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BLACK SAPOTE (*DIOSPYROS DIGYNA*) AS AN UNDERUTILIZED INGREDIENT IN THE PREPARATION OF VEGAN BREADS FOR SCHOOL CHILDREN IN PUEBLA, MEXICO

Morales Paredes YR¹, Santiesteban López NA^{1*},
 Arellano Rios KS¹, Ramírez Martínez TY¹ and SG Romero Rodriguez¹



Yesbek Rocío Morales Paredes



Norma Angélica Santiesteban López

*Corresponding author email: norma.santiesteban@correo.buap.mx

ORCID: <https://orcid.org/0000-0002-6037-2266> - Morales Paredes

ORCID: <https://orcid.org/0000-0001-7700-4139> - Santiesteban López

¹Benemérita Universidad Autónoma de Puebla. Facultad de Administración. Av. San Claudio S/N. Ciudad Universitaria. Puebla, Pue. México. CP. 72000



ABSTRACT

The black sapote (*Diospyros digyna*) is a Mexican endemic fruit cultivated in several states of the country, however, despite its production, it is wasted in different locations specifically in the state of Puebla, including Rafael Lara Grajales municipality. The objective of this article was to identify three different samples of vegan breads for the use of this fruit, to evaluate their acceptability in school children (6-12 years old) living in that location. This was achieved through sensory evaluation with a 5-point hedonic scale. The inclusion of an underutilized ingredient, such as black sapote, in their diet expands the variety of foods available to them. This article is based on a mixed, experimental, cross-sectional methodology with an exploratory and descriptive scope, using a documentary and field technique. The ANOVA statistical test and the Tukey test were carried out to evaluate the attributes of each bread evaluated, using the Minitab software version 18. The results showed that there was no significant difference $p < 0.05$ between the three samples, that is, all were sensorially accepted by the untrained panelist school children of Valentín Gómez Farías elementary school in the municipality of Rafael Lara Grajales, Puebla. The attributes of taste, aroma, color, shape and texture did not show significant differences in bread preference, despite the presence of sapote, which is not commonly consumed in the region. The texture, shape and taste were the most liked aspects of the hojaldra (traditional bread for the day of the dead in Mexico), while aroma and color were the least favored. The students favored the color, aroma, and taste of the conchas (fluffy bread with butter topping), but did not prefer their texture and shape. Similarly, the rolls were preferred for their aroma and shape, but were not the top choices in terms of taste, texture, and color. The aroma and taste were the variables with a positive correlation in the evaluated breads. Texture and taste had a low 3.9% positive correlation, and texture and color had a 4.1% correlation across all three samples. An interval graph was also made to determine the most acceptable elements of the breads evaluated, as well as, a multiple correlation to determine the sensorial characteristics with the highest correlation. The most popular bread was the concha.

Key words: black sapote, bread, veganism, sensorial evaluation, sensory evaluation



INTRODUCTION

In the State of Puebla, more than 400,402 tons of black sapote fruit (*Diospyros digyna*) are produced and distributed across 33 municipalities. Unfortunately, a significant amount of this production goes to waste due to poor field management, transportation, and storage methods [1]. The black sapote is mainly used in desserts such as mousses, commonly, at home the pulp is mixed with orange juice for desserts. Other common uses are in drinks, ice cream and sweets, nevertheless, in Mexico, the fruit is not commonly used in houses [2]. Based on this socio-cultural data, the current project aims to develop an alternative approach to utilizing this fruit. According to Greenpeace [3], promoting food sovereignty while respecting human health and the planet is necessary due to the current demand for resources exceeding the earth's renewal capacity both nationally and internationally. To address this issue, the utilization of black sapote is proposed as an underutilized ingredient in the Rafael Lara Grajales region of Puebla for the production of vegan bread for school-age children (6 to 12 years old). Darwin Council [4] describes black sapote as a bright-green and shiny fruit at first, then, the skin becomes olive-green and then rather muddy-green. Within is a mass of glossy, brown to very dark-brown, almost black, somewhat jelly-like pulp, soft, sweet and mild in flavor, Hernández *et al.* [5] noted that the fruit contains thick, flat, black, and shiny seeds. The fruit is widely cultivated in the Yucatán Peninsula and distributed across several Mexican states, including Chiapas, Colima, Guerrero, Jalisco, Michoacán, Morelos, Oaxaca, Tabasco, Veracruz, and Puebla, it also extends to Central America, Colombia, and Ecuador [6]. According to data collected by SIAP [1], the production of this fruit is high in the country. However, it is not widely consumed by residents in diverse regions of Puebla, not fresh cooked, dried or in any form.

