preparation and yield of the final baked foods. In bread, there is an increase in wet dough yield of 6-7%, and shortening is not needed. In many countries soy fortified wheat flour is replacing mixtures of wheat flour and non-fat milk solids in nutritional feeding programs at a substantial savings. In cookies, the nutritionally improved product likely can be made at a lower cost than the conventional cookie because of the savings resulting from a lower level of shortening usage.

The economics of introducing soy fortification of wheat flour for large population groups will vary from country to country. Generally, improved nutrition through soy flour fortification of wheat flour will result in increased production costs. It is felt that governments can best initiate massive nutrition programs by subsidizing the increased costs incurred for fortification of wheat flour with soy flour. From a protein standpoint, soy fortified wheat flour currently represents the greatest value/unit of cost for preparation of any food consumed by man.

Use of Soy Flour in Composite Flours

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INTRODUCTION

In the last decade, much research has been devoted to developing procedures for the production of high protein flours from soybean, peanut, fish, yeast, leaves, and algae. Many of these efforts have been successful in obtaining nutritionally valuable flours, but their utilization in the production of human food is only in its very beginning. Most advanced is the use of soy flour, but even there its utilization is limited.

One of the reasons why the utilization of high protein flours in the battle on malnutrition is still limited to incidental cases must be that insufficient ways have been found to work these flours into generally accepted foods. For this reason Food and Agriculture Organization developed a Composite Flours Program to stimulate the utilization of nonwheat flours in the production of bread, biscuits, and pasta products. Food items like these are excellent carriers for protein enrichment, because of their centralized production and the convenience of admixing protein concentrates in the production.

Another cause impeding the utilization of nonwheat flours in the production of bread and other baking products lies in the fact that the price of these flours is, in general, higher than that of wheat flour.

Another argument in favor of starting a Composite Flours Program was the anticipated stimulation in developing countries of the cultivation and processing of tropical crops required for the production of nonwheat flours. An additional advantage would be a decline in the need for imported raw materials which otherwise would be required.

In the Composite Flours Program, the use of soy flour is emphasized. This is quite understandable with regard to the worldwide cultivation of the soybean, its protein content, and nutritional protein quality.

Two approaches have been followed in the Composite Flours Program: nonwheat flours were either added to wheat flour as a base or used as such. In the latter case, the flours were mostly mixtures of a high protein component and a starchy component.

PROTEIN-ENRICHED WHEAT-BASED PRODUCTS

In those cases where the principal objective is protein enrichment, the addition of high protein flours to wheat flour is the solution close at hand. Admixture of a high protein component up to ca. 5% wheat flour used in breadmaking does not seriously affect taste or color of the bread crumb and exterior bread characteristics. Further increase in the percentage of the high protein flour, however, does impair bread quality. Higher requirements have to be imposed upon the nonwheat component regarding its color and taste. Besides, to maintain a good bread quality with higher percentages of the nonwheat flour, it generally will be necessary to modify the breadmaking procedure. Solutions to these problems have been developed in The Netherlands (Institute for Cereals, Flour, and Bread TNO, Wageningen), in England (Tropical Products Institute, London), and in the U.S. (Kansas State University, Department of Grain Science and Industry, Manhattan). A large variety of wheat-based breads with 30% nonwheat flours have been made and are satisfactory.

ENTIRELY NONWHEAT PRODUCTS

If, besides protein enrichment, the objective is to stimulate agriculture and processing of agricultural crops in developing countries, it may be necessary to consider the preparation of bakery products and pasta goods entirely from nonwheat flours. One should be aware, then, that the resultant products may have characteristics different from those of the wheat-based products for which they are intended to be a substitute.

Breads prepared from a composite flour made up of 80 parts cassava starch and 20 parts defatted soy flour have been developed by the Institute for Cereals, Flour, and Bread TNO. Also biscuits were developed on the basis of cassava-soy or cassava-soy-milk protein mixtures. These biscuits contain 12% and 20% protein.

TABLE I

Biological Evaluation of Protein Quality

Product	Flour composition	Proportions	Protein content, %	PER[a]
Bread	White wheat flour	100	10.9	0.82
Bread	Wheat-rice	70/30	9.9	0.98
Bread	Wheat-rice-soy	70/27/3	11.0	1.37
Bread	Wheat-rice-soy	70/25/5	11.8	1.51
Bread	Cassava-soy	80/20	11.3	2.40
Biscuits	Cassava-soy	67/33	12.0	1.90
Biscuits	Cassava-soy-milk protein	50/17/33	20.0	3.20
Biscuits	Cassava-soy-caseinate	50/30/20	20.0	2.23
Casein (reference protein)		100		2.50

[a]PER = protein efficiency ratio = g wt gain of experimental animals/g protein consumed.

Another example of the use of composite flours is the macaroni developed by the Institute for Food Technology, Campinas, Brazil. The composite flour used for the macaroni is made up of wheat, maize, and soy flour (proportions 30:40:30); its protein content is ca. 20%.

