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EVALUATION OF INTERVENTIONS
FOR THE CONTROL OF
VITAMIN A DEFICIENCY
IN GUATEMALA
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IV. SUGAR FORTIFICATION

INTRODUCTION

1. The 1965 National Nutrition Survey of Guatemala showed that vitamin A deficiency was a widespread public health problem: at the national level, 26.22% of all children below 5 years of age had serum retinol levels below 20 µg/dL (1).
2. The Institute of Nutrition of Central America and Panama (INCAP) decided to attack the problem by fortifying a widely consumed food item. Sugar was decided on for the following reasons: It is centrally produced, is consumed by the majority of the population in relatively constant quantities, vitamin A does not segregate from it, and it stores well without changing its organoleptic properties (2).
3. INCAP researchers, headed by Dr. Guillermo Arroyave, with support and collaboration of the National Committee for the Blind and Deaf, especially by Mrs. Elisa Molina de Stahl, convinced the Guatemala Congress to mandate fortification with vitamin A of sugar produced for domestic consumption. The sugar fortification program was initiated in 1975.
4. The beneficial effects of fortified sugar were evaluated in 12 rural communities in which the consumption of vitamin A, retinol levels in serum and breast milk, and concentrations of vitamin A in the livers of persons dying of accidental causes were measured (2).
5. Nevertheless, the national fortification program closed in 1977. By 1988, it was estimated that the prevalence of vitamin A deficiency was similar to that found in 1965. It was shown that 21.8% of preschool age children from several regions of the country had serum retinol levels below 20 µg/dL (3). In one rural community of Alta Verapaz department, the prevalence was 60.0% (4).
6. In 1988 a three pronged vitamin A intervention program was adopted, consisting of supplementation of children 1-7 years of age a single time with a 200,000 IU capsule (the vitamin A round), re-initiation of sugar fortification during the 1987-88 harvest, and promotion of production and consumption of vegetables rich in vitamin A precursors (3).
7. Fortification of sugar with vitamin A has continued to the present time under the responsibility of and financed by the sugar producers, and supervised by the Department of Food Registry and Control of the Ministry of Health.
8. During the past three years, more than 90% of sugar samples collected at sugar factories contained vitamin A; only 1/3 - 1/5 were within the limits specified by law,

although the average vitamin A content was close to specifications. At the level of retail outlets and consumers, a smaller proportion met the requirements (3).

9. The present evaluation of the sugar fortification process in Guatemala was carried out with two objectives: document the Guatemala experience so as to disseminate the successful elements, and identify those stages of the process which need improvement.
10. For the evaluation, documents in the files were reviewed, interviews were held and field trips were made to plants where the vitamin A premix and fortified sugar are produced. Annex 2 of this report contains the questionnaire protocol which was used.

1. Planning and Coordination

1.1 Characteristics of Sugar Consumption

- 1.1.a The 1965 nutrition survey showed that sugar was consumed by the vast majority of the population in direct proportion to the socio-economic level. The daily consumption reported was 20, 28 and 47 grams per day per person respectively for low, medium and high income levels (6).
- 1.1.b Consumption of 20 grams/day by the most at-risk groups was the basis used to determine the fortification level so as to provide the Recommended Daily Allowance for children of 300 ug/day. Thus, a fortification level of 15 ug of vitamin A per gram of sugar (or 50 IU/gram) (2).
- 1.1.c Although the present level of sugar consumed by different segments of the population has not been established, a 1991 dietary survey carried out by the Hope project in the departments of Quetzaltenango and San Marcos suggests that per capita consumption has increased rather than reduced, as would be expected due to the rapid increase in price over time. This can be explained by the fact that sugar is the lowest cost source of calories in Guatemala.
- 1.1.d Some populations in isolated areas of the country consume dried molasses (panela) instead of sugar. Panela consumption was investigated during the 1988 vitamin A round. It was found that 11% of the children supplemented with the vitamin A capsule were consuming panela rather than sugar. These populations are concentrated in the departments of Huehuetenango, San Marcos, Quetzaltenango, Atla and Baja Verapaz (7). The remaining 89% of the population, i.e. 7.2 million of a total population of 8.0 million, can benefit from sugar fortification.
- 1.1.e The sugar producers and distributors do not have plans to promote sugar consumption in areas where little is presently consumed. Nevertheless, due to improvements being made in the distribution system by the organization of Sugar Distributors of Guatemala

(DAZGUA), it can be expected that sugar will be accessible to a higher percentage of the population in the near future.

