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Study of the nutritional properties of cocoa husks (*theobroma cacao l.)* for industrialization in tea and infusion sachets

Estudio de las propiedades nutricionales de la cascarilla de cacao (*theobroma cacao l.)* Para su industrialización en sobres de té e infusiones

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Abstract

The objective of this research is to study the nutritional properties of the cocoa husk (*Theobroma cacao L.)* for its industrialization in tea and infusion sachets by means of descriptive, documentary-bibliographic research. At world level, the use of residues has taken great strength among the scientific community and especially at industrial level, for which the nutritional qualities of the cocoa husk are intended to be promoted. This husk has been totally dehydrated to approximately 6% of humidity for its preparation in tea and infusions sachets. The roasting method is responsible for the characteristic flavor of by-products such as chocolate, as well as for removing the remaining moisture in the bean and additionally eliminating any microbiological contaminants. The cocoa husk is obtained from the cocoa bean in the process of shelling and then grinding to obtain the cocoa husk powder, then by analyzing its physicochemical and microbiological properties of this raw material (cocoa husk powder) its nutritional value is evaluated. The elaboration of tea sachets and infusions is done by mixing the cocoa husk powder with an aromatic herb, in this case mint (*Menta arrensis*) and chamomile (*Matricaria chamomilla L.*) with the addition of Stevia (*Stevia rebaudiana)* The physical-chemical results of the infusions show ash and protein values of 8.21% and 16% respectively, while the fat and carbohydrate values are 3.40% and 58.49%, noting that the carbohydrates are those that supply energy to the body, especially to the brain and nervous system, thus providing this infusion with a good amount of energy.

Key words: *cocoa husk powder, infusions, dehydrated, milling, nutritional value.*

Resumen

La presente investigación tiene como objetivo el estudio de las propiedades nutricionales de la cascarilla de cacao *(Theobroma cacao L.)* para su industrialización en sobres de té e infusiones mediante la Investigación descriptiva, documental-bibliográfica. A nivel mundial el aprovechamiento de residuos ha tomado gran fuerza entre la comunidad científica y sobre todo a nivel industrial para lo cual se

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pretende incentivar las cualidades nutricionales de la cascarilla de cacao. Esta cascarilla ha sido totalmente deshidratada aproximadamente al 6% de humedad para su elaboración en sobre de té e infusiones. El método del tostado es responsable del sabor característico de los subproductos como el chocolate, además permite remover la humedad remanente en el grano y eliminar adicionalmente cualquier contaminante microbiológico. La cascarilla de cacao es obtenida de la semilla de cacao en el proceso del descascarillado para luego pasar a la molienda obteniendo así el polvo de la cascarilla de cacao, luego mediante análisis de sus propiedades fisicoquímicas y microbiológica de esta materia prima (polvo de cascarilla de cacao) se evalúa su valor nutricional. La elaboración de sobres de té e infusiones es mediante el mezclado del polvo de la cascarilla de cacao con una hierba aromática en este caso menta(*Menta arrensis*) y manzanilla(*Matricaria chamomilla L.*) con la adición de Stevia(*Stevia rebaudiana)* En los resultados físico químico de las infusiones muestra valores de cenizas y proteína de 8,21% y 16% respectivamente, en tanto que los valores de grasa y carbohidratos de 3,40% y 58,49% notándose que los carbohidratos son los que suministran energía al cuerpo, especialmente al cerebro y al sistema nervioso, proporcionando así esta infusión una buena cantidad de energía.

Palabras clave: *Polvo de cascarilla de caco, infusiones, deshidratado, molienda, valor nutricional.*

Introduction

In Ecuador there is a unique type of cocoa in the world known as "National", the national cocoa is characterized by having a very short fermentation and give a smooth chocolate with good flavor and aroma, so it is internationally recognized with the classification of "Cacao Fino de Aroma". According to data from the International Cocoa Organization, in Ecuador the national variety of cocoa, "fine aroma", represents 75% of production, the difference corresponds to the ordinary.

