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FOOD EDUCATION PROMOTES THE CONSUMPTION OF AMARANTH TO IMPROVE CHILDREN'S NUTRITIONAL STATUS

María Elena **Calderón-Martínez**[1], Oswaldo Rey **Taboada-Gaytán**[1]*, Pedro Antonio **López**[1], Enrique **Ortiz-Torres**[1], Adrián **Argumedo-Macías**[1], Margarita **Cervantes-Rodríguez**[2]

[1]Colegio de Postgraduados, Campus Puebla. Boulevard Forjadores de Puebla 205, Santiago Momoxpan, San Pedro Cholula, Puebla, México. 72760.
[2]Universidad Autónoma de Tlaxcala, Campus San Pablo del Monte. Av. Xicohtencatl Norte 466, Barrio de San Nicolás, San Pablo del Monte, Tlaxcala, México. 90920.
*Corresponding author: toswaldo@colpos.mx

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ABSTRACT

Children's nutritional status is vulnerable to food crises, especially in rural areas. Likewise, lack of knowledge about food and unhealthy consumption habits increase the risk of malnutrition. Focused food education and the use of traditional local crops, such as amaranth, can benefit nutrition and food security, enriching the local food culture. The objectives of this study were to promote the consumption of amaranth through food education in order to observe its effect on children's nutritional indicators and present the methodology implemented to promote the use of this food resource in the study area. A mixed, explanatory and longitudinal design was proposed. A baseline evaluation was carried out for nine children between three and eight years of age from Tochimilco, Puebla, who consumed 20 g/day of popped amaranth as a complement to homemade dishes for five months; individual food workshops were implemented and anthropometry and consumption patterns were monitored. By means of food education focused on families, amaranth became conspicuous and was consumed as part of the regular diet; even during the health pandemic, it remained available, accessible and stable in the family food scheme. Its consumption and the variety of dishes increased following food education, in all cases. Regarding the anthropometric indicators, seven cases improved and the final diagnosis was healthy, but two cases were found to be overweight at the end. It was concluded that focused food education helps incorporate amaranth into regular food and makes it possible to improve the nutritional status of children even during food crises.

Keywords: *Amaranthus hypochondriacus*, nutritional status, nutritional assessment, child population, dietary strategy**.**

INTRODUCTION

The global food policy that seeks homogenization of food culture (Carrasco, 2006), together with inadequate consumption patterns and a sedentary lifestyle are detrimental factors in terms of nutritional status and quality of life (Lucas *et al.*, 2013), leading to malnutrition among the population. Malnutrition is a complex phenomenon that encompasses both malnutrition, micronutrient deficiency and overweight and obesity issues (UNICEF Mexico *et al.*, 2020); public health problems that represent a challenge at all levels.

The food crises experienced in recent years, especially the one derived from the COVID-19 pandemic, have had great repercussions on the health and nutrition of children worldwide

(Sandoval, 2021; Zemrani *et al.*, 2021), because this is the age group most vulnerable to this instability (Boix, 2021; UNICEF Mexico, FAO Mexico, PAHO/WHO Mexico, National Institute of Public Health [INSP], 20 20).

It is estimated that in the world 155 million children suffer from chronic malnutrition and 52 million are emaciated (UNICEF, 2018); at the opposite extreme, 340 million children and adolescents suffer from obesity (Jimeno-Martínez *et al.*, 2021). In Mexico, 14.2% of children under five years of age are stunted, 4.8% underweight, and 1.4% emaciated, while the national prevalence of overweight and obesity among schoolchildren is 35.5% (Shamah-Levy *et al.*, 2020). Specifically in the state of Puebla, the percentage of preschoolers with stunted growth is 18.8%; considering those overweight and obese, the result is 6.1% among children under five years of age and 26.6% among boys and girls between five and eleven years of age (INSP, 2020).

Both governments and civil and academic societies propose and implement alternative solutions to the problem of malnutrition (López-Alonso *et al.*, 2021; Keats *et al.*, 2020; UNICEF México *et al.*, 2020). Unfortunately, some approaches are manifestations of the hegemonic food policy, which is why they infringe upon the identity and culture of the target population (Carrasco, 2006); in addition to not being adopted by the people or sustainable over time (De la Cruz, 2018). However, some proposals indicate the importance of focusing strategies on local culture (Calderón-Martínez *et al.*, 2017), as well as the use of local resources, especially traditional foods (Chadare *et al.*, 2018; Martínez *et al.*, 2018; May and Ciocchini, 2018). Undoubtedly, if you want to modify current alimentary habits, the approach should embrace planning strategies that combat malnutrition; with the help of tools such as food education (De la Cruz, 2018) and food schemes (Ponce, 2017), excellent results can be obtained.

Food education refers to the teaching-learning process, where some kind of guidance promotes healthy eating habits in a population (De la Cruz, 2018); the food scheme includes all food-related aspects that families are aware of, both at home and outside (Ponce, 2017). These two tools are based on the characteristics and resources of the target population, and promote community participation through upward and horizontal teaching, resulting in desirable changes in eating habits and behavior; easily adopted in order to persist in the long term (De la Cruz, 2018).

Amaranth is considered a traditional grain in Latin America (May and Ciocchini, 2018) and has been widely studied in recent years due to its nutritional potential (Gabriel *et al.*, 2018; D'Amico and Schoenlechner, 2017). This crop is the subject of various investigations that propose its use to alleviate malnutrition and food insecurity (Aderibigbe *et al.*, 2022; Chadare *et al.*, 2018; Martínez *et al.*, 2018; May and Ciocchini, 2018; Martínez-Salvador, 2016), there are even favorable evaluations concerning the effect of consumption on the part of children under five years of age, suffering from malnutrition (López-Alonso *et al.*, 2021; Vértiz-Cardona *et al.*, 2019; Díaz, 1999).

Although in recent years the effects of amaranth on the human organism have been investigated worldwide, not all the advantages in terms of correcting food insecurity,

malnutrition and comorbidities have been implemented. The average consumption in Mexico barely reached half a gram per person per day in 2016 (Ponce, 2018). This problem is similar in the municipality of Tochimilco, Puebla, where peasant families widely produce this crop and it is part of their way of life, but not of their alimentary cultural identity because they know few culinary alternatives to integrate amaranth into their diet and do not have much knowledge of its nutritional benefits (Calderón-Martínez *et al*., 2017).