1.2 Legal Basis for Fortification

- 1.2.a Sugar fortification in Guatemala was made mandatory by Decree No. 56-74 dated June 11, 1974 by the Congress of the Republic. This decree is implemented in the Regulation for Enriching Sugar with vitamin A (SP-G-105-74) dated May 2, 1975. Decree law 145-85, dated December 27, 1985 modifies Decree 56-74 slightly (8). According to this legislation, all the sugar for internal consumption in Guatemala should be fortified with vitamin A to the level of 13-17 ug/gram. INCAP is responsible for quality control of the premix and the General Direction of Health Services (DGSS) is responsible for control of sugar fortification by analyzing samples in its laboratories and applying sanctions when the law is not being obeyed. Sanctions are dictated by the Third Book of the Health Code. The sanctions include verbal warning, written warning, a maximum annual fine of 2,000 Quetzales (\pm U.S.\$400), confiscation of the product, and temporary closure of the offending factory. During recent years, there have only been warnings for producing some batches devoid of vitamin A, but no serious sanctions have been applied.
- 1.2.b In addition to the above legislation, COGUANOR, according to Legislative Decree No. 23/87, also has the charge of verifying sugar quality. COGUANOR is Comprised of Members representing private initiative, (Chambers of Commerce, Industry, Agriculture), the Academy (College of Engineers of Guatemala), and government ministries, (Health, Labor and Economy). The specifications for fortified sugar are described in COGUANOR norm NGO 34034.
- 1.2.c The working philosophy of COGUANOR is to identify problems in products so as to offer technical assistance to producers. Corrective actions are then evaluated by testing the product two or three more times subsequently. If the problems have not been corrected, producers can be fined up to 50% of the value of goods produced during the month preceding the infraction.

1.3 Implementers of the Program

- 1.3.a The Guatemala Sugar Producers Association (ASAZGUA) has assumed responsibility for the financing and production of fortified sugar. To carry this out, it has a premix plant in the Santa Theresa sugar factory (city of Villa Canales, Department of Guatemala, elevation 1220 meters, average annual rainfall 1 meter, temperature range 10-33°C) (9) and the 17 factories located along the Pacific Coast which produce white sugar. This area has a typical subtropical/tropical climate i.e. high temperature and humidity. At the beginning of the sugar harvest period, ASAZGUA calculates the required amount of premix according to the estimated amount of sugar to be produced

by each factory (10).

- 1.3.b Supervision of the sugar fortification process is the responsibility of DGSS through the Department of Registry and Control of Foods (DRCA), which is staffed with 4 inspectors and 3 field staff to collect sugar samples in factories and retail outlets and random samples from trucks on highways. DGSS operates LUCAM, which is a laboratory where analysis of the sugar samples is done. LUCAM has 2 professionals and 3 technicians available for this task. Analyses results are sent to DRCA officials who are to take any required action.
- 1.3.c Premix samples are analyzed in laboratories of the Biochemical Nutrition Section of INCAP, using reagents provided by ASAZGUA. The results are used daily to adjust the vitamin A: sugar ratio so that the premix contains 15 µg of vitamin A per gram.

2. Equipment and Supplies

2.1 Costs and Sources of Financing

- 2.1.a ASAZGUA has assumed total responsibility to fund the cost of materials and personnel for the fortification process. ASAZGUA is also responsible for maintenance of the premix plant and measuring devices in each of the participating sugar factories. The following costs are estimated for the 1991-92 processing season, during which about 3.5 million tons of sugar will be produced.

ITEM	COST IN QUETZALES	COST IN U.S. DOLLARS (+)
700,000 lbs sugar	500,250	100,000
60,000 kg vitamin A concentrate	10,000,000	2,000,000
1,500 gallons vegetable oil	28,000	5,600
13,000 bags	16,250	3,250
Electricity	1,000	200
Transport	20,000	4,000
Salaries	40,000	8,000
25 kg Ronoxan A	4,000	800
TOTAL	Q10,809,500	\$2,125,850

The above estimate does not include the cost of quality control.

- 2.1.b The cost of fortifying sugar with vitamin A is thus about Q0.015 (\$0.003) per pound. In terms of cost per person per year, the cost is Q1.32 (\$0.30).
- 2.1.c The consumer cost of a pound of sugar as of August 14, 1991 is Q0.95 (\$0.19) (11). Thus, fortification represents 1.6% of the consumer price of sugar.
- 2.1.d Foreign exchange is purchased in the Bank of Guatemala, following established legal procedures. UNICEF has promised to collaborate in obtaining foreign exchange if this were to become necessary but there is no signed contract.
- 2.1.e As the following table demonstrates, the increase in sugar price has been similar to that of other staple food items:

INCREMENT OVER 1975 PRICES

<u>Food</u>	<u>1980</u>	<u>1985</u>	<u>1990</u>
Com tortillas	1.36	1.24	5.14
Bread	1.38	1.50	4.23
Beans	1.76	1.94	8.88
Eggs	1.24	1.88	5.00
Vegetables	1.75	2.81	9.06
Sugar	1.70	2.40	6.40

2.2 Supply Sources

- 2.2.a The premixer and measuring devices were manufactured in Talleres Hernández, Guatemala City. The premixer was donated by Hoffman-La Roche; the measuring devices by ASAZGUA.
- 2.2.b The vitamin A concentrate (retinol palmitate, form 250-CWS cold water soluble) and Ronoxan (an antioxidant) are purchased from Hoffman-La Roche and BASF.
- 2.2.c White sugar used to make the premix is purchased from the Santa Theresa factory.
- 2.2.d Cotton seed oil was used during the past but sunflower seed oil (which is more appropriate) will be used during the 1991-1992 season.
- 2.2.e Merck reagents are used for quality control testing (isopropanol, hexane, kerosene, xylene, trichloroacetic acid and dichlormethane).

