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Topic 29: REPORT ON THE DEVELOPMENT AND UTILIZATION OF INCAPARINA

The activities carried out by the Institute of Nutrition of Central America and Panama (INCAP) directed toward the development of a vegetable mixture known by the generic name INCAPARINA, low in cost and high in nutritive value, for the purpose of preventing protein malnutrition among people of scanty means, have aroused such interest that the Director of the Pan American Sanitary Bureau has deemed it advisable to submit a report thereon to the XII Meeting of the Directing Council of the Pan American Health Organization.

The Director hopes that this report will stimulate the production and consumption of INCAPARINA in regions where the product can be adapted satisfactorily to local conditions and also that it will promote the development of similar mixtures in areas where the raw materials available and the people's dietary habits are different.

In presenting this report to the Directing Council of the PAHO, the Director wishes to point out that the Member Governments of INCAP merit special recognition, since the INCAP activities that have led to such promising results could not have been realized without their full support. The Director also hopes that the satisfactory results set forth in this document will be of the utmost value to all the governments and institutions so interested in solving the serious public health problem constituted by malnutrition.

A. BASIC RESEARCH STUDIES

In 1957, several scientific publications carried information on INCAP's preliminary activities in developing the first of such mixtures. This was known as INCAP Vegetable Mixture 8 (1-4), and its formula is: ground maize, 50 per cent; sesame flour, 35 per cent; cottonseed flour, 9 per cent; Torula yeast, 3 per cent; and dehydrated leaf (kikuyu) meal, 3 per cent. This mixture contains 25.1 per cent protein, 13.7 per cent fats, and 503 calories per 100 grams; and in comparing its amino acid pattern with that of the FAO Reference Protein, the indications are that the limiting amino acids of the product, in decreasing order, are lysine, tryptophan, and methionine, with a protein score of 83, 86, and 91, respectively.

Lime-treated maize, the cereal base for the mixture, is its source of calcium. The sesame flour, as supplied, was milled from the de-hulled seeds and contained 33 per cent fat. The cottonseed flour was a high-protein, low-gossypol product supplied under the name "Pro-flo." The Torula yeast provides B-complex vitamins, and the carotene-rich leaf meal is added as a source of vitamin A.

The initial studies with experimental animals that served as the basis for the development of this product were recently reported (2,5). Extensive trials with rats and chicks showed that the mixture sustained good growth but was improved by the addition of lysine. It proved to be well tolerated by children and, apparently, to give a nitrogen retention equivalent to milk in a series of five-day balance trials carried out in 5 children fed at levels of 2.4 to 3.8 gm protein per kg of body weight. After children recovering from kwashiorkor had done well on the mixture as the sole source of protein for a period exceeding two months, it was used for the treatment of 7 children with acute kwashiorkor. The results were similar to those customarily obtained with milk, except for a slightly slower regeneration of serum albumin.

In considering plans for possible large-scale, low-cost production of the mixture, it was discovered that the supply of sesame seed in Central America had decreased and the price had risen. This, coupled with difficulties in harvesting and in separating the husk, made it desirable to search further for an equally nutritious formula that would eliminate the need for sesame. Favorable results had attended all the experience with the cottonseed flour in Mixture 8 and in a long series of biological trials in rats and chicks previously carried out in the Instituto Agropecuario Nacional (IAN) of Guatemala and in the INCAP laboratories. Accordingly, in 1957 a new formula was developed based on cottonseed flour as the main protein source and with sorghum optionally substituted for part of the maize to reduce the cost. Preliminary calculations suggested that the optimum combination of cottonseed flour and this cereal would provide a mixture slightly higher in protein content and slightly lower in protein score if the Torula yeast and leaf meal were held at the same concentration.

The formula for INCAP Vegetable Mixture 9 went through a number of variations (see Table 1). The original formula used lime-treated maize and sorghum grain along with Torula yeast and dehydrated leaf meal. Mixture 9' was prepared with whole ground maize and sorghum to facilitate animal feeding experiments. Mixture 9A used maize and sorghum cooked without the addition of lime, substituted synthetic vitamin A acetate for dehydrated leaf meal, and had 1 per cent calcium carbonate added as a source of calcium.

