FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Monitoring of Fortified Food Programs at Sales Sites in Honduras

Results Report

USAID
FROM THE AMERICAN PEOPLE

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Executive Summary

Food fortification is one of the most cost-effective strategies, when correctly implemented and under the appropriate conditions, to address micronutrient deficiencies. Since the 1960s, Honduras has had public health programs for food fortification. However, these programs were not active all the time. In the 1990s, programs for salt and wheat flour were reactivated, and one for sugar was introduced. Currently, in Honduras salt must be fortified with iodine; sugar with vitamin A; and wheat flour with iron, thiamin, riboflavin, niacin, and folic acid. Additionally, some foods are voluntarily fortified, such as nixtamalized corn flour and milk.

Despite the existence of all these programs for many years, the country lacks up-to-date information on compliance with established fortification regulations. The objective of this study was to obtain recent information on the sales outlets, on the micronutrient content of foods that must be fortified in the country (sugar, salt, and wheat flour), as well as some foods that are fortified. voluntarily (nixtamalized corn flour and milk). Powdered bouillon and cubes were also included to determine the use of iodized salt in their manufacture. Based on the results of this study, recommendations have been made aimed at different key actors in the country, to improve the performance of fortification programs.

The study was designed to obtain data on fortified foods with regional representativeness. For this, samples were obtained from 14 municipalities and the same number of departments. These municipalities were distributed in the six geographic regions of Honduras: Western, Northwestern, Northeastern, Central Western, Central Eastern, and Southern. Each of these regions was represented by either two or three municipalities. For each region, 12 units of sugar, 12 units of salt, and 12 units of culinary products (either flavoring cubes or bouillon), 6 units of milk, 6 units of wheat flour, and 6 units of corn flour were taken. This total number of samples was distributed among the two or three municipalities of each region. Thus, if there were two municipalities, each of them contributed half of the samples. If there were three municipalities, each of them contributed a third of the samples. The priority departments of USAID Advancing Nutrition, Copán, Lempira, Ocotepeque, Santa Bárbara, and the USAID work regions characterized by high migration, were included.

In each of the selected municipalities, the largest establishment (warehouse, supermarket or grocery store) or where there was the greatest commercial movement was identified. Samples were purchased as any consumer would. In the selection of units, all products available in the establishment were considered, regardless of the type (for example, white or brown sugar, coarse or refined salt), the brand of food, or whether it was domestically produced or imported. All samples were sent to the laboratories of the Integral Analytical Center (CAI) of the Institute of Nutrition of Central America and Panama (INCAP), where micronutrients in food were quantitatively determined. In the case of wheat flour and nixtamalized corn, and milk, iron was determined, which is usually used as an indicator micronutrient due to its ease of quantification compared to vitamins, and folic acid was determined in a smaller number of samples to confirm also fortification with vitamins.

All the sugar samples taken (n = 71) were packaged and fortified by the Central de Ingenios SA (CISA) and 100 % indicated on the label that they were fortified. 100% of the samples were identified as fortified. 63 % of the samples contained vitamin A levels above 4 mg/kg, which is the legal minimum established in the Honduran Technical Regulation (Agreement No. 4667, 2016). The national average content of vitamin A was 5.2 ± 2.6 mg/kg and the average results by region varied between 4.6 mg/kg (Western region) and 6.1 mg/kg (Southern region), except in the Northeast region where a vitamin A average of 3.1 mg/kg.

Of the salt samples taken (n = 78), 26.9 % were coarse and wet, and 73.1 % were dry and ground. It was found that 86% of the samples contained iodine (levels above 5 mg/kg), although not necessarily at levels sufficient to meet the World Health Organization (WHO) requirement that salt must contain 20 -40

mg/kg in production, so that in homes the salt has 15 mg/kg. 55% of the samples have iodine levels above 20 mg/kg. The average iodine in the regions was between 28.8 mg/kg in the Central Eastern region and 51.8 mg/kg in the Northwestern region, except in the Western region where the average was 13.3 mg/kg. The percentage of samples with levels below 20 mg/kg in each region was between 25% in the Southern region and 91.7% in the Western region, indicating that a percentage of samples do not meet the required iodine level. The results obtained confirm the need to resume training aimed at the salt sector in the salt iodization process and the recommended practices for quality assurance and control.

Regarding the public sector, it is recommended that the Health Regulation Agency (ARSA) resume monitoring of salt iodization to ensure compliance, while the Ministry of Health updates the salt iodization regulation that dates back to the 1960s and which stipulates very high iodine contents (67-100 mg/kg). Considering that there are currently other sources of iodine, such as bouillon powder and cubes, it is necessary to adjust the iodine content in the salt. It is also recommended that urinary iodine excretion be monitored in the population to determine iodine intake, and take appropriate measures as necessary, which could include adjusting levels of iodine from salt to ensure optimal iodine nutrition, without excess or deficiency.

From the samples of culinary products (consommé powder and cubes), six brands were identified, of which two were Honduran-made. All brands showed average iodine levels between 33.8 mg/kg and 46.7 mg/kg, except for one of the Honduran brands, which averaged 10.6 mg/kg. It was estimated that 91.8% of all samples consisting of bouillon and ice cubes contained iodine levels above 20 mg/kg. This indicates that the food industry that manufactures these products, with very few exceptions, does use iodized salt. At the national level , the average iodine obtained (35.7 mg/kg) in bouillon powder and cubes is similar to the average obtained in salt for direct consumption (35.6 mg/kg). This confirms that, as long as there is a salt iodization regulation that indicates that the salt used in food processing must be iodized, the industry will follow the requirements to ensure compliance with the regulations in force in the country.

For wheat flour (n = 36), based on the intrinsic iron level of wheat flour, which is between 10-20 mg/kg, it was found that 100% of the samples were identified as fortified. 87 % of the samples met the minimum of 55 mg/kg of iron content indicated in the Central American Technical Regulations and all contained iron levels above 40 mg/kg.

It was found that 27.8 % of the nixtamalized corn flour samples were fortified, based on iron content above 25 mg/kg, the limit established in this study to affirm that they were fortified. These results show that the voluntary fortification of nixtamalized corn flour, although not universal, is being applied in the country. Corn flour is a good vehicle for delivering micronutrients to the population and can be better utilized, especially considering that, according to the opinion of some corn flour processors, Honduras has a percentage of "flourization" (that is, the percentage of use of corn flour to replace the use of grain corn) between 70% and 75%, higher than other countries in the region.

Regarding the milk samples, 46.2% were powdered milk and 53.8% were long-life fluid milk or processed at ultra high temperatures (UHT). 33.3% of the powdered milk samples and 14.3% of the fluid milk samples had less than 0.5 mg/100 g of iron. Based on the intrinsic iron content in milk reported in the INCAP Food Composition Table for fluid milk (0.08 mg/250 ml) and powdered milk (0.47 mg/100 g), it can be said that these samples were not fortified with iron, that is, they contained less than 0.5 mg/100 g or 0.5 mg /250 ml of iron. Of the fluid milk samples, 85.7 % were fortified, as well as 66.7 % of the powdered milk samples. In general, the practice of fortifying milk is applied by most of the brand producers present in Honduras, including one of the national producers, which is why the country has the experience to provide fortified milk in the Glass of Milk program. The status of this program in the country is unknown, but it is recommended that the fortification specifications to be met by milk suppliers to the program be clearly defined.

The results of this study have the limitation that they apply to wheat flour and nixtamalized corn marketed in 2 lb (approximately 1 kg) packages, since samples were not taken in 25 lb (11 kg) and 50 lb packages (22 kg), which are generally used in bakeries, wheat derivative factories or tortilla shops. In the case of milk, the results apply to long-life or UHT fluid milk and the fortification situation of pasteurized milk is unknown, since the cold chain could not be guaranteed in the sampling. In the case of salt, the results reflect the situation of salt that has a sanitary registry and that is marketed in legally established outlets, but it is unknown what percentage of non-fortified salt, a product of informal trade directly from the salt flats, is present in the country market.

It is recommended that the Sanitary Regulation Agency (ARSA) resume the monitoring activities of the mandatory fortification programs, giving priority to factory monitoring, to cover all the product from the origin, where it is easier to take corrective actions if deficiencies are found. in the fortification process.

Regarding strategies to reduce sugar and salt consumption for the prevention of non-communicable diseases related to their high consumption, food fortification is a strategy that is not incompatible with them, since reduction programs Consumption guidelines for these products can be implemented, and fortification can be adjusted when necessary, as indicated by the results of periodic monitoring of food consumption and the micronutrient nutritional status of the population.

It is important to recognize that the Honduran wheat flour and sugar industry have maintained their compliance with the fortification regulations that apply to them, despite the lack of incentives and supervision by the regulatory body. It is recommended that this effort be recognized by the authorities as a way of motivating the industries that comply with the established obligation and the contribution they have made to the nutrition of the Honduran population through fortification.

Background

Food fortification, when properly designed and implemented under the appropriate conditions, is one of the most cost-effective strategies to address micronutrient deficiencies. Since the 1960s, Honduras has had public health programs for food fortification; however, they were not active all the time and in the 1990s, they were reactivated. Currently, in Honduras salt must be fortified with iodine, sugar with vitamin A, and wheat flour with iron, thiamine, riboflavin, niacin, and folic acid. There is also voluntary fortification of nixtamalized corn flour and milk with micronutrients such as iron, folic acid and vitamin D.[1]

Despite the existence of all these programs for many years, the country lacks current information on compliance with established fortification regulations. The most recent data in Honduras belong to a study carried out in 2018 in the department of Intibucá, where samples of fortified foods were collected in homes. The results showed that 58% of the salt samples (n = 52) had iodine levels above 15 mg/kg, and that 150 µg of iodine is enough to cover the daily dietary recommendation (RDD) of iodine. per day for adults [2], assuming an availability of 10 grams of salt per person per day. The same study showed that the per capita daily availability of sugar was 44.7 grams. 96% of the sugar samples (n = 49) contained levels above 3.5 mg/kg (minimum level expected in homes for sugar fortification to have a biological effect when consumed by the population) and the average vitamin A in the samples analyzed it was 8.3 mg/kg. This information shows that fortified sugar is reaching homes in Intibucá with levels of vitamin A that predict a biological impact on the population. Wheat flour samples purchased at retail outlets were also analyzed for iron content, although the information obtained was limited as only 5 samples were taken.[3]

This information, which is the most recent, was collected in a specific area of the department of Intibucá and it is necessary to know the current situation of fortified food programs at the national level to guide actions aimed at improving the performance of food fortification programs, food and, consequently, the micronutrient status of the population, especially in the context of the COVID-19 pandemic that had various effects in the countries.

[1]COMISCA/IDB/FANCAP. Consulting report. Central American Food Fortification Project with Folic Acid and other Micronutrients as a Regional Public Good. March, 2009.
[2]Applies to adults, except pregnant women. The daily dietary recommendation for pregnant women is 200 µg. Allen L, de Benoist B, Dary O and Hurrell R. (Eds). Guidelines for food fortification with micronutrients. Geneva, FAO/WHO. 2006. 341 p.
[3]INCAP/PAHO/USAID. Phase B Results Report: Prototype test of nutritional surveillance through a community study in Intibucá, Honduras Project "Generation of Valid and Reliable Information on Micronutrient Deficiencies in Children 6-59 Months and Women of Childbearing Age Resident in Seven Communities of the Department of Intibucá in Honduras".

Objectives

1. Obtain recent information on the micronutrient content of foods that must be fortified in the country (sugar, salt, and wheat flour, and in culinary products in which salt is the main ingredient), as well as some foods that are voluntarily fortified, such as nixtamalized corn flour and milk, at retail locations.
2. Make recommendations to improve the performance of fortification programs addressed to the different key actors that have a role in these programs.

Methodology

Selection of foods and micronutrients to include in the study

For the design of the sampling and the selection of the foods that were included, the following aspects were taken into consideration:

- the fortification mandatory in Honduras it applies to sugar, salt, and wheat flour.
- were included cubes, consommés or broths in powder, and were called together as "culinary products" were taken samples of these products by considering the following:
  - these products are primarily salt (50% or more in content),
  - in many communities totally or partially replace salt at discretion (table salt and kitchen salt) ,
  - the food industry should use salt fortified with iodine.
- Fortification of nixtamalized corn flour (HMN) is voluntary in Honduras, and it is known that the producers fortify following the example of some neighbors (Guatemala and El Salvador) that do so on a mandatory basis. Possibly they are HMN samples that comply with the legislation of those countries, since company's producers are the same and the production process is also the same.
- Although there is no health program for public fortification of milk, in Honduras there is the Law of the Glass of Milk for the strengthening of the school snack (Decree No. 54-2010) and that requests that the milk that is distributed in schools ought to be fortified. for another side , industry dairy processor in the region voluntarily fortified to add added value to the product and so can compete better with products from Costa Rica, a country that requires fortification compulsory milk.
- Based on the results of the study carried out by INCAP and PAHO in Intibucá in 2018, it was decided take milk samples from plastic bags or Tetrapaks, and milk in dust. I Intibucá, it was found that 51.7 % of households visited indicated that they drink fluid milk from a plastic bag, 25.9 % indicated who drink "milk at the foot of the cow" (that is, raw, unpasteurized, freshly milked milk) and 19.0% drink powdered milk.

