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Artículo

Chocolate coverage based on two Ecuadorian varieties CCN51 and Super Tree in the province of Pastaza, Ecuador

Cobertura de chocolate con base en dos variedades ecuatorianas CCN51 y Súper Árbol en la provincia de Pastaza, Ecuador

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Abstract

Objective: Its objective is to produce a bitter-type chocolate coating from the combination of cocoa of the CCN51 and Super Tree variety. Methodology: the product was elaborated through an experimental, quantitative, and qualitative method. Results: 18 experimental units were generated in the design, where 2 formulations with 2 replications were obtained, which allowed us to determine the best treatment through sensory analysis with a structured hedonic scale of acceptability (assessment from 1 to 5). The sensory evaluation was carried out with 30 untrained panelists, where they determined that T1 with 70% cocoa liquor is the most accepted, while for the trained judges there was no significant difference. The samples were subjected to bromatological analysis, obtaining as a result a moisture content of 1.59%, fat 37.86%, protein 9.26%, ash 2.04%, dry extract of defatted cocoa 99.38%, dry extract of total cocoa 98.41%, microbiological less than 100 cfu. ml-1 in total mesophiles, yeasts, and total coliforms. Limitations: have pilot equipment for processing. Conclusions: The parameters of the best treatment T1 are framed in the NTE INEN 621: 2010 in force in Ecuador for the manufacture of chocolates.

Keywords: contemporary food, saquifrancia, cocoa, Super Tree, cocoa liquor, cocoa butter.

Resumen

Objetivo: elaborar una cobertura de chocolate tipo amarga a partir de la combinación de cacao de la variedad CCN51 y Súper Árbol. Metodología: el producto se elaboró mediante un método de tipo experimental, cuantitativo y cualitativo. Resultados: se generó 18 unidades experimentales en el diseño, donde se obtuvieron dos formulaciones con dos réplicas que nos permitió determinar el mejor tratamiento mediante un análisis sensorial con una escala hedónica estructurada de aceptabilidad (valoración de 1 a 5). La evaluación sensorial se llevó a cabo con 30 panelistas no entrenados, donde determinaron que el T1 con 70 % de licor de cacao es el más aceptado, mientras que para los jueces entrenados no hubo diferencia significativa. Las distintas muestras fueron sometidas a los análisis bromatológicos, se obtuvo como resultado un contenido de humedad 1.59%, grasa 37.86%, proteína 9.26%, ceniza 2.04%, extracto seco de cacao desgrasado 99.38%, extracto seco de cacao total 98.41%, microbiológicos menores a 100 ufc. ml-1 en mesófilos totales, levaduras y coliformes totales. Limitaciones: tener equipos piloto para el procesamiento. Conclusiones: los parámetros del mejor tratamiento T1 se enmarcan en la NTE INEN 621: 2010 vigente en el Ecuador para fabricación de chocolates.

Palabras claves: alimentación contemporánea, saquifrancia, cacao, Super Árbol, licor de cacao, manteca de cacao.

Introduction

Cocoa (*Theobroma cacao L*.) is from Amazonian, introduced in Europe, since then it is a product of great global demand. Cocoa trade is based on quality, classified into fine aroma and ordinary (Campaña, Hidalgo, & Sigcha, 2016). Cocoa originated from America, currently there are cocoa plantations in Mexico, Brazil, Ecuador, and other countries. The Olmecs, Mayas, know it as "Food of the Gods" and the Spaniards, who sent it to Spain, used Aztecs, the seeds as currency for gold. They added sweeteners to the drink and developed new recipes with the addition of sugar, cinnamon, almonds, eggs, and vanilla, which was gradually spread to France and the rest of world. Over the years, chocolate has evolved into a smooth and creamy food with an unsettling pleasure on our senses. Chocolate is a mixture of cocoa liquor and cocoa butter with sugar, sometimes milk or fruit. Depending on the percentage of each ingredient, added, different types of chocolates are made (Costaguta, 2007). Chocolate is a complete nutritional food that has approximately 30% fat (cocoa butter with 35% Oleic ac., 35% Stearic ac. and 25% Palmitic ac.), 6% protein, 61% carbohydrates and 3% humidity and ashes composed with minerals such as phosphorus, iron, calcium. It also contains vitamin A and B complex. Inexpensive chocolates are made with synthetic cocoa butter, which have characteristics with pleasant and fatty flavors on the palate (Valenzuela, 2007). Saquifrancia farm is dedicated to the cropping of CCN51 cocoa variety, fine of aroma and Super Tree cocoa. The CCN51 cocoa variety is known for its high productivity, however, compared at fine aroma, the organoleptic characteristics of flavor and aroma are not equal (Enriquez, 2022). In relation to the super tree variety that has characteristics like the fine aroma cocoa of the country, which has acid and sweet notes, delicate roasted flavors, fruity aroma, and floral notes (Alcides & Ramírez, 2016). Saquifrancia also has a chocolate processing plant where cocoa paste or liquor is obtained. Currently, there is a need to expand the production lines due to international requirements and trends in the use of raw materials with other characteristics in chocolate plants. There are products on the market that contain innovative inputs or ingredients which have achieved a high

