Sweet Potato and Amaranth Chips and their Economic Analysis

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Abstract

The study aims to take advantage of the nutritional benefits of purple sweet potato and amaranth since these products are not traditionally used in the food industry, generating nutritional and economic losses due to their poor nutritional use. For this reason, through the production of sweet potato and amaranth cookies, we seek to promote the use of these foods, giving them an added value in their industrialization, starting with the transformation of the raw material into flour and subsequently elaborate cookies chips, which allows this product to be directed to all people of any age due to its nutritional benefits, for which a bromatological, industrial and economic analysis validated through the analysis of variance and the cost-benefit of the industrialized product, it is concluded that it is beneficial to carry out the industrialization of sweet potato and amaranth.

Keywords: *Sweetpotato, Amaranth, Nutritional properties, Economic analysis.*

1. Introduction

Ecuador is rich in biodiversity due to the Andean mountain range that crosses the country from north to south, allowing for exotic climates, which favors atmospheric conditions and this, in turn, favors the availability of water and fertile soil, allowing for progress in agricultural activities and being a main source of economic resources for the rural population of the country. Emphasizing the agricultural sector, it focuses on the sweet potato (Ipomoea batatas L.), a native tuber of Latin America [1]. It is mentioned that it grows in tropical climates and is easy to propagate, it is also maintained without the need for inputs, so its production costs are low.

The nutritional properties of sweet potato are very important in food because it provides health benefits to consumers, so developing countries consider them as an alternative to the shortage of food and the high malnutrition rate, as mentioned [2].

On the other hand, amaranth stands out for its high nutritional value [3], as it contains about 17% protein; however, its importance lies in the fact that the amino acid balance of this protein, which is the one that most resembles the structure of the ideal protein, is rich in lysine, essential amino acids in human nutrition and which is deficient in cereal protein. If amaranth is used as a complement to cereals, food with high nutritional value will be obtained to make cookies, among others.

The development of new products and competition in the market has led many countries to excel and increase their economic income, thanks to innovation and creativity on the part of the productive sector. Today, there are many new products, most of which come from small enterprises by small associations. For example, the use of sweetpotato in enterprises has made it possible to boost its production and diversity, as is the case of sweet potato flour, which can be introduced in the bakery industries, which is also an advantage in reducing costs, providing consumers with another substitute for wheat flour [4].

Cipotato [4] mentions that the etymological root of sweet potato is found in the Nahuatl word camotli. The term is used in several American countries and the Philippines. Montero [5] also points out the importance it has acquired by being used as a healthy food and emphasizes that the crop should be considered within food security plans in many countries.

The quality of the sweet potato depends on the firmness of the tuber, the epidermis of the characteristic reddish color, and the pulp should be whitish. In addition, according to research, it contains polyphenols that help the defense mechanisms against mosquitoes and are also responsible for the brown color produced by oxidation when cutting or peeling the sweet potato. It has low-fat content, is free of cholesterol, and has a digestible fiber in this starch, in addition to the low amount of protein contained in it [6].

Sweet potato, thanks to its anthocyanin content, has great health benefits, such as: reducing uric acid levels in the blood, as well as helping to reduce uric acid absorption in the kidneys from the urine, controlling blood sugar levels by increasing insulin sensitivity and reducing liver inflammation as well as aiding in the production of antioxidant enzymes [7].

Zanin [8] mentions that it helps to control hypertension, treats gout disease, reduces oxidative stress, reduces inflammation, helps prevent heart disease, controls diabetes and slows aging at an early age. On the other hand, the purple sweet potato contains cyanidin and peonidin discovered in the skin that covers them, reducing the growth of cancer cells. For all the above, consuming it as a fresh tuber, in sweets, or in any food where it is present is recommended.

Amaranth is an ancestral pseudocereal considered a superfood that provides many amino acids, proteins and vitamins. Amatis [9] mentions that the plant grows very fast and withstands drought very well, so it is a crop with many opportunities in Peru and the high regions of Ecuador, Bolivia and Argentina. In the panicle of amaranth has numerous flowers, which is where the seeds that are used to produce cereals, flour and derivatives are housed; not only can it be consumed as seed and flour, also the plant as such can be consumed its leaves, stem and even its flower in infusions or soups.

Amaranth grain does not have gluten, an element in cereals such as wheat, oats, rye and barley; its main component is starch, representing between 50% and 60% of its dry weight. The diameter of the starch granule is very small, measuring between 1 and 3 microns [3].

In this case, amaranth is used as grain and plant as a vegetable or as foliage for animals. The seed has a high protein, iron, vitamins and minerals, so it is recommended for children. It also helps prevent malnutrition and anemia, food to take into account in osteoporosis because it contains calcium and magnesium [10].

Amaranth is a plant with a great future since, apart from its nutritional interest, it can also be used in the production of cosmetics, dyes and even biodegradable plastics [10].

Chocolate chips or chocolate nuggets are small pieces of chocolate, often sold in a round, flat or teardrop shape, and these are deposited in the form of drops on a band that passes through a cooling system to solidify them and keep the shape [11]. So the sprinkles give a nice flavor to the cookies consumed by the general public.

