Soy Protein Products in Other Foods

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ABSTRACT

Both long-term and emerging patterns of utilization underscore the diversity of the use of soy protein products in processed foods other than meat foods. The purpose of this paper is to present a selective overview of this diverse usage.

INTRODUCTION

This presentation emphasizes the utilization of soy proteins in engineered dairy-type foods as well as in beverages unrelated to dairy products. In addition, there is a large usage in what is termed "cereal products." The et ceteras are many and diversified.

The engineered dairy products consist of "soy milk," coffee whiteners, whipping agents for the so-called cream toppings, baby foods, puddings, and cheese-like foods. Since we mentioned whipping agents, we will elaborate upon such uses in confections by themselves, or as supplements to egg whites.

Under the cereal or baked goods other-than-bread category, we will discuss use and advantages in pancakes, waffles, doughnuts, cake mixes, cookies, toppings, snack foods such as specialty crackers, pie crusts, cereal products to be eaten dry or cooked, health foods, diet foods, and geriatric foods. Last but not least in this category are pasta products of all types. There are some that may question inclusion of health foods, diet foods, and geriatric products in a cereal classification, but most of them, although high in protein, are often a blend of various cereals.

In confections, in addition to the whipping agents previously mentioned, there has been an increase in the usage of "soy nuts" as direct additions in whole or chopped form, or preprocessed full-fat flakes similar to sliced almonds for topping. In addition, "soy nuts" are consumed as such with various snack-flavored seasonings, or as chocolate coated or sugar panned snack foods.

In addition, in what may be called "catchall" usages, we find soy protein products being used in a particulate form in soups, either for high protein soups or as a simulated vegetable product primarily for cost reduction of expensive garnishes. Their inclusion in gravies and vegetable stews is increasing each year. They have also been used as a dusting powder with yeast to hold flavorings or seasonings on snack foods. The use of hydrolyzed proteins in "soy sauces" has been propounded by our associates from the Far East. In the last few years, work on controlling and changing flavors by various enzyme treatments to give differing flavors will undoubtedly enlarge the field for hydrolysates.

In all of the above described food categories, you will find usage of full-fat products or extraction products of the same, including extraction products of differing particulate size, as well as varying protein solubility index. Mechanically processed low-fat products of various sizes also can be prepared to give mild nutty effects when desired. Protein concentrates of ca. 70% protein and 90% protein isolates of either the isoelectric or soluble protein type can be comingled in their use. Whole beans preprocessed in many ways can and are used in canning products for human use and in pet foods.

All of these products have been known for several years; their increasing use in the foods mentioned earlier is the result of these products finally coming into their own. The newer "engineered foods" have undoubtedly lent tremendous impetus to the growing interest in soy and other proteins. However, we must be humble and give thought to the statement: "There is nothing more powerful than an idea whose time has come."

Within the context of that thought, let us proceed to a discussion of the value and properties of soy proteins in the foods previously mentioned.

VALUE AND PROPERTIES OF SOY PROTEINS

A very important utilization of soy is in engineered dairy-type foods. One of the early uses of soy was in infant feeding formulas for babies who were allergic to milk products. The first soy product used was a full-fat soy flour. The product separated on standing, but it was accepted because the need of the baby was paramount. With improved technology in soybean processing and the development of soluble isolated proteins acceptable and nutritious soy milks for infants are now available.

Because of its hydration capacity and its ability to emulsify fats, soy protein has found its way increasingly into simulated dairy products. The early stimulus for the development of non-dairy coffee whiteners, milk-free margarine, whipped toppings, imitation sour creams, and cheeses was derived from religious groups seeking to conform to dietary laws. Later the need for a more economical protein than milk protein became evident. Soy provided the economy without diminishing the quality of selected dairy-type products.

In margarine, soy flour replaced non-fat milk solids either alone or in soy-whey combinations.

Coffee whiteners, whipped toppings, soft-serve desserts, imitation cheeses, and sour creams have used isolated soy protein to great advantage. Usually ca. 1% isolate based on formula wt is used to emulsify ca. 12% fat, with the homogenization pressures being adjusted to accommodate the different physical properties of the products.

