>bac</sup>
Suwon 186	27.5	12.6 <sup>bdec</sup>	15.2 <sup>de</sup>	13.1 <sup>b</sup>	40.9 <sup>cb</sup>	59.1 <sup>bc</sup>	1.5 <sup>bc</sup>
Suwon 193	29.9	13.5 <sup>ba</sup>	17.4 <sup>ba</sup>	8.9 <sup>f</sup>	39.8 <sup>cbd</sup>	60.2 <sup>bac</sup>	1.6 <sup>c</sup>
Suwon 194	36.3	13.2 <sup>bac</sup>	16.6 <sup>bc</sup>	10.8 <sup>d</sup>	40.5 <sup>cb</sup>	59.5 <sup>bc</sup>	1.5 <sup>bc</sup>
Suwon 195	31.6	11.7 <sup>fe</sup>	14.5 <sup>e</sup>	15.0 <sup>a</sup>	41.2 <sup>b</sup>	58.8 <sup>c</sup>	1.5 <sup>bc</sup>
Milyang 69	36.3	13.3 <sup>bac</sup>	15.7 <sup>dec</sup>	9.2 <sup>fe</sup>	38.2 <sup>cd</sup>	61.8 <sup>ba</sup>	1.7 <sup>ba</sup>
Milyang 77	35.0	13.7 <sup>ba</sup>	17.8 <sup>a</sup>	12.6 <sup>cb</sup>	44.1 <sup>a</sup>	55.9 <sup>d</sup>	1.3 <sup>d</sup>
Milyang 88	28.5	14.1 <sup>a</sup>	17.9 <sup>a</sup>	9.1 <sup>fe</sup>	41.1 <sup>b</sup>	58.9 <sup>c</sup>	1.5 <sup>dc</sup>
Milyang 89	32.3	12.6 <sup>bdec</sup>	16.1 <sup>dc</sup>	11.9 <sup>cbd</sup>	40.5 <sup>cb</sup>	59.5 <sup>bc</sup>	1.5 <sup>bc</sup>
Kangwon 2	28.3	11.4 <sup>f</sup>	15.4 <sup>dec</sup>	10.5 <sup>cd</sup>	37.3 <sup>d</sup>	62.7 <sup>a</sup>	1.7 <sup>a</sup>
Chungnam 1	26.8	13.0 <sup>bdac</sup>	16.7 <sup>bc</sup>	9.1 <sup>fe</sup>	38.8 <sup>cbd</sup>	61.3 <sup>bac</sup>	1.7 <sup>bac</sup>
Mean	31.3	12.8	16.2	11.1	40.0	59.9	1.6

<sup>r</sup> Within columns, means followed by the same letter are not significantly different at p=0.05 according to Duncan's multiple range test.

<sup>#</sup> A sum of 7S and 11S proteins, indicating percentage(%) of total protein concentration in soybean seeds.

**Table 5. Analysis of variance for 7S( $\alpha'$ -,  $\alpha$ -,  $\beta$ -subunit) and 11S protein concentrations and a 11S/7S ratio in four soybean groups at three locations(Suwon, Iksan, Milyang).**

Source	df	Mean squares <sup>+</sup>					
		$\alpha'$	$\alpha$	$\beta$	7S	11S	11S/7S ratio
Group(G)	3	43.51**	35.23**	121.76**	142.27**	133.33**	0.11**
Loc(L)	2	77.73**	54.96**	282.85**	97.70**	110.00**	0.08**
G*L	6	23.97**	36.73**	81.72**	94.99**	94.67**	0.08**
Error	558	3.24	2.88	4.76	12.86	12.88	0.01

<sup>+</sup>, \*\* Significantly different at the 0.05 and 0.01 probability levels, respectively.

**Table 6. Differences in 7S( $\alpha'$ -,  $\alpha$ -,  $\beta$ -subunit) and 11S protein concentrations and a 11S/7S ratio in four soybean groups averaged over three locations(Suwon, Iksan, Milyang).**

Group	$\alpha'$	$\alpha$	$\beta$	7S	11S	11S/7S ratio
	----- % -----					
Soybeans for vegetable	12.9 <sup>b*</sup>	16.7 <sup>a</sup>	8.1 <sup>b</sup>	37.7 <sup>c</sup>	62.3 <sup>a</sup>	1.7 <sup>a</sup>
Soybeans for sprout	13.3 <sup>b</sup>	15.4 <sup>c</sup>	10.6 <sup>a</sup>	39.2 <sup>b</sup>	60.8 <sup>b</sup>	1.6 <sup>b</sup>
Soybeans for sauce and paste	14.0 <sup>a</sup>	16.0 <sup>b</sup>	10.6 <sup>a</sup>	40.6 <sup>a</sup>	59.4 <sup>c</sup>	1.5 <sup>c</sup>
Soybeans with colored seed coat	12.8 <sup>b</sup>	16.2 <sup>b</sup>	11.1 <sup>a</sup>	40.2 <sup>b</sup> <sup>a</sup>	59.9 <sup>cb</sup>	1.6 <sup>b</sup>
Mean	13.3	16.1	10.1	39.4	60.6	1.6

<sup>\*</sup> Within columns, means followed by the same letter are not significantly different at p=0.05 according to Duncan's multiple range test.

groups ranged from 59.4% to 62.3%. Soybean for vegetable was the highest(62.3%) due to much lower  $\beta$ -subunit concentration(8.1%) than other groups. In the other hand, soybean for sauce and paste was the lowest (59.4%) in 11S protein concentration. A ratio of 11S/7S protein concentration ranged from 1.5 to 1.7. Soybean for vegetable was the highest(1.7) and soybean for sauce and paste was the lowest(1.5) (Table 6). In the view of the fact that 11S protein has much higher sulfur containing amino acids than 7S protein, it was shown the soybeans for vegetable may have higher nutrition value than other groups.

## REFERENCES

De Lumen, B. O. 1990. Molecular approaches to improving the nutritional and functional properties of plant seeds as food sources : *Development and comments*. J. Agric. Food Chem.

- 38:1779.
- Han, E. S. 1990. Hypocholesterolemic effect of soybean peptides in rats and its mechanism. Seoul Nat'l Univ. Ph. D. Thesis.
- Iibuchi, C. and K. Imahori. 1978. Interconversion between monomer and dimer of the 7S globulin of soybean seed. Agric. Biol. Chem. 42(1):25-30.
- Kitamura, K. 1995. Genetic improvement of nutritional and food processing quality in soybean. JARQ. 29:1-8.
- Koshiyama, I. 1968. Chemical and physical properties of a 7S protein in soybean globulins. Arch. Biochem. Biophys. 130:370.
- Nielsen, N. C. 1984. Urea-elicited changes in relative electrophoretic mobility of certain glycine and  $\beta$ -conglycinin subunits. Plant Physiol. 76:840-842.
- Serretti, C., W. T. Jr. Schapaugh, and R. C. Leffel. 1994. Amino acid profile of high seed protein soybean. Crop Sci. 34:207-209.
- Shotwell, M. A. and B. A. Larkins. 1989. The biochemistry and molecular biology of seed storage proteins. The Biochem. Plants. Academic press. Inc. vol(15):297-345.
- Tsukada, Y. M., K. Kitamura, K. Harada, and N. Kaizuma. 1986. Genetic analysis of subunit of two major( $\beta$ -conglycinin and glycinin) in soybean seeds. Japan. J. Breed. 36:390-400.