



Preparation of snack with machica flour and nuts to combat malnutrition in Monte Sinai Educational Unit in Guayaquil-Ecuador

Elaboración de snack con harina de machica y frutos secos para combatir la desnutrición en Unidad Educativa Monte Sinaí Guayaquil-Ecuador

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Abstract

The purpose of this titling work is to prepare a snack with machica flour and nuts to combat malnutrition in vulnerable areas of Guayaquil-Monte Sinaí, being the main problem the lack of knowledge in giving the first nutritional collation, machica was included as an ingredient Main in snack making, these were distributed in the Monte Sinaí Guayaquil Educational Unit. Its methodological approach was based on the quantitative method, it was also directed under the experimental method where study tests were carried out on the selected products such as: machica flour and nuts (almond and walnut). The study population was composed of 95 children who start from 5-10 years of age, belonging to the Educational Unit already exposed. As a result, the initial general average weight of 17.2 ± 4.0323 was obtained. Putting into practice the proposal of this work (Snack of machica flour and dried fruits-balanced diet) new measures were taken in the current weight-size, where the data show that the average weight gained corresponds to $0.52173913 \pm 0.338626551$. Also, in what corresponds to the size, it is stated that the initial average size is 121.6195 ± 11.040 ; In consideration of the average size of the first month of the trial in terms of the proposal (biscuit of machica flour and nuts-balanced diet according to the requirements) it was evidenced that it is 122.54 ± 11.24 . As a result, it was concluded that the balanced diet and the nutritious cookie had a positive impact on children's nutrition

key words

Malnutrition, Snack, Flour, Dried Fruit, Healthy Food.

Resumen

El presente trabajo de titulación tiene como objetivo elaborar un snack con harina de machica y frutos secos para combatir la desnutrición en zona vulnerable de Guayaquil-Monte Sinaí, siendo el principal problema el desconocimiento en dar la primera colación nutritiva, se incluyó la machica como ingrediente principal en elaboración de snack, estas fueron distribuidas en la Unidad Educativa Monte Sinaí Guayaquil. Su enfoque metodológico se basó en el método cuantitativo, asimismo se direccionó bajo el método experimental donde se efectuaron pruebas de estudio en los productos seleccionados como son: harina de machica y frutos secos (almendra y nuez). La población de estudio estuvo compuesta por 95 niños que parten desde 5-10 años de edad, pertenecientes a la Unidad Educativa ya expuesta. Como resultado se obtuvo el peso promedio general inicial de $17,2 \pm 4,0323$. Poniendo en práctica la propuesta de este trabajo (Snack de harina machica y frutos secos-dieta balanceada) se tomaron nuevas medidas en el peso- talla actual, donde los datos exponen que peso promedio ganado corresponde a $0,52173913 \pm 0,338626551$. Así también en lo que corresponde a la talla se expone que la talla promedio inicial es de $121,6195 \pm 11,040$; en consideración con la talla promedio del primer mes de prueba en cuanto a la propuesta (galleta de harina machica y frutos secos-dieta balanceada según los requerimientos) se evidenció que es de $122,54 \pm 11,24$. Como resultado se pudo concluir que la dieta balanceada y la galleta nutritiva incidieron de manera positiva en la nutrición de los niños.

Palabras clave

Desnutrición, Snack, Harina de Machica, Frutos Secos, Alimentos Saludables.

1. Introduction

Snack

Nowadays, with the growing popularity of snacks and new food trends, the concept of "snack" is progressively changing. It has transitioned from being perceived as something unhealthy to having an image of a healthy product, ready to be consumed at any time and place. Thus, the habit of snacking between meals is becoming more common, even achieving the status of healthy eating [1].

According to Pineda, snacks are "a small amount of food, such as nuts, chips, or crackers, consumed as an accompaniment to a drink in a public establishment." In this sense, it is determined that snacks are foods that

people generally consume outside of main meal times, in public spaces, and over a short period of time [2].