Until now, there is no published research to evaluate the incorporation of amaranth into the diet of post-intervention families, only concerning the effect it had on boys and girls, as in López-Alonso *et al*. (2021), Vertiz-Cardona *et al*. (2019) and Diaz (1999); studies in which amaranth was used as a food supplement in a specific presentation (a sweet known as "alegria" and in the form of amaranth flour); however food culture and local knowledge of the target population were not addressed. Likewise, there is no research concerning impact on nutritional status when amaranth is incorporated into the regular diet through food education and without any particular presentation; just as an extra ingredient in dishes typical of traditional cuisine. Due to the above, this study is relevant to highlight the potential impact of amaranth on nutritional status and from the perspective of food anthropology, promoting nutritional development and enriching traditional cuisine, even subsequent to the termination of the intervention.

This research aims to promote the consumption of amaranth through food education programs, in order to observe the effect of this local resource on anthropometric and dietary indicators of boys and girls. In addition, it seeks to present the methodology (strategy) that was implemented to promote the consumption of this food resource in the study area, which includes aspects such as the food scheme and gastronomic workshops.

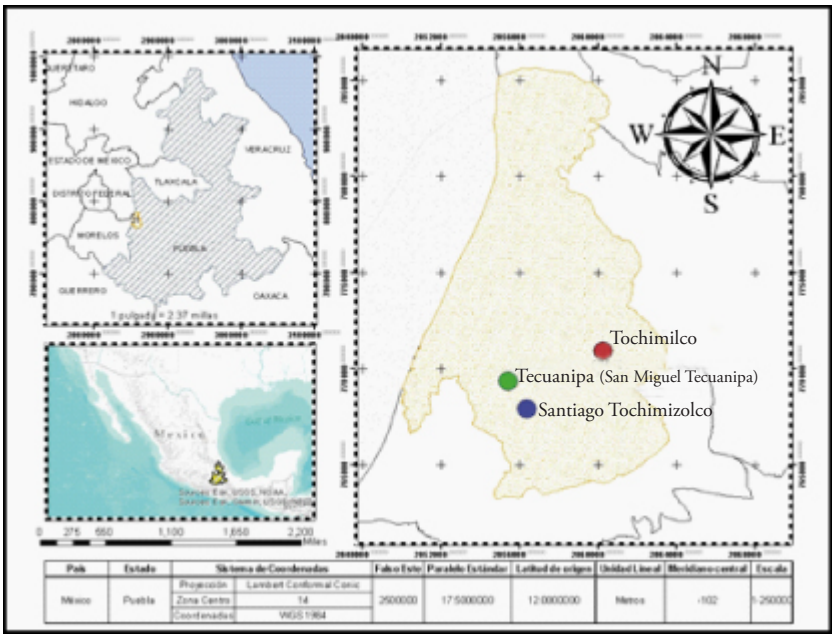
METHODOLOGY

This research was proposed to consist of a mixed, explanatory and longitudinal design (Hernández-Sampieri *et al*., 2014). It was carried out during the period from May 2019 to May 2021, with some intermittencies and reconsiderations due to the global pandemic generated by the SARS-CoV-2 virus (Covid-19) in the years 2020 and 2021.

Location and characteristics of the study area

The research was carried out in three locations in the municipality of Tochimilco in the state of Puebla, Mexico, located in the central region of the country (Figure 1). The selected localities were the municipal capital, known as Tochimilco, classified as urban due to the number of inhabitants, as well as San Miguel Tecuanipa and Santiago Tochimizolco, classified as rural (INEGI, 2017); however, all three share similar conditions with predominantly rural characteristics and with areas manifesting high social backwardness (SEDESOL, 2017).

The main economic activity is agriculture, with special dedication to the cultivation of amaranth (Sánchez-Olarte *et al*., 2016). In fact, the municipality is one of the main



Source: elaborated by Juan Velázquez, 2021.
Figure 1. Geographic location of Tochimilco in the State of Puebla, Mexico.

producers of amaranth with a total annual production of 2,779.80 t, which represents around 47.6% of national production (SIAP, 2020). Most of the production of amaranth is for sale in the form of grain, mostly to intermediaries; some is for local sale, with or without added value through its transformation (grain popping, preparation of "alegria" sweets, etc.); it is a resource little used in food because only a meager part is for local and family consumption and people hardly include it in their regular diets (Calderón-Martínez *et al.*, 2017).

Diet in this area has tortillas as the daily staple, scarce foods of animal origin or vegetables each week and to a greater extent, beans, bread made with wheat flour and fruit (Calderón-Martínez *et al.*, 2017).

METHODOLOGY

Isolation caused by the SARS-CoV-2 (Covid-19) virus pandemic resulted in important changes in the study; the international health situation influenced adjustments in methods, activities and sample size. This condition was a factor that could not be either controlled or predicted, however it helped us to reassess the study.

Sample size initially consisted of 39 boys and girls, diagnosed as suffering from malnutrition or at latent risk; however, due to sanitary restrictions, it was not possible to continue with this number of cases. The investigation continued with only those families who chose to remain, with whom it was agreed that pertinent sanitary measures should be implemented.

Finally, the sample was reduced to six girls and three boys, from three to eight years old; all residents of Tochimilco.

Qualitative research instruments and methods were employed, such as participant observation and in-depth interviews (Hernández-Sampieri *et al*., 2014); activities took place in meetings with a minimum number of people present and directly in private homes, applying appropriate safety measures. Following this process, we obtained data concerning food schemes, lifestyle, habits and consumption patterns of both amaranth and in terms of general diet.

Participating boys and girls fulfilled the following criteria for inclusion: a) The mother, father or guardian signed the informed consent to authorize nutritional evaluation and participation in the study, b) They were under 10 years of age, c) They had been anthropometrically evaluated in an assessment carried out in May-June 2019 in their academic institutions and d) The mothers or guardians of the children wished to participate and permitted entry into their homes.

Meetings for food education workshops

Through contact with school and local authorities, the people in charge of feeding the family, mostly mothers, grandmothers and aunts, were requested to attend five meetings during the second two-month period of 2019, which were held within the facilities of the municipal Comprehensive Family Development (DIF) government institution. Here a semi-regular group of mothers was formed to attend food education workshops (De La Cruz, 2018) promoting the preparation of culinary preparations with amaranth; the purpose of the meetings was to train the mothers to recognize the benefits of amaranth as well as how to prepare dishes enriched with this grain; in this way, a more structured study on the effects of daily amaranth consumption was initiated.

The meetings ceased in 2020 before the study started because of the closure of schools and government institutions due to the health pandemic. Telephone contact was maintained with some mothers who expressed their wish to continue in the study and individualized visits to their private homes began. From December 2020 to April 2021, four meetings were held in each house, where talks, workshops, taking of anthropometric measurements and application of methods took place.

Study of amaranth consumption effect on nutritional development

During visits, activities were carried out to monitor infant development by taking anthropometric measurements, as well as the consumption of amaranth by boys and girls and its monthly supply. In this sense, the following methods were applied: questionnaire on amaranth consumption, analysis of the family food scheme (Ponce, 2017) and in-depth interviews concerning changes in consumption patterns. In the last visit, information was obtained on the changes in the consumption of amaranth in the family diet and the social benefits of its incorporation.

