nutritious protein in itself. Recent studies clearly demonstrate that it is of comparable protein quality to milk, meat and egg protein.

Enforcement

Several methods are used worldwide to control the use of soy protein to prevent fraud or abuse. The ability to determine the presence of soy protein in foods has been a concern of governments. At the same time, these governments strongly believe the technical problems associated with this concern should not delay or prevent the regulatory development for the use and recognition of soy protein in foods. Countries such as Canada, Denmark, United Kingdom, France, the U.S. and Spain, and world food bodies such as the Codex Alimentraius Commission under FAO/WHO, and the EEC Section of Food Legislation are all committed to solve this concern, and still have recognized through regulation or policy the unique benefits and advantages of soy protein.

In some countries, the need or desire to determine analytically the presence and level of soy protein in foods has been expressed. These countries feel that an exact analytical method is necessary in order to ensure that the product composition is as represented on the label. Considerable research effort has been devoted to the qualitative and quantitative analysis of soy protein in meat products. "Qualitative" refers to detection of the presence of soy protein; "quantitative" refers to detection of the presence and level.

Several methods are being considered today for analyzing food products for their soy protein content. These methods include microscopic examination, and immunological and electrophoresis tests.

While other methods are still in various degrees of development, the electrophoretic method looks very promising. It is workable and is being used or considered by several governments for the detection of soy protein in meat products.

The use of a tracer such as titanium dioxide as an analytical method should only be adopted if other analytical methods are found to be too complex. Although it is generally recognized as a safe food additive, it does not contribute to the biological or physical enhancement of the food. For this reason, there is a general trend against the use of tracers in many countries.

A requirement to determine the exact composition of foods containing soy protein is thought to be regulatory excess in countries that have recently considered the question such as Canada, Spain and France. Compositional and labeling regulations state the requirements the food manufacturer must follow. The requirements to keep and disclose formulation records for products assist the compliance effort.

Restrictions on Using Soya Proteins in Foods in Latin America and the World

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ABSTRACT

Potential applications of soybean protein in developing countries are generally very different from those in industrialized countries with the exception of foods demanded by state feeding programs. Hence, the way restrictions affect usage and consumption of soya proteins varies greatly in the two types of regions. This paper discusses those factors that can restrict the soybean protein usage related to acceptability, price and legislation. A general discussion of these factors is given, followed by a brief analysis of experiences in Latin America. This analysis illustrates the interactions existing among the three factors under consideration, and the important role that market development techniques and integrated food and nutrition policies may play in the promotion of highly nutritious and relatively low-cost foods that use soya proteins.

It seems appropriate to begin this presentation with a brief analysis of the potential applications of soybean proteins in industrialized (IC) and developing countries (DC). Table I lists some of the market possibilities in DC. The food service market (restaurants and others) is growing rapidly in the U.S., where 30% of the consumer's budget is spent for food service (1) and in France, 6 million meals were eaten outside the home in 1980 (2); in DC, however, this market has serious income restrictions. Institutional food services also find restrictions due to lack of a cold chain or appropriate handling equipment as elementary as meat-mincing machines in central cooking facilities.

The greatest market for soya proteins and products no doubt has been in the state feeding programs, school lunches and target-group-oriented food distribution programs. Under U.S. Title PL 480 for fiscal year 1974, 60,750 tons of soya flour were used (3), an amount equivalent to two-thirds of the milk included in the EEC food aid program the same year (4). Developing countries hope to replace partially or totally these tonnages with locally grown products. In several cases, the replacement is done with locally grown soybeans and locally produced products.

The ingredient market is strong and diversified in IC. Applications in DC are mainly limited to cereal enriching and fortifying, or to wheat or milk extenders, two commodities that are in great deficit in tropical areas.

FACTORS AFFECTING SOYBEAN PROTEIN USAGE

Acceptability

Acceptability of soybean proteins and products is directly related to the knowledge of food habits, characterization of traditional food dishes and functional characterization of the proteins as ingredients in complex food systems (5,6).

An incomplete knowledge of the first two factors for DC has been and may constitute in the future an important restriction to the use of soybean proteins and products. According to Hermansson, functionality depends on the knowledge of the physicochemical properties of a protein which, in turn, will give information on how protein will behave in a food system (6). These physicochemical characteristics are not always completely understood (5) but much help is coming from work combining the study of these properties with structural and microstructural investigations (5-7).

