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Acceptability and nutritional value of three different formulas made from a mix of oatmeal flour, amaranth (*Amaranthus spp*), and Ramón seed (*Brosimum alicastrum*)

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Abstract
Background: Adequate, balanced, and varied feeding is very important for the human body because it helps normal growth and development. In Latin America, Guatemala ranks first in the prevalence of chronic malnutrition in children under the age of five and ranks sixth globally. There are various studies on plant mixtures combining two or more incomplete proteins, causing these proteins to complete each other and thus providing all the essential amino acids needed for the human body.
Materials and Methods: Three formulations were developed, each with different amounts of oatmeal, amaranth, and Ramón seed to assess the acceptability of the population and evaluate its nutritional content. Nutritional information should indicate its content of calories, proteins, carbohydrates, fats, and fiber.
Results: The formulation with code 9357 (25% Ramon seed flour, 50% oatmeal, and 25% amaranth flour) obtained the highest acceptability, in addition, it obtained a rating greater than 4.0 in smell, taste, color, and texture. The results of the Friedman test show that there is a statistically significant difference between the pancake samples regarding color, smell, taste, and texture ($P<0.05$). In addition, the sample with code 9357 provides a higher protein and calorie content.
Conclusions: The results confirmed the good quality of the flour mixtures and their nutritional content. It was also shown to have high acceptability on the part of the population so it is a product that could be used in the feeding of children because it has better protein and caloric contribution, in addition, it is a good alternative to prevent child malnutrition.
Keywords: Oatmeal, Amaranth, Ramón seed, Malnutrition.

Background

Food is an important factor for the normal growth, development, and organic maturation of an individual; therefore, it is important to maintain an adequate, sufficient, balanced, and varied diet that contains the necessary nutrients for the proper functioning of the body.[1]

Poverty and social inequality are the main reasons that access to many food products is difficult, which leads to child malnutrition.[2] In Guatemala, poverty increased from 51.2% in 2006 to 59.3% in 2014; while extreme poverty increased from 15.3% to 23.4% in the same period.[3] In Latin America and the Caribbean, Guatemala ranks first in the prevalence of chronic malnutrition in children under the age of five and sixth in the world. According to the National Child Maternal Health Survey (ENSMI-2014/2015, the prevalence of chronic malnutrition in children under five is 46.5%.[4]

Cereal proteins are deficient in lysine, while legumes are deficient in sulfur amino acids (methionine and cysteine). Two or more incomplete proteins can be combined in such a way that the deficiency of one or more essential amino acids is compensated by another protein and vice versa. When combined, these complementary proteins provide all the essential amino acids necessary for the human body. An example of a complementary protein combination is the mixture of dietary proteins from soy and corn or wheat flour and casein. In these cases, the quality of the protein mixtures exceeds the quality of the protein sources individually provided, so the effect of combining them is synergistic.[5]

Since the time of the Mayans, the Ramón seed (*Brosimum alicastrum*) was a food source due to its great bioavailability. Currently, in the market, there is great interest in the Ramón seed tree due to its high nutritional value and its variability in making recipes such as cookies, hot Ramón seed drink, breads, etc.. The Ramón seed tree is found in 15 of 22 departments in Guatemala, it has

high nutritional content such as protein, 17 amino acids, iron, calcium, vitamins B and C, etc, which allows a new alternative for rural communities since it is a high protein food.[6]

Analysis of the proximal composition of amaranth seed flours shows that the protein content varies between 13 and 18%, fat is 6.3 to 8.1%, fiber is between 2.2 and 5.8% and ash content is 2.8 to 4.4%.[7] Ramon seed flour contains 11% protein, 1.5% fat, and 70% carbohydrates.[8] Oatmeal contains 100 grams, 11.7% protein, 7.1% lipids, 59.8% carbohydrates, and 361 calories.[9]

Materials and Methods
Development of Formulations
Three different formulations of flour mixtures were developed, 60% Ramón seed, 20% oatmeal and 20% amaranth flour (7379), 50% Ramón seed, 25% oatmeal and 25% flour amaranth (4597), 25% Ramón seed, 50% oatmeal and 25% amaranth flour (9357). Raw materials such as sugar, milk, eggs, cinnamon powder, and baking powder were also used, and the formulations were made into pancakes.

