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Educational Strategies to Increase the Acceptability of Products with Vegetables among Children

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Abstract

This study aimed to evaluate the effect of different educational techniques on the acceptability of products made with spinach among schoolchildren and analyze their physicochemical composition. Muffins and pancakes containing spinach were developed. Two hundred and fifty children were organized into five groups: Control Group (CG), sensory analysis of the products without any educational action; Group 1 (G1), theoretical activity; Group 2 (G2), cooking workshops; Group 3 (G3), implementation and cultivation of school vegetable garden; Group 4 (G4), cooking workshops and implementation of vegetable garden. Then, the children evaluated the food products sensorially. The combination of workshop and garden (G4) increased the acceptability of the muffin for aroma, color, and global acceptance and acceptability index ($p < 0.05$). The isolated interventions of workshop (G2), garden (G3), and both (G4) improved the acceptance of the taste, with no significant difference between the scores of the groups for appearance and texture in the muffin ($p > 0.05$). Superior scores for the appearance and aroma of the pancake ($p < 0.05$) were observed in G4 compared to CG. G4 also showed better acceptance for color, global acceptance, and acceptability index when compared to CG, G1, and G3. Aroma and texture were not influenced by the interventions ($p > 0.05$). In conclusion, the cooking workshop and the vegetable garden combined are superior in increasing the sensory acceptance of food products to which vegetables with low acceptability among children are added. The preparations have a favorable nutritional profile and can be offered to children.

Keywords: integral use of food, food and nutrition education, childhood

1. Introduction

Obesity is an abnormal or excessive accumulation of adipose tissue that causes damage to the health of individuals (WHO, 2021). It is classified as a chronic, complex, and multifactorial disease (Gómez et al., 2021). In 2016, more than 1.9 billion adults were overweight/obese worldwide; obesity also affects more than 340 million children and adolescents aged from 5 to 19 years (WHO, 2021). In Brazil, it reached 20.3% of the adult population in 2019 (Brasil, 2020) and 13.2% of the child population aged between 5 and 9 years (Brasil, 2021). The data demonstrate that obesity is a public health problem that needs urgent prevention and control interventions.

The nutritional transition phase that occurred worldwide from the 1950s is one of the main factors that changed the eating behavior of individuals (Baker et al., 2020), increasing cases of obesity. At this period, families began to work outside their homes, choosing the consumption of fast and convenient foods in addition to those industrialized, which often have low nutritional value (Monteiro et al., 2019, Branco et al., 2021). This eating habit persists to the present day, affecting the eating behavior of school-age children (7 to 10 years old), who frequently consume fast food and foods high in calories, sodium, fat, energy, and sugar (Cuadrado-Soto et al., 2018). In contrast, the consumption of fruits and vegetables was reduced to two servings (Lim et al., 2020), which is below the recommendation of 400 g daily, equivalent to five servings (PAHO, 2019). In addition, children naturally have low acceptability for these foods, especially due to food neophobia, characterized by the refusal to taste little-known foods (Reilly, 2018).

Research has already shown that fruits and vegetables are among the foods that present the greatest rejection among children (Chung & Fong, 2018; Raggio & Gámbaro, 2018; Rigal et al., 2021). This is due to the presence of glucosinolates and isothiocyanates, which promote a bitter taste in fruits and vegetables (Wieczorek et al., 2017). Citric and acetic acids are responsible for the sour taste (Zeece, 2020), which can also reduce the acceptability of these foods. Some fruits and vegetables also contain high levels of polyphenols, which promote a feeling of astringency, referred to as dry or rough mouth (Huang & Xu, 2020). They also have a high fiber content, which can affect the texture (Amezquita et al., 2018; Pop et al., 2021), impairing chewability.