2.3 Management of Supplies

- 2.3.a ASAZGUA calculates early in the calendar year the amount of supplies which will be required for the next sugar season. This is about 10 months in advance.
- 2.3.b ASAZGUA follows-up on orders to assure timely arrival at port and processing through customs. No problems have been encountered.
- 2.3.c ASAZGUA audits shipments as received. The premix plant has special forms for recording receipt of materials. No, as only a single order is placed for each of the imported ingredients. The purchase orders and invoices are kept on file. Raw materials are usually not left over at the end of the premix preparation period.
- 2.3.d The vitamin A, Ronoxan and vegetable oil are stored in an area in the premix plant at Santa Theresa. Environmental conditions are moderate. The same warehouse is used for storage of other chemicals used in cane and sugar production.

3. Premix Production

3.1 Personnel and Training

- 3.1.a Three persons prepare the premix. One loads sugar and the vitamin A concentrate in the mixer, while another prepares the vegetable oil and antioxidant. The third empties the mixer, fills and sews the bags shut. They work 8 hour days, six days a week during premix production (late October to mid-March). They also have a supervisor. Twenty-Five 55 lbs. bags of premix are produced per hour on average.
- 3.1.b Workers receive simple instructions regarding the correct manner to handle the materials and maintain the area clean. The supervisor has worked in the premix plant since 1987.
- 3.1.c There is no annual refresher training nor are there instruction or supervision manuals. However, the process is simple and there is periodic supervision by the premix production coordinator, Ing. Leonel Angelu. There is a simple operations manual for preparing the premix which was prepared by Dr. Oscar Pineda (13). Dr. Pineda and INCAP staff are preparing a more advanced version of the manual.

3.2 Planning

- 3.2.a The quantity of bags of premix to prepare is calculated on the basis of the quota of fortified sugar which has been assigned to each factory.

- 3.2.b Preparation of the premix begins at least one week before sugar production is initiated. Also, leftover bags of premix from the previous season are used first. At the beginning of the 1991 season there were 373 bags of premix (55 lbs. each) on hand, which is sufficient to fortify 20,515,000 lbs. of sugar.
- 3.2.c At the end of the season, any defective or worn equipment parts are replaced. The machinery has been modified over time to make the premix preparation process more efficient.
- 3.2.d Before beginning production of the premix, the equipment is inspected and stocks reviewed to assure that all necessary supplies are on hand.
- 3.3 Processing
- 3.3.a Preparation of the premix begins at least a week before the initiation of sugar processing, i.e. late October. All premix needed for the season has been produced by mid-March.
- 3.3.b Equipment breakdowns are infrequent. When they do happen, repairs are made on an emergency basis and the plant works overtime until production is back on schedule.
- 3.3.c About 200 bags of premix, weighing 55 pounds each, are prepared daily (average of 25 bags/hour). The annual production is approximately 12,700 bags, or nearly 700,000 pounds. This is sufficient to fortify 700 million pounds of sugar.
- 3.3.d For quality control, a sample is taken during each morning and each afternoon, i.e. a sample each 100 bags, or each 5,500 pounds. In previous years, a sample was also taken at mid-day but this is now considered unnecessary as the mixing operation has improved a great deal. The Biochemical Nutrition laboratory of INCAP analyzes the samples, reporting results daily to ASAZGUA. Recently, ASAZGUA has also initiated premix sample analysis in its own laboratory as an internal quality control procedure.
- 3.4 Storage and Distribution
- 3.4.a The premix is bagged in a black polyethylene bag, which is then put into a white polypropylene bag. The outside bag contains lettering identifying the contents and clearly indicating that the product is not for human consumption.
- 3.4.b The bagged premix is warehoused in the production site at Santa Theresa sugar factory. Premix is shipped weekly to each factory which produces white sugar for local consumption.

3.4.c The premix is normally used within 4 months of being prepared. A small amount is left over each year. For example, for the 1990-1991 season, there was an excess of 218 bags (12,000 lbs) left in the premix plant and 155 bags (8,500 lbs) at three sugar factories. Analyses have shown that premix stored at the production site does not deteriorate during the 7-8 month storage period. It is not known if there is deterioration during this period of storage at the sugar factories.

3.5 Control and Supervision

3.5.a The quantities of premix ingredients used is recorded daily, as is the number of bags of premix produced. This report is sent daily to the ASAZGUA central offices.

3.5.b A record is kept of all shipments to the sugar factories. Each shipment must be personally approved by Ing. Anleu.

3.5.c The bags of premix are numbered consecutively each production year. There is a permanent record indicating the preparation date of each. The policy is to ship them in the same order as produced.

3.5.d Analysis of the premix samples show that quality control is adequate: 90% of samples are within the range specified by the law, 15 ± 2 mg of retinol per gram. Two percent are slightly below this range and 8% slightly above it (INCAP data).

4. **Production of Fortified Sugar**

4.1 Personnel

4.1.a Fortification of sugar is a responsibility of ASAZGUA, implemented through its own workers who are rotated every 2 months in the sugar factories. Four workers are assigned to each factory. Their principal task is to monitor production through numbering of the 100 lb. bags of sugar as produced. The same workers keep a record of the number of bags of premix used and number of bags of sugar produced. It is planned for the 1991-1992 harvest to assign 3 more workers to each factory to constantly oversee the mixing of premix and sugar on a 24 hour a day basis.

