Journal of Namibian Studies, 33 S2(2023): 2726–2764 ISSN: 2197-5523 (online)

# ELABORATION OF AN ENERGY BAR FROM QUINOA POP WITH OATS, HONEY, AND NUTS

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*Abstract*

One of the main problems in the food industries is the use of various additives for the preservation of their products and to give an artificial flavor without the need to add natural products in their product, so these products have a relatively low percentage in terms of organic raw material and therefore your product will not have the same nutritional characteristics as a product made to Base of organic raw material such as fruits, cereals and vegetables. For this reason, food companies need to formulate and develop products that are based on organic raw material to bring to market products with high nutritional values and that do not have a great cost of obtaining so that the product is directed to all social classes without exclusion.

Taking into account the need of the food company, quinoa pop will be formulated and elaborated for later use in the formulation and elaboration of an energy bar based on organic raw material using different concentrations of quinoa pop, nuts and honey to obtain a product of quality and safety, and sensory characteristics that are ideal for the consumer.

Keywords: ENERGY BAR, QUINOA POP; OATS, HONEY, NUTS.

## Introduction

The different additives that are added to food products such as snacks, have their benefits, but all depending on the amount that is present in the products such as salt, which is an important source of sodium and

potassium. Additives, as well as having their benefits also have their disadvantages, since there are several additives of artificial origin that are harmful as is the case of monosodium glutamate that can cause serious health effects, causing migraines, nausea, allergies and epilepsy.

Currently there is a great demand for industrialized food products, especially snacks which are made of different raw materials and also contain several additives that allow the product to have a longer life and added value in terms of the organoleptic attraction of the product, so it means that these products are mostly made with the least amount of natural raw material and therefore with relatively low nutritional values, which leads to an unhealthy product for the different consumers of these products.

Products made from cereals and pseudocereals have been widely received in recent years, being that these foods have a large amount of nutrients, so they are given great importance for the development of energy bars and snacks that are aimed at school populations or athletes for their great nutritional contribution, in addition to its pleasant taste.

Food additives

Food additives are substances that are added to foods to improve their safety, shelf life, taste, texture or appearance. Food additives play an important role in maintaining food safety so they have been used for a long time, but it should also be noted that the use of these additives is only justified if it responds to a technological need and does not mislead the consumer (WHO, 2008).

These substances can be extracted from plants, animals, minerals and can even be produced synthetically. At present, there is a wide variety of additives that give food the property of being safer and improving its appearance, in addition to intensifying its organoleptic properties being more striking for the consumer.

Flavouring

Flavorings are substances used to give taste or smell to food, such substances have been used in products such as soft drinks, cereals, cakes and yogurts. The amount of flavourings to be used is relatively low so consumers would not present any problem when consuming them (EFSA, 2022).

**Figure 1. Food flavourings**


Source: (Aida Lirola, 2019)

Enzyme preparations

Enzyme preparations are additives that may or may not be present in the food product. Enzymes are natural proteins that metabolize biochemical reactions, converting large molecules into smaller molecules or their components, these enzymes are extracted from animals, plants or microorganisms such as bacteria (WHO, 2008).

Generally, its use is intended for pastry (to give better properties to the dough), in the realization of fruit juices (to improve its performance), in the production of wines and beers (so that the raw material has a better fermentation) and in the production of cheeses (so that they have a better formation of the curd) (WHO, 2008).

Quinoa

Quinoa (Chenopodium quinoa) are crunchy light yellow grains, with a delicate flavor and that when ingested does not interfere with more intense flavors. When quinoa grains are prepared, they are loose, shiny and their spiral-shaped germ is clearly noticeable. The cultivation of quinoa is given from a quenopoduaceous plant, which began to be cultivated centuries ago in the surroundings of Lake Titicaca and was a staple food of indigenous cultures until the arrival of the Spaniards (Carpintero Alfredo, 2021).

Quinoa has several health benefits such as energy, protein and mineral richness so quinoa becomes a complete and suitable food for consumption without excluding any age. In addition, people suffering from diabetes can also consume quinoa since it has a low glycemic index

thanks to its complex carbohydrates, fiber and its content of amino acids such as isoleucine, leucine and valine, which are responsible for balancing the blood sugar level (Carpintero Alfredo, 2021).

Kañiwa, quinoa and kiwicha are pseudocereals from the Andes of South America, which have served as raw material since pre-Hispanic times thanks to their protein quantity and their high content of fiber and bioactive compounds (Ramos Diaz et al., 2015).

Thanks to all the properties that quinoa has, it can be used in several areas such as human food, animal feed, in medicinal use leaves, stems and grains are used as they have healing, anti-inflammatory, analgesic, disinfectant properties. Quinoa also has industrial uses in the production of aerosols, pastes, carbonless paper, desserts, excipients in the plastic industry, talcs and anti-offset powder, all this is thanks to the presence of starch in quinoa (FAO, 2018a).

**Figure 2. Black, white and red quinoa**

Fuente: (Derulo, 2018)

Nutritional Value and Benefits of Quinoa

Quinoa (Chenopodium quinoa) is recognized as a food crop in the Andes of South America, its grains have a fairly high nutritional value with a large amount of protein and bioactive compounds surpassing the biological value of several cereal grains. With its high nutritional value, it has multiple relevant functional properties that influence the reduction of risk of chronic diseases that are attributable to its antioxidant, anti-inflammatory, immunomodulatory, anticarcinogenic, etc. activity (FAO, 2018b).

Quinoa is one of the foods used as a very important food supplement for the treatment of some diseases related to poor diet for this reason Peressini et al expose that eating habits should be modified by promoting a good diet through the intake of cereals, pseudocereals,

fruits, nuts and especially foods with low sugar content and high fiber intake combined with physical activity would obtain an excellent lifestyle without health problems (Peressini et al., 2015).

According to several laboratory analyses and research conducted by the United States Department of Agriculture and Agricultural Research Service (USDA) in 2013, the nutrient content of quinoa is as follows:

**Table 1. Nutritional content of quinoa (Chenopodium quinoa)**

| NUTRITIOUS | UNIT | VALUE 100g |
|---|---|---|
| Water | g | 13,28 |
| Energy | Kcal | 368 |
| Energy | KJ | 1539 |
| Protein | g | 14,12 |
| Total Lipids (fat) | g | 6,07 |
| Ashes | g | 2,38 |
| Carbohydrates by difference | g | 64,16 |
| Total dietary fiber | g | 7,00 |
| Starch | g | 52,22 |
| Calcium, Ca | mg | 47,00 |
| Iron, Faith | mg | 4,57 |
| Magnesium, Mg | mg | 197,00 |
| Phosphorus, P | mg | 457,00 |
| Potassium, K | mg | 563,00 |
| Sodium, Na | mg | 5,00 |
| Zinc, Zn | mg | 3,10 |
| Cobras, with | mg | 0,59 |
| Manganese, Mn | mg | 2033,00 |
| Selenium, | µg | 8,50 |

Source: (FAO, 2018b)

In addition to having a large number of benefits, there may be a variation of the components of quinoa or other cereals or pseudocereals that can provide positive effects to human health, such as the relevant amounts of nutritionally valuable molecules, especially antioxidant compounds such as phenolic acids, carotenoids, tocopherols and polyphenols (Hidalgo et al., 2018).

Nuts

Nuts are fruits whose edible part contains less than 50% water in its composition. Although these foods have little water, they have a large amount of nutrients such as lipids and proteins being a favorite food for diets and as "snacks" between meals, since in addition to providing several nutrients to our body they also help digestion by the contribution of fiber that they also have (Lara, 2006, pp. 1–8).

Nuts are foods rich in thiamine (B1), folic acid (B9) and vitamin E, but especially minerals are the most abundant in nuts. The disadvantage of nuts is also related to minerals since zinc, iron and calcium have a low bioavailability, the reason for their low bioavailability is the presence of phylates that are the culprits of the sequestration of minerals which prevent their absorption. The iron that is present in nuts is of the "non-heme" type so it will not have much less absorption compared to the iron present in meat and fish (Lara, 2006, pp. 1–8).