2. Materials and Methods

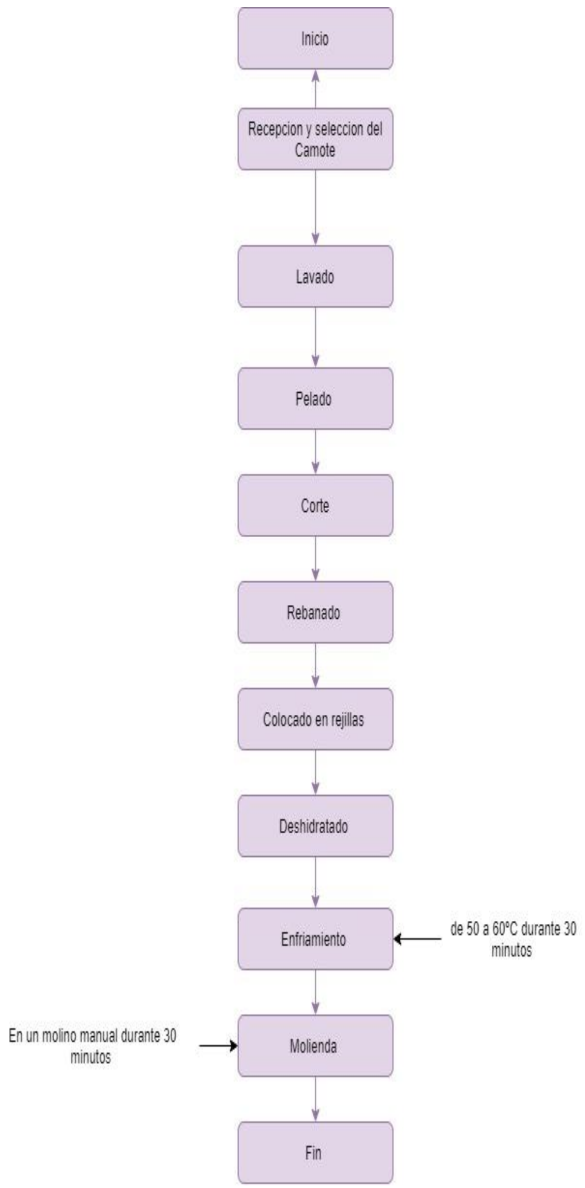
The study was carried out by applying a raw material classification, discarding any damage, blows or signs of biological damage.

The present research used a hypothetico-deductive and analytical-synthetic method, which according to “The hypothetico-deductive method is the process followed by the researcher to make his activity a scientific practice” [12]; while Martinez expresses that “The analytical-synthetic method consists of the decomposition of a whole, which divides it into parts to observe the causes, nature and effects to then relate them through the elaboration of a general synthesis of the phenomenon studied” [13].

A relationship was established between the dependent variables, which is the one that explains the objective of the research or tries to explain it in terms of other elements, identifying it within the research as the nutritional values of sweet potato and amaranth, while the independent variable explains the factors or elements susceptible to explain the dependent variables and are manipulable, being this the materials used to manufacture the cookies.

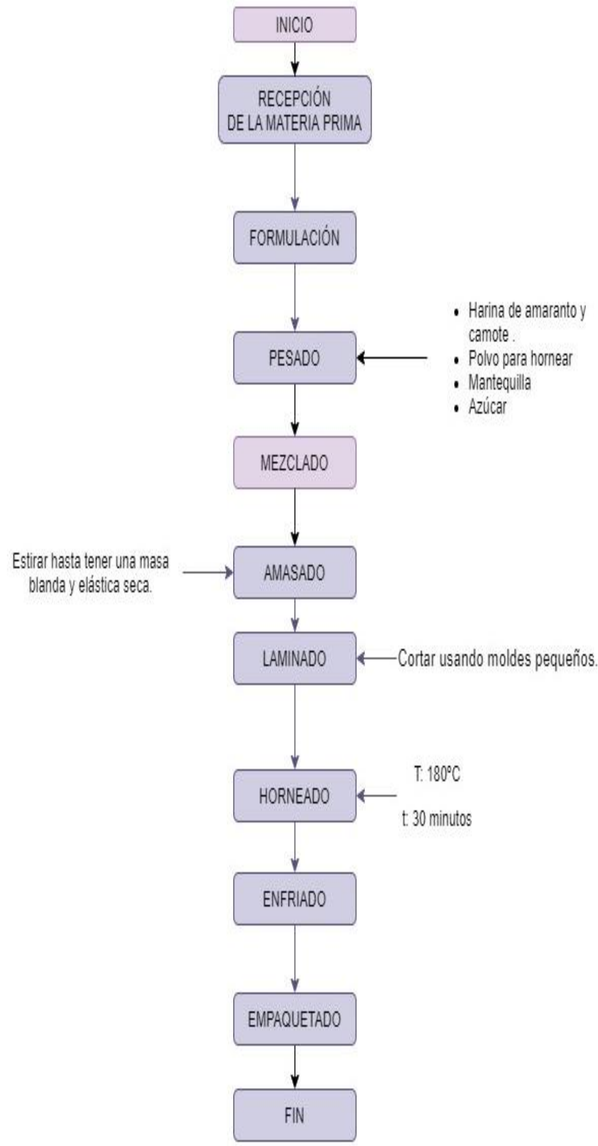
To obtain the sweetpotato flour (Figure 1), the selected raw material is washed with 0.1% chlorinated water, eliminating any foreign or extraneous matter from the raw material. The peeling process continues using mechanical methods to eliminate the skin of the sweet potato, cutting the sweet potato to obtain symmetrical portions. The portions are sliced to have a thickness of approximately 3 to 4 mm, and the slices are placed one after the other, trying not to accumulate in one place. Then dehydration is carried out in an oven at a temperature of 50 to 70 °C for 30 to 40 min and then let them cool to a temperature of approximately 7 to 9 °C finally, the dehydrated raw material is added to a mill and is reduced to a particle size of approximately 150 μm.

