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Soyfoods: Adding Value to Soybeans

Current Topic

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ATTRA's publications *Adding Value to Farm Products: An Overview* and *Keys to Success in Value-Added Agriculture* serve as companions to this publication. They introduce the concept of value-added farm products, outline keys for success, and provide resources for additional information on the essential topics of regulations and starting a business.

Introduction

A 1939 Agricultural Experiment Station Bulletin from the University of Illinois (1) states:

> When soybeans were first introduced into America from the Orient, where the seed had been used as food since ancient times, only the field types were included in the importations. These were suitable primarily for the manufacture of oil and for other industrial uses, or for forage. More recently, however, seed of a different type of soybean, especially adapted to use as a human food, has been brought into this country . . .

Today, although soyfood bean production accounts for only a small fraction of the nation's soybean market share, this market is proving to be a profitable niche for soybean growers (2). Some, hoping to capture better returns for their farm products, are considering on-farm value-added processing of these specialty beans. Soybeans are used for many different products, both edible and non-edible. Soy-based human foods include tofu, miso, soy sauce, natto, tempeh, soymilk, soy flour, soy oil, concentrates and isolates, and soy sprouts.

"Soyfoods have made the journey from Asian and health food groceries to major supermarket chains," says Rebecca Richardson of the Illinois Soybean Association. "Not only are they in these stores, they've broken out of the specialty sections. Soy milks, cheeses, and yogurts sit side by side in the dairy case with milk products; soy butter is next to peanut butter; and frozen microwave items, corn dogs and soyburgers are all mixed together with meat products in the freezer case." It helps that the U.S. Food and Drug Administration decided in 1999 to permit the health claim that soy intake can reduce cholesterol and thus help guard against heart disease (3). The soyfoods business is now a $2.5 billion industry in the U.S., and growing. Sales of organic tofu alone increased 13.6% (from $40,768,862 to $46,608,645) between 1999 and 2000 (3, 4).

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Traditional Foods Produced from Soybeans

Tofu is a cheese-like food made from soybean "milk." Tofu contains no cholesterol, is low in sodium, and is a good source of calcium, iron, and B-vitamins. Often used as a meat substitute, it has little flavor by itself, but absorbs the flavors it is cooked with (5).

The basic process for making tofu is described in the article "An American's Introduction to Tofu" (6).

- Raw beans are soaked overnight, then drained.
- The beans are pulverized as a small quantity of boiling water is poured over them. The resulting mash will have the consistency of mashed potatoes.
- The mash is ladled into boiling water and allowed to boil gently for about 10 minutes. This breaks down an enzyme in the bean. If the enzyme is not destroyed, the soy protein will not be digestible.
- The resulting slurry is filtered to remove the pulp, called *okara*, from the soymilk. Okara is good for mixing with flour to make bread.
- A small amount of either calcium sulfate or magnesium chloride is introduced to coagulate the milk.
- After the coagulant is introduced, the milk will separate into curds and whey. The curds will float to the top and the resulting whey should be clear.
- The curds are gently scooped off the top of the whey and ladled into a forming container lined with cheesecloth. The forming container has many small holes in it to allow leftover whey to drain. A lid is placed on the forming container.
- A small weight is placed on the lid of the container and allowed to sit for several hours. The resulting block of tofu is emptied into a tub of cold water and allowed to sit for another hour.

Yield, texture, and other qualities of the tofu will vary, depending on the soybean cultivar. High quantities of available protein and oil result in high tofu yields. A high protein-to-oil ratio produces a hard (or firm) tofu; a high oil-to-protein ration makes a soft (or silky) tofu (7).

Miso is a whitish-brown, brown, or reddish-brown fermented soup-base paste. This thick salty paste is high in protein, and low in fat and calories. The basic process for making miso is to first wash the beans, then soak them so that they absorb enough water for cooking. The soaked beans are cooked in water or steam. After cooling, the beans are mixed with salt and a koji starter (*Aspergillus oryzae* mold fungus), and allowed to ferment at 77°–86°F for varying periods, from one week to over 2 years, depending on final product requirements. The fermentation breaks down the protein and carbohydrate contents to form palatable flavor components (7).

