NUTRITIONAL BAR BASED ON COCOA (Theobroma cacao L.) WITH NATURAL AGGLUTINANTS WITH NO ADDED SUGARS

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Abstract

Cereal or nutritional bars are prepared products that can contain many nutrients, besides being very useful when there is little time to prepare something more elaborated (Aldaz & Tantaleán, 2019). This research's objective was to prepare a nutritional bar made from cocoa (Theobroma cacao L.) using natural binders for food use, such as bee honey and mucilage honey. A completely randomized design was applied, resulting in eight treatments and six replicates. The sensory analysis was carried out with the different formulations by employing an acceptability test with a hedonic scale for semi-trained judges. To determine differences between means of the physicochemical analysis, the Tukey test was used (p ≤0.05). Furthermore, the nonparametric Kruskal Wallis test was applied to the sensory analysis, which resulted in T6 (cocoa 40% and mucilage honey 20%) as the best treatment, the microbiological analysis was performed on treatment T6 after five days of having made the product and it complies with the INEN 2085:2005 Standard for cookies or baked products, which indicates that it is suitable for human consumption. The economic analysis of the nutritional bars indicated that T6 in the 120g presentation had a production cost of $ 3.95 cts.

Keywords: food, acceptability, functional, functional, nutritional.

INTRODUCTION

Cereal bars, in particular, provide nutrients for daily activity and are the ideal snack to replace traditional sweets and candy bars are a dietary supplement with high fiber content, among other virtues, which keeps the intestine clean, prevents anemia and benefits the heart. (Alvarez, 2017). The ingredients of the nutritional bars vary depending on the proposed purpose: energetic, hydrocarbon or protein. (Reina, Moreno, Mendoza, Parra, & Reyna) Under this concept, cocoa can be used to enhance its characteristics; there is a growing demand for nuts for their high nutritional and functional value, as numerous studies show that their consumption reduces the risk of cardiovascular disease (Aquino et al., 2019). The raw materials used in the elaboration of cereal bars are rich sources of omega 3 and omega 6 essential oils, which the body needs and cannot synthesize by itself. Although functional foods can be found in the environment, they have limited alternatives and satisfy specific needs, such as cereal bars, and few take advantage of the nutritional quality of healthy and functional foods with good nutritional value. (Olivera et al., 2012) Currently, no nutritional bar contains natural binders and is adapted to the context of the environment, i.e., to the physiological and especially economic needs of the person who wants to acquire it. The few options that exist in the market, the rate of acceptability is quite low, they are focused on being protein bars and a large amount of this nutrient is added to them, affecting the acceptance by the public. On the other hand, if they do not have a high protein content, these bars have a high content of added sugars and artificial substances that ultimately alter the nutritional purpose of the product.

Therefore, natural binders (bee honey, mucilage honey) are an alternative for efficient use in elaborating nutritional bars and to develop much healthier formulations with good nutritional and organoleptic characteristics, without added sugars.
MATERIALS AND METHODS

Study area

The research was carried out in the Bromatology Laboratory of the Experimental Farm "La María", property of the State Technical University of Quevedo, located at km 7½ of the Quevedo-El Empalme road, Reto. San Felipe, Cantón Mocache, Province of Los Ríos.

Sampling

The research was carried out by collecting 3,000 cocoa cobs, which were placed in plastic tubs for transportation and conservation, then transported to the laboratories located at the State Technical University of Quevedo, where the separation of almonds, mucilage and placenta was carried out, using preliminary treatments to work with the by-products.

Research design

A Completely Randomized Design (CRD) was applied in the present investigation, with 8 treatments and 6 replicates. Tukey's test was used to determine differences between means in the physicochemical analysis (p≤0.05). In addition, the best treatment was chosen for the sensory results using the Kruskall Wallis nonparametric analysis.

Mathematical model.