Interest in consuming foods known as snacks has been increasing as the epidemic of overweight, obesity, and their undesirable effects continue to grow [3]. his form of eating has emerged on a large scale in recent years.

However, the components of many snacks available on the market have been evaluated because they cause obesity or are harmful to people with delicate health conditions, such as diabetics or those with high blood pressure. It is essential not to overlook these obesity-related problems and other diseases faced worldwide, as

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well as the growing concern among consumers to obtain healthier foods [4].

As daily life evolves, humans seek different types of food that generate processed foods. In this regard, global consumers spent \$347 billion on snacks annually between 2013 and 2014, an increase of 2% year-on-year, according to a new global report by Nielsen. While Europe (\$167 billion) and North America (\$124 billion) account for the largest share of global snack sales, annual sales are growing faster in the major developing regions. Asia-Pacific (\$46 billion) and Latin America (\$30 billion) increased by 4% and 9%, respectively, while sales in the Middle East/Africa (\$7 billion) rose by 5% [5].

Latin Americans lean more towards snacks that are entirely natural (64%), made with natural flavors (59%), high in fiber (58%), low in salt or sodium (52%), high in protein (51%), low in fat (50%), without or low in sugar (49%), and not genetically modified (49%). Additionally, the most appreciated flavor and texture attributes by Latin Americans are: tasty (74%), fresh (71%), and juicy (53%) [6].

Now, if it is true that consumers increasingly seek to combine nutritional quality with convenience in consumption, this is why healthy snacks are becoming a trend. This aspect is of great importance to the food industry, which must find a balance between taste and health, launching products that cover the inherent pleasure aspect of snacks, while at the same time not creating a feeling of guilt in the consumer. For this reason, vegetable snacks such as carrot or kale snacks, like Inspiral Kale-Os kale crisps with sweet chili and mint, can already be found on the market [7].

Barley

Barley (*Hordeum vulgare*), a member of the grass family, is an important cereal grain grown in temperate climates worldwide. It was one of the first grains to be cultivated, particularly in Eurasia as early as 10,000 years ago. Barley has been used as animal feed, as a source of fermentable material for beer and certain distilled beverages, and as a component of various healthy foods. It is used in soups and stews, and in barley bread from various cultures. Barley grains are commonly malted in a traditional and ancient method of preparation [8].

Machica is the main food of the population in the highlands, known as the food of the poor due to the simplicity of its production from ground barley flour. Barley is processed to obtain products such as:

- Maska or Hak: sifted toasted barley flour used for human consumption.

- Chanco: unsifted raw barley flour used in animal feed, especially for pigs.
- Phataspa: peeled, dried, ventilated, and stored barley.
- Pounded barley: obtained from Phataspa, subjected to cooking and drying.

Flour is the result of grinding cereals, nuts, or dried legumes into a fine powder. All have culinary uses and can be combined with wheat flour for fermentation and baking [9].

Description of Barley

Barley (*Hordeum vulgare*), a member of the grass family, is an important cereal grain grown in temperate climates worldwide. It was one of the first grains to be cultivated, particularly in Eurasia as early as 10,000 years ago [10] Barley has been used as animal feed, as a source of fermentable material for beer and certain distilled beverages, and as a component of various healthy foods.

It is used in soups and stews, and in barley bread from various cultures. Barley grains are commonly malted in a traditional and ancient method of preparation. According to the Food and Agriculture Organization of the United Nations, in 2016, barley ranked fourth among grains in terms of quantity produced (141 million tons), behind corn, rice, and wheat [11].

Taxonomy

The genus *Hordeum* consists of 25 species. The cultivated species are divided into three species, as described by Astudillo (2012):

- *Hordeum vulgare*: six-rowed with three fertile florets at each node of the rachis.
- *Hordeum distichum*: two-rowed with only the central row producing grain.
- *Hordeum irregulare*: the central florets are fertile and the lateral ones may be fertile, sterile, sexless, or absent, with their proportion distributed irregularly on the same spike [12].