Anthropometric assessment

Measurements were taken a total of five times during the study in addition to the baseline, with the intention of analyzing trends and treatment outcomes. Anthropometric measurements were taken every five weeks between December 2020 and April 2021.

The following anthropometric measurements were taken: weight and height, complying with the Lohman protocol (Lohman *et al*., 1988). The indicators applied were: weight for age, height for age, weight for height and Body Mass Index (BMI) for age (WHO, 2006). Subsequently, these results were interpreted with the z scores provided by the WHO (2008). The comparison with the reference parameters (WHO, 2008) (Table 1) was followed up and a diagnosis was recorded for each child. The instruments used were a Tanita HA-621WH Dial Weight Scale and a Seca model 201 ergonomic tape to measure circumferences.

Consumption of amaranth in the daily diet

The recommendation was 20 g of popped amaranth per day; based on the study carried out by Díaz (1999), which in household measurements equals approximately one cup. The approximate nutritional contribution was 3.58 g/protein, 1.54 g/lipids, 11.4 g/carbohydrates and 0.44 g/fiber (Huerta and Barba, 2012). Two half kilo bags were provided each month, the amaranth was in the form of cereal and purchased from a micro-enterprise from the same municipality (Amadelys trademark). We recommended daily consumption incorporated in various dishes prepared by those in charge of family care, so that this could be included as part of everyday food without affecting their usual diet. Some suggestions for preparations supplemented with amaranth included: fruit smoothies, atole (maize drink), floured chicken, beans, maize tortillas, salads, fruit cocktails, sweet cookies, pancakes, truffles, and amaranth "horchata" cordial. In order to increase the diversity of dishes enriched with amaranth, three culinary and food education workshops were held

Table 1. Interpretations of growth indicators.

z scores	Growth indicators			
	Size for age	Weight for age	Weight for size	BMI for age
Above 3	Very tall	Assess by weight for height or BMI for age	Obese	Obese
Above 2	Adecuate		Overweight	Overweight
Above 1			Possible risk of overweight	Possible risk of overweight
0 (median)		Adecuate	Adecuate	Adecuate
Below -1				
Below -2	Stunted	Underweight	Underweight	Underweight
Below -3	Severely stunted	Severely underweight	Severely underweight	Severely underweight

Source: OMS, 2008, pág. 14.

with each family; similarly, didactic material was incorporated into their food schemes (Ponce, 2017), for example: weekly menu calendars that include an amaranth dish, with amaranth stored ready for use in an always visible transparent container.

Likewise, we sought to identify any changes in eating patterns, in terms of amaranth consumption that the families assumed, as a result of the study. At the beginning of the study, a semi-structured questionnaire was applied itemizing current consumption of amaranth with questions based on research from previous years (Calderón-Martínez *et al*., 2017). This included questions about the frequency of purchase and consumption of this grain, as well as its purchase cost, place of acquisition, preferred presentations, and the number of products or foods made from amaranth that they consume at home. Information was also obtained concerning customs and training for preparing dishes with amaranth, participation in production, knowledge about the transformation process and their opinion concerning prices and relevance of amaranth in the study area. Using the same methods, the home food scheme was partially analyzed, as questions were asked about the amount of wheat and amaranth-based products that they keep at home (cupboard, larder, dining table and refrigerator).

At the end of the investigation, nine in-depth interviews were carried out (Sampieri *et al*., 2014) to assess the incorporation of amaranth into the diet of minors, as well as the impact that this strategy had in the context of the health pandemic and greater risk of food insecurity. Two sessions were held in private homes, each session lasting approximately one hour; these were recorded and subsequently transcribed for analysis. The interviews were conducted with the participating mothers, grandmothers and aunts, who had completed an average of 9 years of schooling, two of these women are in sales and the others take care of family and household tasks.

Despite the small sample size, similar information was obtained from interviewees, achieving data completion during the last three interviews. Information was collected concerning the knowledge they have about the nutrition-health relationship and the importance of their role as managers of family nutrition; questions also referred to; their eating habits prior to and after the pandemic, strategic foods, and the relevance of amaranth in their family life, both as food for their sons and daughters, and in terms of the productive-economic aspect.

Bioethical considerations

Research was undertaken in compliance with bioethical principles: dignity, respect, protection, autonomy, distributive justice, equity, confidentiality, respect for traditions, informed consent, as well as optimization of positive results and minimization of negative ones, as presented in the Helsinki Declaration, regarding research that involves human beings (World Medical Association, 2013). Likewise, it was necessary to receive authorization from the mothers of minors with their signature of informed consent (Correal-Muñoz and Arango-Restrepo, 2014).

Methodology to analyze the effect of amaranth consumption on anthropometry and eating patterns

For a better analysis of the effect of regular consumption of amaranth in terms of anthropometric and dietary evaluation, the trend in terms of anthropometric indicators was analyzed by applying tools for descriptive statistics to assess overall tendency. Variables affecting changes in eating patterns were also analyzed, specifically concerning the consumption of amaranth and diet post pandemic and food education, by means of discourse analysis based on the four mainstays of food security: 1) availability of food, 2) access, 3) profitability and use and 4) stability (Martínez-Salvador, 2016). Using this information, we proceeded to scrutinize the answers on a case-by-case basis and report on individual reactions (Hernández-Sampieri *et al*., 2014).

Strategy for nutritional benefit derived from traditional crops: the case of amaranth

In order to achieve the participation of families and motivate their allegiance throughout the study, as well as ensuring positive results in the anthropometry of boys and girls, it was necessary to implement a series of tactics that would make this possible, such as seeking contact and approval from authorities, establishing a link with mothers and others in charge of child care, together with knowledge about the context where families reside, while providing focused food education.

Likewise, respect and knowledge of food culture, local knowledge and community identity were essential for planning and implementing this research. Carrasco (2006) criticizes interventions (including those of a nutritional nature) that ignore the reality and complexity of the real nutritional habits of families, as the independence of the population is disregarded so that the sustainability of health strategies declines. For this reason, in the methodology applied in this research, food and nutrition were promoted as a sociocultural phenomenon and social reality, together with respect for culture and food self-management; thus, we agree that "nutrition as an overriding social factor ceases to refer only to behavior but is also conceived as a value and aspect of consciousness and power" (Carrasco, 2006).

Targeted food education

A first intention for the strategy should have been to make amaranth with all its benefits prominent in the social and nutritional context. It was very important to stress the need to consume it, and this could be achieved through promotion and educational food training. In this study, food education was not limited to vertical type meetings, but sought to address the reality of families, as De la Cruz (2018) comments: "assess their food history" and recognize weaknesses in eating patterns. Considering this topic, it is necessary to determine the social actors who are most involved and the person responsible for activities related to food. In most cases, the greatest participants are women who care for minors: mothers, grandmothers or aunts.