The formula at present employed is Mixture 9B, which uses uncooked maize and sorghum. It consits of 29 per cent ground maize, 29 per cent ground sorghum, 38 per cent cottonseed flour, 3 per cent Torula yeast, 1 per cent calcium carbonate, and 4,500 I.U. of vitamin A per 100 gm. Type CF-2 Torula, or its equivalent, is specified for its preparation. All ingredients must pass an 80-mesh screen. For all practical purposes, the protein quality of the variations in Table 1, is identical. Mixture 9B avoids the expense of cooking the maize and sorghum, eliminates the unstable and relatively costly leaf meal, and still supplies suitable amounts of calcium and vitamin A. In fact, it represents the lowest cost possible with the available raw materials.

The proximate composition and the vitamin and mineral content of INCAP Vegetable Mixture 9B are given in Table 2, and the amino acid composition in Table 3. By comparison with the FAO Reference Protein, it has a tryptophan score of 61 and a methionine-cystine score of 77, and lysine should not be limiting. These figures are markedly lower than those indicated by the results of subsequent biological and clinical trials.

Up to the present time, ten biological trials have been completed in rats, using some 600 animals; twenty others have involved some 1,000 baby chicks; and 96 nitrogen balance periods in 9 children have been studied, the results of which are summarized in Table 4. These data show that, at an average protein intake of 2.3 gm per kg, there is no significant difference in nitrogen retention whether the protein is furnished by cow's milk or by Mixture 9, even though the percentage of nitrogen absorbed is consistently less with the latter.

B. Acceptability Trials

In order to determine the acceptability of Mixture 9B, 76 needy families in 4 Guatemalan communities were selected by local health centers, and sufficient amounts of the product were provided for each preschool child to drink three glasses. The trials varied in duration from 17 to 19 weeks. Acceptance was extremely good to begin with and tended to improve further during the trial period. Ninety-nine children out of a total of 129 consumed an average of two or more glasses daily throughout the entire period; during the final two weeks 110 children consumed two or more glasses daily. The great majority of these children said they liked the drink very much and most of the parents indicated a desire to buy it if it were available at low cost.

Another similar trial was carried out among 53 preschool children in a district in San Salvador, El Salvador. In this case, at the end of the first week, 81 per cent, and at the end of the fourth week 88 per cent of the children said they liked it. All of these drank with evident enjoyment the Mixture 9B gruel offered to them.

C. Large-Scale Production and Distribution Trials

The promising results described above led the Government of Guatemala to authorize a pilot project, starting in March 1960, for the production and distribution of INCAPARINA (Mixture 9B), using cotton-seed flour from El Salvador. The object of this trial was to obtain basic data for determining what production capacity and installations were necessary. The product was distributed to stores in 43 towns widely scattered throughout most of the country's territory; communities were chosen that had active health centers or units, which could recommend INCAPARINA to the most needy families. The initial production, 8,000 bags per day, proved insufficient even before distribution to these towns had been completed. Although production was raised to 12,000 bags a day (60,000 per week), the demand was so great that distribution outside the capital city became less and less adequate. This situation cannot be corrected until the projected completion of a modern plant capable of producing at least three tons a day to satisfy the country's expected needs. The acceptability of the product is even more satisfactory since it is based only on word of mouth. In the meantime, authorization has been given by the respective Ministries of Health for large-scale production in El Salvador and Nicaragua, and it is expected that this goal will be reached during the course of this year. Furthermore, requests for information on INCAPARINA have been received from almost all the countries of the Americas, which are showing considerable interest in the possibility of producing the mixture.

Annex I shows the data relating to the costs of production and distribution, based on the experience obtained in Guatemala.

