

## Effect of some factors post-harvest on the sensory quality of the Criollo cocoa porcelana (*Theobroma cacao* L.)

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### Abstract

Cocoa (*Theobroma cacao* L.) has had a great importance in the agricultural development of the country since the time of the colony, due to the production of high quality cocoa (porcelana and chuao). To guarantee this quality it is important a good handling of the crop that includes a suitable practical post-crop (fermentation and dried). Therefore, the aim of this research is to evaluate the effect of some factors that influence on the fermentation of porcelain cacao such as: Type of fermentator (TF), removal frequency (FR), endurance of the ear (AM) and type of fermentator (TPF). The methodology consisted on a split plot arrangement design, where three factors were studied (TF, FR and AM), at two levels and the time of fermentation (TPF) at five. The evaluation was sensorial considering the following descriptor: acidity, smell, bitterness, astringency, floral, fruit and global evaluation. Fermented cacao on squared boxes had lower acidity than fermented in rectangle boxes. At the same time, a global evaluation was obtained in cacaos that fermented on squared boxes. In relation to the endurance, the best results of aromatic intensity and global evaluation, as well a lower acidity was obtained for endurance cero. The removal frequency done every 24 hours showed a lower bitterness and higher preference. The time of optimum fermentation was of 48 and 72 hours. These results allow recommending that porcelain cacao must be fermented on squared boxes, with a mass removal every 24 hours, with cero endurance and a time of fermentation that would not surpasses 72 hours.

**Key words:** *Theobroma cacao* L., sensorial analysis, quality.

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## Introduction

The specie (*Theobroma cacao* L.) comes from the highlands of Amazonas, specifically in Colombia, Ecuador, Peru and Brazil, and it is the most commercially exploited specie. Then was disseminated in two classifications in function of the type of cacao, that is, criollo types were oriented towards North and Amazonian towards South, which crossed later and originated Trinitarian cacao. Likewise, two other species are reported: *Theobroma grandiflorum* and *Theobroma bicolor*, which importance and use mostly lays on the genetic improvement (5).

The taste of chocolate is obtained after: fermentation, dried, which is done by the producer, and torrefaction, done in the industry. In the practice, fermentation methods vary from a production location to another different and even from a producer to another. The type of cacao, the fermentation method used, along to the type of fermentation, the removal frequency, dried and atmospheric conditions of the area determine the quality of cacao and at the same time establish the price to be paid (9).

There is not a unique criterion to be adopted in order to determine whether the cacao of a specific area has to be classified as a fine cacao, or aromatic cacao.

The participation of fine or aromatic cacao in the worldwide production has been reducing, from an average of 40% and 50% at the beginning of this century, to

approximately 5% nowadays. This reduction might be due to failures on the crop handling, including post-harvest and natural and artificial crossing occurred between criollo and foreigner cacao. Latin America and the Caribe provide 80% of the fine or aromatic cacao to the rest of the world, followed by Asian and Oceania (18%) and Africa (2%). Ecuador is the higher supplier country followed by Venezuela, Costa Rica and Colombia (10, 11).

The South area of the of Maracaibo's Lake that belongs to Mérida, Zulia, Táchira and Trujillo, is mentioned as the first region where initiated the production of cacao in Venezuela from the time of the colony (7). Likewise, it is characterized by the production of cacao criollo types such as: Porcelana, Mérida, Guasare, considered as fine or aromatic cacaos. On the other hand, the introduction of foreigner materials with the purpose of guaranteeing the tolerance to the main illnesses that affect the crop has caused a gradual reduction on the quality of criollo cacaos (12).

Nationally, there is a scarce of trustable information on the evolution of sensorial components during fermentation and dried. Research done indicate that fermentation consists on the main and decisive aspect to obtain a good quality of the fruit (12).

Fermentation is the most important phase on the benefit of cacao, and this operation involves two different phenomena, which are not independent: a microbial

fermentation that contributes to the elimination of the mucilaginous pulp which is present on fruits. It also induces to a couple of chemical reactions inside cotyledons that cause the modification of the chemical composition of fruits, especially on the formation of the aroma precursors. These reactions are induced by any temperature increase of the cacao mass during fermentation and to the migration of the acetic cycle of the pulp to the fruit. These two phenomena also lift the germinative power of the embryo. This fermentation is affected by the genetic origin of cacao, interval between harvests, quantity of the cacao to be fermented, quantity of the pulp in the seed, the method of fermentation and the conditions on the media where the process is done (4).

The most important consequence of modifications that happens during fermentation is the development of precursors of the aroma to chocolate. These substances are formed just after cotyledons die, at the time that the fast destruction of anthocyanin is produced. Only these substances are capable of giving the cacao during the torrefaction the taste and characteristic aroma of chocolate (1).

During the fermentation and

dryness compounds are formed that during the toasting process originate the taste and aroma which is so characteristic of the chocolate (13). The same author mentions that it is unknown if tastes is developed in the fermentation or in the dryness, or in both.