purchasing value, and there is a trend towards the consumption of bitter chocolate, especially in chocolate coverages where the cocoa aroma characteristic is appreciated. Chocolate coverage is the most in demand; however, it is not the variety that is grown on the farm, in this context, it is urgent to respond to the current market dynamics by innovating. The proposal is to combine the advantages of the two Saquifrancia cocoa varieties: CCN51 cocoa of high productivity (volume) and Super Tree (aroma and flavor), trying to find a mixture that is sensorially accepted by the consumer and find the desired characteristics in a chocolate coating, thus managing to compete with the fine aroma cocoa coating offered by other companies. Preserving the organoleptic characteristics of the final product is a benefit obtained from raw materials (Enríquez y Ojeda, 2020).

In Ecuador, cocoa is a traditional crop and main export product since ancient times, recognized worldwide for its aroma and characteristic flavor " fine scent " appreciated for the chocolates and coverages elaboration. The product quality depends on main factors such as post-harvest, fermentation, drying, roasting and conching (Díaz & Pinoargote, 2011).

According to Quintana, Gómez, García and Martínez (2015), CCN51 cocoa has been classified for its high perceived acidity, astringency, bitterness, and low presence of floral and fruity flavors. Therefore, aspects such as origin and other factors that is performed until having a coverage chocolate have been improved (Morales et al., 2016) and (Teneda, 2016). With the help of the Super Tree variety, which is characterized by its fruity and floral flavors, as well as similar characteristics to fine aroma cocoa, it is possible to achieve a coverage chocolate exquisite to the palate (Alcides & Ramírez, 2016). CCN51 cocoa is a clone that stands out for its productivity, resistance to pests and diseases, and an unusual bitter taste and with a good fermentation it would become an appetizing product (Perea, Ramírez & Villamizar, 2011).

The agronomist Homero Castro Zurita discovered cocoa clone CCN51 in 1962, after 70% of the cocoa crop destruction, caused by the pests known as witches' broom (*Crenipellis perniciosa*) and monilla (*moniliophthora roreri*). The CCN51 clone whose acronym stands for

"Colección Castro Naranjal" and the number 51 because of the trial conducted in Naranjal at Hacienda Sofí (Quintana & Gómez, 2011). The two varieties of cocoa mentioned have potential as raw materials that when combined can offer innovative products for the chocolate industry. The development of new products for the company, such as bitter chocolate coverage, covers the market needs and solves the deficiency of products they have. This coating type is popular in food products worldwide due to its nutritional value (protein and fat) sensory characteristics are pleasant for the consumer (Wells & Van der Gaag, 2006) and it is a versatile product used in different areas of gastronomy, medicine, confectionery, ice cream and pastry shops.

The coatings have less sweetness and are more fluid than chocolate bars the fluidity is due to the addition of cocoa butter (Gianola, 1993). They are of vegetable origin constituted mainly by cocoa, 55% of its composition is cocoa butter, which allows it to be more workable due to its greater elasticity and remains in solid state at ambience temperature (Torroglosa, 2014). It contains 65% vegetable fat (cocoa butter), about 24% sugar, 10% previously defat-ted cocoa powder, 0.75% of an emulsifying agent (lecithin) and 0.25% of flavoring substances (Castillo & Mestres, 2004). There are different types of chocolate coatings in a minimum proportion of 30% cocoa butter (Domenech, 2014). Extra bitter: contains more than 70% cocoa in its composition.