D. Method of Preparation

The commonest form of preparation in Central America is a thin gruel (atole) made by adding one glass of water to each 25 gm of mixture and cooking for 15 minutes. It may be flavored to taste with sugar, cinnamon, vanilla, anise, chocolate, and soon, and served either hot or cold. The mixture can also be substituted for two thirds of the flour in most non-bread recipes calling for wheat flour and can be used for puddings or for enriching soups. To facilitate its use, a specially prepared pamphlet of recipes has been widely distributed. The product is highly acceptable for mass feeding and is a means of stretching limited institutional food budgets without lowering the nutritional value of the diet.

E. Availability of Raw Materials and Potential Use of INCAPARINA in Other Areas

All the ingredients of Mixture 9B, with the possible exception of the yeast and the vitamin A, are readily available throughout Central America and in other parts of the world as well. Both the corn and the sorghum may be purchased in the regular market. The cottonseed flour has not yet been produced in Central America in adequate volume or quality for human consumption. However, during a survey conducted by Dr. Aaron M. Altschul, Chief Chemist of the Agricultural Research Laboratory, Sothern Utilization Research and Development Division, U.S. Department of Agriculture, several cottonseed mills were found to be capable of producing a cottonseed cake suitable for human consumption with little modification of their present procedure. The specifications for cottonseed for this purpose are the following:

1. The flour should not contain more than 8 per cent or less than 4 per cent of fat.

2. The flour should contain no more than 1.5 per cent crude fiber.

3. The flour should not have more than 5.5 per cent moisture.

4. Under the described circumstances the protein (Nitrogen X 6.25) content of the flour should not be less than 50 per cent.

5. The total gossypol content is not to exceed 1.00 per cent.

6. Free gossypol in the flour must not exceed 0.07 per cent.

7. The flour should have a solubility of nitrogen, in 0.02 N alkaline, not less than 65 per cent.

8. The content of epsilon amino lysine should not be less than 3.6 per cent of the total protein on a 16 per cent nitrogen basis.

9. 100 per cent of the flour must pass a screen of 80 mesh.

The Torula yeast represents only 3 per cent of the formula, and its importation during the early stages of production will create no problem. A type has been specified that contains 50 per cent protein, 0.6 mg thiamin, 0.2 mg riboflavin, and 1.0 mg niacin, per gram.

As production increases, justifying local manufacture of the yeast, molasses could be used. Or ordinary brewer's yeast can be debittered for the purpose.

Since the amount of vitamin A required is so small, and ample supplies can be imported from the United States or Europe at reasonable cost, the establishment of local production facilities is not warranted.

In assessing the total social and economic importance of INCAPARINA, it should be pointed out that rice and possibly other cereals can be substituted for the corn and sorghum in the formula. Thus, it can be produced at low cost in many parts of the world where corn may not be readily available. Continued research will undoubtedly reveal other types of substitutions, extending even further the product's potential for combating the effects of malnutrition in the underdeveloped areas of the world.

F. Use of INCAPARINA in Central America and Panama

In order to secure the widest possible benefits and make available the fruits of its research that lead to the development of the product, the Council of INCAP at its 10th Meeting in September 1959 adopted a resolution whose operative part reads as follows:

1. To recommend the promotion of the production of INCAP Vegetable Mixture 9.

2. To establish, in relation to the distribution of INCAPARINA, the following basic principles:

   A. The product must meet at all times the basic components of the formula as established by INCAP's patents or requested patents.

   B. The product, during the various stages of production and distribution, will be subject to the health regulations enforced in each country.

   C. The information related to the formula of the product and its method of preparation, and any other information or technical recommendations that may appear on the wrapping or be meant to serve as advertising or propaganda of the product, must be approved previously by the Public Health Departments.

D. The type and size of the package must first be approved by the Public Health Departments.

E. The product will be distributed under the generic name INCAPARINA, and the name or the identification of the producer may be added.

F. The Public Health Departments, besides carrying out or demanding the necessary analyses for the control of manufactured products, will allow the Institute to carry out qualitative analyses of the product or any of its ingredients.

3. To request the Institute to assist the Public Health Departments in the study of requests regarding the production and distribution of INCAPARINA, or of similar products.

