Soy Flour and Grits for Use in Food Products[1]

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ABSTRACT

Processing alternatives enable the soybean processor to manufacture soy flour products which vary in fat content, granulation and degree of heat treatment. By controlling these variables, the processor is able to regulate the nutritional value and functional properties of these products. The application of soy flour products is dependent upon their functional properties, nutritional value and low cost. Currently, the major markets for soy flour and grits are in pet foods and animal feeds, cereal based foods and ingredients, meat based foods, and as a substrate for refined protein products such as the textured vegetable proteins, soy protein concentrates, isolates and hydrolysates. These soy protein products are generally marketed as functional and nutritional substitutes for meat, milk and egg protein. For example, soy flour is a functional replacement for milk in many cereal-based foods, e.g., bread, and also enhances the nutritional value of the cereal protein by supplying lysine to the formulation. The United States government has pioneered the development and marketing of protein-enriched, cereal-based foods designed to combat worldwide starvation. The government has directly supported the research and development of corn and wheat-based food substrates supplemented with soy flour, and has purchased over one billion pounds of these products since 1966 for worldwide distribution.

INTRODUCTION

The consequence of inadequate protein supplies is malnutrition (1). This deficiency arises when either insufficient quantities of protein are consumed or when the quality of the dietary protein is poor. In both cases, physiological maintenance and growth are impaired, and malnutrition results. The correlation between national per capita income and the quantity of animal protein consumed is well documented (2). Developing countries have low per capita incomes and consume protein which has relatively low nutritional value (3). Animal protein constitutes only a small proportion of the diet of people in developing countries. Nearly all of their food protein is derived from cereals and starchy roots, substrates with protein which is generally inferior, nutritionally, to animal protein because they are deficient in the essential amino acid lysine. Numerous short range and long range programs directed toward combating worldwide malnutrition have been suggested and implemented (4). The addition of soy flour to the food substrates consumed by the malnourished has become a favored means of upgrading both the quantity and quality of the protein in the diets of people suffering from malnutrition (5). The value of adding soy flour to foods for the undernourished can be better understood by reviewing the uses of soy flour in today's foods.

DISCUSSION

Two types of flour are produced from soybeans for use in foods. Full fat soy flour is milled from cleaned, dehulled soybeans while defatted soy flour is produced from cleaned, dehulled soybeans which have been solvent-extracted. The general processing steps involved in the manufacture of these products are reviewed in Figure 1. Flour and grits are differentiated on the basis of granulation. Grits have a particle size larger than 100 mesh (U.S. standard screen size) while flour has a particle size finer than 100 mesh. A proximate analysis of full fat and defatted soy flour is presented in Table I. Carbohydrates account for approximately 30% of the defatted soy flour. Nearly half of this carbohydrate fraction consists of oligosaccharides of which 8.2% is sucrose, 5.5% stachyose and 1.2% raffinose. High molecular weight polysaccharides account for the remainder of this fraction.

Processing alternatives enable the manufacture of defatted soy products with varying degrees of heat treatment and with varying granulations. These variables affect the functional and nutritional properties of these products. Untoasted products have maximal functionality. Fully toasted products have optimal nutritional value. By closely controlling the heat treatment and granulation, it is possible to regulate the functional and nutritional properties of the soy flour so they are optimized for each application.

Soy flour and grits are used in food products because of their functionality, nutritional value and low cost. Functional properties are characteristics such as water absorption, fat absorption, fat emulsifying capacity, protein binding capacity and adhesiveness. These properties can be regulated so that they are similar to those of milk, meat or eggs. Therefore, properly processed soy products can functionally supplement and be substituted for animal proteins in certain applications in foods. Because it contains a high percentage of good quality protein, soy flour can make a significant contribution to the nutritional value of

[1]One of 21 papers presented at the Symposium, "Oilseed Processors Challenged by World Protein Need," ISF-AOCS World Congress, Chicago, September 1970.