Morphology of Barley

Barley is an annual plant that reaches 60–120 cm in height. Barley has two types of root systems: seminal and adventitious. According to abcagro.com (2015), the depth reached by the roots depends on the condition, texture, and structure of the soil, as well as temperature. The deepest roots are generally of seminal origin, and the upper soil layers tend to be compacted with adventitious roots that develop later. If the grain is planted deeply, a "rhizomatous stem" forms, which sheds leaves as it reaches the surface. The "rhizome" may have one or several internodes in length and may have adventitious roots. [13]



The stems are erect and composed of hollow, cylindrical internodes separated by nodes that carry the leaves. A mature barley plant consists of a central stem and 2–5 branch stems, called tillers. The apex of the main stem and each fertile tiller bears a spike. On or near the soil surface, the part of the stem that carries the leaf bases swells to form the crown. Adventitious roots and tillers develop from the crown.

Barley leaves are linear, 5 to 15 mm wide, and produced alternately on the stem. The leaf structure consists of the sheath, blade, auricles, and ligule. The sheath completely surrounds the stem. The ligule and auricles distinguish barley from other cereals because they are soft, encircle the stem, and may be pigmented with anthocyanins.

Reproductive Morphology

According to Cano & Moral, the barley inflorescence is known as the ear, head, or spike. The flowering units, called spikelets, are directly attached to the central axis or rachis, which is an extension of the stem supporting the spike. There are three spikelets at each node, called triplets, which alternate on opposite sides of the spike. Each spikelet consists of two glumes, which are empty bracts, and a floret that includes the lemma, palea, and enclosed reproductive components. Depending on the variety, each lemma extends as an awn or, more rarely, a Hood [14].

Sterile glumes in some varieties may also be awned. Awnless varieties are also known. In hulled or unhulled varieties, the palea and lemma adhere to the grain. In hullless or naked varieties, the palea and lemma are not attached and are separated from the grain during threshing.

Roots

Barley's seminal roots emerge when the seed germinates, forming a branched fibrous mass of roots, some of which extend deeply downward. Later, at the tillering stage, the adventitious root system emerges from the crown, tending to be thicker and less branched.

Under certain conditions, such as drought, adventitious roots may not develop at all. In other cases, seminal roots may cease functioning during the plant's life. Different barley varieties may vary significantly in root systems, affecting their competitive ability.

Leaves

After germination, the coleoptile (a leaf sheath enclosing the embryonic plant) reaches the surface, and the first leaf emerges from its tip. The leaves grow rolled up from the tube formed by the bases of the previous leaves and unroll once they emerge [15]. Leaves continuously

emerge on the main stem and tillers until the final leaf (flag) emerges.

The flag leaf is an important growth stage for timing the application of certain growth regulators. Mature leaves progressively senesce, and the entire plant gradually dries out until full maturity when the grain is ripe.

Stems and Tillers

Stem elongation usually begins when the plant is about 5 cm tall and coincides with leaf emergence, tillering, and spike formation [15]. During stem elongation, the developing spike is carried upward.

Nutritional Composition of Barley

Its composition is very similar to that of wheat, with the only difference being a lower percentage of protein, fewer carbohydrates, and the same amount of vitamin B1 and B2. It is rich in minerals such as zinc, and it provides various trace elements; however, it lacks calcium. It also provides a significant amount of fiber, essential for good intestinal transit, and offers a sense of satiety that is very useful in weight loss [16]

Barley Cultivation in Ecuador

Barley cultivated in Ecuador is the most significant. The province of Chimborazo records the largest area dedicated to its cultivation, followed by the province of Cotopaxi. A large portion of the barley cultivated in the indigenous communities of these two provinces is used for self-consumption.

It is consumed in a semi-ground form, prepared in soups, porridges, mixed with milk or water. The surplus is sold to generate economic income.

Machica

Machica, derived from the Quechua word "machka," is a traditional cereal from the highland region made from barley grain. It results from a post-harvest process that involves production, roasting, and grinding, ensuring that all elements (proteins, carbohydrates, vitamins, and minerals) are in harmony. The resulting flour is very fine, with a maximum consumption period of 6 months from the packaging date.