In Ecuador, the variety known as CCN-51 (Castro Naranjal Collection - 51) was created by the agronomist Homero Castro Zurita who, after several investigations, managed to obtain in 1965 the type 51, tolerant to diseases, and with high productivity and quality, although it is considered as ordinary cocoa.

Cocoa, *Theobroma cacao L.*, is a plant of American origin. Due to the nomadic lifestyle of the first inhabitants of this continent, it is practically impossible to say for certain where it originated. According to studies, cocoa originated in South America, in the area of the upper Amazon. (Enríquez, 1985). In this context, cocoa husk tea is a product that has not been fully exploited in the world, Colombia being one of the pioneer countries in this market niche.

Ecuador is the eighth largest producer of cocoa and the first producer of fine aroma cocoa, accounting for 50% of the supply that feeds this small but important segment of the world market. There are currently close to 100,000 production units with more than 400,000 hectares of cocoa, mostly in the coastal region. (INIAP, 2009). In this context, according to the background information studied, there is no evidence of tea production based on cocoa husks,

so the production processes developed throughout the study respond to an innovative and pioneering entrepreneurial alternative.

Theobroma cacao L. is a single species, but it has varieties, with different fruits and seeds. Three native varieties are recognized in the Mesoamerican region: Criollo cacao, which has been cultivated in southern Mexico, Central America and northern South America for more than 2000 years, the wild forastero, cultivated since 1750 in the Amazon basin, and the national cacao of Ecuador, which has been cultivated since 1600.

The industrialization and creation of processed cocoa products produces thousands of tons of waste which are not used for the benefit of the cocoa producer and the chocolate industry, such is the case of the cocoa husk, which is used as a simple fertilizer for cocoa plantations. Cocoa husks contain many nutrients such as fiber, carbohydrates and vitamins.

One of the processes (shelling) produces cocoa husks as waste; these husks have the appropriate physicochemical properties for the generation of a potential by-product. Using the technical tools of the agroindustry, the generation of an additional transformation process is proposed, in which the cocoa husk is the main input to obtain a derivative product.

Materials and methods

In order to carry out this work, a descriptive approach was sought through documentary - bibliographic research for which the research work was supported by contextual theoretical analysis and research sources where information was extracted from books, journals, theses, articles, projects, internet, among others.

As a basic modality of the research, we have the use of agroindustrial waste such as cocoa husk (*Theobroma cacao L*.) with the Nacional variety in the preparation of an infusion with medicinal plants such as Chamomile (*Matricaria chamomilla L.)* and Mint (*Menta arvensis*) in the appropriate proportion using Stevia (*Stevia rebaudiana*) as sweetener. Consequently, the formulation of the three treatments of infusions in tea sachets was carried out.

Table 1. *Formulation of treatments*

Formulation of treatments:	**%**	**%**	**%**
	T1	**T2**	**T3**
Cocoa powder - cocoa shells National			

Dehydrated chamomile			
Dehydrated mint	5	5	
Stevia			
Total	100%	100%	100%

Note: Selected by the Researcher, 2021.

For the preparation of the raw material, fermented cocoa (*Theobroma cacao L.*) of the Nacional variety was used; the dried cocoa reached 7% humidity and was roasted at 140°C for 60 minutes. The medicinal plants and sweetener were acquired in dried leaves that had a humidity between 9% and 12%.

In the fat extraction analysis, the fat is extracted with petroleum ether by continuous Soxhlet extraction for 12 hours, the solvent is recovered from the ethereal extract and then the fat is dried in an oven at 105°C for two hours, the dried fat is transferred to a desiccator to cool and weighed.

In the determination of total polyphenols, these are extracted with an aqueous solution of 70% methanol, by continuous magnetic stirring for 45 minutes, the extract obtained is filtered, an aliquot is taken and a colorimetric reaction is performed with the Folin and Ciocalteu reagent with which a blue coloration is obtained, which is quantified in a UVVIS spectrophotometer at a wavelength of 760 nm.