The fact of attending the homes of the participating boys and girls due to the COVID-19 global health pandemic facilitated the incorporation of amaranth into the food scheme. Although positive results are reported when implemented among small groups of people, a greater impact was noted when targeted food education was implemented.

The topics included in this were: 1) Sessions to promote comprehensive access to knowledge concerning the benefits of consuming amaranth, 2) gastronomic workshops with proposals for dishes including this grain as an ingredient, 3) tools and strategies to promote consumption. However, the most important goal of food education was to encourage healthier food decisions based on knowledge acquired during the study, in order to achieve sustainability for the strategy. The acquisition of knowledge about amaranth and the type of decisions about food were evaluated by means of in-depth interviews at the end of the study, specifically referring to strategic foods and recipes proposed by those in charge of family care, as a result of food education. The most notable examples are when people who cook for their family come up with other dishes and preparations with amaranth and also prepare them at home. As Carreón (2012, pp 9) mentions: "Food and nutritional education is another context which the Mexican State should pay attention to, in order to provide the necessary tools for the population to opt for a healthy diet, while avoiding the trickery of advertising."

RESULTS

Presentation of the study population

At the beginning, the characteristics of the study population are presented (Table 2). The average age of the children was 5.1 years. Most of the families lived in a locality considered rural and two cases resided in the municipal capital, which is urban. Similarly, only two cases were found with a nutritional diagnosis other than healthy, in terms of their anthropometric indicators.

Table 2. Characteristics of the study population at three locations in the municipality of Tochimilco, Puebla.

Case	Sex	Age (years) at start of study	Type of location	Basic nutritional assessment
C1	Female	3.5	Urban	Healthy
C2	Female	4.5	Urban	Low weight for age
C3	Male	7.7	Rural	Healthy
C4	Male	3.9	Rural	Healthy
C5	Female	7.4	Rural	Possible overweight risk de sobrepeso
C6	Male	3.9	Rural	Healthy
C7	Female	6.7	Rural	Healthy
C8	Female	3.8	Rural	Healthy
C9	Female	4.5	Rural	Healthy

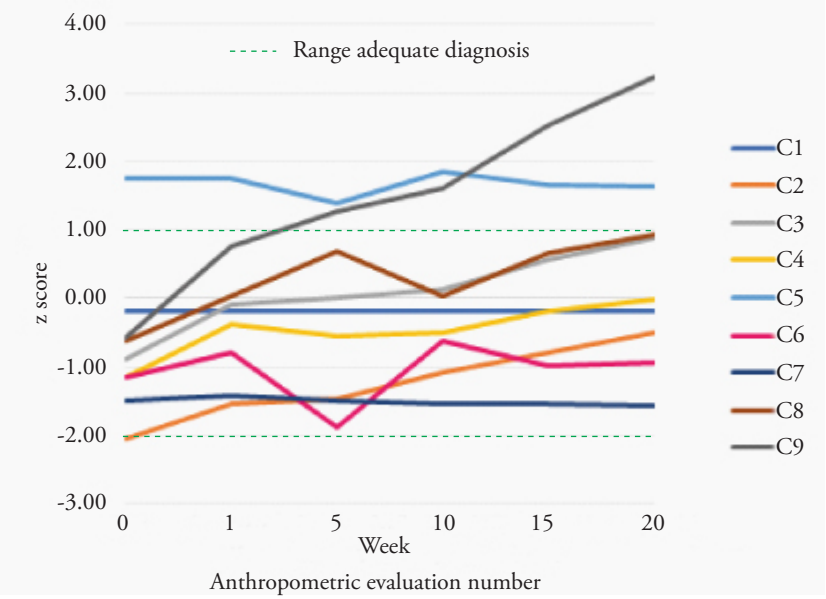
Source: self elaborated.

Effect of amaranth consumption on anthropometry

In order to assess whether amaranth consumption influenced nutritional development, anthropometric height measurements of the study population were taken. The trend towards weight increase was observed in almost all the boys and girls, including C2 who started with a z value of -2.05, but at the end was diagnosed with a healthy weight (z=-0.50). With the exception of one case (C5) who reached z=1.76, all initiated with a score under zero (mean=-0.70); at the end, the average was 0.39. C3 was the person whose score increased most; by 1.76 points. No case showed significant weight reduction, but weight between the appropriate parameters was maintained; the only negative case was C9, whose tendency inclined towards a diagnosis of obesity (Figure 2).

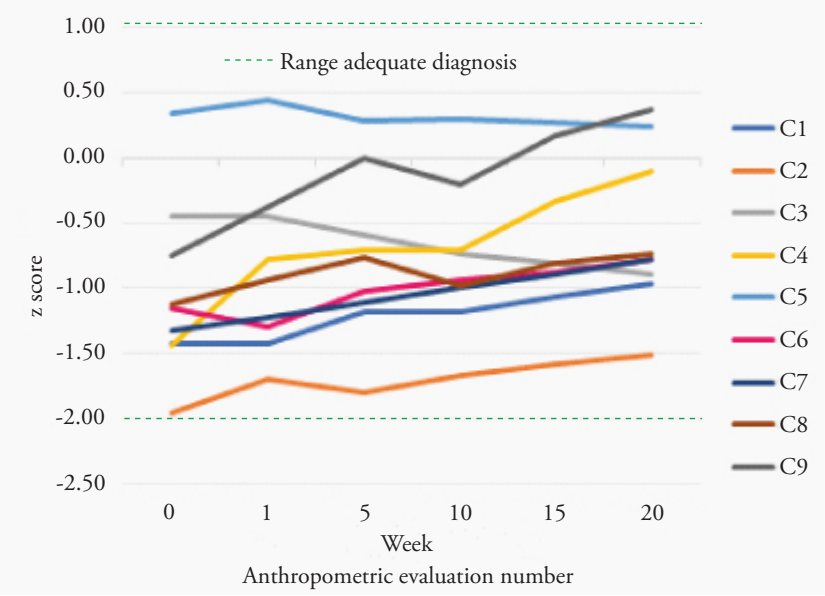
Concerning height for age, a tendency for improvement in height was found among the majority (Figure 3), with the exception of C3 and C5 whose score worsened, from -0.45 to -0.90 and from 0.34 to 0.25, respectively; although notably, they did continue within the appropriate size parameters. However, despite the increase seen in terms of measurements, they persisted with negative scores; the starting average of -1.03 increased to -0.58, and once again the case with the worst scores was C2, who started with values close to low height (z= -1.95), and improved to -1.51. The case considered to be most successful was C4, who increased 1.33 points, reaching a final z value of -0.11.

