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Research Article

# Conservation of the Natural Characteristics of the Cocoa Paste (*Theobroma cacao* L.) in Ecuador Using the Grinding and Toasting Methods

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**ABSTRACT**
Ecuador has been characterized as one of the pioneers in the recovery and cultivation of fine aroma cocoa, for which, two methods of grinding and roasting (traditional and semi-industrial) were tested applying a complete random design with a 2x2x3 factorial arrangement. Weight, pH and moisture analyzes were performed on the raw material. After obtaining the cocoa paste, analyzes were made of: weight, pH and sensory evaluation, as well as, measurement of bromatological parameters of moisture, total ash and fat in the best treatment. In the raw material, the results were within the allowed, in the pH and weight analyzes of the cocoa paste, there was no significant statistical difference between treatments. On the other hand, in the sensory analysis, treatment 4 (method of "semi-industrial grinding and roasting") presented greater acceptance by the tasters, selecting this as the best. The results obtained in the bromatological analysis were within the allowed parameters.

**Keywords:** Natural characteristics, cocoa, ground, toasted.

## INTRODUCTION

The cocoa, receives the scientific name of *Theobroma cacao* L "food of the gods" belongs to the family *Sterculiaceae* and is the only species of the genus *Theobroma* that is commercially exploited. The cacao tree, or cocoa tree, is a perennial plant that yields several harvests per year, from which its almonds are commercialized[1]. It began to be cultivated in America, where it was already a basic product in some cultures before the arrival of the Spaniards. The Aztecs believed that the god "Quetzalcoatl" had taught the cultivation of this species to their ancestors, so that, many times, cocoa seeds were used as currency in commercial transactions[2].

The cocoa comes from the tropical regions of Mexico and Central America, although in the sixteenth century it was introduced in Africa, which is where most is grown today. Currently, in American Continent the cocoa is grown mainly in Brazil, Ecuador, Mexico, Colombia, Venezuela and Dominican Republic[3]. The cacao tree reaches an average height of 6 m and has glossy leaves up to 30 cm long and small pink flowers that form on the trunk and on the older branches. Only about thirty of the approximately 6,000 flowers that open during the year come to bear fruit, which are called pineapples or maracas, which must be collected at the right moment of maturity[4].

From the cocoa bean, cocoa paste is obtained, which is the product obtained by grinding the cocoa bean, peeling and roasting. It is the edible part of the cocoa bean, which could be defined as chocolate without sugar, strongly bitter and difficult to swallow. In spite of everything, it is ideal to balance recipes with an excessive percentage of sugar (sweet fruits, chocolate caramel)[5].

Nowadays, the elaboration of cocoa paste in the canton Las Naves has been processed in an artisanal way, which is why it has low quality characteristics, in terms of (flavor, aroma, color and texture). In view of this, semi-industrial (toasted and ground) processes have been implemented to improve and preserve the quality attributes of cocoa paste. Besides studies have determined that the canton Las Naves, Prov. Bolivar, is a highly productive area of fine cocoa aroma, optimal for making a paste of excellent quality6.

In Las Naves there is an organization of cocoa producers (UCOCS) Cantonal Union of Peasant Organizations, which is dedicated to the commercialization of cocoa, in an agreement made with a private company, which sends cocoa paste to Germany. Considering the previously described, in the present investigation the objective was to determine the best method of roasting and grinding that allows to preserve the organoleptic characteristics of the cocoa paste.

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Table 1: Study factors.

| Methods | Factors | Levels |
|---|---|---|
| Roasting method | A | A1: traditional<br>A2: Semi-industrial |
| Grinding method | B | B1: traditional<br>B2: Semi-industrial |

Table 2: Organoleptic evaluation of the aroma.

| characteristics | Alternative | Qualification |
|---|---|---|
| Aroma | Floral | 4 |
| | cacoa | 3 |
| | Fruit | 2 |
| | Nut | 1 |
| Color | Dark coffee | 4 |
| | Light brown | 3 |
| | Reddish | 2 |
| | Concho de vino | 1 |
| Flavor | Nice | 4 |
| | Very nice | 3 |
| | Little nice | 2 |
| | unpleasant | 1 |
| Texture | Fine | 4 |
| | Semi-fine | 3 |
| | Semi- thick | 2 |
| | gross | 1 |

Table 3: Analysis of raw material.

| Analysis | Dates | Unity |
|---|---|---|
| Weight | 6 | Kg |
| Humidity | 6.8 | % |
| pH | 6 | Acido |

Table 4: Average pH in the treatments.