At this point, I would like to pause and recognize that what I have said so far is somewhat trite and many of us have heard the same thing many times. We believe that this is the result of what is still a growing industry which has so many divergent products that data on all the functional qualities that can be expected from such products is still fragmentary and certainly unclear. For example, we talk of emulsifying, moisture retention, dispersibility, gelling, particulate size, color, flavor, enzyme-active properties, and many others, but how much do we know about multiple usage of various soy proteins with their divergent properties within the same product? We should not attribute to any one product a cure-all ability but must recognize that each product serves a usage that is peculiar to itself, and that when attempting to introduce nutrition one should also be able to introduce not merely function but capability.

Since time is too short to take a series of products and work through on a total formula, it is necessary to generalize and thus I must fall back once more on what is known. However, we will show one example of a usage which embodies what we have just talked about.

FUNCTIONAL PROPERTIES OF SOY PROTEINS IN BAKED GOODS

For example, many people are talking about mixing soy flour in 6% or 12% quantities with wheat flour to make

bread using various glycolipids and synthetic emulsifiers to give good loaf volume. However, there has been some indication of soy used with wheat products possessing gel characteristics such as in a cooked wheat breakfast cereal known as Farina. this has been accomplished with tight control of the nitrogen solubility index in the preparation of the particular soy product; most important was a tight particulate size that would be close to that of the Farina after cooking. This type of control has also been used with a whole wheat type of product, but in that case, other than the control work on the particulate size, there has been an additional control of the color and toasted flavor without, of course, diminishing the lysine content.

For years, soy flours were used in cake mixes in greater or lesser amounts, and in most cases, as we all know, for water-holding capacity. Today, however, each soy protein is used for its own functional value and we now find both soy flour and isolated protein used in the same mix. If there has been any advance in the utilization of soy protein products in foods, it has come with the recognition that of the 25 or 30 different protein products available, each has its own particular value in the food, whether it be gelling, emulsifying, moisture retention, particulate size, retention of form, fat binding, stabilizing, dispersibility, whipping and foaming properties, antioxidant properties, enzyme-active properties, color, flavor, and textural properties of all shapes and forms.

The users of soy proteins will have determined which of these functions best suit their needs, and there is no one product, no single soy protein, that will be universal in its application. In fact, it would be ridiculous were we now to sit on our hands and say that there are no new soy proteins to be developed. In fact, it is our opinion that insufficient thought has been given to the fact that form and particulate size are additional functions which must be compatible with the food product if that product is to be successful in the marketplace. In products such as bulgur, the added protein must have firmness to the bite rather than a spongy or fibrous characteristic since bulgur does not have either of these characteristics.

Protein can be used for its moisture retention and fat emulsification properties. For example, in bakery-type products such as pancakes, waffles, and cakes, soy flour will absorb ca. 2-3 times its wt of water and will retain the moisture under baking and other food processing conditions. Not only is a greater product yield obtained, but shelf life and freshness are increased.

In pancakes it is possible to replace 25-50% of the wheat flour with soy flour without affecting the sensory characteristics; in fact, in recent tests the product containing soy was preferred over the pancake mix containing no soy ingredient. Storage test of the dry mix indicated no adverse flavors over an extended storage period of 12 months. Similar results are obtained with waffle mixes. What a dramatic change when just 20 years ago a soy-labeled product struggled for acceptance, today, a product, albeit no better in quality, is widely accepted.

Doughnut flour mixes are composed of wheat flour, shortening, sugar, and chemical leavening agents. Soy flour (or soy protein) is added to the mix at levels of 4-10%. The purpose of the soy flour is to prevent fat absorption during the frying operations. It has been shown that as little as a 4% level of addition decreased the fat absorption by 25%. The shelf life of the product is increased by the retention of a higher moisture in the finished product. The type of soy flour used may be a defatted flour, full-fat flour, or a defatted flour with addition of 5-15% soy lecithin.

Excellent success in customer acceptance has been advanced with the use of soy flour and soy nuts or chips in cookies. A typical formulation for cookies is flour, shortening, sugar, salt, and flavors. In addition, sodium bicarbonate and acid phosphate powder is used if open crumb texture and a crisp bite is desired. An addition of 2-5% soy flour will improve the machineability of the dough and will improve the handling and release properties. The proper soy flour or soy protein (50%) will impart a nutty flavor to the cookie. The cookie can also be topped with ca. 5% of soy nuts. These soy nuts can be incorporated in the dough if desired. The soy nuts or chips are made by roasting, wet steam debittering, or soaking and frying.