According to the Mexican System of Food Equivalents (SMAE) [7], 150 g of black sapote contains 52 kcal, 0.7 g of protein, 0.1 g of lipids, 13.5 g of carbohydrates and 125 mg of vitamin C. It is commonly used in traditional medicine as a mild laxative and hypoglycemic agent. Tapia [6] notes that the Badiano Codex, a sixteenth century book of medicinal recipes, mentions its use in treating leprosy, intestinal parasites, and scabies. Escamilla y Moreno [8] highlights that, drinking the infusion of boiled sapote leaves for a long period of time, can help reduce cholesterol levels. Navarrete [9], mentions that black sapote is a fruit containing 247.816 mg of gallic acid, 100 g of soluble polyphenols, and 399.409 µg of β-carotene.

Black sapote has been a source of pride in ancient Mexico since ancient times and is part of Mexican culture. However, it is rarely appreciated due to its characteristic dark pulp and green skin in the surrounding communities in Puebla. Despite this, it



is used to make desserts in Mexico and other countries by adding small amounts of milk or orange juice. Citrus fruits, such as orange or lemon, can be added to achieve a desirable texture for the pulp, which is commonly used as a filling for cakes, pies, or other bakery products. Additionally, it has been used in the production of ice cream [10].

Based on the information provided, it is clear that black sapote, despite its existence in pre-Hispanic Mexico, is currently underutilized as an endemic ingredient. This overlooks its potential in the food industry. Therefore, this research proposes the development of three types of vegan sweet breads that use the fruit in their preparation. Between 4000 and 3800 B.C. in Egypt, there were villages of farmers who made bread with cereals [11]. Nowadays, it is commonly made with ingredients such as flour, water, sugars, edible fats or oils, yeast, additives, and fruits.

Eggs are often used in bread-making, but this research aims to replace animal-derived ingredients with plant-based ones to contribute to the ethics of veganism. In this study, conchas, hojaldras, and rolls were prepared without using any animal products. Muñoz [12] describes the concha as a half-sphere-shaped bread covered with a special paste made from sugar, flour, and shortening: the bread is scored with lines to simulate a seashell. The hojaldra is a type of bread traditionally associated with the Day of the Dead, it is round in shape and decorated with two small dough rolls, sprinkled with white sugar, and in some areas with pink sugar. This description is based on information from the National Institute of Indigenous People [13] and Maghaydah *et al.* [14]. The dough is made with yeast and rolled out into a sheet, which is then sprinkled with a mixture of cinnamon and sugar before a thin layer of butter is added.

Regarding vegan diets, Menal-Puey *et al.* [15] mentions that this lifestyle does not include any food or derivative of animal origin in its consumption habits. Besides, a vegan lifestyle not only excludes animals from their diet but also from their way of life, including clothing, shoes, cosmetics, entertainment, among others. All of this is to avoid using animals as human property.

In relation to food production, these diets benefit the environment because proteins obtained from animal sources represent a greater ecological footprint with a negative impact on environmental resources, because of that, it is necessary to lead the population towards greater consumption of proteins of plant origin, ensuring combinations that allow nutritional recommendations to be achieved [16]. Arús [17] states that, "livestock farming contributes to the loss of biodiversity through land degradation, which is caused by deforestation and climate change".



This is why some people choose to transition to veganism, which increases the availability of natural resources and, consequently, protects animals.

According to Melina *et al.* [18], the Academy of Nutrition and Dietetics considers vegan diets to be healthy, nutritionally adequate, and capable of preventing diseases at various stages of life. While some believe that a child may have deficiencies from an early age by not consuming animal-derived foods, Lawrence [19] says, “as long as a child’s diet includes the necessary nutrition, a plan-based diet can be healthy for all ages.”

The current study was conducted with untrained panelists of primary school students from Valentín Gómez Farías in the municipality of Rafael Lara Grajales (RLG), Puebla. RLG was founded in 1922 as a railway town [20].

According to the National Institute of Statistics, Geography, and Informatics [21], the population of RLG was 15,952 inhabitants, with 8,327 women (52.2%) and 7,625 men (47.8%). The predominant age ranges were 5 to 9 years (1,529), 10 to 14 years (1,648), and 15 to 19 years (1,573). The number of school-age inhabitants was 3,300 people, which represents 30.6% of the total population aged 15 and over. An opportunity was identified to investigate the field of food innovation for the preparation of vegan sweet breads using black sapote, an endemic fruit of Puebla. The aim is to benefit the school-age population of RLG, as this period of life is crucial for sowing and strengthening the foundations of future nutrition and healthy lifestyle habits [22].

METHODOLOGY

Materials

The necessary quantity of black sapote (*Diospyros digyna*) indicated in the recipes below, was purchased from a market in the city of Puebla and from a local produce shop in the San Manuel neighborhood near Ciudad Universitaria in the same city. The fruit was obtained in two ripening stages, ripening stage 3 (green with presence of black spots) and ripening stage 4 (black), according to the color scale established by Navarrete-Zapata *et al.* [23].

