

Chapter 18

Processing and Utilization

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Arkansas ranks eighth nationally in soybean production with approximately 3.5 million acres devoted to soybeans and an annual production of between 80 to 100 million bushels. Three processing plants (ADM in Little Rock and Helena, and Riceland Foods in Stuttgart) process about 33 percent, or 30 million bushels, annually. The initial raw products of the processing operation are:

1. Oil products
2. Whole soybean products
3. Protein products



Figure 18.1. Products made from soybeans include tofu, soy milk and soy chips.

A typical bushel of soybean grain (60 pounds) will yield about 11 pounds (18.3 percent) of oil and 48 pounds (80 percent) of protein-rich meal. Hulls make up the remaining 1.7 percent. The relatively high oil and protein content and the almost infinite uses and transformations of soybean grain have resulted in the crop being referred to as the “Cinderella Crop.” This chapter will briefly address the extraction processes used to obtain the raw products and will concentrate on some of the new and very beneficial uses of the soybean.

Processing Soybeans

Although there are continued advancements and/or refinements in the technology associated with processing soybeans, the primary method used at the present is referred to as the “Extraction or Solvent” process. This process uses organic solvents such as hexane to recover 95 to 98 percent of the oil and about 95 percent of the protein. Other, but less common, methods include Hydraulic and Expeller or Screw-Press. Typically, these older and less common methods recover less oil but slightly higher protein. Regardless of the soybean processing method, the soybeans need to be cleaned, heated (dried), crushed and then flaked before either of the previously identified processes are implemented.

Oil Products

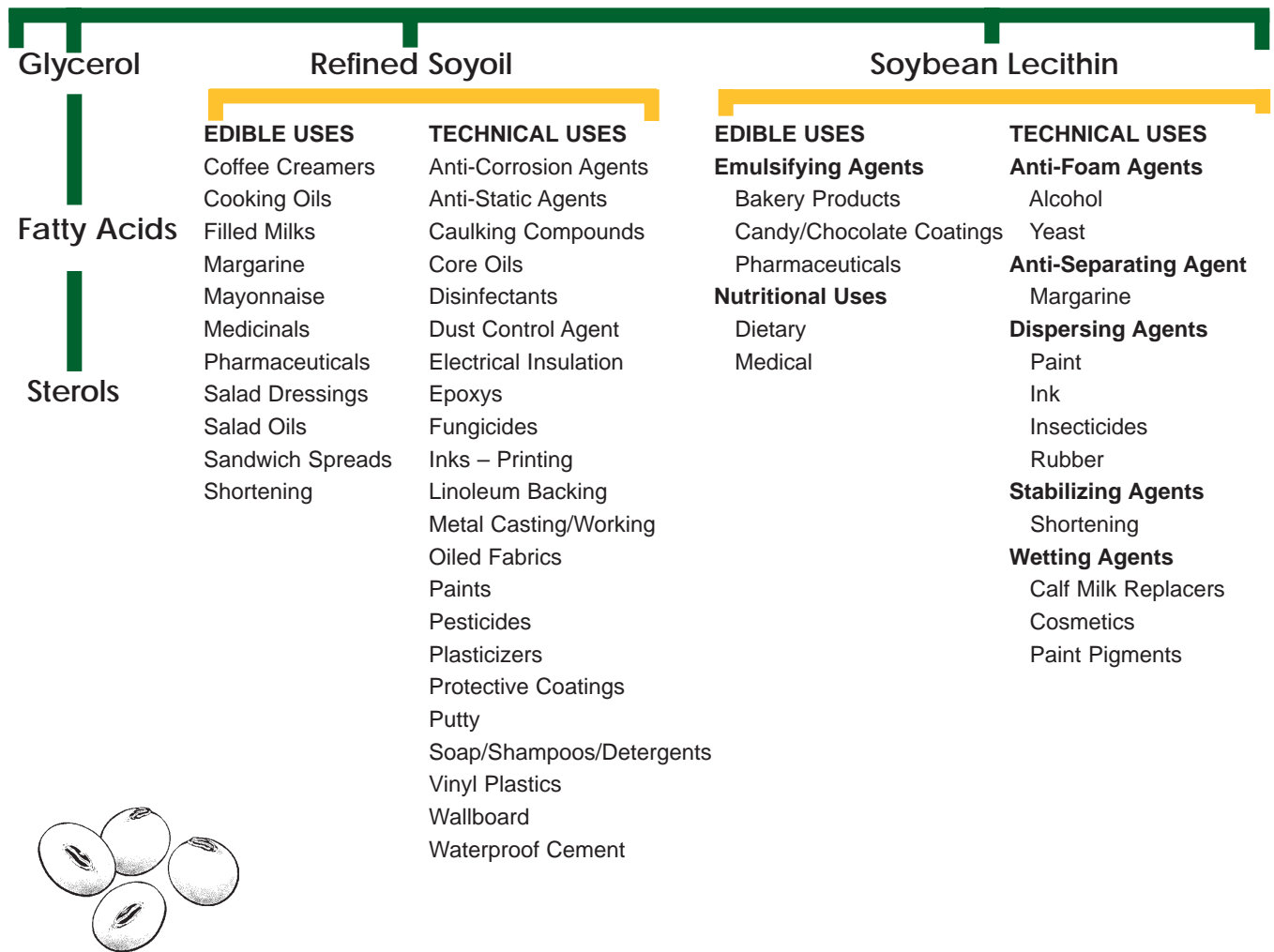
Oil products can be manufactured into many products as shown in Figure 18.2. Crude oil is the major raw oil product, but it must be further processed to obtain a bland-tasting, light-colored oil acceptable to consumers. This additional processing removes substances which would compromise the quality of the refined oil, but these substances can be developed into other commercial products. One of these commercial products includes soy lecithin, which is comprised mainly of phospholipids and serves as an important emulsifying agent for food, pharmaceutical and other industries. Lecithin is also removed from the oil to avoid cloudiness and discoloration of the refined oil. Free fatty acids and glycerol are formed as a result of oil breakdown. Free fatty acids are removed to avoid the smoking when oil is used for frying. The extracted free fatty acids are used as emulsifying agents. Glycerol is distilled from the oil during a deodorization process. Sterols, sterol esters and tocopherols (vitamin E) are important nutritional substances also extracted from the oil during deodorization processing.