The bitter chocolate coating is characterized by the ease of molding and retains temperature, made up of cocoa paste (60%), cocoa butter, sugar, flavoring substances (vanilla) and lecithin (Méndez & Polo, 2017). White coverage contains a higher proportion of cocoa butter (approximately 30%) and does not contain cocoa so it is not considered chocolate (Schuhmacher, Forsthofer, Rizzi & Teubner, 2007). Milk coverage is a mixture of at least 36% cocoa with milk (Enriquez, 2022). The objective of research was to elaborate cocoa coating by means of an experimental design with three treatments and two formulations.

Material and methods

Location

The research was carried out in Pastaza province, city of Puyo, located in the northwest of the Ecuadorian. The product was manufactured at the "Saquifrancia" Agroindustrial and Tourist farm, the analyses were carried out in the chemistry, bromatology and microbiology laboratories of the Amazon State University.

Experimental research

An experimental design was carried out to determine the treatments and formulations to develop the product.

Quantitative investigation

It was used a statistical means to validate the results, allowing to obtain accurate and objective information (to identify the best product).

One-factor completely randomized design (ACD).

Eighteen experimental units with three treatments, two formulations and three replicates were used for the experimental design.

Study variables. Independent variables:

Percentage of cocoa liquor.

Percentage of vegetable fat (cocoa butter)

Dependent variables:

Physical-chemical composition.

Percentage of sugar.

Percentage of lecithin.

Organoleptic characteristics: brightness, color, aroma, flavor (cocoa and sweet), bitterness, astringency, texture, and fluidity.

Chocolate formulation for coverage

Three treatments were carried out with different concentrations of cocoa liquor (combination of cocoa CCN51 and Super Tree), as detailed in Table 1.

Table 1.
Concentration of varieties to obtain cocoa liquor

VARIETIES	T1	T2	T3
Cocoa CCN51	80%	70%	60%
Super Tree Cocoa	20%	30%	40%

Source: Authors.

With the treatments established, we proceeded to work with two formulations. Each formulation has a certain percentage of ingredients that are within the ranges established in the literature on coverage chocolate. Table 2 specifies the processing formulations.

Table 2.
Chocolate formulations for coverage

Formulation	Ingredients	ments (Combination in % of cocoa liquor CCN51 and Super Tree)		
		T1 (80-20)	T2 (70-30)	T3 (60-40)
F1	Cocoa liquor	70%	70%	70%
	Sugar	24,5%	24,5%	24,5%
	Vegetable shortening (cocoa)	5,0%	5,0%	5,0%
	Lecithin	0,5%	0,5%	0,5%
	TOTAL	100 %	100 %	100 %
F2	Cocoa liquor	65%	65%	65%
	Sugar	27,5%	27,5%	27,5%
	Vegetable shortening (cocoa)	7%	7%	7%
	Lecithin	0,5%	0,5%	0,5%
	TOTAL	100 %	100 %	100 %

Source: Authors.

Development of technological process

Table 3 below details the procedures that were executed to obtain coverage.

Table 3.
Procedures to obtain coverage

Process	Characteristic
Fermentation	Here takes place the biochemical process that modifies the characteristic flavor and aroma of chocolate
Dried and roasted	Cocoa beans must be free of impurities
Shelling and grinding	In this process, the cocoa liquor is obtained in liquid form.
Mixing and refining	Here, sugar is added to the cocoa paste, and it is subjected to a temperature that ranges between 60°C and 70°C, obtaining a homogeneous mass.
Conched	Here the missing ingredients such as cocoa butter and lecithin are incorporated to improve the organoleptic parameters.
Tempered	This process is done to improve consistency and texture.
Molded	In this process, the pieces or pieces for packaging are formed.

Source: Authors.

Sensory analysis of the product

Sensory tests were carried out using the structured hedonic scale; this allows us to quantify the magnitude of the difference between the intensity (rating 0 to 5) and acceptability (rating 1 to 5) of the treatments. The evaluation is detailed in Table 4.

Table 4.
Hedonic scale

Intensity		Aceptability	
0	Absent	1	Poor
1	Barely detectable	2	Bad
2	Present	3	Regular
3	Characteristics of the sample	4	Good
4	Dominant	5	Excellent
5	Extreme		

Source: Authors.

According to intensity, the parameters evaluated are color, aroma, flavor (cocoa and sweet), bitterness and astringency. In addition, with respect to acceptability, they are color, aroma, flavor (cocoa and sweet), texture and fluidity.