The methodology used for the physicochemical analyses was based on the following standards and methods:

Ecuadorian Technical Standard INEN-ISO, 1842:2013 Vegetable and fruit products. Determination of pH (IDT).

Moisture Determination: PE15-5.4-FQ. AOAC Ed 19, 2012 925.10

Fat Determination: PE17-5.4-FQ. AOAC Ed 19, 2012 2003.06

Ash Determination: PE14-5.4FQ. AOAC Ed 19, 2012 923.03

Protein Determination: PE16-5.4-FQ. AOAC Ed 19 2012 2001.11

Determination of Total Dietary Fiber: AOAC 985.29. Ed 19, 2012

The sensory analysis of the treatments resulting from the infusion was carried out with a block factorial design, the treatments were evaluated by semi-trained tasters, each taster analyzed THREE samples so that there were 3 treatments. The sensory evaluation was carried out through tasting sheets that allowed evaluating the attributes of color, aroma, flavor and acceptability.

The analysis of microorganisms was carried out at the best treatment where microbiological counts (molds and yeasts; mesophilic aerobes; *E. coli and Staphylococcus aureus*) were performed, using the following standards:

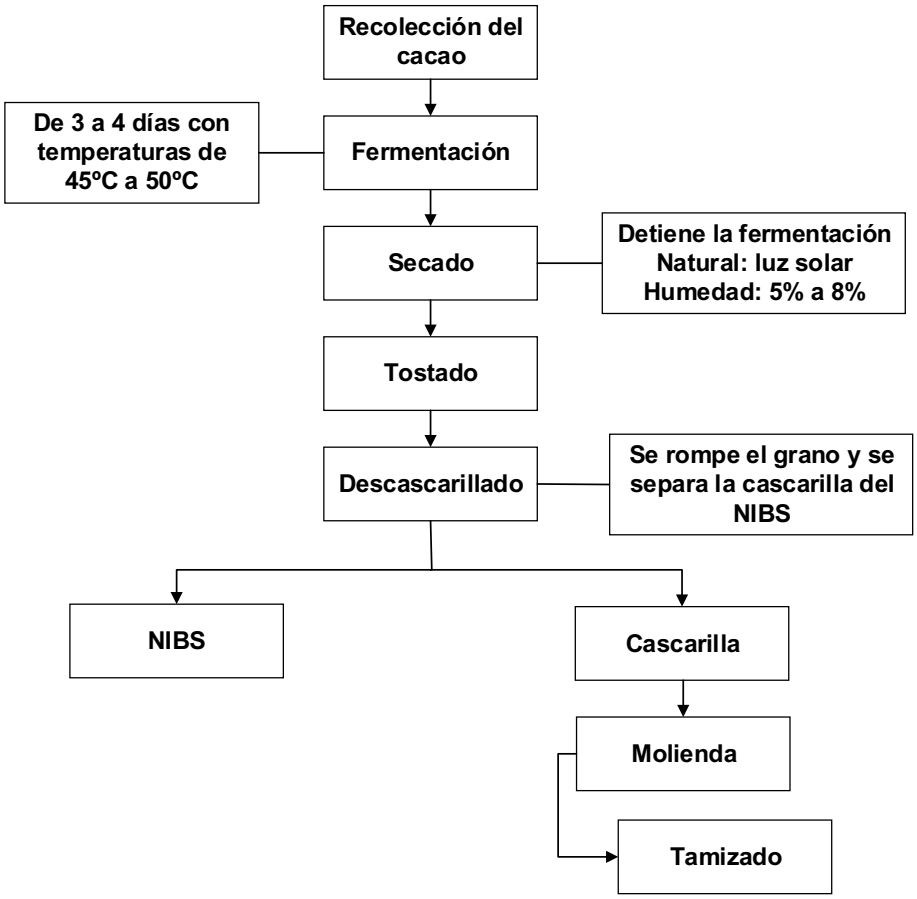
- Ecuadorian Technical Standard INEN, 1529-5 Microbiological control of food. Determination of the amount of mesophilic aerobic microorganisms.
- Ecuadorian Technical Standard INEN, 1529-11:98 Microbiological control of foodstuffs viable molds and yeasts detection.
- Ecuadorian Technical Standard INEN, 1529-7:2013 Microbiological control of food. Determination of coliform microorganisms by colony count technique. Ecuadorian Technical Standard INEN, 1529-14:2013

