Plant Proteins: Their Role in the Future[1]

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ABSTRACT

Schools in the U.S. used about 60 million lb of hydrated textured vegetable protein in 1973-74 compared with 40 million lb in 1972-73 and 28 million lb in 1971-72. Plant proteins are projected to replace ca. 2146 million lb meats and other proteins in the U.S. by 1980.

INTRODUCTION

The USDA and food processors are paving the innovative road, so that, in the U.S., a smooth transition may be made from a predominantly animal protein economy to a plant protein one. In 1970, 69% of U.S. food grade proteins came from animal products and 31% from plants. In another decade or so, we may be in a situation where the higher proportion of our proteins will have to be derived from plants. If true, we need to start work now on developing plant protein products that will meet our needs of acceptability, palatability, cultural profiles, eating habits, texture, shelf-life and storage, and nutrition. This is a tall order for oilseed chemists, but the demands of the future will require the best from all of us.

Among all the nonanimal proteins, soybeans appear to have the greatest immediate potential in terms of low cost, versatility, and function. Before we discuss soy proteins, however, let us look at some of the other nonanimal protein possibilities. Single cell organisms, bacteria, yeast, and other microorganisms may be grown on various media, such as petroleum-based products, bagasse, sewage sludge, industrial wastes, food processing wastes, corn cobs, or ever sawdust. Some proteins may come from sea source materials like plankton, algae, and assorted trash fish. Leaves and grasses have been examined as protein source materials for human food. All these protein products, derived from low cost source materials, may play some role in our food economy of the future, but each has cultural, technical, or economic limitations that prevent it from being accepted immediately into our food system. In spite of the limitations, a substantial increase in interest in these nonconventional foods is projected for the next decade.

PLANT PROTEIN FOODS IN USDA FEEDING PROGRAMS

The primary reason we, in the Department, are interested in plant proteins is the cost advantages. At current meat and soy prices, cost savings in the millions of dollars are possible to schools. In USDA programs, plant proteins are blended and used with other foods, and the combination food has a better balanced amino acid pattern than if the plant foods were the sole source of protein. A second advantage of the blending of plant proteins with animal proteins is palatability. A third advantage is that there is a nutritional safeguard in using a variety of foods. Lastly, animal proteins carry with them a status effect. To many people, they give a social sense of well being, and this is important. Many of the conclusions in this paper are derived from experiences and associations with plant proteins in our several USDA feeding programs.

Textured Vegetable Proteins

Textured vegetable proteins are now derived from soy, although, in the future, some will be made from cottonseed, peanuts, other oilseeds, or mixtures of several plant origin materials. They come as extruded or compacted (50% protein); concentrates (70% protein), isolate formulations (55-67% protein); or mixtures of the above items. They may be used at ratios of up to 30% of a meat mixture. In hydrated form, their minimum protein level is 18% protein. Their protein efficiency ratio (PER) is to be at least 1.8. Ca. 28 million lb (wet wt) were sold to schools in the 1971-72 school year. The volume was ca. 40 million lbs in the 1972-73 school year and ca. 60 million lb (wet wt) in the 1973-74 school year. Figuring the average cost, on a wet wt basis, of the soy protein at 16 cents/lb, and using 80 cents/lb for the cost of the meat, poultry, or fish it replaces, this replacement will have saved the school lunch program ca. $38 million during the 1973-74 school year.

During the past year, textured plant proteins have been sold in U.S. retail grocery stores across the country, and the meat mixtures with 25% hydrated plant protein have carved a niche for themselves in this market. Several points may be mentioned in this connection: (A) as the price of ground beef increased, sales of the meat-textured vegetable protein mixture increased, and vice versa; (B) in a nonexpert taste panel, participants liked the mixtures as well as the pure meat product that served as the control.

Enriched Macaroni with Fortified Protein

Enriched macaroni with fortified protein also is used as a partial meat alternate. An oz of the new macaroni and an oz of meat or cheese fulfills the 2 oz cooked lean meat-alternate requirement of the Type A school lunch. The protein is to be at the 20-25% level and have a PER of 2.38.

Analogues

These nonmeat proteins may be derived from soy; cereal grains, such as wheat gluten; or other products; or they may be mixtures of several plant proteins. They are in limited usage, in health foods and religious markets, but are soon to be approved for use in USDA programs. They are used in Seventh Day Adventist schools as a complete meat substitute.

Wheat-Soy Macaroni

This macaroni has been distributed to needy families in the USDA Family Feeding Program. It has specifications that require it to have a minimum of 15.2% protein. No PER level is specified.

Lysine-Fortified Wheat Flour

This flour is being sent to Indians in the Navajo nation. Amount of lysine added is 0.3%. No PER level is specified.

Formulated Pizzas

Formulated pizzas for children are in general usage in schools. Our Food and Nutrition Service Guidelines (1) specify that each serving contains a full 2 oz. meat, meat alternate, cheese, or some combination and meets the bread and butter-margarine requirements. Vegetable is optional. Textured vegetable protein often is used as one protein ingredient, along with the meat and cheese.