**Table 2. Nutritional composition of nuts (per 100g without shell)**

| Nutritious | Almonds | Nuts | Hazelnuts | Sunflower seeds | Pistachio |
|---|---|---|---|---|---|
| Kcal energy | 589 | 595 | 656 | 574 | 594 |
| Lipids g | 45.2 | 63.3 | 56.2 | 43 | 49.2 |
| Hydrates g | 6.2 | 3.3 | 10.5 | 20 | 15.2 |
| Protein | 19.1 | 14 | 12 | 27 | 17.6 |
| Fiber g | 8.3 | 5.2 | 8.2 | 2.7 | 6.5 |
| Folic acid ug | 70 | 66 | 71 | 238 | 58 |
| Vitamin B1 mg | 0.21 | 0.3 | 0.39 | 1.6 | 0.69 |
| Vitamin E mg | 24 | 0.8 | 26.2 | 37.8 | 5.2 |
| Vitamin B6 mg | 0.11 | 0.73 | 0.59 | 0.77 | 1.27 |
| Potassium mg | 767 | 690 | 636 | 710 | 811 |
| Iron mg | 3.6 | 2.3 | 3.8 | 6.4 | 7.2 |
| Magnesium mg | 258 | 140 | 156 | 390 | 122 |
| Phosphorus mg | 525 | 304 | 333 | 651 | 390 |
| Zinc mg | 3.6 | 2.1 | 2.1 | 5.1 | 2.8 |

Fuente: (Lara, 2006, pp. 1–8)

Honey

Honey is a sweet liquid that is made by bees using nectar from flowering plants. There are about 320 types of honey, which vary in color, aroma and flavor. Honey is mainly composed of sugar, followed by amino acids, vitamins, minerals, iron, zinc and antioxidants. Honey is usually used as a natural sweetener but also has other properties such as anti-inflammatory, antioxidant and antibiotic agent (Herrera, 2020).

Honey depends on several factors to have a certain composition, these factors are the source of nectar, beekeeping practices, climate and environmental conditions. Honey has the following physicochemical properties:

Carbohydrates

Carbohydrates are the main components of honey since it is constituted of approximately 25 complex sugars, but these are present at very low levels, with the monosaccharides fructose and glucose being the main

carbohydrates of its composition and responsible for joining these sugars in different combinations (Ulloa et al., 2010, pp. 11–18).

**Table 3. Main constituents of honey sugars**

| **Monosaccharides** | **Disaccharides** | **Trisacáridos** | **Complex saccharides** |
|---|---|---|---|
| Fructose | Gentibiosa | Centosa | Isomaltopentosa |
| Glucose | Isomaltosa | Eriosa | Isomaltotetraos |
| | Maltose | Isomaltotriosa | |
| | Maltulosa | Isopanosa | |
| | Nigerosa | Laminaritriosa | |
| | Palatinosa | Maltotriosa | |
| | Sucrose | Melezitosa | |
| | Turalosa | Panosa | |

Source:(Ulloa et al., 2010, pp. 11–18)

Water

One of the most important characteristics of honey is the moisture content, but this characteristic is dependent on some factors such as the environment and the moisture content of the nectar. Normally, mature honey has its moisture content below 18.5% and when this level is exceeded, it tends to be more susceptible to fermentation, especially if the amount of osmophilic yeasts is highly sufficient. The moisture content can also be altered after the extraction of honey from the hive, with storage conditions being the factor that causes the change in moisture content (Ulloa et al., 2010, pp. 11–18).

Enzymes

The enzymes present in honey come from plants, but are mainly added by bees, this is done in order to achieve the maturation of nectar into honey, bees being responsible for the compositional complexity of honey. The main enzyme for the conversion of nectar to honey is α-glucosidase (invertase or sucrase) since it converts the sucrose of honey into its constituents: fructose and glucose (Ulloa et al., 2010, pp. 11–18).

Proteins and amino acids

Proteins and amino acids are the least abundant components in honey as they make up about 0.5% of the composition of honey. The levels of amino acids and proteins in honey reflect the presence of nitrogen, between 40-80% of the nitrogen present in honey are proteins (Ulloa et al., 2010, pp. 11–18).

Breathed

Blowing is a process of explosive vaporization of the internal water of the grains, with a sudden decrease in pressure, causing swelling of the grains until they reach sizes larger than the originals. This process can be applied to several grains such as: quinoa, amaranth, rice, wheat and oats (GRUPO PROALNAT, 2016).

**Figure 3. Blown quinoa**

Source: (Vasquez, 2014)

Energy bar

Energy bars are a caloric and nutritional supplement for cases in which it is necessary to increase the energy or nutrients provided by the diet. They are cereal-based products that are marketed under different brands and that, having little weight, provide a large amount of nutrients and therefore energy. The weight of these bars ranges between 25-70 g, so they are very easy to transport, preserve and consume (Ruiz de las Heras, 2018).

Energy bars have several benefits for consumers being that it is a great dietary supplement, helps keep the intestine clean, prevents diseases related to poor diet such as anemia, is beneficial for the heart, everything is because it contains a lot of fiber, iron, fatty acids (Omega 3 and 6) (Daireaux, 2017).

In addition, according to López et al, energy bars are products that can be easily adapted to most dietary needs that the consumer may need, some needs can range from replacing saturated fats with unsaturated fats to increasing the consumption of cereals, pseudocereals, legumes and nuts, taking into account that for an energy bar it should be

considered that it is a product that is a set of ingredients which will provide a great amount of nutritional value (López-López et al., 2009).

**Figure 4. Quinoa Energy Bar**

Source: (UNAL, 2011)

BEnergy bar elements

Energy bars are a food supplement that are generally consumed by athletes or people who perform great physical activity to maintain the necessary calories after having done a day of physical activity. As its name mentions, they are a source of energy since they have a high amount of complex carbohydrates in addition to proteins, vitamins and minerals that are provided by cereals, nuts, honey and other components. The calories in food come from three different sources: carbohydrates, fats, and proteins. One gram of protein or carbohydrates provides four calories, while one gram of fat provides nine calories. Fiber is usually increased in energy bars to increase volume without calories and to slow down glucose absorption (Ochoa, 2012, p. 1).

When hearing about energy bars, it is usually related to foods with beneficial properties for health, these bars are composed of the compression of cereals, nuts, pseudocereals, flavorings and some binding ingredients so it is possible to obtain a product of high nutritional and functional content to meet the nutritional needs that the consumer usually demands (Rios, Lobo and Samman, 2018).

Lately the demand for nutritious and safe food has been growing exponentially because in recent years there have been important health problems caused especially by the lack of good nutrition so it is about developing new products to cover the need to remedy health problems

related to food such as obesity, diabetes, malnutrition, heart disease and several other diseases (Marques et al., 2015).

Nutritional value of the energy bar

The nutritional value of energy bars varies according to their composition, but they generally provide every 100 grams: 60-80% carbohydrates (reason why they are so energetic), 3-24% fat, 4-15% protein, 370-490 calories and also provide vitamins and minerals. Its water content (humidity) is very low so it is recommended to eat this type of food with a liquid companion (Ochoa, 2012, pp. 1–2).

Quality control

Quality control is a way to verify the standard of a product or service throughout the manufacturing or production process and serves to reduce the probability of bringing to market products with failures or that do not comply with the requirements set out in the different standards on which most products are based. Quality control has a fundamental role in the industrial field since it allows monitoring the entire production process and thus eliminate errors, failures or defects that may occur in any of the steps until reaching the final product. When detecting a failure in a production process, what is done is to correct said failure in order to improve the production line and thus obtain quality final products complying with all the requirements that are exposed in the INEN standards for each product (Pablo Orellana Nirian, 2020).

Proximal analysis

The proximal system for ordinary analysis was designed in the mid-nineteenth century at the Weende experimental station in Germany. It was created to obtain a very broad classification and with a maximum level of food components. The system consists of the analytical determination of water (moisture), ash, crude fats (ether extraction), proteins and crude fiber. The nitrogen-free extract (ELN), which roughly represents sugars and starches, is calculated by difference rather than measured by analysis (Greenfield and Southgate, 2003, p. 107–111).

Microbiological analysis

It allows us to know the total number of microorganisms present in the food. This number is not related to the number of pathogenic microorganisms and therefore cannot be used as an index of their presence and should only be considered as an indicator of the general hygienic characteristics of the food. It can detect the presence of microorganisms and bacteria such as mesophilic aerobes, Bacillus cereus, Campylobacter, Candida albicans, Clostridium perfringesns, etc. (Supe, 2021).