Sensory test design

The sensory analysis was carried out on trained people who were familiar with the product and on untrained panelists, (three replicates will be carried out). The samples were coded with three digits taken from the random number table.

Tasting procedure

The untrained judges were each assigned the samples (10g) previously coded, accompanied by a glass of water to drink between each sample, plus a piece of apple to cleanse the taste buds and evaluation sheet using a structured hedonic scale (see Annex 4). The tasting was carried out between 9:00 am-10:00 am and 11:00 am-12:00 pm, so the results would not be affected by external factors (lunch time). The parameters evaluated were brightness, color, aroma, flavor (cocoa and sweet), bitterness, astringency, and texture.

The trained judges were each assigned the pre-coded samples (100g) and the evaluation sheet using a structured hedonic scale (see Annex 4). They worked according to their sales product. The parameters to be evaluated were color, aroma, flavor (cocoa and sweet), bitterness, astringency, texture, fluidity, and gloss.

Statistical analysis of sample tasting.

The evaluation of results was first carried out with the Excel software, where an analysis of variance ANOVA is obtained. This allows us to know if there is a significant difference or not. If there is a significant difference. Tukey test was applied with a confidence level of 95%, with a 5% error. Statistical analysis was performed using the computerized package In-foStat 2011 software version. Physical, chemical, and microbiological analysis of coverage chocolate. The following analyses were performed on the best treatment:

Moisture analysis (Gravimetric method): with AOAC 931.04 method (oven method), in the oven temperature is calibrated at 103°C±2°C, the weighed sample was placed in a mortar.

By equation (1), the moisture content was calculated (Hart,1958).

$$H = \frac{\text{wet sample (g)} - \text{Dry sample (g)}}{\text{wet sample (g)}} * 100 \quad \text{Equation (1)}$$

Protein analysis (volumetric method): according to the AOAC 960.52 method (Kjeldahl digestion), three stages were carried out digestion, distillation, and titration (Helrich, 1990). To obtain the crude protein content, it was calculated by means of the following equation (2):

$$\%P = \frac{(V_{HCL} - V_b) * meqN * N_{HCL} * F}{\text{M}} \quad \text{Equation (2)}$$

Where:

meqN: atomic weight of nitrogen

HHCL: normality of 0.1N hydrochloric acid.

F: conversion factor (6.25)

VHCL: volume of hydrochloric acid consumed in the titration.

Vb: target volume (0.1)

Fat analysis (Gravimetric method): governed to the AOAC 963.15 method (Soxhlet extraction) or NTE INEN 535, with the help of an organic solvent the fat is extracted semi- continuously. By means of equation (3) the fat content was calculated (Hart, 1958).

$$\%G = \frac{m_2 - m_1}{\text{M}} * 100 \quad \text{Equation (3)}$$

Where:

m1: weight in g of the empty round bottom flask (with porcelain piece and support).

m2: weight in g of the round bottom flask with fat after drying (with porcelain piece and support).

M: weight of the sample in g.

Ash analysis (gravimetric method): the sample is incinerated in a muffle at 600°C. This method is in accordance with NTE INEN 533. This method is in accordance with NTE INEN 533. The following equation (5) was used to obtain the percentage of ash:

$$\%Ceniza = \frac{peso\ g\ de\ cenizas - peso\ g\ del\ crisol}{peso\ de\ la\ muestra\ g} * 100 \qquad \text{Equation (4)}$$

Analysis of defatted dry extract and total cocoa dry extract (gravimetric method): the fat was extracted by solvent and the sample was taken to the oven to determine the extract content by weight difference, using the following equations to determine each analysis (1 and 5):

$$\%H = \frac{peso\ humedo - peso\ seco}{peso\ humedo} \times 100 \qquad \text{Equation (1)}$$

$$\%ESD = 100 - \%H \qquad \text{Equation (5)}$$

Analysis of molds and yeasts: according to NTE INEN 1529-10, the sterilized sample is placed in a culture between 22°C and 25°C, the agar must contain yeast extract, glucose, and mineral salts. The plate count technique was used by deep sowing.

Coliforms: according to NTE INEN 1529-7, it consisted of a plate count by deep sowing of the sample on agar, incubating it at 30°C±1°C for 24±2h.

Mesophilic aerobes: according to NTE INEN 1529-5, the sample was inoculated in a solid nutrient medium, incubated at 30°C±1°C for 78 hours. The plate count was performed by deep sowing in the agar, this serves to calculate the amount of m/o per g or cm3 of food.

