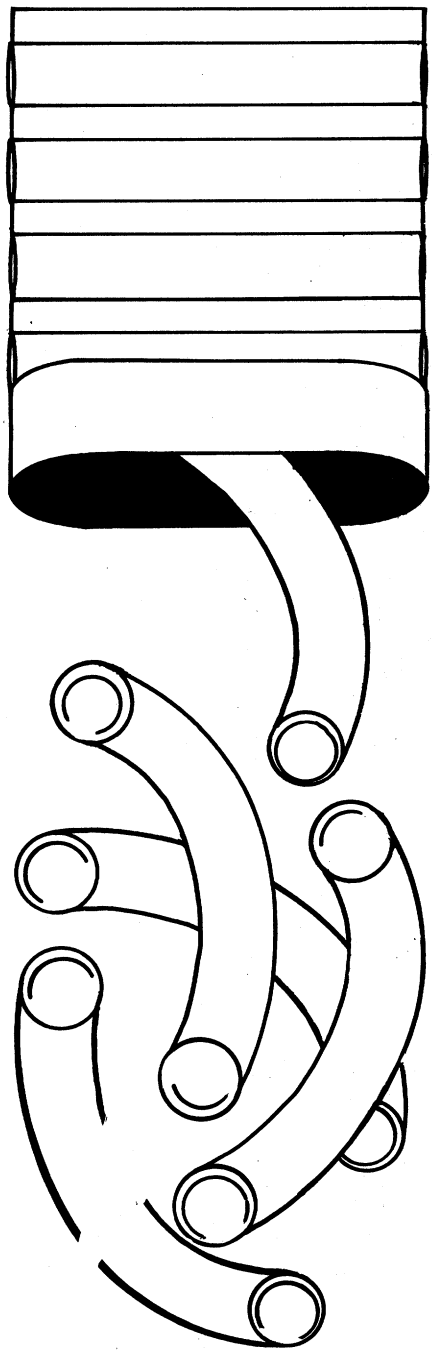
Whey Protein Fortification of Macaroni



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Recent emphasis on present and future world food problems has stimulated a great deal of national and international concern about the nutritional value of foods. American consumers, for example, are becoming increasingly aware of the health benefits and the nutritive value of high-quality proteins in the diet. Our food habits being what they are, it is especially important that popular, large-volume items such as macaroni products, cereals and extruded snack items reflect good nutrition. Their widespread popularity and use in school breakfast and school lunch programs make them prime candidates for nutritional upgrading. Several packaged protein-enriched food products are currently on the market. Some manufacturers, however, have tended to use wheat, corn and soy flours exclusively as sources of added protein. Although the cereal and soy proteins are important and valuable sources of nutritious foods, especially when used in combination, whey protein is even better.

Work done by the U.S. Department of Agriculture at the Eastern Regional Research Center, Philadelphia, PA, shows that macaroni enriched with high quality whey protein yields products with nutritional value equal to that of casein, the major protein of milk and cheese. The process is uncomplicated, requiring no change or modification in the commercial macaroni production process. What is more, preliminary taste tests indicate that the whey protein-enriched macaroni is highly acceptable. The key to this new fortified food product is the heat-coagulated protein obtained from cottage cheese whey.

Cottage cheese whey is the aqueous product remaining after removal of casein and fat from milk in the process of making cottage cheese. Cottage cheese whey is more acid than the "sweet whey" from Cheddar, Swiss and Italian cheese varieties because it contains a higher concentration of lactic acid. Although whey generally contains about one-half the total milk solids and is rich in amino acids, vitamins, lactose and highly nutritious soluble protein, it is, nevertheless, 93 to 94% water. To its credit, the food industry has become increasingly interested in ways and means of utilizing the whey proteins in various foods. Several methods useful for concentrating and fractionating whey proteins have been developed, such as reverse osmosis, polyphosphate precipitation, gel filtration, ultrafiltration and heat coagulation. Besides being the simplest and most economical, heat coagulation results in a water-insoluble whey protein product needed in the intended application.

The process of heat coagulation involves holding the whey at a high enough temperature and for a sufficient length of time for the proteins to become insoluble and form a curd or clot. Up to 60% of the whey proteins can be coagulated in this way. Experiments conducted by engineers of the USDA's Agricultural Research Service designed to determine optimum conditions for heat coagulation showed that adjusting the whey to pH 6.0, heating it to 250° F. and holding at that temperature for up to eight minutes achieved the best results. However, the calcium salts of whey are insoluble above pH 5.8; therefore, this particular process will result in a product having a high (20 to 25%) ash content. For applications where this might be undesirable, the whey slurry

containing coagulated protein can be acidified with acetic acid to pH 4.6. This serves to redissolve the calcium salts before final separation of the insoluble protein. This step reduces the ash content of the dried protein product to less than 5%. Spray drying is the method of choice because it yields a powdered product directly. Other methods, such as freeze-drying, drum-drying and cross-circulation-drying, yield a hard, caked product that must be ground before use. The goal of this ARS study was to find a whey protein preparation suitable for adding to durum flour to achieve a total protein content of 20% in the macaroni formulation. The 20% total protein content is specified for enriched macaroni-type products for use in the National School Lunch Program. Several high-protein fractions containing varying amounts of soluble whey proteins were tested; however, processing difficulties precluded their use. No processing difficulties were encountered with the insoluble, heat-coagulated protein; analyses showed that it retained its amino acid balance throughout the manufacturing, drying and cooking of the macaroni.

Common macaroni has a protein content of about 13%; sufficient whey protein was incorporated to bring the total protein content up to 20%. Results from animal feeding tests designed to quantify nutritional value (protein efficiency ratio) indicate that the added whey protein substantially improved the food value of macaroni. The protein efficiency ratio (PER) is a widely used index of protein nutritive value and is defined as the grams of weight gain per gram of protein eaten by weanling rats. Common macaroni gave a corrected PER value of 0.80, whereas the whey protein-enriched macaroni had a corrected PER value of 2.5—not significantly different from the standard casein. Incidentally, the heat-coagulated insoluble protein alone had PER values ranging from 2.8 to 3.1.

The plain and protein-enriched macaroni products were also subjected to comparative flavor and texture tests. The trained taste panel was able to detect a difference in the texture, but the difference was not such that would render the protein-enriched product unacceptable. Similarly, the panel was also able to detect differences in flavor, but both the flavor and texture differences became insignificant when tomato or cheese sauces were added to the test samples. As a matter of comparison, the taste panel consistently preferred the whey protein-enriched macaroni samples over samples enriched to 20% protein now commercially available at retail.

In summary, this work demonstrates an uncomplicated and technically feasible method for protein fortification of macaroni and similar food products made from pasta. Basic to the production of these protein-enriched products is the use of high quality insoluble protein from whey obtained by a controlled heat-coagulation process. The success of this work suggests that whey protein can be used to upgrade the nutritional value of other processed foods such as breakfast cereals and extruded snacks.

The Author

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