

Incaparina and other Incaparina-based foods: Experience of INCAP in Central America

INCAP Publication PCI/096

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Abstract

Incaparina is a high-quality protein vegetable food used in Guatemala. It was developed in the 1960s for children and other population groups with nutritional deficiencies. The original formula is still used as a commercial product, but both its ingredients and its micronutrient composition needed to be improved. Protein quality was improved, vitamin A content was reduced, and the contents of iron, B vitamins, zinc, and calcium were increased. The price of new Incaparina is still very competitive. In order to ensure the quality of this commercial product, a Seal of Nutritional Excellence was developed and is expected to be used by private firms.

Introduction

Incaparina was the result of a research programme initiated in 1950 to develop a high-quality protein vegetable food mainly for children but also useful for other population groups with nutritional deficiencies [1]. It has been the subject of numerous scientific papers published over the past 20 years and is well known all over the world. The objectives of this paper are to present basic information about the original Incaparina, focusing on its nutritional characteristics and development as a commercial product; to provide an overview of the efforts of the Institute of Nutrition of Central America and Panama (INCAP) to improve Incaparina's formulation; and describe INCAP's plan for monitoring the quality of commercial nutritional foods.

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Mention of the names of firms and commercial products does not imply endorsement by the United Nations University.

Original Incaparina

The purpose of developing Incaparina was to provide a food capable of efficiently supplementing the usual diets of children [2], with the following features:

- » in the form of a flour;
- » consistent with the dietary habits and practices of the population;
- » formulated from locally available ingredients with a corn-like flavour;
- » protein content and quality similar to that of animal proteins;
- » supplemented with B vitamins as well as with vitamin A and iron;
- » free of anti-physiological factors;
- » stable with an acceptable shelf-life;
- » cooked before consumption.

Nutritional characteristics

The nutritional characteristics of original Incaparina are shown in table 1. The ingredients are maize flour, cottonseed flour, and soya bean flour, and it is fortified with vitamin A, thiamine, riboflavin, niacin, calcium, zinc, phosphorus, and lysine.

Product development

Incaparina is similar to a traditional drink in Guatemala called *atole*, which is made with maize and consumed by a large population, especially in the highlands. Details about the development of Incaparina have been widely published [4–14]. In addition to food technology research, INCAP also conducted clinical evaluation and acceptability trials. The clinical trials showed that Incaparina not only was widely accepted in the diets of persons without obvious malnutrition but also was effective in the treatment of severe protein malnutrition in children [15]. The results of the acceptability trials showed that Incaparina was well accepted, especially in the highlands (table 2) [16]. After the clinical and acceptability trials, INCAP transferred the tech-

TABLE 1. Nutritional characteristics of original Incaparina (Guatemala)^a

| Nutrient | Amount per 100 g dry product | Compound (where applicable) |
|--------------------------------------|------------------------------|-----------------------------|
| Protein | 21.3 g | NA ^b |
| Energy (CHO) | 373 g | NA |
| Fat | 5.3 g | NA |
| Vitamin A | 4,500 IU | Vitamin A acetate 500 |
| Thiamine (vitamin B ₁) | 1.7 mg | Thiamine mononitrate |
| Riboflavin (vitamin B ₂) | 1.01 mg | Riboflavin |
| Niacin | 13.6 mg NE | Nicotinamide |
| Vitamin B ₆ | — | — |
| Vitamin B ₁₂ | — | — |
| Folic acid | — | — |
| Vitamin C | — | — |
| Calcium | 305 mg | Tricalcic calcium |
| Zinc | — | — |
| Iron | 11.2 mg | Ferrous fumarate |
| Magnesium | — | — |
| Phosphorus | 65 mg | Phosphorus |
| Iodine | — | — |
| Selenium | — | — |
| Copper | — | — |
| Other: lysine | 250 mg | Lysine |

a. *Ingredients*: maize flour (65%), cottonseed flour (25%), soya bean flour (10%). *Energy density (kcal/g)*: dry product, 3.67; with water added, 0.27; with water and sugar added, 0.58. *Ration size per day (dry product)*: 18.75 g. *Volume per ration with water added*: 250 ml. *Suggested servings per day*: 4. *Energy per day*: 69 kcal. *Cost (US\$)*: per ration, 0.018; per 100 g, 0.10. *Rations per package*: 24. *Cooking instructions*: cook for at least 15 min. *Other relevant information*: protein efficiency ratio (PER), 1.93 ± 0.13 [3], representing 67% of casein protein quality.

b. Not applicable.

nology for commercial production of Incaparina to a national company, Alimentos.

Cost

Because of inflation, the cost of all foods has increased since Incaparina was introduced in the market. At the moment, its price is about US\$0.10/100 g, as compared with about US\$0.05 when it was introduced in the 1960s and 1970s.