Treatment design: The following table details the treatments of combination in both types of cocoa: CCN51 and Super Tree.

Results and discussion

Analysis of sensory attributes according to their intensity

This type of evaluation (intensity) was developed because it helps to detail the profile of the samples. According to the rating made by the untrained and trained judges is analyzed in the following table 5.

Table 5.
Summary ANOVA table of the organoleptic attributes evaluated (Intensity).

Analysis of Variance Table (SC Type III)						
	Untrained tasters			Trained tasters		
Organoleptic attributes	Variance factor: Treatments			Variance factor: Treatments		
	F	P-value	Critical value for F	F	P-value	Critical value for F
Brightness	1,3519	0,24483*	2,2661	0,6238	0,6820*	2,3231
Color	9,5039	0,0000000497**	2,2661	0,7133	0,6151*	2,3231
Aroma	2,9440	0,01409**	2,2661	1,7909	0,1235*	2,3231
Cocoa flavor	1,2575	0,2845*	2,2661	1,3498	0,2516*	2,3231
Sweet taste	1,2326	0,2958*	2,2661	1,7452	0,1332*	2,3231
Bitterness	0,2600	0,9343*	2,2661	1,7385	0,1347*	2,3231
Astringency	0,4288	0,8281*	2,2661	0,6829	0,6376*	2,3231

Source: Authors.
*: no significant difference (according to P-value is greater than α= 0.05).
**: there is a significant difference (according to P-value is less than α= 0.05).
------: parameter not evaluated.

Based on the values obtained in Table 6 for the organoleptic attributes evaluated according to intensity. They are statistically equal in the opinion of the trained tasters, while for the untrained tasters there was a significant difference in aroma and color with a reliability of 95%, as evidenced in Table 6, which shows the Tukey test, where the best treatment in each organoleptic attribute was verified.

Table 6.
Tukey test - Organoleptic parameters - intensity

Test: Tukey				
Variance Factor	Treatments	Stockings	Ranges	
Color	6	3,33	A	
	5	3,13	A	
	2	3	A	
	1	2,6	A	
	3	2,47	A	
	4	1,4		B
Aroma	1	3,63	A	
	2	3,37	A	B
	5	3,13	A	B
	3	3,07	A	B
	6	2,93	A	B
	4	2,6		B

Source: Authors

The tukey test determines that T6 presented a different result between the measurements, which means that the untrained tasters defined a characteristic color of chocolate. This contrasts with what Caballero and Maldonado (2012) indicate that the color of the product should be dark brown, complementing compliance with the parameters. In relation to aroma, T1 shows a higher value among the measurements.

Untrained tasters found one cocoa aroma to stand out from the rest. Zambrano et al. (2010) indicate that the aroma is produced during fermentation and roasting where at 120°C the amino acids precursors of the chocolate aroma are released. It also depends on the variety type of cocoa with which it is going to be made; then with a mixture of 20% of Super tree cocoa liquor added is enough to have that fruity aroma typical of the almond. According to Jinap, Bakar, and Saari (2004), the pyrazine contained in cocoa is responsible for giving the characteristic aroma and flavor of chocolate in the roasting process. Beckett (2008) points out that conching is one of the important operations for minimizing undesirable parameters, refining the aroma, and homogenizing the ingredients to give a good texture and flavor, losing the bitter and astringent taste (Zambrano et al., 2010).

Analysis of sensory attributes according to their acceptability

The following table shows the scores of the untrained and trained judges:

Table 7.
Summary ANOVA table of the organoleptic attributes evaluated (Acceptability).

Analysis of Variance Table (SC Type III)						
Organoleptic attributes	Untrained tasters			Trained tasters		
	Variance factor: Treatments			Variance factor: Treatments		
	F	P-value	Critical value for F	F	P-value	Critical value for F
Brightness	1,4635	0,2041*	2,2661	2,9647	0,0163**	2,3231
Color	9,5326	0,0000000471**	2,2661	2,4291	0,0416**	2,3231
Aroma	2,4013	0,0390**	2,2661	4,7738	0,00069**	2,3231
Cocoa flavor	1,7776	0,1198*	2,2661	2,0980	0,0736*	2,3231
Sweet taste	1,1572	0,3323*	2,2661	0,6079	0,6941*	2,3231
Texture	7,7213	0,0000013967**	2,2661	4,5832	0,00096**	2,3231
Fluency	--------	---------	---------	1,7092	0,1414*	2,3231

Source: Authors
*: no significant difference (according to P-value is greater than α= 0.05).
**: there is a significant difference (according to P-value is less than α= 0.05).
------: parameter not evaluated.

