The Story of Incaparina

UTILIZATION OF AVAILABLE SOURCES OF VEGETABLE PROTEIN FOR HUMAN FEEDING*

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In 1946, the six countries of Central America and Panama decided to create, in a cooperative effort, an Institute responsible for the study of the nutritional problems of the area and for finding the means to their solution.

In 1949, after the initial preparatory work, the Institute of Nutrition of Central America and Panama (INCAP) started its operation. It had a difficult task ahead. Nutritional deficiencies were found to be one of the most serious public health problems of the area, and, among them, protein deficiency was the most widespread.[1,2]

The effects of protein deficiency are far more serious than indicated by the relatively few children seen in hospitals with the advanced manifestations of protein-calorie malnutrition, namely kwashiorkor and marasmus. It has been demonstrated that this nutritional deficiency is an important factor contributing to the very high rates of morbidity and mortality in children, particularly during the weaning and postweaning period.[3] Furthermore, its effects on those who manage to survive are also extremely significant. There is evidence that both the nutritional deficiencies and the high prevalence of infectious diseases, acting synergystically, are seriously interfering with adequate growth and development of the large majority of children in the area.[4] This problem is characteristic of tropical and subtropical regions throughout the world.[5]

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THE NEED FOR A PROTEIN SUPPLEMENT

The epidemiology of protein deficiency is extremely complex. An important factor is the scarcity of adequate sources of dietary protein suitable for the feeding of young children and accessible to the population. In Central America, the availability of milk and other foods of animal origin is limited and it is considered that a significant increase in their production would take a long period of time. Furthermore, these products are high-priced in relation to the purchasing power of the population. The lack of facilities for transportation and for the preservation of these products limits their use even further.

Cultural factors also interfere with the use of animal products for human and particularly for infant feeding. In the case of milk, for instance, the very sad experience of severe diarrhea observed when small children are fed impure, poorly preserved milk, is interpreted as an effect of the milk itself, and not of infection, for a concept of infection is still nonexistent with these populations. The fact was that the lack of adequate sources of protein for infant feeding adaptable to this situation was a serious handicap to educational efforts. Very little, if anything, could be done by instructing the large majority of mothers on how to feed their children properly under those conditions.

The distribution of powdered milk or other products could only be considered as an emergency treatment and of limited coverage. For a sound program for the prevention of protein malnutrition it was considered imperative to make available to these populations nutritionally adequate foods which they would be able and willing to use.

Faced with the problem, the idea of using available sources of vegetable proteins for human consumption developed. Previous work in other areas;[6] the advances made in fields relating to protein and amino acid requirements, particularly, in the concept of the basic role of amino acid composition in determining the biological value of a protein;[7] the advances in food technology; and, specifically, the studies for the local formulation of animal feeds using available oil seed meals as protein sources were the bases for the work. The purpose was to develop a food that was adaptable to the eating habits of the population, within their economic capacity, convenient for transportation, preservation, and preparation under the local conditions, and nutritionally adequate to supplement the regular diets with the needed protein, and, if possible, with the other essential nutrients in which these were also usually deficient.

Different flours cooked with water as a gruel are very commonly used in the area for the feeding of small children, particularly as a substitute for milk during and after weaning. This practice is one of the main dietary factors responsible for protein malnutrition, because the flours commonly used are either corn or rice flour or, even worse, very frequently corn or yuca (cassava) starch. This indicated, however, the desirability of developing the protein supplement as a flour, as similar as possible to those already widely used, which would be recommended for use in a similar way.

Taking into consideration the amino acid composition of the different possible sources of protein available for this purpose, as well as their cost, the formulation of different mixtures began. The fundamental idea was to use a cereal flour as the basis, supplemented with a protein concentrate for improving both the concentration and biological value of the protein. From the beginning, it was also considered desirable to add to the mixture, if this proved to be practical, adequate sources of vitamins and minerals. Vitamin A and riboflavin were of particular interest because they are usually deficient in the local diets and the mixture under study was designed to be used when milk, a natural source of these vitamins, was not available. For this last reason, it was also considered necessary to assure an adequate calcium content of the mixture.

