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THE DEVELOPMENT OF A HIGH-PROTEIN SOY BEVERAGE IN ALLEVIATING MALNUTRITION

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There are several methods of increasing protein supplies in the developing nations; fortification of existing foods and shipment of surpluses from the more affluent countries to the underdeveloped countries represent short-term methods. There is no question as to the importance of such short-term methods, and these will continue to be used in the future. Another method or approach represents the long-range development of new protein foods. This is a more difficult method. First of all, the scientific problems associated with the development of a processed food must be resolved, and, secondly, it requires much preparation in terms of an educational program as to the beneficial aspects of the food. Marketing and distribution techniques become important in any long-term development. Flavor habits, religious customs, and many other factors are involved in the successful acceptance of a new food.

The American food industry as well as universities have been stimulated recently to pursue or intensify the attack on world malnutrition problems. Much of the stimulus for this increased effort has come from various foundations and governmental agencies (Ford and Rockefeller Foundations, UNICEF, and AID, for example). This fight against hunger and malnutrition is a never-ending offensive battle that must continue, and, in fact, it may be difficult to show much improvement if the population explosion continues as predicted by many writers and scientific authorities.

High-protein food supplements represent the area of greatest concern, although it is recognized that a general malnutrition problem involving calories, vitamins, and minerals is observed in the underdeveloped countries, as well as protein undernutrition. Nevertheless, protein malnutrition is the more fashionable research area at the present time, perhaps because it has been easier to observe harmful effects of protein undernutrition. Furthermore, it affects not only physical growth but also mental development during the early stages of life, as infants up to an age of 4-6 years are very vulnerable to a deficit of protein in the diet. Also, it is much easier to produce extra calories, or to fortify foods with needed vitamins and minerals than it is to produce high-quality protein in an acceptable form.

During the last year, at least three new beverage products have appeared on the market[1]. Two of these have soy as the base ingredient. This paper deals with some of the problems associated with the development of a soy beverage. Of principal interest are some of the effects of various processing treatments on the subsequent flavor and nutritional value of a water-extract

[1] Companies marketing new protein beverages are Yoo-Hoo Chocolate Beverage Corporation, Coca-Cola Company, and Soypro International.

from whole or dehulled soybeans. The soybean was selected, primarily, because of its high content of good quality protein. In addition, at the time the research was started, UNICEF was supporting a plant producing a soy beverage in which the quality varied from day to day.

The potential value of soybeans in alleviating protein malnutrition has been demonstrated especially well by Bean (1), who reported that 1 acre of land devoted to soybeans will produce enough protein to satisfy a moderately active man's requirements for 2,224 days, while protein supplied by 1 acre of land devoted to beef cattle would supply only 77 days of a moderately active man's requirement.

Preparation of Soy Milk. Figure 1 shows very simply the preparation of soy milk from whole or dehulled soybeans (full-fat). Soy milk prepared by the water extraction procedure contains from 60-65 per cent of the solids present in the original whole soybean and 80-83 per cent of the protein. The yield of solids and protein is influenced by the processing procedures used in the preparation of soy milk (2, 3, 4, and 5).

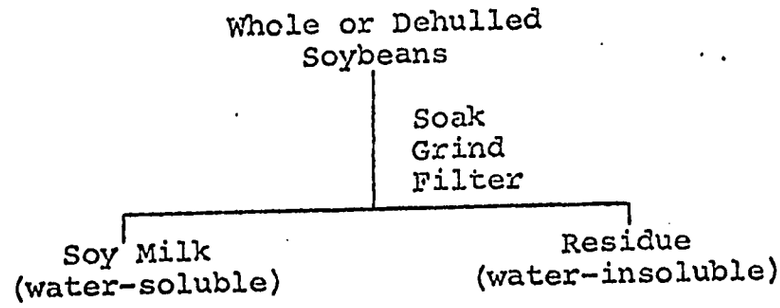

Fig. 1.--Flow diagram illustrating the preparation of soy milk.