According to the values obtained in Table 9 on the organoleptic attributes evaluated according to acceptability. There is a statistically significant difference in certain sensory attributes; the untrained tasters considered a significant difference in color, aroma, and texture, while the trained tasters found a significant difference in brightness, color, aroma, and texture with a reliability of 95% as evidenced in Table 8, which shows the Tukey test, where the best treatment was verified in each organoleptic attribute.

Table 8.

Tukey summary table of the organoleptic attributes that had a significant difference. (Acceptability).

Organoleptic Attributes	Untrained tasters						Trained tasters					
	Test: Tukey						Test: Tukey					
	Treatments		Stockings	Ranges			Treatments		Stockings	Ranges		
Brightness							1		3,8	A		
							5		3,67	A		
								3	3,27	A	B	
								2	3,27	A	B	
								4	3,2	A	B	
								6	2,8		B	
Color		6	3,93	A			1		4,27	A		
	5		3,87	A				3	4,2	A	B	
		2	3,6	A				2	4,13	A	B	
	1		3,6	A				6	4,07	A	B	
		3	3,23	A			5		4	A	B	
		4	2,47		B			4	3,53		B	
Aroma		6	3,8	A				3	4	A		
	1		3,77	A	B		1		3,8	A	B	
	5		3,73	A	B			6	3,47	A	B	C
		3	3,5	A	B			2	3,47	A	B	C
		2	3,43	A	B		5		3,07		B	C
		4	3,07		B			4	2,67			C
Texture	1		4,1	A			1		4,27	A		
		2	3,87	A	B		5		2,93	A	B	
	5		3,8	A	B			2	2,93	A	B	
		6	3,73	A	B			6	2,8		B	
		3	3,3		B	C		3	2,67		B	
		4	2,8			C		4	2		B	

Source: Authors

As indicated in table 10, the tukey test determines that the expectations of the trained judges in terms of brightness, color, texture perceived an excellent aroma in T3. While the untrained judges liked the T6 in relation to color and aroma, agreeing with the trained judges that, the best texture is in the T1. Caballero and Maldonado (2012) mention that a product is appetizing for its texture when it does not feel lumpy on the palate and when breaking it, a crunch is felt. To obtain this consistency, brightness and color of the chocolate depends on the size of the particles (less than 30 microns) and a good tempering process, which helps to give a good crystallization of the fat.

Analysis of the best treatment

With the averages obtained from the evaluation, the analysis of variance of the treatments was carried out.

Table 9.
ANOVA of the treatments evaluated

Analysis of	Variance Table (SC		Type III)	
Variance factor	Untrained tasters		Trained tasters	
	F	p-value	F	p-value
Treatments	12,208	0,000230	1,99	0,1527

Source: Authors

According to the statistical results of ANOVA (Table 10), with respect to untrained judges there is a significant difference between treatments because according to p-value obtained is less than α= 0.05. Meanwhile, for trained judges, the statistical results indicate that there is no significant difference between treatments (all are equal), because according to p-value obtained is greater than α= 0.05. The best treatment was determined using Tukey's method.

Table 10.
Comparisons of means by Tukey's test.

Untrained tasters				
Treatments (T)	Stockings	n	Ranges	
1	3,8		A	
5	3,73		A	B
6	3,7		A	B
2	3,57		A	B
3	3,33			B C
4	2,9			C

Source: Authors

Table 10 shows statistically that, for the untrained judges, the best coverage chocolate is the one with 70% cocoa liquor (treatment 1) in which it is mixed with two types of varieties (80% CCN51 cocoa and 20% Super tree). According to the analysis of the attributes, this is the one that has stood out in brightness, color, aroma, and texture: then with 20% of Super tree

cocoa liquor combined with CCN51, it shows better sensory characteristics.

Physical-Chemical Analysis

The results of the physical-chemical analysis of bitter coverage chocolate were compared with the Mexican standard NMX-F-061-1964 and NTE INEN 621:2010.