In 1956 a mixture was obtained which passed all the laboratory studies as well as the very strict assays of its nutritive value in experimental animals; it was known in the laboratories as "vegetable mixture no. 8." Its formula was:

Corn "masa" flour	50%
Sesame flour	35%
Cottonseed flour	9%
Torula yeast	3%
Dehydrated kikuyu flour	3%

The corn "masa" flour is obtained from corn which has previously been cooked with lime, as is customary in the area for the preparation of tortillas. This preparation of corn was chosen because previous studies[8] indicated that it had some nutritive advantages over corn not subjected to this treatment. This preparation also provided a suitable amount of calcium. The sesame flour and cottonseed flour provided the protein, which, when combined with that of the corn in the proportions contained in the mixture, resulted in a protein of an adequate biological value in a desirable concentration. The torula yeast was added as a source of B complex vitamins, particularly of riboflavin, and also contributed to improve the biological value of the protein of the mixture. The kikuyu is a common grass which had previously been studied and was known to be an excellent source of carotene.[9]

Mixture no. 8 was the first to be subjected to clinical evaluation in children. For this purpose normal preschool age children, kept under close hospital supervision, were first given the mixture cooked with water and sugar as a gruel once or twice a day to check its acceptability and tolerance by the children. When enough satisfactory experience had been obtained, the mixture was again given to normal children, but this time as the only source of protein; various children were kept on this diet for as long as 3 to 4 months. They continued to gain weight normally, were happy and active, and showed no clinical or biochemical abnormalities. Nitrogen balance studies were carried out in children fed the mixture as the only source of protein. Milk was used as a control, the diets in both cases providing 2 to 3 Gm. of protein per Kg. of body weight per day, as well as adequate amounts of calories and of all other essential nutrients. The results showed no significant differences in the nitrogen retained when either the mixture or milk were used.