The base dough formulation for making concha, hojaldra, and roll breads was created using the recipe proposed by Stone [24]. The ingredients used were; instant yeast (Tradipan, Mexico), soy milk beverage (Ades, Mexico), water (Ciel, Mexico), granulated sugar (Zulka, Mexico), vegetable margarine (Puratos Perla, Mexico), vanilla essence (El Papantla Molina, Mexico), and wheat flour (San Blas, Mexico).

The concha formulation included additional ingredients such as; pink paste made from flour (San Blas, Mexico), powdered sugar (Zulka, Mexico), margarine



(Puratos Perla, Mexico), and vegetable red food coloring (Badia, United States). The filling was made with homemade black sapote jam, sugar (Zulka, Mexico), fresh orange juice, and ground cinnamon (bulk, Mexico).

The hojaldra formulation included; orange blossom essence (Deiman, Mexico), orange essence (Deiman, Mexico), margarine (Puratos Perla, Mexico), sugar (Zulka, Mexico), and a syrup made from black sapote, orange, guava, piloncillo, and cinnamon.

The roll with homemade black sapote jam included the same ingredients used for the concha jam, plus dark chocolate for sprinkling over the roll.

Preparation of the base dough

The base dough was prepared by students from the Benemérita Universidad Autónoma de Puebla, as follows: in a stainless steel bowl, instant yeast (21 g), soy milk beverage (366 ml), water (366 ml), and sugar (240 g) were mixed together. The mixture was allowed to rest for fifteen minutes at room temperature (17.5°C). To prepare the dough, a volcano shape was formed with the flour (1,245 g), and the previous mixture which contains instant yeast, soy milk beverage, water and sugar was gradually incorporated until a homogeneous dough was obtained. The recipe called for adding 240 g of room temperature margarine (17.5°C), cut into cubes, to the dough. The dough was kneaded for twenty-five minutes and left to rest in a stainless-steel bowl covered with plastic wrap.

Table 1, shows the ingredient quantities used for the three bread samples, and twelve pieces were obtained for each sample.

Preparation of the Hojaldra

To the base dough, 5 ml of orange blossom essence (Deiman, Mexico) and 4 ml of orange essence (Deiman, Mexico) were added. Once the dough rested for 45 minutes, it was portioned into 70 g balls with an extra 15 g for forming the little bones on top. Subsequently, in a 21 cm diameter Teflon skillet (Tefal, Mexico), a syrup was prepared with black sapote pulp (20 g), sugar (5 g), orange juice (25 ml), and piloncillo (30 g) at 25°C to glaze the samples. On a tray (Wilton, United States) measuring 22.86 cm wide by 33.02 cm long by 1.88 cm high, over a wax paper sheet the samples were placed and taken to the oven (Mabe, Mexico) at 220°C for 20 minutes (See figure 1).





Figure 1: Hojaldras

Preparation of the Concha

The base dough was allowed to rest for 50 minutes. Then, it was punched (culinary technique involving pressing the dough to release air bubbles), and portions of 60 g were made for each of the conchas. For the topping, powdered sugar (125 g), wheat flour (195 g), vegetable margarine (125 g), and red vegetable coloring (3 ml) were mixed in a stainless steel bowl until a homogeneous mixture was formed. 20 g of topping were weighed for each of the conchas using a stainless steel heart-shaped cutter, placed on top of the base dough, and mounted on a tray (Wilton, United States) measuring 22.86 cm wide by 33.02 cm long by 1.88 cm high, lined with wax paper. The samples were then placed in the oven (Mabe, Mexico) at 220°C for 20 minutes. After baking, they were allowed to cool at room temperature (17.5°C), and then filled with homemade black sapote jam prepared in a stainless steel bowl by mixing black sapote pulp (220 g), orange juice (20 ml), ground cinnamon (5 g), and sugar (40 g) with a metal whisk (See figure 2).



Figure 2: Conchas

Preparation of the roll with artisanal black sapote jam:

The base dough was divided into two portions of 300g each. It was then rolled out with a wooden rolling pin to obtain a rectangle 40 cm long, 25 cm wide and 5 mm thick. The dough was covered with a layer of artisanal black sapote jam, prepared in a stainless steel bowl by mixing black sapote pulp (220 g), orange juice (20 ml), cinnamon powder (5 g), dark chocolate (50 g) and sugar (40 g) with a metal whisk. The mixture was then rolled into a log 6 cm in height. Using a 20 cm chef's knife (Victorinox, Switzerland), portions of 3.5 cm in width were cut and placed in a circular stainless steel mold with a diameter of 22 cm and a height of 6 cm, covered with a sheet of waxed paper. The product was placed in a preheated oven (Mabe, Mexico) at a temperature of 220°C and baked for 25 minutes at 220°C (see Figure 3).