Microbiological control of food Staphylococcus aureus. Counting on sowing plate by surface extension. For the determination of shelf **life**, the shelf life study was carried out using an evaluation time of 30 days at refrigerated temperature of the infusions for which 7 controls were carried out for each of the treatments, an initial one (day 1) on (day 5), (day 10), (day 15), (day 20), (day 25) and finally (day 30), using the following parameters. Organoleptic characteristics, degradation products, microbiological count.

Result

The flow chart on the method of obtaining cocoa husk powder is as follows, for which the operations to be followed are described as follows.

Table 2. *Process flow diagram*



Note: Process suggested by the author.

At reception, 5 kilos of fermented cocoa beans of the Nacional variety arrived with an initial humidity of 5-8%.

For drying, the cocoa was placed on trays lined with aluminum foil at a temperature of no more than 45 °C for a period of approximately 24 hours until it reached a humidity of 7%. This process was carried out in the drying tunnel of the food processing laboratory of the fcial-uta.

Roasting was carried out at 145°C for 45 minutes to one hour in a gemmy model yco oven.

The husking was done manually, where the Nibs were separated from the husk, and from this point on, the husk was used exclusively.

The husk grinding was carried out in a hammer mill operated at 510 rpm, Weber Bros & White Metal Works INC. model 49419.

In the sieving the particles were separated according to the size in coarse sieve #10, intermediate #20 and fine sieve #30, being of interest for the processing of the husk the particle size of 0.595 mm of 28 mesh /in, in the sieve number 30, was used the BICO sieve, INC. Porter Sand Shaker, model: 5K909A.

The first step was to cut a one meter long piece of polyethylene paper, then fold it in half so that both edges are exactly the same. To obtain the bags it is important to make the side seals and then cut each one of them. While filling the bags with 1.5 grams of ground material. It is important to make sure that the weight is correct, this is a critical factor because it is difficult to find a scale that weighs one gram. If the weights are not uniform, the flavor of the infusion will be plain and this may result in a poor sensory evaluation.

Once the bags have the appropriate weight, the tip of the hemp thread is inserted into the bag and the bag is sealed (double sealing is recommended).

Preparation of medicinal herbs for blending

Reception: 1 kilogram of mint, 1 kilogram of chamomile and 1 kilogram of Stevia with 9 and 12% humidity were used.

Selection: The quality of dried leaf products depends considerably on the quality of the whole product that is processed for such reason those with the best physical characteristics were chosen and impurities removed.

Grinding: Grinding of the dried leaves was carried out in a hammer mill operated at 510 rpm Weber Bros & White Metal Works INC. model 49419.

Sieving: In this operation the particles were separated according to size into: coarse sieve #10, intermediate #20 and fine sieve #30, being of interest for processing the particle size of 0.595 mm of 28 mesh/in, in the sieve number 30, was used BICO, INC. Porter Sand Shaker, model: 5K909A.

Mixing: The different plants were weighed separately.

Filling the bags: The bags were filled with 1.5 grams of ground material. It is important to make sure that the weight is correct, this is a critical factor because it is difficult to find a scale that weighs one gram. If the weights are not uniform, the flavor of the infusion will be plain and this can result in a poor sensory evaluation. SEALING THE SACHETS: Once the sachets have the correct weight, the tip of the hemp thread is inserted into the sachet and the sachet is sealed (double sealing is recommended).

In the evaluation of the nutritional content of the raw material (cocoa-mint-chamomile husk powder) we have the following analyses of moisture, fat, pH and polyphenols.

For the analysis of the percentage of moisture in the raw material, moisture in the raw material for infusions is an important parameter in its quality. Due to its hygroscopic nature, this raw material can be easily contaminated during handling. With a high percentage of moisture, microbiological growth benefits, which translates into a deterioration of the material. (Macrae et al., 2003).