A cookie of this type not only has a very pleasant nutty taste, good texture, and appearance, but also has a bonus of a 30% increase in protein content. Ingredient costs are reduced by the substitution of soy in place of nutmeats such as pecans, walnuts, and other nuts.

At the present time, there are several types of high-protein cookies produced commercially. Some of these cookies may contain soy at the same level as wheat flour. In some cases a specially prepared full-fat soy flake may be added to enhance the product. Formulas are available for various types of high soy-containing cookies.

There are many products sold in the U.S. which are referred to as mixes. These are convenience items used by the housewife or for institutional uses. The mixes contain flour, shortening, flavor, and leavening agents, and are made so that all that is necessary is to add water, milk, or minor ingredients to make a finished food product. Possibly the most popular are the various cake mixes. Mixes for bread, pancakes, waffles, buns, and many other baked items are available. Defatted and full-fat soy flour and grits are added to such mixes at a level of 2-15%. In addition, in many mixes, several types of soy protein may be added such as protein isolates or concentrates along with the soy flour.

The soy product in the mixes helps with the emulsification of fats and other ingredients. The doughs are more uniform, more smooth, and pliable, and less sticky. The finished baked products will have improved crust color, grain, texture, symmetry, and longer freshness of the baked product due to moisture retention.

In pie crusts a low-fat lecithinated flour at 5% level will result in a flakier, tender crust. The lecithin will have an antioxidant effect on the fat and will help prevent rancidity of the crust during frozen storage.

Soy products' greatest use is in baked goods. Soy provides substantial economies in baked goods formulations alone, or in combination with dairy products. As the cost of dairy products increase, processors substitute more and more of the soy ingredients that have similar functional properties at a lower cost. Also, lower cost dairy products such as whey solids may be combined with soy to replace a higher cost ingredient such as non-fat milk solids. There are many other cereal-based baked goods that incorporate soy products. These include products such as crackers and various snack items which will be discussed later.

Since our area of discussion is not that of nutrition, we have been stressing functional properties of soy protein products in baked goods. To recapitulate, soy protein ingredients in baked products serve the following functions: (A) Improves eating quality; (B) Lessens moisture loss during baking; (C) Makes doughs more pliable and easier to handle; (D) Increases rate of browning and provides a better crust color; (E) Increases shelf life; (F) Improves texture of baked products. All of the above is accomplished while reducing cost. However, it is difficult to draw tight lines and if we do mention nutrition, it is because nutrition is of primary significance.

NUTRITION AND SOY PROTEIN

Prepared breakfast cereals have traditionally been based only on grains such as wheat, rice, oats, and corn. These products were usually flaked, puffed, or extruded. In recent years, breakfast cereals that are more flavorful and more nutritious have been developed. This has been accomplished

by addition of soy to the traditional grain products or a mixture of various grain products. Combinations of soy and dairy products also are used. The type of soy flour used is a fine-grind defatted soy flour, and is added at 15-20% levels. In addition to the added nutrition value, the soy product will result in certain dough handling characteristics that aid in manufacturing of the cereals.

In baby and junior-type foods, 5% soy proteins, soy grits, and dairy proteins are added to canned and dry foods containing starches, grain and vegetable products. Baby cereals are usually in a fine flake form made by roller drying of a slurry of the cereal products with the soy ingredient. The soy will impart a certain viscosity to the slurry which will allow for good pickup on the rolls and for product release after drying. The level of soy or soy and protein may be as high as 30-40% of the product.

There are quite a few soy beverages on the market. A full-fat soy flour with proper enzyme deactivation, sugar, and flavor are the basic ingredients. These beverages contain protein at ca. 3.6% with a fat content of ca. 2.0%.

For use in infant and child feeding, several products have been successfully marketed. In South America, Duryea of corn flour, soy flour, and non-fat milk solids contains 20% protein and is used as a drink or gruel. Solein, a product of 70% soy flour and 30% milk protein, is marketed as a drink for infants in Brazil. Bal Amul consisting of soy flour and non-fat milk solids is being sold in India as a baby food. All of these are being marketed by private concerns.

