Predigested Soybeans

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ABSTRACT

Soybeans have a high content of good quality protein; nevertheless, direct utilization of beans for preparation of dishes is not done due to the unpleasant beany flavor and the gastrointestinal disturbance produced by the oligosaccharides. This paper describes a process for producing predigested soybeans. It can be used in the preparation of standard foods, replacing navy beans, chickpeas or lentils. In the process, raw soybeans are dehulled, broken into halves, then macerated with a papain solution and submitted to lactic fermentation using *L. acidophilus* and *L. bulgaricus*. The fermented soybean is precooked and dried.

INTRODUCTION

Almost the entire world soybean crop is used for oil extraction and production of high-protein meal. Very few whole soybeans are used for food. One important reason is that the foods containing beans had "beany" flavors and odors. Another serious drawback to the use of whole soybean was the gastrointestinal disturbance produced by the oligosaccharides raffinose and stachyose. The long cooking time required to achieve acceptable tenderness is another limiting factor. This paper describes a process for the production of predigested soybeans that can be used in the preparation of standard foods, replacing navy beans, chickpeas or lentils.

PROCESS DESCRIPTION

In the process raw soybeans are dehulled and broken into halves, then soaked at room temperature in water containing 200 mg of papain/kg of soybean for 12 hr. The soaked soybeans are submitted to a lactic fermentation using *L. acidophilus* and *L. bulgaricus* for 24 hr. The fermented soybean is neutralized and precooked, and washed and dried, thus obtaining the end product.

COMPOSITION OF SOYBEAN

Table I shows that predigested soybean increases in protein and fats, and decreases in fiber, ash and carbohydrate, due to the elimination of the hulls, the solubilization of mineral compounds, and the consumption of sugars during the fermentation.

Nutritional Value

Table I also shows no significative differences in digestibility and biological value, and no changes in protein efficiency ratio (PER) and ND_pE % (net dietary protein energy %).

Inorganic Constituents

Table I shows a reduction of inorganic constituents in predigested soybean; this is due to a partial solubilization of the salts by the liquor during the fermentation. However, the amounts remaining satisfy the requirements of phosphorus and iron but not of calcium, as is the case for untreated soybean.

Phytates and Available Iron

There were no changes in the amounts of phytates and available iron in predigested soybean compared with untreated soybean.

Phosphatides

Table I also shows a reduction of total phosphatides and lecithin due to a solubilization by the fermentation liquor. However, it is necessary to emphasize that none of the present soya foods contains lecithin. When used as a dietary supplement, lecithin reduces cholesterol levels and increases the assimilation of nutrients and vitamins.

Sugar Composition

Raffinose and stachyose are present in whole soybean and are responsible for flatulence in humans. In some soya products such as textured protein or isolates, both of these sugars were removed. In protein concentrate the level of stachyose and raffinose is less than 10% of the amount in soy flour. Table I shows that raffinose and stachyose were removed in predigested soybean.

CHARACTERISTICS OF SOYBEAN OIL

The chemical characteristics of soybean oil by hexane extraction are the same for both untreated and predigested soybean oil, except for the acid value, which is slightly higher for predigested beans.

There was no change in the percentage of saturated fatty acids in soybean oil from untreated and undigested soybean. We found a slight reduction in 18:3 (linolenic acid) from 8.0 to 6.8% of the oil. This reduction was not found in all the batches of predigested soybeans; hence, we suppose

TABLE I

Characteristics of Soybeans and Treated Soybeans

	Untreated soybeans	Predigested soybeans
Moisture (%)	.00	.00
Fats (%)	21.45	22.38
Fiber (%)	5.16	3.85
Protein (%)	38.26	48.80
Ash (%)	4.85	2.19
Carbohydrates (%)	30.28	22.78
NPU op	57.60 ± 1.02	57.35 ± .98
NPU st	69.83	66.49
Digestibility	83.40 ± .21	87.80 ± .11
NDPE (%)	7.02	7.11
PER	2.28 ± .14	2.22 ± .11
Biological value	69.10 ± 1.03	65.32 ± 1.67
Ash (mg/100 g)	4.7	2.2
Phosphorus (mg/100 g)	659	288
Calcium (mg/100 g)	210	94
Iron (mg/100 g)	9.3	9.3
Available iron (mg/100 g)	6.0	6.2
Phytic acid (mg/100 g)	11.6	11.2
Total phosphatides (%)	1.10	0.45
Lecithin (%)	0.64	0.15
Glucose (%)	.60	.65
Sucrose (%)	5.00	4.28
Raffinose (%)	.30	.00
Estachiose (%)	3.00	.00