NUTRITIVE VALUE

From the standpoint of nutrition, composite flours containing soy flour compare favorably with white wheat flour in their protein characteristics.

From Table I which shows figures for the biological evaluation of some bread types and biscuits, it is evident that the nutritional protein quality is improved substantially by the addition of soy flour to the bread flour, even at levels as low as 3-5%. The protein efficiency ratio is increased from less than 1.0 to ca. 1.5.

Detection of Soy Proteins

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INTRODUCTION

Many studies have been made on this up-to-date and important subject. These studies can be classified into four broad groups.

Histological Methods

They are simple and often allow strong presumptions but cannot give formal proofs, because the natural structure of the soybean is destroyed and the aspect found at the microscopic analysis essentially depends upon the transformation treatment of soy proteins.

Serology

We do not know good methods at this time, but it is possible that a quick, simple solution will be found one day, because the chemical characteristic of soy proteins is made.

Immunoelectrophoresis

Lambion and Basseman have published a precise, sensible method, but this method is complicated and combines the difficulties inherent to obtaining serum and those difficulties linked to the electrophoresis, which is not a simple chemical method.

Electrophoresis

These methods were the first to give results. They have been used more and are, in my opinion, the ones which are the best at the present time. The bibliography presented below helps to review its history, which essentially contributed to improved performances, leading to sensibility limits which are below 0.5-1% in the most difficult cases, i.e. on textured products used in products containing various ingredients in sterilized tins.

THREE METHODS

Our own works have aimed to improve these methods, mainly the Penny-Hofmann method, according to a technique similar to the one followed by Spell, the works of whom I was not aware, because they were not yet published. I think that the most interesting is to compare the Penny-Hofmann method, ours, and Spell improvements.

Spell, like ourselves, has improved the performances in preparing the sample before electrophoresis, in both cases using the known effects of high concentration of urea.

However, our methods are different. Spell makes a fat extraction with ketone, then with ether by mixing and centrifugation. We prefer a total extraction with Soxhlet with the nonpolar solvent, petroleum-ether. Spell then makes a direct test with urea 6.6M in limiting the time delay to 1 hr at 35-40 C.

We prefer first, to use NaOH with pH 9, followed by a centrifugation which eliminates all soluble proteins. Then, the dried and rinsed residual is taken over with urea 8 during one night and mercaptoethanol is added, as in the Penny-Hofmann method, to break the linked S-S, a technique which has been eliminated oy Spell. Then comes the electrophoresis. As in the Spell method, we have worked on disc electrophoresis, which increases the residual quantity, i.e. the detection sensibility.

Gels are classical in most cases; ours is more concentrated than Spell's, which itself is more concentrated than Penny-Hofmann's. This is to obtain a better separation because the PM of isolated proteins is weak. Like the Penny-Hofmann method, and contrary to Spell, we have found it indispensible to maintain the dodecyl-sulfate which negatively saturates the charge of proteins. Since we cannot bring it into the gel that makes it turbid, we maintained it in a buffer electrode bath, leaving a time delay of 1/2 hr, so that it can penetrate and react in the sample gel.

We have kept the Penny-Hofmann electrode buffers and coloring systems; Spell modified them. He preferred the Tris buffer and the boric acid to tetraborate; I do not think that this is an important point. He makes the fixing, the coloring, and the decoloring in trichloracetic acid, instead of acetic acid-water-methanol. This last operation is delicate; and, since I do not have enough experience on Spell's solvent, I cannot say what is the best.

The Penny-Hofmann method allows a detection to 1% on uncooked or slightly cooked soy protein. We believe that much research effort is unnecessary if interest is for the sterilized products only. In fact, this test also allows the product to be sterilized before analysis, to eliminate the largest number of the bands. This makes the reading easier and avoids mistakes.

We have used this method many times on various products without mistakes, but we found that it is not very easy to make it quantitative because of the sugar proteins interaction during the heating treatment.

We have published two versions of our method, one, the easiest, was discussed at the European Meeting of Meat Research Workers in 1973. The other method was published in the *Annales des Falsifications et de l'Expertise Chimique;* it is more precise yet more complicated.

BIBLIOGRAPHY

Bessemans, J., and Lambion, R. 1972. Recherche des proteines etrangeres dans les produits de viande. Revue de Ferment. Ind. Alim. 27:61.

de Hogg, P.; Van Den Reek, S.; and Brouwer, F. 1970. Nachweis und Bestimmung von Aufgeschlossenem Milcheiweiss und Soja-protein in Fleischerzeugnissen. Die Fleischwirtschaft. 12:1663.

Fleischmann, O. 1964. Nachweis und Bestimmung von Milcheiweiss in Fleischerzeugnissen. Die Fleischwirtschaft. 4:985.

Frouin, A.; Barraud, C.; and Jondeau, D. Detection des Proteines de Soja ou de Lait dans les Produits de Viande Sterilises ou Non. Reunion Europeenne des Chercheurs en Viandes, Paris, September 1973.