Lots of investigations have determined the importance of compounds involves on the formation of the aroma of cacao, and consequently the development of precursors of chocolate taste. On this matter; volatile compounds such as pyrazines and aldehyde represent a basic taste, and esters that originate a taste to fruit. Likewise, the astringency grade of chocolate is determined by the polyphenolic compounds and the bitterness by purines (caffeine and theobromine). Finally, the complex polypeptide-phenols and pyrazines influence on the honey and nuts taste (6).

The main objective of this research was to evaluate the removal effect of the cacao mass, type of fermentator, endurance of the ear and time of fermentation on the evolution of the sensorial profile of the cacao criollo porcelana of the South of Maracaibo's Lake.

## Materials and methods

The essay was carried out at the Experimental station Chama of Corpozulia, located at Km 41, of Santa Bárbara road, el Vigía, Colón municipality, Zulia state. The station has a plantation of approximately 6

ha of porcelain cacao, which guaranteed that the quality of the material were homogenous seen from the handling point of view, as well as the phenotypic and genetic characteristics. The cacao used in this

essay belongs to the «criollo» porcelain type, from the collection of the experimental station Chama, in the South of Maracaibo's Lake.

The essay was carried out using a randomized split plot arrangement design  $2^3 \times 5$ , where four factors with two replications were evaluated: type of fermenter (TF), squared and rectangle box, both with the same capacity. Removal frequency (FR), removals every 12 and 24 hours after initiated the process. Endurance of the ear (AM), zero endurance, which means to ferment immediately after the harvest and endurance of five days, which means to do the process five days after the harvest. Time of fermentation (TPF), five times were considered; zero hour (without being fermented), 24, 48, 72 and 96 hours after the harvest. Samples (400 g) were selected at random from the center of the mass of the fermented and were exposed to the sun until dried, for a period of 4 hours daily for six days. Selected samples were packaged on paper bags and then on plastic bags, which were previously identified and sent to the Chemistry and Technology Laboratory of CIRAD-Montpellier (France) for the sensorial analysis (2). Subsequently, the corresponding chocolates were

done for each of the considered treatments, for that reason almonds were submitted to a torrefaction process at a temperature of 129°C for 25 min. Then were ground and the cacao mass was obtained, which was later refined (25µm), and were put on the shellness at 70°C, for 2 hours. Chocolate paste was tempered until a temperature of 34°C and finally was put in moulds and storage on a refrigerator at 7°C.

On the sensorial analysis a group of experts formed by 6 tasters was used. The data was analyzed using the software SAS, for a total of 144 observations. For defining the sensorial profile the following descriptors were considered: Aromatic intensity, acidity, bitterness, astringency, taste of the fruit, floral and global evaluation. These descriptors were evaluated with a scale from 1 to 5, where one (1) indicated the lowest intensity and five (5) the highest. The statistical analysis correspondent to organoleptic variables was done at CIRAD (France), using the procedure of generalized lineal model (GLM), and the statistical software SAS, doing the means analysis of Duncan for the descriptors that showed significant differences (14).

## Results and discussion

Considering the variation source type of fermentator (TF), the variance analysis revealed the existence of significant differences ( $P < 0.05$ ) for descriptors: acidity. Taste to fruit, floral and global evaluation. In relation

to descriptors; intensity, aromatic, bitterness and astringency, the analysis did not show significant differences for the evaluated treatments.

High acidity content might

(table 1) be related to a lower aroma of chocolate (3). On the other hand, comparing these results to other investigations where porcelain cacao has been evaluated in a sensorial way, a global average score of 2.8 was obtained, without considering the fermentation system employed; mentioning that elevated values with fruit and floral flavor indicate softness and fineness in the taste (4).

In relation to the endurance of the ear (AM), the statistical analysis detected significant differences ( $P < 0.05$ ) for aroma, acidity and global evaluation. Meanwhile, there were not significant differences ( $P < 0.05$ ) for characteristics bitterness, astringency, taste to fruit and floral. Mean test (table 2) demonstrated that cacaos fermented just immediately after the harvest (0 days for the endurance) showed an aromatic intensity (2.80) and a lower acidity (1.90), therefore the global evaluation was superior (2.58 vs 2.21)

The aromatic intensity and acidity are affected by the delay on ear threshing, thus reducing the aromatic intensity of the cacao with

the storage (2). Other authors indicate that the aroma depends on the variety, maturity of the fruit and of the post-harvest treatment (fermentation, dryness and toast) (3).