4.1.b The leader of the ASAZGUA team at each sugar factory receives instructions from Ing. Anleu, the general coordinator of production, and his supervisor, Mr. José del Cid Salguero. These persons are trained annually at INCAP on field techniques to estimate the retinol content in sugar. The workers are highly motivated but have not received sufficient instruction regarding the social importance of their work.

4.1.c The sugar factory workers participate indirectly in the fortification process by virtue of

storing the premix, bringing it to the mixing point and interaction with the tasks of ASAZGUA workers.

- 4.1.d In nearly all the sugar factories, there is a laboratory chief responsible for quality control of the cane brought in and the sugar produced, and a production chief in charge of production logistics. The overall factory operation is supervised and directed by a superintendent. These three professionals are aware of the fortification process, even though they have not been given direct responsibility for it.

4.2 Planning

- 4.2.a The chief of the ASAZGUA group of workers in each factory records on special forms and reports daily by radio the amount of sugar produced, the number of bags of premix used and the remaining stock of premix.

These data are used to determine need for and initiate timely shipment of premix to each factory.

- 4.2.b Though each bag of premix does not have the receipt date marked on it, they can be used on a first in-first out basis because they are numbered consecutively.
- 4.2.c The bags of premix are stored in the factory warehouse along with other materials needed for sugar processing and bagging. The warehouses are usually protected from the heat and humidity inherent to the sugar production process.
- 4.2.d Operation of the measuring devices and their maintenance at the end of the processing season is the responsibility of ASAZGUA, not the sugar factory workers. The reconditioning and adjustment of the measuring devices at the beginning of the processing season is adequate but apparently they get out of adjustment due to heavy use under conditions of constant vibration. Sugar processing cannot be halted even though the measuring device may not be delivering premix at the proper rate. To improve this stage of the process, ASAZGUA will arrange this year for constant oversight of the measuring devices.

4.3 Processing

- 4.3.a Originally, premix was added to the sugar during the centrifuging stage of the production process. However, this proved to be overly difficult. Since 1987, the premix is added in most factories at the stage where sugar is being moved from the centrifuge to the drying chamber with the objective of achieving more precise premix/sugar homogenization during the drying stage. In a few factories which are able to mix the sugar after it is dried, the measuring devices are installed between the dryer and bagger.

- 4.3.b Sugar for domestic consumption is packaged in 100 lb polyethylene bags. The identification number of the factory and production number is marked on the outside of each bag. These data permit determination of the site and production date of each bag.
- 4.3.c A production quota is assigned to each factory, as shown in Annex F-4. It is estimated that about 700 million pounds will be fortified in the 1991-1992 season.
- 4.3.d The sugar fortification process has required the installation of a measuring device which does not interfere with the overall process. The only additional work is adding premix to the measuring device and oversight to see that it is operating correctly.

4.4 Warehousing and Distribution

- 4.4.a Fortified sugar is stored in 100 lb. polyethylene bags for a maximum of one year in the same factory or at distribution points located in the different regions of the country.
- 4.4.b The sugar is shipped by truck to distribution points.
- 4.4.c Consumers can purchase sugar in the original 100 lb bags, or in 25, 10 and 5 lb cloth or plastic bags. Plastic bags are the most common.
- 4.4.d Distribution of sugar to the consumer is done by middlemen completely independent of the producers. Nevertheless, the producers distribution arm, DAZGUA, is assuming a more important role. DAZGUA wishes to provide the public security that honest weight is being received.
- 4.4.e It was not possible to establish the turnover rate of sugar at distribution points or retail outlets but it is believed to be only a few weeks.

4.5 Control and Supervision

- 4.5.a The fortification process is the direct responsibility of the ASAZGUA workers in each factory. Starting this year, ASAZGUA will assign 3 workers daily in 8 hour shifts to assure effective mixing.
- 4.5.b The ASAZGUA team leader at each factory keeps a detailed record of operations and reports daily by radio. Up to now, these records do not contain quality control data. The efficacy of the fortification process is examined only on the basis of the ratio between quantity of premix used and sugar produced.
- 4.5.c The ASAZGUA team leader in each factory is to do colorimetric analyses (14) to establish that the amount of vitamin A in the sugar is within the margin established by

law. Four samples are taken each day, which represents a sample for about each 4,000 bags of 100 lbs each. The validity and value of this procedure to assure quality control is undetermined.