Types of quinoa

There are several species of quinoa, exceeding 120 species, but usually you will find 3 types of quinoa in the market being these differentiated by the color of the seeds:

White quinoa

This type of quinoa is the one that is usually marketed more frequently since its flavor, color and texture is similar to white rice, so in many dishes it is used as a substitute for rice. White quinoa contains a large amount of fiber and its caloric values are not high (Patiño, 2018).

**Figure 5. White quinoa**

Source: (Gómez, 2014)

Red Quinoa

The flavor of red quinoa is much more intense than the flavor of white quinoa but contains less fat and more carbohydrates and proteins (Patiño, 2018).

**Figure 6. Red Quinoa**

Source: (Méndez, 2019)

Black quinoa

Black quinoa is a hybrid created by crossing spinach and quinoa, has an earthy flavor and its consistency is harder and crunchier compared to the other 2 types of quinoa. It has relaxing properties due to the presence of lithium and what possibly gives it the black color is the presence of anthocyanins, being powerful antioxidants that protect the plant from the harmful effects of the sun's UV rays (Patiño, 2018).

**Figure 7. Black quinoa**

Source: (Suarez, 2014)

**METHODOLOGICAL FRAMEWORK**

1.1 Description of processes

1.1.1 Breathed

Blowing is a process to which some grains or cereals are subjected to increase their volume by using a suitable temperature so that the grains reach a different size than the normal size.

1.1.2 Saborización

Flavoring is a process where different flavorings (panela, sugar, fruit pulp, etc.) are used to cause a change in flavor or add a greater flavor to some food that does not have such a remarkable flavor.

1.1.3 Bain-marie

The water bath is a method that is used to heat a solid or liquid substance uniformly and slowly, in this method a small container is used (container containing the substance) and a large container which will be

with water to cover half of the small container and this is brought to a boil.

1.1.4 Bromatological analysis

Bromatological analyses are several analytical methods that are applied to a food sample to know its composition, its organoleptic qualities and its possible alterations (Pablos, 2021).

1.1.5 Microbiological analysis

Microbiological analyses consist of checking several aspects such as conservation capacity, hygiene conditions during production and the possible presence of microorganisms (Iriarte R, 2006).

1.1.6 Product Test

The product test is a type of evaluation that allows the researcher to collect useful information to check whether or not a product meets the appropriate characteristics to meet the different needs that the consumer may present and also allows to determine if it will be received in the market (QuestionPro, 2021).

1.2 Materials

In the present experimental work, various materials, ingredients and equipment were used to arrive at the final product which is the flavored quinoa pop and the energy bar.

**Table 4. Materials, ingredients and equipment used for the elaboration of quinoa pop and the artisanal energy bar**

| Materials | Ingredients | Equipment |
|---|---|---|
| Silicone mold | Pop Quinoa | Oven |
| Bowls | Oat flakes | Balance |
| Nitrile gloves | Nuts | |
| Cap | Blueberries | |
| Spoons different sizes | Grated coconut | |
| Gas | Honey | |
| Packaging covers | Glucose syrup | |
| | Pot | |

1.2.1 Research focus

The present work was carried out under a quantitative remediation approach. Through several transformation processes such as flavoring and blowing, obtaining the flavored quinoa POP and the energy bar based on quinoa POP, in addition the nutritional value and safety of the products was determined through bromatological and microbiological analysis, which work with numerical values.

1.2.2 Scope of research

The present work was carried out with an exploratory and correlational scope, since there are few studies of the subject of this work and it was necessary to make several formulations to obtain a quality product that meets consumer standards, it is also considered to have a correlational scope because this work used dependent and independent variables.

1.2.3 Research Design

1.2.3.1 Depending on the manipulation or not of the independent variable

This work was carried out with an experimental design, since both dependent and independent variables are handled, obtaining different results when manipulating any of the variables.

1.2.3.2 According to fieldwork interventions

Thiswork was carried out under a longitudinal study, since they involve several formulations for each product, obtaining as a result several data from both bromatological and microbiological analyses.

1.2.4 Type of study

The present work was carried out under a type of documentary study, investigating the properties and benefits of quinoa, nuts and honey for the human organism, in addition to obtaining results indicators of a high nutritional value and a product free of microorganisms.

1.2.5 Research methods, techniques and instruments

1.2.5.1 Research methods

The present work was of experimental design and comparative analysis; experimental design because this work considered variables and therefore it was necessary to corroborate or discard the hypothesis, in addition a comparative analysis of the results obtained with the standard values of the INEN standards was carried out.

1.2.5.2 Research techniques

• The experiment is a research technique that was used during the present work since this technique allowed the manipulation of the variables and in this way have several results, in addition to that in order to obtain quality products and that meets consumer standards, several formulations were made until obtaining the appropriate products.

• Observation is a fundamental research technique for all types of research so it was indispensable for the present work being that through observation it was possible to obtain some key parameters to achieve the flavored quinoa pop and the energy bar with excellent organoleptic properties.

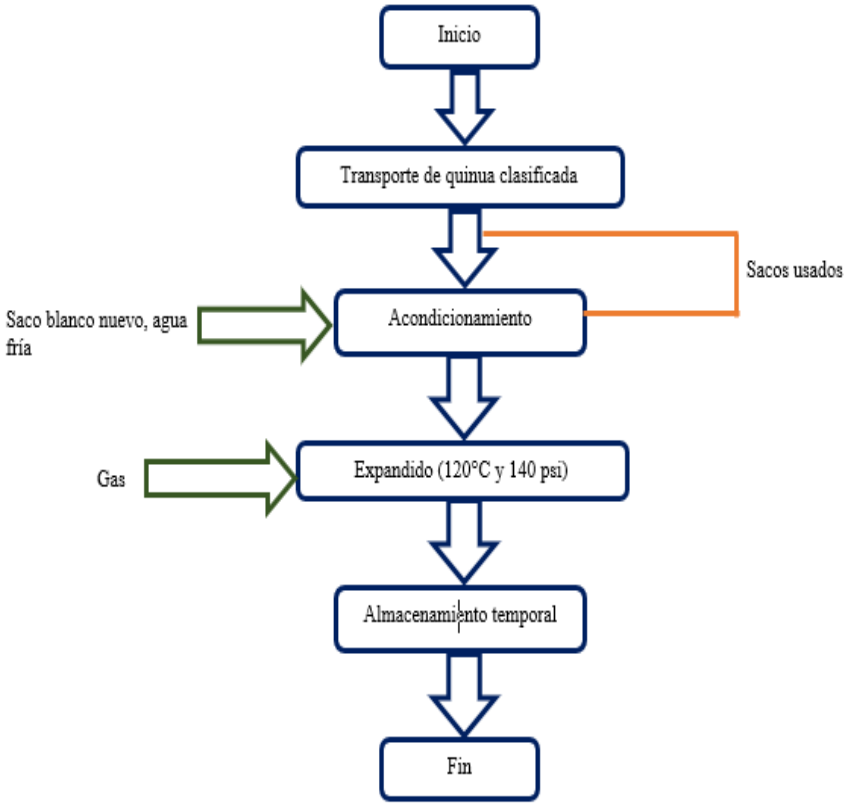
• The survey is a research technique widely used to obtain statistical data which serve to make comparisons between products and thus choose the product that will have the most impact on the market, this being the reason why this type of technique was used for this work.

1.2.5.3 Research tools

• For the realization of the first objective: Use quinoa pop (Chenopodium quinoa), as raw material for the elaboration of an energy bar.

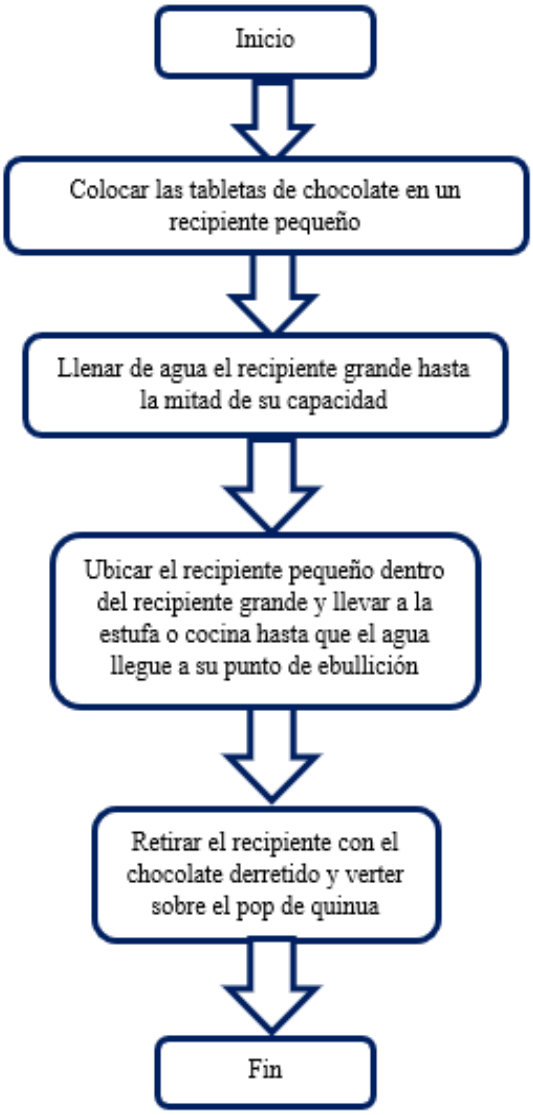
Quinoa grains were used, which were exposed to an adequate temperature until reaching a volume higher than normal, in this way the quinoa pop was obtained.