The moisture content obtained in the husk with an average of three replicates was 9.76% in the National variety husk, while in the mint samples it was 9.56% and in chamomile it was 10.0%, respectively, as shown in Table 3.

Table 3. *Moisture percentage (%H) values obtained in the raw material*

	% H			
Raw Materials	R1	R2	R3	$\bar{X}$
National Shell	9,6	9,8	9,9	9,76
Mint	9,4	9,7	9,6	9,56
Chamomile		9,9	10,1	

Average of 3 replicates. *Data* Selected by the Researcher, 2021

Analysis of fat in raw material

The fat content found in the national husk, with an average of three replicates, was 5.37%, according to previous studies carried out by (Lecumberri et al., 2007) The fat content found in the national husk with an average of three replicates was 5.37%, according to previous studies carried out by the company (Lumberri et al., 2007). While in the mint and chamomile samples no fat content was found, as shown in Table 4.

Table 4. *Values of fat percentage obtained in the raw material*

%Fat

Raw Materials	R1	R2	R3	$\bar{X}$
National Shell	5,29	5,44	5,39	5,37
Mint	0,00	0,00	0,00	0,00
Chamomile	0,00	0,00	0,00	0,00

Average of 3 replicates. *Data* Selected by the Researcher, 2021

Determination of pH in raw material

The pH is a symbol that indicates whether a substance is acidic, neutral or basic. The pH is calculated by the concentration of hydrogen ions, and is a factor that controls the regulation of many chemical, biochemical and microbiological reactions. (Pisabarro, 2003).

The pH content found with the average of three replicates was 6.9 % in the husk of the Nacional variety. While in the mint samples it was 6.9 and chamomile was 6.5 as shown in Table 5.

Table 5. *pH values obtained in the raw material*

pH

Raw Materials	R1	R2	R3	$\bar{X}$
National Shell	6,9	6,9	6,9	6,9
Mint	6,9	6,9	7,0	6,9
Chamomile	6,5	6,4	6,6	6.5

Average of 3 replicates. *Data* Selected by the Researcher, 2021

Polyphenol analysis (mg gallic acid/g) in the raw material

The average result of three replicates of the analysis of total polyphenols in the cocoa husk samples of Nacional, mint and chamomile varieties shown in Table 6 were 11.41, 4.74 and 6.61 mg gallic acid/g, respectively.

Table 6. *Total polyphenol values for the raw material*

	Abs760nm					(mg Gallic Acid/g)
Raw Materials	R1	R2	R3	_ X	Equation y=0.0057x - 0.0127	
Domestic husk	0,055	0,042	0,060	0,052	11,41	11,41
Mint	0,020	0,009	0,014	0,014	4,74	4,74
Chamomile	0,027	0,032	0,016	0,025	6,61	6,61

Average of 3 replicates. *Data* Selected by the Researcher, 2021

Proximal analysis

Table 7. *Factors, levels and treatments of the Research Project*

FACTORS	LEVELS	TREATMENTS		
		T1	**T2**	**T3**
Factor A (Husk variety)	National			
Factor B (Grass variety)	Chamomile Mint	5	5	
Factor C (% of husk)	Shell			
Factor D (Sweetener)	With Stevia			

Average of 3 replicates. *Data* Selected by the Researcher, 2021

For the significant determination between the bromatological properties (pH, acidity, humidity) and sensory properties in the proportions of cocoa husks to be used in the preparation of infusions.

Infusion pH analysis

pH measurements were made for each treatment. The data is reported in Table 8 and is the average of three determinations. This parameter allows controlling the decomposition process of the infusion because microorganisms can only grow in a narrow pH range.

Table 8. *pH values in the prepared infusion*

	pH			
	R1	**R2**	**R3**	**$\overline{X}$**
T2	6,90	7,00	7,00	6,96
T3	6,80	6,85	6,89	6,85
T1	6,80	6,90	6,80	6,83

Average of 3 replicates. *Data* Selected by the Researcher, 2021

Analysis of acidity in the infusion

The data determined for acidity are reported in Table 8, the results of Titratable Acidity in the 3 treatments for the preparation of the infusion were expressed in % of Citric Acid.