Figure 3: Rolls

In table 2 are the ingredients used for the syrup, shell and jam that complement the breads samples.

Sensory evaluation

The formulations of the vegan breads were evaluated with RLG students through a sensory evaluation using a five-point hedonic scale, where 5 is the highest and 1 is the lowest rating (5: "loved it"; 4: "liked it"; 3: "indifferent"; 2: "disliked it"; 1: "hated it") [5, 25, 26].

Measuring attributes such as taste, aroma, color, shape and texture were measured. The test was conducted with 21 untrained panelists between the ages of 8 and 9 years old. Each untrained panelist was given a sample of the breads to evaluate. After consuming each sample, they were given a glass of water to prevent confusion during the evaluation.

Sample size was determined according to Lazaro [27] who used a sample with 21 panelists as an accepted quantity for this kind of studies.

Statistical Analysis

The statistical analysis was conducted using Microsoft Excel 2018 (Microsoft Inc., United States) and Minitab software version 18 for ANOVA statistical analysis and Tukey test to assess the attributes of each evaluated bread.

RESULTS AND DISCUSSION

Sample size was conformed for 21 untrained panelists that were fourth-grade boys and girls from Valentín Gómez Farías Elementary School, the demographic data is shown in table 6. These students conducted the sensory evaluation of the three bread samples that were prepared. They were instructed on how to fill out the printed form distributed to them.

At the end of the test application, a discussion was held to identify the attributes that were most liked. Six out of the twenty-one students expressed displeasure with the chocolate sprinkled on the rolls due to its bitter taste. On the other hand, all students indicated that the bread had good texture, color, taste, and overall acceptability.

The sensory evaluation results for each of the three breads are displayed in Figure 4.

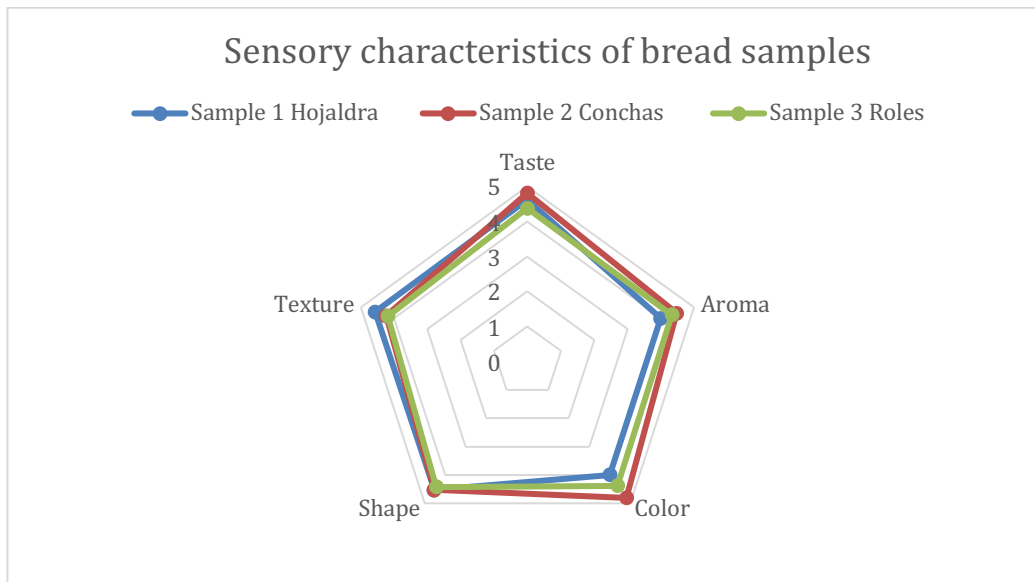


Figure 4: Results of sensory evaluation

Figure 4, shows that the attributes of taste, aroma, color, shape and texture did not show significant differences in bread preference, despite the presence of sapote, which is not commonly consumed in the region. The texture, shape, and taste were the most liked aspects of the hojaldra, while aroma and color were the least

avored. The students favored the color, aroma, and taste of the conchas, but did not prefer their texture and shape. Similarly, the rolls were preferred for their aroma and shape, but were not the top choices in terms of taste, texture, and color. Table 3, displays the multiple correlations conducted on the sensory attributes, including taste, aroma, shape, color and texture of the concha bread. It can be seen that the variables with a positive correlation are: 66.6 % of aroma-taste, 42.1 % of color- taste, 44.4 % of color-aroma, this means that the taste, aroma and color of the concha bread was more relevant for the untrained panelist; and variables with a low positive correlation are: 17.8 % of texture-shape, this means that the texture and shape of the concha bread was not relevant for the untrained panelist. Table 4, displays the multiple correlation on the sensory attributes, including taste, aroma, shape, color and texture of the roll bread. It can be seen that, the variables with a positive correlation are: 81.2 % of aroma-shape, 52.2 % of color- shape, which means that the aroma, shape and color of the roll was more relevant for the untrained panelist. variables with a low correlation are: -8.6 % of texture, -9.5 % of taste which means that the texture and taste of the roll was not relevant.

