Chemical Comparison of a Mexican Soybean Variety with a US Variety

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ABSTRACT

The proximate analysis, protein, amino acid, and fatty acid composition and flavor evaluation of mature seeds of a commercial variety soybeans grown in Mexico and of one grown in the United States were compared. The study indicated very little difference between the two varieties.

INTRODUCTION

Because of rapid population growth in many developing countries, local availability of a low-cost protein source has become necessary. One economic source of a good dietary protein is the soybean. However, the number of varieties that are adaptable to tropical production appears insufficient (1). Banafunzi and Mena (1) at the Instituto Superior Autonomo Agropeculario del Estado de Guerrero (ISAAEG) developed a new soybean variety, called ISAAEG-BM_2 (BM_2).

The BM_2 variety was produced by crossing a soybean variety used in Hawaii with the Lee variety. It is well suited for production in low latitudes at both low and high altitudes, and has been recommended for human consumption both as immature green soybeans (2, 3) and as mature seeds (4) in countries with tropical climates. The possibility of using green soybeans for human consumption is of interest, because more crops per year are possible in the tropics. Bourges et al. (3) have reported on the composition and nutritional value of green BM_2 soybeans. They examined 85-day-old green soybeans that were boiled in water 20 min to inactivate various thermolabile antinutritional factors; they found the protein efficiency ratio and net protein utilization to be 94—95% of that of casein.

Banafunzi et al. (4) reported the development of BM_2 soybeans and gave its agonomic characteristics; it takes 103 days to reach full maturity. In the same paper, Banafunzi states that the BM_2 soybean variety is mild in flavor and that a heat treatment commonly used to denature the antinutritional factors is sufficient to completely eliminate the "painty" flavor normally associated with soybeans.

Since our laboratory has made extensive studies on the flavor of soybeans and soybean products (5, 6); I compared the proximate and chemical analyses of the new BM_2 variety with well established certified variety and also studied the organoleptic qualities of the new variety.

EXPERIMENTAL PROCEDURES

Materials

ISAAEG-BM_2 soybeans were a gift from Dr. Nuren M. S. Banafunzi and were procured in Acapulco, Mexico, in November 1980. Certified TS-280 variety soybeans, 1980 crop year, were purchased from Somer Bros. Seed Company, Pekin, IL.

Methods

Proximate analyses for oil and protein were carried out by near infrared reflectance, using a Neotec Model 51 grain quality analyzer calibrated for soybeans.

Defatted soybean meal was prepared by cracking, dehulling, flaking and extraction of the oil with pentane-hexane (7). The nitrogen solubility index (NSI) of the defatted meals was measured by official methods (8), and soybean trypsin-inhibitor (TI) activity of the defatted meals was determined by the method of Hamerstrand et al. (9).

For ultracentrifugal analysis, defatted flakes were extracted with water at a solvent-to-flake ratio of 10:1. After centrifugation, the extracts were dialyzed against potassium phosphate/sodium chloride buffer, pH 7.6, 0.5 ionic strength, containing 0.01 M 2-mercaptoethanol for 48 hr. Analyses of the water-extractable proteins were performed at room temperature in a Spinco Model E ultracentrifuge with a 30-mm cell and a plastic double-sector center piece at 47,660 rpm.

The total amino acid composition was determined by refluxing the sample in 6 N HCl for 24 hr to hydrolyze the protein, and analysis was conducted on a Glenco MM-100 amino acid analyzer.

The fatty acid composition of the oil from the two varieties was determined by gas liquid chromatography of the methyl esters (J. F. Cavins, personal communication).

Organoleptic evaluations of the defatted meals and protein isolates from the defatted meals were conducted by a 15-member trained panel from our laboratory. The samples were rated on a 10-point scale, where 10 is excellent. Flavor intensity values for the different flavors were calculated by the procedure described by Rackis et al. (10).

RESULTS AND DISCUSSION

The analyses of both BM_2 and TS-280 soybeans are given in Table I. The values for the oil are nearly the same, but the Mexican variety appears to have slightly more protein than the soybeans grown in Central Illinois. The nitrogen solubility index of the untoasted, hexane-defatted flakes of both varieties is nearly the same. Gardner color values indicate that the crude oil from the Mexican beans is lighter than the Illinois soybeans. Trypsin inhibitor in the two varieties appears to be present at about the same levels.