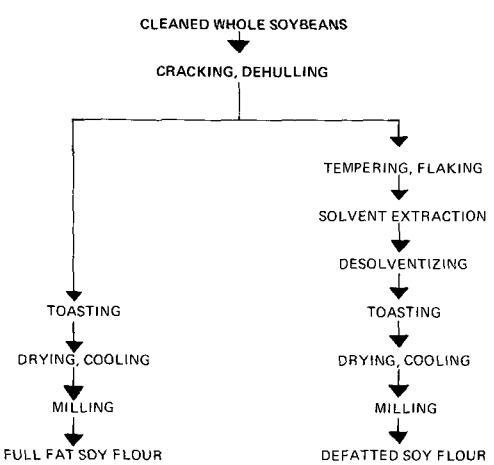

FIG. 1. Manufacture of full fat and defatted soy flour.

TABLE I

Proximate Analysis of Soy Flour

Composition	Defatted soy flour, %	Full fat soy flour, %
Protein (N x 6.25)	52.5	41.0
Moisture	6.5	6.0
Fat	1.0	20.5
Fiber	3.0	2.7
Ash	5.7	5.3

TABLE II

Cost of Protein From Various Sources

Product	Protein, %	Price of product, $/lb.	Price of protein, $/lb.
Defatted soy flour	52	0.070	0.14
Full fat soy flour	40	0.085	0.21
Soy concentrate	70	0.180	0.26
Soy isolate	92	0.350	0.38
Corn meal	9	0.046	0.51
Wheat flour	11	0.068	0.59
Rice flour	7	0.074	1.06
Nonfat dry milk	35	0.240	0.67
Chicken	23	0.300	1.30
Eggs, fresh	13	0.310	2.36
Beef, round steak	20	0.900	4.50

[a]Prices are for wholesale lots, F.O.B., U.S. point of manufacture, October, 1970.

foods. The quality of the protein in toasted soy flour is superior to the quality or protein in other grains as judged by the generally accepted procedures and indices used to make such determinations (6). Because the protein in soy flour is a rich source of lysine, it offers special value as a supplement to all protein sources deficient in this essential amino acid. Both the quality and quantity of the protein are raised in cereal based foods to which soy flour has been added. Table II shows that soy flour is among the lowest cost sources of food protein available.

The functionality, nutritional value and low cost of soy flour products account for their growing use in foods, and as a base material for the manufacture of further processed food ingredients. Several of these further processed products are identified in Figure 2. In foods, soy flour can compete with animal protein on the basis of nutritional value and functional characteristics. In these applications, the economic factors are the major incentive to the food processor for using soy. In mixtures with cereals, soy is competitive on an economic basis. Now the incentives are nutrition and functionality. The major factor which limits the use of soy flour and grits in foods is the beany flavor. Untoasted flours have the strongest beany character. Fully toasted products are quite bland. Table III lists the major applications of defatted soy flour in the food industry. More than 300 million pounds of defatted soy flour and grits are marketed annually to the food industry, exclusive of government purchases. The largest consumers are the

TABLE III

Applications of Defatted Soy Flour in Foods

PCI[a]	Application
90+	White bread-bleaching agent Fermentation Soy protein isolates, fibers
60-75	Doughnut mix Bakery mix Pasta Baby foods Meat products Breakfast cereals Soy protein concentrates
30-45	Meat products Bakery mix
10-25	Baby foods Protein beverages Meat products Hydrolyzed vegetable proteins

[a]Protein Dispersibility Index is a standard AOCS method (Ba 10-65) for measuring the amount of heat treatment used in the processing of soybean meal products.