Table 5, displays the multiple correlation on the sensory attributes, including taste, aroma, shape, color and texture of the hojaldra bread. It can be seen that the variables with a positive correlation are: 44.5% of shape-taste, 71.7% of texture-taste, this means that the shape, taste and texture of the hojaldra were the most widely accepted attributes for the untrained panelist. variables with a low correlation are: -24.3% of color-aroma, this means that the color and the aroma of the hojaldra were not relevant for the untrained panelist.

The ANOVA, conducted using Minitab software version 18, produced a graph of taste intervals against the product (hojaldra, roll and concha). The concha was the favorite bread for the majority of the untrained panelist (86%) with taste and color as the most accepted attributes. The bread samples were ranked in order of preference with the 'concha' being the most accepted, followed by the hojaldra, and lastly, the roll with handmade sapote jam (Figure 5).



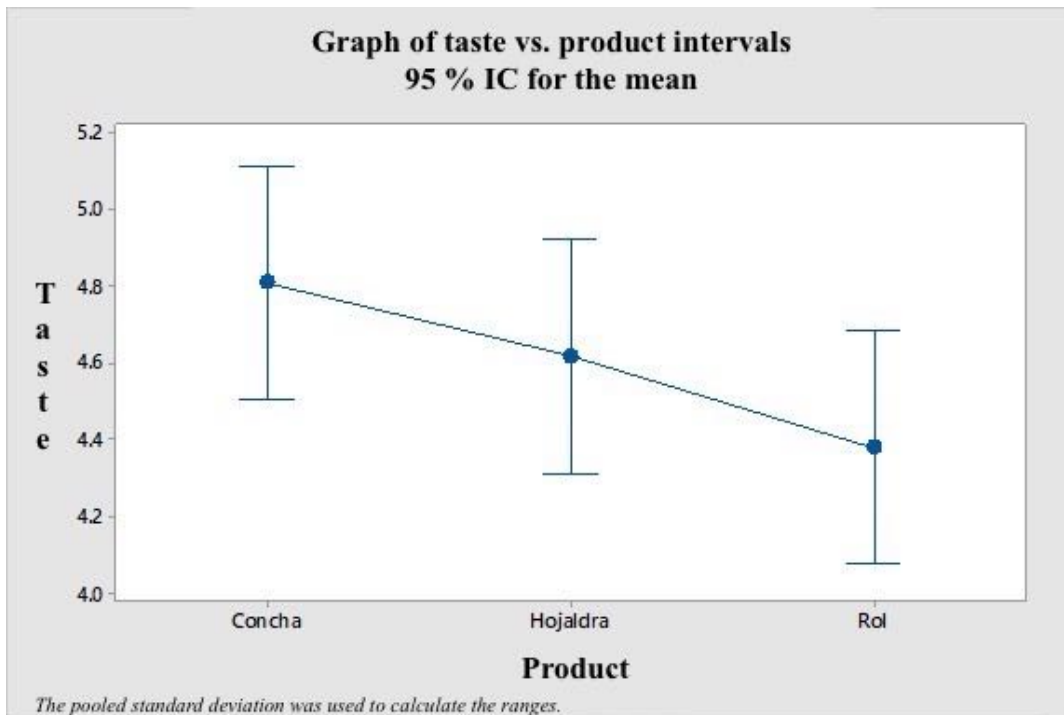


Figure 5: Graph of taste vs. product intervals

Figure 5 displays the ranking of the evaluated breads based on preference, indicating no significant differences among the three samples.

In Mexico and worldwide, numerous plant-based ingredients rich in health-beneficial components exist, such as black sapote. However, many of these ingredients are underutilized due to low consumption, despite their functional properties [28]. Specifically, for this study, untrained panelist indicate they do not like the color of the black sapote, even, they do not know its flavor and only go by the appearance. In this context, the use of black sapote in sweet bread could be an alternative to increase consumption and promote sales in local communities. This could counter the monopoly generated by global companies and avoid the waste of thousands of tons that rot or are discarded each year [1].

It is important to note that black sapote is a seasonal fruit and produces ethylene, resulting in a short ripening period, because of this, the fruit spoils faster and is thrown away, reinforcing that it is an underutilized ingredient [29].

The primary use of black sapote pulp is in the preparation of ice creams, frozen popsicles, and in combination with orange juice, cherry wine, and sugar. However, these products are typically only available in areas where the fruit is grown, limiting awareness and appreciation of both the fruit and its derived products in other markets. Specifically, in Rafael Lara Grajales, people do not consume sapote or prepare it in any way mentioned.