Nutrition Studies. The results obtained with soy milk which had been subjected to a processing temperature of 93°C from 0-240 minutes are shown in Figure 2. The data indicate that, once the toxic substances present in soybeans are inactivated, no change in protein efficiency ratio (PER) occurs for soy milk processed for 4 hours at 93°C. Other studies have indicated that no change in PER occurs with soy milk processed for as long as 6 hours at 93°C. However, using a processing temperature of 121°C results in a marked depression in PER for soy milk processed more than 16 minutes (Fig. 3). It should be noted that none of the soy milk samples produced a PER value equal to that found for soybean meal (PER = 2.39). This supports an earlier observation by Hackler *et al.* in 1963 (6) on several soybean fractions, in which the soy milk fraction was found to be inferior to ground soybeans (PER = 2.51), as well as to the soybean residue (PER = 2.71) left behind on the filter.

Chemical Estimate of Nutritive Value. The food technologist is continually seeking a chemical means which can be used to routinely evaluate the effect of processing variables on the nutritive value of soy products. Research results (7) indicate that trypsin inhibitor retention is a very good method for evaluating whether a product has received sufficient heat treatment to knock out or destroy the toxic factors (trypsin inhibitors) present in the raw beans or soy milk.

Several studies indicate that it is necessary to have a trypsin inhibitor retention value of less than 20 per cent in order to obtain maximum utiliza-

tion of the protein as measured in 4-week protein efficiency ratio studies with weanling rats. It is more difficult, however, to find a chemical method that can be used routinely for estimating or establishing that a soy product has been over-processed.

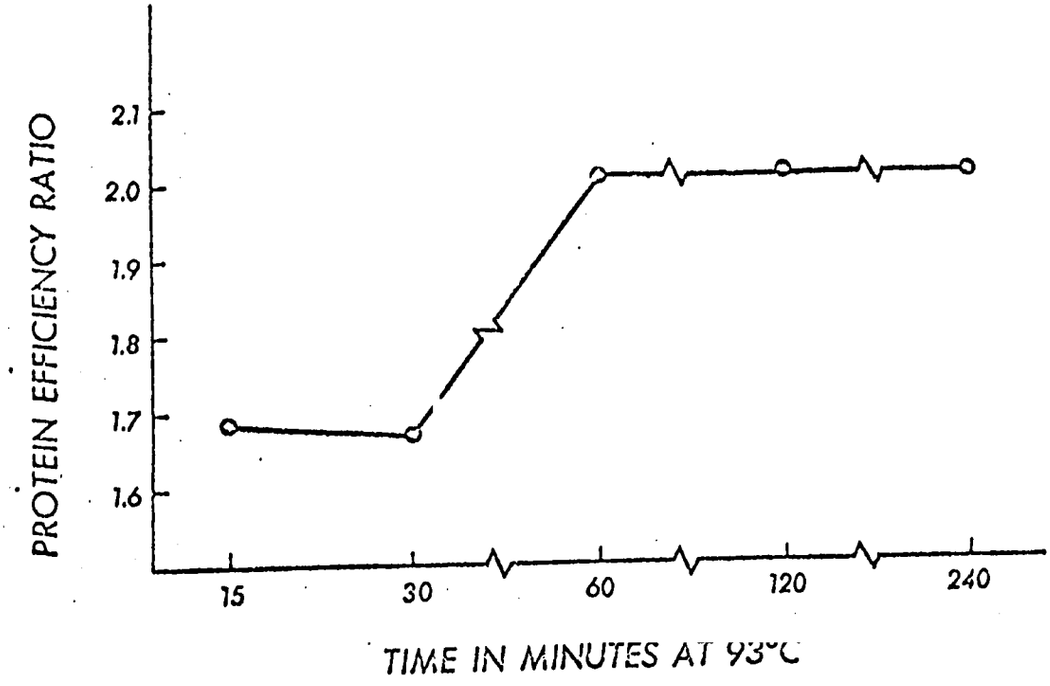

Fig. 2.--PER values of soy milk heat processed from 0 to 240 minutes at 93°C.