Figure 1. Block diagram of sweetpotato flour production.



To obtain the cookie (Figure 2), place the butter in a bowl with half of the sugar, beat until a homogeneous mixture is obtained, and add the egg yolks and all the solid ingredients (flour, the rest of the sugar, and baking powder). Next, make the cookies' molds, place them in a baking tin with wax paper, and bake them for 30 minutes at 180°C. Finally, the cookies are left to cool, and 6 are packed in each bag according to the plan.

Figure 2. Block diagram of the cookie production process.



3. Results

3.1 Bromatological tests

The bromatological analysis to be performed on our product is based on the Ecuadorian Technical Standard (NTE) INEN 2 085:2005, which establishes the following bromatological requirements:

Cookies shall comply with the requirements specified in Table 1 below.

Table 1. Bromatological Requirements

Requirements	Minimum	Maximum	Test method
Protein % Protein	3,0	--	NTE INEN 519
Humidity % Humidity	--	10,0	NTE INEN 518

Source: (INEN, Biscuit requirements, 2005).

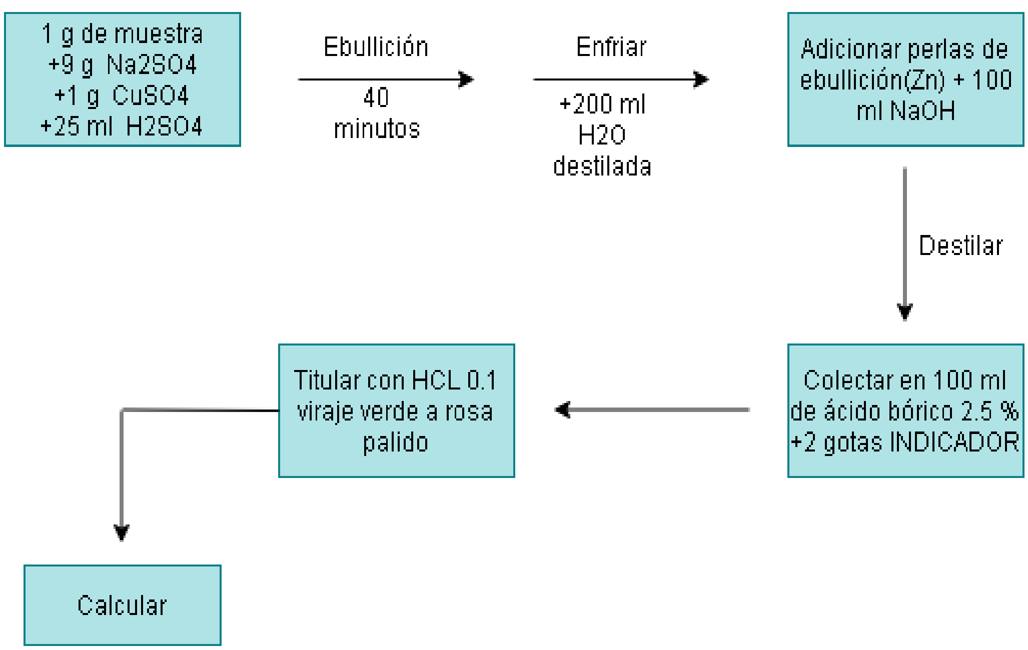
Once the pertinent analyses for sweet cookies have been established, they will be carried out at the Laboratory of Bromatology and Animal Nutrition at the Faculty of Animal Sciences of ESPOCH, where the following procedures will be performed.

3.1.1. Protein Analysis

This analysis is governed by the INEN 519 standard, which allows determining the protein content by the Kjeldahl method and multiplying the result by a factor to express it as protein [14].

This analysis will be carried out based on the procedure established in the Bromatology and Animal Nutrition laboratory, which serves as a guide for the students and details the protein determination procedure step by step. This process diagram is located in front of the area where the procedure is carried out.

Figure 3. Protein analysis processes.



Where:

N HCl= hydrochloric acid

V HCl= volume of hydrochloric acid

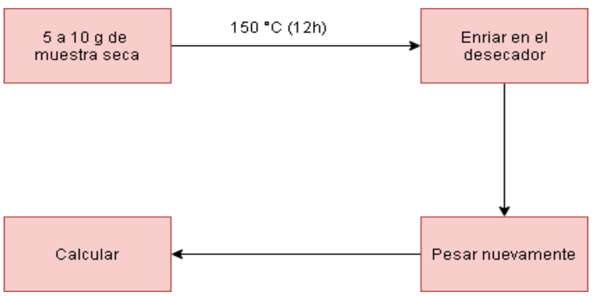
WM= sample weight

3.1.2. Moisture Analysis

This analysis is governed by INEN 518, which establishes the method for determining the moisture content and other volatile matter in flours of vegetable origin [15].