Spinach is among the vegetables that have low acceptability by children (*Tetragonia expansa*) (Raggio & Gámbaro, 2018). Originating in New Zealand, this vegetable belongs to the family *Aizoaceae* and is characterized by having dark green leaves (Murcia et al., 2020). It can be used in different culinary preparations, such as muffins (Xu et al., 2020) and pies (Maiz et al., 2021). Spinach is commercialized worldwide, being produced mainly in Asia, Europe, and part of America, with China being the largest producer, followed by the United States and Japan (FAO, 2018). In Brazil, the estimated spinach production is around 17.413 tons, with emphasis on the state of São Paulo, the largest producer (IBGE, 2017). Generally, the low consumption of this vegetable is related to the sensory aspect, mainly due to the characteristic color and taste (Raggio & Gámbaro, 2018), which occurs due to the presence of high levels of chlorophyll and polyphenols, which produce the green color and astringent taste, respectively (Huang & Xu, 2020). Spinach also has high levels of potassium, vitamin A, folate, sodium, magnesium, calcium, vitamin C, and iron (USDA, 2021a), which are essential for child growth and development. It is important that children have access to educational strategies that help in healthier food consumption, especially focused on a higher intake of vegetables that have low preference, such as spinach.

Some educational tools such as cooking workshops (Maiz et al., 2021), school vegetable gardens (Schreinemachers et al., 2020), folders (Silva et al., 2021), and theoretical-practical activities (Baranowski et al., 2019) can improve the acceptability of fruits and vegetables among children. These techniques increase the understanding, familiarity, and consumption of foods with low acceptance by children (Sustersic et al., 2016, Schreinemachers et al., 2020, Maiz et al., 2021). In this aspect, the school becomes a favorable place for the development of educational actions aimed at promoting children's eating habits. This is because children spend a long period of time in this place and have daily contact with teachers and peers, who reinforce continuous learning (Kostyrka-Allchorne et al., 2019). In this sense, the research aimed to evaluate the effect of different educational techniques on the acceptability of food products made with the addition of spinach among schoolchildren and also to examine the physicochemical composition of these products.

2. Method

2.1 Ethical Issues

This research was approved by the Ethics Committee for Research Involving Human Beings of UNICENTRO under Opinion No. 3.787.067/2019. All ethical aspects of research with human beings followed the recommendation of Resolution No. 466/2012 of the National Health Council.

The inclusion criteria considered students aged from 7 to 10 years, enrolled in the 2nd, 3rd, 4th, or 5th grade of the two participating schools, the signature of the Informed Consent Form by the legal guardians, the signature of the Informed Assent Form by the children, the absence of food allergies or known pathologies, and participation of the child in all stages of the research. Children who did not meet these inclusion criteria did not participate in the study.

2.2 Type of Study and Target Audience

This is a cross-sectional study with the participation of schoolchildren aged from 7 to 10 years, enrolled between the 2nd and 5th grade of elementary school in two public schools in the urban area of Guarapuava, PR, Brazil. After the application of the inclusion and exclusion criteria, 250 children effectively participated in the research, 131 females and 119 males.

2.3 Study Design

Initially, the children sensorially evaluated two food products with spinach, muffin and pancake. The researchers organized the children into five groups, with fifty participants each. Control Group (CG): the children performed the sensory analysis of the products without participating in any educational activity. Group 1 (G1): the children participated in a theoretical educational activity addressing topics related to the vegetable. Group 2 (G2): the children participated in two cooking workshops in which the two food products were prepared. Group 3 (G3): the children participated in the implementation and cultivation of a school vegetable garden. Group 4 (G4): the children participated in two culinary workshops and in the implementation of a school vegetable garden. At the end of educational activities, the four groups (G1, G2, G3, and G4) also performed the sensory analysis of the food

products. The physicochemical analysis of the products was also carried out to evaluate their nutritional composition.

2.4 Procedures

2.4.1 Development of Food Products

Two food products with the addition of spinach were developed: muffin and pancake (Table 1). The percentages of addition of each ingredient were defined through preliminary sensory tests performed with the products. All the ingredients were purchased in a local business of the municipality. After preparation, the products were packed in hermetically sealed containers until the analysis.

