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# FOOD PRODUCTS WITH ADDITION OF PUMPKIN (*Cucurbita moschata*) FLOUR AS A CONTRIBUTION TO VITAMIN A CONSUMPTION

# PRODUCTOS ALIMENTICIOS CON ADICIÓN DE HARINA DE AHUYAMA (*Cucurbita moschata*) COMO CONTRIBUCIÓN AL CONSUMO DE VITAMINA A

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## ABSTRACT

Vitamin A deficiency is a more frequent problem in children with protein-calorie malnutrition and pregnant women, with prevalence in developing countries. This vitamin must be supplied in the diet as an essential micronutrient. Vegetables such as pumpkin (or squash) contain carotenoids precursors of Vitamin A with high bioactivity, therefore, the objective of this study was to develop food products with the addition of pumpkin flour as a contribution to the consumption of Vitamin A. Breads were formulated with wheat flour and arepas with corn flour, substituting them with proportions of pumpkin flour

to obtain products that comply with "good source" and "excellent source" of Vitamin A claims in accordance with the provisions of the Colombian food labeling regulation. Sensory analysis was performed on the products against control samples and the nutritional composition was analyzed according to the data of the Food Composition Table of the ICBF. The breads and arepas that complied with “good source” and “excellent source” of Vitamin A descriptors had a good consumer acceptance in their sensory attributes. There were no significant differences between the bread samples, but in the texture between the arepas samples. The formulations of breads and arepas let to obtain products classified as "good source" and "excellent source" of vitamin A, representing an alternative consumption of this vitamin.

**Keywords:** Arepa, Bread, Carotenoids, Pumpkin flour, Vitamin A.

## RESUMEN

La deficiencia de Vitamina A es un problema más frecuente en niños con desnutrición proteico-calórica y mujeres embarazadas, con prevalencia en países en desarrollo. Esta vitamina debe ser suministrada en la dieta por ser un micronutriente esencial. Hortalizas como la ahuyama contienen carotenoides precursores de Vitamina A con alta bioactividad, por lo tanto, el objetivo de este estudio fue desarrollar productos alimenticios de amplio consumo en el contexto colombiano con adición de harina de ahuyama como contribución al consumo de Vitamina A. Se formularon panes con harina de trigo y arepas con harina de maíz, sustituyendo con proporciones de harina de ahuyama para obtener

productos con la descripción de “buena fuente” y “excelente fuente” de Vitamina A de acuerdo con lo estipulado en la Resolución 810 de 2021. Se realizó análisis sensorial a los productos frente a muestras control y se analizó la composición nutricional de acuerdo con los datos de la Tabla de Composición de Alimentos del ICBF. Los panes y arepas buena fuente y excelente fuente de Vitamina A tuvieron una buena aceptación en sus atributos sensoriales. No hubo diferencias significativas entre las muestras de panes, pero sí en la aceptabilidad de la textura entre las muestras de arepas. La formulación de los panes y las arepas permitió obtener productos catalogados como “buena fuente” y “excelente fuente” de Vitamina A representando una alternativa de consumo de esta Vitamina.

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***Palabras clave:*** Arepa, Carotenoides, Harina de ahuyama, Pan, Vitamina A.

## INTRODUCCIÓN

Vitamin A deficiency is a problem that affects children with protein-calorie malnutrition and pregnant women, being more prevalent in the population of non-industrialized countries. In infants and children, high intakes of vitamin A are necessary to promote accelerated growth and development and to help fight infections. An insufficient intake of vitamin A can lead to deficiency and, in the long term, to eye disorders such as xerophthalmia, loss of vision and aggravate very common childhood diseases such as measles, respiratory infections and diarrhea, increasing the risk of death (World Health Organization, 2009).