- 4.5.d The Santa Ana factory is the only one to carry out its own analysis of fortified sugar. Its' data were not obtained.
- 4.5.e During the 1990-91 season, DRCA inspectors obtained 1200 samples of fortified sugar at the factories, which represents one sample for about 6,000 bags of 100 lbs each. Because of a shortage of reagents, four of these samples were combined and analyzed as a single sample. Ninety-four percent of these analysis indicated the presence of vitamin A, but within a very wide margin: 50% had levels lower than 80% of the legal limit, 30% within the legal limit, and 14% with higher concentrations than the legal range. A study carried out by COGUANOR to verify product quality produced similar results. Tests carried out for a sugar factory showed levels of 0, 9, 15 and 34 µg/gram, although the average was 14.5 µg/gram, extremely close to the target level (5). These data indicate that the factories are adding the vitamin A premix but that proper homogenization is not being achieved.
- 4.5.f DRCA, because of inadequate resources, has not taken samples at distribution centers.
- 4.5.g Data from samples obtained at retail outlets and homes show that few contain the recommended level of vitamin A (5, 15). The reasons have not been determined but it is suspected that they may be a combination of: illegal sale of unfortified sugar from neighboring countries, inadequate homogeneity in fortified sugar, segregation and deterioration of vitamin A. During development of the fortification process, the stability of sugar fortified with the 250-CWS form of vitamin A was evaluated. The conclusions were that vitamin A did not segregate from the sugar and that about 9% was lost during a 6-9 month period (2), which is minimal considering that most sugar is consumed well within this period after being produced. Similar stability data have been provided by Hoffman-La Roche (16). ASAZGUA and INCAP are carrying out studies to retest these results under current packaging and marketing conditions.

5. Quality Control Laboratories

5.1. Installations and Operations

- 5.1.a ASAZGUA has a chemical laboratory with the indispensable equipment for quality control of the premix and fortified sugar. The current laboratory personnel would not be able to assume responsibility for quality control of the fortification process for the sugar factories.

- 5.1.b Most of the factories have chemical laboratories for analysis of the sugar cane and sugar. However, with the exception of ingenio Santa Ana, these laboratories do no quality control of fortification.
- 5.1.c LUCAM has adequate equipment and competent personnel to function as an oversight laboratory for MOH. Its limitations are the inability to contract sufficient technicians and acquire sufficient reagents to take on more work.
- 5.1.d INCAP has the staff and laboratories to serve as a training center in laboratory methods. Until now, INCAP has fulfilled its role for quality control of the premix. Nevertheless, it lacks financing for this activity, both for contracting staff, equipment maintenance and acquiring reagents. Frequently ASAZGUA has had to assist in the purchase of necessary reagents.
- 5.1.e Although there have been informal contacts between the ASAZGUA and INCAP laboratories, and between LUCAM and INCAP, there is no established mechanism which could function as a control and reference system. The quality of analysis has not been verified between laboratories.
- 5.1.f The premix analysis results have been useful for management of the preparation process: the results are reported daily to ASAZGUA. The analysis of fortified sugar have served more as an oversight instrument than for technical support of the production process.

6. Sanitary Control

6.1 The MOH Inspection System

- 6.1.a DRCA has 4 professional inspectors dedicated to full time quality control of sugar fortification during the processing season. They assume other fortified food responsibilities during the remaining months of the year. In addition to these inspectors, DRCA has 3 field staff whose charge is to collect random food samples from trucks on highways. They are not collecting sugar samples.
- 6.1.b The DRCA inspectors are trained to obtain sugar samples and transport them to the laboratory. Because of financial limitations, the samples have been taken almost only in the sugar factories and usually from sugar being produced while the inspector is present instead of from the sugar stocks.
- 6.1.c Each factory is visited each 2 weeks by an inspector and the samples are taken in his presence.
- 6.1.d LUCAM conducts the analyses for DRCA, and generally provides results within 3

days of receiving samples. Delays do occur due to shortages of reagents. This is being overcome (although incorrectly), by combining 4 samples for a single analysis.

- 6.1.e The Chief of DRCA, Dr. Danny Cifuentes, maintains a confidential file of the results. These data have the sole purpose of assuring that the law is being complied with.

DISCUSSION

1. Fortification of sugar with vitamin A has been continuous in Guatemala since the 1987-88 harvest. The fundamental reason for this achievement has been the willingness of the producers to collaborate in complying with current legislation. The producers have assumed the cost and execution of the process, and have directed resources, coordinated by ASAZGUA, so that high quality premix is produced on schedule and delivered to the factories as needed.
2. The logistics of acquiring ingredients, preparing, distribution and quality control of the premix; and of sugar production are being carried out adequately by ASAZGUA. Few suggestions can be made regarding improvement of these stages of the overall process. Combining the premix and sugar is the weak link in the chain.
3. The price of sugar has increased about the same as the cost of other foods and at the present time is one of the lowest cost sources of calories. Thus, its consumption by low income groups has probably increased rather than diminished. This presumption should be investigated as the outcome would allow adjustment of the level of vitamin A level to achieve optimal results.
4. The specified range for fortification of sugar with vitamin A is very narrow and does not reflect real life processing conditions. This range should be reviewed and re-established on the basis of an analysis of an adequate, rather than perfect, set of conditions.
5. Quality control results of fortified sugar indicate that vitamin A is being added to sugar in the factories but that the mixing process is deficient. Apparently, the stage where the fault lies is in adding the premix to the sugar. ASAZGUA will attempt to resolve the problem during the 1991-92 harvest by adding extra personnel; nevertheless, it probably also will be necessary to improve the design of the measuring devices.
6. The laboratory and production chiefs, and superintendent of each sugar factory are conscious of the fortification process, yet have little influence regarding it as it has been assigned to the ASAZGUA workers. It would be worthwhile to motivate and train these individuals so that they perceive fortification as an integral part of sugar

production. The ASAZGUA workers could still oversee the process but each factory could assume final responsibility for product quality.