Table **1** presents the selected foods and the micronutrients that were quantified according to the food. In sugar, vitamin A was determined; iodine in salt and selected culinary products, iron and folic acid, in wheat and corn flour, and milk. In all flour and milk samples, the iron content was quantified. In the case of folic acid, quantification was only performed in one in four samples per type of food, because the cost

of analyzing folic acid is 4 times the cost of analyzing iron. On the other hand, considering that the micronutrients are in the same premix, both micronutrients should be at the levels indicated in the regulations or the nutritional labeling of the product. Folic acid analysis was included as confirmation of this. Regarding the analyzes of the selected culinary products, samples composed by brand and by type of product were formed, that is, samples composed of cubes or bouillon were formed separately.

Table 1. Selected foods and micronutrients evaluated in the study.

Selected food	Fortification type	Micronutrients analyzed	Testing method
Sugar	compulsory	Vitamin A	INCAP-spectrophotometric
Salt sold directly or contained in selected culinary products (powdered bouillon and cubes)	compulsory	Iodine	INCAP-kinetic spectrophotometric
Wheat flour	compulsory	Iron and folic acid	Colorimetric/Microbiological AOAC
Nixtamalized corn flour	volunteer	Iron and folic acid	Colorimetric/Microbiological AOAC
Long lasting fluid milk	volunteer	Iron and folic acid	Microbiological MP-EAS/AOAC
Milk powder	volunteer	Iron and folic acid	Microbiological MP-EAS/AOAC

All the samples were sent by land to Guatemala to be analyzed in the laboratories of the Integral Analytical Center (CAI) of the Institute of Nutrition of Central America and Panama (INCAP).

Study design

Sample size

For the calculation of the sample size, it was considered that the results were representative by geographical region of the country and the variability of the fortification process of each particular food. For sugar and salt, a variability of 35% was considered, based on data from the vitamin A sugar fortification program in Guatemala and the observed variability of salt in the Guatemalan data. In the case of the selected culinary products, the same variability was used, considering that they contain more than 50% of salt as an ingredient. [4]For milk and corn and wheat flours, the variability taken was 25% based on the [5]food fortification formulator. [4] For each region, they had to take 12 units of sugar, 12 units of salt and 12 units of selected culinary products, 6 units of milk, 6 units of wheat flour and 6 units of corn flour.

Selection of departments and municipalities

The six administrative regions of the country considered were the Western, Northwestern, Northeastern, Central Western, Central Eastern, and Southern (see **Figure 1**). In total, 14 departments and one municipality for each of the selected departments were randomly selected. The priority departments of the USAID Advancing Nutrition project, Copán, Lempira, Ocotepeque, Santa Bárbara, and USAID work

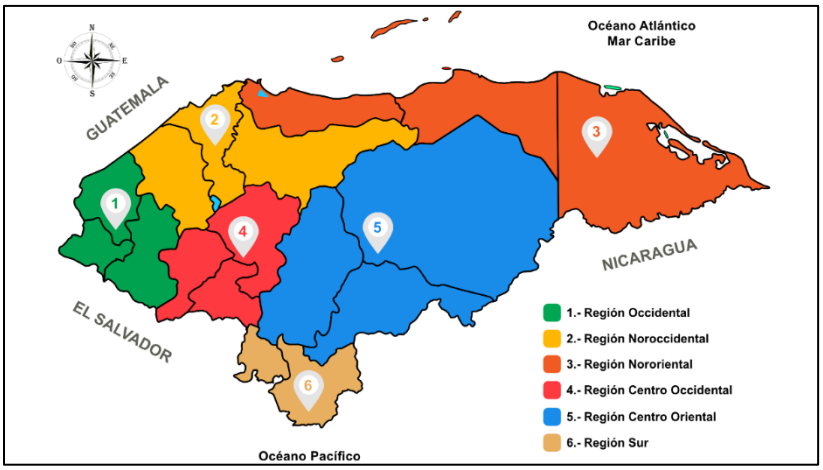
[4]Sugar, salt, selected culinary products (bouillon powder and cubes): n = 3.2×CVE2=3.2×0.350.332=12 , CV: coefficient of variation, E: precision Milk and flour: n = 3.2×CVE2=3.2×0.250.332=6

[5] Dary O and Hainsworth M. The Food Fortification Formulator : Technical Determination of Fortification Levels and Standards for Mass Fortification. A2Z Project/USAID/Academy for Educational Development. 2008. 29 p.

regions characterized by high migration, were included. Table **2** shows the departments and municipalities selected by region, as well as the identification code used by the National Institute of Statistics and the National Registry of Persons of Honduras.

The accessibility to the municipality was the main inclusion criterion that was taken into consideration for the selection of the municipalities. Access was considered difficult if any of the following situations occurred: lack of passable roads, flooding or landslides that impeded access or violence (regions classified as "red") and that represented a risk to people responsible for taking the sample. If any of these situations occurred, another municipality would be selected again, randomly to replace it, always within the same department. None of these situations happened and it was not necessary to change the initially selected municipality.

Figure 1. Regions: geographical areas of Honduras



Taken from: Red Honduras. Geographic Regions of Honduras. https://redhonduras.com/geografia/regiones-geograficas-de-honduras/1. Western Region 2. Northwest Region 3. Northeast Region 4. Central West Region 5. Central East Region 6. Southern Region

The number of samples to be obtained by region was distributed among the selected municipalities. Therefore, in the Western region, where 3 municipalities were considered, it was planned to take 4 samples of sugar, 4 samples of salt, 4 samples of culinary products (2 of bouillon and 2 of cubes), 2 of milk, 2 of flour wheat and 2 corn flour in each selected municipality. In the rest of the regions, where only 2 municipalities were selected, it was planned to take 6 salt samples, 6 sugar samples, 6 culinary product samples (3 bouillon powders and 3 cubes), 3 milk, 3 flour wheat and 3 corn flour in each selected municipality. In the Northeast region, more samples were taken than initially considered, because during the field work the opportunity to take samples in Roatán (Bay Islands) arose, which had not been initially considered due to its accessibility. In some regions it was not possible to complete the number of samples due to lack of availability in the selected municipality. The detail of the samples that were taken by region is described in the results section.

Table 2. Departments and municipalities selected for the study.

No. –	Region	Department	Selected municipality	Unique identification code ++
1	Western	Ocotepeque	Belen*	1402
2	Western	Copan	Copan Ruins*	0404
3	Western	Lempira	Lapaera *	1313
4	Northwest	Cortes	San Francisco de Yojoa	0510

No. –	Region	Department	Selected municipality	Unique identification code ++
5	Northwest	Santa Barbara	Macuelizo*	1613
6	Northeast	Atlantida	Esparta	0103
7	Northeast	Colon	Santa Fe	0206
8	Northeast	Bay Islands	Roatan	1104
9	West Central	Intibucá	San Francisco de Opalaca	1017
10	West Central	La Paz	La Paz	1201
11	Eastern Center	Francisco Morazan	Central District	0801
12	Eastern Center	Olancho	Patuca	1523
13	South	Choluteca	Corpus	0605
14	South	Valle	San Lorenzo	1709

* Priority municipalities of the Advancing Nutrition/USAID project.

++ Source: National Institute of Statistics and National Registry of Persons of Honduras

Buying fortified foods

Prior to the purchase of the food, a remote training was carried out to explain to the field staff each of the details of the sample purchase and to resolve doubts. The training included the explanation of the instructions with the details of the number of samples to be taken for food in each municipality, their selection, labeling, care in handling and shipping to Tegucigalpa (Annex 1), the correct completion of the registration form for the samples taken (Annex 2), and how to perform georeferencing using Google Maps .

In each of the selected municipalities, the largest establishment (warehouse, supermarket or grocery store) or where there was the greatest commercial movement was identified. This was determined through observation or questions of passers-by. This is a strategy generally used when a strict random selection cannot be made from the statistical point of view due to lack of information. In cases where there was more than one establishment that met the characteristics, one was selected at random. Because there is no updated national list of outlets, a random selection could not be made based on it.

Samples were purchased as any consumer would. In the selection of units, all products available in the establishment were considered, regardless of the type (for example, white or brown sugar, coarse or refined salt), the brand of food, or whether it was domestically produced or imported. In general, for all foods, an attempt was made to select one unit of each brand and type of food (that is, an attempt was made to include coarse and refined salt, brown and white sugar, fluid and powdered milk, ice cubes, and consommés) available in the establishment, until completing the required number.

Results

The results of the study are presented below, both at the national level and broken down by region. For some foods, data by brand is also presented for informational purposes only, since the study was not designed to be representative by brand and the limited number of samples that were obtained for some of them; therefore, no conclusions can be drawn on compliance or not with the regulations in force by brand.

Vitamin A Fortified Sugar

In total, 71 sugar samples were taken, of which 6% corresponded to brown sugar. Due to the small number of brown sugar samples (n = 4), the analysis of results was not broken down by sugar type. 34 % of the samples corresponded to the Doña Matilde brand (standard white sugar), 6 % to Doña Matilde Morena (brown sugar), 39 % to El Cañal and 21 % to the Prieta brand. All the brands indicated that the manufacturer is Central de Ingenios SA de CV (CISA) and 100 % of the samples indicated on the label that they were fortified.

The Honduran Technical Regulation for the Fortification of Sugar with Vitamin A (Agreement No. 4667 of 2016) [6]indicates that the vitamin A fortification levels that must be met are 4-12 mg/kg of sugar if the fortification is carried out in plants packing houses and 8-20 mg/kg if carried out in mills. According to an interview with CISA and the packaging of the samples, all the sugar is fortified in the packing plants. Although the regulation only indicates a range, in order to achieve compliance with the minimum of 4 mg/kg, the theoretical (average) target fortification level should be 8 mg/kg of vitamin A, considering process variations in the sugar fortification. Table **3** and **Figure 2** show the distribution of the results in different intervals of vitamin A, selected based on the Technical Regulation. 37 % of the samples showed levels below the legal minimum established in the regulation (4 mg/kg) and this is possibly due to the fact that the target level is close to the lower limit, 4 mg/kg, and not to the average of the interval 8 mg/kg. No samples without vitamin A were found.

Table 3. Frequency of vitamin A results in sugar samples taken at outlets in Honduras-2022.

Interval of vitamin A (mg/kg)	Frequency (n)	Percentage (%)	Percentage accumulated (%)
<4.0	26	36.6	36.6
4.0-5.9	27	38.0	74.6
6.0-7.9	6	8.5	83.1
8.0-9.9	7	9.9	93.0
10.0-11.9	3	4.2	97.2
≥12.0	2	2.8	100.0
Total	**71**	**100**	

[6] Honduran Technical Regulations . Food and drinks. Fortification of sugar with vitamin A. Requirements. Agreement No. 4667. 2016. La Gaceta No. 34,222. December 26, 2016. http://extwprlegs1.fao.org/docs/pdf/hon168286.pdf.

Figure 2. Distribution of vitamin A (mg/kg) in sugar samples taken in outlets in Honduras-2022.

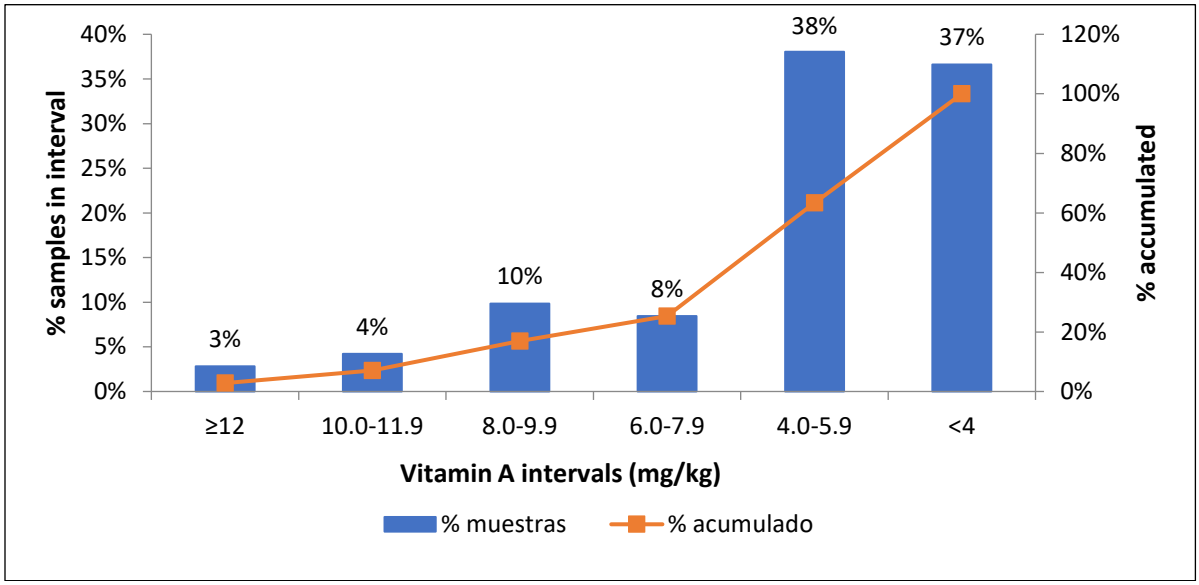


Table **4** and **Figure 3** present the results obtained for vitamin A found in the samples at the national level and for each of the regions where samples were taken. The national average for vitamin A was 5.2 ± 2.6 mg/kg (mean ± SD), and when disaggregating the results by region, all regions have averages between 4.6 mg/kg (Western region) and 6.1 mg/kg (West region, South), except the Northeast region that showed an average vitamin A of 3.1 mg/kg. According to the minimum values of vitamin A observed, all the sugar samples taken in the Central Western and Central Eastern regions contained values above the legal minimum established (4 mg/kg) in the Honduran Technical Regulations, but this was not the case for the rest of the regions, where samples with values below the legal minimum were found.