| Treatments | Average values | Ranks |
|---|---|---|
| T4 | 5.37 | A |
| T3 | 5.30 | A |
| T2 | 5.30 | A |
| T1 | 5.20 | A |

*DMS= 0.027216; Error= 0.0108; Gl= 8*

Table 5: Weight averages in treatments.

| Treatments | Average values | Ranks |
|---|---|---|
| T4 | 4447.70 | A |
| T2 | 4447.70 | A |
| T3 | 4447.50 | A |
| T1 | 4448.02 | A |

*DSM=1.42422; Error=0.2967; Gl= 8*

## MATERIALS AND METHODS

This work was carried out in the Cantonal Union of Social Peasant Organizations (UCOCS) located in the canton Las Naves, province of Bolivar (Ecuador), for which, the Nacional variety of cacao was analyzed. The following combination of factors was applied, table 1.

A complete random design (CRD) with factorial arrangement 2x2x3 was applied, giving rise to 4 treatments that respond to the following mathematical model:

$$Y_{ijk} = \mu + A_i + B_j + AB_{ij} + \epsilon_{ijk}$$

$Y_{ijk}$= Any variable subject to measurement; $\mu$= general average; $A_i$= Effect of factor A; $B_j$= Effect of factor B; $AB_{ij}$= Effect of interaction (A*B); $\epsilon_{ijk}$ = Effect of experimental error.

*Experimental value in the raw material*

Weight analysis was performed to determine the yield, moisture analysis was performed using a moisture calibrator, placing between 20 and 30 cocoa almonds the moisture value should be between 7 and 8% (percentage obtained after the process drying).

*Specific management of the investigation.*

In carrying out the present investigation, the following process was followed:

*Reception of raw material:* normally fresh cocoa (in drool) was received after harvested, the cocoa was subjected to the processes of fermentation and drying.

*Heavy 1*: the weighing of the raw material was development.

*Fermentation:* This was carried out for 4 days in boxes covered with banana leaves (this contains yeasts that facilitate fermentation).

*Drying:* Fermented almonds were exposed to heat to reduce humidity to 7%. Two drying systems were used: natural by means of the sun (using 8 cm thick canvas) and artificial by means of gas dryers.

*Cleaning:* The cocoa bean was classified by its appreciation and to remove impurities or foreign objects.

*Heavy 2:* We perform a second weighing of the raw material free of impurities.

*Toasting*: This was done at a temperature of 130ºC during 40 minutes in the semi-industrial method, while in the traditional method parameters, were not controlled.

*Piling:* The cocoa beans were broken into small pieces with the purpose of separating the husk from the test (cacao seed).

*Grinding:* This process was carried out using an electric semi-industrial mill (Arhur Fried, 300 mm Ecuador).

*Molded:* The paste was placed in molds that allowed to have uniformity in weight.

*Packing:* In polyethylene covers that prevent the entry of UV rays, moisture and thus prevent the deterioration of cocoa paste, finally the labeling and storage was carried out.

*Measurements in the finished product*

pH: for which, a pH meter was used (Hanna, HI991001, USA); Weight: to determine the product's performance.

*Sensory analysis of the finished product*

Sensory analyzes were performed through cupping, with two panels of evaluators (group of students from the Universidad Estatal de Bolívar previously trained and 2 expert tasters from INIAP-UNOCACE. For which, the following parameters were evaluated:

*Aroma*, was made according to the methodology applied in the *Agricultural Research Center of Pichilingue,* the aromas of the pasta were evaluated, the aromas fluctuated as follows floral, cocoa, fruit and nut.

*Color:* It is a visual perception that is generated in the brains of humans and other animals when interpreting the

Table 6: Averages of treatments in the organoleptic characteristics in cocoa paste.

| Treatments | Average values | Ranks |
|---|---|---|
| Aroma | | |
| T4 | 3.43 | A |
| T1 | 3.27 | A |
| T2 | 3.07 | AB |
| T3 | 2.50 | B |
| Color | | |
| T4 | 3.27 | A |
| T2 | 3.07 | A |
| T1 | 3.97 | A |
| T3 | 2.83 | A |
| Taste | | |
| T4 | 3.37 | A |
| T1 | 3.27 | A |
| T2 | 3.97 | A |
| T3 | 2.80 | A |
| Texture | | |
| T4 | 3.47 | A |
| T1 | 3.13 | AB |
| T3 | 3.47 | B |
| T2 | 2.47 | B |

*DMS= 0.73184; Error= 0.0783; Gl= 8*

Table 7: Bromatological analysis in cocoa mass

| Analysis | Value (%) | Standard |
|---|---|---|
| Humidity | 1.75 | AOAC925.10 2005.06 |
| Total ash | 1.85 | AOAC930.30 2006 |
| Fat | 51.3 | AOAC2006.6 |

nervous signals sent by photoreceptors in the retina of the eye. It was done in accordance with the INEN 623 standard[7].