The National Survey of Nutritional Status in Colombia-ENSIN-2015 (Ministry of Health and Social Protection, 2015) showed that vitamin A deficiency continues to be a public health problem, reporting that 27.3% of children nationwide are deficient in this

vitamin. This figure increased by 2.3 percentage points with respect to the ENSIN 2010 data, which means that 1 in 4 children have vitamin A deficiency.

Vitamin A is an essential nutrient that is not synthesized in the human body; therefore, it needs to be supplied in the diet. It is required in small amounts for the normal functioning of vision, growth, development, reproduction, immunity, maintenance of epithelial tissue and brain function (Meléndez-Martínez, 2019).Vitamin A can be obtained in the diet from animal foods containing preformed vitamin A, known as retinol, or as carotenoids from plant products, which are precursors of vitamin A (Tang, 2010) Beta-carotene is the precursor of provitamin A that has the highest bioactivity, due to this it is widely used in medicine and as an additive in the food industry, not only for its biological activity but also for being a pigment with properties of imparting an orange-yellow color (Bogacz-Radomska & Harasym, 2018). It is found in green and orange-yellow vegetables and fruits such as carrot, sweet potato and pumpkin, among others.

The pumpkin (Cucurbita moschata) is a vegetable that due to its low cost is very affordable to any socioeconomic stratum, however, the consumption style is not so varied, being widely used as an ingredient in soups and stews, which is not very attractive to the child population. The use of pumpkin represents an added value in the development of food products due to its contribution of provitamin A carotenoids such as beta-carotene (Navas et al., 2019). Raw pumpkin contains 1775 ER of Vitamin A in 100 g of pulp (ICBF, 2018).

Currently, one of the most studied products made from pumpkin is flour. The diversification of food products made from pumpkin flour, with palatable characteristics and significant nutritional value, is an alternative to reduce nutritional deficiencies and significantly reduce infant mortality. The purpose of this study was to develop food products with the addition of pumpkin flour as a contribution to vitamin A intake.

## MATERIALS AND METHODS

### *Obtaining the pumpkin flour*

The pumpkin was obtained from a local market in the city of Barranquilla-Colombia, which was subjected to washing and disinfection processes with a 50 ppm chlorinated solution, peeling and separation of pulp and seed. The pulp was cut into 2 cm cubes and carried through a convection drying process at a temperature of 65 C for 11 hours, established in previous research that showed a loss percentage of carotenoids less than 65°C compared with temperatures of 75 C and 85 C (García-Pacheco et al., 2016) The dehydrated pumpkin was processed in a mill and passed through a 600 µm mesh sieve. The flour obtained was packed in polyethylene bags for storage until it was used for processing the products.

### *Elaboration of food products*

### *Definition of proportions of pumpkin flour for product formulation*

The proportions of pumpkin flour for the formulation of the products were obtained taking into account its vitamin A content and in accordance with the provisions of Article 19 of Resolution 810 of 2021 (Ministry of Health and Social Protection, 2021), which indicates the nutrient reference value (NRV) that foods must have to be called “good source” and “excellent source”. In this sense, it was proposed to formulate breads and arepas with the addition of pumpkin flour, calculating the amount of this flour to be added so that the products would comply with the resolution and could be declared “good source of vitamin A” and “excellent source of vitamin A”.

### *Formulation and preparation of breads with pumpkin flour.*

Three bread formulations were made with wheat flour: CB (control bread), BGS (Bread good source of Vitamin A) and BES (Bread excellent source of Vitamin A), as shown in Table 1. The other ingredients used in the preparation of the breads were yeast, water, vegetable oil and salt. All the ingredients were weighed and mixed, after activation of the yeast, with 10 ml of water at 45°C for 30 minutes. The mixture was kneaded and left to rest for 1 hour. The breads were made with 5 g of dough, left to rest for 15 minutes and baked at 250°C for 30 minutes.

**Table 1.** Bread formulations in relation to flours

| Flours | Formulations* (%) | | |
|---|---|---|---|
| | CB | BGS | BES |
| Pumpkin flour | 0 | 13,3 | 26,7 |
| Wheat flour | 100 | 74,2 | 60,8 |

*CB: Control bread; BGS: Good source of Vitamin A bread; BES: Excellent source of Vitamin A bread.