The variance analysis done to the removal frequency factor (FR), only detected significant differences ( $P < 0.05$ ) for the bitterness descriptor and global evaluation. Mean tests (table 3) show that the highest values of bitterness (2.51) were detected when the removal of the cacao mass was done every 12 hours and though there were not differences on the other descriptors, the group of taster qualified samples of cacao with a higher removal, and with an inferior global quality. The removal rhythm is an important factor, since it allows the oxygenation of the cacao mass which favors the acetic fermentation that occurs after the alcoholic fermentation. This implies that when the cacao mass is moved every 12 hours, an adequate temperature is not reached that would allow to obtain an acetic fermentation, which is important to obtain the desire quality, since the lactic fermentation would be

**Table 1. Mean test for the type of fermentator in the different descriptors.**

Descriptors	Type of fermentators	
	Squared	Rectangle
Acidity	1.75 <sup>b</sup>	2.28 <sup>a</sup>
Taste to fruit	1.12 <sup>a</sup>	0.78 <sup>b</sup>
Floral	0.51 <sup>a</sup>	0.30 <sup>b</sup>
Global evaluation	2.58 <sup>a</sup>	2.21 <sup>b</sup>

a, b. Jeans followed by different letters indicate significant differences ( $P < 0.05$ ).

**Table 2. Mean test for the endurance of the ear in the different descriptors**

Descriptors	Endurance of the ear (days)	
	0	5
Aromatic intensity	2.80 <sup>a</sup>	2.50 <sup>b</sup>
Acidity	1.90 <sup>b</sup>	2.12 <sup>a</sup>
Global evaluation	2.58 <sup>a</sup>	2.21 <sup>b</sup>

a, b. Means followed by different letters indicate significant differences ( $P < 0.05$ ).

favoring, thus affecting the quality of commercial cacao.

Regarding the time of fermentation, the variance analysis revealed statistical significant differences ( $P < 0.05$ ) for descriptors: aromatic intensity, acidity, astringency, taste to fruits, floral and general evaluation, and for bitterness values were statistically the same. Mean test (table 4) reveals that the intensity of most descriptors that showed variation increases with fermentation except astringency which reduces. Likewise, it is observed that differences are mainly between 0 and 48 hours of fermentation, being constant later. In

relation to treatments of 24 and 96 hours of fermentation, these were discharged, in the first case by being too early the time of fermentation and in the second case by considering that the time was excessive, where fruits showed symptoms of an over fermentation (bad smell).

Research done in this area only show the variation of some descriptors mentioned in this investigation, only considering the time of fermentation on the foreigner cacao. On this matter, other investigators found that the development of cacao increases at the time that happens the time of fermentation, with a negative correlation with astringency, that is,

**Cuadro 3. Prueba de medias para el factor frecuencia de remoción de la masa de cacao para los diferentes descriptores**

Descriptors	Renoval frequency (hours)	
	12 hours	24 hours
Bitterness	2.51 <sup>a</sup>	2.33 <sup>b</sup>
Global evaluation	2.26 <sup>b</sup>	2.52 <sup>a</sup>

a,b. Medias seguidas por letras distintas indican diferencias significativas ( $P < 0,05$ ).

**Cuadro 4. Prueba de medias para el factor tiempo de fermentación en los diferentes descriptores**

Descriptors	Time of fermentation (hours)		
	0	48	72
Aroma	2.12 <sup>b</sup>	2.81 <sup>a</sup>	3.02 <sup>a</sup>
Acidity	1.50 <sup>b</sup>	2.23 <sup>a</sup>	2.31 <sup>a</sup>
Astringency	3.00 <sup>a</sup>	2.02 <sup>b</sup>	1.98 <sup>b</sup>
Fruit	0.48 <sup>b</sup>	1.19 <sup>a</sup>	1.19 <sup>a</sup>
Floral	0.19 <sup>b</sup>	0.52 <sup>a</sup>	0.52 <sup>a</sup>
Global	1.56 <sup>b</sup>	2.79 <sup>a</sup>	2.83 <sup>a</sup>

a,b. Medias seguidas por letras distintas indican diferencias significativas ( $P < 0.05$ ).

that at the time that happens the time of fermentation reduces the astringency of grain (8).

These results allow to conclude that porcelain cacao fermented for 48 hours allow to obtain a cacao with

better organoleptic characteristics, therefore, it is recommended not to extend fermentation for a longer period than the established, because from that time on changes that are generated are not important.

## Conclusions

Fermentation in squared boxes reveals a lower acidity and a higher intensity of fruit and floral taste. The best values in aroma and acidity were obtained when ears were fermented immediately after the harvest. The removal frequency only affected the bitterness descriptor, reducing when removals were done every 24 hours.

The obtained results show that fermentation favors the aromatic

intensity, acidity, taste to fruit and floral, astringency reduced and did not have any effect on bitterness

Sensorial tests allow mentioning that porcelain cacao must be fermented immediately after the harvest on square boxes, with removals done every 24 hours and a fermentation period of 48 hours (2 days).

## Recommendation

To continue investigating the quality of cacao in base of the sensorial indicators, that involve the harvest, selection of fruits and

almonds, fermentation, dried, storage and processing, in a way that would allow to obtain further information and thus establishing the comparison

and follow up of results.

To ferment porcelain cacao for 48 hours on squared boxes, to move

the mass every 24 hours and immediately after the harvest.

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