**Figure 8. Process of making quinoa pop**



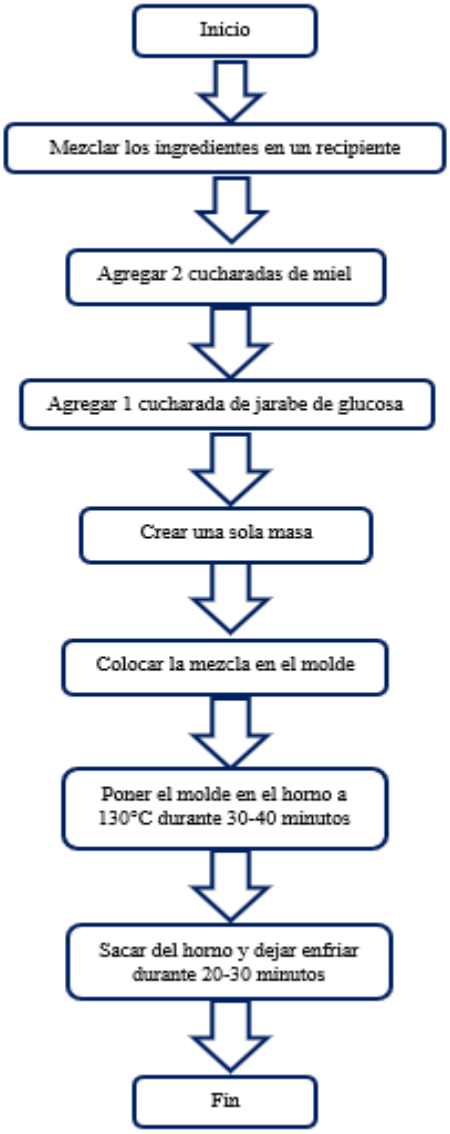

At the time of obtaining the quinoa pop, we proceeded to perform the flavoring of the quinoa pop following the following procedure:

**Figure 9. Quinoa pop flavoring process**




After having obtained the flavored quinoa pop, the following steps were followed to obtain the energy bar:

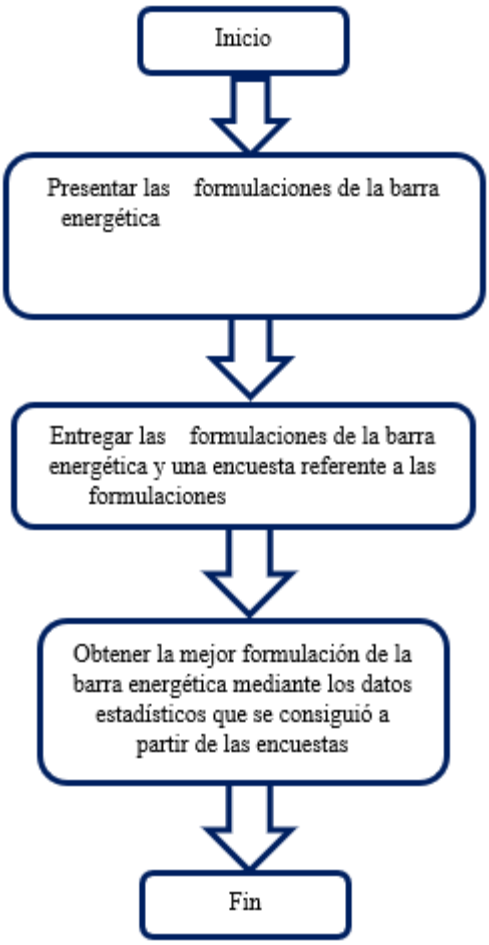
**Figure 10. Energy bar elaboration process**




• For the realization of the second objective: Determine the best formulation through the sensory acceptance of the product to a population of adults, through a consumer test.

The tasting was carried out to the adults, in addition a survey was applied to choose the best formulation of the energy bar.

**Figure 11. Obtaining the best product formulation through a consumer test**




• For the realization of the third objective: Perform the physicochemical and microbiological characterization of the different formulations of the energy bar.

Se performed the different analyses that were required for these types of products both physicochemical and microbiological characteristics. As for the physicochemical analysis, the nutritional values of carbohydrates, fats and proteins were obtained, which allowed the nutritional table of the product and its respective traffic lights to be made. While the microbiological analyzes helped to determine how safe the product ended up and therefore if its consumption would not have any impact on the health of the consumer.

• For the realization of the fourth objective: Design the graphic system or traffic light of the final product.

For the realization of the nutritional traffic light, the values of each nutrient that has the quinoa pop and the energy bar were used to then proceed to perform the respective calculations and in this way obtain values, which will be compared with the standard values for this type of products and thus obtain the traffic lights of the products.

**Results and discussions**

Quinoa insufflating (pop)

The quinoa blowing was made in the production area where the quinoa acquired from the producers / partners of the company was conditioned and exposed to a temperature of 120 ° C and a pressure of 140 psi, resulting in burst quinoa grains or quinoa pop. According to Blazes, the process of blowing or bursting cereal grains can be done industrially (on a large scale) where heavy machinery is used for greater production and acquisition of several batches or can only be done at home where only the quinoa grains previously washed and dried at a relatively high temperature and with the help of oil (either vegetable or animal) should be exposed. so that these grains burst and in this way acquire the quinoa pop (Blazes, 2019).

Once the quinoa pop was obtained, quality control was carried out, acquiring results of the physicochemical and microbiological characterization, which are expressed in the following tables:

**Table 5. Physicochemical characterization of quinoa pop**

| Requirements | Requirements NTE INEN 1673 | | Result |
|---|---|---|---|
| | Minimal | Maximum | |
| Humidity | - | 13.5% | 9.87 |
| Protein | 10% | - | 13.00 |
| Ashes | - | 3.5% | 2.63 |
| Grease | 4% | - | 7.15 |
| Crude fiber | 3% | - | 1.98 |
| Carbohydrates | 65% | - | 64.78 |

According to table 1-4, we can see that the quinoa pop obtained by the blowing method has suitable physicochemical properties since the results obtained are in the range of the reference values indicated by the INEN 1673 standard, certifying that quinoa pop can be consumed without problems or in this case, use it as raw material to formulate and elaborate an energy bar (INEN, 1992b).

According to Angeli et al, there are factors that can vary the properties of quinoa such as species, climatic conditions, geographical location and

soil quality, a clear example are the quinoa crops that occur in Chile or Peru that have a much higher carbohydrate intake than in other countries since it is between 51.9% - 68.1% contribution of these biomolecules in comparison of Ecuador that is within the range with approximately 66% (Angeli et al., 2020).

**Table 6. Microbiological characterization of quinoa pop**

| Microbiological characterization | Requirement NTE INEN 1673 | | Result |
|---|---|---|---|
| | m (good quality) | M (acceptable quality | |
| Mold count | $10^2$ | $10^2$ | 10 UFC/g |
| Yeast count | Non-specific | Non-specific | < 10 UFC/g |

For the microbiological characterization of quinoa pop, the reference values set forth in the INEN 1673 standard were used, where only the reference values of molds were specified, but not the reference values of yeasts. Comparing the results obtained with the reference values, it can be concluded that quinoa pop was free of mycotoxin-producing microorganisms, so it is suitable for consumption or for use as a raw material as used in this research (INEN, 1992b).