Table II, from Kinsella (5), shows the multiple functional properties performed by soya protein preparations in food systems. The picture is complex, because of the versatility of soy products. Similar complexity may be found in the technical characterization of national food dishes where soya has to play an important role in a model, which is not sufficiently known to the food technologist. Characterization of traditional foods has been done systematically within food technology research projects concerning maize foods and have proved to be fundamental

TABLE I

Markets for Soybean Products (1)

Market		Industrialized countries	Developing countries
Retail consumer	Textured soya	X	X
	Soy beef-blends	X	a
	Fab. products (e.g., frozen pizza)	X	a
	Complete analogs	X	
Food service			
Public	Restaurants, "fast food" snack bars	X	b
Institutional	Universities, hospitals, prisons, factories	X	a
State feeding			
Programs	School lunches	X	a
	Target group oriented food programs		X
Ingredient[c]	Baked	X	
	Canned	X	
	Wheat-extended or fortified cereals		X
	Protein fortifier		X
	Milk extender		X
	Gelating, emulsifying agent, others	X	

[a]Restricted by lack of appropriate equipment.

[b]Income restrictions.

[c]Intermediate market composed of food processors.

TABLE II

Functional Properties Performed by Soy Protein Preparations in Food Systems (5)

Functional property	Food system	Preparation used
Solubility	Beverages	F,C,I,H[a]
Water absorption and binding	Meats, sausages, breads, cakes	F,C
Viscosity	Soups, gravies, gruels, "coladas"	F,C,I
Gelation	Meats, curds, cheese	C,I
Cohesion-adhesion	Meats, sausages, baked goods, pasta products	F,C,I
Elasticity	Meats, bakery	I
Emulsification	Sausages, bologna, soup, cakes	F,C,I
Fat adsorption	Meats, sausages, donuts	F,C,I
Flavor-binding	Simulated meats, bakery	C,I,H
Foaming	Whipped toppings, chiffon desserts, angel cakes	I,W,H
Color control, staling control	Breads, "arepas," "tortillas"	F

[a]F,C,I,H,W: soy flour—concentrate, isolate, hydrolysate and whey, respectively.

for the successful introduction of precooked corn flour to the Colombian market (8). This technical characterization is essential for successful application of Martinez's concept of functionality, defined as "the set of properties that contributes to the desired color, flavor, texture or nutritive value of a product" (9). Extensive work should be done on model food systems for DC.

Among the constraints on the use of soya protein foods related to acceptability, flavor and flatulence are listed as the most important (10). Flavor problems of soybean products have been identified as two kinds: (a) off-flavors intrisic to soya and, (b) the absence of an attractive positive flavor (11).

Off-flavors in soya protein products for which responsible compounds and precursors have been identified are listed in Table III (11). Of the processes for removal or prevention listed, the majority are applied in DC, with the exception of alcohol or special solvent extractions to produce bland materials. Cost of these solvents is relatively high compared to textured soya flour or water-soluble protein concentrates.

The techniques for selecting and adding flavors to soya products are still being developed and are complex. The mastering of these techniques in DC may represent a restriction when applied to food systems with greater complexity than beverages, soups and gruels. Flavor companies have paid little attention to flavors encountered in DC traditional foods.

Flatulence has not been reported as an important objectionable characteristic among populations of DC which are accustomed to eating pulses. Hence, in tropical DC areas, it does not have to be considered as serious a restriction as it is in industrialized countries.

Price

Price as a restriction should be discussed in relation to the markets listed in Table I. For the retail consumer market, the consumption of textured soya will be favored only with positive changes in the relative prices of vegetable protein to meat (1). In the case of DC, Figure 1 illustrates the effect that TVP consumption could have on the family budget assigned to meat by different income groups in Colombia in 1971 (12). The lowest curve shows that only income group IV and V spent, in the year under study, the right amount in meat with respect to the recommended minimum allowance (minimum basic family budget). By using a 1:1 mixture of TVP and ground beef, income of group II could increase its adequacy from 46 to 72%. If the entire family budget assigned to meat were spent in purchasing TVP, income of group I could attain a level of adequacy of 87% from a starting level of 23%. However, this very favorable price ratio between meat and TVP (initially 3.5, at present 2.5) is not by itself promoting the massive consumption of this product, as will be shown later.