Type of Study
This research constituted a descriptive and cross-sectional study, which was carried out to establish the acceptability and nutritional value of three different formulas of pancake flour made from mixtures of oatmeal, amaranth, and Ramón seed.

Sensory Analysis
The sensory analysis was performed using a 5-point hedonic test, the meaning of the 5-point scale is as follows: value 1: I extremely dislike it, value 2: I dislike it moderately, value 3: I do not like it or dislike it, value 4: I like it moderately and value 5: I extremely like it. The formulations were evaluated in terms of color, odor, taste, and texture. The samples previously coded were presented in an orderly manner to each sensory judge for their tasting.

Nutritional Value
The nutritional value was calculated with a rule of three, in which the grams used of the different types of flour (oats, amaranth, and Ramón seed) were multiplied by the number of calories, proteins, carbohydrates, or fats that indicates the table of food composition for each type of food. This result was divided by 100 g of food since the number of macronutrients in the food composition table is provided by 100 g of the food. Finally, the sum of each of the macronutrients provided by oatmeal, amaranth, and Ramón seed was made to obtain the nutritional value of each of the three formulas (Table 1). The Food Composition Table of Peru and the investigation called: The inclusion of Brosimum alicastrum (Ramón seed) is a case study by Alfonso Larqué Saavedra, June 2014.

Statistical Analysis
The Friedman test was used to analyze the results of the sensory analysis. Statistical analysis was performed with a confidence level of 95% using the Minitab 15 program.

Results and Discussion
The pancakes made with three flours were evaluated by 50 potential consumers regarding color, odor, taste, and texture, for this purpose 5-point hedonic scales were used; value 1 means: «I extremely dislike it» and value 5 means: «I extremely like it».

The flour formulation of code 9357 had the highest acceptability (83.6%), while pancakes made with the flour formulation of code 7379 had the lowest acceptability (67.7%) (Figure 1). In addition, the pancake sample with code 9537 had a score greater than 4.0 in the four sensory attributes (color, smell, taste, and texture) (Figure 2). The higher acceptance percentage of the sample 9357 may be due to the balance in consistency and flavor because it has a lower proportion of Ramón seed and a higher content of oatmeal, making it more palatable by providing better texture and balance in the sweetness since sample 7379
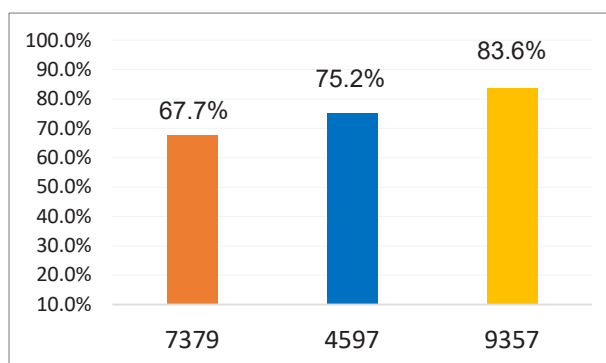

Figure 1. The Average Percentage of Acceptability of Pancake Samples by 50 Potential Consumers.
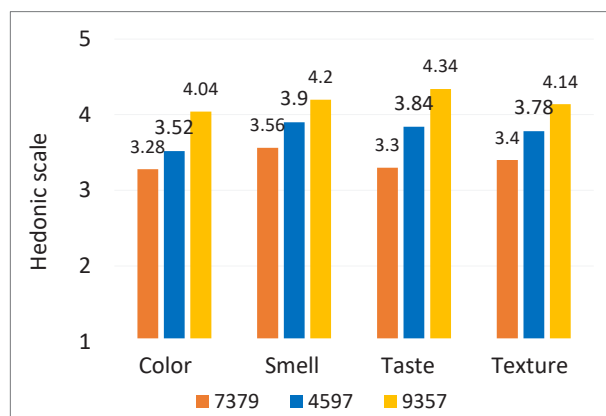

Figure 2. Average Rating Assigned to Color, Smell, Taste, and Texture of Pancake Samples by 50 Potential Consumers.