Table 11.
Comparison of the physicochemical results of the best treatment with the standards

Parameters	Result of the analysis	Mexican Standard NMX-F-061-1964		Standard NTE INEN 621:2010	
		Min.	Max.	Min.	Max.
% Humidity	1,59	---	2,0	---	---
% Protein	9,26	7,25		---	---
% Grease	37,86		---	31	
% Ash	2,04	1,9	2,1	---	---
% Dry defatted cocoa extract	99,38	---	---	2,5	
Total % of cocoa dry extract	98,41	---	---	35	

Source: Authors.

Table 11 shows the experimental results. The moisture and ash contents are within the established ranges compared to the Mexican standard NMX-F-061-1964. When fermentation is carried out under appropriate conditions, the cocoa bean does not incorporate substances that can increase the percentage of minerals (Beckett, 2008).

The protein (9.26%) and fat (37.86%) contents have a high percentage according to the minimum established in the Mexican standard NMX-F-061-1964 and NTE INEN 621:2010. The high percentage ratio may be due to the mixture of the two raw materials, CCN51 and Super Tree, which contain different concentrations of protein and fat (Graziani, Ortiz, & Parra, 2003).

The contents of defatted dry extract and total cocoa dry extract analyzed compared to the NTE INEN 621:2010 standard is higher than the minimum level of 2.5% and 35% established

according to the requirements that a coverage chocolate must contain. The product itself partially has a high content of non-fat components with minimal moisture content, favoring the preservation of the product (INEN, 2010).

Microbiological analysis

Microbiological analyses were performed to verify that the product does not represent a health hazard caused by microorganisms.

Table 12.
Comparison of the microbiological results of the chocolate sample for coverage with INEN 621

CHOCOLATE AN	ALYSIS FOR COU	OUVERTURE
Parameters	Sample analyzed	According to standard
Total mesophiles	<100 CFU	<2.0×104UFC
Yeast	<25 UFC	<1.0×102UFC
Total coliforms	<100 CFU	<1.0×102UFC

Source**:** Authors.

As can be seen in Table 14, the results of the microbiological analysis of the chocolate for coverage report the presence of total mesophiles, total coliforms, and yeasts, which are less than 100 CFU.

Conclusions

Bitter coverage chocolate was made from cocoa liquor containing a combination of two varieties (CCN51 and Super tree), plus the addition of sugar, cocoa butter, and lecithin, according to the proposed treatments; the conching process was controlled where the paste is refined and undesirable flavors are eliminated, giving it the product's own characteristics.

The untrained judges, through statistical analysis, reported that the best organoleptic characteristics in brightness, color, aroma, flavor, and texture were found in treatment 1 containing 70% cocoa liquor; that is, the Super Tree variety influences the characteristics of the CCN51 variety; unlike the trained judges, no significant difference was found between treatments.

According to the formulation has the best treatment for bitter type coverage chocolate, its composition is within the parameters, both physical-chemical and microbiological according to NTE INEN 621:2010, concluding its feasibility in the production line at the Saquifrancia farm.

References

Alcides, C. y Ramírez, P. (2016). *Technical guide for the establishment and management of super tree cocoa*. Quito: GIZ

Beckett, S. (2008). *The science of chococlate*. Zaragoza: Editorial Acribia.

Caballero, L. y Maldonado, Y. (2012). Influence of cocoa butter crystallization on the sensory and physicochemical properties of a milk chocolate coverage. *ALIMENTECH*, *10*(1), 57-64.

Campaña, A., Hidalgo, F. y Sigcha, A. (2016). *Campo y campesino: production and research experience*. Quito: SIPAE.

Castillo, R. y Mestres, J. (2004). *Dairy products. Tecnología.* Barcelona: Ediciones UPC.

Costaguta, M. E. (2007). *Chocolate*. Buenos Aires: Albatros.

Di Rienzo, J. A. et al. (2014). *InfoStat Group, Faculty of Agricultural Sciences*, National University of Córdoba, Argentina. Retrieved from http://www.infostat.com.ar.

Díaz, S. y Pinoargote, M. (2011). *Analysis of the organoleptic characteristics of chocolate from cocoa CCN51 enzymatic treatment and roasting at different temperatures.* Guayaquil: ESPOL.

Doménech, R. (2014). *Presentación y decoración de productos de repostería y pastelería, tipos de acabado y decoraciones sencillas con chocolate, caramel y frutasas.* Vigo: Ideas Propias ed.