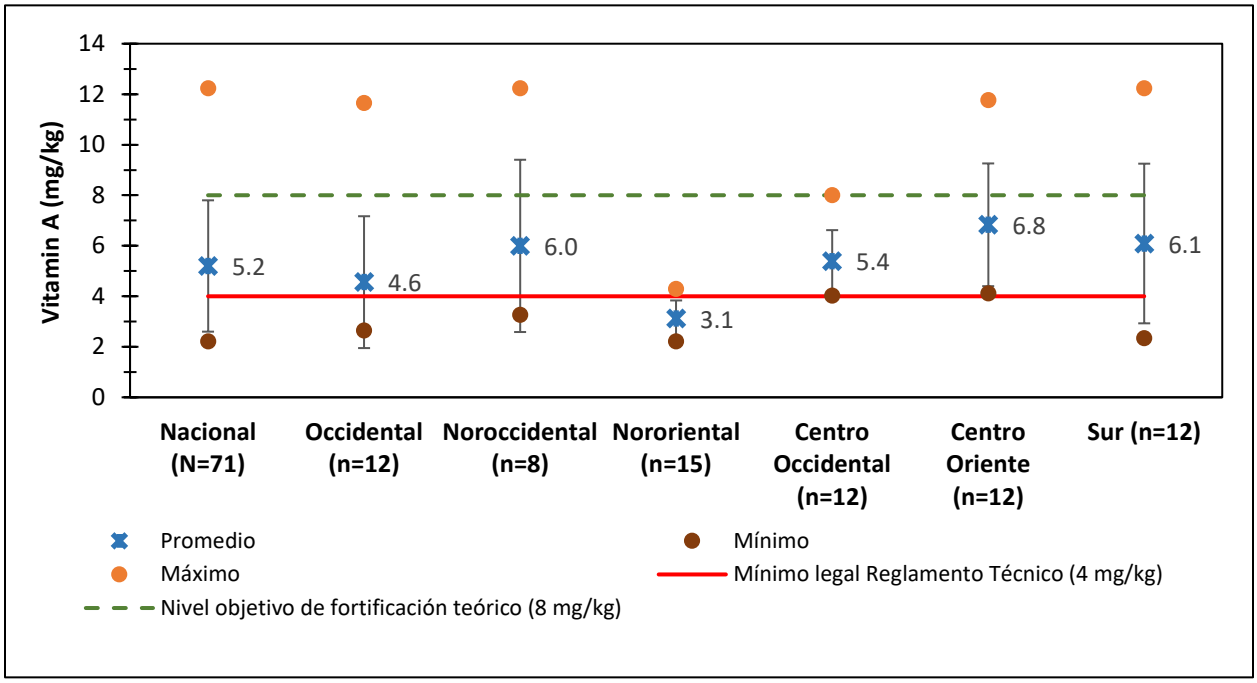
Table 4. Summary of the results of vitamin A in samples taken at outlets in Honduras-2022.

Region	Vitamin A (mg/kg)					
	Average	OF*	CV(%)*	Mini-mum	Maxi-mum	Median
National (n = 71)	5.2	2.6	50.0	2.2	12.2	4.3
Western (n = 12)	4.6	2.6	57.2	2.7	11.7	3.6
Northwest (n = 8)	6.0	3.4	56.9	3.3	12.2	4.5
Northeast (n = 15)	3.1	0.7	23.1	2.2	4.3	3.0
West Central (n = 12)	5.4	1.2	22.8	4.0	8.0	5.0
Eastern Central (n = 12)	6.8	2.4	35.6	4.1	11.8	6.2
South (n = 12)	6.1	3.2	51.9	23	12.2	5.5

*SD= Standard deviation. CV= Coefficient of variation (relative standard deviation).

In the case of the Northeast region, where the average found (3.1 mg/kg) is below the legal minimum, it is recommended to investigate the causes of this difference in relation to the other regions. Some of the causes that are recommended to be reviewed are: a) the turnover time in the commercial life of sugar in this region, which could be greater than that estimated by the manufacturer; b) that the sugar from this region comes from a specific plant that needs to review its process; and c) the climatic conditions of this region could be affecting the stability of vitamin A. In general, it is recommended to optimize the process in packing plants, adjusting the target level of fortification to the average (8 mg/kg) of the interval established by law. and improve process variation.

Figure 3. Results of vitamin A in sugar samples taken in outlets in Honduras-2022, at the national level and by region.



The results shown in **Figure 3** show that it is not recommended to use only vitamin A content intervals in the legislation, since the lower limit, 4 mg/kg in this case, tends to be used as the target level of fortification. It is necessary to place the average value, in this case 8 mg/kg, so that the variation of the process allows the concentration of vitamin A to be within the established intervals.

The results obtained show that, although it is necessary to optimize the sugar fortification process, 100 % of the samples were identified as fortified, and 63 % of the samples comply with the legal minimum established in the Honduran Technical Regulation for fortified sugar with vitamin A.

Iodine fortified salt

78 salt samples were taken, of which 26.9% were coarse and wet, and 73.1% were dry and ground. The sampling carried out for salt has the limitation that the results reflect the situation of salt that has a sanitary registry and that is sold in formal outlets such as warehouses, supermarkets and grocery stores. In an interview with the Association of Salt Producers of Honduras (ASOPROSALH), it was indicated that a problem with salt iodization is informal trade, because there are trucks that go directly to the salt mines to stock up on salt to distribute in markets and it is unknown if it is iodized.

Table **5** and **Figure 4** show the distribution of the results in different iodine ranges. The Presidential Agreement No. 531 [7]for the application of the Salt Iodization Law dating from 1961 indicates in Article 13 that salt must be iodized so as not to contain more than 1 part of iodine per 15,000 parts of salt. This is equivalent to saying that the salt must contain less than 67 mg of iodine per kilogram of salt. With this value as a reference, 65.4% of the samples contained iodine levels between 5-60 mg/kg ; however, this regulation does not refer to an interval that indicates the legal minimum required. If it is considered that the WHO recommendation is to fortify between 20-40 mg/kg so that upon arrival at home they have 15 mg/kg, 56.4% of the samples contain sufficient levels of iodine, that is, above 20 mg/kg , to reach the home with enough iodine and produce a biological impact on the population.

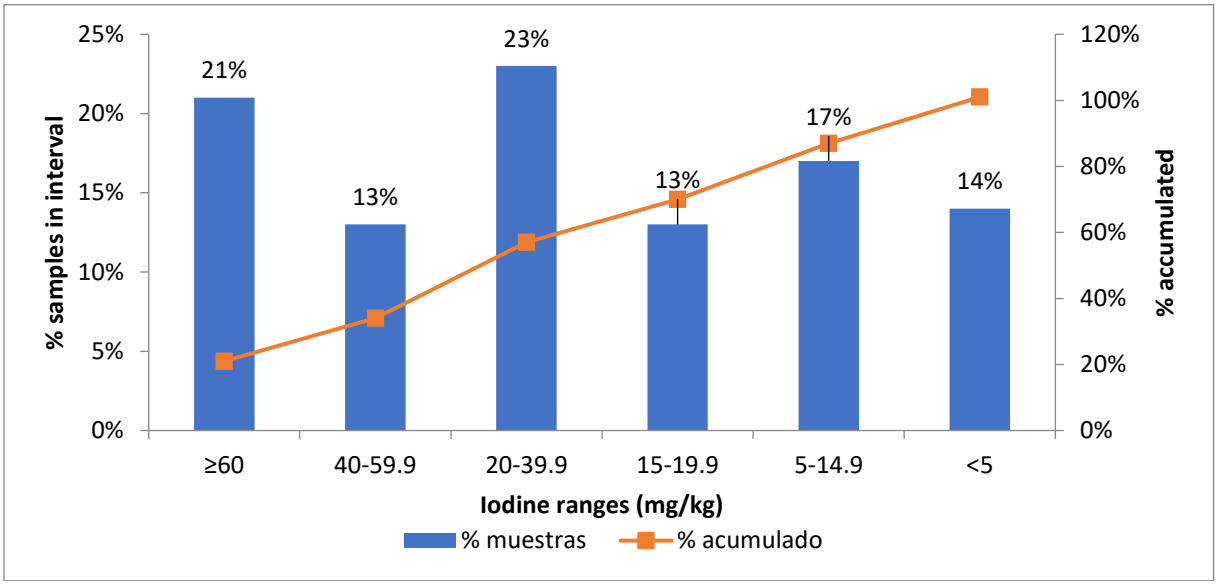
If the results are analyzed based on the levels indicated in Decree 304 (repealed as of the issuance of the General Food Fortification Law [8]) which indicated that iodine levels should be between 67mg/kg and 100mg/kg, 21% of the samples taken have levels above 67 mg/kg.

Table 5. Frequency of iodine results in salt samples taken at outlets in Honduras-2022.

interval of Iodine (mg/kg)	Frequency (n)	Percentage (%)	Accumulated percentage (%)
<5.0	11	14.1	14.1
5.0-14.9	13	16.7	30.8
15.0-19.9	10	12.8	43.6
20.0-39.9	18	23.1	66.7
40.0-59.9	10	12.8	79.5
≥60.0 _	16	20.5	100.0
Total	**78**	**100.0**	

[7]Presidential Agreement No. 531. Regulations for the Application of Decree 304 on the Iodization of Common Salt in the Republic of Honduras. The Gazette No. 17,471. September 5, 1961. https://extranet.who.int/nutrition/gina/en/node/14868.
[8]Decree 234-2010. General Law of Food Fortification. The Gazette No. 32,427. January 27, 2011.

Figure 4. Distribution of iodine (mg/kg) in salt samples taken in outlets in Honduras-2022.



The producers have indicated that there is no updated regulation and that the iodination levels to be met are not clear. The lack of clarity that exists is reflected in the iodination levels declared on the sample labels. 25% of the samples declare iodination levels between 30-60 mg/kg, 36.9% between 50-100 mg/kg, 34.5% do not indicate, and 3.6% of the samples declare iodination levels between 67-100 mg/kg as indicated by Decree 304 that was repealed, and these brands generally correspond to supermarket brands. As shown in **Table 6** , the declared levels do not necessarily reflect the iodization levels of the salt, since samples were found with values below the lower limit of the declared iodine range.

Table 6. Iodine levels declared on the label of salt samples taken at outlets in Honduras-2022.

Iodine levels declared on the label	Iodine (mg/kg)					
	No.	% of samples	Average	OF*	Minimum	Maximum
30-60mg/kg	21	26.9	38.76	35.6	0	137.7
50-100mg/kg	25	32.1	35.80	24.5	8.02	110.3
67-100mg/kg	3	3.8	123.12	37.8	83.04	158.2
Not shown	29	37.2	24.09	27.0	0	78.5

*SD= Standard deviation.

Table **7** and **Figure 5** present the results obtained from iodine found in the samples at the national level and for each of the regions where samples were taken. The national average for iodine was 35.6 mg/kg ± 34.2 mg/kg (mean ± SD). The average iodine in the regions was between 28.8 mg/kg in the Central Eastern region and 51.8 mg/kg in the Northwestern region, except in the Western region where the average was 13.3 mg/kg. Despite the fact that the average iodine per region is above 20 mg/kg and that it provides enough iodine to meet the daily requirements for this nutrient, the percentage of samples with levels below 20 mg/kg in each region was between 25 % in the Southern region and 91.7% in the Western region.

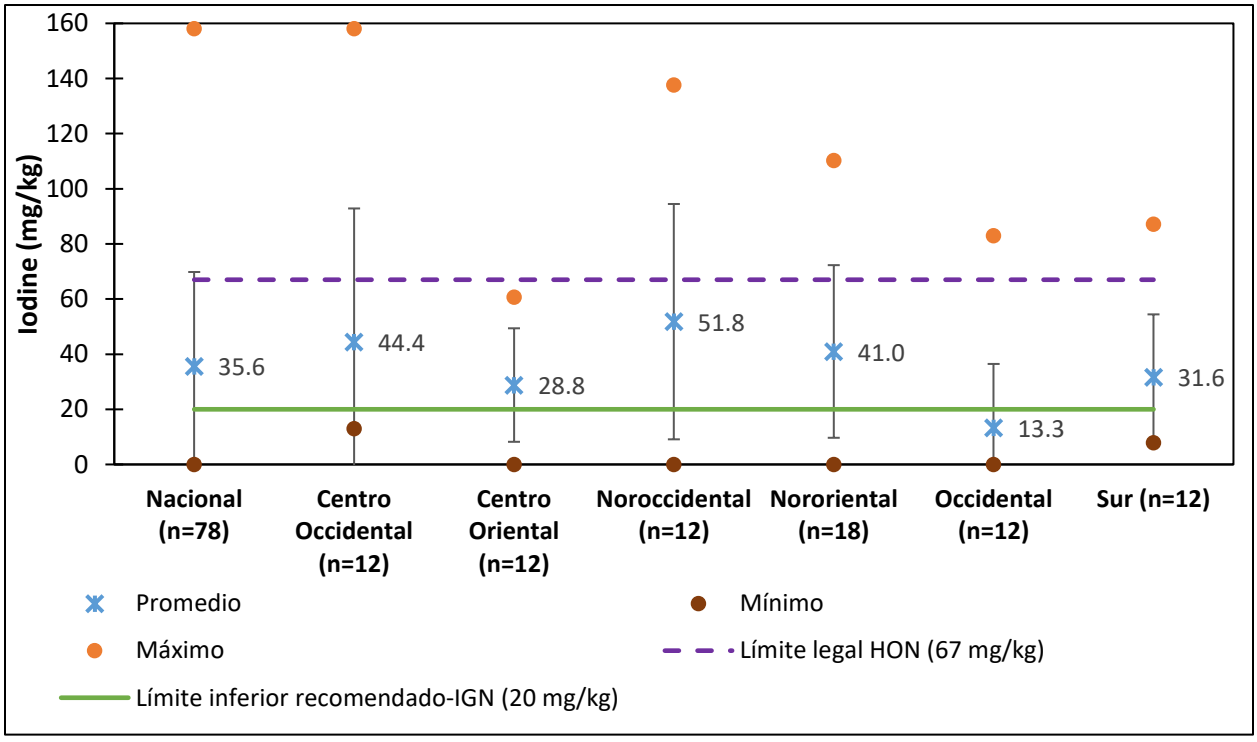
Table 7. Summary of the iodine results in salt samples taken at outlets in Honduras-2022.