Production and distribution

To protect the consumer by guaranteeing the quality of the mixtures licensed by INCAP to qualified industries, INCAP established licensing requirements as well as a control system for the packaging, identification, advertising, and quality analysis of the product at the moment of the technology transfer [2]. The control included analysis of chemical composition and microbiological quality, and, less frequently, control of biological nutritional quality. The analyses were carried out on samples collected at the production level or in food stores at the intervals and in the manner prescribed in the respective authorization. The number of samples analysed was based on the quantity produced.

TABLE 2. Acceptability trials of original Incaparina in Guatemala

| Location | Duration (wk) | No. of children | % consuming ≥ 2 glasses/day |
|----------------|---------------|-----------------|-----------------------------|
| Amatitlan I | 17 | 28 | 74.2 |
| Amatitlan II | 15 | 21 | 92.1 |
| Escuintla | 17 | 24 | 65.6 |
| Zacapa | 19 | 26 | 65.1 |
| Quetzaltenango | 18 | 51 | 89.5 |

Source: ref. 16.

An example of the quality-control scheme is shown in table 3.

Presently, all the responsibility for production, quality control, and distribution rests on Alimentos, the private firm that produces Incaparina, and INCAP no longer has control over its quality. From time to time INCAP samples Incaparina from the market for quality analysis. No major problems have been found with nutritional composition. However, problems have been detected with microbiological quality, especially with mycotoxin content (aflatoxin), because of inefficient storage of grain or other raw materials.

TABLE 3. Original quality-control scheme for Incaparina

| Production (metric tons) | No. of samples ^a |
|--------------------------|-----------------------------|
| 10 | 1 |
| 11–24 | 2 |
| 25–49 | 3 |
| Each additional 25 | 1 additional |

Source: ref. 2.

a. Samples taken at production site or market place. *Chemical analyses*: moisture, protein, fat, fibre, ash, vitamin B₂, vitamin A, free gossypol, available lysine, trypsin inhibitors. *Microbiological analyses*: total bacterial count and *E. coli*. *Biological assays*: protein efficiency ratio (PER) or net protein ratio (NPR) occasionally or when requested.

Each month about one million pounds of weaning foods produced by Alimentos are sold. On the basis of an intake of 60 g per child per day, it can be calculated that these foods are reaching around 260,000 Guatemalan children under four years of age. This number is relatively small, about 16% of the children in this age group in Guatemala [2]. Incaparina is also still used in government programmes to give a nutritious breakfast to school-aged children.

New Incaparina

Some problems have been encountered with respect to the availability of raw materials for the production of Incaparina, especially cottonseed flour, since cotton is no longer produced in the region. Alimentos has to import the flour from the United States, where cottonseed flour is primarily used for animal food and there is less control of the gossypol content and the presence of aflatoxins. Governmental institutions (hospitals and pre-schools) report that Incaparina has changed its flavour and is not as well accepted by consumers.

To address the problems outlined above, INCAP contacted Alimentos in 1998 to discuss the preparation of an improved formulation for Incaparina. The goal was to replace the cottonseed flour with another flour available in the region and to revise the micronutrient content on the basis of the most recent scientific evidence. A new formulation of Incaparina has been developed and will be marketed later this year.

A similar effort to improve the quality of a product developed by INCAP, Bienestarina, was made several years ago with another company. Unfortunately, INCAP received financial remuneration neither for the technology transfer nor for the monitoring of quality. Therefore, INCAP had to remove its support for this firm. Bienestarina is still on the market but is of poor quality.

Nutritional characteristics

New Incaparina is based on the following three concepts:

- » The principal ingredients are maize and soya bean flours;
- » The micronutrient content is based on the recent nutritional situation in Central America and calculated to provide at least 20% of the recommended daily allowance (RDA) for adult women;
- » It requires less cooking time than old Incaparina.

The nutritional characteristics of new Incaparina are shown in table 4. In addition to the elimination of cottonseed flour, it differs from old Incaparina in its protein quality and its contents of vitamin A, iron, vitamin B, zinc, and calcium.

Protein quality

As a consequence of the substitution of soya bean flour for cottonseed flour, the protein quality has been increased. A specific biological evaluation done recently at INCAP to calculate the protein efficiency ratio (PER) showed that the new formulation reached 97% of casein protein quality.

Vitamin A content

The vitamin A content has been reduced. Sugar in Guatemala has been fortified with vitamin A since 1974 at a minimum level of 5 mg/kg, and vitamin A deficiency is no longer a public health problem in several countries of Central America. The preparation of Incaparina for consumption by cooking in water involves the addition of sugar at a weight ratio of about 3 to 7. Therefore, the intake of vitamin A by the consumer is increased through the addition of the fortified sugar. The level of fortification of new Incaparina with vitamin A was kept to 25% of the RDA for children one to five years of age. This is the only group that still has relatively high levels of deficiency, with 16% having retinol levels < 20 µg/dl (table 5).