Acid soluble soy proteins are used to make a clear beverage. The soy protein is such that it can withstand food acids such as found in oranges and lemons, and retain clarity of product. The use level of this acid soluble proteins is ca. 2%.

There has been a great increase in the consumption of snack foods in the U.S. Consumer concern for nutritional value of foods has led to the development of protein-fortified snacks. There are many varied snack items on the market. The items include products such as corn curls, collettes, corn chips, pretzels, potato chips, and various combinations of grain products extruded in many shapes with various flavors such as cheese, pizza, barbecue spice, garlic, and onion. After extrusion and expansion, the snacks are baked or fried. They may be coated with cheese or other flavor coating as desired.

Since the greatest consumption of snacks is by young consumers, several high-protein snacks have been introduced in the market. For example, a typical product formulation for a fortified corn curl is 30% soy flour or fine grit and corn meal with a small amount of wheat germ added. This product is extruded and has a protein content of ca. 20% as compared to a standard corn curl which only has 7% protein.

The confectionery field uses soy flour in various types of confections. Caramels and toffee-type products handle better with the addition of soy flour, and there is less stickiness on a high speed wrapping machine. In fudge, soy flour will slow the rate of dehydration and thereby aid in preventing the crystallization of the sugar.

Full-fat soy chips may be french fried and incorporated in bar candy in place of nutmeats.

Soy flour and grits are used in stews, gravies, soups, and other similar products for their thickening effect and also to improve flavor and nutrition. Textured vegetable protein products from soy can be made to simulate mushrooms, green peppers, and other vegetables. These are added to soups and stews as vegetable garnishes. A pea legume soup of 60% pea flour, 20% soy flour, 5% milk solids, salt and seasonings is an excellent product.

The characteristics of traditional foods should be changed as little as possible to ensure acceptance by consumers. However, economic considerations are necessary. Beans with pork in tomato sauce is a well-accepted product. The beans in this product are navy beans, which can be replaced by properly prepared soybeans to cut costs 50%. However, there is a different eating quality between navy beans that are mealy and soybeans that are firmer. The protein content of the navy bean is 22% whereas the soybean is ca. 44%. As a result the protein content is doubled.

Pasta products of all types such as macaroni, spaghetti, and vermicelli are being fortified with soy flour to increase their nutritional value. Defatted soy flour or full-fat soy flours are used. The basic ingredients are semolina, durum wheat flour, Farina or hard wheat flour or any combination of two or more of these ingredients and a moistening ingredient. These pastas contain soy at 15% level on a dry basis. If desired, vitamin enrichment may be added. The resulting pasta will have a 15-17% protein content. Foods of this type have been accepted for U.S. military, government feeding programs, and school lunches.

Soy flour and soy grits are used as bases for artificial spice flavorings such as mace or nutmeg, cinnamon, and cloves. The soy product may be roasted to develop a color similar to the intended spice or may be colored with an approved vegetable dye. Particle size is also determined by the traditional size of the natural spice product.

Soy protein can be hydrolyzed in a controlled manner through the use of proteases such as pepsin. This improves the water solubility of the protein and gives it the ability to form a stable foam when whipped in water. Soy protein thus treated can replace egg white in applications where whipping agents are required. It has certain advantages, most importantly, lower cost. A soy whip also whips faster, is more tolerant to overbeating and to higher temperatures. It can be used in nougats, frappes, mazettas, and marshmallows. In the confection, it has good moisture retention so that it improves the shelf life of marshmallows.

Another application of soy whipping agents is in the foam mat drying of fruits, where the product is whipped before drying. The whipping ability of this type of hydrolyzed soy protein has been improved through the addition of sodium hexmetaphosphate and small percentages of sugar, and in some instances, vegetable gums.

The many soy protein products now manufactured will, of course, continue to increase, and uses of these products will likewise increase. It is important to remember that many of the basic manufacturers produce some or most of the soy protein products offered to the total food industries so that they can produce the necessary "new engineered foods." Lest we forget, the greatest value in soy is that we have a reasonably priced protein that superbly balances the proteins of cereal grains and vegetables. We have learned much about how to use their natural and built-in functional properties. More remains to be learned. There now appears to be a favorable climate for wide acceptance of soy protein products in food and we can see this trend accelerating rapidly.