Texturized Protein Products

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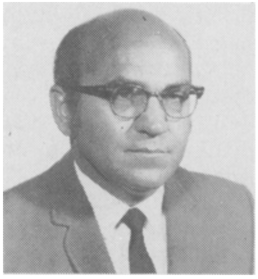

ABSTRACT

Texture is changed in oilseed protein fractions by mechanical and chemical means in specialized equipment. Processing conditions are closely controlled to ensure end product forms wanted. The arrangement of equipment used in the production of textured proteins is discussed as it relates to a commercial plant design. The nature of feed materials and details of processing conditions required to produce texture in soy protein are presented. Other forms of textured oilseed protein are discussed.

INTRODUCTION

Texturized protein products can be produced from many oilseed proteins and other proteins. Among these are soy, cottonseed, rapeseed, peanut, corn gluten, wheat gluten, casein, sesame, chick pea, fish protein concentrate, and single cell proteins. The articles of commerce in the U.S. are derived almost wholly from soy protein. Soy isolate is spun and manipulated, soy concentrate is extruded, and soy flour or grits are extruded to form texturized proteins.

The productive capacity of textured soy protein in the U.S. is estimated to be slightly over 1 billion lb per year. Textured soy isolate is a relatively new product, and production rate is not known to the writer; however, the production capability is in excess of 30 million pounds per year. Productive capability of spun soy isolate fibers is in excess of 25 million pounds per year on a dry basis.

About 15% of the productive capability for textured soy protein is presently used. About 40% of the spun soy isolate fiber capability is presently used.

Soy protein was texturized commercially more than 25 years ago. The product is still made for use in canned pet food. While not a pleximellar fibril rearrangement as done by Atkinson (1), there is a degree of texturizing imparted to the protein. Use of the product permits canned pet food ingredients to be slurry loaded to cans, with the slurry firming up during the cooking operation. Texturizing prevents a sliminess or excessive softness occurring after cooking that is encountered with soy grits.

Soy isolate has been texturized commercially in the U.S. for more than a decade. Boyer (2) taught a basic process in 1954 to make the products a commercial reality.

Approximately 60% of the soy flour and grit texturizing capacity in the U.S. is licensed under the Atkinson patent. Atkinson taught the conditions of processing that yield a pleximellar fibril from raw materials of completely different character. The product of the patent of Atkinson was given a large market in 1971 when it was accepted into the school lunch program in the U.S. The Food and Nutrition Service (FNS) issued FNS Notice 219 permitting the use of textured vegetable protein products with meat on February 22, 1971. Additional markets were available in 1973 when the economics of adding the product to hamburger as an extender were favorable due to the high price of beef. Still another market opened up when the product was added to canned pet food in a beef chunk form.

The largest tonnage product in texturized proteins is the soy flour or grit product. The processing of this product is discussed in detail.

PROCESSING FLOW

Several elements make up a soy flour or grit texturizing process. Included are feed material grinding and conditioning, extrusion, extrudate sizing, conveying, drying and cooling, and flavoring and fortification.

Feed material to a texturizing process for soy flour or grits is normally at 70% protein dispersable index (PDI) as measured by AOCS methods (3). Moisture is at a 7% range. A flour that is 95% minus 100 mesh is used as feed. A flour grinding system will yield 33 lb per system horsepower hour. Grits can also be used, and Table I gives the approximate size of a typical grit feed material.

The residual fat content as measured by AOCS method Ba 3-38 (4) should be <1% to produce a good quality of texture in the soy protein. One method of measuring texture quality is to subject the hydrated finished product to an autoclaving at 15 psig for 15 min. After autoclaving and cooling, the textured material is screened. The material weight retained on the screen is corrected to initial product moisture and is divided by initial product weight. The resulting fraction times 100 is the percent texture. Visual methods do not indicate how a dry textured product will retain its shape when hydrated and cooked.