In the case of the BMI indicator, it was found that C1, C3 and C4 remained constant within adequate parameters; in contrast, C7 also remained constant, but with slight



Source: self elaborated.

Figure 2. Trend for the anthropometric indicator of weight for age, among nine cases of boys and girls in three locations in the municipality of Tochimilco, Puebla.

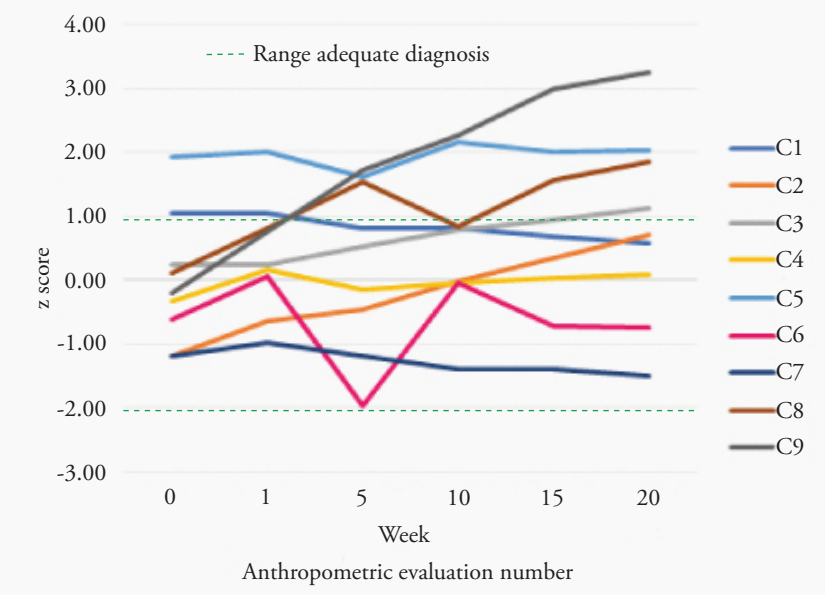


Source: self elaborated.
Figure 3. Trend for the anthropometric indicator of height for age, for nine cases of boys and girls in three locations in the municipality of Tochimilco, Puebla.

reductions that led to a risky z=-1.49. C5 weighed heavily in terms of his height; although this did not change significantly in numerical terms, his diagnosis did change, as at the end he registered as overweight (z=2.15), because his weight increased faster than his height. Something similar happened with C8 and C9, who maintained a trend that indicated a risk of becoming overweight; the first case increased 1.75 points, resulting in a z value of 1.85; the second case ended with a diagnosis of obesity (z >3). C6 showed radical changes in weight, which translated into abrupt changes in BMI (Figure 4). Specifically, in the third evaluation he manifested significant weight loss, due to a stomach condition that he had suffered a few weeks prior to the evaluation and the minor's weight decreased. C2 was deemed the most successful, as the girl increased 1.88 points, which led her to a z value of 0.70, due to a constant increase in weight and height.

Amaranth consumption patterns and their importance

Evidently this grain was procured from their own production (35% indicated so) and from a local store (35% mentioned this), the rest was acquired at school and in government food banks. All the people who affirmed that they buy this product, considered that the price they pay for it is fair, both in the form of cereal and in "alegria" sweets and bars. For popped amaranth on the last occasion, they paid from $60 to $80 per kilogram and for bars, $50 for 30 pieces.
In the initial interview, the results indicated relatively low consumption among participating families, as almost half of the families surveyed responded that their son or daughter



Source: self elaborated.
Figure 4. Trend for the anthropometric indicator of Body Mass Index (BMI) by age, among nine cases of boys and girls at three locations in the municipality of Tochimilco, Puebla.

had eaten amaranth in the five days prior to the interview and for the rest between one and three months had passed since they had last eaten it; only one case indicated that they had not consumed it for six months. The families that said they consume amaranth (30%) cook it two or three times a week; the others do not maintain an average monthly consumption.

However, it was apparent that culinary knowledge existed for preparing various dishes with amaranth; 82% mentioned that they add amaranth to customary dishes such as: yogurt, smoothies, hot cakes and potato cakes. Other presentations that were frequently mentioned were in candy-type "alegria" bars, as cereal, in smoothies, with fruit, in wafers, cookies, and granola. All of them considered that they do not know how to cook more elaborate dishes with amaranth.

In the nutritional context, 45% stated that they have amaranth in their larders, in the form of cereal, or "alegria" sweets and bars, but the quantities are minimal: less than 250 g of amaranth in the form of cereal and less than five pieces of "alegria" (200 g of amaranth). Contrarily, 100% of respondents had wheat pasta in the larder, 55% had wheat flour or rolls, 46% also had commercial cereal and 36% of homes had pastries or cakes.

At the end of the study, during the in-depth interviews, amaranth was mentioned as a food incorporated into the diet and that the whole family usually eats at least once a week, and currently it forms part of the strategic foods that have not been missing from their table for a long time: tortillas, beans, seasonal vegetables and fruits, and in one case, eggs. Boys

and girls were those who consumed amaranth the most, practically every day; especially in the form of smoothies, cereal and hotcakes, although they also mentioned banana pasties, squash and atole as preparations recently incorporated into the regular diet; likewise, they decided to add amaranth flour to almost all dishes: liquid soups, beans, stews, etc., as it does not have a strong flavor, and does not alter the other dishes.

> "In the beginning, we knew that this food was a possibility or could be prepared, but we didn't know how; but by the end, now, yes we do, because, for example, before we just prepared smoothies or fruit, but now it's combined with amaranth... so at this time it's served as cereal, or at least as cordial..., so then we learned to make drinks, so the next day when I said "I'm going to make lime cordial with amaranth"... then everyone said "oh wow, it tastes good, we just didn't know how to make it" (Miriam P.)

Likewise, the importance of this traditional crop in this context was corroborated, as 100% of respondents answered that it is important for their community in terms of health and economy. 73 % opined that the amaranth crop was irreplaceable.

For the interviewees, preparing food for the entire family and ensuring nutritional content for the little ones is something that they consider inherent to their activities, knowledge and experiences, as only one case mentioned that they received nutrition talks from the PROSPERA government program; the others said that no one taught them; they just know that this is best for their boys and girls.

For various reasons by the end of the study, this was chosen more often as a regular ingredient in their preparations: its subtle flavor, its importance for the economy, its nutritional benefits, and as a crop, it is part of their culture and daily practices. There were interviewees who affirmed that amaranth is good for the growth and health of children; healthy because it does not contain many chemicals: "Because it is natural, without preservatives and lasts a long time" (Gabriela V.), "Because it is a healthy food" (Ibeth C.), "From which meals can be produced" (Alondra V.).

