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PREPARATION OF A SNACK BASED ON QUINOA (CHENOPODIUM QUINOA) ORANGE AND CHOCOLATE FLAVOR THROUGH THE USE OF AN EXPANDED CANNON.

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Abstract:

Themain objective of the research project was to experiment with quinoa (Chenopodium quinoa.), expanded with high protein value and different flavors. The methodology applied in the development of the research was experimental and exploratory research; deductive and analytical methods; starting with the physical, chemical, bromatological and microbiological characterization of the raw material as requested in the "NTE INEN 1673 (2013): Quinoa. Requirements. Subsequently, the industrial-level process of expan-sion of quinoa was developed to obtain the quinoa snack using an expander cannon, then proceeded to perform the two ensayos to obtain the quinoa snack rich in expanded protein flavor of orange and chocolate, in this process they performed operations of Dilution, mixing and drying to obtain a quality and safety product. Once the productor final product was obtained, quality control was carried out using as a reference the "NTE INEN 2570 (2011): Snacks of grains, cereals and seeds. Requirements.", obtaining values within the limits recommended by the Standard, in this way the product is of quality and safety suitable for human consumption.

Keywords: Extrusion; quinoa; protein, quality

1. Introduction

Chenopodium Quinoa or better known as quinoa or quinoa is a complete food for its great nutritional contribution in relation to another cereal, for the presence of polyphenols, phytosterols and flavonoids, being con-sidered as a functional food for its therapeutic, pharmaceutical, food industry use (Razzeto, 2019) for its excellent properties such as: high solubility, gelatinization, emulsiveness, Technological potential in the design of new foods. The protein content varies between 13.81 and 21.9%, depending on the variety of the grain, quinoa guarantees a com-plete coverage of the daily dietary requirements, (Hernandéz-Ledezma, 2019) (USDA / ARS, 2014). An element to highlight is the high pres-ence of methionine, threonine, lysine and tryptophan,

since these amino acids are limiting (they are never fully supplied) in other cereals, (Gor-instein, 2002)

For some populations, including high-quality protein in their diets is a problem, especially those who consume little animal protein and must obtain protein from cereals, legumes and other grains. Even when the energy intake of these foods is adequate, the concentration of essential amino acids (EAA) can be deficient, leading to a diet low in protein. A fundamental characteristic of quinoa is that the grain, leaves and inflo-rescences are sources of protein of very good quality. (PRESS, 2019)

Cereals are the most widely used raw materials in expandedfood bo-rating, mainly due to functional properties, low cost and availability. However, legumes and oilseeds can be used effectively due to the high protein content to obtain nutritional improvement from extruded cere-al-based snacks (Deshpande and Poshadri, 2011).

Quinoa is an Andean grain that has a high protein content (about 15%), which are mainly albumins and globulins. Its balance of essential amino acids is excellent due to a wider spectrum of amino acids than in cereals and legumes. Therefore, quinoa proteins are able to complement cereal or legume proteins (Abugoch et al., 2008).

Inorder to obtain an extruded with good expansion and nutritional value, Coutinho et al. (2013) elaborated extruded snacks from a mixture of broken rice grains, rice bran and black soy pulp (81:9:10). Likewise, Rehal et al. (2017) found that the protein content of commercial extruded snacks was in the range of 2.8 to 9.2%.

The regular consumption of quinoa helps protect cardiovascular health in different ways: collaborating with the decrease of blood cholesterol due to its contribution of unsaturated lipids, for its low sodium content, ideal in the prevention and treatment of high blood pressure, it has a low glycemic index, recommended for people with insulin resistance, di-abetes and obesity. (Vargas Zambrano, 2019). As for the contribution of vegetable iron, it is higher than that of most cereals; It contains 13.2 mg of iron/100 grams of crude quinoa. However, like all plant foods, it con-tains some non-nutritive components that can reduce the content and absorption of mineral substances. According to Bhargava in terms of an edible serving of 100 g, quinoa supplies 0.20 mg of vitamin B6, 0.61 mg of pantothenic acid, 23.5 g of folic acid and 7.1 g of biotin. (Bhargava, 2016). No less important are the lipid contributions, which in quinoa vary between a range of 1.8-9.5%, with an average of 5.0-7.2%, this is signifi-cant if one considers that they are higher than the contributions made by corn (3-4%), (Hernandéz-Ledezma, 2019) (Lorusso, 2017). A relevant aspect of the composition of these lipids is the presence of polyunsatu-rated fatty acids and their important effects on health and human nu-trition. (Vargas Zambrano, 2019)

2. Materials and Methods

Raw material.