*Taste:* It is the impression that causes a food or other substance and is determined mainly by chemical sensations detected by taste. It was done in accordance with the INEN 623 standard[7].

*Texture:* It is the property that the external parts of objects have, as well as the sensations that are captured by the sense of touch. It was done in accordance with the INEN 623 standard[7]. The model sheet for the evaluation of the aroma is shown in table 2.

*Statistical analysis*

To determine the best treatment, the medias analysis was applied, for which the Tukey test was applied at 5%.

## RESULTS AND DISCUSSION

*In the raw material*

The pH value obtained indicates that it is slightly acidic and according to the Transmar standard (Ecuador), it is within the range permitted parameters (5.5-6.2)[8]. It was determined that the humidity of the cocoa beans according to the norm INEN 173 1975-12[9], should be of 7.5%, the moisture value obtained in this investigation is within the established parameters (table 3).

*In the finished product*

After the statistical analysis it can be determined that there was no significant statistical difference between the treatments, although numerically if differences are shown between the treatments, in all cases, the treatments present pH values within the permitted parameters (5.2-5.7), is important to consider that the pH values depend on the process of fermentation and drying of the cocoa. The pH values obtained indicate that it is slightly acidic, these results determined that T4 (A2B2) is the best acceptable pH value (table 4).

Statistically, there was no significant difference between the treatments, but numerically if there was a difference, because in the treatment T1 (A1B1) that corresponds to the method of traditional roasting and grinding, the process is carried out manually, thus avoiding the loss of material premium during this process. These data determine that the T1 treatment (A1B1) is the best with the highest weight obtained (table 5).

*Organoleptic analysis*

In *aroma*, it is appreciated that there are significant differences in the treatments, indicating that the semi-industrial method used in the roasting and grinding processes influenced the organoleptic characteristics while preserving its aroma. We can state that the T4 (A2B2) treatment was superior to the other treatments, considering between a floral aroma and cocoa according to the established scale, for this reason we consider the importance of processing with the semi-industrial method of roasting and grinding because it maintains the aroma of the cocoa.

The *color* analysis indicates that statistically there are no significant differences between treatments, but numerically if there is a difference, this is due to the fact that in the semi-industrial method, roasting influenced improving the color variable. We can state that the treatments are different, considering as the best a dark brown color according to the established scale, for this reason, the importance of processing with the semi-industrial method of roasting and grinding is considered given that it improves the color. Treatment T4 (A2B2) was rated superior compared to the other treatments.

In *flavor*, the results indicate that statistically there are no significant differences between treatments, but, numerically, it is stated that the treatments are different, for this reason we consider the importance to process with the semi-industrial method of roasting and grinding because it improves the flavor of the characteristics of cocoa. The treatment, T4 (A2B2) obtained a higher rating according to the values given by the evaluators.

In *texture*, it is determined that there are significant differences in the treatments, a texture of fine cocoa paste was obtained according to the scale established by the authors of the research work, for this reason we consider the importance of grinding with the semi-industrial grinding method, because it improves texture compared to the traditional method. According to the data established by the evaluators for the variable texture, determined that the treatment T4 (A2B2) (table 6).

$R^2$ Aj = correlation coefficient adjusted 0.20 = 20%. Explain the changes of the dependent variable depending on the behavior of the weight that will depend on the temperature, where in the future it will be possible to

forecast what will happen with a certain volume of raw material in this case of cocoa paste.

*Bromatological analysis*

Considering the results of the bromatological analysis of cocoa paste (Table 7), it is important to note that it meets the requirements of the INEN 623.1988-06 standard[7], for this reason we state that the cocoa mass that we elaborate with the semi-industrial method is within the regulations. Considering in said norm fat values of a minimum of 48% and a maximum of 54%; also, in moisture content with a maximum of 3% and total ash with a maximum of 7.5. This is the first time that methods of conservation of the organoleptic characteristics of cocoa paste have been analyzed.

In conclusion, it is demonstrated that the treatment T4 (A2B2) that corresponds to the method of toast and semi-industrial milled presents a better organoleptic quality in terms of aroma, color flavor and texture of the final product, we conclude that the use of fine national cocoa aroma It helped us to preserve the quality characteristics.

**GRATITUDE**

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