> "We consumed it, just for something to eat, that is, we did not know about its properties or benefits... but I think the benefits that you revealed to us did influence us a lot, what you told me about giving them maize atole with amaranth, which you say has a lot of protein, giving them either meat or atole... I prefer to give them their maize atole with amaranth, which is what they really like... putting amaranth in it does not change the flavor or anything, I prefer to give them maize, I mean, maize is something natural and so is amaranth; neither contain preservatives, it doesn't affect anything... chicken is already highly processed, as are almost all meats; you don't even know what you're eating anymore" (Nayeli R.)

DISCUSSION

The consumption of amaranth in greater quantities may have initially contributed to faster increase than usual in Z scores (WHO, 2008) in terms of anthropometric indicators. Better results were observed in the accelerated increase in weight than in height, as weight

is a measure that is very sensitive to factors such as diet and changes rapidly, unlike height which increases slowly (Lucas *et al*., 2013).

The results found are also observed in similar studies with boys and girls suffering from malnutrition, who consume amaranth (López-Alonso *et al*., 2021; Vértiz-Cardona *et al*., 2019; Díaz, 1999); this accelerates the increase in anthropometric measurements; however, the sample size and variables without controls because of the health pandemic represented limitations to this study, meaning it would be necessary to increase the study population to confirm these results. In particular, it is necessary to analyze trends among cases manifesting a diagnosis of overweight in greater depth, as childhood obesity is a fairly complex pathological situation, in which various factors are involved, such as age, sex, genetics, economic and environmental aspects, in addition to lifestyle (Jimeno-Martínez *et al*., 2021). In particular, the two cases deemed overweight at the end of the study reported consumption habits with a high intake of refined carbohydrates and little physical activity, which are the factors most likely to explain this pathological situation; however, they are not definitive, as an analysis of the rest of the factors is required, as proposed by Jimeno-Martínez *et al*. (2021), for example socioeconomic level of the families and the eating patterns of the parents or closely related adults; factors not considered in this research.

The main reason for choosing this grain as the focus of study was its nutritional value (Gabriel *et al*., 2018; D'Amico and Schoenlechner, 2017); however, it was confirmed that this is a food that can potentially fulfill the four mainstays of food security, as suggested by Martínez-Salvador (2016) and Aderibigbe *et al*., (2022), although food education is necessary to intensify its use.

Before implementing food education programs, the families in the study did not include amaranth as an ingredient in everyday dishes, nor was it part of their consumption patterns. The reason was neither the lack of availability or access to this seed, as apparently these mainstays of food security can be fulfilled in the study area, as well as in other parts of Mexico and the world (Aderibigbe *et al*., 2022; Chadare *et a*l., 2018; May and Ciocchini, 2018; Martínez-Salvador, 2016); in Tochimilco it is almost always accessible to most of the population, due to its agronomic characteristics (Aderibigbe *et al*., 2022) and the elevated production of this grain (SIAP, 2020; Calderón-Martínez *et al*., 2017).

However, it was confirmed that the aspect that remains unfulfilled is that of use and utilization, which is related to the use of nutrients by the organism (biological use) and with the way food is obtained, prepared and consumed (food use) (Martínez-Salvador, 2016). In the case of amaranth, among the population of Tochimilco, consumption is insufficient to take advantage of its nutritional potential; meaning, biological utilization is lacking; nor do they conceive it as part of their eating pattern, in terms of culture, use, customs and habits (Martínez-Salvador, 2016). These results are very similar to those found in 2015 in the same study area (Calderón-Martínez *et al*., 2017) and similar to the situation in the Platense Horticultural Belt (Argentine region), where May and Ciocchini (2018) affirm that the producing families do not consume the amaranth they sow, instead they send it to the market. The same thing happens in other regions of the African continent; different

species of amaranth are produced with the potential to remedy food insecurity, but they are not consumed (Aderibigbe *et al*., 2022).

Moreover, stability as the fourth mainstay of food security is fulfilled through the very nature of the seed, as amaranth as a grain (prior to processing) can be kept as a supply for a long time, thus helping to maintain stability throughout the year and can then be popped or toasted at the desired time. This means it can be stored and consumed during food crises, such as the one experienced in 2020 and 2021. In the case of the participating families, they suffered changes in their diet during the SARS-CoV-2 pandemic, like many others in this country and throughout the world (Sandoval, 2021; Zemrani *et al*., 2021); however, the nutritional status of the children in the study did not worsen. In addition to the decrease in economic income and the change in routine, the interruption of government programs is a factor that may have worsened eating patterns over the last year (Keats *et al*., 2020) however, contrarily, anthropometric measurements improved and amaranth was incorporated into their consumption patterns, thus maximizing their intake of proteins, complex carbohydrates, fiber and micronutrients, at least in the short term (Gabriel *et al*., 2018; D'Amico and Schoenlechner, 2017); this was even able to position itself as a substitute for its greatest competitor wheat, and for some processed products such as packaged cereal, which is much consumed in Mexico but is not healthy (Ponce, 2017).

The incorporation of amaranth into consumption patterns and greater biological use was achieved by means of food education programs, particularly directed towards people in charge of family care. In the study, these people were mothers, aunts and grandmothers, who have common sense and a strong awareness in terms of feeding and caring for their offspring, as indicated by Carrasco (2006), which may result in improved growth and development of their sons and daughters, resulting from training in nutrition and by implementing this new knowledge (De la Cruz, 2018); this also contradicts the idea that "those who do not eat or who eat poorly are those who do not have" (Carrasco, 2006), because if traditional foods of high nutritional quality are consumed, everyone could be healthy (May and Ciocchini, 2018).

This is where the role of food education comes in, as this encourages the appropriation of healthy consumption patterns and an adequate lifestyle, causing an improvement in the nutrition of the target population (López-Alonso *et a*l., 2021; De la Cruz, 2018). In this research, we focused on providing the missing knowledge and culinary innovation that could be easily applied in daily life without disrupting their identity and culture; food education helped make amaranth conspicuous to women in charge of feeding the family; although previously this was part of the scenario of having land nearby where it is planted; the food education meetings managed to make it part of the food scenario of their home, with the placement of this food in their store cupboards, ensuring constant access to it (Ponce, 2017).

The incorporation of these elements increased the possibility of being successful in terms of improving nutrition for individuals and families, as at the end of the study families

were able to include this as part of their consumption habits, there was an increase in its nutritional use and a reinforced awareness of amaranth, as forming part of the cultural identity of the producers and their families, while also contributing to local knowledge. This represents an example of a crop that "contravenes the criteria of homogenization, disregard for seasons and relocation, associated with industrialized food" (May and Ciocchini, 2018).