Table 9. *Average acidity results expressed in grams of citric acid per gram of product in all 3 treatments.*

	Acidity (g	**Citric Acid/ g**	**of product)**	
	R1	R2	R3	$\overline{X}$
T2	6,90	7,00	7,00	6,96
T3	6,80	6,85	6,89	6,88
T1	6,80	6,90	6,80	6,83

Average of 3 replicates. *Data* Selected by the Researcher, 2021

Moisture percentage analysis in the infusion

The results for the % moisture content are reported in Table 10, which were measured in triplicate.

Table 10. *Average result of % moisture in the 3 treatments.*

	% H			
	R1	R2	R3	$\overline{X}$
T2	9,60	9,60	9,60	9,60
T1	9,30	9,30	9,30	9,30
T3	8,90	8,90	8,90	8,90

Average of 3 replicates. *Data* Selected by the Researcher, 2021

Sensory evaluation

Table 11. *Composition of the levels corresponding to the study factors and treatments.*

	Description of factors			
T2	National Variety	with Chamomile 60% and Mint 5%.	Husk 25%.	With Stevia 10%.
T3	National Variety	with Chamomile 25% and Mint 50%.	Husk 15%.	With Stevia 10%.
T1	National Variety	with Chamomile 15% and Mint 5%.	Husk 70%.	With Stevia 10%.

Average of 3 replicates. *Data* Selected by the Researcher, 2021

Sensory evaluation

Color: The multiple range test shows that treatment 2 (National husk variety with 25%, chamomile 60%, mint 5%, and with Stevia 10%) has the highest rating for this sensory attribute with a mean of 3.993; followed by treatments T1 (National husk variety, with chamomile 15%, mint 5% and 70% husk with Stevia 10%) with a mean value of 3.951. Therefore, the high level values help to improve the color in the infusion.

Table 12. *Multiple range test for color by treatments.*

Treatments	Cases	LS Media
T2		3,993
T3		3,951

Average of 2 replicates. *Data* Selected by the Researcher, 2021

Aroma. - Tukey's multiple range test is shown for all treatments. The treatment with the highest value is T2 (National husk variety, with chamomile 60%, mint 5%, husk 25% and with Stevia 10%) with a mean of 4.069; followed by treatment T1 (National husk variety, with chamomile 15%, mint 5%, husk 70% and with Stevia 10%) with a mean value of 3.65. The influence of the high level values that help to improve the aroma in the infusion due to the presence of its own polyphenols, highly perceptible to the tasters, is noticeable.

Table 13. *Multiple range test for aroma by treatments*

Treatments	Cases	LS Media
T2		4,07
T1		3,65

Average of 2 replicates. *Data* Selected by the Investigator, 2021

Flavor: Tukey's multiple range test is shown for all treatments. Treatment T2 (National husk variety, with chamomile 60%, mint 5%, husk 25% and with Stevia 10%) has the highest valuation with an average of 4.96 being the one with the highest predilection by the tasters in terms of flavor (5: I like it), followed by treatment T3 (National husk variety, with chamomile 25%, mint 50%, 15% husk and with Stevia 10%) with an average of 4.15.

Table 14. *Multiple range test for flavor by treatments*

Treatments	Cases	LS Media
T2		4,96
T3		4,15

Average of 2 replicates. *Data* Selected by the Researcher, 2021

Acceptability: Tukey's multiple range test is shown for all treatments. It is observed that the T2 treatment (National variety of cascarilla with 60% chamomile, 5% mint at 25% cascarilla and 10% Stevia) has the highest rating with an average of 4.17 being the one with the highest preference by tasters in terms of acceptability (5: I like it), followed by the treatments: T3(National husk variety with chamomile 25%, mint 50%, at 15% husk and with Stevia 10%) and treatment T1 (National husk variety with chamomile 15% and mint 5% , at 70% husk and with Stevia 10%) with averages of 4.04 and 3.85 respectively.