Only long-term trends in the price difference between vegetable and animal protein (1) will promote an increase in vegetable protein consumption in institutional markets, because they operate with fixed budgets under rising food costs. State feeding programs will always be regulated by the relative low-cost food concept. In the ingredient market, the substitution of wheat and milk by using soybean products as extenders may be restricted by locally subsidized wheat and milk prices.

Legislation

In discussing legislation, I would like to list some of the points made by the 12th session of the Codex Alimentarius Commission on Vegetable Proteins (13): (a) vegetable proteins intended for human consumption should meet definite nutritional standards; (b) vegetable proteins should offer economic incentives to both processors and consumers; (c) use of vegetable proteins to improve the diets of populations at nutritional risk is of particular economic and social interest when animal proteins are not accessible to such groups. Any legislation based on these parameters should greatly benefit both consumers and producers worldwide.

The subject of legislation and regulations of vegetable proteins for the U.S. and Europe was extensively covered at the World Conference on Vegetable Proteins held in Amsterdam in 1978. Many of the problems raised in the past by a vertical type of legislation applied to vegetable proteins are being corrected, according to Roberts (14), by the horizontal regulatory approach which accepts a given set of national food standards and allows the use of vegetable protein with labeling, nutritional and hygienic guidelines for the vegetable protein as an ingredient.

The labeling guidelines establish rules for adding vegetable proteins to already standardized food products without introducing any changes in their standards. This approach is being followed by U.S. government agencies and by the European communities, and may clear the way to harmonization of policies.

There are other factors that, when considered in food

TABLE III

Off-Flavor in Soy Protein Materials (11)

Off-flavor	Processes for prevention/removal
Bitter taste	Alcohol extraction
Sweet taste	Water extraction,
Green, grassy odors	Hexane extraction, heating intact beans
Cooked soybean odors	Low heat treatment, alcohol extraction
Burnt flavor	Low heat treatment, water extraction
Catty odors	Solvent removal
Fusel note	Solvent removal

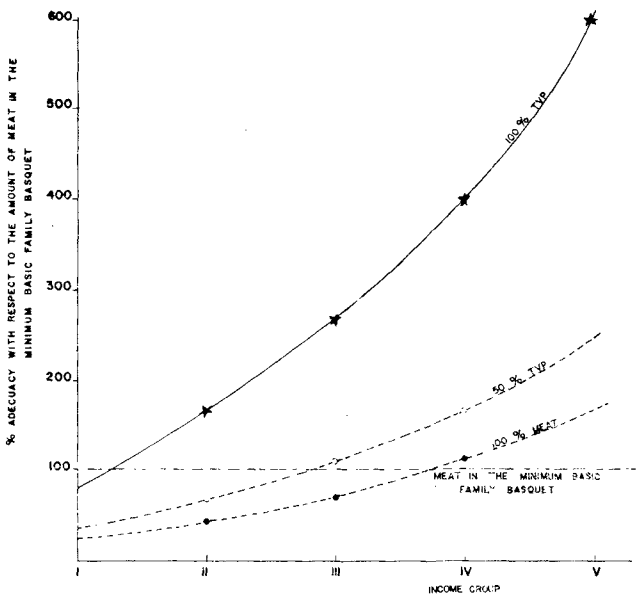

FIG. 1. TVP as a substitute of meat for different income levels (12).

legislation, could become restrictions: (a) protecting eating habits of the population to avoid quick changes in the consumption of basic foods; (b) economical consequences derived from the introduction of a meat- or milk-like product in the market to avoid rapid changes in agricultural and economical structures (15), especially considering agricultural subsidies existing in developed communities (16); (c) in countries where the hygienic conditions for the production and handling of basic foods like milk are still not well controlled, the introduction of a milk extender will bring additional problems for the quality control of the final products, causing the refusal of governments to accept the introduction of vegetable proteins as milk extenders in the open market, e.g., as in Brazil and Colombia (from Bogotá [1978]; and Guarneli [1980], personal communications).

As far as standards in developing countries are concerned, information is scarce and difficult to gather. There are known standards for soybeans, soybean meal and soybean oil in most Latin American countries. With regard to vegetable protein and products for human consumption in Brazil, there is legislation that limits to 7.5%, dry basis, the TVP content of sausages and salami and content must be declared on the label (Guarneli, personal communication).

In Mexico, 0.1% of titanium dioxide must be added to TVP and a 10% maximum level dry basis is allowed in sausages, salami and similar products. If the meat is substituted by more than 10% TVP, the product must be called "vegetable protein sausages, meat-style." TVP cannot be called "meat substitute" or "meat analog," but "soy product" (17).