Table 1. Food preparations with spinach

Preparation	Ingredients	Main steps of the recipe
Muffin 	Eggs (36%), oatmeal (25.1%), whole milk (16.7%), spinach (13%), butter (4.2%), sugar (1.7%), chemical yeast (1.7%), salt (1.7%).	Blend eggs, milk, and melted butter. Gradually add the flour. Add the sugar, spinach, and salt and mix until smooth. Add the yeast and mix gently into the dough. Pour the content into muffin pans. Bake in a preheated oven (180°C) for 10–12 minutes.
Pancake 	Dough: whole milk (15.4%), eggs (12%), wheat flour (8.5%), oatmeal (7.7%), spinach (7%), olive oil (1%), salt (0.2%). Filling: chicken breast (20.3%), onion (10.2%), tomato (9.1%), spinach (6%), whole milk (2%), salt (0.4%).	Dough: liquefy milk and eggs. Little by little, add the flour and the spinach until homogenization. Pour 60 ml of the dough into a heated frying pan (100 ºC), brown on both sides, and set aside. The recipe yields two pancakes. Filling: cook the chicken under pressure and then shred. Mix the onion, chicken, spinach, tomato, milk, and salt and cook for 8 minutes (120 ºC). Fill each pancake with half the filling.

2.4.2 Sensory Analysis

The acceptability of the products was evaluated by all experimental groups, considering the design proposed for each one. The preparations were analyzed according to appearance, aroma, taste, texture, and color, using a 7-point mixed structured hedonic face scale, ranging from 1 (“super bad”) to 7 (“super good”), adapted from Resurreccion (1998). A global acceptance test was applied and analyzed using a 5-point mixed structured hedonic face scale (1 “hated” to 5 “loved”) (Brasil, 2017). Each child was taken to a place with a ballot box-like booth so that they could evaluate the products. At this time, a portion of the samples (approximately 15 g) was given in a white disposable container in a sequential monadic way.

The acceptability index (AI) was evaluated according to the equation: AI (%) = A x 100/B (A = average grade obtained for the product, B = maximum grade given to the product) (Guimarães et al., 2013).

2.4.3 Theoretical Educational Activity

The activity was applied to G1 in three steps in a school classroom. In the first step, the children were asked the following questions: “What is spinach?”, “Do you know spinach?”, “Do you like spinach?", and “Do you know why it is important to eat spinach?”. The researchers asked aloud and the children could freely answer each question. In the second step, the children were presented with a spinach seedling (Figure 1). Each participant was invited to go to the front of the room to see and touch the vegetable. The purpose of this activity was to introduce to and/or make the child remember the spinach, arousing curiosity for future questions. In the last step, the children received theoretical information about spinach, which included sensory aspects (Wieczorek et al., 2017, Huang & Xu, 2020; Zeece, 2020), nutritional composition – iron, calcium, phosphorus, potassium, vitamin A, C, and magnesium (USDA, 2021a), importance and quantity (PAHO, 2019), and forms of consumption, especially the introduction of the vegetable in different preparations (Xu et al., 2020, Maiz et al., 2021). Participants could interact freely on the topics covered, asking questions or making observations. To fix the content, the children were given coloring, crossword puzzles, and correlation and description activities.

Figure 1. Theoretical educational activity applied to the children.

After one week of the application of the theoretical action, the children performed the sensory analysis of the food products with spinach as described in subsection 2.4.2 Sensory Analysis.

2.4.4 Cooking Workshops

The cooking workshops were applied to groups G2 and G4. The children were arranged into two subgroups of twenty-five individuals to carry out the activity. Each subgroup participated in two cooking workshops, one for the muffin and another for the pancake (Table 1). The workshops had an average duration of 1 hour each and were held in a classroom once a week during school hours (for a total of 2 consecutive weeks).

At the beginning of the activity, the researchers showed the children a spinach seedling, not allowing them to touch it. Then they were given succinct information about spinach, which covered the following questions: “What is spinach?”, “Do you know spinach?”, “Do you like spinach?", and “Do you know why it is important to eat spinach?” The participants individually assisted in some of the stages of the preparation of the products, such as peeling, cutting, chopping, weighing, adding, and mixing the ingredients. The researchers also provided verbal instructions during the workshop, aiming to increase the understanding at each step of recipe-making.