Encouraged by these results and for the

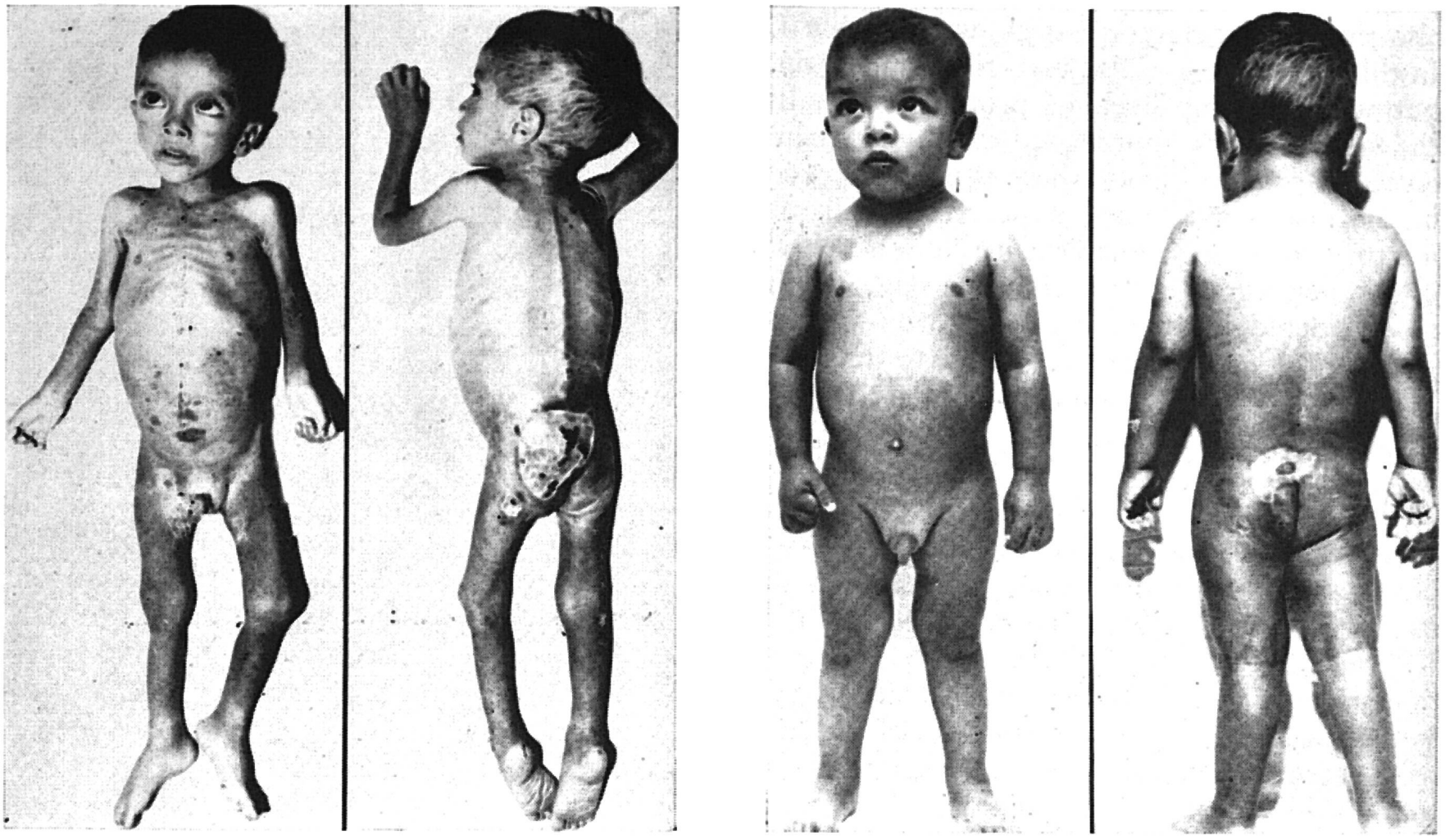

Fig. 1. Twenty-four month old boy admitted with severe kwashiorkor. *Left*, when recovery had started under milk therapy, and *Right*, 10 weeks later when recovery was completed under Incaparina treatment.

purpose of testing further the value of the mixture as a source of protein, it was used in the treatment of children with protein malnutrition. The first assays were done in children who had already started their recovery with milk; recovery progressed satisfactorily in all cases. Figure 1 shows one of these cases when the child was started on mixture no. 8 as the only source of protein in his diet, and about 10 weeks later when complete recovery had been obtained.

Some cases of kwashiorkor were then treated on admission with mixture no. 8 as the only protein source. The results, when compared to those obtained with milk, were different only in that the edema disappeared a little later, and the serum albumin increased to normal levels at a slower rate.[10] The final result was equally satisfactory, as illustrated in figure 2.

By the time all the mixture no. 8 tests were completed, an important change had occurred in relation to the availability of its ingredients. Cotton production had increased to the extent where it had displaced sesame in the oil seed industry. Sesame meal, an important ingredient of the formula was then unavailable. The basic principle had, however, been established; a vegetable mixture adequate as a protein source for human feeding, particularly for small children, was feasible. The work was then continued in order to produce another formula better adapted to the currently existing materials. The information then available on the possible utilization of cottonseed flour for human consumption made it possible to formulate mixture no. 9 in which the sesame flour was eliminated. Vegetable mixture no. 9 has the following composition:

Corn "masa" flour	28%
Sorghum "masa" flour	28%
Cottonseed flour	38%
Torula yeast	3%
Dehydrated kikuyu flour	3%

Sorghum "masa" is prepared in the same way as indicated for corn "masa" and was used to reduce the cost while yet maintaining the nutritive and organoleptic characteristics of the product. The other ingredients were the same as indicated for mixture no. 8.