Flavoring quinoa pop

The flavoring of quinoa pop was made in the production area where the kitchen was used to melt the panela with the help of little oil so that there is a better adhesion of the panela with the quinoa pop, obtaining as a result quinoa pop flavored with panela. According to Fischer, the grains or seeds can be exposed to two types of flavoring being these sweet or salty, in the case of this work we opted for sweet flavoring where panela was used to fulfill this task since quinoa does not have a strong flavor that characterizes it so that this flavoring helped the quinoa pop to have a more characteristic and pleasant flavor for tasting (Eleonor Fischer, 2020).

Formulation

For the formulation of the energy bar, four formulations were developed where they only asked for variation in the amount of flavored quinoa pop and in the amount of nuts, so we proceeded to make four formulations resulting in four energy bars with different concentrations with regard to quinoa pop and nuts. Table 3-4 shows the amount of ingredients used for each formulation.

**Table 7. Energy Bar Formulations: Ingredients and Proportions**

| Ingredients | F1 g | F2 g | F3 g | F4 g |
|---|---|---|---|---|
| Pop Quinoa | 65 | 53 | 45 | 38 |
| Oat flakes | 25 | 27 | 29 | 28 |
| Nuts | 32 | 42 | 48 | 56 |

| | | | | |
|---|---|---|---|---|
| Grated coconut | 14 | 14 | 14 | 14 |
| Blueberries | 14 | 14 | 14 | 14 |
| Total | 150 | 150 | 150 | 150 |

The formulations were subjected to organoleptic characterization in the adult population. Table 4-4 details the formulation with greateracptación by consumers in this case the most acceptability was: the energy bar F1 which had oat flakes and walnuts.

**Table 8. Ideal formulation for the elaboration of the energy bar**

| Ingredients | Formula 1 (F1) | |
|---|---|---|
| | Quantity % | Quantity g |
| Pop Quinoa | 44 | 65 |
| Oat flakes | 16 | 25 |
| Nuts | 22 | 32 |
| Grated coconut | 9 | 14 |
| Blueberries | 9 | 14 |
| Total | 100 | 150 |

This acceptability was given because the ingredients used (quinoa pop, oat flakes, walnuts, grated coconut, blueberries, honey, impalpable sugar, glucose syrup) contributed considerably on the organoleptic characteristics, this information agrees with what Solís exposed, "energy bars are products composed of several elements of high nutritional value and are intended for people who perform physical activity or seek to enjoy a healthy bite and get energy" (Solís Reyes and Gonzalez Valdivia, 2019).

To find the ideal formulation of a product, optimization techniques must be applied, investigating how independent variables affect one or more dependent variables. Because of this, the methodology of the mixture design is suitable for innovative food products since they require a composition of key ingredients, being that the proportions of the ingredients in mixture and their levels depend on each other and the sum of all the components should always be 1 or 100% (Carvalho and Conti-Silva, 2018).

Elaboration

The energy bars were made in the area of the science laboratory to be developed in batches according to the following detail: from 450 g of the mixture of all the ingredients 18 bars of a unit weight of 34 grams were obtained.

1 Weighing the ingredients

For the weighing of the ingredients for each formulation of the energy bar, a balance and table 3-4 were used as a guide to the quantities

needed for each formulation, obtaining the quantities required to start with the elaboration of the energy bars.

2 Mixing of ingredients

After weighing the ingredients, they were placed in a container to proceed to mix them to obtain a homogeneous mass that would be placed in the molds. In the container was added 2 tablespoons of honey, 4 tablespoons of glucose syrup and 2 tablespoons and a half of impalpable sugar which were essential to obtain an adequate mass to proceed to place the mixture in the mold.

3 Baking the energy bar

The oven was preheated when the dough reached the right texture was placed in the different spaces of the mold to the edge of each space to continue to enter the mold in the oven for 20-25 minutes at a temperature of 120-130 ° C with constant review to obtain energy bars with attractive organoleptic characteristics.

4 Cooling of energy bars

When the proposed time was met, the mold was removed from the oven to place it on a cold surface to begin the cooling process for 20-25 minutes so that the energy bars are compacted thanks to honey and glucose syrup which are the main substances that at the time of being exposed to a sudden change in temperature will harden helping the ingredients to form a single product that would be energy bars.

## RESULTS

Tasting test or acceptability

The test that was applied was that of consumers through the descriptive analytical method in order to determine which is the formulation of greater acceptability, verifying if the product met the sensory profile. In addition to taking into account consumer preferences, the intention to purchase the product and whether there were any changes to be made to the product were also evaluated. In Table 5-4, the order of acceptability or preference of the energy bars can be observed.

**Table 9. Preference results of Energy bars**

| Formulations | Adults | Preference % |
|---|---|---|
| F1 | 23 | 54.51 |
| F2 | 8 | 19.2 |
| F3 | 7 | 18.2 |
| F4 | 6 | 13.2 |

The formulation of the energy bar that obtained greater preference was F1 with a preference percentage of 54.51%, this is because the quinoa

pop is present in greater quantity than the other ingredients giving an extra in appearance, texture, flavor, aroma and sweetness when removing the bar from the oven. Taking into account that these formulations were subjected to the same elaboration process, their organoleptic characteristics are similar.

According to Iuliano et al, the consumer test is an essential statistical method for determining the best formulation of a specific product since it is based on data collected from several participants, giving much more weight to the results that will be obtained when selecting the formulation with greater acceptability by the public (Iuliano et al., 2019).

**Table 10. Evaluation of the organoleptic characteristics of Energy bar formulations**

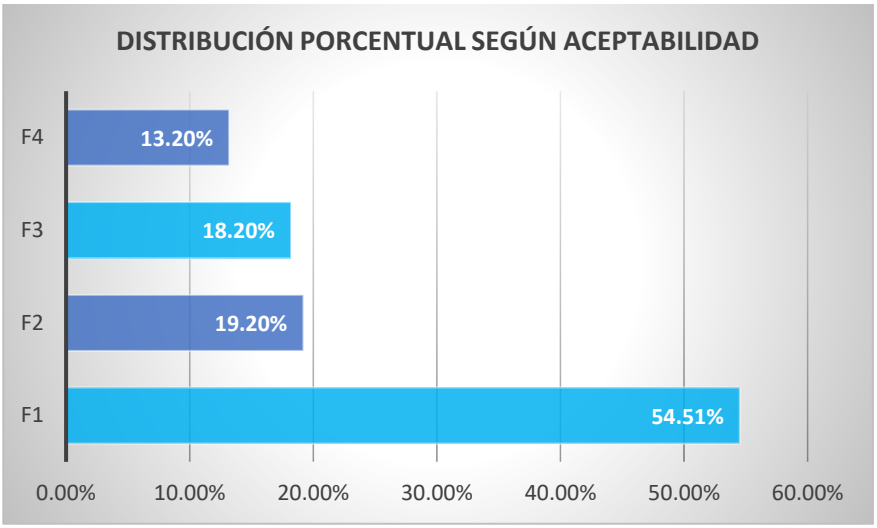
| Organoleptic characteristics | F1% | F2% | F3% | F4% |
|---|---|---|---|---|
| Acceptability | 54.51 | 19.20 | 18.20 | 13.20 |
| Texture | 55.45 | 11.40 | 23.55 | 9.60 |
| Taste | 56.75 | 10.65 | 15.65 | 16.95 |
| Aroma | 51.00 | 12.00 | 25.20 | 11.80 |
| Sweetness | 61.05 | 10.05 | 16.54 | 12.36 |

Table 10 details the evaluation of the organoleptic characteristics of the formulations tasted, which were discussed below.

1 Appearance or acceptability

According to Figure 6-4, 54.51% of consumers determined that the energy bar that had the highest amount of quinoa pop is the most striking due to its attractive color compared to the other formulations that have a lower amount of quinoa pop, but have more of other ingredients which prevented them from acquiring a color similar to F1 and thus not having a percentage of acceptability close to to that of the best formulation (F1). These results were obtained through the use of sight since according to Pérez, sensory evaluation helps to interpret responses of perceived products through the use of the senses such as sight, smell, touch, taste and hearing, being that for this organoleptic property the sense of sight was used (Severiano Pérez, 2019).