The following analysis is performed based on the procedure established in the Laboratory of Bromatology and Animal Nutrition, which is located in front of the moisture analysis area and serves as a guide for students to perform an efficient process.

Figure 4. Processes for moisture analysis



$$\%Humidity = \frac{M_1 - M_2}{M} x\ 100$$

Where:

M1= weight of crucible plus wet sample

M2= crucible weight plus dry sample

M= sample weight

3.1.3. Cost-benefit of the product

Table 2. Costs of sweetpotato flour processing.

COST OF PRODUCTION			
INSUMO	QUANTITY	UNITS	COST ($)
Sweet potato	3000	g	3,00
Gas			1,00
Mill	1		2,00
Total production cost			6,00

Analysis:

The final costs of sweet potato flour production are reflected in the production of 1500 g due to dehydration. This calculation considers that the process was carried out at home and omits large-scale costs since they are reduced as sweet potato flour production increases.

Table 3. Production costs in the production of sweet potato and amaranth flour cookies chips.

PRODUCTION COSTS			
RAW MATERIALS	COST ($)	QUANTITY	UNITS
Sweet potato flour	0,60	100	g
Amaranth flour	0,50	100	g
Wheat flour	0,50	175	g
Baking powder	0,25	5,5	g
Butter	0,27	100	g
Sugar	0,10	5,5	g
Packaging	0,40	1	u
Total	2,62	486,00	g

Table 4. Final product costs.

COSTS	
Cost per unit	$ 0,13
Cost of inputs	$ 2,62
Expected return	25%
Total finished product cost	$ 3,49
Cost per packaged portion	$ 1,40
Cookies produced	30 pcs
Cookie weight	24 g
Quantity of the portion in package	6 cookies

Analysis:

The selling price is defined for the moment at $1.40 after a cost analysis after the first draft of the elaboration of the sample cookies. This price should be taken into account that not all the original raw material was used, and the data are still to be defined specifically in the final elaboration of the product and analyze the variables that are not yet taken into account as the time and labor necessary for the production on a larger scale since in a larger production the costs of the same are reduced.

Sensory analysis

- Test to be performed: Acceptability Test.

This acceptability test needs to be carried out through a survey to determine if the product is to the consumer's liking in terms of color, smell, taste and texture. Therefore, a format was established to be implemented for untrained panelists.

Bromatological tests such as:

Moisture extraction: with the aid of the thermobalance, which is made up of a balance and a weighing system.

Ashes: by the muffle incineration method, calcining the sample of 1 gram (approximately) until the absence of smoke is achieved.

Fat: with the Goldfish method and the addition of ethyl ether or hexane to separate the fat from the remaining solids in the sample.

Protein: by the kjeldahl method, adding to the sample copper sulfate, sodium sulfate, sulfuric acid and finally the zinc shot with its due measurements, pour in the distillate 3 to 4 drops of the mixed indicator methyl red and titrate with hydrochloric acid n°10.

Fiber: with the weede method, sulfuric acid and hexane are added once the sample is degreased to obtain the crude fiber.

Finally, determine the water activity with the waterlab equipment. The steps to perform these tests are described in the laboratory guide of bromatology and toxicology of the Faculty of Livestock Sciences.

The inverted plate method was used with culture media (Soborund, PCA, MRS and Columbia) with 3 replicates each for microbiological tests.

The sensory analysis evaluation was carried out with the affective test using the hedonic scale with a score from 1 (I dislike it very much) to 7 (I like it very much) so that untrained panelists could evaluate the attributes of aroma, color, texture and flavor.

3.2. Results of bromatological analysis

3.2.1 Fiber analysis

Table 5. Crude fiber analysis data.

Paper with digested sample	**3,62**
Paper only	1,7
Crucible with digested sample	20,71
Crucible with ashes	20,65

$$\%FC = \frac{\text{Wcrisol con muestra digerida} - \text{W crisol con cenizas}}{W\ papel\ con\ muestra - W\ del\ papel\ solo}\ x\ 100$$

$$\%FC = \frac{20{,}71 - 20{,}65}{3{,}62 - 1{,}7}\ x\ 100$$

%FC= 3.125

A total value of 3.125 % crude fiber was obtained.

3.2.2. Fat analysis

Table 6. Fat analysis data.

mSample weight	**1,0231**
m1Paper weight only	3,3234
paper with m2Weight grease	3,3246

$$\%GRASA\ CRUDA = \frac{m_2 - m_1}{m}\ x\ 100$$

$$\%GRASA\ CRUDA = \frac{3{,}3246 - 3{,}3234}{1{,}0231}$$

CRUDE FAT % = 0.11

A value of 0.11 % of total crude fat content was obtained.

3.2.3. Ash analysis

Table 7. Ash analysis data.

Crucible weight	**28,6794**
Crucible weight with ashes	29,2009
Sample weight	6,04

$$\%ASHES = \frac{Crucible\ weight\ with\ ashes\ -\ Crucible\ weight}{Sample\ weight} * 100$$

$$\%ASHES = \frac{29{,}2009 - 28{,}6794}{6{,}04} * 100$$

% ASH = 8.64

A total value of 8.64 % ash was obtained.