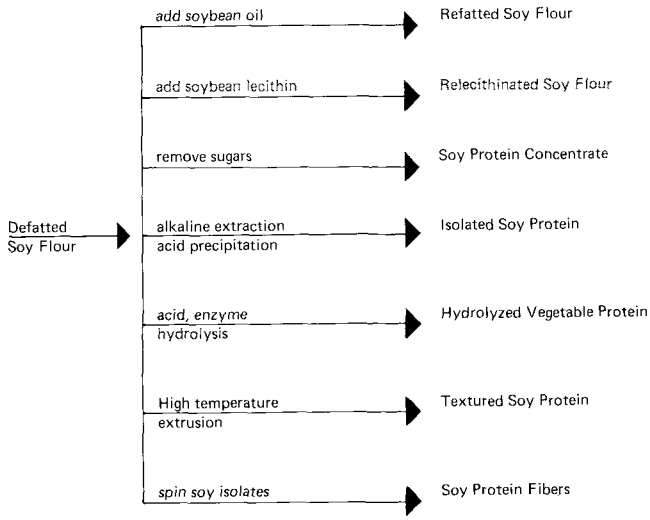

FIG. 2. The use of soy flour as a substrate for further processed food ingredients.

baking and meat industries. Less than seven million pounds of full fat soy flour are marketed yearly, exclusive of government purchases.

The United States government has supported research efforts directed towards the development of nutritious foods designed to alleviate the world's deficiency of protein. As a result of this support, two such products are now being produced commercially and distributed throughout the world, CSM (corn-soy-milk) and WSB (wheat-soy blend). Table IV lists the major ingredients in CSM and WSB and a proximate analysis of each product. These foods are designed to be highly nutritious, versatile in use, and acceptable. The Protein Efficiency Ratio (PER) of the protein in CSM and WSB is nearly equivalent to that of casein. Both CSM and WSB can be used in beverages, gruels, and in a variety of baked and fried products. More than 400 million pounds of defatted soy flour have been used in CSM since this product was first marketed in 1966.

Through the Agency for International Development, the United States Government has cooperated with food processing industries to research, develop and market new, engineered foods designed to effectively combat malnutrition. Eleven companies are currently involved in such cooperative programs in nine countries (7). Soy flour plays a vital role in the formulation of many of these new engineered foods. It raises the percentage of protein in the formula and improves the quality of the protein in the food by helping to overcome the deficiency in lysine common to most cereals and starchy roots. Because of its functionality,

TABLE IV

Composition and Proximate Analysis of Corn-Soy-Milk and Wheat-Soy Blend

Product	Ingredient	Percentage
Corn-soy-milk	Processed corn meal	64.00
	Defatted soybean flour	24.00
	Non-fat dried milk	5.00
	Refined soybean oil	5.00
	Vitamins, minerals	2.00
Wheat-soy-blend	Wheat fraction	73.35
	Defatted soybean flour	20.00
	Refined soybean oil	4.00
	Vitamins, minerals	2.65
Corn-soy-milk	Protein, dry basis (N x 6.25)	20.0
	Fat, dry basis	6.5
Wheat-soy blend	Protein, dry basis (N x 6.25)	20.0
	Fat	6.0

soy flour adds versatility to the use of these new, engineered foods.

Several factors can be cited which indicate that the markets for soy flour and grits will expand. First, a new awareness and understanding of protein and nutrition is being experienced, expecially in developed countries. Growing emphasis is being placed on the nutritional value of food products. Foods are being designed with nutrition in mind. Both the food technologist and the consumer are recognizing that nutritious foods can be based on protein originating from a variety of substrates such as beef, soybeans or single cell microorganisms. Food proteins know no imitation though their source and quality may vary. Second, an increasing world population ensures a growing market for food and protein. The challenge to the food industry is to meet this need by developing more nutritious foods, more acceptable foods, and by overcoming the economic, marketing and distribution problems common to those populations with the greatest need for these products. Finally, the rising cost of animal proteins provides a growing incentive to the processor of foods containing animal protein to use vegetable protein supplements and substitutes to reduce his raw material costs and his price to the consumer. This incentive challenges the oilseed processor to upgrade the quality of products he now produces, and to develop new products which have improved flavor, acceptability, functionality, appearance, texture and nutritional value.

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[Received December 11, 1970]