Soy-Fortified Cornmeal or Tortilla Flour

This type of cornmeal or flour is proposed to upgrade the protein quality (and quantity) for cornmeal in South and Southwest areas of the U.S. where corn is an important

[1]One of 13 papers presented in the symposium, "Soy Protein," at the AOCS Spring Meeting, Mexico City, April 1974.

item of the diet. There is also consideration of adding soy flour to regular all-purpose flour, to bulgur, and to farina. All these grain products currently are used in our Family Feeding Program that is soon to be phased out partially and replaced by food stamps.

Meat-Plant Protein Frankfurter

This frankfurter is being investigated for possible use in school lunches. Current plans are still uncertain, but a hot dog that contains a minimum of 49% lean meat, a maximum of 25% fat, a maximum of 5% seasonings, and 21% hydrated plant protein could lower our hot dog cost by ca. 15%. It would have ca. 13.5% protein and a PER of 2.5, as compared with the usual commercial frank that contains ca. 11.5% protein with a PER of ca. 2.5. In our school lunch program, we use ca. 50 million lb franks/month, so this frankfurter looms as a substantial market for plant proteins. I reemphasize that this hot dog is still in the concept stage and may be a year coming into fruition.

Alternate Cheese Products

An imitation cheese recently was introduced to the public via the School Lunch Program (2). Now, accepted as a cheese alternate in the Type A school lunch, it may be used as follows: (A) it could receive credit for up to one-half the meat-meat alternate requirement, i.e. no more than 1 oz credit/meal would be allowed; (B) it must be used with natural or processed cheese at a 50-50 ratio; and (C) it would be allowed to be used only in cooked products, such as pizza, macaroni and cheese, grilled cheese sandwiches, and like products. Animal proteins would be allowed as the protein source, and current products are using caseinate. The lipid source may be either animal or vegetable. The protein level is set at 23% minimum, and the PER is to be at least 2.5.

IMPROVEMENTS IN USDA PLANT PROTEIN PROGRAMS

Discussed below are some changes that would improve our methods of operation.

We need a simple test for estimating protein quality. The present 28 day rat test for PERs takes too long and is too expensive for many purposes. A sister agency in the Department is looking into the possibility of using amino acid values in a computer program to estimate PERs. Preliminary results, using a small number of samples, look favorable, but further testing needs to be done before the results are used to delineate products. I believe we should move to another measurement of protein quality, such as net protein utilizable, chemical score, or biological value.

We need a scale for judging protein quantity and quality simultaneously. Our Type A school lunch requires 2 oz (edible portion as served) of cooked lean meat, poultry, or fish; 4 tablespoons of peanut butter; or 1/2 cup cooked dry beans (or peas); or textured vegetable protein; or enriched macaroni with fortified protein; or some combination of the above. These protein foods are far from being equal to each other in their utilizable protein content.

In the decade ahead, we will need entirely new plant protein foods to supplement and add volumes to the ones we now are using. These could be proteins from corn, rapeseed, grass, and perhaps others. We need to learn how to mix the proteins from several source materials. This could involve mixing plant proteins together or plant proteins with nonplant proteins.

We need help in monitoring plant protein foods that have been accepted in our programs. One present problem is how to ascertain the amount of plant proteins in a meat-textured vegetable protein mixture.

We, in the U.S., need a standard of identity for plant proteins. Perhaps other countries have the problem of definition.

FOR THE FUTURE

Plant proteins will be used increasingly in USDA programs, the U.S. armed forces, the institutional market, the retail grocery store market, and the foreign market. By 1980 ca. 2146 million lb plant protein products will be used in the form of meat extenders, dairy product substitutes, and as a protein supplement in grain flour.

In countries other than the U.S., plant proteins will be equally important, but there will not be the great substitution process, since they are not so dependent upon animal products for their proteins.

The degree of acceptance of our newer plant proteins will depend on their: palatability, texture, image, nutrition, low cost, and ability to provide function.

Concerning nutrition, plant proteins have proven that they can provide adequate protein of acceptable quality. Palatability is, however, still a problem with some plant proteins. An associated problem, flatulence, is particularly true with legume proteins. Texture is a conundrum of the first magnitude, and much work should be directed toward solving it. The image of plant proteins is low and needs the cooperative work of our marketing friends. Better tasting products will help. Concerning cost, the cost level will remain low, relative to animal proteins, so that aspect presents no problem. Plant proteins have a distinct advantage in functionality.

In spite of the limitation, drawbacks, and problems involved in increasing the proportions of plant proteins we eat in our national diet, the change over to them in greater proportions is necessary and inevitable. The transition process can be orderly and smooth, and the work we do now will pay dividends in the decades ahead.

REFERENCES

1. Food and Nutrition Service, USDA, "Food and Nutrition Service Guidelines," USDA, Washington, D.C.
2. Anonymous, Fed. Reg. 39:31514 (August 29, 1974).

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