Table 15. *Multiple range test for acceptability by treatments*

Treatments	Cases	LS Media
T2		4,17
T3		4,04
T1		3,85

Average of 2 replicates. *Data* Selected by the Researcher, 2021

***Analysis of the best** treatment*

Through the statistical analysis of the sensory evaluation of the infusion, it was established that **the best treatment is T2 (National husk variety, with 60% chamomile, 5% mint, 25% husk and 10% Stevia),** for having a higher evaluation for the tasters in the attributes of color, flavor, aroma and acceptability. Treatment T3 (National husk variety, with chamomile 25%, mint 50%, at 15% husk and with Stevia 10%), is the second best treatment with respect to the attributes of flavor and acceptability and is third in color and aroma. Treatment T1 (National husk variety, with 15% chamomile, 5% mint, 70% husk and 10% Stevia) is the third best treatment because it occupies the third place in aroma and acceptability and is the second best in color and odor.

Proximal analysis

The results of the analyses performed on the best treatment T2 (National variety of husk, with 60% chamomile, 5% mint, 25% husk and 10% Stevia) are reported, which were compared with a control that had 100% husk of the National variety. It is observed that the values reported for ash and protein for treatment T2 were 8.21% and 16% respectively, while for the control were: ash 8.41%, protein 16.2% Likewise, the values for fat and total carbohydrates were 3.40% and 58.49% in treatment T2, while for the control were carbohydrates 56.9% and fat 5.36%, noting that it is the carbohydrates that supply energy to the body, especially to the brain and the nervous system, thus providing this infusion with a good amount of energy. (Varela et al., 2012).

Microbiological analysis

Microbiological analysis is simply an inspection to assess the microbial load. That is why it is so important to inspect the food and make sure that it complies with current standards in order to be distributed. For the best treatment, the count of molds and yeasts, mesophilic aerobes, E.

coli and Staphylococcus aureus was determined based on INEN 2392. These tests were performed at the end of the preparation of the infusion, which was stored at a temperature of **18 °C±2** , **25 °C±2** and **35 °C±** 2. The time of 288 hours corresponds to 12 days, the time of 576 hours corresponds to 24 days and the time of 864 corresponds to 36 days. The results of these microbiological tests are shown in the following tables.

Table 16. *Average results and standard deviation of total mold and yeast counts (cfu/g) *10E-2 of the T2 treatment stored at 18, 25 and 35 °C as a function of time.*

t (h)	T 18°C			T 25°C			T 35°C		
	R_1	R_2	$\bar{X}\pm D_e^1$	R_1	R_2	$\bar{X}\pm D_e^1$	R_1	R_2	$\bar{X}\pm D_e^1$
0	0	0	0+0,00	0	0	0+0,00	0	0	0+0,00
288	0	0	0+0,00	0	0	0+0,00	0	0	0+0,00
576	200	100	150+70,71	100	100	100+0,00	0	0	0+0,00
864	400	300	350+70,71	300	100	200+141,42	0	0	0+0,00

Average of 3 replicates. *Data* Selected by the Researcher, 2021

Table17. *Results of the total aerobic mesophilic count (cfu/g)*10E-3of treatment T2*

t (h)	T 18°C			T 25°C			T 35°C		
	R_1	R_2	$\bar{X}\pm D_e^1$	R_1	R_2	$\bar{X}\pm D_e^1$	R_1	R_2	$\bar{X}\pm D_e^1$
0	47	50	48,50±2,12	51	42	46,50±6,36	66	43	54,50±16,26
288	41	34	37,50±4,95	47	45	46±1,41	55	51	53±2,83
576	29	34	31,50±3,54	42	40	41±1,41	51	45	48±4,24
864	21	29	25±5,66	33	31	32±1,41	49	37	43±8,49