Iron

The iron content was increased to cover 48% of the RDA for one- to five-year-old children. Iron deficiency is still common in Central America, especially in this age group. However, the iron may not be as readily available because of factors in the product, such as dietary fibre, phytate, and other compounds, which interfere with its bioavailability. INCAP is conducting a new study to address the bioavailability of different compounds of iron in maize flour used in tortillas fortified with soya bean flour and several other micronutrients.

Vitamin B

The content of the B vitamins—niacin, thiamine, riboflavin, B₁₂, and folic acid—was increased to between 32% to 40% of the RDA for one- to five-year-old children.

Other minerals

Zinc was incorporated at a level of 35% of the RDA

TABLE 4. Nutritional characteristics of new Incaparina (Guatemala)^a

| Nutrient | Amount per 100 g dry product | Compound (where applicable) |
|--------------------------------------|------------------------------|--|
| Protein | 23.5 g (23.5%) | NA ^b |
| Energy (CHO) | 63 g (63%) | NA |
| Fat | 4 g (4%) | NA |
| Vitamin A | 1,759 IU | Vitamin A palmitate 500 |
| Thiamine (vitamin B ₁) | 0.85 mg | Thiamine mononitrate |
| Riboflavin (vitamin B ₂) | 1.2 mg | Riboflavin |
| Niacin | 15 mg NE | Nicotinamide |
| Vitamin B ₆ | — | — |
| Vitamin B ₁₂ | 1.1 µg | Vitamin B ₁₂ 0.1% in mannitol |
| Folic acid | 213 µg | Folic acid |
| Vitamin C | — | — |
| Calcium | 1,066 mg | Tricalcic calcium |
| Zinc | 15 mg | Zinc oxide |
| Iron | 25.6 mg | Ferrous fumarate |
| Magnesium | — | — |
| Phosphorus | — | — |
| Iodine | — | — |
| Selenium | — | — |
| Copper | — | — |
| Other | — | — |

a. *Ingredients*: maize flour (70%), soya bean flour (30%). *Energy density (kcal/g)*: dry product, 5.33; with water added, 0.40; with water and sugar added, 0.69. *Ration size per day (dry product)*: 18.75 g. *Volume per ration with water added*: 250 ml. *Suggested servings per day*: 4. *Energy per day*: 100 kcal. *Cost (US\$)*: per ration, 0.02; per 100 g, 0.11. *Rations per package*: 24. *Cooking instructions*: cook for 10 min. *Other relevant information*: protein efficiency ratio (PER), 2.81 ± 0.20 [3], representing 97% of casein protein quality.

b. Not applicable.

TABLE 5. Micronutrient status of populations in Central America

| Country | Vitamin A ^a in children 1–5 yr | Iron ^b | | | Iodine ^c in students |
|-------------|---|--------------------|-------------------|-------------------|------------------------------------|
| | | Children 1–5 yr | Women 15–48 yr | Pregnant women | |
| Guatemala | 16 | 26 | 32 | 39 | 22 |
| Belize | — | — | — | 52 | 18.4 |
| El Salvador | <5 | 31 | 16 | — | — |
| Honduras | 13 | 28 | 22 | 30 | — |
| Nicaragua | 31 | 28 | 36 | — | 10.6 |
| Costa Rica | 9 | 26 | 19 | 28 | 23.3 |
| Panama | 6 | 18 | — | — | >15 |

a. % < 20 µg retinol/dl.

b. % prevalence of anaemia (% haemoglobin < WHO cut-off point).

c. Median urinary iodine (µg/dl).

for one- to five-year-old children, and calcium was increased to 50% of the RDA for this group.

Cost

The new Incaparina is slightly more expensive than the original (table 6). Both the new and the original Incaparina are still very competitive in price with other products on the market such as milk, infant formulas, and

instant cereals, which cost between one and eight times as much per ration. Other products cost one to five times as much as Incaparina per unit of energy or protein.