The use of black sapote in Mexico and other Latin American countries, is customarily served as a dessert with a touch of milk or orange juice. The addition of lemon juice, lime performs the function of unifying the texture of the pulp, and this in turn allows it to be desirable and used as a filling for cakes, pastries and ice cream. In Mexico, it is very common for the pulp to be mixed with orange juice and served as a dessert. In the state of Yucatan, in the Mexican Republic, the cooking of leaves of the tree is used as an astringent. In various medicinal preparations it is used against leprosy, ringworm and itchy skin [9, 23, 30].

The present research aims to incorporate this fruit into the evaluated breads, making it consumable for people from different regions of the country. This will take advantage of its benefits, including its high levels of vitamin C, iron, antimicrobial properties, iodine content, antioxidants, and other properties. Most importantly, the aim is to incorporate it into the diets of young school children, allowing them to consume it in products they enjoy, such as baked goods. As the black sapote is a rich source of vitamin C, it helps in building the body's immune system. It helps enhance resistance against bacteria and viruses [31].

Based on the aforementioned, including the underutilized ingredients in the diets of school-aged girls and boys, this presents an opportunity to instill proper eating habits during their growth and development stages [22]. Well-planned vegan diets are suitable for individuals throughout all stages of the life cycle, including for athletes, provided that their nutritional needs are met [31]. Supervision of diets by an expert can be beneficial for school-aged children, specifically due to the reduction in the consumption of saturated fats and cholesterol compared to non-vegan diets. In addition, vegan diets can provide high levels of dietary fiber, minerals, and phytochemicals that contribute to maintaining good health [32], the health benefits of vegetarian diets include promoting the maintenance of normal body weight and reducing the risks of chronic diseases [33].

Messina and Mangels [34], state that plant-based diets are nutritionally adequate for children, provided that the mother's diet during pregnancy was sufficient, optimal breastfeeding is practiced, and complementary feeding is balanced. This approach helps to prevent any negative health effects on the child.

The inclusion of vegan ingredients in the bread-making process positively affected how school children perceived the color, taste, and aroma of each sample. This result is significant for school nutrition and the promotion of plant-based foods.

During the sensory evaluation of three samples of vegan breads with black sapote by an untrained panelist, no significant difference in consumer preference was detected ($p>0.05$). This finding suggests that consumers may successfully accept foods containing these products.



However, the judges noted dissatisfaction with the sample of rolls containing handmade black sapote jam due to the presence of bitter chocolate. Rojas Allende *et al.* [33] conducted research that supports the idea that the taste of bitter coating can affect consumer product rejection.

Aguayo-Mendoza [35], demonstrated that a food's image, aroma, taste, texture, and temperature, as well as personal factors such as food preferences, impact children's acceptance. This aligns with the present research, which observed that these factors influenced how students accepted the presented samples, either due to the familiarity generated by the aroma, texture, or taste that reminded them of home, this is according to the final comments made by the 21 untrained panelists at the end of the sensory evaluation.

According to the objective of this article, which was to elaborate three different samples of vegan breads for the use of black sapote to evaluate their acceptability in school children (5-11 years old) living in RLG, through a sensory evaluation with a 5-point hedonic scale; the results obtained indicated that the proposal of breads with sapote as an underutilized ingredient was accepted for the taste as follows: the concha was the bread with the highest acceptance (86%) followed by hojaldra (76%) and finally roll (52%)

Some challenges engaged with the present project included; getting acceptance from the school to allow students to participate as judges of the bread presented, and willingness of children to try an ingredient practically unknown to them. Regarding cultural implications, scholars were open to try the bread with sapote, mentioning they had never tasted it before; also, kids were instructed about the importance of eating underutilized ingredients in order to support local products.

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

The use of black sapote in the production of vegan bread is a viable option as it does not affect the color, taste, aroma or texture. It is worth noting that the vegan bread was well-received in a sensory evaluation conducted with students from RLG. According to the results presented, the bread concha was well accepted for its color, aroma and taste but wasn't accepted for its texture. The bread roll wasn't liked because of the taste, texture and color, but the untrained panelist liked the aroma and shape. The hojaldra was accepted for the texture and taste while the aroma and color were disliked by the students. Therefore, future research can explore the development of other types of vegan breads using black sapote or other underutilized ingredients to verify if this acceptance persists. Therefore, the utilization of black sapote presents an opportunity to preserve locally grown and readily-available products, which can be incorporated into the bakery industry.