Machica can be consumed raw, boiled, or roasted, retaining its rich aroma and nutritional value. It is an ideal source of carbohydrates in the morning.

Barley flour (machica) contains proteins, iron, iodine, vitamins, calcium, phosphorus, potassium, magnesium, and, most importantly, fiber.

According to Diario El Expreso, machica flour is a viable consumption alternative since it can be used to prepare



porridge, soup bases, and the famous "chapo." It can be consumed raw, boiled, or roasted, retaining its rich toasted grain aroma, while maintaining its nutritional value in all three forms.

In addition to its flavor and aroma, machica possesses a high nutritional value, making it an ideal source of carbohydrates for breakfast..

Advantages of Consuming Machica

1. The nutritional benefits attributed to machica come from barley as its primary raw material. Some notable benefits include:
2. It develops a preventive effect on the cells of internal organs and the skin, which helps prevent cellular aging, thanks to its content of enzymes, vitamins, minerals, and proteins.
3. It helps maintain proper water balance in the body, preventing dehydration and fluid retention due to its mineral content.
4. It aids in maintaining a healthy body weight due to its contribution of complex carbohydrates.
5. It offers protection for women, due to its isoflavone content, which has the ability to act like estrogen.
6. It benefits growth and improves the immune system due to its zinc content. In bodybuilding, zinc helps stimulate muscle growth.
7. It safeguards heart health, thanks to its low-fat content and its essential fatty acids, vitamins, minerals, and fiber.
8. It benefits intestinal function.
9. It helps control blood sugar levels (glycemia), which is essential for people with conditions like diabetes and overweight issues. [17]

For all these reasons, it is recommended that people consume it as part of a healthy diet, with at least 3 servings (90g) per day of whole grains like machica and the rich pinol from Salcedo to improve their mental and physical conditions.

Nutritional Characteristics of Nuts

1. They contain less than 50% water, have a low carbohydrate content (except for chestnuts), and are rich in proteins (10-30%) and fats (30-60%), particularly monounsaturated and polyunsaturated fatty acids.
2. Walnuts contain omega-3 fatty acids, which are precursors of DHA and EPA.
3. They present easily absorbable minerals, such as potassium, calcium, phosphorus, iron, and magnesium.
4. Their vitamin content is low, except for vitamin A. They contain variable amounts of thiamine, riboflavin, and niacin.

5. They are rich in insoluble fiber, iron, calcium, magnesium, folic acid, vitamins E and B1.
6. They also contain phytosterols and other phytochemicals.
7. Some nuts, like walnuts, have been shown to reduce heart disease by helping improve blood vessel elasticity

2. Materials and Methods

Snack (Cookies) Regulations

The INEN Standard NTE INEN 3084 2015 defines any dry bakery and pastry mix as a snack made from cereal derivatives, food additives, and other ingredients suitable for human consumption. These must meet requirements for market commercialization, such as moisture content in the case of physical-chemical aspects, and must comply with microbiological parameters such as Salmonella, E. coli, yeast, and mold. Additionally, they must comply with labeling as specified in the NTE INEN 1334-1 standard.

According to the Health, Work, and Environment Program in Central America (SALTRA) (2014), anthropometric and functional characteristics of individuals are important determinants of ergonomic conditions. Therefore, anthropometric studies must represent specific populations. These population characteristics are fundamental for establishing normative databases that allow for appropriate decision-making regarding parameters for the design of ergonomic work system.[18].

In this study, anthropometric records were taken, where weight, height, and body measurements were controlled. The body perimeter (head) was measured accurately due to its significant contribution to research development. These measurements were taken from children at the Monte Sinai Educational Unit, and will later be analyzed to meet the objective of determining the anthropometric and nutritional values of the children in this institution.