At the end of each cooking workshop, the children performed the sensory analysis of the food products, following the procedures described in subsection 2.4.2 Sensory Analysis.

2.4.5 School Vegetable Garden

The garden was installed in schools for groups G3 and G4 for two months at each site, taking approximately 30 minutes per week. In each group, the researchers organized the children into two subgroups of 25 members to carry out the activity. The average size of the vegetable gardens was 32 m by 1.5 m, with approximately 1.5 m of distance between the beds. The environment was initially cleaned and organized by the researchers. In the first week, the researchers assisted the children in the soil preparation process, which included plowing to prepare the soil for drainage and oxygen supply. In the second week, the vegetable seedlings were planted in holes with an average depth of 6 cm and were spaced 15 cm apart, with the surrounding areas covered with soil. The children were instructed in the following weeks to perform the garden's watering and maintenance. The researchers and the children watered the seedlings every two days with a hand-watering can. Concurrently, the maintenance of the beds was conducted to remove possible weeds and dirt from the site. In the eighth week, the children helped harvest the vegetables and clean the garden.

Throughout the process of implementing the garden, the children received information on how to carry out the

cultivation processes and were able to interact freely during the period. One week after the implementation of the school gardens, the children performed a sensory analysis of food products, following the procedures described in subsection 2.4.2 Sensory Analysis.

2.5 Physicochemical Composition

The following evaluations were performed on the products in triplicate. Moisture: determined in an oven at 105 °C until constant weight (AOAC, 2011). Ash: analyzed in a muffle (550°C) (AOAC, 2011). Lipid: determined through the cold extraction method (Bligh & Dyer, 1959). Protein: evaluated through the total nitrogen content of the sample by the Kjeldahl method, determined at the semi-micro level (AOAC, 2011). Dietary fiber: measured by theoretical calculation—spinach (USDA, 2021a), muffin (USDA, 2021a, 2022), pancake (USDA, 2019a, 2020, 2021a, 2021b, 2022). Carbohydrate: evaluation using theoretical calculation (by difference), according to the equation: % Carbohydrate = 100 - (% moisture + % protein + % lipid + % ash + % dietary fiber). Total caloric value (kcal): theoretical calculation using the factors of Atwater and Woods (1896) for lipid (9 kcal g^{-1}), protein (4 kcal g^{-1}), and carbohydrate (4 kcal g^{-1}).

2.6 Statistical Analysis

The data were analyzed with the help of software R version 3.6.1 through analysis of variance (ANOVA). The comparison of means was performed by the Student's t-test and Tukey's test, with a 5% significance level.

3. Results and Discussion

3.1 Sensory Analysis

The sensory analysis results of the products evaluated by the children are in Table 2.

Table 2. Mean sensory scores (± standard deviation) and acceptability index (%) of food products evaluated by the children