Natto is made of fermented whole soybeans. It has a sticky, viscous coating with a cheesy texture. In Asian countries, natto is traditionally served as a topping for rice, in miso soups, and with vegetables. The basic process for making natto is to wash, soak, and steam the beans, allow them to cool down to 140°F, and mix in a starter of *Bacillus natto* for an 8-hour fermentation process at 108°F (7).

Tempeh is made of whole cooked soybeans infused with a culture to form a dense, chewy cake used as a meat substitute. It can be marinated and grilled, or used in soups, casseroles, or chili. Tempeh is high in fiber, calcium, B-vitamins, iron, and protein. It is cholesterol-free and low in saturated fat (5).

Soymilk is a preliminary product in the production of tofu. It can be used the same way cow's milk is used. It contains no cholesterol or lactose, and is a good source of protein and iron. It can be fortified with calcium, Vitamin D, and B-12 (5).

Soy flour is made from finely-ground roasted soybeans and is widely used in baked goods. An excellent source of iron, calcium, and B-vitamins, it is rich in high-quality protein. Soy flour can be made with or without removal of the natural oils during processing (5).

Soy oil is extracted from whole soybeans. It is cholesterol-free, low in saturated fat, and contains no protein. Soy oil is one of the few oils that contains linolenic acid (omega-3 fatty acid), which has been shown to reduce the risk of heart disease (5).

Bean Variety Selection

David Druding (8), a tofu-maker in Fayetteville, Arkansas, says that one should select soybeans that are described as food-grade beans, as opposed to oil varieties. Vinton 81 is an old cultivar that is still utilized and commercially available (9). Druding suggested Hutchinson as another appropriate variety. Several other varieties such as Jacques J-231, Burlison, Jack, Beeson 80, HP 204, Ohio FG1, and Ohio FG2 are also appropriate.

In the publication *Marketing Food-Quality Soybeans in Japan* (7) it is noted that the definition of the "ideal" bean varies from user to user and is thus subjective. There are no exacting industry-wide standards:

> The making of a soy-based food is still an art form . . . based on experience and instinct. Even should the composition of the soybean produced by you and another farmer be exactly the same, factors influencing the quality at the time of use, such as storage and shipping, can change the overall quality and performance of one shipment when compared with another. In other words, the user's standards cover a range of quality to which he adapts in making the soy-based food. In addition, the user recognizes the fact that finding beans that will meet his ideal cannot be guaranteed all of the time.

Visual appearance of the seed is a critical factor for most buyers of food-grade soybeans (10). Shrunken, discolored, and broken seed is undesirable, and will cause price discounts or even rejection. Seed coats must be colorless. Complete absence of hilum pigmentation is most desirable, but a light-colored hilum is often acceptable. "Bleeding" of the hilum color into the seed coat is unacceptable.

The size of the seed is often crucial, and may be either smaller or larger than average soybean cultivars. For example, small seeds are sought out for natto, while large seeds are preferred for tofu. Perfectly round seeds are generally prized, while oblong or kidney-shaped soybeans are usually avoided.

The requirements for seed composition (percentages of protein, lipid, and carbohydrate) will vary depending on the individual food-grade product. Seed with a high protein content (>45%) is appropriate for tofu. For natto, the most desirable soybeans appear to be those with a high content of carbohydrate, for quick conversion to sugars during the fermentation process.

Iowa State University has the largest breeding program for food-grade soybeans in the U.S., but their new varieties are "licensed," and can be obtained only to produce additional Parent Seed or as

Commercial Grain. A catalog listing licensed varieties is available from the ISU Research Foundation (11).

USDA Agricultural Research Service soybean breeders are also working on new lines especially for tofu production (12), as is Ohio State University (13). It should be noted that soybean plants are sensitive to day length. Growers should contact their local Cooperative Extension Service or seed dealer to learn which varieties are adapted to their area.