Among the raw material used mainly is quinoa (Chenopodiun quinoa), obtained from Canton Colta, chocolate, orange flavoring, water, milk, powdered sugar.

Methods of analysis.

The proximal and microbiological analysis was performed in tripli-cate to the raw materials and the snack andxpandido of the final for-mulation.

For quinoa as raw material, the parameters requested by the Ecuadorian Technical Standard "NTE INEN 1673 (2013): Quinoa. Requirements."

Determination of the level of infestation and impurities. NTE INEN 1671:2013 Quinoa. Sieves with circular openings of 2 millimeters (see NTE INEN 154 and NTE INEN 1515) are used, which have a bottom tray, or base. In the quinoa sample, the degree of insect infestation is ex-pressed as the number of insects per kg of sample.

Determination of impurities. Sieves with circular openings of 4.75 mm and 1 mm are used (see NTE INEN 154 and NTE INEN 1515), which have a bottom tray, or base. A portion of moreor less 500 grams is taken properly quartered, after which it isimpied with an electric sieve, at approximately 68 swings / min, for aminute, using the sieves.

Determination of moisture content. was done by drying the samples in an oven at 130-133°C, keeping it for 2, according to NTE INEN 1235. According to (Román, 2013) mentions that: The drying of grains aims to reduce the level of moisture in them, below a level considered safe, which helps to ensure their conservation, by preventing both their germination and the growth of microorganisms.

The protein determination was performed by the Kjeldahl method, us-ing ISO 20483 as a reference, determination of nitrogen content and calculation of crude protein content.

Crude fiber: Crude fiber was expressed as the loss of mass that is lost in the incineration of dry residue, obtained after digestion with solutions of HSO4 and NaOH at 1.25%, AOAC 962.09 (AOAC, 2005).

Ash: by muffle incineration at 550 °C, AOAC 942.05.05 (AOAC, 2005).

Experimental methodology.

Raw material selection

The raw material selected to obtain the expanded quinoa snack is received and the humidity is verified as an important parameter being the value of 14% at the reception, once processed and dried the wet value d of thefinished product is maximum 11%.

Industrial Expanded Quinoa Procedure

Process variables

Table 1: Process variables

Variable	Method of measurement	Process	Parameter
Humidity	Hygrometer	Reception of raw material	Max. 14 %
	Termobalanza	Quinoa drying	Max. 11 %
Temperature	Termocupla	Expansion	100 ºC

3. Results

The improvement of quinoa has prioritized the incorporation of the nutritional value and agro-industrial aptitude for the development of food products, based on quinoa and at the same time these comply with the Ecuadorian Technical Standard NTE INEN 2561: 2010 for the reali-zation of snacks of vegetable products Requirements. (STANDARDIZATION, 2011)

With these parameters it is considered as an extruded or expanded product to that which is obtained from the process in which the grain, flour or by-product is forced to flow, under one or more varieties of mixing, heating, and shearing through a nozzle designed to shape or expand the ingredients. The product must have characteristic colour, smell, taste and texture, the addition of additives and colourants setout in NTE INEN 2 074 is permitted. It is important to highlight the hy-drophilic antioxidant capacity. In varieties of quinoa and other Andean grains, dietary fiber has a high antioxidant capacity, even with remark-able values such as purple quinoa with 367.86 uMT rolox / g. In the case of polyphenols, they can be associated with the fraction of insoluble fiber as compounds of a higher degree of polymerization: condensed tannins and hydrolyzable tannins. While associated with the soluble fiber frac-tion are the polyphenols of lower molecular weight, such as some fla-vonoids, phenolic acids, dimers and trimers of proactocyanidin. (Rioja, 2018)(Tang, 2015)

Characterization of the raw material

The procedure performed for the analysis of the physical, bromatological and microbiological characteristics of quinoa can be seen in Table 2, 3, 4. It should be considered that for the characterizationthere are specific standards, the Ecuadorian Technical Standards INEN and the Official Methods of Analysis AOAC on which it was based to meet the different parameters, then the results of these characterizations are presented.