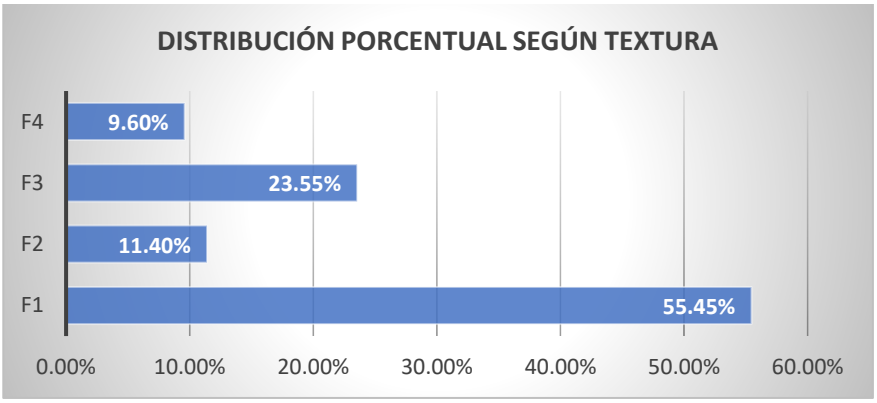
**Figure 12. Percentage of acceptance of the appearance of the formulations of the energy bar**




2 Texture

In Figure 7-4 it was determined that 55.45% of consumers chose F1 as the best formulation in relation to texture since they knew how to express that it had a greater crispness compared to the other formulations. The crispness is a fundamental characteristic for this type of products since it is the result of the reaction of starch at the time of being exposed to a heat treatment as exposed by Noguera and Gigante, "the modification by heat of the consistency of a food is linked to very diverse phenomena, mainly due to effects on proteins and polysaccharides." In this case it would be dextrinization which occurs when the starch is heated in a dry medium and at the time of caramelization it will harden and obtain a crispy or crunchy texture (Noguera and Gigante, 2018).

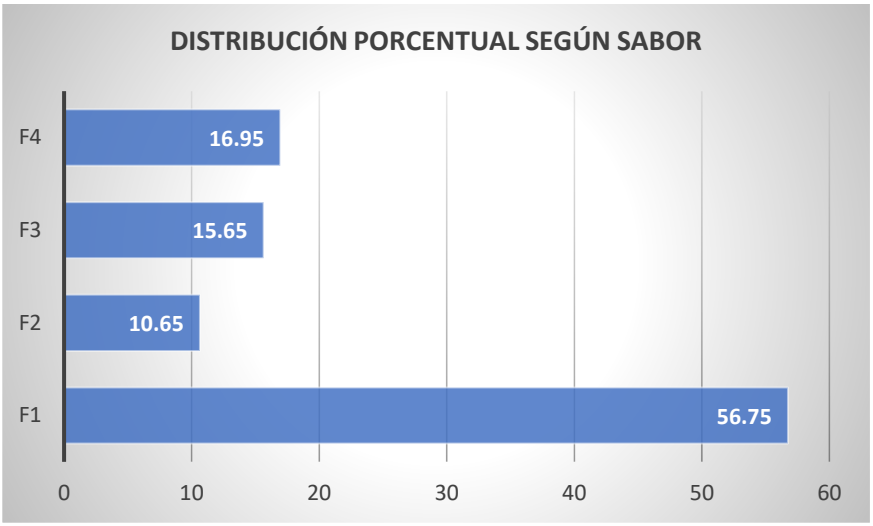
**Figure 13. Percentage of acceptance of the texture of the formulations of the energy bar**



3 Taste

In Figure 8-4, it was concluded that F1 has a very pleasant taste for the palate of consumers by 56.75%, since it is composed of a greater amount of flavored quinoa and nut pop, in addition to the fact that the flavor is intensified by a chemical browning reaction (caramelization and Maillard) where aromatic components are obtained as a product that will contribute to intensify both the taste and smell of the food to which it was exposed to this type of reactions corroborating what Preven System exposes, where it implies that the Maillard reaction gives organoleptic benefits to several foods giving them a different taste and smell compared to before being exposed to heat treatment (PS Formación S.L, 2019).

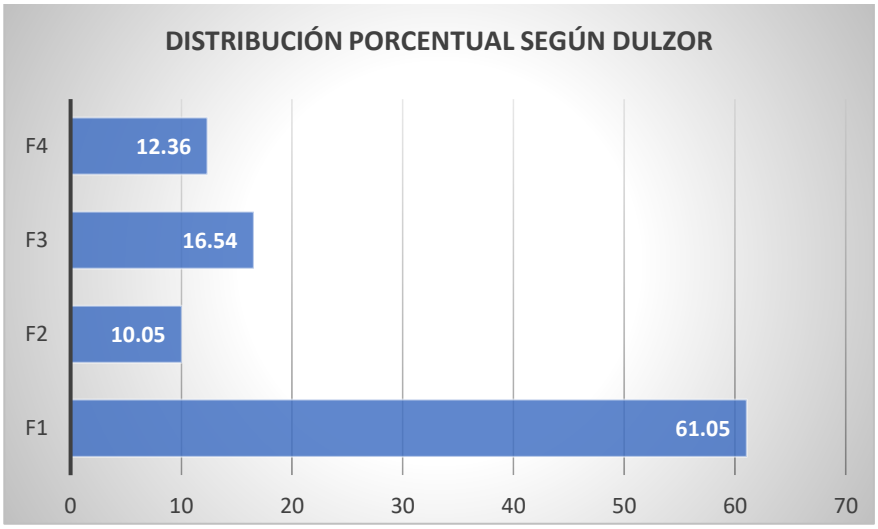
**Figure 14. Percentage of acceptance of the taste of the formulations of the energy bar**




4 Sweetness

In Figure 9-4, the adult population in 61.05% opted for F1 since this formulation contained a greater amount of flavored quinoa pop, walnut and a few more tablespoons of honey and glucose syrup which increased the sweetness of the energy bar taking into account that honey is composed of fructose, glucose, maltose, some sucrose and dextrins which gives a great plus to the energy bar at the time of being tasted, as expressed in Le Rucher de l'Ours (Le Rucher de l'Ours, 2018).

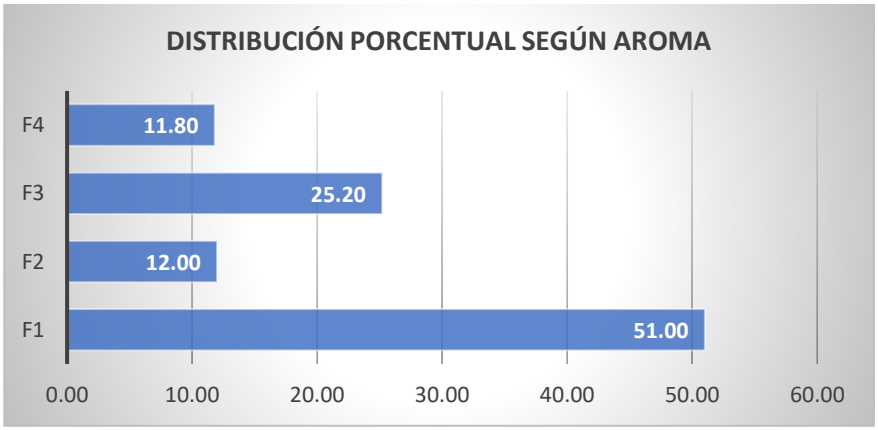
**Figure 15. Percentage of acceptance of the sweetness of the formulations of the energy bar**




5 Aroma

In Figure 10-4, F1 with 51.00% expressed that the aroma was pleasant to the sense of smell of the people who tasted the energy bar. When removing the energy bars from the oven, they emanate a characteristic sweet smell which occurs in the cooking process as a result of the reactions between proteins and sugars which is known as the Maillard reaction or also called browning reaction, this reaction helps to enhance the organoleptic properties of foods such as flavor, aroma and presentation of the food, coinciding with what Gómez expresses, where he says that the Maillard reaction is generally used in the pastry industry, snack preparation and meat and fish processing (Gómez, 2020).

**Figure 16. Percentage of acceptance of the aroma of the formulations of the energy bar**



Physicochemical analysis of energy bars

Although the ideal formulation for the energy bar was already determined through a consumer test, it was decided to carry out the physicochemical characterization of both the best formulation and the other formulations to have a better idea of why F1 was chosen as the best formulation. Table 7-4 details the data obtained by the physicochemical analyses for each of the formulations, helping to have a better criterion on the determination of the best formulation.