Harvest and Post-harvest Handling

Harvest management is a crucial skill for the specialty soybean producer, simply because the physical appearance of the beans is so important to the buyer. Small-seeded soybeans tend to thresh well, but air adjustments may have to be fine-tuned to remove chaff without blowing the small seeds out the back of the combine. Large-seeded soybeans are extremely prone to mechanical damage during threshing operations, which can knock off the seed coat and/or split the embryo into its cotyledonal halves. The combine's cylinder speeds will have to be slowed considerably to avoid this, and the crop may require harvesting at somewhat higher moisture content.

Prompt harvesting will always be a must, as field deterioration of the seed—affecting appearance—can commence soon after the moisture content of the physiologically mature seed drops to 14%. Specialty soybeans should always be given the highest priority during the favorable-weather "harvest windows" that occur in the fall. If storage is necessary, the producer will have to ensure that storage facilities are clean, dry, and free from any materials that may be toxic to humans (10).

The conditions under which beans are stored greatly influence the quality of the processed product. Moisture content of 13% or less will prevent mold growth. However, very dry beans tend to split when being transferred, and the splitting lowers the quality. To minimize mold growth, soybeans should be stored at the lowest temperature feasible. Cleanliness is also extremely important (14).

Consultants and Additional Information for Soyfood Production

The Soyfoods Center (15), founded in 1976 by William Shurtleff and Akiko Aoyagi Shurtleff, owns the largest computerized database on soyfoods in the world. They also sell 55 book titles on soyfoods and have sold 750,000 copies of these books to date. They specialize in consulting, and are able to provide reports on almost any aspect of the soyfoods industry. William Shurtleff, director of the Soyfoods Center, is the author of numerous books about soyfoods, including *Soyfoods Industry and Market Directory and Databook*; *History of Tempeh; Using Tofu, Tempeh, & Other Soyfoods in Restaurants, Delis & Cafeterias*; and *Tofu and Soymilk Production*. The four books most relevant to people starting a soyfoods business are *The Book of Tofu*, *The Book of Miso, Tofu and Soymilk Production*, and *The Book of Tempeh*. These books are available from Amazon.com, the Soyfoods Center, or <http://www.tofu.com>.

The International Soybean Program (INTSOY) (16) provides some useful soyfoods information—including publications, preparation methods for a number of soyfoods, and assistance for those looking for soybean processing equipment and supplies. They also provide education and training opportunities in post-harvest handling and processing of food-grade soybeans. Visit their website for details on what they offer.

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302 Beverly Blvd.
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319-988-4187

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11) Julie Gusfafson
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12) Thomas Carter
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15) The Soyfoods Center
P.O. Box 234
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925-283-2991

16) International Soybean Program (INTSOY)
University of Illinois at Urbana-Champaign
169 Environmental and Agricultural Sciences Building
Urbana, IL 61801-4723
217-333-6422
217-333-5838 Fax
e-mail: intsoy@uiuc.edu
http://spectre.ag.uiuc.edu/~intsoy/intsoy.htm

Resources:

The Soy Information Page
http://www.ag.uiuc.edu/~food-lab/soy
Provides information on the various types of soyfoods, the health benefits of soyfoods, soyfood recipes, and other information sources.

Soyfoods Association of America
1723 U Street, N.W.
Washington, D.C. 20009
202-986-5600
202-387-5553 Fax
e-mail: info@soyfoods.org
http://www.soyfoods.org/
The Soyfoods Association of North America is a nonprofit trade organization connecting growers, bean processors, soyfood manufacturers, retailers, and consumers. It promotes the consumption of soyfoods, offering nutritional information, recipes, and an extensive listing of soyfoods companies.

Snyder, Harry E. 1990. Understanding Soybean Products and Processing. Technical Paper # 73. VITA, Arlington, VA. 14 p.
Provides an introduction to the importance of soybeans to the world's food supply, types of soybean products, composition of beans, and processing (oils, concentrates and isolates, soy sprouts, soy milk, tofu, soy sauce, miso, tempeh, and natto). Includes a bibliography. To obtain a copy or catalog of other publications, contact:
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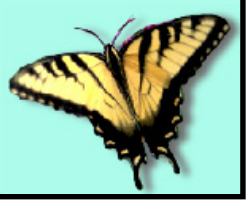

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