Moisture analysis

Moisture analysis was carried out in the bromatology laboratory using a moisture meter that allowed a faster and more direct determination of moisture without the need to use the traditional method by applying formulas, where it was obtained that the product analyzed contained 93.97% moisture.

Water activity

Water activity analysis was performed, where a value of 0.88 % was obtained.

3.2.6. Protein analysis

Table 8. Protein analysis data

Sample weight	**0.9893**
Hydrochloric acid (HCL) weight	50ml
Weight sodium hydroxide	12ml

$$\%N = \frac{N.V * Pmeq}{Sample\ weight} * 100$$

$$\%Eq = Eq.HCL - Eq.NaCL$$

$$\%Eq = (NHCL * VHCL) - (NNaOH * VNaOH)$$

$$\%Eq = (0{,}11 * 50) - (0{,}09 * 12)$$
$$\%Eq = 4{,}42$$

$$\%N = (\frac{N.V * Pmeq}{Sample\ weight}) * 100$$

$$\%N = (\frac{4{,}42 * 0{,}014}{0{,}9893}) * 100$$

$$\%N = 6{,}25$$

3.3. Microbiological analysis results

3.3.1 Microbiological requirements

INEN Standard 2 085:2005

Microbiological: determination of molds and yeasts, by counting on Petri film plates, based on cookie requirements.

Table 9. Microbiological analysis requirements of the INEN 2 085:2005 standard

Requirements	***n***	***m***	***M***	***c***	***Test method***
P.E.R. cfu/g		**1,0 x 10^3**	**1,0 x 10^4**	**1**	NTE INEN 1529-5
Molds and yeasts upc/g		**1,0 x 10^2**	**1,0 x 10^2**	**1**	NTE INEN 1529-10

Where:

n: number of sample units

m: acceptance level

M: level of rejection

c: number of units between m and M

- Data for P.E.R. cfu/g

Table 10. Data R.E.P cfu/g

NUMBER OF NEIGHBORHOODS		**# OF PLATES**
First dilution	220 y 170	2
Second dilution	25 y 10	2

Culture media: peptonized water, agar for plate count. INEN Standard 1529-1

Formula to calculate the number of microorganisms per gram or cm3:

$$N = \frac{\sum c}{V\ (n_1 + 0{,}1 n_2) d}$$

Where:

$\sum c$ = sum of all colonies counted on all selected plates.

V = volume inoculated per Petri dish

n1 = number of plates of the first dilution selected

n2 = number of plates of the second selected dilution

d = dilution factor of the first selected dilution (d = 1 when an undiluted liquid sample has been inoculated).

Calculations:

$$N = \frac{220+170+25+10}{1(2+0{,}1*2\ )10^{-2}}$$

$$N = \frac{425}{0{,}022}$$

N = 19 318

Rounding the result
20 000 = 2,0 x 10^4

3.3.2. Analysis

The result obtained is 2.0 x 104, which expresses the number of microorganisms/g or cm3 present in the cookies within the requirements of INEN 2 085:2005 in which M is the number of rejections.

- Estimated counts, formula:

$$N_E = \frac{\sum c}{V * n * d}$$

Where:

$\sum c$ = sum of colonies counted on all selected plates.

V = volume inoculated in each plate

n = number of plates selected (in this case, n = 2)

d = dilution factor of the initial suspension or the first inoculated or selected dilution (d = 1 when an undiluted liquid product is inoculated).

Data of the first dilution retained: (10 - 2) 12 and 9 colonies.

$$N_E = \frac{12 + 9}{1 * 2 * 10^{-2}}$$

$$N_E = \frac{21}{0{,}02}$$

$$N_E = 1050 \; the\ result\ is\ rounded\ off$$

$$N_E = 1\,100$$

$$N_E = 1{,}1 \; x \; 10^3$$

In liquid products, N_E = m

3.3.3 Analysis

The result obtained is 1.1 x 103, expressing the number of microorganisms/g or cm present in the biscuits. N_E microorganisms/g or cm3 present in the cookies, which is within the requirements of INEN 2 085:2005 in which m is the acceptance number.

Mold and yeast data upc/g

Table 11. Molds and yeasts data

NUMBER OF NEIGHBORHOODS		# OF PLATES
First dilution 10^{-2}	80 y 93	2
Second dilution 10^{-3}	32 y 25	2
Volume sown	$1cm^3$	

Culture medium: Davis salt-yeast agar or similar according to INEN Standard 1529-2.

Formula: Calculate the number (N) of programmer units (PU) of molds and yeasts per cm3 or g per sample.

$$N = \frac{Total\ number\ of\ colonies\ counted\ or\ calculated}{Total\ number\ of\ sample\ seeded}$$

$$N = \frac{\sum c}{V\,(n_1 + 0{,}1 m_2) d}$$

Where:

$\sum$c = sum of all colonies counted or calculated on all chosen plates.