Álvarez and Herrera (2019) had similar results from their intervention with quinoa, as they also found that the group who received nutritional workshops and quinoa improved in their assessment; likewise, as in the present investigation, the population was unaware of the benefits of this Andean grain and wasted it, even when it was part of their local agrodiversity; however, with the help of food education, favorable results were achieved.

Based on this study, it is recommended that dietary education be implemented prior to the evaluation of the effect of amaranth consumption, in order to sensitize the population. It is also advisable to have someone from this group who lives in the town and can make contact with others, this will help to motivate the participation of the entire group and create more efficient and positive agreements.

CONCLUSIONS

Two aspects that helped with the implementation of this strategy, were the initial observation and identification of the social context and the subsequent focused nutritional education. Likewise, the monitoring and permanence of the message helped amaranth to become a constant part of the diet, even after a radical change in lifestyles due to a global health pandemic. Food education focused and directed towards key people allowed participating families to make the ancestral seed conspicuous and increase its consumption, thus appropriating its flavor, preparations and nutritional advantages.

Food education programs promoted the consumption of amaranth as an essential requirement for the study. The qualitative aspect of the research regarding eating patterns had positive results, as families increased the amount of amaranth consumed and the diversity of dishes prepared with this cereal. Notably, the participating families incorporated amaranth into their consumption patterns in the short term, even after the end of the study and under the adverse conditions typical of the pandemic.

The effect of amaranth consumption on quantitative data such as anthropometric measurements was positive among children in most cases, except those with a tendency to be overweight and obese, for whom a greater control of variables is required, also taking into account variables related to the health pandemic.

Amaranth is a resource for the population of Tochimilco, Puebla, with the potential to fulfill the four mainstays of food security and thus improve the nutritional status of children and adults. Besides encouraging food security, amaranth can be a tool to promote development in the region, as the use of a local and traditional food resource can bring benefits in a balanced way in terms of nutritional status, as well as for culture, the economy, the agro-system and the environment.

Lastly, as food problems have multiple causes, the strategy for their eradication should necessarily be comprehensive. The planning must include basic nutritious, traditional, local and accessible food resources that are part of the culture or economy of the target population. It should also include food education focused on local knowledge, food history and consumption patterns; while also providing a constant reminder about nutritious food by applying tools such as a food scheme, which will improve the possibility of appropriating the "new" food.

Study limitations

Importantly, the limitations presented by the results of this research lie in the small number of samples and unconsidered variables that refer to time and space. Due to the situation triggered by the health pandemic, it was not possible to measure long term physical activity, exact food consumption and products, nor was the daily consumption of amaranth controlled, or the health condition of the study population and their families assessed. Therefore, the results presented should be treated with caution, as they represent a minority in the study area and there were other variables that might have affected measurements and results.

REFERENCES

Aderibigbe OR, Ezekiel OO, Owolade SO, Korese JK, Sturm, Hensel O. 2022. Exploring the potentials of underutilized grain amaranth (*Amarathus* spp.) along the value chain for food and nutrition security: A review. Critical reviews in food science and nutrition, 62(3), 656-669. DOI: 10.1080/10408398.2020.1825323.

Álvarez GJJ, Herrera MJP. 2019. La quinua como alternativa a la proteína animal en la desnutrición infantil. Revista UNIANDES de Ciencias de la Salud, 2(2), 72-81. Recuperado de: http://45.238.216.13/ojs/index.php/RUCSALUD/article/view/1354/688.

Boix CAM. 2021. Seguridad alimentaria en los hogares durante la fase 3 de la pandemia por coronavirus en México. RD-ICUAP, 7(19), 105-116. Recuperado de: http://rd.buap.mx/ojs-dm/index.php/rdicuap/article/view/508.

Calderón-Martínez ME, Taboada-Gaytán O, Argumedo-Macías A, Ortiz-Torres E, López PA, Jacinto-Hernández C. 2017. Cultura alimentaria: clave para el diseño de estrategias de mejoramiento nutricional de poblaciones rurales. Agricultura, Sociedad y Desarrollo, 14, 303-321. DOI: 10.22231/asyd.v14i2.594.

Carrasco HN. 2006. Desarrollos de la antropología de la alimentación en América Latina: hacia el estudio de los problemas alimentarios contemporáneos. Estudios Sociales, 16(30), 79-101. Recuperado de: http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0188-45572007000200003&lng=es&tlng=es.

Carreón MIG. 2012. Los retos de México en materia de derecho a la alimentación. Revista de derechos humanos - Dfensor, 09, 6-10. Recuperado de: https://cdhcm.org.mx/wp-content/uploads/2014/05/dfensor_09_2012.pdf.

Chadare FJ, Madode YE, Fanou-Fogny N, Kindossi JM, Ayosso JOG, Honfo SH, Kayodé APP, Linnemann AR, Hounhouigan DJ. 2018. Indigenous food ingredients for complementary food formulations to combat infant malnutrition in Benin: a review. Journal of the Science Food and Agriculture, 98, 439-455. DOI: 10.1002/jsfa.8568.

Correal-Muñoz CA, Arango-Restrepo P. 2014. Aspectos bioéticos en la salud comunitaria. Persona y bioética. 18(2), 194-212. DOI: 10.5294/pebi.2014.18.2.9.

D'Amico S, Schoenlechner R. 2017. Capítulo 6 Amaranth: Its unique nutritional and health-promoting attributes. *In*: Taylor JRN, Awika JM (eds), Gluten-Free Ancient Grains. Cereals, Pseudocereals, and Legumes: Sustainable, Nutritious, and Health-Promoting Foods for the 21st Century. Woodhead Publishing. DOI: 10.1016/B978-0-08-100866-9.00006-6. pp: 131-159

De La Cruz SEE. 2018. La educación alimentaria y nutricional como hecho educativo. Laurus Revista de Educación, 17(1), 232-253. Recuperado de: http://www.revistas.upel.edu.ve/index.php/laurus/article/

view/9146.

Díaz SC. 1999. El amaranto, alternativa actual en la disminución de la desnutrición. Programa IMSS-Solidaridad, Delegación Estatal en Oaxaca. Recuperado de: http://studylib.es/doc/8621663/el-amaranto--alternativa-actual-en-la-disminuci%C3%B3n-de-la-d.

Gabriel ML, Hernández HBR; Peña CV, Torres LNG, Espinoza MVA, Ramírez PL. 2018. Usos actuales y potenciales del amaranto (*Amaranthus* spp.). Journal of negative & no positive results, 3(6), 423-436. DOI: 10.19230/jonnpr.2410.

Hernández-Sampieri R, Fernández CC, Baptista LM. 2014. Parte 3: Proceso de la investigación cualitativa. *In*: Hernández SR, Fernández CC, Baptista LM, Metodología de la investigación. México:McGraw-Hill/Interamericana Editores S. A. de C. V. pp: 355-530.