India has specifications and standards for edible soya flour (expeller and solvent extracted), full-fat soya flour and soya protein isolate.

With regard to general legislation concerning the production, distribution and commercialization of foods, most Latin American countries have food supplementary programs addressed to the target population of nutritional programs. Some of the programs correspond to a national food and nutritional policy, as in Brazil, Chile, Colombia and Bolivia, and the rest are run through health departments or special agencies whose main role is to handle the logistics of donated or locally purchased foods within those programs. This type of legislation, instead of restricting the use of soya protein in foods, promotes their use in amounts as great as 6,700 tons of soybean flour distributed in four Andean countries during 1979, of which 50% was produced in the Subregion (Andean Pact, Lima, Perú).

Case Analyses

The following three cases have been selected for analysis because they represent different approaches in which soybean products enter as important ingredients of food products; two of the cases correspond to government food intervention/target-oriented food programs and the third case refers to an experience in the commercial market. In all cases, the private, industrial sector is involved and local raw materials are used with the exception of wheat in the last case.

Table IV shows the main characteristics of the three cases. Case discussion is oriented with respect to cost or price, acceptability and legislation. The population covered by cases I and III is quite large in Brazil and still small in Colombia. The tonnage involved is important in both of these cases and the number of food products is large in case III. The soybean products used come from the least sophisticated technologies available. The main difference between these two experiences is that, in case III, the product is sold in regular food shops and no production contracts are

TABLE IV

Production-Distribution of Cereal and Soya Protein Foods: Analysis of Three Cases

Case	Population attended/1980	Coverage	Tonnage handled/year	No. products	No. industries	Soybean products used	Concentration	Free distribution through government	Sold at food shops
I Brazil Jan. 1979[a]	400,000 mothers and children under 5 years	3 large cities (expanding)	6,000	3	5	Water-soluble extract	15%	X	
	3,500,000 school children	1 state	30,000			Soy TVP FFSF		X	
II Colombia 1976-77[a]	Open market	7 large cities and PAN's districts[b]		2	2	Soy TVP			X
III Colombia Jan. 1978[a]	43,200 mothers 134,650 preschool children	11 states 3 large cities (expanding)	12,000	8	15	Defatted soy flour TVP	10-33%		X[c]

[a]Starting date.
[b]See case III.
[c]Through PAN's coupon system, subsidy to consumer equipment to 40-60% of commercial price.

signed between government and industry.

Case II refers to the introduction of TVP to a conventional retail market and describes a set of constraints relating to cooking, to eating facilities and habits and to acceptability.

Case I—Brazil

This case deals with target-oriented food distribution programs addressed to mothers and preschool children and to school children and is fully operated by the Brazilian government. Foods are produced by five private industries under contract with the government. The programs are managed by the departments of Welfare and Education and the foods are delivered free of charge to the target population through health centers and schools. The volumes handled are rather large and expansions are expected to take place in the coming years. It is important to mention that these programs are just two of many that are run in Brazil.

The price ratio in Brazil between whole, powdered milk and soya water-soluble extract is 2.3 and 6 between beef and TVP. Products were designed within known food habits of the target population (soups, gruels, vegetable mixtures for baby feeding, milk-shake-like products). Reported acceptability is good, although it has been found advisable not to advertise that products are based on or fortified with soybeans in order to avoid rejection.

Food distribution programs are favored by national food and nutrition policies; existing regulations and standards are not obstacles to these programs with the exception of prohibiting the use of the soybean water-soluble extract to extend fresh milk.

This case is an example of a successful arrangement between local industry and government to service a segment of the population vulnerable to malnutrition, introducing vegetable proteins within existing food habits under a conventional type of food distribution program.

Case II—Colombia

TVP was first introduced into Colombia in 1975 by a local company with an installed capacity of 900 tons/year. Present-day installed capacity in two plants is close to 12,000 tons/year. The product was introduced into the retail market in dry form, in 165-g boxes, addressed to all income groups. The marketing strategy used for the introduction of the product made use of many of the modern techniques available today for launching new foods, as described by Cummings (18).

Almost 5 years after the initial introduction of the product, sales in the retail market are not larger than 5% of the installed capacity and half of them correspond to sales done under PAN's subsidized scheme described under case III. Most of the sales are addressed to the ingredient market.