V = volume of inoculum seeded in each box

n1 = number of plates of the first dilution selected

n2 = number of plates of the second selected dilution

d = dilution from which the first counts were obtained, e.g., 10-2

Calculations:

$$N = \frac{80 + 93 + 32 + 25}{1\,(2 + 0{,}1 * 2) 10^{-2}}$$

$$N = \frac{230}{0{,}022}$$

$$N = 10\,454$$

The result is rounded to 11 000 and ends up expressed as

N = 1.1 x 104

3.3.4. Analysis

The result obtained was 1.1 x 104 mold and yeast propagating units, which comply with the table of regulations for the production of cookies according to INEN 2 085:2005.

3.4. Results of sensory analysis

Table 12. Summary of panelists' scores by aroma

Attribute: Aroma							
Score	**7**	**6**	**5**	**4**	**3**	**2**	**1**
Grade level	I like it very much	I like it moderately	I do not like it very much	I neither like nor dislike it	I dislike it very little	I moderately dislike	I dislike it very much
Panelist 1		X					
Panelist 2	X						
Panelist 3		X					
Panelist 4		X					
Panelist 5	X						
Panelist 6		X					
Panelist 7			X				
Panelist 8		X					
Panelist 9	X						
Panelist 10	X						
Panelist 11	X						
Panelist 12			X				
Panelist 13	X						
Panelist 14	X						

Table 13. Summary of panelist scores by color

Attribute: Color							
Score			**5**				**1**
Grade level	I like it very much	I like it moderately	I do not like it very much	I neither like nor dislike it	I dislike it very little	I moderately dislike	I dislike it very much
Panelist 1			X				
Panelist 2	X						
Panelist 3		X					
Panelist 4			X				
Panelist 5	X						
Panelist 6		X					
Panelist 7			X				
Panelist 8	X						
Panelist 9		X					
Panelist 10					X		
Panelist 11		X					
Panelist 12	X						
Panelist 13		X					
Panelist 14		X					

Table 14. Summary of panelists' scores by texture

Attribute: Texture							
Score			**5**				**1**
Grade level	I like it very much	I like it moderately	I do not like it very much	I neither like nor dislike it	I dislike it very little	I moderately dislike	I dislike it very much
Panelist 1	X						
Panelist 2		X					
Panelist 3			X				
Panelist 4					X		
Panelist 5	X						
Panelist 6	X						
Panelist 7		X					
Panelist 8	X						
Panelist 9					X		
Panelist 10		X					
Panelist 11	X						
Panelist 12			X				
Panelist 13			X				
Panelist 14		X					

Table 15. Summary of panelists' scores by flavor

Attribute: Flavor							
Score			**5**				**1**
Grade level	I like it very much	I like it moderately	I do not like it very much	I neither like nor dislike it	I do not dislike it very much	I moderately dislike	I dislike it very much
Panelist 1	X						
Panelist 2	X						
Panelist 3		X					
Panelist 4			X				
Panelist 5	X						
Panelist 6	X						
Panelist 7		X					
Panelist 8	X						
Panelist 9		X					
Panelist 10	X						
Panelist 11	X						
Panelist 12	X						
Panelist 13	X						
Panelist 14	X						