Huerta OJA, Barba RAP. 2012. Caracterización bioquímica y estructural de las proteínas de reserva de amaranto. *In*: ER Espitia (ed), Amaranto: Ciencia y Tecnología. México: INIFAP/SINAREFI. pp: 293-302.

INEGI. 2017. Anuario estadístico y geográfico de Puebla 2017. México: INEGI. Recuperado de: https://www.datatur.sectur.gob.mx/ITxEF_Docs/PUE_ANUARIO_PDF.pdf.

INSP (Instituto Nacional de Salud Pública). 2020. Encuesta Nacional de Salud y Nutrición 2018. Resultados de Puebla. México: Instituto Nacional de Salud Pública.

Jimeno-Martínez A, Maneschy I, Rupérez AI, Moreno LA. 2021. Factores determinantes del comportamiento alimentario y su impacto en la ingesta y la obesidad en niños. Journal of Behavior and Feeding, 1(1), 60-71. Recuperado de: http://www.jbf.cusur.udg.mx/index.php/JBF/article/view/20.

Keats EC, Jain RP, Bhutta ZA. 2020. Indirect health sector actions and supportive strategies to prevent malnutrition. Current opinion in clinical nutrition and metabolic care, 23(3), 190-195. DOI: 10.1097/MCO.0000000000000653.

Lohman TG, Roche AF, Martorell R. 1988. Anthropometric standardization reference manual. Champaing, Illinois: Human Kinetics Books.

López-Alonso WM, Gallegos-Martínez J, Reyes-Hernández J. 2021. Impact of a nutritional intervention based on amaranth flour consumption to recovery undernourished children. Current Research in Nutrition and Food Science, 9(1), 222-232. DOI: 10.12944/CRNFSJ.9.1.22.

Lucas B, Feucht S, Ogata B. 2013. Nutrición en la infancia. *In*: K Mahan, S Escott-Stump, JL Raymond (ed), Krause Dietoterapia. España: Elsevier. pp: 389-404.

Martínez MEC, Gaytán ORT, López PA, Torres EO. 2018. Improvement of nutritional quality of local dishes and their acceptance by children of different ages. Brazilian Journal of Nutrition, 31(6), 603-615. DOI: 10.1590/1678-98652018000600009.

Martínez-Salvador L. 2016. Seguridad alimentaria, autosuficiencia y disponibilidad del amaranto en México. Revista Problemas del Desarrollo, 186(47), 107-132. DOI: 10.1016/j.rpd.2016.08.004.

May MP, Ciocchini FI. 2018. Crisis alimentaria global, posibles salidas locales: cultivos tradicionales en La Plata, Argentina. Observatorio Medioambiental, 21, 211-231. DOI: 10.5209/OBMD.62660.

OMS (Organización Mundial de la Salud). 2006. Patrones de crecimiento infantil de la OSM: Longitud/estatura para la edad, peso para la edad, peso para la longitud, peso para la estatura e índice de masa corporal para la edad. Métodos y desarrollo. OMS. Recuperado de: https://www.who.int/childgrowth/standards/tr_summary_spanish_rev.pdf.

OMS (Organización Mundial de la Salud). 2008. Patrones de crecimiento del niño de la OMS, Curso de capacitación sobre la evaluación del crecimiento del niño. Interpretando los indicadores de crecimiento. Ginebra: OMS.

Ponce SJ. 19 agosto 2017. Paisaje alimentario como detonador del consumo. La Jornada del campo, núm. 119. Recuperado de: https://www.jornada.com.mx/2017/08/19/cam-paisaje.html?utm_content=buffer33154&utm_medium=social&utm_source=facebook.com&utm_campaign=buffer.

Ponce J. 2018. Amaranto: entre el deber y el derecho. *In*: Del Villar M, Bermúdez G, García ME (coords), Amaranto semilla ancestral, contribución a la soberanía alimentaria de México. México: Universidad Autónoma Chapingo, Grupo de Enlace para la Promoción del Amaranto en México. pp: 71-73.

Sandoval BE. 2021. Influencia de la pandemia por COVID-19 en la alimentación. Boletín sobre COVID-19, 2(14), 3-6. Recuperado de: http://dsp.facmed.unam.mx/wp-content/uploads/2013/12/COVID-19-No.14-00-Boleti%CC%81n-completo.pdf.

Sánchez-Olarte J, Argumedo-Macías A, Álvarez-Gaxiola JF, Méndez-Espinoza JA, Ortiz-Espejel B. 2016. Análisis económico del sistema sociotécnico del cultivo de amaranto en Tochimilco, Puebla. Acta Universitaria, 26(3), 95-104.

SEDESOL. 2017. Informe anual sobre la situación de pobreza y rezago social 2017. Recuperado de: https://diariooficial.gob.mx/SEDESOL/2017/Puebla_188.pdf.

Shamah-Levy T, Vielma-Orozco E, Heredia-Hernández O, Romero-Martínez M, Mojica-Cuevas J, cuevas-Nasu L, Santaella-Castell JA, Rivera-Dommarco J. 2020. Encuesta Nacional de Salud y Nutrición 2018-19: Resultados Nacionales. México: Instituto Nacional de Salud Pública. pp: 177-225.

SIAP (Sistema de Información Agroalimentaria y Pesquera). 2020. Cierre de la producción agrícola. Recuperado de: https://nube.siap.gob.mx/cierreagricola/.

UNICEF. 2018. Undernutrition contributes to nearly half of all deaths in children under 5 and is widespread in Asia and Africa. Recuperado de: https://data.unicef.org/topic/nutrition/malnutrition/#.

UNICEF México, FAO México, OPS/OMS México, INSP. 2020. Recomendaciones de política pública nacional, estatal y local para la prevención, control y reducción de la mala nutrición en niñas, niños y adolescentes en México. Recuperado de: https://www.unicef.org/mexico/media/5076/file/Recomendaciones.pdf.

Vértiz-Cardona A, Gallegos-Martínez J, Reyes-Hernández J. 2019. An intervention based on self efficacy and parenting competence to help recovery childhood malnutrition. Journal of Nursing Education and Practice, 9(11), 107-113. DOI: 10.5430/jnep.v9n11p107.

World Medical Association. 2013. World Medical Association Declaration of Helsinki. Ethical principles for medical research involving human subjects. Clinical Review & Education, 310(20), 2191-2194. Recuperado de: https://www.wma.net/es/que-hacemos/etica-medica/declaracion-de-helsinki/

Zemrani B, Gehri M, Masserey E, Knob C, Pellaton R. 2021. A hidden side of the COVID-19 pandemic in children: the double burden of undernutrition and overnutrition. International Journal for Equity in Health, 20(44), 1-4. DOI: 10.1186/s12939-021-01390-w.