**Table 2.** Formulations of arepas in relation to flours

| Flours | Formulations* (%) | | |
|---|---|---|---|
| | AC | AGS | AES |
| Pumpkin flour | 0 | 10,5 | 19,3 |
| Corn flour | 100 | 89,5 | 80,7 |

*AC: Arepa control; AGS: Arepa good source of Vitamin A; AES: Arepa Excellent Vitamin A source.

***Formulation and preparation of arepas with pumpkin flour***

Three arepa formulations were made with yellow corn flour and the addition of pumpkin flour (Table 2): AC (Arepa control), AGS (Arepa good source of Vitamin A) and AES (Arepa Excellent Source of Vitamin A). The arepas were made after weighing the ingredients, mixing the flours, adding water at a temperature of 40°C to facilitate kneading. Kneading was done until a homogeneous consistency was obtained. The arepas were formed with 50 g of dough and cooked on a grill over medium heat until golden brown on both sides.

**Sensory acceptability analysis of the products**

The products were evaluated by a panel of 40 untrained judges using a five-point hedonic scale corresponding to 1: I dislike, 2: I dislike very much, 3: I neither like nor dislike, 4: I like, 5: I like very much. The attributes of aroma, flavor, texture and overall impression were evaluated.

**Analysis of the nutritional contribution of the products**

The nutritional information of the products was obtained from the data established in the Table of Food Composition of the Colombian Institute of Family Welfare (ICBF) (Instituto Colombiano de Bienestar Familiar, 2018) taking into account each of the formulations.

**Statistical análisis**

The data were processed by analysis of variance and Tukey's test ($p<0.05$) to establish differences between means, using the statistical program Minitab 17 (Minitab Inc.).

## RESULTS AND DISCUSSION

**Analysis of the sensory acceptability of breads with the addition of pumpkin flour.**

The addition of pumpkin flour to the breads had no effect on the sensory attributes of aroma, flavor, texture and overall impression because the results of the statistical analysis showed that there were no significant differences between the formulations evaluated ($p>0.05$) (Figure 1). Vitamin A BGS had higher scores in aroma and flavor attributes compared to CB and BES, while BES was the best rated in overall impression.

On the other hand, even though the formulations are not significant, the texture of the BC was softer and more flexible, resulting more pleasant for the panelists than the texture of the breads with the addition of pumpkin flour. The BC, having only wheat flour, has a higher gluten content that favors the texture of the bread, making it fluffier and more flexible.