Percentage presentation in bar chart of results by attribute

Figure 5. Percentage of results by aroma

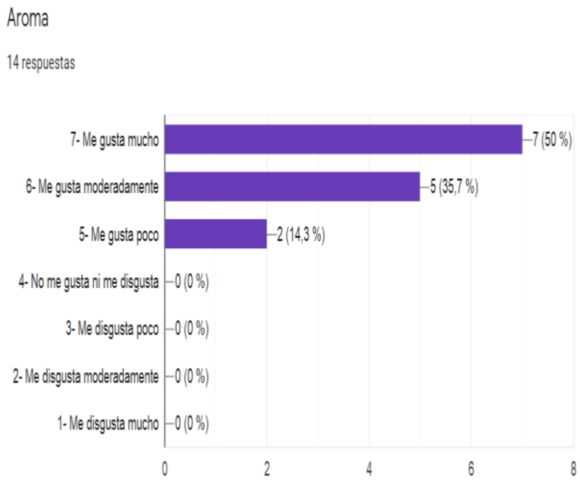


Figure 6. Percentage of results by color

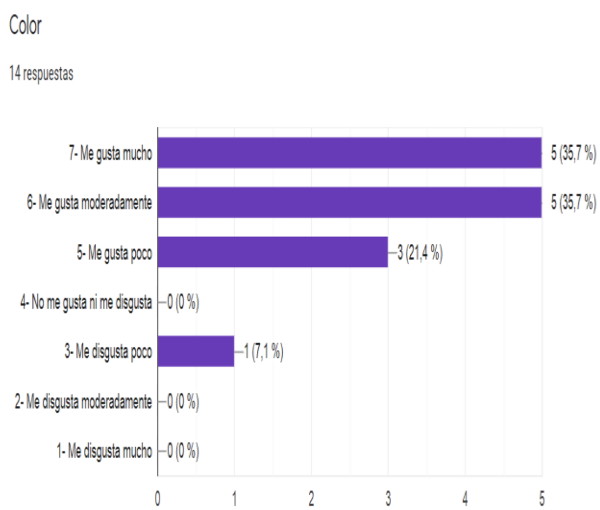


Figure 7. Percentage of the results by texture

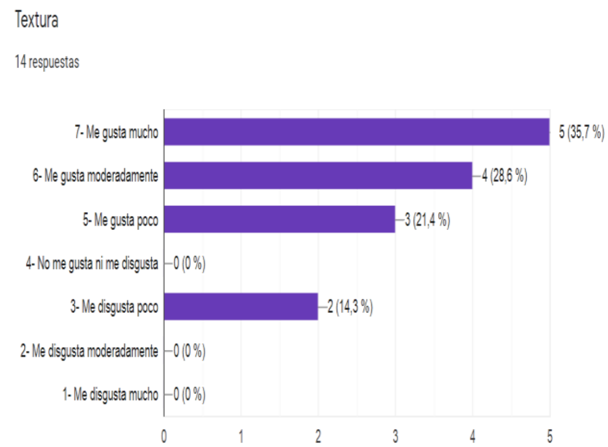


Figure 8. Percentage of the results by texture

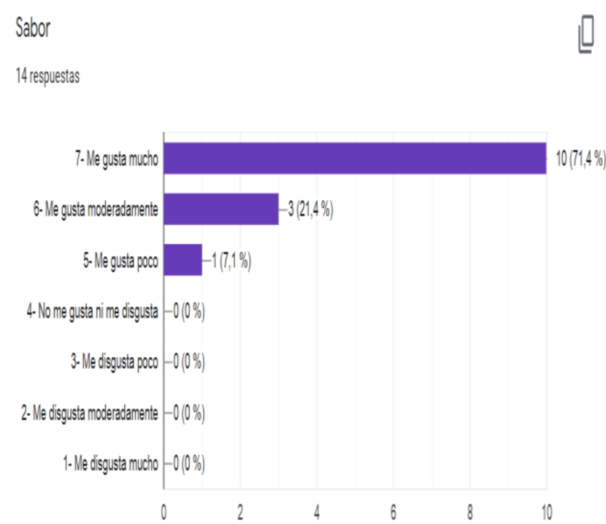
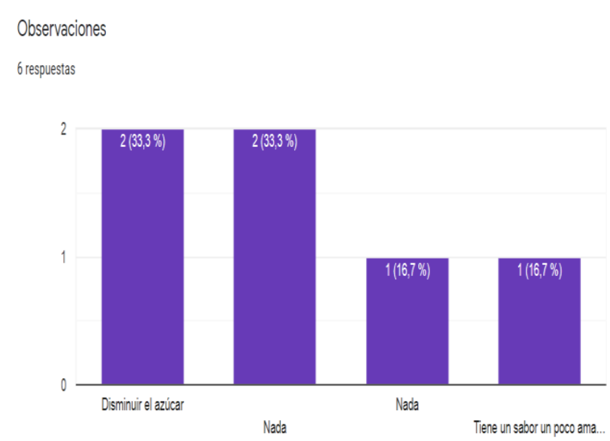


Figure 9. Percentage of results by observations



Application of analysis of variance

Table 16. Analysis of variance of panelists

	Aroma	Color	Texture	Taste
Panelist 1	6	5	7	7
Panelist 2	7	7	6	7
Panelist 3	6	6	5	6
Panelist 4	6	5	3	7
Panelist 5	7	7	7	7
Panelist 6	6	6	7	7
Panelist 7	5	5	6	6
Panelist 8	6	7	7	7
Panelist 9	7	6	3	6
Panelist 10	7	3	6	7
Panelist 11	7	6	7	7
Panelist 12	5	7	5	7
Panelist 13	7	6	5	7
Panelist 14	7	6	6	7

The ANOVA test or analysis of variance is a statistical method that allows discovering whether a product was accepted or rejected by the panelists, allowing them to determine whether it is necessary to reject the null hypothesis or accept the alternative hypothesis.

Null hypothesis: Tasters are not satisfied with the formulation of amaranth and sweet potato flour cookies with chocolate chips regarding attributes such as aroma, color, flavor and texture.

Alternative hypothesis: Tasters are satisfied with the formulation of amaranth and sweet potato flour cookies with chocolate chips in terms of attributes such as aroma, color, flavor and texture.

Significance level: It worked with a significance level of 0.05, which generates a 95% Confidence Interval (CI).

Table 17. Analysis of variance of panelists

	AROMA	COLOR	TEXTURE	TASTE	AVERAGE
panelist 1	6	5	7	7	6,25
panelist 2	7	7	6	7	6,75
panelist 3	6	6	5	6	5,75
panelist 4	6	5	3	7	5,25
panelist 5	7	7	7	7	7,00
panelist 6	6	6	7	7	6,50
panelist 7	5	5	6	6	5,50
panelist 8	6	7	7	7	6,75
panelist 9	7	6	3	6	5,50

panelist 10	7	3	6	7	5,75
panelist 11	7	6	7	7	6,75
panelist 12	5	7	5	7	6,00
panelist 13	7	6	5	7	6,25
panelist 14	7	6	6	7	6,50
Average	6,35714286	5,85714286	5,71428571	6,78571429	