Table 1: Ingredients for the base dough of the three breads

Ingredient	Quantity
Instant yeast	7 g
Soy milk beverage	122 ml
Water	122 ml
Sugar	80 g
Flour	415 g
Margarine	80 g

Table 2: Ingredients for the preparation of syrup for hojaldra, shell for concha and jam for roll of the bread samples

Ingredients	Syrup	Dough/Shell	Jam
Black sapote pulp	20 g	-	220 g
Sugar	5 g	-	40 g
Orange juice	25 ml	-	20 ml
Cinnamon powder	-	-	5 g
Brown sugar	30 g	-	-
Powdered sugar	-	125 g	-
Dark chocolate	-	-	50 g
Flour	-	195 g	-
Margarine	-	125 g	-
Vegetable coloring	-	3 ml	-

Note: These ingredients are different from base dough because every single bread has a different complement

Table 3: Multiple correlation: Taste, aroma, color, shape and texture of the concha bread

	Taste	Aroma	Color	Shape	Texture
Taste	0.701				
Aroma	0.666	1.333			
Color	0.421	0.444	1.274		
Shape	-0.020	0.111	0.087	0.368	
Texture	-0.154	0.055	-0.026	0.178	0.485

Table 4: Multiple correlation: Taste, aroma, color, shape and texture of the roll bread

	Taste	Aroma	Color	Shape	Texture
Taste	-0.095				
Aroma	0.446	0.446			
Color	0.157	0.227	0.007		
Shape	0.160	0.812	0.681	0.272	
Texture	0.189	0.157	-0.114	0.522	-0.086

Table 5: Multiple correlation: Taste, aroma, color, shape and texture of the hojaldra bread

	Taste	Aroma	Color	Shape	Texture
Taste	0.308				
Aroma	0.172	0.033			
Color	0.234	-0.243	0.193		
Shape	0.445	0.289	0.308	0.296	
Texture	0.717	0.193	0.251	0.766	0.273

Table 6: Demographic data

Untrained panelist	Age	Gender
1	8	Female
2	9	Female
3	9	Female
4	9	Male
5	9	Female
6	9	Male
7	9	Female
8	9	Male
9	9	Female
10	9	Female
11	9	Male
12	9	Female
13	9	Female
14	9	Female
15	9	Female
16	9	Male
17	9	Female
18	9	Female
19	9	Male
20	9	Female
21	9	Male



REFERENCES

1. **Servicio de Información Agroalimentaria y Pesquera (SIAP).** Zapote negro, 2022.
2. **Gobierno de México.** Fideicomiso de Riesgo Compartido. Zapote negro, fruta mexicana con gran sabor y tradición popular, 2017.
3. **Greenpeace.** ¿Quién alimentará al mundo? Hacia una agricultura diversa y sostenible como motor de desarrollo, 2009.
4. **Darwin Council.** Black Sapote - Community Orchard Fact Sheet. City of Darwin, Northern Territory, 2018.
5. **Hernández M, Dávila R, Navarro A, Rodríguez M and C Aceves** Desarrollo de un producto a base de zapote negro (*diospyros digyna*) y jugo de naranja (*Citrus aurantium*). Revista Verde de Agroecología e Desenvolvimento Sustentável. 2011; **6**: 50-45.
6. **Tapia J** Desde el herbario CICY, 2013.
7. **Sistema Digital de Alimentos.** Sistemadigitaldealimentos.org, 2018.
8. **Escamilla Pérez B and P Moreno** Plantas medicinales de La Matamba y El Piñoral, municipio de Jamapa, Veracruz. 2015.
9. **Navarrete C** Caracterización morfológica, bromatológica y fitoquímica de zapote negro (*Diospyros digyna* Jacq.). (Tesis de grado). 2019.
10. **Merino-Sánchez L, Romero-Luna H, García-Barradas O, Mendoza-López M and M Jiménez-Fernández** Cambios fisicoquímicos y antioxidantes de zapote negro (*Diospyros digyna*, Ebenaceae) durante el desarrollo de frutos en el árbol. Acta Botánica Mexicana. 2022; 129.
11. **Aliaga Muñoz B** History and evolution of food. 2017.
12. **Muñoz R** Larousse Diccionario Enciclopédico de la Gastronomía Mexicana (1st ed.). Ediciones Larousse, 2024.
13. **Instituto Nacional de los Pueblos Indígenas INPI.** El origen del pan de muerto y las variedades regionales actuales. 2019.