Region	No.	Iodine (mg/kg)						% of samples below 20 mg/kg
		Average	OF*	CV*	Minimum	Maximum	Median	
National	78	35.6	34.2	96.1	0.0	158.2	24.5	43.6
West Central	12	44.4	48.5	109.2	13.0	158.2	22.6	41.7
Eastern Central	12	28.8	20.6	71.5	0.0	60.7	33.0	33.3
Northwestern	12	51.8	42.7	82.4	0.0	137.7	46.4	33.3
Northeast	18	41.0	31.3	76.4	0.0	110.3	45.4	38.9
Western	12	13.3	23.1	173.8	0.0	83.0	8.0	91.7
South	12	31.6	22.8	72.0	7.9	87.2	25.8	25.0

*SD= Standard deviation. CV= Coefficient of variation (relative standard deviation).

It is also important to mention that the variation of the results is more than 70% since, just as there were samples without iodine, there were also samples with iodine levels above 100 mg/kg.

Figure 5. Iodine results in salt samples taken in outlets in Honduras-2022, at the national level and by region



For informational purposes, **Table 8** presents a summary of the brands taken in stores and the average levels of iodine obtained.

Table 8. Brands of salt taken in stores in Honduras-2022 and average levels of iodine found.

Brand	No.	% of total samples	Iodine (mg/kg)	
			Average	OF*
Cris-salt	24	30.8%	32.9	24.5
Del Pacífico	8	10.3%	25.7	16.9
Deli-Salt	4	5.1%	0.0	0.0
Diamante	2	2.6%	18.4	0.8
El Caracol	13	16.7%	50.1	40.7
El Palomo	1	1.3%	0.0	---------
El Pato Azul	2	2.6%	0.0	0.0
La Buena Cocina	1	1.3%	60.7	---------
La Ola Azul	8	10.3%	6.8	4.7
La Tortuga	8	10.3%	61.2	14.7
Lago Salado	1	1.3%	2.0	---------
Sabe Más	3	3.8%	123.1	37.8
Sal Yodada Radiante	3	3.8%	38.6	9.8

*SD= Standard deviation.

Table **9** presents the results by type of salt, as well as if an iodization declaration was made on the label and if it had a sanitary registry. In general, 94.9% of the samples had a sanitary registry. All the samples that did not have a sanitary registration were of the wet and course type (n = 4) and 3 of the 4 samples indicated "sanitary registration in process". Only 14.3 % of the wet and coarse salt samples contained iodine levels above 20 mg/kg, compared to 71.9 % of the dry and ground salt samples. This is an indication of the need to review the iodization process, with emphasis on coarse, wet salt.

Table 9. Information on the iodine content, the declaration of iodization on the label and the sanitary registry in salt samples taken in stores, by type of salt.

Type of salt	No.	% of the total	Iodine (mg/kg)		Indicates that it is iodized on the front (%)	Has a health record	% samples with iodine above 20mg/kg
			Average	OF*			
Course and wet	21	26.9%	10.0	13.7	100%	80.9%	14.3%
Dried and ground	57	73.1%	45.0	34.7	98.2%	100%	71.9%
Grand total	**78**	**100.0%**	**35.6**	**34.2**	**98.7%**	**94.9%**	**------**

*SD= Standard deviation.

The results obtained confirm what the interviewed salt producers have indicated regarding the need to resume training in the salt iodization process and the recommended practices of quality assurance and control. Also, priority should be given to updating the salt iodization regulation so that the required iodization levels are clear. Another priority point to guarantee compliance with iodization is that the Health Regulation Agency (ARSA) resume monitoring of salt iodization, for which ASOPROSALH has offered all the necessary support as it was done in the past.

Likewise, it is important that the iodization levels specified in the regulation be reduced, since, due to the consumption of salt and other sources of iodine, such as cubes and bouillon, the population already

receives a sufficient contribution of iodine. The results of this study should be complemented by monitoring the urinary iodine excretion of the population to confirm that they are receiving sufficient iodine and to identify priority regions, where they may be receiving non-iodized salt due to informal trade. On the other hand, Honduras does not yet have a strategy to reduce sodium/salt consumption, but the reduction in salt consumption would not compete with the salt fortification strategy with iodine, since both are complementary, and if the studies monitoring of urinary iodine excretion will indicate that the iodine that the population is receiving is not enough, the levels of iodization in salt can be adjusted. The results for iodine in bouillon and cube samples are presented below.

Selected culinary products (powdered bouillon and cubes)

Of all the bouillon and cube samples taken, composite samples were formed by brand to complete a total of 36 samples. The objective of taking samples of these products was to determine the use of iodized salt in their manufacture, so the same iodine intervals were used as for salt. Table **10** and **Figure 6** show the distribution of iodine in the samples taken. It was found that 91.8% of the samples contained iodine levels above 20 mg/kg. This indicates that the food industry that manufactures these products is indeed using iodized salt.

Table 10. Frequency of iodine results in samples taken from bouillon powder and cubes in stores in Honduras-2022.

interval of Iodine (mg/kg)	Frequency (n)	Percentage (%)	Accumulated percentage (%)
<5.0	0	0.0	0.0
5.0-14.9	2	5.6	5.6
15.0-19.9	1	2.8	8.3
20.0-39.9	20	55.6	63.9
40.0-59.9	11	30.6	94.4
≥60.0 _	2	5.6	100.0
Total	**36**	**100**	

More than half of the samples (55.6%) contained iodine levels between 20-39.9 mg/kg and 36% contained levels above 40 mg/kg. Of the three samples that contained iodine levels below 20 mg/kg, one of them corresponded to shrimp flavor bouillon (Maggi brand) (see the minimum value of this brand in Table 11 **)** . It is worth mentioning that this sample was included in the study for informational purposes only, since the sample was not enough to homogenize it properly, and it is not a type of consommé that is widely consumed by the population.

Figure 6. Distribution of iodine results in samples taken from broth in powder and cubes in outlets in Honduras-2022.

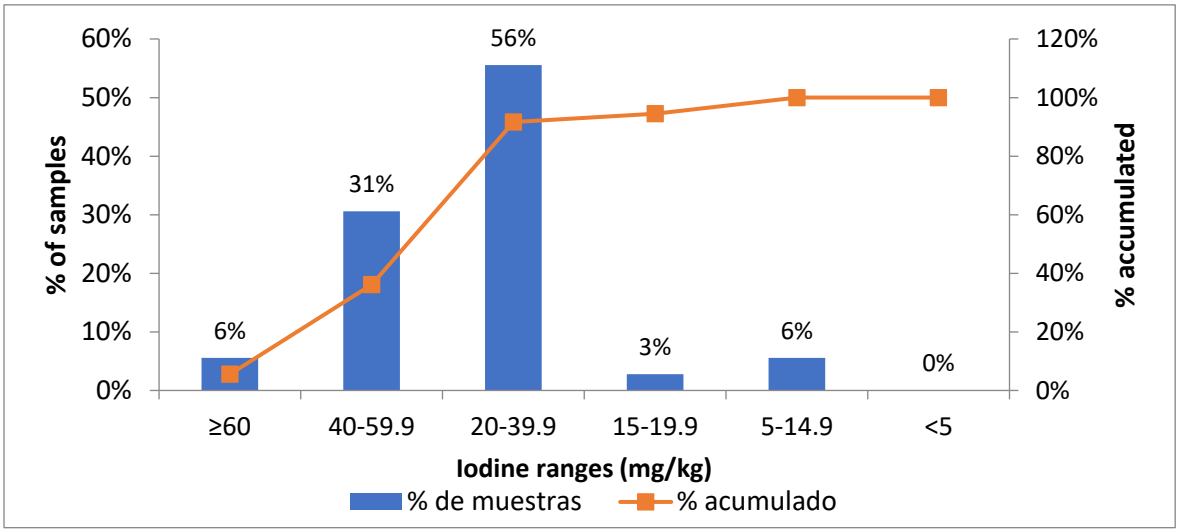


Table **11** and **Figure 7** show the iodine results obtained by brand. From the averages obtained by brand, which are between 33.8 mg/kg and 46.7 mg/kg, it is confirmed that iodized salt is being used for the production of cubes and bouillon, with the exception of the Madona bouillon brand, where obtained an iodine average of 10.6 mg/kg in the samples analyzed.

Table 11. Results of iodine in samples taken from bouillon powder and cubes in outlets in Honduras-2022.

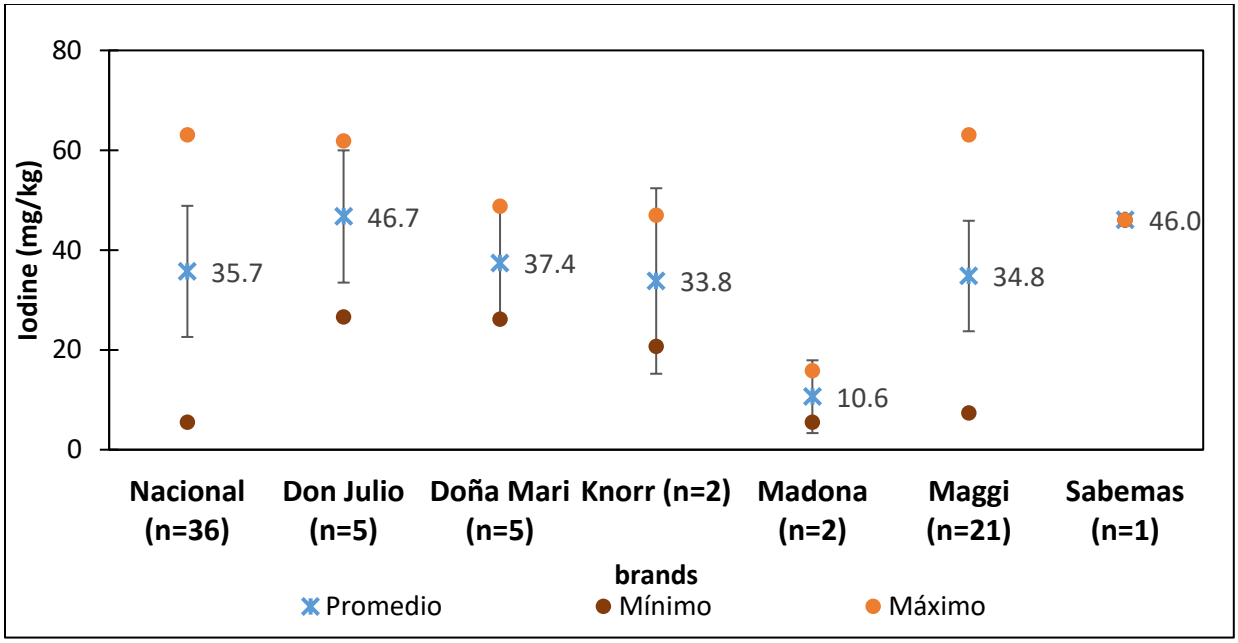
Brand	Iodine (mg/kg)					
	Ave-rage	OF*	CV* (%)	Mini-mum	Maxi-mum	Median
Don Julio (n = 5)	46.7	13.2	28.3	26.6	61.9	46.4
Mrs. Mari (n = 5)	37.4	10.9	29.3	26.2	48.8	38.1
Knorr (n = 2)	33.8	18.6	55.0	20.7	46.9	33.8
Madonna (n = 2)	10.6	7.3	68.7	5.5	15.8	10.6
Maggie (n=21)	34.8	11.1	31.8	7.3	63.1	34.0
Sabe Más (n = 1)	46.0	----	----	46.0	46.0	----
National (n = 36)	**35.7**	**13.1**	**36.8**	**5.5**	**63.1**	**34.0**

*SD= Standard deviation. CV= Coefficient of variation (relative standard deviation).

At the national level , the average iodine obtained (35.7 mg/kg) in culinary products is similar to the average obtained in salt for direct consumption (35.6 mg/kg), with the difference that in these products only 8.3% of the samples have iodine levels below 20 mg/kg, while in salt almost half (43.6%) of the samples do not reach this iodine level. Considering that culinary products contain about half as much salt, this means that the iodine content in the salt used is close to 70 mg/kg. Due to the lack of an updated regulation that has clearly defined iodine levels, it follows that the industry has taken as a minimum level to meet 67 mg/kg for salt, which it requires from its salt suppliers.