Two-factor analysis of variance with a single sample per group

Table 18. Analysis of variance of panelists

SUMMARY	ACCOUNT	SUMA	AVERAGE	VARIANCE
Panelist 1	4	25	6,25	0,91666667
Panelist 2	4	27	6,75	0,25
Panelist 3	4	23	5,75	0,25
Panelist 4	4	21	5,25	2,91666667
Panelist 5	4	28	7,00	0
Panelist 6	4	26	6,50	0,33333333
Panelist 7	4	22	5,50	0,33333333
Panelist 8	4	27	6,75	0,25
Panelist 9	4	22	5,50	
Panelist 10	4	23	5,75	3,58333333
Panelist 11	4	27	6,75	0,25
Panelist 12	4	24	6,00	1,33333333
Panelist 13	4	25	6,25	0,91666667
Panelist 14	4	26	6,50	0,33333333

Table 19. Analysis of Variance for Attributes

SUMMARY	ACCOUNT	SUMA	AVERAGE	VARIANCE
Aroma	14	89	6,35714286	0,55494505
Color	14	82	5,85714286	1,20879121
Texture	14	80	5,71428571	1,91208791
Taste	14	95	6,78571429	0,18131868

Table 20. Analysis of Variance

Origin of variations	Sum of squares	Degrees of freedom	Mean squares	F	Probability p-value	Critical value for F
Between groups	16,2142857	13	1,24725275	1,19055944	0,031929589	1,9612184
Within the groups	44	42	1,04761905			
Total	60,2142857	55				

For the interpretation of the result of table XVIII, Mendivelso [16] points out that if the p-value is less than the significance level, the null hypothesis is false and is rejected, and the alternative hypothesis is accepted, while when the p-value is greater than the significance level, the null hypothesis is true and is not rejected.

The analysis showed that the p-value is less than the significance level; therefore, the null hypothesis is rejected, and the alternative hypothesis is accepted where it is interpreted that tasters are satisfied with the formulation of amaranth and sweet potato flour cookies with chocolate chips in terms of attributes such as aroma, color, flavor and texture.

$$0{,}031929589 < NS$$
$$0{,}031929589 < 0{,}05$$

4. DISCUSSION

In the bromatological tests carried out in the fiber analysis, the resulting content in the product was 3.125%, according to INEN 2085:2005, where it is indicated that the maximum crude fiber content is 3%, also [17] mentions in a research carried out where sweet potato and corn flour is used a value of 2.23% and [18] report values between 0.005 - 1.972 % in cookies with roasted amaranth wholemeal flour, so it can be said that the values obtained are not far from the permitted limit, since this is also due to the fiber content of sweet potato, resulting in slightly higher fiber content.

In the fat analysis, a value of 0.11% of total crude fat content was obtained, which indicates that its content is minimal since, according to Pilamala [19], he mentions that the lower the fiber content, the higher the amount of protein, which refers to a better substitution of the normal cookie.

The NTE [20] indicates that the ash content is acceptable since this test shows that the mineral content is part of the inorganic components of food, i.e., those that are found in nature without being part of living beings and play a very important role in the organism since they are necessary for the elaboration of tissues, synthesis of hormones and in most of the chemical reactions in which enzymes intervene.

For the moisture analysis, a value of 9.39% was obtained. The technical standard [15] indicates that as a requirement to have a quality cookie, it must have up to a maximum of 10% moisture, so it can be said that the product does not exceed the permitted limit and based on the technical standard and that it can have a moderately prolonged shelf life.

Water activity is a very important factor in product quality because contamination by molds or microorganisms is easier, which causes the product to deteriorate and lose its organoleptic characteristics. For this, the ISO:18787 standard [21] mentions that for cookies the water activity should be <60; by obtaining the resulting value of 0.88 indicates that there may have been contamination possibly in the manufacturing process, it can also be said that by the observed data the product quality will be reduced.

As a result of the protein analysis was obtained 6,25% which is an acceptable value since the technical standard [22] does not specify the maximum protein content, so it can be said that the content of the product under analysis is acceptable, the composite wheat cookie contains 15.7% of the recommended daily value, showing that it is much higher than the analyzed product since the cookie made with wheat flour contains other additional components that make its protein content increase as indicated in a research work developed [23].

According to the results obtained in the sensory analysis in which the level of liking was evaluated with a scale of 1 - 5, using the ANOVA test or variance analysis to determine whether or not the product was accepted by the panelists, taking as a reference a null hypothesis and an alternative hypothesis in which it is proposed that the panelists are dissatisfied or satisfied with the formulation of the cookie. For this, we worked with a significance level of 0.05, which generates a Confidence Interval (CI) of 95%, having as an answer that the alternative hypothesis is accepted, which refers to the fact that the panelists accepted the cookie formulation since the p-value was lower than the significance level stipulated.

5. CONCLUSIONS

Sweet potato (ipomoea batatas) and amaranth (amaranthus) chips were prepared as a new nutritional alternative, with good organoleptic characteristics (color, smell, flavor, texture) and without complications during the manufacturing process. The use of sweetpotato and amaranth are very important in human nutrition because they are healthy foods produced without difficulty in the Sierra region; these foods provide different benefits to the consumer.

Bromatological tests carried out on the cookies indicate a high-quality nutritional composition that can offer a great benefit to people's diets.

The product's cost-benefit is $1.40 per package, which contains 6 units.

The results obtained in the sensory analysis indicate that the tasters are satisfied with the preparation of amaranth and sweet potato chip cookies because they have positive attributes such as aroma, color, flavor and texture of good quality.

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