Ultracentrifuge analysis of the water-soluble proteins revealed the 2S, 7S, 11S and 15S components in virtually

TABLE I

Analyses of BM_2 and TS-280 Soybeans, Dry Basis

	BM_2	TS-280
Oil	20.1	20.4
Protein	45.2	43.5
NSI[a]	83.0	85.2
Gardner color value of oil	9.5	10.5
TI mg/g[a]	29.7	28.9

[a]Values for nitrogen solubility index (NSI) and trypsin inhibitor (TI) on untoasted, hexane-defatted meal.

TABLE II

Amino Acid Composition of BM_2 and TS-280 Soybeans

Amino acid	BM_2	TS-280 (g AA/16 g N)	Smith and Circle (12)
Aspartic acid	14.10	13.41	12.01
Threonine	4.65	4.47	4.31
Serine	5.95	5.88	5.57
Glutamic acid	22.55	21.17	21.00
Proline	6.16	6.19	6.28
Glycine	4.97	4.96	4.52
Alanine	5.05	4.75	4.51
Valine	5.52	5.41	5.38
Cystine	1.36	1.18	1.58
Methionine	1.45	1.45	1.56
Isoleucine	5.16	5.14	5.10
Leucine	8.89	8.58	7.72
Tyrosine	4.55	4.37	3.90
Phenylalanine	5.96	5.89	5.01
Lysine	7.45	7.27	6.86
Histidine	3.15	3.08	2.55
Arginine	9.40	8.87	8.42

identical concentrations for each variety, and the ultracentrifuge patterns were typical of soybeans grown in the United States. These results are in contrast to those obtained when soybeans from the United States were compared with soybeans from Japan (11). Certain soybean varieties from Japan had a higher concentration of β-conglycinin (7S) than did varieties grown in the United States.

The total amino acid compositions of the two varieties studied are given in Table II. There is no substantial difference in the amino acid composition of BM_2 and TS-280 soybeans. The amino acid compositions as presented in this paper agree very well with other published amino acid data (12) that are included in Table II.

A recent paper by Wolf et al. (13) suggests that the total sulfur amino acids may increase with increases of day/night temperatures. They noticed a twofold increase in the total methionine plus cystine as the day/night temperatures increase from 18/13 to 33/18 C. No difference was observed in the total sulfur amino acids of the samples used in the present study; however, I analyzed different varieties, whereas Wolf et al. (13) examined the same variety under different conditions.

Table III gives the fatty acid composition of the oil from TS-280 and BM_2 soybeans. The data for average fatty acid composition of soybean oil (14) are also included. The two varieties in this study compare well but differ slightly from the average composition reported by Pryde (14). The average values for palmitic (10.7%) and for linoleic (50.8%) appear to be lower than the values determined for the TS-280 and BM_2 varieties.

Flavor and odor evaluations were conducted on raw flours, steamed flours, and soy protein isolates prepared from the hexane-defatted flakes of the two varieties. Table IV shows the overall flavor scores and the flavor descriptions noted by our panel when raw and steamed hexane-defatted soybean flours and protein isolates were evaluated. The two predominant flavors noted by our panel were grassy/beany and bitter in all samples; none of the values are significantly different when TS-280 and BM_2 flavors of raw flours are compared.

The same overall results were noted after the flakes were steamed at atmospheric pressure for 10 min. There appears to be no difference between varieties, but there is a significant increase in the flavor score from ca. 4.0 to 6.8 with the simple steaming or cooking treatment.