Equipment Used:

Among the kitchen equipment used are;

- Oven
- Electric mixer
- Scale

Kitchen Utensils

- Silicone spatula
- Bowl
- Baking sheet

Values of Physical-Chemical Tests



Table 1
Values of Physical-Chemical Tests

Physical-Chemical Tests	Units	Values	Environmental Conditions	Method	Observations
Proteins	g/100g	6,40	25 °C	PEE/LA-IIT-UG/07	-
Fat	g/100g	24,22	25 °C	PEE/LA-IIT-UG/08	-
Moisture	g/100g	4,20	25 °C	PEE/LA-IIT-UG/05	-
Ash	g/100g	1,72	25 °C	PEE/LA-IIT-UG/10	-
Carbohydrates	g/100g	63,46	-	Diferencia	-
Energy	g/100g	497,40	-	Cálculo	-

Source: Laboratorio LA-IIT-UG, 2019.

Data Analysis

Table 2
Population Age

Age	Frequency	
	Population	Percentage
5 years	9	10%
6 years	14	15%
7 years	31	34%
8 years	5	5%
9 years	11	12%
10 years	22	24%
TOTAL	92	100%

In analyzing the age distribution of the children at Monte Sinaí Educational Unit, it was evident that a significant percentage, 34%, corresponded to 7-year-old students. This age group is in a physical development stage marked by changes in weight and height, which should increase at a steady rate. This was followed by 10-year-olds, representing 24%, a period characterized by the onset of puberty. A smaller percentage includes 6-year-olds, marked by the loss of baby teeth and a consistent increase in weight and height. Similarly, 9-year-olds made up 12%, 5-year-olds 10%, and 8-year-olds 5%.

Table 3
Population Gender

Gender	Frequency	
	Population	Percentage
Female	45	49%
Male	47	51%
TOTAL	92	100%

Regarding the gender of the study population, it was determined that 51% are male (boys), while 49% are female (girls).

Table 4
Initial Weight Distribution

Initial Weight	Frequency	
	Population	Percentage
12 kg-20 kg	39	42%
21kg - 25 kg	24	26%
26kg- 30 kg	12	13%
31 kg- 35 kg	9	10%
36 kg- 40 kg	2	2%
41 kg- 45 kg	3	3%
50 kg-56 kg	3	3%
TOTAL	92	100%

In analyzing the initial weight distribution, it was found that the general average was 17.2 ± 4.0323 , with most children weighing between 12 kg and 20 kg.

Table 5
Nutritional Diagnosis

Nutritional Diagnosis	Frequency	
	Population	Percentage
Mild Malnutrition	38	41%
Moderate Malnutrition	29	32%
Severe Malnutrition	0	0%
Obesity	7	8%
Eutrophic Weight	18	20%
TOTAL	92	100%

From the data analyzed, with an initial general average weight of 17.2 ± 4.0323 , it was determined that the nutritional diagnosis of the students at Monte Sinaí Educational Unit primarily indicated mild malnutrition, affecting 41% of the children. This is reflected in a

normal weight, but with a height lower than what is expected for their age. This was followed by moderate malnutrition, affecting 32% of the children, characterized by a lower-than-expected weight for their height. In contrast, 20% of the study population had eutrophic weight (when weight/height and height/age are within normal parameters), and 8% were obese.

Table 6
Height Diagnosis

Height	Frequency	
	Population	Percentage
Acute High Stature	57	62%
Chronic Short Stature	35	38%
TOTAL	92	100%

Regarding the height diagnosis, it was found that the study population primarily had acute high stature, characterized by a normal height appropriate for their age, representing 62%. On the other hand, chronic short stature, characterized by a height lower than expected for their weight and age, was found in 38% of the children

3. Results

Ingredients for Cookies

Table 7.
Ingredients for Cookies

Ingredients	Quantity
Butter	125g
White Sugar	100g
Almonds	150g
Brown Sugar	100g
Eggs	1 unit
Vanilla Essence	5ml
Flour	5g
Machica	200g

3.2 Flow Diagram



Figure 1. Flow Diagram

3.3 Description of Critical Control Points: Reception and Selection of Raw Materials

At this stage, a critical control point is identified, as the delivery of the product may contain microorganisms or foreign materials. The moisture content must be controlled to not exceed 14%, and impurities should not exceed 1%. Therefore, it is recommended to sift the flour lightly before use to remove any impurities..