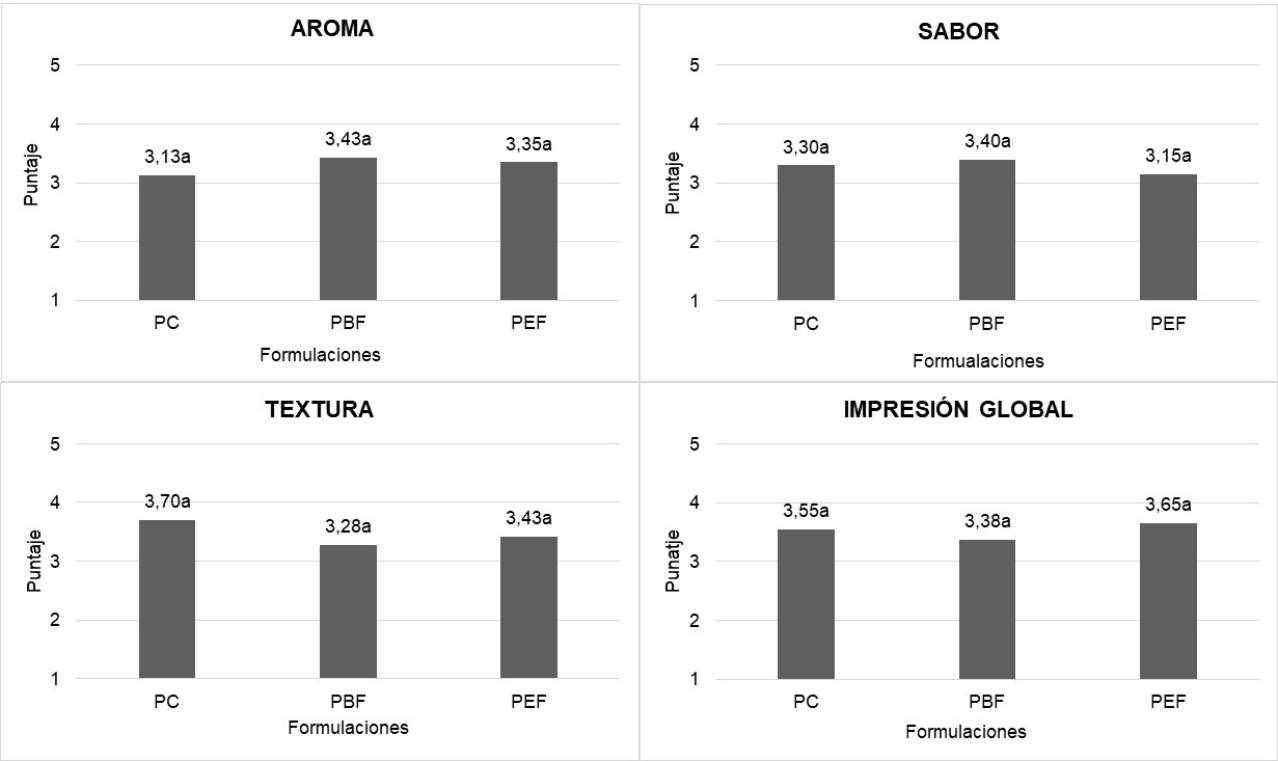


Figure 1. Results of bread attribute analysis. CB: Control bread (100% wheat flour bread); BGS: Bread good source of Vitamin A; BES: Bread excellent source of Vitamin A. Means with equal letters above the columns are not significantly different (α>0.05).

Aljahani (2022) observed that the texture of pan bread and pita bread with higher concentrations of pumpkin powder were less preferred by the panelists. Increased substitution of wheat flour with pumpkin powder reduced the volume of the breads indirectly increasing the firmness of the composite bread. Sathiya Mala et al. (2018) found that substitution of wheat flour with 20% pumpkin powder in muffins resulted in higher acceptability in appearance, color, taste, flavor, and sweetness attributes compared to muffins with higher concentrations of pumpkin powder, in which physical and sensory characteristics were affected.

**Sensory acceptability analysis of arepas with pumpkin flour addition**

Figure 2 shows the results of the sensory analysis of arepas. It was evidenced that the Vitamin A AGS presented the highest scores in all the attributes evaluated, however, for aroma, flavor and overall impression, the three formulations are not significantly different ($p>0.05$), therefore, the use of pumpkin flour in arepas is a good indicator to improve their sensory characteristics.

Similar results were reported by Mirhosseini et al. (2015) in pastas made from corn flour with a 25% replacement of pumpkin flour, showing an improvement in the sensory quality of the product. On the other hand, it was evidenced in the arepas that the AGS texture of Vitamin A presented a significance with the AES texture of Vitamin A but not with AC. Both AC and AGS have higher values than those found in the AES, possibly due to the fact that a lower concentration of corn flour and a higher concentration of pumpkin flour in the formulation produce a less consistent arepa.

García-Pacheco et al (2020) reported lower acceptability results in arepas and breads formulated with flour composed of pumpkin and pigeon pea. It is possible that the addition of pigeon pea in this formulation influences the flavor and aroma attributes of the product.