Table 2: Physical characterization of the raw material

Requirement	Method	Requirement NTE INEN 1673		Result
		Minimal	Maximum	
Pebbles in 100 grams of sample	NTE INEN 1671	-	Absence	Absence
Insects (whole, parts or larvae)	NTE INEN 1671	-	Absence	Absence

Table 3: Bromatological characterization of the raw material

Requirement	Method	Requirement NTE INEN 1673		Result
		Minimal	Maximum	
Humidity	NTE INEN 1235	-	13,5%	9,73
Proteins	ISO 20483	10%	-	12,16
Grease	ISO 11085	4%	-	6,03
Ashes	AOAC 942.05.05	-	3,5%	2,98
Crude fiber	AOAC 962.09	3%		2,11

Table 4: Microbiological analysis of the raw material

Requirement	Method	Requirement NTE INEN 1673		Result
		m (good quality)	M (acceptable quality)	
Mold count	NTE INEN 1529-10	10^2	10^5	<10 UFC/g

Procedure for the preparation of the expanded quinoa snack

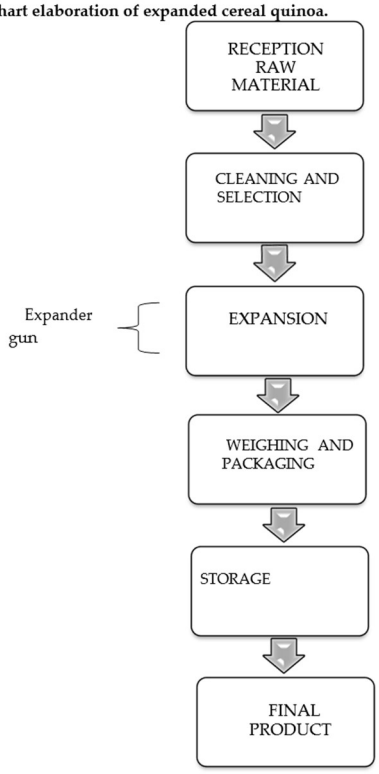
For the procedure of expanding quinoa snack it is necessary to take into account the humidity since it plays a fundamental rolel in this process, if this parameter is not controlled in the raw material it be-comes impossible to carry out the expansion process

In the drying process that is carried out to quinoa, a maximum hu-midity percentage of 11% is obtained, complying with the standard, in this way the quinoa expansion process can be carried out.

Expansion process.

Once the raw material that must meet the necessary conditions was verified, the expansion process was carried out, Figure 1, where the expander gun was fed with 0.500 kg of quinoa and after one minute due to the effect of pressure andtemperature, 0.410 kg of expanded product or snack of natural quinoa (unflavored) was obtained.), it was then packed to prevent it from absorbing moisture and altering its texture and organoleptic characteristics. Subsequently, the quinoa snack is ready for the next process in which it is given a characteristic flavor.

Figure 1. Flowchart elaboration of expanded cereal quinoa.



Preparation of raw materials

Preparation of the orange-flavored quinoa snack

Dilución.

For this process we proceeded to measure 1.5 liters of whole milk, 1liter of water, and 20 ml of orange flavoring, then proceeded to weigh 500 g of powdered sugar , then placed in the stainless steel tank which has an inner stirrer to obtain a homogeneous mixture the same as By means of a hose it is transferred and dosed to the mixing drum to the quinoa snack that is inside.