Parameter	CG	G1	G2	G3	G4
Muffin					
Appearance	5.1 ± 1.27^{aA}	5.2 ± 1.49^{aA}	5.2 ± 1.81^{aA}	5.4 ± 1.63^{aA}	5.9 ± 1.43^{aA}
Aroma	4.6 ± 2.05^{bB}	5.1 ± 1.57^{abA}	5.2 ± 1.58^{abA}	5.3 ± 1.50^{abA}	5.6 ± 1.60^{aB}
Taste	3.7 ± 2.01^{bB}	4.5 ± 1.82^{abB}	5.1 ± 2.06^{aB}	4.9 ± 1.94^{aB}	5.1 ± 1.78^{aB}
Texture	5.3 ± 1.91^{aA}	5.3 ± 1.80^{aA}	5.5 ± 1.53^{aA}	5.4 ± 1.18^{aA}	5.7 ± 1.42^{aA}
Color	4.6 ± 1.76^{bA}	5.0 ± 1.81^{abA}	5.4 ± 1.66^{abA}	5.2 ± 1.28^{abA}	5.6 ± 1.57^{aA}
Global acceptance	3.2 ± 1.23^{bB}	3.5 ± 1.18^{abB}	3.8 ± 1.15^{abB}	3.7 ± 1.08^{abA}	4.1 ± 0.93^{aB}
Acceptability index (%)	64^{bB}	70^{abB}	76^{abB}	74^{abA}	82^{aB}
Pancake					
Appearance	5.1 ± 1.43^{bA}	5.2 ± 1.59^{abA}	5.6 ± 1.71^{abA}	5.6 ± 1.50^{abA}	6.0 ± 1.38^{aA}
Aroma	5.5 ± 1.57^{aA}	5.4 ± 1.42^{aA}	5.8 ± 1.48^{aA}	5.6 ± 1.82^{aA}	6.2 ± 1.05^{aA}
Taste	5.2 ± 1.58^{bA}	5.6 ± 1.56^{abA}	6.0 ± 1.75^{abA}	5.8 ± 1.78^{abA}	6.2 ± 1.18^{aA}
Texture	5.4 ± 1.61^{aA}	5.4 ± 1.53^{aA}	6.1 ± 1.61^{aA}	5.6 ± 1.68^{aA}	6.0 ± 1.13^{aA}
Color	5.1 ± 1.70^{bA}	5.0 ± 1.32^{bA}	5.3 ± 1.78^{abA}	5.1 ± 1.70^{bA}	5.9 ± 1.27^{aA}
Global acceptance	3.9 ± 1.00^{bA}	4.1 ± 1.07^{bA}	4.3 ± 1.05^{abA}	4.1 ± 0.83^{bA}	4.6 ± 0.69^{aA}
Acceptability index (%)	78^{bA}	82^{bA}	86^{abA}	82^{bA}	92^{aA}

Note. n = 250; distinct lowercase letters in the row indicate a significant difference by Tukey's test ($p<0.05$) between the different groups; distinct uppercase letters in the column indicate a significant difference by Student's t-test ($p<0.05$) between the same attributes of the different products; Acceptability index referring to global acceptance (Guimarães et al., 2013); CG: control group; G1: theoretical activity; G2: cooking workshop; G3: school garden; G4: cooking workshop and school garden; hedonic scale for attributes (7 points): from 1 ("super bad") to 7 ("super good"); hedonic scale for global acceptance (5 points): from 1 ("hated") to 5 ("loved").

The combination of the cooking workshop with the vegetable garden (G4) increased the acceptability of the muffin for the attributes of aroma, color, global acceptance, and AI ($p < 0.05$). Regarding the taste of the product, the isolated interventions of the workshop (G2), garden (G3), and both (G4) were efficient in improving this parameter. None of the interventions altered sensory notes ($p > 0.05$) concerning appearance and texture. In the evaluation of the pancake, higher grades for appearance and taste ($p < 0.05$) were observed for G4 compared to the control group. Also, G4 showed greater sensory acceptance for color, global acceptance, and AI compared to CG, G1, and G3.

The aroma and texture parameters were not influenced by the interventions ($p > 0.05$). The products can be classified with good acceptance since they presented AI ≥ 70% (Corradini et al., 2014). Thus, the superiority of the combined strategies of the cooking workshop and the vegetable garden to increase the sensory acceptance of food

products with vegetables of low acceptability by children is verified.

In general, the pancake was the most accepted preparation by children. There was no statistical difference between the groups for appearance, texture, and color parameters ($p > 0.05$). Higher scores for aroma ($p < 0.05$) were observed for CG and G4, while taste acceptance was higher in all groups for the pancake compared to the muffin. Groups CG, G1, G2, and G4 had higher scores for pancake regarding global acceptance and AI. The greater preference for the pancake can be explained by the presence of chicken meat in this product since it is a food with high acceptability among children (Demonteil et al., 2019).