TABLE II

Complementary Effect of Predigested Soybean Protein/Rice, Corn and Cheese Whey Protein

	Proportion of the products	PER	BV
Predig. soybean/rice	1:1	2.66 ± .15	74.63 ± .30
Predig. soybean/corn	1:5.66	1.67 ± .17	74.00 ± .42
Predig. soybean/cheese whey (dry basis)	1:1.03	2.31 ± .15	74.00 ± 0.17

(without experimental confirmation) that in some instances during fermentation, lactobacilus can produce lipases, which would liberate the fatty acid from the glycerides. This fact would explain the increase in the acid value for predigested soybean oil.

EFFECT OF COMPLEMENTS WITH PREDIGESTED SOYBEAN

As with soya products, predigested soybean protein is a good complement to rice, corn and cheese whey. Table II shows PER figures and biological values (BV) indicating that predigested soybean complements well with those products.

HUMAN ASSAYS

Experiments were made to confirm that predigested soybean does not have a beany flavor and does not produce flatulence after meals. Two studies were conducted with adults; one group of 258 were fed a diet containing whole predigested soybeans, and the other group of 229 were fed a diet containing broken predigested soybean (cotyledons) The results in Table III show that broken soybean has higher acceptance than whole soybeans. The medical report shows that flatulence was not detected and that a beany flavor was not found.

TABLE III

Results of Feeding Humans with Standard Dishes Prepared with Predigested Soybean

Number tested	Whole soybean	(%)	Broken soybean	(%)
Amount inquired	258	100	229	100
High acceptance	129	50	197	86
Medium acceptance	74	29	23	10
Low acceptance	45	17	9	4
Rejected	10	4	0	0

Nutrition Aspects of Fiber in Soya Products

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INTRODUCTION

The hypothesis that dietary fiber may act as a prophylactic agent with regard to certain diseases has attracted the interest of the scientific community. Consumption of diets low in dietary fiber by man has been correlated with increased incidence of colon cancer, coronary heart disease, diabetes, diverticular disease of the colon and various other maladies of the lower gastrointestinal tract. The current literature contains many research reports concerning the association of one or more types of fiber with one or more physiological effects. Few studies have dealt directly with the subject of this review: the nutritional effects of feeding soybean fiber to man or experimental animals.

CHEMICAL AND PHYSICAL PROPERTIES OF SOYBEAN FIBER

The fiber components in soya hull and in the cotyledon are distinct and thus should be considered separately. Soybean hulls have been analyzed (1-9; J. Ramon and B.P. Klein, personal communication) for crude fiber and components of dietary fiber. There is considerable variation in the reported values for individual fiber components (Table I). This variation is due to differences in methods used, laboratory-to-laboratory technique and perhaps to variety of bean analyzed. Variations in preparation and extraction conditions (10) result in large alterations in amount and physical characteristics of soybean hull fiber.

Soybean hulls are reported to contain about 87% dietary fiber, between 40 and 53% crude cellulose, 14 and 33% crude hemicellulose and 1 and 3% crude lignin (dry basis). In addition to the fiber, the soybean hull contains 7.0% protein, 0.9% oil, 4.3% ash and less than 1% starch (3).

Sparse published data were found for the fiber content of non-hull soya products. Dehulled soybean flour was reported to contain 6.2% NDF, 5.7% ADF, 4.6% crude cellulose, 0.5% crude hemicellulose and 1.3% lignin by the Van Soest method (J. Ramon and B.P. Klein, personal communication). Soya concentrates contain slightly higher levels of dietary fiber. A commercial soya bran source (ADM Co., Decatur, IL) was reported to contain 38.1% ADF and 50.8 NDF using similar methodology (11). In a practical sense, soya isolates have no fiber. In total, soya products certainly would not contribute a significant portion of American dietary fiber consumption.

Particle size, density, hydration capacity and ion exchange capacity are the four major physical properties of