**Table 11. Physicochemical characterization of energy bar formulations**

| Physicochemical characterization | F1 % | F2 % | F3 % | F4 % |
|---|---|---|---|---|
| Humidity | 8.0 | 7.5 | 7.0 | 6.1 |
| Protein | 5.6 | 4.6 | 5.0 | 4.1 |
| Grease | 15.9 | 17.2 | 18.0 | 18.6 |
| Ash | 1.4 | 1.7 | 1.5 | 2.0 |
| Carbohydrates | 62.9 | 59.1 | 60.1 | 53.9 |
| Fibre | 3.6 | 3.0 | 3.4 | 2.9 |

The F1 was the formula that had an adequate balance of its characteristics which makes it a stable product in terms of nutrients, focused on the contribution of energy, complying with a large amount of carbohydrates, protein, fiber in relation to the other formulas.

Due to the presence of pseudocereal, oats and also nuts (walnut, blueberry, grated coconut) that were used during the preparation of this bar being that the chemical composition and nutritional value of plant foods can vary by genetic factors (variety and species) and environmental. Each of the ingredients mentioned above provide a lot of benefits such as quinoa that in addition to giving an energy contribution due to the presence of carbohydrates, proteins and fats, also helps people suffering from diabetes since it has a low glycemic index according to what was exposed by Kaur et al where they say that quinoa is one of the main foods for people who are intolerant to lactose and people suffering from celiac disease since quinoa is a food with a high nutritional profile and multifunctional characteristics such as providing a large amount of minerals and vitamins (Kaur et al., 2018).

Nuts are also essential for this type of products as they provide a large amount of fats, carbohydrates and minerals as well as help to have a better digestion due to the presence of fiber. Oatmeal is a cereal widely used and consumed by people because it provides a lot of energy and digestive benefits thanks to the presence of its high content of carbohydrates and fiber. Both honey and glucose syrup are essential for the energy bar since they are the main substances that help the product to compact with all the ingredients in addition to providing a large amount of carbohydrates.

Guided by the results obtained from the physicochemical analysis we can argue that the ideal formulation of the energy bar is within the parameters exposed by Licata where it expresses that the energy bars, generally, provide every 100 g: 60-80% carbohydrates, 3-24% fats and 4-15% proteins, implying that the energy bar made meets the standards of nutritional value for this type of food (Licata, 2019).

Taking into account the results of the physicochemical characterization of an energy bar of choco-quinoa carried out by Padmashree et al, it can be said that compared to the energy bar carried out in this research there is not a great difference between its main attributes being that they have similar values except for calories since F1 has 1753 kcal while the choco-quinoa energy bar only has 426.75 kcal (Padmashree et al., 2018).

1 Moisture Determination

According to the INEN 2595: 2011 standard of Granola requirements, it indicates that the percentage of humidity for this type of products should not exceed 10% so F1 with 8.0% humidity is within the reference value provided by the regulations, this means that the ideal formulation of the energy bar meets the amount of water sufficient to be consumed by the entire public (NTE INEN 278, 2006).

The results obtained agree with what Mayta, Danitza, Durán et al indicate that the water content of cereals and pseudocereals cannot exceed 14%; this factor is important because the energy bar was made with oats and quinoa, which are cereals and pseudocereals in addition to having nuts, which do not contribute a large amount of water to the final product (Mamani Mayta et al., 2017).

2 Protein determination

The ideal formulation (F1) of the energy bar presented an amount of protein of 5.6%, this is because the ingredients used for the preparation of the energy bar in addition to providing a large amount of carbohydrates also provided a small amount of amino acids, in this way the small percentage that was obtained for this product is explained. According to Prado et al, pseudocereals provide carbohydrates mainly but in second place are proteins since they provide amino acids and essential amino acids in balanced portions, these being of better quality than the proteins provided by cereals and as the product made in this research has as its main ingredient quinoa pop (pseudocereal) this also provides a number of amino acids apart from oats and nuts that also make a contribution to the amount of protein present in the final product (Prado et al., 2020).

According to some FAO recommendations, a 10-year-old student weighing approximately 30 kg should consume 0.91 g/kg/day, which is equivalent to 27.3 g of protein per day. An energy bar of 34 g would

provide 5.4 g of protein and considering a net protein unit (UPN) of 50, it would easily cover 7% of the complete protein needs of the child (FAO and WHO, 2007).

3 Fat determination

The fat content of F1 was 15.9% due to the ingredients that were used for the preparation of the energy bar such as quinoa (5% fat) and oats (6.7% fat) that do not have a great contribution in terms of lipids compared to nuts which are known to have significant amounts of lipids, this agrees with what was stated by Prado et al, since it states that pseudocereals such as quinoa can provide a little more lipids than some cereals such as rice, barley and rye contribute, being that quinoa can provide 4.9-6.8% of lipids, corroborating the percentage obtained of fats for the energy bar treated in this research (Prado et al., 2020).

According to Carvajal, fats are important biomolecules that have the characteristic of being a source of energy since for each gram of lipids generates 9 kcal, this is thanks to the proportions of carbon atoms that exist within the fats that make up food, in this case the ingredients that were used for the energy bar such as quinoa, oats, nuts, especially the latter being that they provide a significant amount of lipids and therefore a significant amount of kilocalories (Carvajal, 2019).

4 Determination of digestible carbohydrates

The percentage of carbohydrates obtained for the ideal formulation of the energy bar was 62.9%, this result was quite predictable being that the energy bars are recognized for providing a high caloric or energy value since these bars are composed in large percentage by carbohydrates, fats and proteins, but in much lower percentages than carbohydrates. The percentage obtained was not only thanks to the pseudocereal, cereal and nuts being honey and glucose syrup one of the main ingredients of the contributions of carbohydrates to the energy bar, since according to Le Rucher de l'Ours, only honey has fructose (38%), glucose (31%), maltose and sucrose (31%) supporting that the energy bar obtains large amounts of energy from the ingredients that were used in its elaboration (Le Rucher de l'Ours, 2018).

The large amount ofcarbohydrates found in quinoa have outstanding characteristics being that they reduce the hypoglycemic effects and help decrease free fatty acids having a high nutritional impact. Thanks to these characteristics, quinoa can be used in the production of several foods such as noodles, which can be made from quinoa flour that, not having a high gluten content, can obtain several products with a low gluten content for people with celiac disease or gluten intolerant (Hussain et al., 2021).

5 Fiber determination

The amount of fiber obtained from the ideal formulation (F1) of the energy bar was 3.6%, because the ingredients that "most" contribute to the amount of fiber is only oats and nuts while the other ingredients do provide fiber, but in very little quantity. These results agree with what was stated by Villanueva, since it indicates that fiber is present in several foods but in small amounts which are not enough to take effect in the human body but there are also other foods with a large amount of fiber such as some fruits and nuts that provide enough fiber for the human body to have a better digestion and in this way the intestine of the consumer is free of impurities (Villanueva Flores, 2019).

The fiber results of the energy bar were not very high because the ingredients used did not have high levels of fiber but in the case of wanting to increase the fiber levels of the energy bar you could use the peel and heart of the pineapple taking into account that these components of the pineapple have a high content of soluble fiber as insoluble (de Carvalho, 2011).

6 Determination of ash

The percentage obtained from F1 ashes was 1.4%, because the ingredients that constitute the energy bar when exposed to high temperatures organic compounds will degrade resulting in inorganic compounds soluble and insoluble in water and inorganic compounds soluble in acid medium. According to Mayta et al, products made from quinoa tend to have a percentage of ashes of 0.9-2.6% being that quinoa has a small contribution in terms of minerals but as in this research some ingredients were used that also provide minerals the percentage obtained is within the range that the authors exposed in their article (Mamani Mayta et al., 2017).

7 Calculation of energy input

Table 9-4 shows that F1 has an energy input of 1753.4 kJ (417.3 kcal) which was calculated using INEN 1334-2:2011 (Numeral 5.2). The energy bar reached this energy contribution thanks to the presence of carbohydrates and lipids that contain the ingredients used in its preparation, taking into account that carbohydrates and fats are those that provide a greater amount of calories because they are in a greater percentage in food (INEN 1334-2: 2011, 2011).

Carbohydrates are the biomolecules that provide the most energy since for each gram they provide 4 kcal in addition to Youdim, carbohydrates are a better source of energy than fats since their metabolism is much faster compared to the metabolism of fats that are much slower (Youdim, 2021).