4. To recommend to the Public Health Departments that in granting permission for the distribution of INCAPARINA, they set aside funds coming from its sales to cover the costs of analyses by INCAP, its improvement, and new research and development in relation to other similar products.

5. To recommend to the different Governments that they study the desirability of negotiating the importation of enough INCAP Vegetable Mixture 9 manufactured elsewhere in order to evaluate the acceptability, cost, and so on, of the product, so as to have pertinent information for the manufacture of the mixture by private companies on a local basis.

SUMMARY

INCAP Vegetable Mixture 9B contains 29 per cent whole ground maize, 29 per cent whole ground sorghum grain, 38 per cent cottonseed flour, 3 per cent Torula yeast, 1 per cent calcium carbonate, and 4,500 units of added vitamin A per 100 grams. It has a protein content of 27.5 per cent, and is similar in protein quality to milk. It can be produced at very low cost, and in the form of a thin cereal gruel (atole) has proved to be highly acceptable in Central America. This formula and other similar ones will be known by the generic name INCAPARINA.

The favorable acceptance that has been accorded to the product prepared according to this formula suggests that INCAPARINA will make a significant contribution toward solving the problem of preventing protein malnutrition in this area.

The Council of INCAP has established basic principles that will enable the public health authorities of any country to authorize the production and distribution of INCAPARINA within the areas under their jurisdiction. Whether or not the product proves useful outside the INCAP area, experience so far warrants the conclusion that it is feasible to produce a low-cost, highly nutritive, and extremely acceptable vegetable mixture that may be of the utmost help in national efforts against protein malnutrition.

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Table 1

FORMULAS FOR INCAP VEGETABLE MIXTURE 9

Ingredients g/100 g.	9	9'	9A	9B
Ground Whole Corn				
Lime treated	28	-	-	-
Uncooked	-	28	-	29
Cooked	-	-	29	-
Sorghum				
Uncooked	28	28	-	29
Cooked	-	-	29	-
Cottonseed Flour	38	38	38	38
Torula Yeast	3	3	3	3
Dehydrated Leaf Meal	3	3	-	-
$CaCO_3$	-	-	1	1
Vitamin A I.U.	-	-	4500	4500

Table 2

COMPOSITION OF INCAP VEGETABLE MIXTURE 9B

Nutrient	Per 100 g	Nutrient	Per 100 g
Moisture	7.6 g	Thiamine	2.1 mg
Protein	27.5 g	Riboflavin	1.1 mg
Ether Extract	4.2 g	Nicotinic Acid	7.8 mg
Ash	3.5 g	Vitamin A Acetate	4500 I.U.
Crude Fiber	2.4 g	Calcium	0.5 g
Carbohydrate	54.8 g	Phosphorus	0.8 g
Calories	370	Iron	6.2 mg

Table 3

ESSENTIAL AMINO ACID COMPOSITION OF INCAP VEGETABLE MIXTURE No. 9B

Amino Acid	g/100 g	% FAO Pattern	Amino Acid	g/100 g	% FAO Pattern
Arginine	2.34	--	Phenilalanine	1.52	192
Histidine	1.00	--	Total Sulphur A. A.	0.92	77
Isoleucine	1.12	94	Threonine	0.87	110
Leucine	2.08	154	Tryptophan	0.24	61
Lysine	1.58	129	Valine	1.14	96

Table 4

COMPARISON OF NITROGEN BALANCE IN PRESCHOOL CHILDREN

	Milk	INCAP VM-9
No. of Children	9	9
Balance Periods	48	48
Average Protein Intake g/kg/day	2.3	2.3
Average % Absorbed	82.6	68.9
Average % Retained *	16.3	17.8

* Difference in retention is not significant

Annex I

Cost of Production and Distribution of INCAPARINA in Central America. Prepared on the Basis of Formula 9B. *

1. Estimated Manufacturing Cost

Based on the estimated potential market for the product in Guatemala, it was determined that during each of the first years production would probably approximate at least 1,500,000 pounds. The processing-plant requirements were therefore estimated for this volume, using data resulting from the pilot production experience plus additional information obtained directly from manufacturers of the milling, mixing, and packaging machinery required. All cost figures are for a plant located in Guatemala.