7. Some bags of premix have continued to be stored in the factories after the harvest season. This is not acceptable because of the high temperature and humidity, which accelerates rancidity and vitamin A loss.
8. Quality control of the premix has been effective and analysis of the samples has served to make rapid adjustments in the process. Modest investment in the ASAZGUA laboratory would permit transfer of premix quality control responsibility from INCAP to ASAZGUA. INCAP could then continue to collaborate as a reference laboratory and training center.
9. At the present time there is not an effective system for quality control of fortified sugar for the purpose of regulating production. The responsibility for this activity has been assigned to ASAZGUA in each factory; its staff have been trained to carry out a simple colorimetric test. Nevertheless, the level of training, the other responsibilities of these individuals, the characteristics of the analysis and sampling procedure result in the need to improve this process being imperative.
10. The analytical work done by LUCAM is adequate, requiring only assured availability of materials to increase its work capacity.
11. DRCA has done its work responsibly, although because of financial limitations, it has not been able to monitor the quality of sugar in the hands of distributors and retail stores. Since the bags of sugar have reliable identification permitting one to know where and when they were produced, it is not necessary to take samples at the factories. The monitoring activity could concentrate on obtaining samples at distribution centers and at consumer level.
12. The discovery that a substantial proportion of sugar from distribution centers and homes has a low concentration of vitamin A dictates that the causes and remedies be sought.
13. Preparation and publication of production manuals is a real necessity and could be done with little effort and resources.

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ANNEXES (Fortification of Sugar)

FORTIFICACION DE AZUCAR CON VITAMINA A
Guatemala, octubre 1991

ANTECEDENTES:

La encuesta nutricional de INCAP en 1965 puso de manifiesto la deficiencia de Vitamina A en una gran parte de la población guatemalteca. El INCAP propuso como solución la fortificación del azúcar con Vitamina A, hizo toda la investigación necesaria e impulsó la legislación correspondiente. Para más detalles se puede consultar el informe "Situación del Programa de Fortificación de Azúcar con Vitamina A en Guatemala en 1991" (Anexo 1). Este informe fue presentado en la "Reunión de Trabajo del Grupo VITAL", celebrada en Puerto Rico el 27 de septiembre 1991. Posteriormente el informe fue revisado por el Ing. Leonel Anleu de la "Asociación de Azucareros de Guatemala" (AZASGUA), se hicieron algunas correcciones y se agregaron ciertas observaciones (1). El INCAP ha planificado una serie de actividades para evaluar el programa de fortificación y sugerir algunas mejoras para después utilizar el programa de Guatemala como modelo para otros países. El ASAZGUA ha ofrecido todo su apoyo y colaboración para estas actividades.

LEGISLACION:

- "Decreto 56-74", del 11 de junio 1974.
- "Decreto Ley 145-85", del 27 de diciembre 1985: Modificación del Decreto 56-74.
- "Reglamento para el enriquecimiento del azúcar con Vitamina A" SP-G-105-74, del 2 de mayo 1975.
(Anexo 2).

Según esta legislación toda el azúcar que se expende en Guatemala debe ser fortificada con Vitamina A a un nivel de 13-15 ug/g (ppm = partes por millón). Se prevén excepciones que en cada caso deben ser autorizadas por el MSPAS previo dictamen de INCAP. El INCAP debe prestar asesoría a los ingenios para la correcta fortificación del azúcar. La DGSS es responsable de hacer inspecciones en los ingenios, de tomar muestras en ingenios y expendios, de analizar las muestras en sus laboratorios y de imponer sanciones en caso de incumplimiento de la ley.

CUMPLIMIENTO DEL PROGRAMA:

El programa funcionó adecuadamente de 1975 al 1977. Entre 1978 y 1986 no hubo fortificación. El INCAP hizo grandes esfuerzos para impulsar nuevamente el programa, el cual comenzó en forma significativa durante la zafra 1987/1988. Desde entonces el INCAP ha analizado un gran número de muestras como parte de su programa de asesoría a los ingenios.

El cambio de autoridades en el Departamento de Registro y Control de Alimentos (DRCA) del MSPAS en 1986 fué un factor decisivo para el reinicio de la fortificación del azúcar. Se contó con apoyo político y se sostuvo la exigencia a los ingenios de cumplir con la ley. Se siguió con el control, a pesar de problemas muy serios de todo tipo, tanto institucionales como personales.

En 1986 el DRCA comenzó a presionar a los ingenios. Sin embargo, había muy poca respuesta durante la zafra 1986/1987. De 49 muestras analizadas en agosto 1987, provenientes de 14 de los 18 ingenios existentes, solamente 2 muestras tenían Vitamina A y en niveles bajos (5 y 7 ug/g). Todos los ingenios fueron sancionados. Los ingenios comenzaron a fortificar el azúcar en la zafra 1987/1988, así, que de las 21 muestras analizadas en diciembre 1987, 18 estaban fortificadas.

El control del cumplimiento de la ley corresponde al MSPAS, pero los recursos para llevar a cabo las actividades de inspección y análisis son limitados. Sin embargo, se ha dado prioridad al programa de alimentos fortificados, y han habido grandes logros. Debido a los escasos recursos del DRCA, el muestreo de azúcar para control se ha hecho principalmente en los ingenios, mientras que a nivel de expendio el muestreo ha sido escaso.