The sources of variation for this research were performed with the following linear model of experimentation:

\[ Y_{ijk} = \overline{Y} + T_i + E_{ij} \]

Where:

- \( Y_{ijl} \) = Experimental unit observation
- \( \overline{Y} \) = Average per observation
- \( T_i \) = Effect of treatments under study
- \( E_{ij} \) = Experimental error

Description of the manufacturing process of the nutritional bars.

Reception: the authors proceeded to select all the ingredients involved in making the nutritional bars.

Weighing: all the ingredients were weighed in detail, including the nuts for the respective preparation of the bars.

Precooking: all nuts were selected and roasted at a temperature of 30°C for 10 minutes.

Dosage: in this method, the percentage of natural binders is applied (mucilage honey, bee honey).
Mixing: all ingredients were mixed and heated at a temperature of 30°C for about 5 minutes.

Molding: after mixing, all the ingredients were placed in the mold, giving it the respective shape of a 30cm x 5cm bar.

Baking: it was baked at a temperature of 120°C for 15 minutes to give it a golden and crunchy consistency.

Cooling: at this stage, it was left at a temperature of 28°C for 15 minutes.

Packaging: the proper packaging of nutritional bars in sealed bags was incorporated.

Storage: store at 28°C, keep in a cool and dry place.

RESULTS

Results of the physicochemical analysis of the nutritional bars.

Humidity.

Through the analysis of variance, it is observed that there are significant differences between treatments in the moisture variable, with the highest percentage of moisture found in T4 and T5 with a value of 9.53 and 9.94 %, while the lowest value was recorded in T2 with a value of 7.47 %. All treatments are within the percentage established in NORMA INEN 2085, in which the maximum moisture value is 10 %.

pH.

The analysis of variance in the pH variable showed significant differences. T2 recorded the highest value with 6.71, followed by T1 and T4 with values of 6.49 and 6.55 respectively and T8 has a value of 5.68 % values that are within the range established in the INEN 2085 NORM, which indicates that the pH value min is 5.5 % and max. of 9.5 % while T5 and T7 do not comply with the stipulated standard.

Acidity

The highest percentage was recorded by treatment T3, followed by treatments T4 with 0.21 % and T6 with 0.22 %. On the other hand, T5 obtained the lowest value with 0.16 %, which shows significant differences.

Fiber

The highest percentage was recorded by treatment T6 with 15%, followed by treatments T3 with 12% and T7 with 11%. On the other hand, T5 obtained the lowest value with 8%, which shows significant differences.

Protein.

Through the analysis of variance, it is observed that there are significant differences between treatments in the protein variable, with the highest percentage in T3 and T4 with a value of 4.32%, while the lowest value was recorded in T7 with a value of 3.81%. All treatments are within the percentage established in INEN STANDARD 2085, with a minimum value of 3%.

Results of the sensory analysis of the nutritional bars.

The flavor, texture, color, odor, and acceptability of the nutritional bars were analyzed in the sensory analysis.
With the data obtained in the Kruskal Wallis test, for the flavor parameter, it is observed that the best treatment is T6, with a value of 3.75. Followed by treatments T7 and T5 with a value of 3.25, the lowest treatment is T1 with a value of 2.50.

In the aspect of texture, T1 has the best value of 3.60, followed by T4 and T2 which have similar results 3.40 and 3.30, respectively, T6 and T8 also present similar values 3.15 and 3.10, respectively, the treatment with the lowest result is T5 with a value of 2.90.

In the acceptability attribute, the most liked treatment is T6 with a value of 3.10, while treatments T3 and T7 do not have a significant difference with a value of 3.30 and 3.15, respectively, T2 with a value of 3.10 and treatments 5 and 6 are the least liked with the following values 2.85 and 2.75 respectively.

Results of microbiological analysis at the best treatment.

The microbiological analyses on the best treatment gave the following results. For molds and yeasts, the best treatment (T6) gave a value of UFC/g. While for E. coli, it presented an Absence, the humidity content allowed to prove that there is little quantity of microorganisms, which is similar to Morejón (37), in his research indicates that for molds and yeasts, it presented 8 x 10 CFU/g.

