using modified soy protein products. The enzymatically prepared soy protein products, except for a flavor problem, function well; and this is, of course, a prominent use for such products. It has been learned that dry toppings when reconstituted and used as a creamer, for example on fruits, have led to some adverse stability reactions. The functional factor of flavor is extremely important in whip toppings and the soy may cause the green and soybean flavor notes to appear in this type of product.

NUTRITIONAL BEVERAGES

In this application, the functional properties of soy protein isolates are extremely critical. Even when soy protein isolates are used in this type of product, either with or without other protein sources, practically all the functional properties mentioned above take on considerable significance. In dry nutritional type products, wetability and dispersibility of the proteins and the finished product are of considerable importance. Likewise in those products that require hot water for reconstitution, the aroma and taste contribution of the soy protein becomes exceedingly important. Attempts have been made to use soy proteins in such products, but the aroma of the soy definitely was detected by the consumer. Another important consideration in the use of soy isolates in nutritional products is the contribution a soy isolate can make to the flavor notes of the particular product under consideration. Experience has shown that some soy isolates can amplify a cereal note, for example, if that happens to be the basic flavor note in the finished product. Where fruit flavors are involved soy protein isolate must be used at the minimum level with other protein sources to prevent a green or adverse flavor note appearing in the finished reconstituted beverage.

Time will not permit a discussion of all the other factors that are involved in using soy isolates in nutritional beverages because each type of beverage has particular and specific requirements. I would like to emphasize, however, in closing that another one of the critical factors is uniformity of the soy protein isolate from lot to lot. Differences in isolate manufacture can and do have effects upon performance.

Soy Proteins in Dairy-type Foods, Beverages, Confections, Dietary, and Other Foods

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This section deals with beverages, simulated sweet and sour creams, margarine, cheese-like foods, frozen desserts, whipped toppings, substitute nuts and fruits, table vegetables (green or immature beans and sprouts), and soups, based upon soybeans and soybean protein derivatives.

I. Beverages. These fall into several categories.
   A. Traditional soy milks, unfermented.
      1. Starting with uncomminuted full-fat beans.
         a. Oriental process. The beans are soaked in water overnight, then ground in hot water, cooked at boiling, and filtered through cloth. May be refrigerated or retorted.
         b. Contemporary processes. The flavor of above may limit acceptance. Several recent reports indicate that lipoxygenase and perhaps other enzymes in the raw bean may be responsible for off-flavors. Enzyme activity may be diminished at the outset by heating the intact beans either dry (roasting or IR heating) or by cooking them after immersion in various aqueous solutions of salts, alkalies, or acids. Wet cooking may be atmospheric steaming or boiling, or may be under pressure, followed by comminution and filtration. These beverages may be fortified with vitamins, minerals, and other additives. They can be purveyed in wet or dry forms. This type of processing retains the oligosaccharides.
      2. Starting with full-fat or defatted soy flours, precooked, with or without filtering. Fat is added to the defatted flour-based product. Both types have been made commercially.
      3. Starting with soy protein concentrate, full-fat or defatted. These are devoid of oligosaccharides. Some calf milk replacers are of this type.
   B. Traditional fermented. Yogurt-like milks have been studied both in the Far East and the U.S. (using *Lactobacillus bulgaricus* and *L. acidophilus*).
   C. Simulated milks (neutral pH). These are based usually on soy protein isolate, without or with bovine milk ingredients (lactose, non-fat dry milk, cheese whey, caseinates, etc.)
      1. Dairy-type, fluid single strength. Problems with flavor, color, viscosity, mouth feel, etc. Some have appeared on market. Fresh vs. sterilized types. Also concentrated (simulated evaporated milk).
      2. Non-fat dry milk replacers. Soy protein isolate or soy flour mixed with dairy whey and other ingredients.
      3. Infant-feeding beverages to simulate human milk.
      4. Fermented yogurt-like types.

      In the U.S. the Filled Milk Act was declared invalid after 50 years, although there are still some legal restrictions at the state level. There is renewed interest in imitation milks, but there may be requirements for nutritional adequacy and performance equal to dairy milk, from the regulatory standpoint. Possibility exists for extending supplies of dairy milk by admixture.
   D. Still beverages simulating or extending fruit juices (citrus, pineapple) and vegetable juices (tomato, carrot, etc.) or other flavors. These may be acid or neutral. Also protein fortification of natural fruit or vegetable juices. Problems of solubility and mouth-feel on contact with saliva. May require modification of soy protein isolate.
   E. Carbonated beverages (acid). Solubility, mouth feel, and flavor even more of a problem, in addition to problem of clarity. Extensive modification of protein (by hydrolysis) may affect nutritive value.

II. Simulated sweet creams. Includes category of coffee whiteners. Latter requires tolerance to hardness of water and acidity of coffee.

III. Sour cream. Based on milk caseinates or non-fat dry milk, but can be made with soy protein isolate.

IV. Margarine and spreads. Pareve on market; margarine standard permits use of soy flour; can be based upon

soy protein isolate.