An extruder operating with a 200 HP main drive motor would be expected to process 5,000 lb per hour of soy flour or grits to an extruded product. This rate would be without the use of lecithin to increase the production rate. The use of soy or corn lecithin to increase the capacity of an extruder or soy texturizing by up to 50% is taught by Atkinson (5). Lecithin is a mixture of phospholipid materials occurring naturally in most crude vegetable triglyceride oils. A level of 0.2-0.5% lecithin addition is recommended to improve production rates. The end product is slightly more dense, but this is not a problem with some texturized products. The addition of lipid materials to improve extrusion cooking of cereal grains has been used for the past decade, and improvement would be expected as taught in soy protein extrusion.

Processing conditions relating to a 200 HP expander would start with feed material at 7% moisture being raised to 20% moisture and 200 F by the use of sparge steam and water in a preconditioner. Because of inefficiencies in contact, a flash steam loss of a little over 200 lb per hour will occur if the preconditioner is at atmospheric pressure. Water is added in the preconditioner to account for 10% of the mixtures moisture, and condensing steam raises the final mixture level to 20% moisture.

Moisture is added in the extruder barrel to raise the mixture moisture to 22.5%. This moisture is added as water and steam. Water accounts for 2% of the final mixture moisture and condensed steam, 0.5%.

At the exit of the extruder, 250 lb per hour of steam is

TABLE I

Size Distribution of Soy Grits for Extrusion

Micron size	U.S. mesh	Percent retained
420	40	10
250	60	22
149	100	27
74	200	15
44	325	7

flashed off, causing the extrudate to expand. A final moisture of 19% exists after expanding.

Aspiration needs to be provided at the inlet and outlet of the extruder to vent the steam wasted in processing. A design velocity of 6,000 ft per minute is needed in these ducts to keep them from building up due to moisture and fines present.

It is sometimes desirable to reduce further the size of the extrudate to make products such as those used in meat extenders. One device used to reduce the size is the Comitrol® cutter (6). When applying this cutter, you can expect a throughput of 155 lb per HP hour based on the wet material exiting the extruder.

The physical appearance of textured soy protein is improved if an air conveying system is used to transport the sized wet material to drying. The air conveying allows the cut particle to set up and prevents the mashed corners and cell collapse caused by mechanical conveying systems.

Textured soy protein is dried, cooled, and screened prior to packaging. Drying is normally done in tunnel type dryers with drying zone air temperatures at 260 F. Cooling is with ambient air. The perforations on the belt in the dryer-cooler are usually 9/64 in. round hole. Apparent velocity of the cooling air is 160 ft per minute.

An amount of cooling air can be recycled back to the drying operation with significant energy savings. The drying air requirement is ca. 35% of the cooling air requirement, and recycling this air from the cooler will result in a heat saving in excess of 15% compared to using fresh air for dryer air makeup.

Screening the finished product to remove fines produced in processing is done to improve product appearance. This can be done on a variety of screening devices. Sizing of a screen for the meat extender product size range should allow for 500 lb per hour per square foot of screening surface.

Flavorings, colorings, vitamins, and minerals are sometimes added to the textured soy protein. Flavorings and vitamins are usually added to a dry product so that these materials are not subjected to the severe temperatures found in processing. A common carrier for flavoring is a partially hardened triglyceride oil. Vitamins can be carried in either oil or water solutions. Some products are salted after flavor application by adding dry salt. When hardened fat is used, the salt adheres to the melted fat and is carried on the product when the fat cools to bind the salt.

Minerals are generally heat stable and are added to the dry flour or grit prior to extrusion. It is desirable to color the end products all the way through so coloring materials are also added to the dry protein prior to extrusion.

A typical applicator drum for 1 ton per hour of product throughput would be a cylinder measuring 2½ ft in diameter by 10 ft long. The drum would rotate at ca. 1,000 in. per minute peripheral speed and would have internal flights to lift and tumble the texturized protein to mix and coat the flavorings to the product. Gravity flow through the unit is accomplished by pitching the drum at ca. 10° fall to the outlet.

There are many other processes to texturize proteins. Slurries are pumped to a steam atmosphere (7). Doughs are texturized (8,9) with radiant heat application. Fermented materials (10) are texturized. Sulfur (11) and glycerol (12) are added to give unique product characteristics.

Spun proteins are produced from solutions of proteins. An excellent reference on this subject is the paper by Rosenfield and Hartman (13).

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