This formula was submitted to the same biological assays as was mixture no. 8. For the animal assays rats, chickens, pigs, and dogs were used for both growth and metabolic studies.[11] All the information indicated that both mixtures had the same biological value. The nitrogen balance studies in children were

also equally satisfactory as shown in table I. In this case milk was also used for comparison, but with varying levels of protein intake. In the table it can be appreciated that, at adequate levels of protein intake, there is no difference in the nitrogen retained either from milk or mixture no. 9; only when the intake was below 2 Gm. per Kg. of body weight per day, which is considered insufficient for children of this age, a difference appears favorable to milk.

The ultimate objective of these studies was to provide a suitable product to be used by the general population as a regular food; thus far, information had been obtained on its nutritive value and on acceptability by small children under hospital conditions; the next step was then to determine the acceptability by the potential consumers. With the cooperation of the Department of Nutrition and some health centers of the Ministry of Health of Guatemala, the mixture was distributed to mothers of preschool age children regularly attending health centers located in four different regions of Guatemala; indications as to its use were given and this was checked by visiting nurses. It was found that during the period of the test, which varied from 15 to 19 weeks in the four localities, 65 to 92 per cent of the children to whom the mixture was offered liked it and consumed it regularly throughout the period of the experience.

The next step was industrial production and commercial distribution. For that purpose some changes in the formula were first introduced: (1) the dehydrated kikuyu flour was difficult to produce locally on a large scale, and (2) the process has to be well-controlled to prevent the destruction of the carotene. For these reasons it was considered much more convenient, both from the economical and nutritional point of view, to replace this product by synthetic vitamin A. It was also found that it was possible to use crude corn or sorghum flour instead of the specially processed "masa" preparations, which was also advantageous from the industrial point of view. Calcium could then be provided as calcium carbonate added to the formula. Mixture no. 9A has then, the following composition:

	per 100 Gm.
Corn flour	29 Gm.
Sorghum flour	29 Gm.
Cottonseed flour	38 Gm.
Torula yeast	3 Gm.
Calcium carbonate	1 Gm.
Vitamin A	4,500 I. U.