3.3.1 Preparation and Cooling

In this stage of the process, it is essential to ensure that the product reaches an approximate temperature of 30°C, either at room temperature or with the help of fans before packaging. If not properly cooled, moisture may develop inside the packaging, leading to the growth of microorganisms in the product.

3.3.2 Packaging

This process must be carefully managed, with the product being packaged in appropriate materials such as polyethylene bags, depending on the product size. Finally, the packaging should be sealed properly and inspected before being delivered to the public..

3.4 Description of the Cookie-Making Process

- **Reception and Selection of Raw Materials:** During the reception of raw materials, the supplier must ensure the highest possible quality, complying with hygiene standards and providing a quality certificate for the product, as well as adhering to the required quality control procedures.
- **Mise en Place:** Proceed to separate, weigh, and prepare all the ingredients.
- **Mixing and Product Preparation:** Mix the butter with the sugar (creaming), add the egg and vanilla essence, mix well until fully integrated. Then proceed to add all the dry ingredients, including the nuts (almonds or walnuts), and mix until the dough is homogeneous. Chill in the refrigerator for about an hour, shape into cookies, and bake.
- **Baking:** Bake in the oven at 180°C for 10 minutes.
- **Preparation and Cooling:** After removing the cookies from the oven, place them in a dry container and let them cool for about 5 minutes.
- **Packaging:** Place them in hygienically prepared bags ready for delivery..

3.5 Recipe Book

Table 8.
Ingredients

N°	Ingredients	Quantity	Unit
1	Butter	125	g
2	White Sugar	100	g
3	Almonds	150	g
4	Brown Sugar	100	g
5	Eggs	1	u
6	Vanilla Essence	5	ml
7	Flour	5	g
8	Machica	200	g



Figure 2. Cookies Made with Machica Flour and Nuts

3.6 Preparation

Add the butter and sugar (creaming), then add the egg and essence, mixing well until fully integrated. Add the dry ingredients, including the flour, machica, and nuts, and mix with folding movements until the dough is homogeneous. Chill in the refrigerator for about an hour, then shape and bake at 180°C for 10 minutes.

3.6.1 Recipe: Costing

Table 9.
Recipe Book

Ingredients	Unit	Quantity	Unit Cost	Total Cost
Butter	Kg	0,125	\$12,00	\$1,50
White Sugar	Kg	0,100	\$0,86	\$0,09
Almonds	Kg	0,150	\$8,00	\$1,20
Brown Sugar	Kg	0,100	\$1,00	\$0,10
Eggs	Unidad	1	\$0,15	\$0,15
Vanilla Essence	ml	0,005	\$12,54	\$0,06
Flour	Kg	0,050	\$1,10	\$0,06
Machica	kg	0,200	\$1,10	\$0,22
			Net Cost	\$3,38
			10% Miscellaneous	\$0,34
			Total Cost	\$3,72
			Cost per Pax	\$0,12

3.5 Complementary Diet

This complementary diet will allow children to grow and develop normally both physically and intellectually. It is based on growth factors, school and social physical activity. Consequently, a school lunch should contain nutritious, high-quality foods that are selected and prepared with proper hygiene at home. Below is an example of a school snack that a student should have..

- Sandwiches: Made with cheese, butter, mortadella, beef, chicken, sausage, among others.
- Flours: Accompanied by jams, figs, cookies, beans, corn, and lupini beans.
- Fruits: Tangerine, apple, pear, banana, papaya, yellow carrot, kiwi, watermelon, among others.

Meals should be consumed at least 5 times a day, distributed as follows:

- Breakfast: Should be complemented with highly nutritious foods such as milk, eggs, natural fruit juices, bread, tortillas, or cookies.