Como lo exige el Reglamento, el análisis de control de Vitamina A en azúcar se hace en el Laboratorio Unificado de Control de Alimentos y Medicamentos (LUCAM) del MSPAS. El LUCAM ha hecho una extensa investigación metodológica para el análisis de Vitamina A en azúcar, debido a que el método tradicionalmente utilizado es largo y no es conveniente para el análisis de un gran número de muestras (2). El método actualmente utilizado en el LUCAM es confiable, económico, utiliza poco material y es más rápido; una persona puede analizar 20-30 muestras diariamente.

En 1987 se analizaron 70 muestras, en 1988 1048 muestras, en 1989 1199 muestras y en 1990 515 muestras. Durante la zafra 1990/1991 se tomaron en los ingenios alrededor de 1200 muestras que fueron analizadas como 300 muestras compuestas. En el mes de junio 1991 se tomaron además 44 muestras en expendio. Durante el mismo período en 1991 el INCAP analizó alrededor de 100 muestras tomadas en expendio y en hogares.

Los resultados obtenidos entre 1987 y 1991 se pueden observar en las siguientes tablas:

**TABLA NO 1
MUESTRAS TOMADAS EN INGENIO
MSPAS (3,4)**

	1987	1988	1989	1990	1991
Número de muestras	70	1048	1199	515	1203
% con Vitamina A	29	85	94	99	94
% con Vitamina no detectada	71	15	6	1	6
% con < 80% del nivel legal	15	68	76	69	50
% con 80-120% del nivel*	13	10	12	20	30
% con >120% del nivel legal	1	7	6	10	14

*Tomando en cuenta el error analítico, el rango de 12-18 ug/g (80-120 % de 15 ug/g) se considera como aceptable y en cumplimiento de la ley.

Informe mas detallado: Ver Anexo 3.

La Comisión Guatemalteca de Normas (COGUANOR), que según el Decreto Legislativo 23/87 tiene la potestad de verificar la calidad de alimentos con normas COGUANOR vigentes, tomó en marzo 1991 4 muestras de azúcar de la zafra 1990/1991 en cada uno de 15 ingenios que producen azúcar blanca para consumo interno. Las muestras fueron analizadas en el LUCAM con los resultados reportados en la Tabla No.2 (5). Para fines de comparación, los resultados del MSPAS para la misma zafra, ya reportados en la Tabla No. 1, se encuentran entre paréntesis.

**TABLA NO 2
MUESTRAS TOMADAS EN INGENIO
COGUANOR. Marzo, 1991**

No. de muestras:	60	(1203)
% con Vitamina A:	98	(94)
% con Vitamina no detectada:	2	(6)
% con < 80% del nivel legal:	43	(50)
% con 80-120 % del nivel:	32	(30)
% con >120% del nivel legal:	23	(14)

TABLA NO 3
MUESTRAS TOMADAS EN EXPENDIO Y EN HOGARES
Junio, 1991
MSPAS, INCAP (1, 3, 4)

Departamento	n	% del nivel legal			
		nd*	<80%	80-120%	>120%
DRCA					
Zacapa	8	12	88	0	0
Chiquimula	9	0	67	22	11
Quetzaltenango	11	27	64	0	9
Totonicapán	4	50	25	0	25
Antigua	5	20	80	0	0
Jutiapa	5	0	100	0	0
INCAP					
Guatemala Ciudad	30	32	64	3	1
	(aprox.)				
San Marcos y Quetzaltenango	30	52	48	0	0
	(aprox.)				
Costa Sur	30	52	48	0	0
	(aprox.)				

*nd = no detectado, < 1 ug/g.

DISCUSION DE RESULTADOS

En la Tabla No. 1 se puede notar que a partir de la zafra 1987/1988 el azúcar se está fortificando en Guatemala. Según los resultados de las muestras tomadas en ingenio, el 90-100 % del azúcar tiene Vitamina. Sin embargo, es mucho menor la proporción de las muestras que tienen niveles de Vitamina A dentro de los límites establecidos por la ley; fué de 30 % en 1991. Es importante notar la gran similitud entre los resultados obtenidos en 1991 en 2 programas de control diferentes, el del MSPAS y el de la COGUANOR (Tabla No. 2)

Aunque la cantidad de muestras tomadas en expendio es mucho más baja que la tomada en centros de producción, los resultados de las 150 muestras aproximadamente tomadas en tiendas y hogares en 1991, sugieren que en la mayoría de los casos el azúcar que llega realmente al consumidor no tiene Vitamina A o tiene niveles mucho más bajos que los que se encuentran a nivel de ingenio. Es importante analizar las posibles causas y sus soluciones:

1) Estabilidad del azúcar fortificada:

Hay indicios de que la estabilidad de la Vitamina A en el azúcar fortificado es menor de lo que se había asumido. En el INCAP se está llevando a cabo un estudio para tener más información al respecto. En el LUCAM el reanálisis de algunas muestras de azúcar fortificada, almacenado en el laboratorio durante cierto tiempo, demostró disminución en los niveles de Vitamina. Es muy importante que estos aspectos se investiguen a fondo.