72% of the samples taken are produced in Guatemala by Nestlé (Maggi and Doña Mari brands), the Don Julio and Madona brands are produced in Honduras, while the other brands are produced in El Salvador (Knorr) and Costa Rica (Sabemás). Only brands of bouillon and cubes produced abroad indicate that they used iodized salt on the ingredient labeling. None of the brands produced in Honduras indicate it and neither does the salt regulation require it.

Figure 7. Iodine results in product samples culinary selected (consommés in powder and cubes) taken in outlets in Honduras-2022.



Wheat flour fortified with iron, folic acid, thiamin, riboflavin and niacin

In Honduras, wheat flour must be fortified as indicated by the Central American Technical Regulation RTCA 67.01.15:07 [9], which indicates that the minimum levels expected are the following:

- Iron (as ferrous fumarate): 55 mg/kg
- Folic acid: 1.8mg/kg
- Thiamine (B-1): 6.2 mg/kg
- Riboflavin (B-2): 4.2 mg/kg
- Niacin: 55mg/kg

In total, 39 samples of wheat flour were taken according to the availability in the stores visited. 43.6% of the flour samples taken were produced by the Jaremar Group of Honduras, 41.0% by the Sula Flour Mill, 10.3% by Industrias Molineras SA and 5.1% by the Dieck y Dieck Company. It is important to mention that samples of wheat flour were taken to be purchased directly from the consumer and in packages of 2 pounds (approximately 1 kg) due to the ease of transport. Samples were not taken in larger packages that are generally purchased for the production of bread or other products derived from wheat flour, a limitation of the results obtained. 100% of the samples indicated on the front of the packaging that they were fortified.

Table **12** and **Figure 8** show the distribution of iron results in wheat flour. It was found that 87% of the samples meet the minimum of 55 mg/kg indicated in the RTCA and 100% of the samples contain iron levels above 40 mg/kg. Based on the intrinsic iron level of wheat flour, which is between 10-20 mg/kg, it can be stated that 100% of the samples were fortified.

Table 12. Frequency of iron results in wheat flour samples taken at outlets in Honduras-2022.

interval of iron (mg/kg)	Fre-quency (n)	Percen-tage (%)	Accumula-ted percen-tage (%)
<40.0	2	5.1	5.1
40.0-54.9	3	7.7	12.8
55.0-69.9	24	61.5	74.4
70.0-84.9	6	15.4	89.7
≥85.0 _	4	10.3	100.0
Total	**39**	**100**	

[9]EAT. Annex to Resolution No. 201-2007 (COMIECO-XVL). Central American Technical Regulation 67.01.15:07 Flours. Fortified wheat flour. Specifications.

Figure 8. Distribution of iron results in wheat flour samples taken in outlets in Honduras-2022.

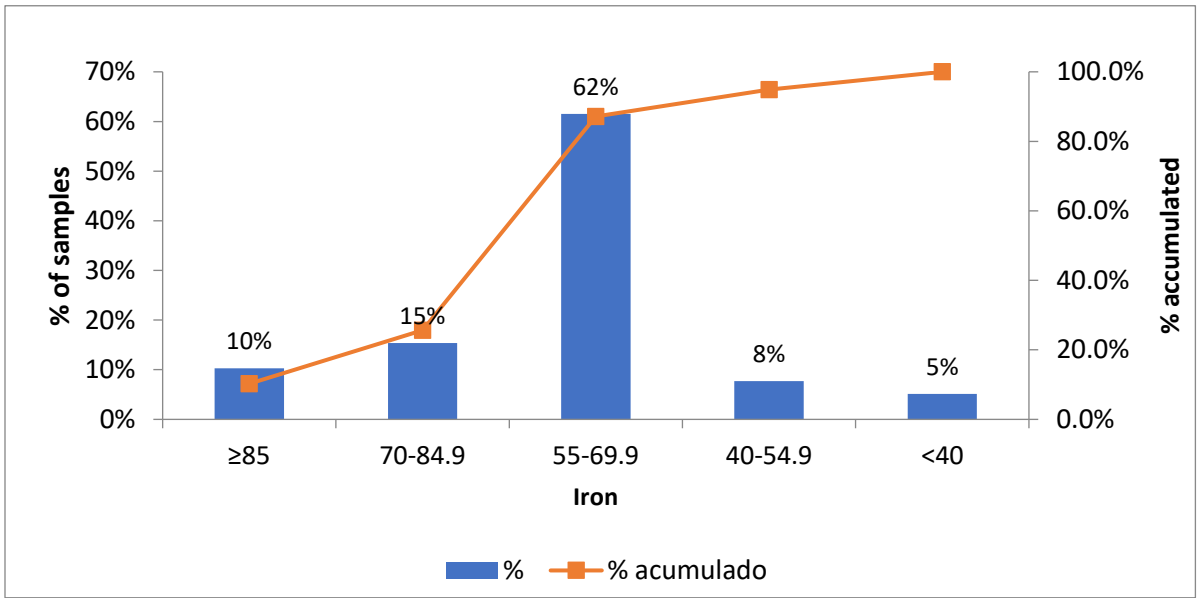


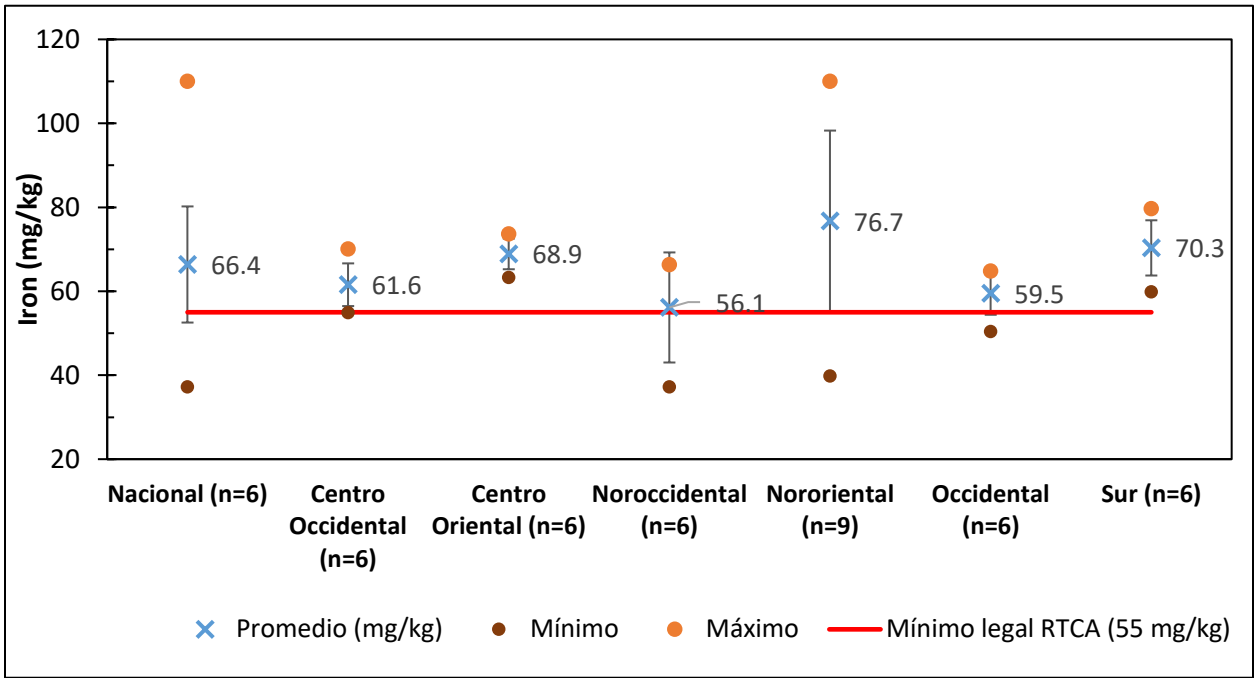
Table **13** and **Figure 9** summarize the iron results found and broken down by region. The national average for iron was 66.4 mg/kg ± 13.8 mg/kg (mean ± SD). The average iron in the regions varied between 56.1 mg/kg in the Northwestern region and 76.7 mg/kg in the Northeastern region. The variation of the results by region was between 5.3% and 23.4%, which is much lower than that obtained in other foods such as sugar and salt. This is due to the characteristics of the wheat flour process, where ensuring the homogenization of all the additives in the flour is vital to obtain good results in baking, in addition to the fact that the granulometry of the products being mixed is similar.

Table 13. Iron results in wheat flour samples taken at outlets in Honduras-2022.

Region	No.	Iron (mg/kg)					
		Average	OF*	CV*(%)	Minimum	Maximum	Median
National	39	66.4	13.8	20.8	37.2	110.0	64.8
West Central	6	61.6	5.1	8.3	54.9	70.1	60.5
Eastern Center	6	68.9	3.7	5.3	63.3	73.6	68.5
Northwestern	6	56.1	13.1	23.4	37.2	66.3	62.6
Northeast	9	76.7	21.6	28.1	39.8	110.0	69.0
Western	6	59.5	5.1	8.5	50.4	64.8	60.6
South	6	70.3	6.6	9.4	59.8	79.7	69.9

*SD= Standard deviation. CV= Coefficient of variation (Relative standard deviation).

Figure 9. Iron results in wheat flour samples taken in outlets in Honduras-2022.



The results show that the samples taken meet the minimum required in the Central American Technical Regulation (55 mg/kg). However, there are some samples with values below 40 mg/kg and the situation of the flour used in baking is unknown. Therefore, it is recommended that ARSA resume the monitoring of fortification at the plant, the wheat mills in this case, where it is available to verify the quality assurance and control practices of the fortification from the origin. Table **14** shows the wheat flour brands of the samples taken for informational purposes, since the sampling was not carried out to obtain the representativeness of the brands. The Doña Blanca brand showed the lowest iron average and it is recommended that this mill review its process in order to improve the iron levels in the wheat flour it produces.

Table 14. Brands of wheat flour from the samples taken at outlets in Honduras-2022 and average iron levels found.

wheat flour brand	No.	% of the total	Iron (mg/kg)	
			Average	OF*
Doña Blanca	4	10.3%	46.3	13.5
El Gallo	3	7.7%	71.1	7.7
El Panadero	1	2.6%	73.6	----
Gold Star	16	41.0%	67.0	13.1
Harina Manhattan	2	5.1%	62.9	11.4
La Rosa	12	30.8%	71.6	12.6
Suli	1	2.6%	59.6	----
Grand total	**39**	**100.0%**	**66.4**	**13.8**

*SD= Standard deviation.

Table **15** presents the results of iron and folic acid in the samples selected to carry out the analysis of the latter. An attempt was made to select at least one sample of each brand. Considering that the intrinsic folate content of wheat flour is 0.3 mg/kg [10], it is evident that all the samples taken were fortified with folic acid, as indicated by the levels of iron and folic acid. Most of the samples do not reach the minimum required by the RTCA, 1.8 mg/kg, but it is important to mention that the folic acid content in wheat flour is 30 times lower than that of iron, which affects the variability in the concentration of said micronutrient in the matrix.

Table 15. Results of folic acid in selected samples of wheat flour taken in stores in Honduras-2022.

Brand	Iron (mg/kg)	Folic acid (mg/kg)
Doña Blanca	37.2	0.9
El Gallo	64.8	1.1
El Panadero	73.6	0.8
Gold Star	61.6	1.6
Harina Manhattan	71.0	0.8
La Rosa	67.5	1.3
La Rosa	69.0	1.6
Suli	59.6	1.8
	Average	**1.23**
	OF*	**0.38**
	CV* (%)	**31.1**

*SD= Standard deviation. CV= coefficient of variation (relative standard deviation).

Nixtamalized corn flour

Fortification of corn flour in Honduras is voluntary and some companies have indicated that they fortify, although not all of their production. The Regulation for the Sanitary Control of Products, Services and Establishments of Sanitary Interest (Agreement No. 06, 2005) indicates that corn flour must be fortified, but does not indicate the levels and there is no regulation for the fortification of corn flour, corn, nor any other legal instrument that defines the fortification criteria. What this regulation indicates can also be interpreted as, when it is declared on the label that corn flour is fortified, the producer must compulsorily comply with what is indicated on its label, otherwise the consumer would be deceived.

In total, 36 corn flour samples were taken. In the Central Western region, it was not possible to complete the corn flour samples, because corn flour is not sold in the municipality of San Francisco de Opalaca. As indicated by the people who took the samples, the inhabitants prefer to continue with the consumption of artisan corn dough. 44.4% (n = 16) of the samples taken are MASECA brand, followed by 11.1% (n = 4) of Del Comal brand samples.

Table **16** and **Figure 10** show the distribution of the iron results in the samples taken. For the purposes of this study and considering that the average level of intrinsic iron would be around 15 mg/kg [10], as well as the variation that could occur in the process, the minimum level was defined to affirm that corn flour was fortified. it was 25mg/kg. 72.2% of the samples had iron levels below 25 mg/kg and only 27.8% of the

[10]INCAP/SICA. Food Composition Table of Central America. 3rd ed. 2018. 365 p.

samples had iron levels above 25 mg/kg. In other words, voluntary fortification is a practice applied by around a third of the producers.