**Analysis of the nutritional content of breads with the addition of pumpkin flour**

Bread is a staple food in many countries. In Colombia, it is widely consumed as part of breakfast or dinner. It is generally made with wheat flour, which represents a cereal with a high nutritional contribution; however, the substitution of wheat flour for other flours can improve the nutritional quality of bread. Table 3 shows the nutritional content of bread formulations with the addition of pumpkin flour compared to a control bread (100% wheat flour).

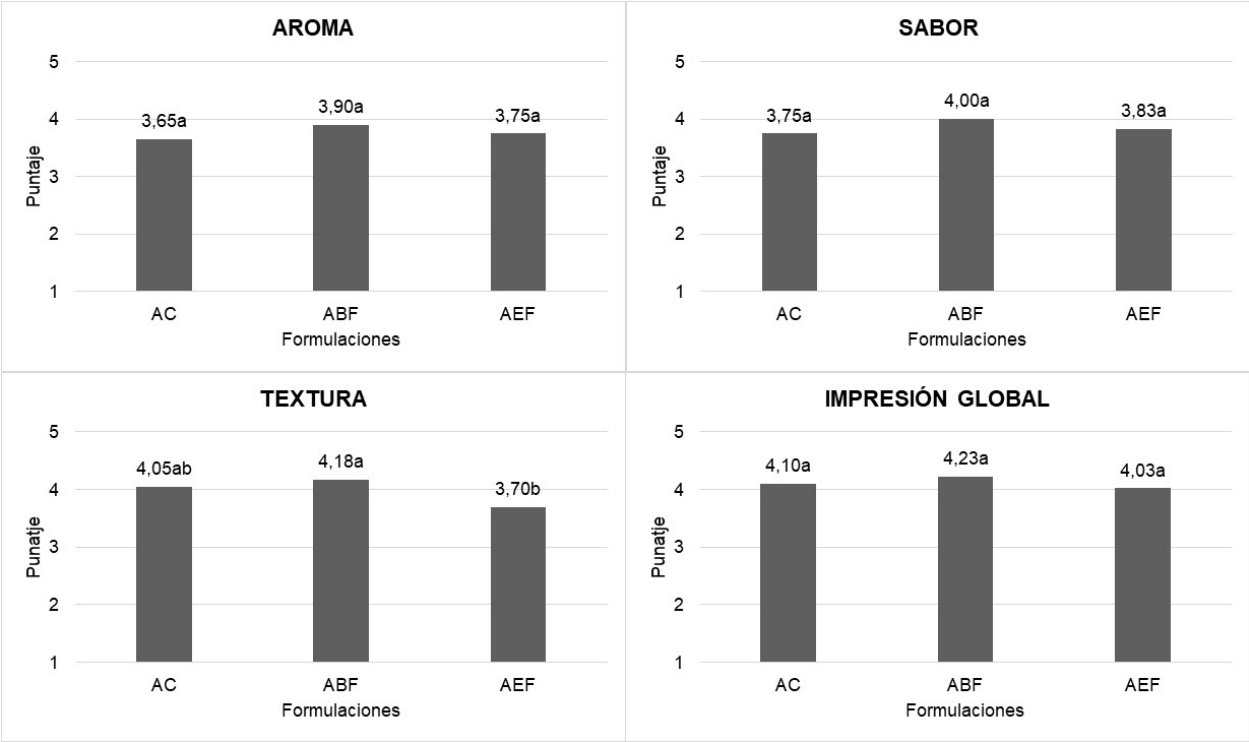


Figure 2. Results of analysis of sensory attributes of arepas. AC: Control Arepa (100% corn flour); AGS: Arepa good source of Vitamin A; AES: Arepa excellent source of Vitamin A. Means with equal letters above the columns are not significantly different (p>0.05).