Energy bars have many variations which serve as a replacement for several meals, which are aimed at satisfying the nutritional needs of

people suffering from diabetes, children and women. Taking into account all the ingredients that constitute the energy bars, their nutritional value will be one of the most important characteristics for this type of food in addition to the fact that other compounds can be added to give it an added value such as probiotics which help the digestion of consumers (Rawat and Darappa, 2015).

Microbiological analysis of the energy bar

Through the use of microbiological analysis it was possible to determine the sanitary quality of the energy bar, making use of the count of mesophilic aerobes, total coliforms, fecal coliforms and E. coli and the determination of molds and yeasts.

As there is no specific regulation for the product made, I rely on the INEN 2595: 2011 standard of Granola Requirements, which shares a great similarity with energy bars (NTE INEN 278, 2006).

**Table 12. Average content of microorganisms in the analyzed sample**

| Microorganisms | Reference values | | Values found |
|---|---|---|---|
| | m | M | |
| Mesophilic aerobes CFU/cm$^2$ | $10^4$ | $10^5$ | 2.1 x $10^2$ |
| Total coliforms NMP/cm$^2$ | 10 | $10^2$ | 0 |
| Faecal coliforms and E. coli NMP/cm$^2$ | 10 | $10^2$ | 0 |
| Yeasts and fungi CFU/cm$^2$ | $10^2$ | $10^3$ | 0 |

The count of mesophilic aerobic microorganisms (2.1x 10 2 CFU / cm2) is an acceptable value for this type of organisms and is within the range of the reference values indicated by the regulations, while in the results of total and fecal coliforms and E. coli, molds and yeasts was zero which indicates that there was absence of these organisms in the final product giving us to understand that the final product complies with the requirements established by the regulations that were used to check the sanitary quality of the energy bar being that it complies with the permissible index of good quality level (M) and the acceptable quality level (M). These results also corroborate that the energy bar was made under adequate sanitary conditions that comply with Good Manufacturing Practices (GMP) which guarantees that the product is suitable for the consumer to consume it without any concern for their health.

In the case of not applying BPH and GMP, both the raw material and the final product would be affected since at any stage of the product's elaboration it can be contaminated due to lack of health, especially

cereals and pseudocereals that must be conditioned in dry places being in this way how the humidity of the grains is controlled, this can prevent the growth of mycotoxin-producing fungi, as indicated by Elika (Elika, 2018).

According to the MSP, in food poisoning of human beings there are some pathogenic organisms that can cause various diseases with enteric, neurological symptoms or even in the worst case can cause cancer, it is for this reason that the correct handling of the raw material should be prioritized from its acquisition to the final stage of the elaboration of the product to avoid any type of contamination of the food (MSP, 2022).

Traffic lights of the final product

Table 13 shows the nutritional information of the ingredients in 100 g or 100 ml of each ingredient.

**Table 13. Nutritional information on 100g of ingredients**

| Ingredients | Calories kcal | Protein g | Fats g | Saturated fat g | Trans fat g | Monoinsaturada G | Poliinsaturada g | Carbohydrates g | Fiber g | Sodium mg | Sugar g |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Quinoa pop | 368 | 13.80 | 6.07 | 0.62 | 0.01 | 0 | - | 64.16 | 5.3 | 7 | 3.21 |
| Oat flakes | 389 | 16.9 | - | 1.2 | 0.01 | 2.2 | 2.5 | 66.3 | 10.6 | 2 | 0.8 |
| Nuts | 654 | 15.23 | 65.21 | 6.13 | 0.01 | 8.93 | 47.17 | 13.71 | 6.7 | 2 | 2.61 |
| Grated coconut | 354 | 3.3 | 33.5 | 29.7 | 0.01 | 1.4 | 0.4 | 15.2 | 9 | 20 | 6.2 |
| Blueberries | 57 | 0.7 | 0.3 | 0.1 | - | 0.1 | 0.1 | 14.5 | 2.4 | 1 | 9.5 |
| Honey | 304 | 0.4 | - | - | - | - | - | 82 | 0.2 | 4 | 82.0 |
| Glucose syrup | 286 | - | - | - | - | - | - | 78.9 | - | 3 | 30.1 |
| Panela molina | 383 | 0.4 | - | - | - | - | - | 97.2 | 0 | 21 | 94.2 |
| TOTAL | 2795 | 50.73 | 105.08 | 37.75 | 0-4 | 12.63 | 50.17 | 431.97 | 34.2 | 60 | 228.62 |

For the actual calculation of the nutritional information, another table (12-4) was prepared with the nutritional information of the ingredients used but this time with the amount that was used in the ideal formulation (F1) of this product, which will be essential for the realization of the graphic system of the final product or also known as nutritional traffic light.

**Table 14. Calculation of the nutritional declaration in relation to the amount used per ingredient**

| Ingredients | Quantity g | Calories kcal | Protein g | Fats g | Poliinsaturada g | Carbohydrates g | Fiber g | Sodium mg |
|---|---|---|---|---|---|---|---|---|
| Quinoa pop | 65 | 239.2 | 8.97 | 3.94 | - | 41.70 | 3.44 | 4.55 |
| Oat flakes | 25 | 97.25 | 4.22 | - | 0.62 | 16.57 | 2.65 | 0.5 |
| Nuts | 32 | 209.2 | 4.87 | 20.86 | 15.26 | 4.38 | 2.14 | 0.64 |
| Grated | 14 | 49.56 | 0.46 | 4.69 | 0.05 | 2.1 | 1.26 | 2.8 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| coconut | | | | | | | | |
| Blueberries | 14 | 7.98 | 0.098 | 0.04 | 0.01 | 2.03 | 0.33 | 0.14 |
| Honey | 10 | 30.4 | 0.04 | - | - | 8.2 | 0.02 | 0.4 |
| Glucose syrup | 5 | 14.3 | - | - | - | 3.94 | - | 0.15 |
| Panela molina | 5 | 19.15 | 0.02 | - | - | 4.86 | - | 1.05 |
| TOTAL | | 667.04 | 18.67 | 29.53 | 15.94 | 83.78 | 9.84 | 10.23 |

It is worth mentioning that the data obtained from the nutritional information for each ingredient may vary depending on the product used or brand.

With table 11-4 of nutritional information obtained, it was possible to carry out the nutritional traffic light, since the data of the nutritional table are indispensable because these data were compared with the reference values of resolution 14 511 of the INEN regulations, resulting in a product with a high level of sugar since the concentration in 100 g is above the 20 g established in the regulations with 228.62 g, the product has a high level of fat since the concentration in 100 g exceeds the 20 g established by the regulations with 100.9 g and as for the salt it has a low level since it is below 120 mg of sodium in 100 g of the product with 10.23 mg. All these data indicate that a product was obtained that fulfills its mission, which is to provide a large amount of energy and being a food supplement that can be consumed among the main meals of the day (INEN, 2014).

**Figure 16. Energy Bar Nutritional Traffic Light**


**Conclusions and recommendations**

• Of the four formulations developed, it was determined by a consumer test in which the adult population participated, it was determined that the best formulation of the energy bar was F1 since when performing the sensory analysis in which parameters such as flavor, texture, aroma,

sweetness and appearance were evaluated, this formulation was the highest scored, making the product attractive to the consumer.

• Regarding the physicochemical and microbiological characterization of quinoa pop was evaluated under the parameters of the NTE INEN 1673 obtaining 13% protein, 7.15% fat, 64.78% carbohydrates, 1.98% fiber, 9.82% moisture and 2.63% ash while in microbiological analysis resulted in mold count 10 CFU / g, that comply with the reference values that the regulations and the energy bar based on the NTE INEN 2595, results were obtained for protein (5.6%), fat (15.9%), carbohydrates (62.9%), fiber (3.6%), moisture (8.0%) and ash (1.4) and with respect to microbiological analysis: mesophilic aerobes were found 2.1x 10 2 CFU/cm2 , while in total coliforms, fecal and molds and yeasts there is no presence of these organisms, complying with the requirements requested, in the Standard, it is for what both the quinoa pop and the energy bar provide a large amount of energy due to the presence of carbohydrates, fats and proteins also comply with quality and safety for the consumer.

• Through the results obtained in the analysis of the energy bar, it was possible to design the graphic system of the final product exposing the values of fat, sugar and salt that make up the parameters of the graphic system, thus having a high concentration of sugar (red color), an average concentration of fat (yellow color) and low concentration in salt (green color), It should be noted that the raw material in the case of quinoa is organic.

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