V. Cheese-like foods.
   1. Traditional (Oriental) unfermented and fermented.
      a. Tofu, kori-tofu, aburage; made from traditional soy milk by precipitation with calcium sulfate.
      b. Sufu, Chinese fermented bean curd by action of *Mucor* organisms.
   2. Simulated cream cheese, based upon soy protein isolate.
   3. Simulated cured and processed cheese and cheese food types, with cheddar characteristics. On the market based upon bovine caseinates. Attaining similar properties with soy protein isolate poses problems.
   4. Cheese spreads and dips.

VI. Frozen desserts, ice cream and sherbet types. Acceptable formulations can be made with respect to texture and overrun and meltdown. Flavor, other than chocolate, and possibly viscosity may pose problems. One company has marketed a dry mix based upon soy protein isolate.

VII. Whipped toppings. Several on market in dry powder, liquid, or aerosol dispenser form. Based upon caseinates for most part but some on soy protein isolate. Formulations available from ingredient purveyors (fats, proteins).

VIII. Substitute nuts and fruits.
   A. Nuts based on processed whole soybeans retaining macrostructure and oil content. Many methods of processing in literature.
   B. Simulated nuts based on dried, compressed protein-fat emulsions.
   C. Simulated bell peppers on market, also simulated mushrooms. Possibility of achieving textures of dried fruits (intermediate moisture); also of tomato paste (imitation tomato pastes are on the market as extenders, based upon starch). One can speculate on simulation of other textures, e.g. artichoke hearts.

IX. Table vegetable, green soybeans, and bean sprouts. Available in canned form, also fresh in season in some areas. Dry beans can be sprouted in home.

X. Soups. Protein fortification as thickener (soy flour, soy protein concentrate, or soy protein isolate) or in high protein noodles or croutons. Oriental use of yuba.

Soy Protein Isolates in Hypoallergenic Infant Formulations and Humanized Milks

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INTRODUCTION

For many years, in both the U.S. and Europe, a number of baby milks, based upon soy protein isolates, have been on the market.

The major reasons for these products was, not only to feed infants who were allergic to cows' milk, but also to replace hypoallergenic infant formulations based upon soybean flour. Since the term "hypoallergenic" generally is defined as an allergy of infants to animal protein, in this discussion we are only considering allergies to animal protein and not, as in some limited cases, allergies to soy proteins. Although soybean flour performed well in providing nutrition, it had some disadvantages, such as unpleasant flavor, and intestinal side effects (gas formation and colic), as well as an occasional tendency to increase dermatitis.

The real reason for infants' allergies to cows' milk is not clear. However, it has been proved that, in the blood of some of these allergic infants, antibodies are present. The cause of these antibodies to milk proteins is not 100% clear.

Nutrition-wise, proteins are the most important part of food and are the building blocks for new cell material. When using raw materials, such as soybean flour, with a protein content of ca. 50%, the presence of the nonprotein fraction also has to be considered carefully, because of secondary reactions. Soluble carbohydrates and insoluble polysaccharides affect the infant's metabolism. Examples are: (A) the effect upon the type of protein curd, (B) transit time from stomach to intestine, and (C) differences in enzymatic or bacterial degradation of components, like soluble carbohydrates and fibers.

SOY PROTEIN ISOLATES

Again, although the incorporation of soybean flour in hypoallergenic formulations was advantageous as far as nutrition was concerned, it also introduced unwanted products. An answer was the replacement of the flour by soy protein isolates, with a minimum protein content of 90%, combined with corn syrup solids, maltodextrins, or sucrose.

However, the nutritional properties of the proteins are important and depend upon production factors. It is apparent that, not only protein content, but also the protein efficiency ratio (PER) must be carefully considered.

In some applications where soy protein isolates are used for their functional properties, PER is not of primary importance; however, in dietetic formulations it is of the utmost importance. Highly nutritional soy protein isolates have a PER of 1.8-1.9. Standard casein, which is taken as a reference, has a PER of 2.5. If a PER of 2.5 is essential, one can supplement the soy protein isolates with methionine (1.0% of the isolate).

Hypoallergenic infant milks normally are produced from corn syrup solids, sucrose, soy protein isolates, and vegetable fats and are supplemented with vitamins and minerals. The protein content varies from 2-2.5% when reconstituted. Due to stable prices for soy protein isolates, as compared with milk proteins, so called hypoallergenic formulations are more and more widely produced to cover, not only the hypoallergenic field, but also to provide a modern food system which answers the nutritional requirements of healthy infants.

HUMANIZED MILKS

An extension of hypoallergenic formulations is the appearance on the market of the so called maternized or humanized milks. The purpose of such milks is to provide nutrition to infants who have not been able to receive maternal milk from time of birth. In such milks, one tries to reconstitute maternal milk with regard to lipids, proteins, lactose, minerals, and vitamin content.

As you may know, cows' milk, which is normally fed to infants, is quite different from maternal milk, not only as far as a level of essential major ingredients is concerned, but also in its chemical structure and composition.

The essential ingredient which is of interest to us today is the protein content. It is an accepted fact that, in cows'