Monitoring of quality: INCAP's seal of nutritional excellence

To assure the quality of complementary foods developed by INCAP and produced by private firms, INCAP

TABLE 6. Costs of food products in Guatemala

| Product | Size of marketed unit (g) | Cost (US\$) | | | | |
|--------------------------|---------------------------|---------------|-------|-----------------|----------|-------------------|
| | | Marketed unit | 100 g | Ration | 100 kcal | 100 g protein |
| Formula Nido Crecimiento | 900 | 5.8 | 0.64 | 0.16 (25 g) | 0.13 | 3.06 |
| Milk Nido | 500 | 2.64 | 0.53 | 0.132 (25 g) | 0.10 | 2.5 |
| Milk Pinito (2 Pinos) | 400 | 2.1 | 0.52 | 0.131 (25 g) | 0.10 | 2.5 |
| Atol Cerevita | 300 | 0.92 | 0.30 | 0.061 (20 g) | — | — |
| Innovarina | 454 | 0.47 | 0.10 | 0.019 (18.75 g) | 0.019 | 0.55 ^a |
| Vitatol | 375 | 0.39 | 0.10 | 0.019 (18.75 g) | — | — |
| Incaparina (original) | 454 | 0.45 | 0.099 | 0.018 (18.75 g) | 0.027 | 0.53 ^a |

a. Cost for protein in vegetable mixture was corrected with a factor of 0.8.

is promoting a Seal of Nutritional Excellence. The objective of this seal is to assist the producers to promote nutritious foods in order to increase their consumption in regional markets as well as to recognize the prestige and image of INCAP in the field of nutrition and in the development of these kinds of foods.

The seal has been defined as a graphic representation on the product that is proof of external monitoring by INCAP to verify its technical, nutritional, sanitary, and toxicological quality. In addition, it will permit consumers to identify the product as a nutritious food.

The seal would be optional when a producer wants to use it for its own existing or new products, using its own technology and trademark. However, it would be obligatory for a producer using INCAP's name and trademark or INCAP's technology either for existing products or new products. The cost of the seal would be proportional to the number of samples analysed.

The main services offered by INCAP for the monitoring of quality are identification of market regions and sales in order to calculate the number of samples to analyse, collection of samples, chemical and nutritional analysis, and microbiological and toxicological analysis.

This seal has been used for three years by the Panamanian company DEMASA on a product they developed called Nutricrema. It is very similar to Incaparina but is adapted to Panamanian consumption habits.

Conclusions

Incaparina appears to be a good commercial product in the long term in Guatemala and has been popular among both children and adults. Its manufacture has contributed to industrial and economic development in the region. The product concept used in developing Incaparina has been exported to a number of countries in Central and South America and has been used to develop other nutritious products, such as the cookie used in school feeding programmes and maize flour for tortillas.

The experience with Incaparina was also a successful transfer of technology to private industry. However, the relation between INCAP and industry has not always been so successful. The failure with Bienestarina and other products and the recent problem with the presence of aflatoxin in Incaparina show that INCAP does not have control over the product it has developed.

The challenge for INCAP is to develop a mechanism to continue to offer nutritious products to the population, but with the assurance of quality, not only nutritionally but also microbiologically and toxicologically. This assurance of quality needs to be based on the most recent methods, such as Good Manufacturing Practices and Hazard Analysis and Critical Control Point in the factory, and on external quality monitoring, such as INCAP's Seal of Nutritional Excellence.

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Summary of discussion of article by Tartanac

Enforcement of agreements. It is important to enforce agreements, but how do you do this? Legal action is viewed as too expensive. INCAP's enforcement procedures need to be clarified. INCAP has no negotiating power over the original Incaparina that is already on the market. However, if a private company does not conform to quality standards for a new product, INCAP will not work with it. Withdrawal of the Seal of Excellence, a registered trademark, is seen by INCAP as its legal recourse. INCAP needs to look at existing government regulations regarding trademarks to ensure legal protection of its trademark. Several of the participants challenged INCAP to look very carefully at its licensing agreements and the trademark laws in Central America.

Starting out with a good contract and licensing agreement is critical. To ensure quality control in Peru, the private sector must produce a laboratory certificate stating that each batch that leaves the company has the composition stated in the contract. Contracts can be terminated for poor quality.

Governments in Latin America tend to have strict regulations for their export products but not for those consumed internally. In Guatemala the government has no systematic control of food products.

Data from the 1960s and 1970s show that low-in-

come families did not use Incaparina because it was too expensive. More recent data show that about 80% of the high-income groups and 50% of the low-income groups consume Incaparina. About 28% of the very poorest use Incaparina. Although some say that this is poor targeting, industry would argue that the consumption of a specific product by 28% of a population group is excellent.

Although observational data suggest that Incaparina is not used as a breastmilk substitute, breastfeeding women do consume it themselves because it is seen as a good food for lactating women.

The efficacy of Incaparina has been demonstrated repeatedly, but its effectiveness has not been investigated.

Incaparina is partially pre-cooked. It is important to take the effect of dilution into consideration when calculating nutrient composition. Thirty percent of vitamin A is lost during cooking. The new formula will put extra micronutrients into the product to compensate for this loss.

The cost data are for the purchase price only and do not include the cost of cooking the product. A subsidy was never provided when the product was marketed. There is no regulation of the price of Incaparina on the open market.