Table 16. Frequency of iron results in nixtamalized corn flour samples taken at outlets in Honduras-2022.

Interval of iron (mg/kg)	Frequency (n)	Percentage (%)	Accumulated percentage (%)
<10.0	10	27.8	27.8
10.0-24.9	16	44.4	72.2
25.0-39.9	6	16.7	88.9
≥40.0	4	11.1	100.0
Total	**36**	**100**	

Figure 10. Distribution of iron results in the corn flour samples taken in outlets in Honduras-2022.

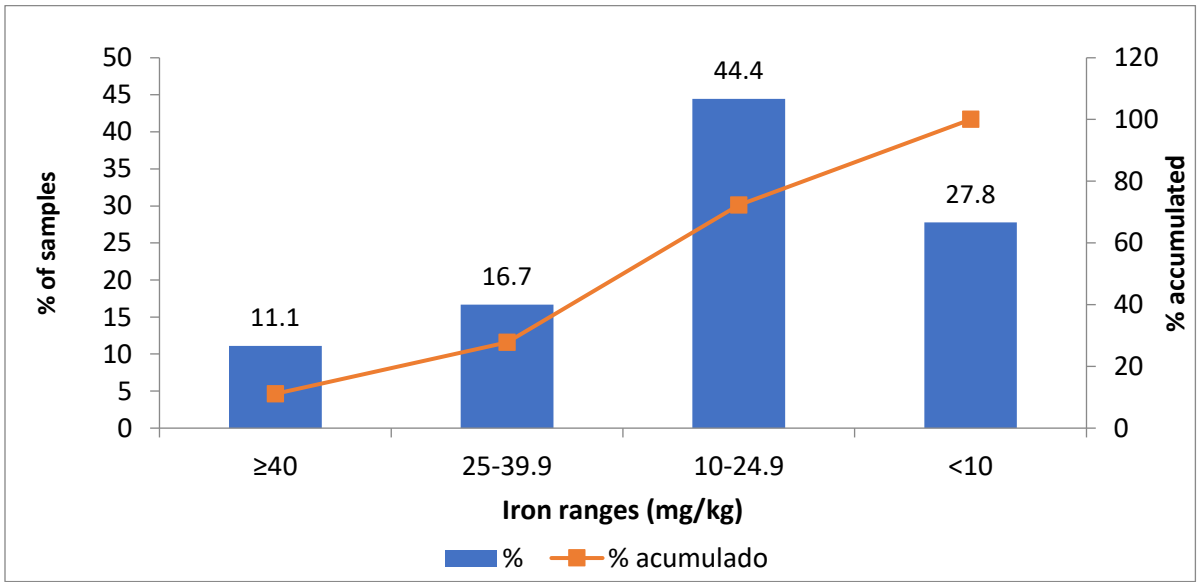


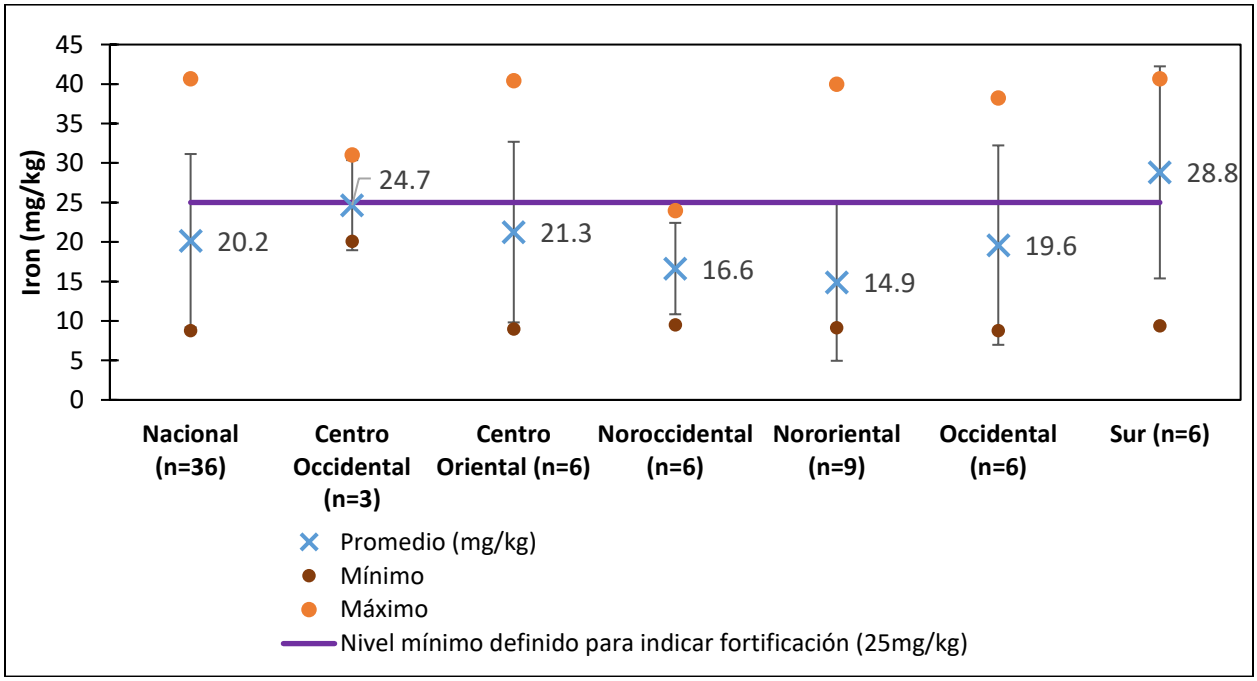
Table **17** and **Figure 11** show the iron results by region. The national average iron in corn flour was 20.2 mg/kg. The observed average per region was between 14.9 mg/kg in the Northeast region and 28.8 mg/kg in the South region. The iron averages by region reflect the intrinsic iron content in most of the samples taken, with the presence of some samples of fortified corn flour. The average iron in the samples from the South region was higher because samples were taken of the Del Comal brand, which comes from El Salvador, where fortification of corn flour with iron, folic acid, and other vitamins of the B complex is mandatory.

Table 17. Results of iron in corn flour by region.

Region	No.	Iron (mg/kg)					
		Ave-rage	OF*	CV* (%)	Mini-mum	Maxi-mum	Median
National	**36**	**20.2**	**11.0**	**54.5**	**8.8**	**40.7**	**17.3**
West Central	3	24.7	5.7	23.1	20.1	31.0	22.9
Eastern Center	6	21.3	11.4	53.8	9.0	40.4	19.3
Northwestern	6	16.6	5.8	34.8	9.5	24.0	17.8
Northeast	9	14.9	9.9	66.7	9.1	40.0	9.7
Western	6	19.6	12.6	64.4	8.8	38.2	14.5
South	6	28.8	13.4	46.6	9.4	40.7	32.7

*SD= Standard deviation. CV= Coefficient of variation (relative standard deviation).

Figure 11. Iron results in corn flour samples taken in outlets in Honduras-2022.



In **Table 18** , The brands of corn flour found in the outlets, the average iron content and the number of samples that indicated on the front of the packaging that they are fortified are presented. The results are presented for informational purposes, since the sampling was not representative to obtain conclusions about the fortification by brand. The brands in which it was found that at least one of the samples was fortified were the following: Del Comal, Maseca, Maturave , Nativa, Suli and Tortimasa . The iron averages obtained in the samples of each brand do not necessarily reflect the fortification, since not all the samples taken were fortified. In the case of the MASECA brand samples, only one of the samples was fortified, with an iron level of 40.7 mg/kg. This sample was the only one in which fortification was declared on the front of the package, while the other fifteen did not declare that they were fortified and this was confirmed by the iron levels found.

As shown in **Table 18** , several brands declare fortification on the front of the package, but no samples were found with levels above 25 mg/kg. Some of these brands state an iron level of 24 mg/kg, although the samples reflect iron levels between 9.4 mg/kg and 24.0 mg/kg. It is recommended that factories that indicate fortification on their packages clearly define the fortification specification to apply, optimize their process based on it, and adjust their quality assurance and control practices to guarantee the consumer the fortification they declare.

Table 18. Brands of nixtamalized corn flour from the samples taken at outlets in Honduras-2022 and average iron levels found.

Brand	No.	% of total samples	Iron (mg/kg)		Indicate fortification on the front of the package (N)
			Average	OF*	
Del Comal§	4	11.1%	36.6	6.7	0
Del Maizal	3	8.3%	18.2	1.9	3
La Capitalina	1	2.8%	16.9	----	1
Masasuave	3	8.3%	20.7	3.2	3
Maseca§	16	44.4%	14.1	8.2	1
Maturave§	2	5.6%	18.5	12.9	2
Nativa§	1	2.8%	40.0	----	1
Selecta	1	2.8%	20.1	----	1
Suli§	2	5.6%	34.6	5.1	2
Tortimasa§	3	8.3%	17.7	12.9	3
Grand total	**36**	**100.0%**	**20.2**	**11.0**	**17**

*SD= Standard deviation.

§ Brands in which at least one sample was found with levels of iron fortification.

Table **19** presents the results of iron and folic acid in the samples selected to carry out the analysis of the latter. The brands were randomly selected. The results show that the samples with iron fortification levels (above 25 mg/kg) also had folic acid fortification levels (1.0 mg/kg to 1.6 mg/kg). In the samples showing intrinsic levels of iron (around 15 mg/kg), natural folate was found, which on average would be 0.3 mg/kg. [10]

Table 19. Results of folic acid in selected samples of corn flour taken in stores in Honduras-2022.

Brand	Iron (mg/kg)	Folic acid (mg/kg)
Del Comal	40.4	1.0
Del Maizal	16.1	0.3
La Capitalina	16.9	<0.3mg/kg
Maseca	10.3	NA
Maturave	9.4	<0.3mg/kg
Nativa	40.0	1.2
Suli	38.2	1.6
Tortimasa	11.9	NA
	Average	**1.3**
	OF	**0.3**
	CV (%)	**25.2**

*SD= Standard deviation. CV (%)= Coefficient of variation. ND= Not detected (<0.036 mg/kg).

Powdered and fluid milk (long life or processed at ultra high temperatures)

In total, 39 milk samples were taken, of which 46.2% (n = 18) were powdered milk and 53.8% (n = 21) were fluid milk. In the Central Western region, only fluid milk samples were taken, while in the South region, only powdered milk samples were taken, depending on the availability of the product in the stores visited. The results of fluid milk have the limitation that they correspond only to long-life milk or milk processed at ultra-high temperatures (UHT), since it was not considered to take samples of milk that needed refrigeration due to the limitations to maintain the cold chain. Milk fortification is voluntary and each producer defines its specifications.

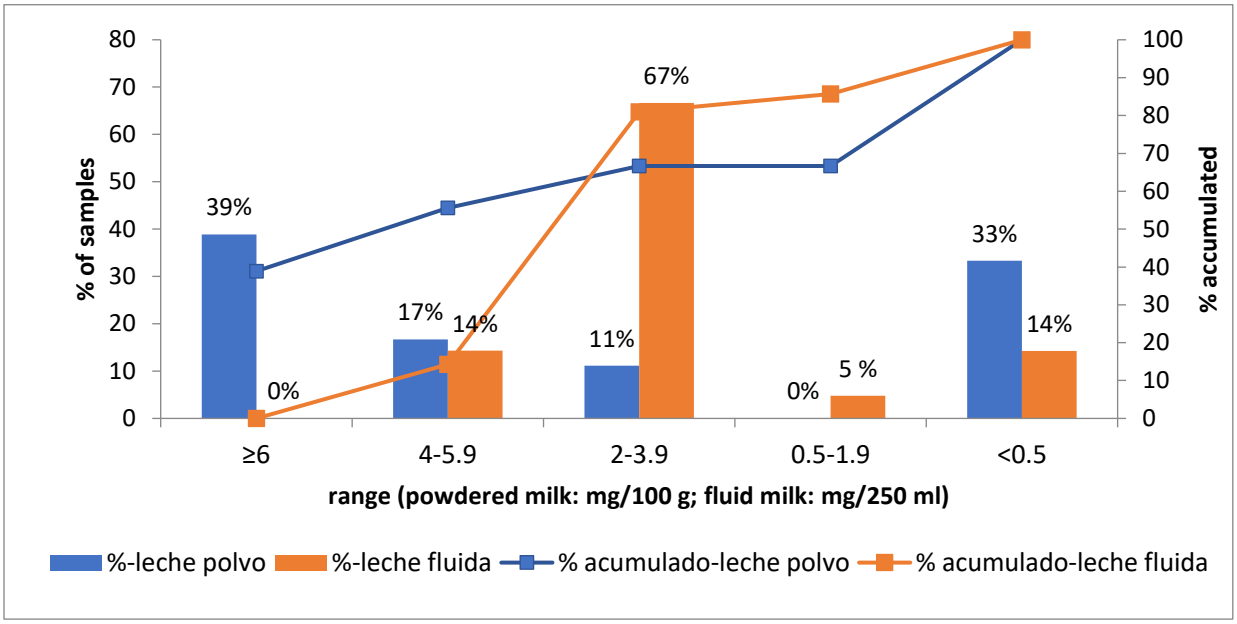
Table **20 and Figure 12** show the distribution of iron content in the samples. 33.3% of the powdered milk samples and 14.3% of the fluid milk samples had less than 0.5 mg/100 g of iron and 0.5 mg/250 ml, respectively. Based on the intrinsic iron content of milk reported in the INCAP [10] Food Composition Table for fluid milk (0.08 mg/250 ml) and powdered milk (0.47 mg/100 g), it can be said that these samples were not fortified.

