VEGETABLE PROTEIN FOODS—A REVIEW

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ABSTRACT

Vegetable protein foods have become economically important to food processors in the past decade and are gaining wide consumer acceptance. Being a “manufactured” food product, they can be tailored organoleptically and nutritionally to satisfy a wide variety of tastes and needs. Most of the vegetable protein foods use soybeans as a protein source, but other plant proteins are also being incorporated into these foods. By-products resulting from the production of animal protein are being developed into sources of protein concentrates which may be used as protein supplements.

The past decade has seen an increased interest in the development of vegetable-protein foods and foods with exogenous-protein added to improve organoleptic qualities. Several companies have invested large sums of money for research and for development of these food products.

The earliest foods of this type were developed primarily for religious or medical reasons. However, the world food shortage and predictions of its increased severity have stimulated a far greater interest in the development of vegetable-protein foods. Two statistics point out the reason for this increased interest. A typical acre of land produces annually about 43 lb. of protein when processed through an animal. The same acre of land will produce about 450 lb. of protein annually when used for plant production, such as soybeans. This typical acre of land produces 800,000 calories in the form of plants, but only 200,000 calories when the plants are fed to animals. Thus, the meat animal uses 75% of each acre’s crop for its own metabolism.

Increased protein and energy (calories) output per acre is only one advantage of vegetable-protein food production. Other advantages include increased consumer acceptability, desirable organoleptic qualities, and dietary reduction of cholesterol and fats.

These products can compete with similar meat food products on a cost-per-pound basis because there is no waste and often there is considerably less shrinkage during preparation. Production of the vegetable-protein foods can be rigidly controlled to give specific percentages of protein-fat-carbohydrates in the finished product.

Since they are unique (balanced amino acid content with controlled biological value of proteins), these foods are of interest to the food scientist, who should be concerned with the total diet of man as it relates to his health. The distinction between foods of plant and animal origin is rapidly being lost. Figuratively speaking, it is becoming difficult to tell the players without a program. The White House Conference on Food, Nutrition, and Health in December 1969 gave impetus to the concept of nutritional enrichment of foods.

Several companies are active in research and development of vegetable-protein foods. Worthington Foods, Inc., the pioneer in this field, was established in 1939. In March 1970, Worthington was merged with Miles Laboratories, Inc. and now operates as a subsidiary of Miles. Other companies are also active in the field including General Mills (Bontrae), Archer Daniels Midland (TVP), Central Soya (Promine D), Swift (Texgran), Griffith Laboratories, A. E. Staley, and Ralston-Purina.

FABRICATED PROTEIN PRODUCTS

The source of crude protein used in manufacture is primarily soybeans, although wheat, cottonseed, sesame seed, and sunflower proteins are also being studied and used to a limited degree. Soybeans may be extracted to produce soybean oil and oil-free flakes which are the basis of soy flour (50% protein), soy protein concentrate (70% protein), and isolated soy protein (95% protein). These protein sources are then used to manufacture textured soy protein and spun soy protein.

Textured protein is produced by flavoring, coloring, and extruding the soy protein to form small fibers or flakes. These particles can be made to resemble a wide variety of products. To produce spun soy protein, soy protein isolate is solubilized in an alkaline bath and then “spun” into filaments which are extruded into a coagulating bath. The filaments are formed, washed, rinsed, and formulated into various end products. The textured and spun soy protein products are bland, light-colored materials which have a great adaptability for use in producing food products.

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Thus, the fabricated protein products may be used in a variety of ways. Food processors use the spun protein to produce a wide variety of meatless food items including chops, chili, vegetarian dinners, luncheon slices, veja-links (sausage), and sandwich spread. The flakes may be used to formulate stews, meatballs, or patties or they may be combined with beef or pork to make such products. The protein flour, concentrate, and isolate are used to make the extruded products or they may be added to meat, poultry, seafood, dairy products, or bakery products to increase protein content, add form and structure, and enhance organoleptic qualities.

Eliminating Problems

To the food hygienist the textured protein foods present few problems. Microbiological data indicate that the cooking and extruding processes reduce plate counts from $10^2 \cdot 10^3$ to $10^1 \cdot 10^2$ per gram. Escherichia coli is not detected post extrusion. Food-borne pathogens such as Staphylococcus, Streptococcus, and Bacillus cereus are destroyed during processing. Salmonella has not been isolated from textured protein products (4).

Recent work by Busta et al. (2) has shown that Clostridium perfringens may present problems in these foods. They showed that addition of soy protein isolate (95% protein) to meat systems stimulated growth of C. perfringens. However, addition of forms with less protein (soy concentrate = 70%; soy flour = 50%) were not stimulatory. There was considerable variation between brands used, indicating that manufacturing practices may affect the potential for stimulation, because of enzyme inactivation, amino acid inactivation, or protein denaturation. Sodium caseinate showed marked inhibitory properties. The stimulatory effect in beef meat-products was low, but it was great in turkey meat-products.