Many of the major soyoil products are developed from further modification(s) of *refined soyoil* for either *edible* or *technical* uses. Refined vegetable oils are hydrogenated to produce hydrogenated oils for margarines and shortenings. Salad oils are made by cooling the refined oil to precipitate waxes out of solution by a process referred to as “winterization.” This ensures the oil is refrigerator stable. Some of the more recent nonfood products developed from soybean oil include bio-diesel, soy ink and soy-based crayons.

Whole Soybean Products

Whole soybean products can also be manufactured into a host of products as shown in Figure 18.3. Most major whole soybean products are used for edible purposes with the final product dependent upon the consumer. Recent research findings support the health benefits of soyfoods and have been at least partially responsible for an increase in human consumption of nearly all edible products, including the whole soybean products.

Figure 18.2.
Soybean Oil Products



The soybean plant provides a high-quality protein and phytochemicals that may be protective against heart disease, certain types of cancer and osteoporosis.

Soybean Protein Products

Soybean protein products can also be manufactured into many products as shown in Figure 18.3. Protein and protein products are the other major raw products derived from processing

the grain and are broadly classified into two categories – *soy flour concentrates and isolates* and *soybean meal*, which has long been recognized as one of, if not the major, protein source available for livestock and humans. Soy flour concentrates and isolates undergo further modification into a host of products that are included in a *technical use* group or an *edible use* group. Many new environmentally friendly products, such as biodegradable plastics, are being developed or researched at the present time.

Figure 18.3.

Whole Soybean Products

EDIBLE USES

Seed

Stock Feeds

Soy Sprouts

Baked Soybeans

Full Fat Soy Flour

- Bread, Cakes and Cake Mixes
- Candy
- Doughnut Mix
- Frozen Desserts
- Instant Milk Drinks
- Low-Cost Gruels
- Pancake Flour
- Pan Grease Extender
- Pie Crust
- Sweet Goods

Roasted Soybeans

- Candies/Confections
- Cookie Ingredient/Topping
- Crackers
- Dietary Items
- Fountain Topping
- Soynut Butter
- Soy Coffee

Traditional Soyfoods

- Bean Curd
- Miso
- Natto
- Tempeh
- Soy milk and related products (i.e., soycheese)
- Tofu

Soybean Protein Products

Soy Flour Concentrates & Isolates

TECHNICAL USES

- Adhesives
- Analytical Reagents
- Antibiotics
- Asphalt Emulsions
- Binders – Wood/Resin
- Cleansing Materials
- Cosmetics
- Fermentation Aids/Nutrients
- Films for Packaging
- Inks
- Leather Substitutes
- Paints – Water Based
- Particle Boards
- Plastics
- Polyesters
- Pharmaceuticals
- Pesticides/Fungicides
- Textiles

EDIBLE USES

- Baby Food
- Bakery Ingredients
- Beer and Ale
- Candy Products
- Cereals
- Diet Food Products
- Hypo-Allergenic Milk
- Infant Formulas
- Meal Replacement Beverages
- Meat Substitutes
- Noodles
- Prepared Mixes
- Sausage Casings
- Seafood Products
- Special Nutritional Products
- Yeast

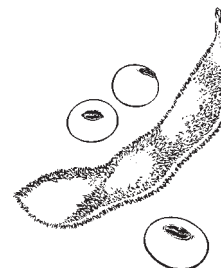
Soybean Meal

FEED USES

- Aquaculture
- Bee Foods
- Calf Milk Replacers
- Fish Food
- Fox and Mink Feeds
- Livestock Feeds
- Poultry Feeds
- Protein Concentrates
- Pet Foods

HULLS

- Dairy Feed
- Premia



Additional Arkansas Research and Educational Efforts

Research is being done in Arkansas to create new value-added products from low-value soy hulls. Pectin has been extracted as a food grade competitor to citrus pectin.

Soy hulls have been used to produce novel carbon adsorbents for water purification and vegetable oil processing hulls. The structure and effectiveness of activated charred soy hull carbon has been demonstrated to and recognized by the U.S. soybean industry.

Soy lecithin is also being used as nutraceuticals and emulsifiers in medical nutritional foods for specific patients who cannot digest conventional oils. A series of dairy analogue foods has been made in which soy lecithin stabilizes medium chain triglyceride (MCT) emulsions used in medical nutritional products. This application of soy lecithin enables the creation of a wider range of MCT foods than has been previously available. Discussions are underway with industry to commercialize these products.



Figure 18.4. Navam Hettiarachchy, a University of Arkansas food scientist, shows experimental products she has made from soybean proteins in her laboratory.

Summary

The soybean plant, which has often been referred to as the “Miracle” or “Cinderella” crop, seemingly has not lost any of its luster in the 21st century. Recent advances have resulted in the development of plastics, cosmetics and nutraceuticals. Continuing research findings are confirming the health benefits of soy-based products and seem to indicate that additional environmental and health-related products are on the horizon.