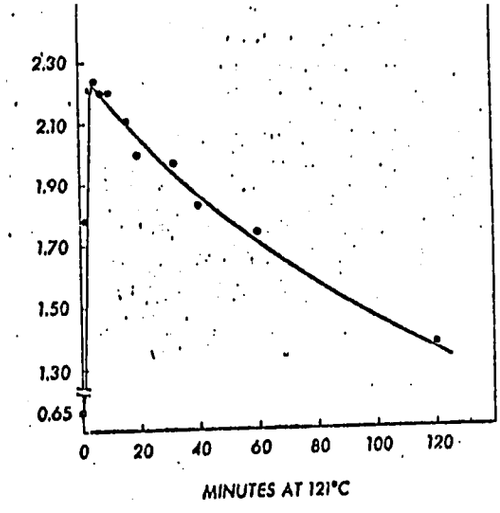

Fig. 3.--PER values of soy milk heat processed from 0 to 120 minutes at 121°C.

Any decrease in cystine or methionine is a very good indication of loss in nutritive value, as the sulfur amino acids are first limiting in soy products. Cystine is the sulfur amino acid that has been most sensitive to destruction by the heat-processing procedures used in the soy milk investiga-

tions. The Hunter color difference meter, also, has been of some value in predicting an over-processed product. However, it is useful only in a very well-defined system.

Flavor Studies. Oxidative off-flavors in soybean milk appear to be one of the big problems insofar as research on full-fat products are concerned. Wilkens *et al.* (8) have recently reported that a high-temperature, rapid-hydration grinding process inactivates the lipoxidase system present in soybeans and that this system is the primary off-flavor potentiator in a water-extract from full-fat soybeans. By using a high-temperature, rapid-hydration grinding process, a much blander soy milk is produced. It has been possible through the use of this procedure to produce an acceptable bland milk by grinding unsoaked, a hulled soybeans with water at temperatures between 80°C and 100°C. It should be noted that it is necessary to maintain the temperature between 80°C and 100°C for 10 minutes in order to completely inactivate the lipoxidase enzymes.

Other processing studies on soak time and temperature of soak on the yield of solids and protein were reported recently by Wilkens and Hackler (5), and it should be noted that the rapid-hydration grinding process can alter the yield of soy milk solids by as much as 2-5 g/100 g of starting material in comparison to the cold extraction procedure.

One other factor with respect to off-flavors in soy milk has been a chalky characteristic. It has been observed that by leaving the hulls on the beans, thus in the ground slurry, during the preparation of soy milk the filtered milk has a better mouthfeel due to less chalkiness. This decrease in chalkiness can be readily picked out by a taste panel. However, leaving the hulls on during the soaking step decreases the water-uptake, thus hydration time is increased.

Mattick (9) recently isolated and identified ethyl vinyl ketone as being partially responsible for the raw bean flavor in soybeans. In addition, Badenhop and Wilkens (10) reported on the isolation and identification of 1-octen-3-ol as one of the volatile components in soybeans. This compound is formed during the soaking step in significant quantities (4 mg/100 g of dry soybeans). This basic research on flavor components of soybeans and products produced from them will make it much easier to adapt or modify the flavor of soy products to suit the tastes of people in the underdeveloped areas of the world.

Problem areas. The preceding remarks indicate that there are many scientific problems. Nevertheless, the scientific and technological problems may be easier to resolve than some of the other aspects of the world food problem. One overwhelming problem is the lack of knowledge concerning food habits and customs. It may be very difficult to modify or change traditional food habits. The introduction of a new or foreign food into a new culture must go hand in hand with the education of the people as to the worth of the product in terms of their nutritional well-being. Related to the food habit problem is the fact that present day methods which are successful in the United States are not workable in the developing countries. There are several reasons for this, but the overriding problem is widespread poverty which limits buying power. Also, marketing and distribution techniques within these countries must be developed.

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