The price ratio between meat and TVP (2.5 at present) should be sufficiently attractive to all income sectors, especially to those in groups I and II of Figure 1. No regulations hinder application of this product. Why has it not reached a large market? Information gathered concerning the marketing restrictions identified so far indicate:

Reduced number of applications for minced meat exists in traditional cooking habits of all segments of the population.

Reduced consumption of minced meat by low income sectors is due to lack of refrigeration equipment.

Mincing equipment is scarce.

Off-flavors are easily identified; use of spices enhances off-flavors.

Insufficient information is available about the product's versatility.

Housewives from low-income groups are too attached to traditional recipes, and direct training is needed to develop their confidence in the product.

This list shows how difficult it is to open a retail market for a product that, because of its nutritional/economic characteristics, could make an important contribution to the massive feeding of low-income groups in DC.

Case III—Colombia

This case refers to a program in which the production and distribution of cereal/soybean protein foods are the responsibility of the private sector. Distribution is through regular commercial channels. A subsidy is involved equivalent to 40-60% of the price of the product. Coupons specific for the program's approved food products are distributed to the target population by the health services. This program is just one of the several components of the National Food and Nutrition Plan of Colombia (PAN) (19).

For the study and approval of industrial foods to be included in the coupon program, the concepts of nutritional intrisic value and relative cost (20) are used. Table V shows these indexes for 10 of the industrial products that are being sold to the target population under PAN's subsidized food stamp scheme. The nutritional-economic advantage of using these products is evident when relative costs of fortified pastas or precooked corn flour are compared with nonfortified equivalent products: 84 to 116, 71 to 116.

All of these products have been designed to improve the nutritional value and the relative cost of traditional foods. The distribution of the demand for the different products available to the target population at the food shops could give an indication of their relative acceptability. During the first semester of 1980, spaghetti was most demanded, followed by a mixture of raw rice and TVP and by protein-enriched, precooked corn flours. Notable is the increase in demand shown by TVP when presented in a mixture with rice. This seems to be an interesting avenue for introducing TVP into a massive market.

The legal framework given by PAN promotes and regulates the industrial production and the distribution of these products by the private sector. By such means, the availability of foods to the target population is increased simultaneously with requirements for health, nutritional education and sanitation which aim at attaining an optimal use of the food consumed.

An interesting phenomenon registered during the past 12 months is that, in some communities, 70% of the cereal soybean foods are sold outside the coupon system. This phenomenon could be indicating that a demand for the fortified products may be created independently of the subsidized system (21).

Case III shows, again, the successful role played by soybeans in improving the availability of foods to a target population, with minor intervention by the state and important input from the private sector.

General Observations

It is anticipated that restrictions on the use of vegetable proteins are going to be smaller in number and less pronounced in the future, both in IC and DC, mainly because of the new approaches being used for legislation and to a greater general demand for target-oriented food programs.

TABLE V

Intrinsic Nutritional Value and Relative Cost of Cereal Soybean Foods in Colombia

Brand of product	Intrinsic value[a]	Relative cost[b]	Distribution of demand (%)[c]
Vegetable mixtures			15.1
A	87	51	
B	118	62	
C	76	67	
Spaghetti			30.4
A	61	84	
B	64	90	
C	61	88	
Regular	32	116	
Cookies	80	80	7.2
Regular	33	247	
Precooked corn flours			16.6
A	54	71	
Regular	31	116	
Rice plus TVP	57	63	23.0
TVP			8.4
A	193	82	
B	193	79	

[a]Intrinsic nutritional value = net calories × A + total protein × chemical score × B, where A = st. price of 1 Cal (sugar for Colombia); B = st. price of 1 g of protein (milk for Colombia).

[b]Relative cost = commercial price/K ÷ intrinsic value × 100 (20).

[c]First semester 1980.

A better method for assessing functionality and for the technical characterization of traditional foods is essential for attaining better acceptability in all types of markets.

Relatively sophisticated technologies are difficult to introduce into the retail market of any type of country if the food habits and cooking methods are not sufficiently known. Work performed by multidisciplinary groups composed of social scientists, marketing experts and food scientists will make it possible to anticipate and identify restrictions to the introduction of novel technologies and products.

An adequate agreement among researchers, industry and government should be aimed at, in order to minimize restrictions related to cost and legislation, once the restrictions concerning acceptability are corrected. The three cases presented in this paper may serve as guidance.

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