2) Tecnología de fortificación:

Los resultados obtenidos en los programas de control sugieren que la tecnología actualmente utilizada para fortificar el azúcar no permite la producción de lotes uniformes y homogéneos. Muchas veces resultados muy bajos se observan junto con resultados muy altos, dentro del mismo ingenio. Los resultados de COGUANOR de 4 muestras tomadas simultáneamente en el mismo ingenio son los siguientes: no detectado (0), 9, 15 y 34 ug/g. El promedio de estos valores es 14.5 ug/g, valor dentro de los límites legales. Esto sugiere que el ingenio sí agregó al azúcar la cantidad requerida de Vitamina A, pero que la distribución fue inadecuada. Cuando este azúcar llega al consumidor, algunas personas no reciben Vitamina alguna, mientras que otras reciben cantidades que duplican las previstas por la ley.

Este mismo fenómeno se ha observado en el LUCAM. Muchas veces los valores obtenidos de un mismo ingenio son dispersos, pero el promedio se acerca al nivel aceptable. Algunos valores encontrados son muy altos; en 1990 se analizó una muestra con 104 ug/g de Vitamina A.

Debe ser prioritario investigar la tecnología utilizada. Existen varias posibles causas de esta situación; puede haber variación en la cantidad de pre-mezcla agregada, puede haber cierta segregación de la Vitamina dentro de los costales durante el almacenamiento o una mala homogenización. Podría pensarse que la "Asociación de Azucareros de Guatemala" contrate a un experto que trabaje con el problema bajo la asesoría de INCAP.

3) Azúcar tipo industrial:

Según la legislación vigente "azúcar no fortificada podrá dedicarse al mercado interno con previa y expresa autorización del Ministerio de Salud Pública y Asistencia Social, y siempre que sea para aquellos usos en los que, en cada caso, se compruebe fehacientemente por un organismo técnico adecuado, la inconveniencia, la no justificación y/o la incompatibilidad del aditivo". "El organismo técnico encargado de determinar los casos contemplados en dicho artículo será el Instituto de Nutrición de Centro América y Panamá (INCAP)".

El DRCA hizo a INCAP una consulta en relación a posibles excepciones, a la cual se respondió que éstas son escasas y que es necesario considerar cada caso por separado. Sin embargo,

excepciones, a la cual se respondió que éstas son escasas y que es necesario considerar cada caso por separado. Sin embargo, varios ingenios han procedido a producir "azúcar tipo industrial", sin autorización previa. El DRCA ha iniciado 6 procesos legales para sancionar este procedimiento.

Se considera posible que parte de este azúcar haya podido ser vendido en el mercado. Es imperativo controlar que esto no suceda.

4) Legislación:

El INCAP ha firmado un contrato con Lic. Helio Urzúa para revisar y proponer cambios a la legislación relacionada con alimentos fortificados. Se considera que los artículos sobre las excepciones para la fortificación del azúcar deben ser eliminadas. Se ha usado como argumento que en ciertos procesos industriales la Vitamina A se destruye, lo que justificaría el uso de azúcar no fortificada. Sin embargo, se considera poco probable que existan procesos industriales con las cuales la Vitamina interfiere y por lo tanto, por razones de control, toda la producción de azúcar sulfitada debe ser fortificada. El azúcar que se exporta es cruda y no se puede confundir con el azúcar blanca, sulfitada.

5) Sistema de control:

Una legislación adecuada y una tecnología apropiada no son suficientes si no existe un extenso programa de control que asegure el cumplimiento de la ley. La responsabilidad del control, según la ley, es del MSPAS, a través del DRCA y el LUCAM. Es importante que estas dos dependencias cuenten con recursos suficientes para cumplir plenamente con sus funciones. Con los recursos existentes se han hecho grandes esfuerzos al respecto y los logros son muchos. Sin embargo, es necesario expandir las actividades de control.

Se ha preparado un proyecto para buscar financiamiento externo para optimizar el programa de control de alimentos fortificados, que incluye Vitamina A en azúcar, yodo en sal y minerales y vitaminas en harina. El proyecto "Fortalecimiento del Programa de Control de Alimentos Fortificados en Guatemala" fue presentado a UNICEF y al Director de la OPS en diciembre 1989, pero no se logró el apoyo solicitado. El monto del proyecto es de \$ 100,000.

El proyecto se presenta en Anexo 4.

APOYO POLITICO

Para que el programa de control pueda tener el impacto necesario, es absolutamente necesario contar con un apoyo político absoluto. Para lograr que la ley se cumpla, es a veces necesario tomar medidas drásticas que representan pérdidas económicas importantes y que encuentran una fuerte oposición por parte de los

CONCLUSIONES:

Para que el programa de alimentos fortificados pueda funcionar satisfactoriamente, se considera necesario priorizar los siguientes aspectos:

- 1) Tecnología adecuada.
- 2) Legislación actualizada.
- 3) Reforzamiento del programa de control.
- 4) Apoyo político.

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- 2) Comisión Guatemalteca de Normas (COGUANOR): "Aditivos alimentarios para consumo humano. Determinación de Vitamina A en azúcar". Norma NGO 34 147 h 1.
- 3) Departamento de Registro y Control de Alimentos (DRCA), MSPAS. 1986-1991.
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- 5) Comisión Guatemalteca de Normas (COGUANOR). 1991.