14. **Maghaydah S, Alkahlout A, Abughoush M, Khalaileh N, Olaimat A, Al-Holy M, Ajo R, Choudhury I and W Hayajneh** Novel Gluten-Free Cinnamon Rolls by Substituting Wheat Flour with Resistant Starch, Lupine and Flaxseed Flour. *Foods*. 2022; **11**: 1022.
15. **Menal-Puey S, Martínez-Biarge M and I Marques-Lopes** Developing a food exchange system for meal planning in vegan children and adolescents. *Nutrients*. 2022; **11**: 43–43. <https://doi.org/10.3390/nu11010043>
16. **Quesada D and G Gómez** ¿Proteínas de origen vegetal o de origen animal?: Una mirada a su impacto sobre la salud y el medio ambiente. *Revista De Nutrición Clínica y Metabolismo*. 2019; **2(1)**: 79–86. <https://doi.org/10.35454/rncm.v2n1.063>
17. **Arús Martínez C** Veganismo y soberanía alimentaria: una alternativa al sistema de consumo y producción actual de carne. GeoGraphos [En línea]. Alicante: Grupo Interdisciplinario de Estudios Críticos y de América Latina (GIECRYAL) de la Universidad de Alicante. 2020; **11(123)**: 26-54 DOI: <https://doi.org/10.14198/GEOGRA2020.11.123>
18. **Melina V, Craig W and S Levin** Position of the Academy of Nutrition and Dietetics: Vegetarian Diets. *Journal of the Academy of Nutrition and Dietetics*. 2016; **116**: 1970-1980. <https://doi.org/10.1016/j.jand.2016.09.025>
19. **Lawrence A** Are vegetarian and vegan (plant-based) diets safe for kids? - CHOC - Children's health hub. CHOC - Children's Health Hub, 2023.
20. **Castañeda Perez T** San Marcos tierra privilegiada. Reproducciones Gráficas Avanzadas, S.A. de C.V., 2010.
21. **Instituto Nacional de Estadística, Geografía e Informática INEGI**. Censo de Población y Vivienda, 2020.
22. **Moreno J and M Galiano** Alimentación del niño preescolar, escolar y del adolescente. *Pediatría Integral*. 2015; **19(4)**: 268-276.
23. **Navarrete-Zapata C, Villanueva E, Cituk D and L Pinzón** Caracterización morfológica y fases de maduración del zapote negro (*Diospyros digyna* Jacq.). *Revista Agroproductividad*, 2020; **13(7)**, 61-66. <https://doi.org/10.32854/agrop.vi.1676>
24. **Stone D** La mejor receta de conchas veganas. Mi Mero Mole | Recetas Veganas Mexicanas, 2021.



25. **Castañeda C, Manrique M, Gamarra C, Jáuregui M, Ramos E, Lizaraso C and H Martínez** Probiótico elaborado en base a las semillas de *Lupinus mutabilis* sweet (chocho o tarwi). *Acta Med Per.* 2008; **25(4)**: 210-215.
26. **Gaytán-Andrade J, Solís Salas L, López López L, Cobos Puc L and S Belmares** Desarrollo y Evaluación Sensorial De Un Postre de Gelatina Funcional Del Fruto Rojo de RESUMEN. 2019; 4.
27. **Lazaro C** Evaluación de la aceptabilidad de galletas nutricionales fortificadas a partir de harina de sangre bovina para escolares de nivel primario que padecen anemia ferropénica. 2017.
28. **Pacheco N, Cuevas J, Ayora T, Valdivia S, Jiménez K, Herrera I, Andueza R, Alday J, Borrás A, Burgos M, Cano J, Canche G, Carrillo G, Catzim P, Cervantes J, Chan J, Castillo M, Cetina R and D Castañeda** Aprovechamiento de frutos, productos y subproductos tropicales. Avances recientes en el sur- sureste de México. Centro de Investigación y Asistencia en Tecnología y Diseño del Estado de Jalisco (CIATEJ). 2020.
29. **Higuera-Ciapara I, Hernández M and A Frisby** Retos de Productos Hortofrutícolas Mexicanos en los Mercados de Exportación. Centro de Investigación en Alimentación y Desarrollo, A.C. Sonora, México. 1998.
30. **Merino L** Evaluación de propiedades fisicoquímicas y actividad antioxidante de zapote negro. (Tesis de grado). 2011.
31. **Johanna S** Health Benefits of Black Sapote or Black Persimmon. Medindia; Medindia, 2015.
32. **Scavino I, Rodríguez L, Maurente L, Koziol S, Machado, K and L García** Dietas vegetarianas en niños, niñas y adolescentes: revisión bibliográfica. *Archivos de Pediatría del Uruguay.* 2022; **93(1)**: e602.
<https://doi.org/10.31134/ap.93.1.8>
33. **Rojas Allende D, Figueras Díaz F and S Durán Agüero** Ventajas y desventajas nutricionales de ser vegano o vegetariano. *Revista chilena de nutrición.* 2017; **44(3)**: 218-225. <https://dx.doi.org/10.4067/s0717-75182017000300218>



34. **Messina V and A Mangels** Considerations in planning vegan diets: children. *Journal of the American Dietetic Association*. 2001; **101(6)**: 661–669. [https://doi.org/10.1016/s0002-8223\(01\)00167-5](https://doi.org/10.1016/s0002-8223(01)00167-5)
35. **Aguayo-Mendoza M** Aceptación de alimentos saludables en niños. 2012.