Table 20. Frequency of iron results in milk samples taken at outlets in Honduras-2022.

Type	Iron range (mg/100g)	Frequency (n)	Percentage (%)	Accumulated percentage (%)
Milk powder	<0.5	6	33.3	33.3
	0.5-1.9	0	0	33.3
	2.0-3.9	2	11.1	44.4
	4.0-5.9	3	16.7	61.1
	≥6	7	38.9	100.0
	Subtotal	**18**	**100.0**	
Type	**Iron range (mg/250 mL)**	**Frequency (n)**	**Percentage (%)**	**Accumulated percentage (%)**
Fluid long life or UHT milk	<0.5	3	14.3	14.3
	0.5-1.9	1	4.8	19.0
	2.0-3.9	14	66.7	85.7
	4.0-5.9	3	14.3	100.0
	≥6	0	0	100.0
	Subtotal	**21**	**100.0**	
Total		**39**		

Regarding the samples of powdered milk, 7 different brands were found, and most of the samples corresponded to the Ceteco brand (12.8%: Ceteco and 5.1%: Ceteco Crecimiento +1) and Nido Crecimiento +1 (12.8%). , while, for fluid milk and all the samples, the Sula brand was the most found (43.6%). Both the Sula brand (fluid and powdered) and the Ceteco brand are produced in Honduras by Lácteos de Honduras, SA The Leyde brand (fluid milk) is also produced in Honduras by Leche y Derivados, SA This brand indicates that it is "vitaminized" and according to the list of ingredients it contains vitamins A, D and C, but iron is not added. Table **21** shows the detail of the brands and the average iron content of each brand and by type of milk.

Figure 12. Distribution of iron results in milk samples powder and long-term fluid milk duration /UHT [+] taken in outlets in Honduras-2022.



[+] UHT= Ultra High Temperature (Ultra High Temperature).

Table 21. Brands of powdered and fluid milk of the samples taken at outlets in Honduras-2022 and average iron levels found.

Type	Brand	No.	% of total samples	Iron (mg/100g) §	
				Average	OF*
Milk powder	Anchor	2	5.1%	4.0	0.6
	Ceteco	5	12.8%	0.1	0.02
	Ceteco Crecimiento +1	2	5.1%	6.8	0.2
	Delactomy	1	2.6%	3.8	----
	Nido Crecimiento +1	5	12.8%	6.9	0.9
	Pinito	2	5.1%	4.3	0.2
	Sula	1	2.6%	0.1	----
Subtotal		**18**	**46.2%**	**3.8**	**3.0**
Type	**Brand**	**No.**	**% of total samples**	**Iron (mg/250 ml) §**	
				Average	**OF***
Long life fluid milk or UHT [+]	Leyde	3	7.7%	0.03	0.00
	Sabe Mas	1	2.6%	1.8	-----
	Sula	17	43.6%	3.2	0.6
Subtotal		**21**	**53.8%**	**2.7**	**1.3**
grand total		**39**	**100.0%**		

*SD= Standard deviation.

§ Results considering all the samples, even when they were not fortified with this micronutrient.

[+] UHT= Ultra High Temperature (Ultra High Temperature).

As can be seen in the results, the iron content in each brand is different because each producer has defined its specifications for each of its products, according to the target population group. Table **22** presents a summary of the results obtained using only the iron data from the fortified milk samples. For the purposes of this study, samples containing iron levels above 0.5 mg/100 g for powdered milk or 0.5 mg/250 ml for fluid milk were taken as "fortified milk". Of the fluid milk samples, 85.7% of the samples were fortified, 17 of the 18 samples corresponded to the Sula Brand, and one to the Sabemás brand. Regarding powdered milk, 66.7% of the samples were fortified and were from the brands Anchor, Nido Crecimiento +1, Pinito, Delactomy and Ceteco Crecimiento +1.

Fortified milk samples ₮ taken at outlets in Honduras-2022.

Parameter	Long life fluid milk or UHT § (Iron-mg/250 ml)	Powdered milk (Iron-mg/100 g)
Average	3.1	5.7
OF*	0.7	1.6
CV (%)*	21.4	27.7
Minimum	1.8	3.6
Maximum	4.8	8.4
Median	2.9	6.2
N fortified (Total N)	18 (21)	12 (18)
% of fortified samples	85.7%	66.7%

₮ Samples with iron levels above 0.5 mg/250 ml or 0.5 mg/100 g were taken as fortified.

* SD= Standard deviation. CV= Coefficient of variation.

§ Of the 18 fortified samples, 17 samples corresponded to Sula brand fluid milk and 1 to the Sabemás brand .

59% of the total samples indicated that it was fortified with aminochelated iron and 12.8% indicated on the label that the fortified salt was ferrous sulfate. The latter corresponded to powdered milk from Nido Crecimiento +1. The rest of the samples did not indicate the type of iron used or were not fortified. None of the samples that were not fortified with iron had a label statement regarding this. Two samples of powdered milk (Anchor) that were fortified with iron did not specifically indicate that they were fortified with this mineral.

Table **23** shows the results of the selected samples to which the folate content was determined. Based on the folate levels reported in the Food Composition Table [10]for powdered milk (37 µg/100 g), it can be said that the levels observed in the Ceteco and Sula samples correspond to intrinsic levels of folate, since the same as for the Leyde brand fluid milk sample . The folate content found in the rest of the fortified samples coincided with what was declared on the nutritional label of the sample.

In general, the practice of fortifying milk is applied by most of the brand producers present in Honduras, including one of the national producers, so the country has the experience to provide fortified milk in the Glass of Milk program. Milk. The status of this program in the country is unknown , but it is recommended that the fortification specifications to be met by milk suppliers to the program be clearly defined.

Table 23. Folate results in selected samples of milk taken at outlets in Honduras-2022.

Type	Brand	Iron (mg/100g)	Folate (µg/100g)
Milk powder	Ceteco	0.13	58
	Pinito	4.43	>125

	Sula	0.13	52
	Ceteco Crecimiento +1	6.92	140
Type	**Brand**	**Iron (mg/250ml)**	**Folate (µg/250 ml)**
Long life fluid milk or UHT [+]	Leyde	0.03	8
	Sabe Mas	1.79	43
	Sula	3.42	83
	Sula	4.18	73

[+] UHT= Ultra High Temperature (Ultra High Temperature).

Conclusions

1. All the sugar samples taken indicated that the manufacturer is the Central de Ingenios SA de CV (CISA) and 100% indicated on the label that they were fortified. 94% of the sugar samples taken were standard white sugar and the brands found were Doña Matilde (white sugar), Doña Matilde Morena, El Cañal and Prieta. 6 percent was brown sugar.

2. All the sugar samples were fortified, and 63% of them showed vitamin A levels above 4 mg/kg, the legal minimum established in the Honduran Technical Regulation (Agreement No. 4667, 2016). The national average content of vitamin A was 5.2 ± 2.6 mg/kg and the average results by region varied between 4.6 mg/kg (Western region) and 6.1 mg/kg (Southern region), except for the Northeast region, which showed an average of vitamin A of 3.1 mg/kg.

3. Of the 78 salt samples taken, 26.9% were of the coarse and wet type and 73.1% were of the dry and ground type. 55% of the samples contained iodine levels above 20 mg/kg, an average that ensures sufficient iodine intake through salt consumption.

4. The average iodine in salt in the regions was between 28.8 mg/kg in the Central Eastern region and 51.8 mg/kg in the Northwestern region, except in the Western region where the average was 13.3 mg/kg. Despite the fact that the average per region, with the exception of the Western region, is above 20 mg/kg of iodine, the percentage of samples with levels below 20 mg/kg in each region was between 25% in the Southern region and 91.7% in the Western region, which indicates that, depending on the region, at least a quarter of the samples do not meet the required iodine level.

5. The results obtained confirm the need to resume training aimed at the salt sector in the salt iodization process and the recommended practices for quality assurance and control.

6. Of the samples of selected culinary products (consommé powder and cubes), 6 brands were identified, of which 2 were Honduran-made. All the brands showed average iodine levels between 33.8 mg/kg and 46.7 mg/kg, except one of the Honduran brands, whose average was 10.6 mg/kg.

7. 91.8% of all samples consisting of bouillon powder and bouillon cubes contained iodine levels above 20 mg/kg. This indicates that the food industry that manufactures these products does use iodized salt, with very few exceptions.

8. At the national level, the average iodine obtained (35.7 mg/kg) in bouillon powder and cubes is similar to the average obtained in salt for direct consumption (35.6 mg/kg). However, considering that culinary products contain about half as much salt, this means that the iodine content in the salt used is close to 70 mg/kg. Another difference between these products and salt is that only 8% of the culinary products presented an iodine level below 20 mg/kg, while almost half (43.6%) of the salt samples were below this value. This confirms that, as long as there is a salt iodization regulation that indicates that the salt used in food processing must be iodized, the industry will follow the requirements to ensure compliance with the regulations in force in the country.

9. For wheat flour, it was found that 87% of the samples meet the minimum of 55 mg/kg indicated in the Central American Technical Regulation and 100% of the samples contain iron levels above 40 mg/kg. Based on the intrinsic iron level of wheat flour, which is between 10-20 mg/kg, it can be stated that 100% of the samples were fortified.

10. It was found that 27.8 % of the nixtamalized corn flour samples had iron levels above 25 mg/kg, the limit established in this study to affirm that there was fortification. These results show that one third of the processors practice voluntary fortification of nixtamalized corn flour. Corn flour is a good vehicle to bring micronutrients to the population and can be better used, especially considering that, according to the opinion of some corn flour processors, Honduras has the highest percentage of "flourization" (that is, the percentage of use of corn flour produced through industrial processing instead of the use of grain corn) than other countries in the region.

11. It was noted that several brands of corn flour declared fortification on the front of the package, but no samples were found with levels above 25 mg/kg. Some of these brands state an iron level of 24 mg/kg, although the samples reflect iron levels between 9.4 mg/kg and 24.0 mg/kg.

12. Regarding the milk samples, 46.2% were powdered milk and 53.8% were long-life fluid milk or UHT. 33.3% of the powdered milk samples and 14.3% of the fluid milk samples had less than 0.5 mg/100g of iron. Based on the intrinsic iron content of milk reported by INCAP for fluid milk (0.08 mg/250 ml) and powdered milk (0.47 mg/100 g), it can be said that these samples were not fortified.

13. Regarding the samples of powdered milk, 7 different brands were found, and most of the samples corresponded to the Ceteco brand (12.8%: Ceteco and 5.1%: Ceteco Crecimiento +1) and Nido Crecimiento +1 (12.8%), while, for fluid milk and all the samples, the Sula brand was the most found (43.6%).

14. 85.7 % of the fluid milk samples were fortified with iron and 66.7% of the powdered milk samples. The iron content in each brand is different because each producer has defined its specifications for each of its products, according to the target population group.

15. In general, most of the brand producers present in Honduras apply the practice of milk fortification, including one of the national producers, so the country has the experience to provide fortified milk in the Glass of Milk program.

16. The results of this study have the limitation that they apply to wheat flour and nixtamalized corn marketed in 2 lb (approximately 1 kg) packages, since samples were not taken in 25 lb (11 kg) and 50 lb packages (22 kg), which are generally used in bakeries, wheat derivative factories, or tortilla shops.

17. In the case of milk, the results have the limitation that they apply to long-life fluid milk and the fortification situation of fresh milk is unknown, since the cold chain could not be guaranteed in the sampling.

18. The salt results reflect the situation of salt that has a sanitary registry and that is marketed in legally established outlets, but it is unknown what percentage of non-fortified salt, product of informal trade directly from the salt flats, is present in the salt market. country.

19. Regarding the strategies to reduce the consumption of sugar and salt for the prevention of non-communicable diseases related to their high consumption, food fortification is a strategy that is compatible with them and can be adapted to the consumer, adjusting the levels of fortification when necessary, as indicated by the results of the periodic monitoring of food consumption and nutritional status of micronutrients of the population.

Recommendations

1. Almost two thirds of the sugar samples taken contain vitamin A levels that meet the legal minimum established in the Honduran Technical Regulation (Agreement No. 4667, 2016) and it is recommended that the fortification process be optimized to improve results.

2. Based on the results obtained from salt iodization, a training plan should be implemented for the salt sector that addresses awareness of the benefits of salt iodization for health, good practices for salt production and quality assurance and control, including the salt iodization process.

3. Regarding the public sector, it is recommended that the Ministry of Health, as the highest authority on food fortification in the country, update the salt iodization regulation dating from the 1960s, by adjusting the iodine level. according to the needs of the population, considering the contribution of other sources of iodine, such as culinary products, such as bouillon powder and cubes. In this way, there will be a legal document that clearly defines the salt fortification requirements in the country.

4. It is recommended that monitoring of urinary iodine excretion in the population be carried out to determine if the population receives sufficient and not excess iodine, and take appropriate measures such as adjusting salt iodization levels to ensure nutritionally optimal iodine, without excesses or insufficient.

5. Corn flour factories that make a fortification declaration on their packages should clearly define the fortification specification to be applied, optimize their process based on it, and adjust their quality assurance and control practices to guarantee the consumer the fortification they require is declared, and not deceive the consumer.