Table 1. Nutritional Composition in 100 Grams and 40 Grams of Ramón Seed, Amaranth, and Oats

Description of Sample	Nutrient	Nutritional Value Per 100 g	Nutritional Value Per Serving (40 g)
Sample 7379 60:20:20 (Ramón seed: amaranth: oatmeal flour)	Calories (kcal)	342	137
	Total Fat (g)	4.3	1.72
	Carbohydrates (g)	67.18	26.87
	Fiber (g)	11.92	4.77
	Protein (g)	12.2	4.88
Sample 4597 50:25:25 (Ramón seed: amaranth: oatmeal flour)	Calories (kcal)	348	139
	Total Fat (g)	5	2
	Carbohydrates (g)	67	26.8
	Fiber (g)	11.17	4.47
	Protein (g)	12.4	4.96
Sample 9357 25:25:50 (Ramón seed: amaranth: oatmeal flour)	Calories (kcal)	370	148
	Total Fat (g)	6.9	2.76
	Carbohydrates (g)	66.43	26.57
	Fiber (g)	9.07	3.63
	Protein (g)	13.22	5.28

obtained the lowest acceptability and presented a slightly bitter taste due to its higher content of Ramón seed.

The results of the Friedman test show that there is a statistically significant difference between the pancake samples with the codes 7379, 4597, and 9357, regarding color, smell, taste, and texture ($P < 0.05$) (Table 2).

The composition of the food table is an ideal tool to obtain the nutritional value of selected preparations. However, it is worth mentioning that it contains a margin of error because the nutritional content depends on the climate and soil where the product is grown, the degree of maturity at the time of harvest or use, and the variety grown (vegetables or derivatives). Also, the nutritional content varies if the product is raw, the way it was prepared, and the changes it undergoes during storage, because of this the values stated in the composition food table are approximations to the current content.[10]

Due to the restrictions established by the President of the Republic for the COVID-19 pandemic, the bromatology test was not carried out in a laboratory.

Conclusions

According to the results obtained, the pancakes made with the flour formulation that has the code 9357 (25 g of Ramón seed, 25 g of amaranth, and 50 g of oats) had the highest acceptability (83.6%); the best acceptability regarding color, smell, taste, and texture ($P < 0.05$), which provides higher protein and calorie content. It also has the lowest total and unit cost which is why it was determined that it is accessible to the population since the ingredients used are available in the country.

Competing Interests
None.

Table 2. Results of the Friedman Test on the Sensory Characteristic of Color, Smell, Taste, and Texture Carried out by 50 Potential Consumers

Treatment	N	Medium	Sum of Ratings	Gl	*P* Value
Attribute			**Color**		
Sample 7379	50	3.666	84.0	2	0.003
Sample 4597	50	3.833	98		
Sample 9357	50	4.000	118.0		
Total	150				
Attribute			**Smell**		
Sample 7379	50	3.666	84	2	0.003
Sample 4597	50	4	98		
Sample 9357	50	4.333	118		
Total	150				
Attribute			**Taste**		
Sample 7379	50	3.333	76.5	2	0.000
Sample 4597	50	3.666	101		
Sample 9357	50	4	122.5		
Total	150				
Attribute			**Texture**		
Sample 7379	50	3.666	81.5	2	0.002
Sample 4597	50	4	101		
Sample 9357	50	4.333	117.5		
Total	150				

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