The total carbohydrate and lipid contents are higher in breads with pumpkin flour; however, the protein value is lower as the wheat flour concentration decreases, this is because wheat flour has a higher protein content compared to the protein content of pumpkin pulp. This was also observed by Păucean and Man (2014) in bread made with pumpkin pulp, obtaining a lower value (11.88%) in bread with 50% pumpkin pulp compared to the 100% wheat flour control bread (14.65%). Kulkarni and Joshi (2013) reported 5.48% protein in wheat flour muffins while 5.03% in muffin with 2.5% replacement with pumpkin powder. Wongsagonsup et al. (2015) reported nutritional values obtained from proximate analysis of pumpkin flour and wheat flour, showing lower protein (10.74%) but higher fat (2.76%), ash (3.96%) and fiber (3.36%) content pumpkin flour compared to wheat flour, (14.68%), (0.79%), (0.5%) and (0.1%) respectively.

**Table 3.** Nutritional content of breads with added pumpkin flour (100g)*.

| NUTRIENTS | CB | BGS | BES |
|---|---|---|---|
| Energy (kcal) | 377 | 377 | 376 |
| Moisture (g) | 14 | 13 | 12 |
| Protein (g) | 11 | 10 | 9,7 |
| Lipids (g) | 7,9 | 8,0 | 8,1 |
| Ashes (g) | 0,51 | 1,5 | 2,5 |
| Total CHO (g) | 64 | 65 | 65 |
| Fiber (g) | 2,6 | 2,2 | 1,9 |
| Calcium (mg) | 14 | 37 | 60 |
| Iron (mg) | 3,9 | 3,6 | 3,2 |
| Sodium (mg) | 2,9 | 2,6 | 2,4 |
| Phosphorus (mg) | 107 | 146 | 186 |
| Iodine (µg) | 690 | 690 | 690 |
| Zinc (mg) | 1,3 | 1,1 | 1,0 |
| Magnesium (mg) | 24 | 23 | 21 |
| Potassium (mg) | 113 | 99 | 85 |
| Thiamine (mg) | 0,93 | 0,83 | 0,72 |
| Riboflavin (mg) | 0,47 | 0,51 | 0,55 |
| Niacin (mg) | 5,8 | 6,1 | 6,4 |
| Folates (µg) | 189 | 161 | 132 |
| Vitamin A (µg ER) | 0,00 | 173 | 347 |

CB: Control Bread (100% wheat flour); BGS: Bread good source of Vitamin A; BES: Bread excellent source of Vitamin A. *Values obtained by calculation according to the Colombian Food Composition Table, ICBF, 2018.

The use of pumpkin flour in bread production contributed to the increase in ash content. According to the data obtained, BGS and BES increased by 1 and 2 percentage points, respectively, with respect to CB, and the values of minerals such as calcium and phosphorus were improved. This was also evidenced by Aljahani (2022) in flatbread and pita bread with addition of 5%, 10% and 15% pumpkin powder, compared to control breads.

The increase in the concentration of pumpkin powder was directly proportional to the increase in the percentage of ash. Anhita et al. (2020) reported 5.6% ash in pumpkin powder and 0.6% in wheat flour, with higher ash content in cookies formulated with pumpkin powder. In addition, they observed a higher content of iron, calcium and vitamin A in pumpkin powder compared to wheat flour.

In this sense, the incorporation of pumpkin in food formulations favors the increase of vitamins and minerals, improving the nutritional quality of the products.

In addition, vitamins such as riboflavin and niacin were found to be higher in BGS and BES breads. As for vitamin A content, the BGS formulation showed a value of 173 µg ER corresponding to 22% of the NRV of vitamin A, which is 800 µg ER for children over 4 years of age and adults as stipulated in Resolution 810 of 2021 (Ministry of Health and Social Protection, 2021). In this sense, PBF bread complies with the requirement of the descriptor “good source” which must have, in the case of vitamins, not less than 15% of the NRV per 100g.