Enríquez, M., Ojeda, G. (2020). Evaluación bromatológica de dietas alimenticias, con la inclusión de harina de plátano de rechazo. *Revista ESPAMCIENCIA* Vol. *11*(1,) pp: 12-18. Retrieved from http://190.15.136.171:4871/index.php/Revista_ESPAMCIENCIA/article/view/200/211

Enríquez-Estrella, M. (2022). La gestión estructural agro-turística en la Finca Saquifrancia, provincia de Pastaza, Ecuador. *REVISTA DE INVESTIGACIÓN SIGMA*, *9*(02). doi: https://doi.org/10.24133/sigma.v9i02.2833

Gianola, C. (1993). La industria del chocolate, bombones y confitería. España: Editorial Paraninfo Cengage Learning.

Graziani, L., Ortiz, L. & Parra, P. (2003). Chemical characteristics of the seed of different types of cocoa from the locality of cumboto Aragua. *Agronomia Tropical*, *53*(2), 133-144.

Haert, P. D. A. (1958). World Health Organization. *The Lancet*, 272(7039), 214. Doi: https://doi.org/10.1016/S0140-6736(58)91553-8

Helrich, K. (1990). *Official methods of analysis, 1*. Virginia: Association of official analytical chemists.

Jinap, S., Bakar, J., & Saari, N. (2004). Effect of polyphenol concentration on pyrazine formation during roasting of cocoa liquor. *Food Chemistry*, *85*(1), 73-80.

Méndez, M., & Polo, D. (2017). *Manual. Elaboracion básica de productos de pastelería (UF0820)* EDITORIAL CEP S. L. ed. AOAC Method 960.52. Protein analysis.

Method AOAC 963.15. Gravimetric method - fat analysis.

Morales, J., García, A., and Méndez, E. (2012). ¿Qué sabe usted acerca de... cacao? *Revista Mexicana de Ciencias Farmacéuticas*, *43*(4):79-81. Retrieved from https://bit.ly/3vHJBDI

NTE INEN (Ecuadorian Institute of Standardization) (2014). *NTE INEN 533: Determination of ash, requirements*. Quito.

NTE INEN (Ecuadorian Institute of Standardization) (2010). NTE INEN 1529-10: Microbiological control of food. Molds and viable yeasts. Plate count by sowing in depth. Quito.

NTE INEN (Ecuadorian Institute of Standardization) 2010. NTE INEN 621: *Chocolates. Requirements.* Quito-Ecuadors. Quito

Perea, J. A., Ramírez, O. L. y Villamizar, A. R. (2011). Caracterización fisicoquímica de materiales regionales de cacao colombiano. *Biotecnología en el Sector Agropecuario y Agroindustrial*, 9, 1 (jul. 2011), 35-42.

Quintana, L., & Gómez, S. (2011). *Flavor profile of clone CCN51 Cocoa (Theobrama cacao L.) produced in three farms in the municipality of San Vicente de Chucurí*. UNAD, 5.

Quintana, L., Gómez, S., García, A., & Martínez, N. (2015). Sensory profile of cocoa clone (Theobroma cacao L.) CCN51 (first harvest of 2015) *ALIMENTECH*, *13*(1), 60-65.

Schuhmacher, K., Forsthofer, L., Rizzi, S., & Teubner, C. (2007). *The big book of chocolate*. Madrid: Everest.

Teneda, W. (2016). *Improvement of the fermentation process of cocoa (Theobroma cacao L.) variety Nacional and variety CCN51 In U. I. d.* Andalucía: Isla de la Cartuja.

Torroglosa, C. (2014). *Preservation in pastry. Packaging, storage. and regeneration.* Vigo*:* IDEASPROPIAS ed., vol. 1.

Valenzuela, A. (2007). Chocolate, a healthy pleasure. *Revista chilena de nutricion, 34*.

Vallego, D. (2011). *Artisanal elaboration of new chocolates and truffles with chocolate.* Cuenca: University of Cuenca.

Wells, T., & Van der Gaag, N. (2006). *The bitter sweetness of chocolate.* 1 ed., Great Britain: New Internationalist Publications Ltd.

Zambrano, A., Romero, C., Gómez, A., Ramos, G., Lacruz, C., Brunetto, M., . . . Delgado, Y. (2010). Chemical evaluation of aroma and flavor precursors of criollo merideño cocoa during fermentation under two edaphoclimatic conditions. *Agronomia Tropical, 60*(2),