Ecuador does not have an INEN Standard that dictates the requirements that must be met for the preparation of nutritional bars; for this reason, INEN Standard 2085: 2005 for cookies or baked goods has been taken into account, which indicates a minimum acceptance value of 1.0 x \(10\)^2 and a maximum of 2.0 x \(10\)^2 for molds and yeasts; therefore, the bars prepared are within the range established by INEN Standard 2085.

Production cost results to the best treatment.

Prime cost: The prime cost was calculated by adding the direct raw material costs.

\[ CP = MPD + MOD \]
\[ CP = (0.33 + 0.03 + 0.01 + 0.01 + 0.02 + 0.05 + 0.15 + 0.15) + 2.00 \]
\[ CP = 2.75 \]

Conversion cost: The conversion cost is the sum of direct labor (operator) and indirect manufacturing costs (protective equipment).

\[ CC = MOD + CIF \]
\[ CC = 2 + (0.50 + 0.20 + 0.10 + 0.30 + 0.10) \]
\[ CC = 3.2 \]

Cost of production: Production costs was calculated with the sum of direct raw material costs, direct labor and indirect manufacturing cost.

\[ CP = MPD + MOD + CIF \]
\[ CP = 0.75 + 2.00 + 1.2 \]
\[ CP = 3.95 \]
Total cost: obtained from the sum of production costs (direct labor, direct raw material and indirect manufacturing cost).

\[ CT = CP + CD \]

CT = 3.95

Selling price: The selling price, was calculated with the total cost plus the profit percentage, in this case it was 15%.

\[ PV = CT + \text{PROFIT } 15\% \]

PV = 3.95 + 0.59

PV = 4.54

The cost of production at the best treatment T4, with a weight of 120 g, is $2.75 ctvs. Therefore, a selling price of $3.95 was added to a profit of 15%. This results in a unit selling price of $4.54.

DISCUSSION

The data obtained on morphological parameters coincide with that reported by, (Tramujas J, 2017), in their research on evaluating the nutritional and lipid quality of salted cereal bars with different binders obtained values from 5.80 % to 9.69 % moisture. While in their research on (Reina, Moreno, Mendoza, Parra, & Reyna) in its research on levels of bee honey in the elaboration of energy bars with pollen as a functional food obtained higher values between 9.52 and 12.45 % of humidity.

The researcher (Reina, Moreno, Mendoza, Parra, & Reyna) in her research on levels of bee honey in the elaboration of energy bars with pollen as a functional food, obtained values from 4.99 % to 5.51 % in pH. These data are similar to those obtained by (Baez & Borja, 2013). The results of the elaboration of an energy bar based on Sacha Inchi as a source of omega 3 and 6 were 5.32 %. According to Barreiro and Sandoval (Barreiro & Sandoval), pathogenic microorganisms develop at a pH close to neutrality between 6 and 7; molds can tolerate low pH and yeasts can grow at intermediate pH.

CONCLUSIONS

In the sensory analysis applied to the cocoa nutritional bars, with the addition of natural binders, the best treatment was T6 4 (cocoa 40% and mucilage honey 20%), which obtained greater acceptability in texture, flavor and odor.

According to the results obtained in the physical-chemical analyses, the moisture in all treatments complies with INEN Standard 2085:2005, and for pH, treatments T1, T2, T3 and T4 comply with the ranges allowed by the same standard.

The microbiological analyses applied to the nutritional bar 5 days after its preparation concluded that the T6 complies with INEN Standard 2085:2005 for cookies or baked products, which indicates that it is fit for human consumption.
The economic analysis of the nutritional bars indicated that the T6 in the 120g presentation had a production cost of $3.95, it is concluded that each 30g bar will have a cost of $0.99 ctvs per unit.

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