Practical educational actions are more efficient than theoretical ones in improving the acceptance of foods, such as vegetables and fruits, among children (Kim & Park, 2020), which concurs with the results of this research. In addition, when applied to children, methodologies such as the cooking workshop (Maiz et al., 2021; Wolf et al., 2022) and school gardens (Schreinemachers et al., 2020) increase the sensory notes of food products with vegetables with low acceptance by children. The findings of this study were even more promising, demonstrating that using both techniques together can be even more efficient in increasing the acceptability of these foods. It is worth emphasizing that methodologies that promote children's involvement enable greater familiarity and knowledge about food, favoring the consumption of foods with low acceptance among children (Allirot et al., 2018). Regarding the cooking workshop, children directly assist in the preparation of the food products, participating in the entire process. This participation awakens the senses and the desire to taste new foods (Ensaff et al., 2017), increases the understanding of perceptions of textures and taste, and develops culinary skills (Muzaffar et al., 2018), which contribute to improving eating habits. Participation in vegetable gardens, on the other hand, allows the child to learn the origin of food, the cultivation process, and its handling, increasing interest in long-term consumption (Laurie et al., 2017). In addition, vegetable gardens help promote sustainability and environmental preservation, facilitating children's learning about environmental education (Wallace, 2019).

3.2 Physicochemical Composition

The results of the physicochemical composition of products containing spinach stalks are presented in Table 3.

Table 3. Average physicochemical composition (± standard deviation) of food products containing spinach prepared in the cooking workshops

Parameter	Raw spinach*	Muffin	Pancake
Moisture (g 100 g^{-1})	92.4	49.8±0.06^{b}	59.7±0.05^{a}
Ash (g 100 g-1)	1.4	3.7±0.05^{a}	1.4±0.07^{b}
Protein (g 100 g^{-1})	2.9	8.6±0.03^{b}	13.2±0.08^{a}
Lipid (g 100 g^{-1})	0.6	9.2±0.09^{a}	6.0±0.06^{b}
Carbohydrate (g 100 g^{-1})	2.6	28.7±0.37^{a}	19.8±0.45^{b}
Total caloric value (kcal 100 g^{-1})	28.0	232.3±1.09^{a}	185.9±1.22^{b}
Total dietary fiber (g 100 g^{-1})	1.6*	3.5**	1.6***

Note. Distinct letters on the line indicate a significant difference between products by Student's t-test ($p<0.05$); values calculated on a wet basis; theoretical calculation: *USDA (2021a); **USDA (2021a, 2022); ***USDA (2019a, 2020, 2021a, 2021b).

Spinach has a better nutrient content than other vegetables such as lettuce and watercress, especially for ash (0.6 g and 1.2 g, respectively) (USDA, 2019b,c), protein (1.4 g and 2.3 g, respectively) (USDA, 2019b,c), lipid (0.1 g for both) (USDA, 2019b,c), and fiber (1.3 g and 0.5 g, respectively) (USDA, 2019b,c). Spinach also has a higher mineral content, such as potassium (460 mg 100 g^{-1}), magnesium (93 mg 100 g^{-1}), and iron (1.05 mg 100 g^{-1}) (USDA, 2021a) when compared to lettuce and watercress (194 mg 100 g^{-1} and 330 mg 100 g^{-1}, 13 mg 100 g^{-1} and 21 mg 100 g^{-1}, 0.86 mg 100 g^{-1} and 0,2 mg 100 g^{-1}, respectively) (USDA, 2019b, 2019c).

Regarding the composition of the products, the muffin has a higher ash, lipid, and calorie content, while the pancake has a higher moisture and protein content ($p < 0.05$). These results can be explained by the baking cooking method of the muffin, which promotes greater evaporation of water and, consequently, a higher concentration of nutrients. Meanwhile, the pancake had chicken meat as its main ingredient, which increased the protein content of the preparation. None of the products can be considered a source of fiber since they have levels lower than a minimum of 10% of the Daily Reference Values (DRV) (Brasil, 2020b). However, they can be offered to children since they have a nutritional profile favorable to human consumption.

4. Conclusion

The educational techniques of the cooking workshop and the school vegetable garden applied together are more efficient in increasing the acceptability of most sensory attributes of food products with vegetables with low acceptability by schoolchildren. These methodologies in isolation are also favorable, to a lesser extent, to improving sensory acceptance. The preparations with the addition of spinach have a favorable nutritional profile for human consumption and can be offered to children to promote healthier food consumption, in addition to helping prevent and combat obesity throughout life.

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