Financing of Operation

Investment Required

Fixed Capital (Plant and Equipment)	$ 29,650
Working Capital	10,000
Total Investment	$ 39,650

2. Operating and Material Costs for the First Year Operation

a.	Plant Operation (Administration, Direct Plant Labor, Power, Maintenance, etc.)	$ 18,420
b.	Depreciation of Plant and Equipment	2,150
c.	Raw Materials (4.176 cents per pound)	63,000
d.	Other Materials	1,500
e.	Return on Investment (15% per year)	6,150
f.	Taxes and Other Costs	2,000
	Total	93,220

*Report rendered by Mr. Richard Shaw, member of the Klein and Saks Economic and Financial Mission, Guatemala

3. Estimated Unit Cost at Maximum Production

	Cents per Pound	Cents per Bag
$93,220 ÷ 1,500,000 Lbs.	6.21	1.03

This figure of 6.21 cents per pound can undoubtedly be reduced through greater volume production as the market for the product grows and through experience and improvements in manufacturing methods. Therefore, it may safely be assumed that the cost per pound to produce INCAPARINA for the retail market in Guatemala should range from 6 to not over 7 cents, at least during the early stages. For the purpose of establishing a suitable retail price for the marketing trials, a manufacturing cost of seven cents was assumed, with the thought that it would be better to reduce the price later than have to raise it if actual cost proves slightly higher.

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ADDENDUM

Topic 29: REPORT ON THE DEVELOPMENT AND UTILIZATION OF INCAPARINA

The preparation of the basic document on this topic was completed on 21 July 1960. The Council of the Institute of Nutrition of Central America and Panama held its XI Meeting from 8 to 10 August in Panama City, Panama. In the course of this meeting, a detailed study was made of the progress achieved up to date in the production of INCAPARINA and of the need for establishing standards relating to the use of the name INCAPARINA that will protect the consuming public. On this subject, the Council adopted the following resolution:

RESOLUTION VIII

"The Council,

Having studied carefully Document CIncap 11/7 on Vegetable Mixture 9;

Taking into account Resolution III adopted by the Council at its X Meeting; and

Taking into account the recommendation formulated by the Technical Advisory Committee at its XI Meeting that, in order to protect the consumer by guaranteeing the quality of INCAPARINA, INCAP establish a control system for the packaging, identification, advertising, and analysis of the quality of this product,

RESOLVES:

1. To request the Director and the technical personnel of INCAP to advise the Governments on all aspects of the industrial production and control of products developed by INCAP.

2. To establish that commercial firms wishing to use the name INCAPARINA, or to refer to INCAP in the identification of vegetable mixtures developed by the Institute, must satisfy the following requirements:

(a) To make the necessary request to the Departments of Public Health or other appropriate government agencies.

(b) To obtain the authorization of INCAP in accordance with the general requirements that are established by the Institute.

(c) To submit samples of the product to INCAP for analysis and approval, prior to its general distribution.

(d) To maintain the specified quality, which shall be determined by means of analyses performed by INCAP of samples of the quantity production. These analyses shall be carried out at the intervals and in the manner prescribed in the respective authorization.

(e) To present for the approval of INCAP all types of packaging intended for the distribution of the product, and all descriptive matter pertaining to it, including advertisements, pamphlets, and other publicity material.

(f) To pay the costs of analysis and other services, in accordance with an appropriate schedule of fees.

(g) To comply with all regulations that are now in force or that may be established by the Governments for the purpose of guaranteeing adequate production and quality control of INCAPARINA.

3. To authorize the Director of INCAP, with the approval of the respective public health authorities, to arrange with other institutes of nutrition or technical organizations to carry out all or part of the analyses necessary for control.

4. To request the Director of INCAP to present to the Council annually a report on the application of these provisions, so that it may revise them in accordance with future experience."