Mixed

It weighed 8Kg of expanded quinoa that was previously packed under conditions of quality and safety, was placed in a mixing drum, while it rotates is slowly sprayed the flavored concentrate elaborated. The mix-ing was done for 5 minutes during which time the quinoa snack has acceptable characteristics.

Once the mixing is done, the product is collected in a dryer that is a stainless steel cylinder, which by means of hot air and constant turns proceed to dry the product for 3 minutes.

Then we proceeded to pack the product in a vertical packaging machine, which contains a former to pack the product in presentation of 100 grams.

Storage

To guarantee the quality and safety of the product, it is stored at room temperature, which makes it possible to preserve the product without losing its organoleptic characteristics and nutritional value.

Preparation of quinoa snack chocolate flavor

Dilución

It measured 1.5 liters of whole milk, 1 liter of water, weighed 400 g of ground sugar and 300 g of chocolate powder, then placed in the stainless steel tank which has an inner stirrer to obtain a homogeneous mixture the same that by means of a hose is transferred and dosed to the mixing drum to the quinoa snack that is inside.

Mixed

It weighed 8Kg of expanded quinoa that was previously packed under conditions of quality and safety, was placed in a mixing drum, while it rotates is slowly sprayed the flavored concentrate elaborated. The mixing was done for 5 minutes during which time the quinoa snack has acceptable characteristics.

Once the mixing is done, the product is collected in a dryer that is a stainless steel cylinder, which by means of cold air and constant turns proceed to dry the product for 2 minutes.

Then we proceeded to pack the product in a vertical packaging machine, which contains a former to pack the product in presentation of 100 grams.

Storage

To guarantee the quality and safety of the product, it is stored at a temperature below 13 ° C, which makes it possible to preserve the product without losing its organoleptic characteristics and nutritional value.

Figure 2. Diagram of the flavoring process of expanded quinoa snack. (orange and chocolate)

Analysis of the final product

The validation of the quinoa ex-pandido was carried out through the bromatological and microbiological characterization of the final product obtained in accordance with the parameters established in the Ecuadorian Technical Standard INEN 2570 (2011): Snacks of grains, cereals and seeds. Requirements. As a result of this process of expansion and flavoring,the results are shown in Table 5 and 6.

Table 5: Bromatological cracterization of the expanded quinoa snack

Requirement	Requirement NTE INEN 2570	Result
Expanded quinoa snack orange flavor		
Peroxide index meq O_2/kg (in extracted fat)	Max.10	0.00 MEQ W_2/kg
Expanded quinoa snack Chocolate flavor		
Peroxide index meq O_2/kg (in extracted fat)	Max.10	1.23 meq O_2/kg

Table 6: Microbiological analysis of the flavored quinoa expanded snack

REQUIREMENT	REQUIREMENT NTE INEN 2570		RESULT	METHOD
Expanded orange flavored quinoa				
Standard plate count,cfu/g	10^3	10^4	60	NTE INEN 1529-5
Mohos, ufc/g	10	10^2	<10	NTE INEN 1529-10
E. coli, ufc/g	<10	-	-	NTE INEN 1529-7
Expanded quinoa chocolate flavor				
Standard plate count,cfu/g	10^3	10^4	100	NTE INEN 1529-5
Mohos, ufc/g	10	10^2	<10	NTE INEN 1529-10
E. coli, ufc/g	<10	-	-	NTE INEN 1529-7

The peroxide index is a measure of the oxidation state of an oil or fat; however, peroxides are lost during the process, so it is considered unreliable. In a study by Robert et al. , the peroxide index was found to increase after the frying process, but this index was lower when hydrogenated oils were used (3.7% in sunflower oil and 1.3% in partially hydrogenated sunflower oil)