Samples of raw (untoasted) hexane-defatted soybean flours from the two varieties were processed into soybean

TABLE III

Fatty Acid Methyl Ester Analysis of BM_2 and TS-280 Soybeans

Variety	Percent fatty acid 16:0	18:0	18:1	18:2	18:3	Other
BM_2	12.5	3.0	24.2	52.9	7.1	0.3
TS-280	12.1	3.6	22.2	54.7	7.3	0.3
Average composition (13)	10.7	3.9	22.8	50.8	6.8	5.0

TABLE IV

Flavor Descriptions and Scores of Raw and Steamed[a] Hexane-Defatted Soybean Flours and Protein Isolates from BM_2 and TS-280 Soybeans

Descriptions	Flavor intensity values: Raw hexane-defatted soybean flour BM_2	Raw TS-280	Steamed hexane-defatted soybean flour BM_2	Steamed TS-280	Protein isolates[b] BM_2	Protein isolates[b] TS-280
Cereal/grain	0.3	–	0.7	0.8	0.4	0.4
Grassy/beany	2.3	2.0	0.6	0.5	1.3	0.8
Bitter	0.9	1.1	0.2	0.2	0.8	0.7
Astringent	0.7	0.5	0.2	0.2	0.6	0.6
Other "off flavors"	–	–	–	–	0.4 (paint, wood soap)	0.4 (metallic, wood paint)
Overall score	3.9	4.3	6.7	6.9	5.8	5.8

[a]Steamed 10 min atmospheric pressure.
[b]Average of three analysis.

protein isolates (6), and the flavor of the isolates was compared. The results are also shown in Table IV and indicate that the overall scores are the same and that the flavor intensity values for the four different flavors are not significantly different.

This study indicates only minor differences between BM_2 and TS-280 soybeans. The proximate analysis, protein, amino acid, and fatty acid composition and flavor evaluation show that the mature seeds from soybeans grown in Mexico and soybeans grown in Central Illinois are very similar.

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Maleyl Esters of Monoglycerides of Saturated Fatty Acids

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ABSTRACT

Esterification between maleic anhydride and monoglycerides of saturated fatty acid has been studied. The nature of reaction vessels, temperature and reaction time have been evaluated in view of the product distribution in the final product. Concentration of monoesters (half-esters) diesters and dimers has been calculated and related to the reactants' ratio, time and temperature of the esterification.

INTRODUCTION

Esterification of maleic anhydride with almost any straight chain alcohol has been carried out yielding mono- and dialkylmaleates (1). Addition of sodium bisulfite to the above esters forms sodium sulfosuccinic alkyl esters, known as important detergents and wetting agents (1).

Caryl (2) in his review, claims that he was able to form, from 50 alcohols, over 50 diesters, 50 half-esters, and 1,225 mixed esters (all sodium salts). All these esters can be further esterified with methyl or some other alkyl or aryl substitute to prepare, theoretically, over 1,125,000 different possible compounds. The majority of the sulfosuccinic esters that have been made have surface-active properties.

Esterification of succinic anhydride and monoglycerides of fatty acids has been the subject of a US patent in 1966 (3). The half-esters of succinylated monoglycerides (SMG) were mentioned as possible food emulsifiers mainly in the bread baking industry (4).

The esterification of monoglycerides with maleic anhydride yields maleyl esters, which can be further sulfonated with sodium bisulfite to form sodium sulfosuccinic monoglyceryl esters. In order to obtain valuable wetting and detergent agents, it is very important in the first stage to prepare mainly the half-esters (or monoesters) and to minimize as much as possible the formation of diesters, other byproducts, or polymerization reactions. Such unwanted products would give, on further sulfonation, poor surfactants. To the best of our knowledge, direct esterification between maleic anhydride and commercial distilled monoglycerides of fatty acids has not yet been fully studied (1,3), and no reaction parameterization has been done.

The present report reinvestigates the esterification reaction between maleic anhydride and distilled monoglycerides under controlled conditions. The type of reaction vessels, reactant ratios, temperatures and time were evaluated. Efforts have been made to obtain full product distribution and to determine the amount of dimers and diesters formed in this reaction.

EXPERIMENTAL

Reagents

Distilled monoglycerides, containing 90–92 wt % monoglycerides, 6–8 wt % diglycerides and 1–2 wt % glycerol from tallow (Dimodan TH, Grindsted, Denmark), from palm (Dimodan PVP, Grindsted), from vegetable oil (Myvaplex 600, Eastman Kodak and Empilan GMS 90 from