6. Regarding the Glass of Milk program for school meals, it is recommended that the fortification specifications to be met by milk suppliers be clearly defined.

7. It is recommended that the Sanitary Regulation Agency (ARSA) resume the monitoring activities of the mandatory fortification programs, giving priority to factory monitoring, to cover all the product from the origin, where it is easier to take corrective actions if deficiencies are found in the fortification process.

8. It is important to recognize that the Honduran wheat flour and sugar industry have maintained their compliance with the fortification regulations that apply to them, despite the lack of incentives and supervision by the regulatory body. It is recommended that this effort be recognized by the authorities as a way of motivating the industries that comply with the established obligation and the contribution they have made to the nutrition of the Honduran population through fortification.

Annex 1. Instructions for Taking Samples of Fortified Foods

Dear collaborator,

You have been assigned to take the sample in the department of (*specify department*), and the municipalities of (*specify the name of the municipalities*) . Follow the instructions described below for the prevention of contagion of COVID-19 and for sample collection. We thank you for your collaboration. Carefully follow all instructions listed.

For any questions or queries, contact:
Dr. Karina Cruz, Coordinator of Technical Cooperation in Honduras, based in the Tegucigalpa office, Cel.: + 504 8979-4250; from 8:00 a.m. to 4:00 p.m., Monday through Friday.

Instructions:

1. When you arrive at the municipality, locate the largest warehouse, market or supermarket in the place where there is the most commercial movement.
2. Go to the place and take a photo of it.
3. Write down the name of the place and its georeferenced location in the sampling registration form, as indicated in the training.
4. Enter the place and ask how many or what brands of each food they have (sugar, salt, wheat flour, corn flour and milk).
5. You must buy the following in the municipality:

    a. Sugar: (*specify number*) samples
    b. Salt: (*specify number*) samples
    c. Wheat flour: (*specify number*) samples
    d. Corn flour: (*specify number*) samples
    e. Milk: (*specify the number*) samples (it can be fluid milk in Tetrapak or long life or powdered)
    f. Powder bouillon and cubes: (*specify number*) samples

6. If you find multiple brands on the sales site, try to buy at least one sample of each brand up to the total number specified, and if there are fewer brands than the samples you need to take, distribute the brands evenly among the number of samples. In the case of milk, if you find powdered milk and fluid milk on site, take half of the samples of each type of milk. For example, if you have to take 2 milk samples, buy 1 powdered milk and 1 fluid milk, and preferably a different brand. It can be fluid milk in Tetrapak or long life or powder.

7. Do not forget to request the invoice for the purchase of the samples, since it will be used to settle the expenses of the project.

8. Label the samples with a previously prepared label or, failing that, with adhesive tape and an indelible marker, with the following information:

- Unique code of the municipality indicated in Table 1 +
- food +
- a correlative number by type of food.

For example: Salt samples taken in the department of Copán, municipality of Copán Ruinas will be labeled as 0404-sal- (correlative number from 1 to 4). The sugar samples will be labeled as 0404-sugar- (sequential number from 1 to 4) and the milk samples will be labeled as 0404-milk- (sequential number from 1 to 2).

Table 1. Unique code of the municipalities used by the National Institute of Statistics and National Registry of Persons of Honduras.

No.	Selected municipality	Code
1	Belen	1402
2	Copan Ruinas	0404
3	Lapaera	1313
4	San Francisco de Yojoa	0510
5	Macuelizo	1613
6	Esparta	0103
7	Santa Fe	0206
8	San Francisco de Opalaca	1017
9	La Paz	1201
10	Distrito Central	0801
11	Patuca	1523
12	Corpus	0605
13	San Lorenzo	1709
14	Roatan	1104

9. Fill out the attached sampling registration form and take a photo of it when completed. Be sure not to leave gaps in the log header information. Use multiple pages if necessary.

10. Send via email to the representative of the CT-INCAP-HON the following:

    g. Photo of the place where the samples were purchased
    h. Venue location
    i. Photo of the completed registration form
    j. Photo of purchased samples

11. The samples by type of food will be placed inside a box indicating the type of food and the code of the municipality. They should be protected from direct exposure to light and heat. In accordance with the instructions given in the training, send the samples by parcel to Tegucigalpa to the representative of the CT-INCAP-Honduras or to the person designated for it in the project.

THANK YOU VERY MUCH FOR YOUR HELP!

Annex 2. Sampling Information Record Format

INSTITUTE OF NUTRITION OF CENTRAL AMERICA AND PANAMA (INCAP)
ANALYSIS OF THE SITUATION OF MASSIVE FOOD FORTIFICATION IN HONDURAS

REGISTRY OF INFORMATION ON THE SAMPLING OF FORTIFIED FOOD

Date: _____ Page No. : _____
Department: _____ Municipality: _____
Property name: _____ Address (georefe-renced location) : _____
Responsible for the purchase: _____ Signature: _____

sample no.	Food	Price (Lempi-ras)	Brand	Net Weight on Label (specify units of measure)	sample code

Observations (write down all the information that is pertinent to the study):
CODING

Annex 3. Sample Collection Tour Report

During the week of September 12 to 19, collaborators from the Technical Unit for Food and Nutrition Security (UTSAN), the USAID "Advancing Nutrition" program, and the Santa Fe municipality visited the selected regions in the study for the taking of the samples where the establishments of sale of greater commercial movement were chosen. Below are the photographs and georeferencing of the places visited by the study volunteers.

Pictures of Patuca, Olancho

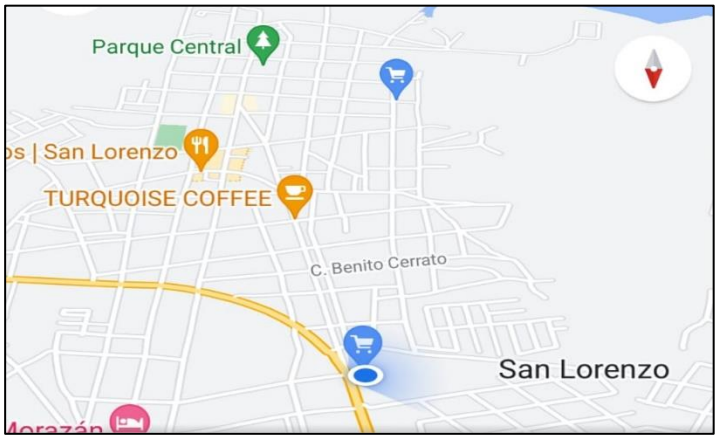
From left to right:

1. Some snags encountered along the way.
2. Establishment where the sampling was carried out.
3. Interior of the establishment where the purchase was made.
4. Georeferencing image.

Pictures of San Lorenzo, Valle

From left to right:

1. Selected commercial establishment.
2. Interior of the establishment where the purchase was made.
3. Georeferencing of the purchase site.



Pictures of El Corpus, Choluteca

From left to right:

1. Making the purchase.
2. Volunteer at El Corpus.
3. Georeferencing image.

Pictures of La Paz

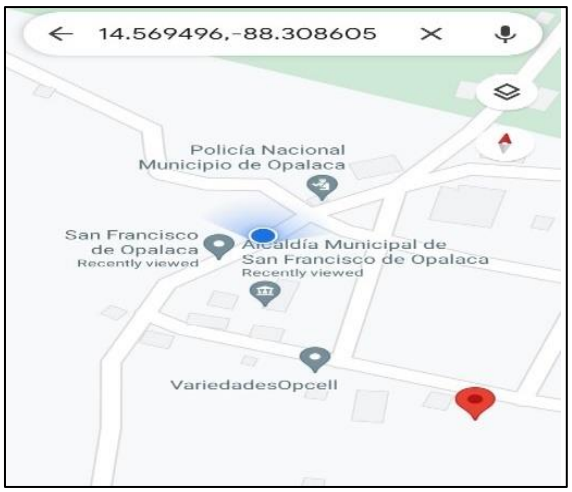
From left to right :

1. Establishment selected .
2. Georeferencing image

San Francisco de Opalaca , Intibucá

From left to right:

1. Establishment where the purchase was made.
2. Georeferencing image.



Sparta, Atlantis

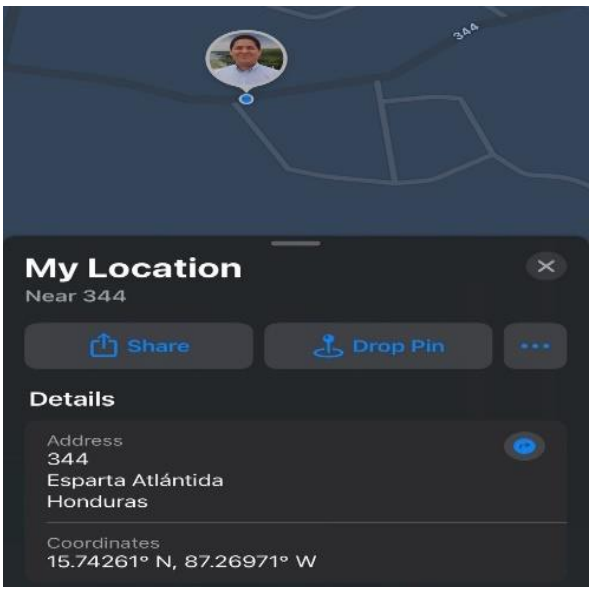
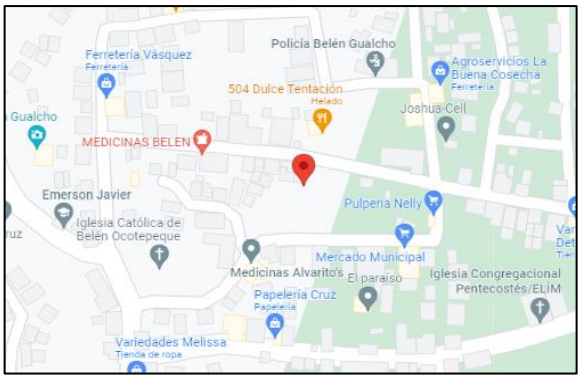


Image of the georeferencing carried out in the establishment in Esparta, Atlántida.

Belen Gualcho , Ocotepeque

From left to right:

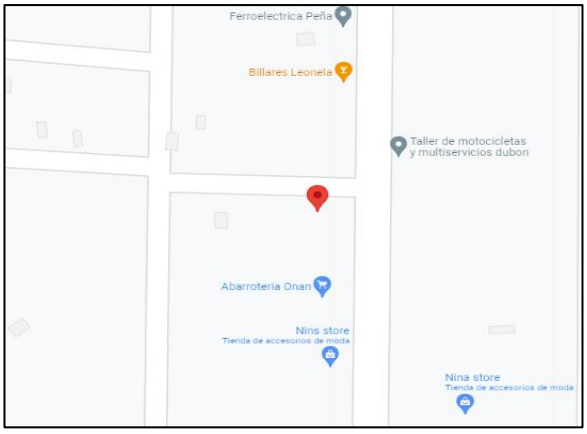
1. Establishment where the purchase was made.
2. Georeferencing image.



Macuelizo, Santa Barbara

From left to right:

1. Selected establishment.
2. Georeferencing image.



Lapaera , Lempira

From left to right:

1. Selected establishment.
2. Georeferencing image.

Copan Ruinas, Copan

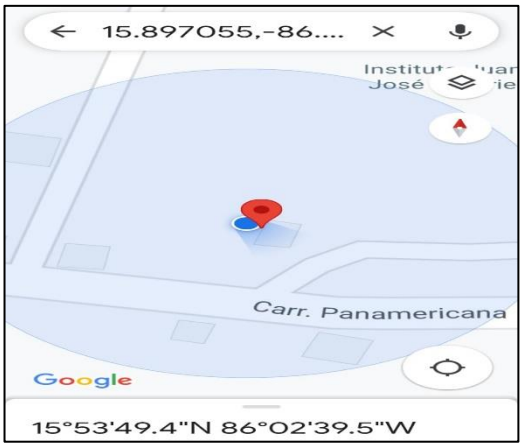
From left to right:

1. Purchase establishment.
2. Georeferencing image.

Santa Fe, Colon

From left to right:

1. Purchase establishment.
2. Georeferencing image.



Roatan, Bay Islands

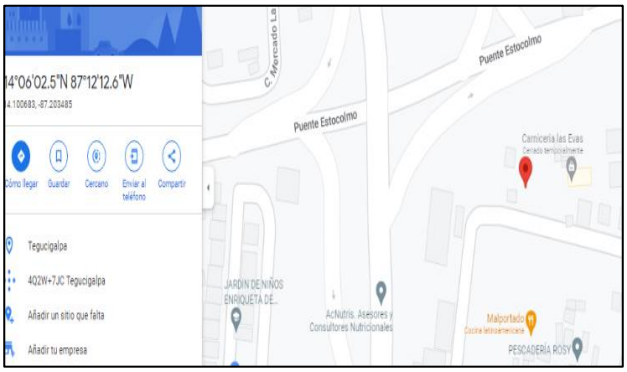
From left to right:

1. Selected establishment.
2. Georeferencing image.

Central District, Francisco Morazán

From left to right:

1. Selected establishment.
2. Georeferencing image.



Other purchase points located in the Farmer's Fair market were selected for the specific purchase of salt, in order to acquire a greater variety of representative brands of the different small salt producers whose brands are marketed in different businesses in the capital. Below are photographs of the selected outlets at the Farmer's Fair in Tegucigalpa.

USAID ADVANCING NUTRITION

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