4. Discussion

Analysis and discussion of results

To carry out the current project, the characterization of the raw material (quinoa) from the Colta Canton was initially carried out, which must comply with the requirements of the Ecuadorian Technical Standard INEN 1673 (2013): Quinoa. Requirements. The respective physical, bromatological and microbiological analysis was carried out on the different samples, obtaining the following results: absence of pebbles and in-sectos, 9.73% humidity, 12.16% protein; 2.98% ash; 6.03% fat, 2.11 % crude fiber as shown in Tables 4 and 5 . Shirani and Ganesharanee (2009), argue that proteins influence the expansion of extruded through their macromolecular structure and their conformation, as well as through their ability to affect the distribution of water in the matrix; on the other hand, the average value of protein in quinoa is close to that indicated in the Peruvian tables of food composition (Reyes et al., 2009)

For microbiological parameters, they are shown in Table 6. we have a mold count of <10 CFU/g, these results tell us that quinoa presents a good quality as a raw material, since the requirement requests to have a value of up to 102 CFU/g, The raw material being from the Canton Colta, belongs to the variety of quinoa "Nativa de Chimborazo", so its composition will be different from quinoa that is grown in other parts of the country.

The objective of the research is to obtain two varieties of snack and quinoa xpandido, in the process an expander gun was used, this is manufactured in stainless steel 304 with high resistance lid and with a capacity of 60 kg / h, in which the raw material will enter so that the expansion process is given and which takes approximately 1 minute. Using stainless steel equipment and materials, the processes of weighing, dilu-tion, mixing, drying, storage were carried out. Kowalski et al. (2016) men-tion that the reduction in expansion is mainly due to the presence of insoluble fiber that tends to retain water in the fiber matrix during ex-trusion cooking, thus reducing the steam created.

The quality of the expanded snack of final quinoa was validated with the bromatological and microbiological characterization of the final products using the Ecuadorian Technical Standard INEN 2570 (2011): Snacks of grains, cereals and seeds. Requirements. Having as results for the expanded quinoa orange flavor a peroxide index equal to 0.00 meq O2 / kg which means that the fat present is not undergoingan oxidation process. When the production of reactive oxygen species (ROS) is in-creased or cellular cleaning systems are inefficient, an excess of oxy-gen-derived free radicals occurs, leading to what is known as oxidative stress (Kumar et al., 2008). It is recognized as a fundamental mechanism in the toxicity of many xenobiotics and is implicated in numerous dis-eases (Repetto Jimenez & Repetto Kuhn, 2009). Abegunde et al. (2013) mention that the recommended moisture for commercial starches should be below 20%, and the variation in humidity can be attributed to the degree of drying of starches. On the other hand, in the microbiological parameters the standard plate count obtained a value of 60 CFU/g; while for themold count an amount <10 CFU/g was determined; and for the E. coli count there was no growth; which indicates a product of quality and safety for the consumer.

For expanded quinoa chocolate flavor a peroxide index equal to 1.23 meq O2/kg. In the microbiological parameters the standard plate count obtained a count of 100 CFU/g; for mold count, an amount <10 CFU/g was determined; and for the E. coli count there was no growth; which indicates a product of quality and safety for the consumer.

5. Conclusions

A pop of quinoa expandido was elaborated using a cannon the same that for the process a temperature of 100 ° C is registered, in this way expands the product, thus obtaining a pop of organoleptic characteristics favorable to the consumer.

The fundamental variables within the process werefinished, these being: humidity, temperature and time, which during the quinoa ex-pansion process were controlled in order to guarantee a quality prod-uct; In the various operations of selection of raw material, explosion, weighing, mixing and drying that are carried out during the process, special care must be taken in the use of stainless steel equipment and containers, and in cleaning and disinfection tasks to avoid contamination in the final product.

Quinoa was characterized physically, bromatologically and microbio-logically as a raw material, under the Ecuadorian Technical Standard NTE INEN 1673 (2013): Quinoa. Requirements, where the parameters analyzed are within the established limits, in such a way that quinoa is considered

as a raw material suitable for the elaboration of the two fla-vored formulations of quinoa expanding.

In the results evaluated through the bromatological and microbiological analysis of the final products, compliance with the parameters estab-lished in the Ecuadorian Technical Standard NTE INEN 2570 (2011) is evident: Snacks of grains, cereals and seeds. Requirements, therefore, the expanded flavored quinoa are suitable for human consumption.

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