- Snack or Lunch: Can be given at 10 a.m. and in the afternoon at 5 p.m. with nutritious and easy-to-prepare foods.
- Lunch: Should include nutritious foods such as meat, chicken, fish, cereals (rice, quinoa, oats, barley), dried legumes (beans, lentils, peas, chickpeas), vegetables (carrots, Swiss chard, spinach, broccoli), and fruits (banana, orange, tangerines, apples), along with butter or cheese, which are animal fats.
- Dinner: Should be moderate and include highly nutritious foods.

3.5.1 Balanced or Equilibrated Diet Focused on a School Menu

Table 10.

Balanced or Equilibrated Diet

Meals	Portions	Foods
Breakfast	1	Bowl of oatmeal with milk
	1	Bread with butter and cheese
	1	Glass of fruit juice
Snack	1	Portion of popcorn
	1	Glass of juice or fruit portions
Lunch	1	Vegetable soup; corn, spinach, lentils, carrots, peas, etc.
	1	Rice with beans
	1	Protein portion (beef, chicken, fish)
Snack	1	Porción de frutas
Dinner	1	Soup
	1	Carbohydrates and legumes (salads)
	1	Protein portion (beef, chicken, fish)
	1	Cereal porridge with milk

3.5.2 Distribution of Daily Portions

Table 11.

Distribution of Daily Portions

Food	Portions
Cow's milk	2 glasses per day
Proteins (chicken, fish, meat)	2 portions per day
Eggs	1 portion per day
Legumes (peas, lentils, beans, chickpeas)	1 portion per day

Carbohydrates (rice, bread, potato, yuca, plantain)	2 portions per day
Cereals (oats, barley, machica, cornstarch)	2 glasses per day (optional with milk)

3.6 Analysis

According to the results obtained in this research, 41% of the evaluated children had a degree of malnutrition (mild). Therefore, it was deemed necessary to implement a snack (cookie) made from machica flour and nuts, with the purpose of contributing to and improving their diet. The best way to achieve a healthy diet is through the consumption of traditional and nutritious products such as machica flour, a fundamental food that contains nutritional values like vitamins A, B12, C, D, E, phosphorus, among others, which contribute to the physical and mental growth of students, as well as improving their immune system.

Through this snack (cookie) along with a balanced diet, it has been possible to implement better daily nutrition for school-aged children (5-10 years), obtaining significant results in their initial weight and, to a lesser extent, their height, which shows less significant changes due to genetic factors..

4. Conclusions

- The nutritional values of machica flour and nuts were theoretically established, as they contain essential nutrients such as vitamins A, B12, C, D, E, phosphorus. Additionally, in the physical-chemical tests, a high content of energy and carbohydrates was found, along with nuts being rich in proteins (10-30%), which help children perform better throughout the school day. This also serves as a supplement to their nutritional plan, which was added to this proposal to assist in their nutrition.
- The anthropometry or nutritional assessment at the beginning and end of the school year was determined for the children, yielding results of 62% corresponding to acute tall stature, while 42% of the population had an average initial weight of 17.2 ± 4.0323 kg. Furthermore, the nutritional diagnosis showed that 41% of the children had a mild degree of malnutrition. Regarding the results at the end of the school year, the children gained an average of 1 kg (within one month), with an average weight gain of 0.52173913 ± 0.338 kg, by implementing the proposal of this thesis (machica flour and nuts cookie—balanced diet according to the requirements).
- Lastly, a snack made from machica flour and nuts was developed with the aim of improving the nutritional status of school-aged children (5-10 years

old). Each 20 g portion provides energy (497.40 cal/100g), carbohydrates (63.46g/100g), and proteins (6.40g/100g), contributing to their nutritional balance. Therefore, the product is of great benefit for children throughout their school years and growth, particularly in improving and preventing their nutritional status.1.

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5. Appendices



Appendix 1. Mixing and Product Preparation



Appendix 2. Packaging



Appendix 3. Baking



Appendix 4. Preparation and Cooling