Rancidity in some products with higher fat levels can be controlled with anti-oxidants. Keeping qualities and shelf-life of textured protein products are very good. They compare favorably with meat, poultry, and dairy products in nutritional value. One advantage of the textured protein foods is that the percentage of protein-fat-carbohydrate can be varied to meet specific dietary or nutritional needs which is difficult or impossible with many other food products. They have been shown to help in reducing serum cholesterol and lipid levels in man (6).

Pressani et al. (1) studied the protein quality of soy protein textured foods and found the Protein Efficiency Ratio (PER) to be 2.30 as compared to a PER of 2.50 for casein and 2.34 for dehydrated beef. The Net Protein Utilization of soy protein textured food was 59.1% compared to 62.6% for casein. Supplementation with lysine and methionine was found to raise the PER of soy protein textured food. These workers concluded that soy protein textured food has about 80% of the food value of milk.

Animal Proteins

Protein from animal sources of lower value is also receiving consideration. Fish protein concentrate (FPC) prepared from so-called trash fish, such as hake, has a promising future and could assist many developing countries in alleviating their nutritional protein deficit (8, 10).

Use of edible beef blood to produce isolated beef protein (IBP) has been reported by Pals (9). This concentrate contains 90% protein of high biological value and a favorable amino acid profile. Rate of recovery is approximately 1 lb. per animal. Meat protein concentrate (MPC) processed from meat by-products which are now used for tankage contains 85-90% protein with a PER of 1.75. This concentrate should be useful in supplementing cereal proteins to improve biological value (7).

Whey protein concentrate (WPC) derived from cheese whey is now available commercially as a 60% protein concentrate that is highly soluble, heat coagulable, and has a PER of 3.1 (11). The commercial applications of this product have not yet been fully explored.

These products have become a part of our food-production system. Whether pro or con, the food hygienist and food scientist must accept their presence and increased utilization. It is unlikely they will entirely replace meat, poultry, seafood, and dairy products in the American diet, but they will surely become a supplement to these products. They may represent the nutritional salvation of many human beings in the world.

References

VOLUNTARY FOOD PROTECTION PROGRAMS DO WORK*

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ABSTRACT

Many “consumer protectionists” are publicly stating that food protection programs will work only if conducted solely and exclusively by the Federal Government. The National Conference on Interstate Milk Shipments (NCIMS) has disproved this view with its industry — state regulatory — Federal agency cooperative voluntary milk control program. The NCIMS was born on June 1, 1950, in St. Louis, Missouri, and adopted as its theme, “The Best Possible Milk Supply for All Our People.” The nation’s milk drinkers — as consumers — have reapèd the benefits of its voluntary program and activities. The Interstate Milk Shipments Program has provided them with the safest dairy products in the world. It also has encouraged free competition in the market place, and, in some instances, helped prevent tax-draining multiple inspection programs through reciprocity endeavours.

“We are in an age of unparalleled, grass-roots consumerism,” recently stated the president of a large food processing operation at an educational symposium. “Consumerism, in its ethically good connotation, is the demand of the purchaser for foods that are safe, wholesome, palatable, nutritious, convenient, and at a price they can afford.”

The speaker went on to state that the food industry, state regulatory agencies, and the Food and Drug Administration (FDA) — United States Public Health Service (USPHS) should cooperatively establish a food protection program that would guarantee these basic buyers’ rights. “This protection program,” he commented, “should be a voluntary one.”

Ironically, a voluntary protection program for the purchasers of milk and some milk products has been carried out for the past 20 years.

Milk marketing, prior to 1939, had been primarily a local affair. Milk was collected and processed within a few miles of the consumer’s home. But World War II changed all that. The outbreak of hosttilities saw tremendous shifts in population. Army, Navy, and Air Corps training camps mushroomed throughout the nation. Milk was made a part of the armed forces’ rations. As a result, procurement officials of the military services and health officials roamed the country in search of milk complying with fundamental quality and health standards. In short, there wasn’t a sufficient amount of clean, safe milk to meet the increased demands of the military bases and other high population areas.

A NEED WAS MET

Consequently, the Association of State and Territorial Health Officers requested the Public Health Service to develop a plan for the certification of interstate milk shippers. If implemented, purchasers could rest assured that milk shipped to their locale from distant states would be safe for consumption, and of exceptional quality.

On June 1, 1950, twenty-six states sent representatives from the milk industry, state health and agriculture departments, and the USPHS to a conference in St. Louis. They had hopes of initiating a voluntary, milk regulatory program that could be applied uniformly throughout the United States. The National Conference on Interstate Milk Shipments (NCIMS) was born that day, and adopted as its theme, “The Best Possible Milk Supply for All Our People.” Twelve conferences have been held since. Representatives from 46 states attended the 1971 event in St. Louis, Missouri.

(Continued on Page 614)

*Presented at the 12th National Conference on Interstate Milk Shipments, St. Louis, Missouri, May 16-20, 1971.