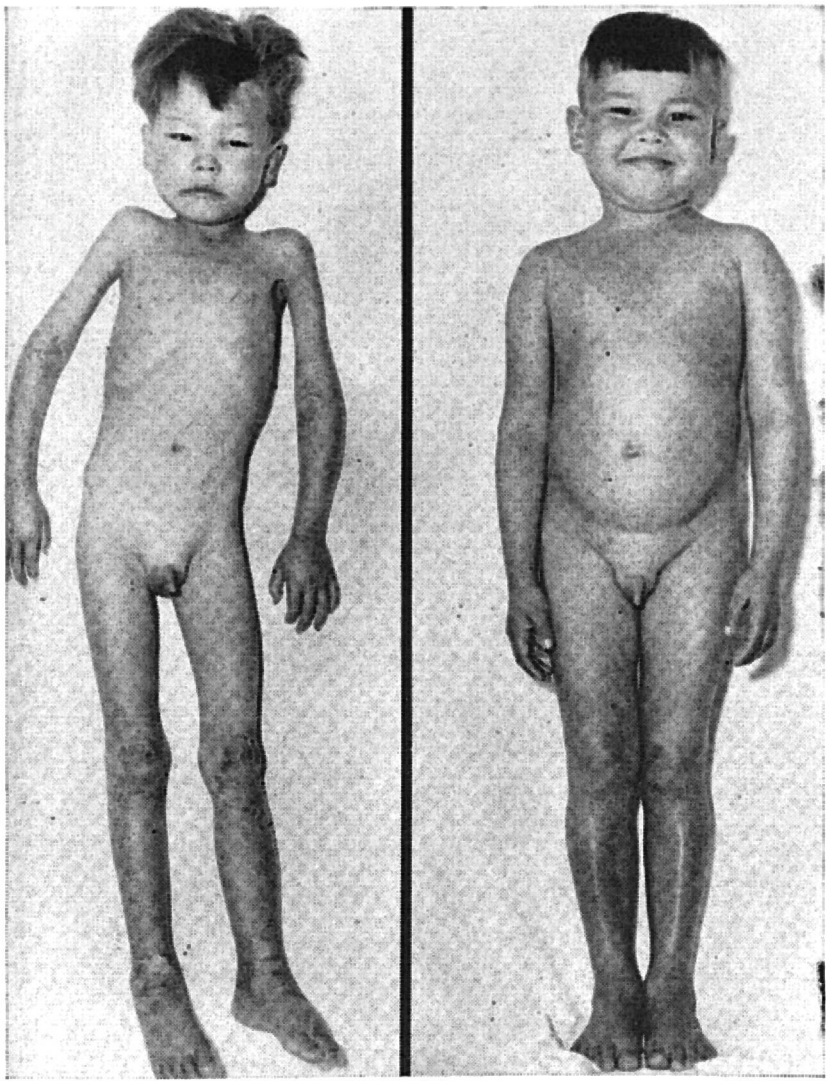

Fig. 2. A 7 year old boy with kwashiorkor. *Left*, on admission, and *Right*, 8 weeks after treatment based on Incaparina.

TABLE I

Comparison of Vegetable Mixture 9 and Milk in Young Children

Protein Gm./Kg.	No. of Children	No. Balance Periods	Milk		Vegetable Mixture 9	
			Absorption % of intake	Retention % of intake	Absorption % of intake	Retention % of intake
> 4.0	1	2	84.4	22.0	66.1	24.1
3.0–3.9	4	11	84.9	17.1	70.2	16.8
2.0–2.9	9	48	82.6	16.3	68.9	17.8
1.0–1.9	4	13	78.1	24.9	66.2	15.2
< 1.0	2	3	67.2	8.1	59.1	4.5

This mixture contains 27.5 per cent protein of adequate biological value for humans, and provides all the other essential nutrients except vitamin C. Its caloric content is low because it was designed primarily as a protein supplement. It was estimated that 75 Gm. of this mixture were able to correct the prevalent deficiencies of the regular diet of preschool age children of the area; this amount can be prepared in 3 or 4 glasses of the popular "atole" (maize gruel).

For the commercial distribution of the product only a trade name was then necessary: Incaparina, from INCAP and *harina* (meaning flour in Spanish), was chosen. It was further decided to use Incaparina as a generic name for all vegetable mixtures developed by the Institute for human consumption and containing at least 25 per cent of protein of high biological value.

After some marketing trials Incaparina was finally produced and commercially distributed in Guatemala under the close supervision of INCAP in 1961. The small plastic bags containing 75 Gm. of Incaparina, a daily ration, are sold to the general public at a price of 4 cents. It is also sold in bulk at a lower price for institutional use. The amount sold is increasing progressively. Incaparina is now well-known in Guatemala and it is used not only as an "atole" but also for the enrichment of soups, cookies, and many other dishes calling for the use of a flour.

In other Latin American countries, industrial companies have been authorized by INCAP to produce and distribute Incaparina and are at different stages in the commercial application of the product.

COMMENT

Meanwhile, INCAP is continuing its studies devoted to the development and testing of suitable modifications to adapt the product to the availability of raw materials and varying consumer acceptability patterns in other areas. It is also collaborating with the authorized producers in their promotional efforts.

In other areas of the world, products with a similar objective are also being developed and tested.[12] The availability of these products and their acceptability and adequate use by populations where protein malnutrition is now prevalent cannot be expected to be *the* solution to this extremely serious and difficult problem. There is no question, however, that better utilization of available resources is a great help in the fight against this serious problem at the present and in facing the challenge of feeding a rapidly increasing population.

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