Likewise, it was observed that the BES formulation complied with the requirement of the descriptor “excellent source” which must have no less than 30% of the NRV per 100 g, resulting in a Vitamin A content of 347 µg ER corresponding to 43% of the NRV. Therefore, it was achieved that the bread formulations with pumpkin flour constitute a contribution to Vitamin A intake due to its carotenoid content.

This was evidenced by Rakcejeva et al. (2011) who reported that wheat flour breads with the addition of pumpkin flour had a higher carotenoid content than control breads with wheat flour. Likewise, it was reported in cakes supplemented with pumpkin flour that increasing the level of substitution from 0 to 20% increased the β-carotene content of the cakes from 6.84 to 9.78 mg/100g (Hosseini Ghaboos et al., 2018). However, it should be noted that severe heat treatments in foods can lead to the loss of carotenoids, and consequently, vitamin A in the products (Navas et al., 2019).

**Analysis of the nutritional content of arepas with pumpkin flour addition**

The arepa, like breads, is a staple food in Colombian cuisine, being an ingredient of many dishes in almost all regions of the country. In the Caribbean region it is

commonly prepared with white corn flour or yellow corn, without filling or filled with egg, meat, chicken, cheese and other ingredients, grilled, baked or fried. It is a very popular food, which is why it is being diversified, offering the population a variety of tastes and preparations using dough made from potato, yucca, plantain, wheat, among others.

According to the nutritional content of arepas (Table 4), an increase in the values of carbohydrates, proteins, fats, fiber and ash was observed in arepas with pumpkin flour compared to the control arepa, as well as an increase in the content of vitamins and minerals.

As for Vitamin A content, the good source arepa provides 17% of the NRV and the excellent source arepa provides 31% of the NRV. In this sense, the addition of pumpkin flour to the arepa not only provides a diversity in flavor but also an added value at a nutritional level, and constitutes a food that favors the consumption of Vitamin A.

**Table 4.** Nutritional content of arepas with pumpkin flour addition (100g)*.

| NUTRIENTS | AC | AGS | AES |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Energy (kcal) | 281 | 378 | 376 |
| Moisture (g) | 8,9 | 12 | 11 |
| Protein (g) | 6,7 | 8,8 | 8,6 |
| Lipids (g) | 2,7 | 3,6 | 3,5 |
| Ashes (g) | 3,2 | 5,0 | 5,6 |
| Total CHO (g) | 55 | 74 | 74 |
| Fiber (g) | 5,6 | 6,7 | 6,1 |
| Calcium (mg) | 27 | 47 | 63 |
| Iron (mg) | 2,3 | 3,0 | 2,9 |
| Sodium (mg) | 854 | 1164 | 1164 |
| Phosphorus (mg) | 184 | 264 | 278 |
| Iodine (mg) | 1800 | 2400 | 2300 |
| Zinc (mg) | 0,96 | 1,2 | 1,1 |
| Magnesium (mg) | 33 | 41 | 38 |
| Potassium (mg) | 126 | 160 | 137 |
| Thiamine (mg) | 0,22 | 0,29 | 0,28 |
| Riboflavin (mg) | 0,09 | 0,19 | 0,25 |
| Niacin (mg) | 2,0 | 3,3 | 3,8 |
| Folates (µg) | 26 | 31 | 28 |
| Vitamin A (µg ER) | 0,00 | 137 | 251 |

AC: Arepa Control (100% corn flour); AGS: Arepa good source of Vitamin A; AES: Arepa excellent source of Vitamin A. *Values obtained by calculation according to the Colombian Food Composition Table, ICBF, 2018.

## CONCLUSIONS

Pumpkin flour is an ideal raw material for the formulation of bakery products and arepas because it has properties that impart good sensory attributes, in addition to its added value to the products due to its content of carotenoids, precursors of Vitamin A. On the other hand, the addition of pumpkin flour to breads and arepas in adequate proportions can result in formulations of products considered “good source of vitamin A” and “excellent source of vitamin A” with good acceptability, so they can be considered as an alternative for vitamin A consumption.

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