Average of 3 replicates. *Data* Selected by the Researcher, 2021

Table 18. *Results of total E. coli count (cfu/g)*10E-1from treatment T2.*

t (h)	T 18°C			T 25°C			T 35°C		
	R_1	R_2	$\bar{X}\pm D_e^1$	R_1	R_2	$\bar{X}\pm D_e^1$	R_1	R_2	$\bar{X}\pm D_e^1$
0	0	0	0±0,00	0	0	0±0,00	0	0	0±0,00
288	0	0	0±0,00	0	0	0±0,00	0	0	0±0,00
576	0	0	0±0,00	0	0	0±0,00	0	0	0±0,00
864	0	0	0±0,00	0	0	0±0,00	0	0	0±0,00

Table 19. *Results of total Staphylococcus aureus count (cfu/g) *10E-2 of treatment T2.*

t (h)	T 18°C			T 25°C			T 35°C		
	R_1	R_2	$\bar{X}\pm D_e^1$	R_1	R_2	$\bar{X}\pm D_e^1$	R_1	R_2	$\bar{X}\pm D_e^1$
0	0	0	0±0,00	0	0	0±0,00	0	0	0±0,00
288	0	0	0±0,00	0	0	0±0,00	0	0	0±0,00
576	0	0	0±0,00	0	0	0±0,00	0	0	0±0,00
864	0	0	0±0,00	0	0	0±0,00	0	0	0±0,00

Average of 3 replicates. *Data* Selected by the Researcher, 2021

Estimated infusion shelf life based on cfu of best treatment.

For the determination of shelf life, the shelf life study was carried out for which an evaluation time of 30 days at refrigeration temperature of the infusions was used, for which 7 controls were carried out for each of the treatments, an initial one (day 1) on (day 5), (day 10), (day 15), (day 20), (day 25) and finally (day 30), using the following parameters: organoleptic characteristics, degradation products, microbiological count. Several predictive models can be used to calculate shelf life, but in this research work there was no loss of quality in the treatments in terms of organoleptic characteristics, nor was there any presence of fungi, bacteria or viruses in the T2 treatment.

Table 20. *Estimated useful life for the best-accepted treatment T2.*

Treatment	Time - Days	Variables - critical	Results
T2	1	Enterobacteriaceae presence	Negative
T2	5	Enterobacteriaceae presence	Negative
T2		Different odor	Negative
T2		Different flavor	Negative
T2		Mesophilic presence	Negative
T2		Different color	Negative
T2		Different texture	Negative

Data Selected by the Researcher, 2021

Macrae et al. (2003), suggests that the consumption of cocoa husks could have beneficial effects for health as those obtained with some seeds, fruits and vegetables, being an important source of natural antioxidants, which have been studied to inactivate free radicals in the oxidation process of the organism, preventing the appearance of cardiovascular and cancer

diseases, among others. The purpose of this descriptive research work is to create the design of an industrial process to produce cocoa husk tea, with great health benefits, and also to provide a new alternative for the consumption of people, it offers theobromine which is a powerful natural energizer equal or longer than caffeine, it is a source of tension and stress regulation as it stimulates the central nervous system.

Barén-Cedeño (2013)The study of the cocoa beans or cocoa beans is based on the fact that once the cocoa beans or almonds are extracted to obtain chocolate, only approximately 105% of the seed is used in its production, leaving behind potential raw materials, such as the husk, wasting the nutritional properties of its composition. In the present descriptive research, bibliographic data was taken on the proposal of a method to obtain cocoa husk for the subsequent production of tea or cocoa husk infusions.

(López, 2013)He states that cocoa husk nutritionally contributes as any other food with macronutrients (proteins, carbohydrates, lipids) and micronutrients (vitamins and minerals). Therefore, according to research conducted in books and internet magazines, cocoa husks are now known and are being used in a variety of by-products such as energy bars, cookies and fermented beverages.

(Cardona et al., 2002)in his work "Establishment of a database for the elaboration of nutritional content tables for animal feed", shows that due to the higher protein and fat content and the lower fiber content, cocoa husk becomes a more energetic raw material than soybean husk (*Glycine max*), it also presents a higher ash content. This descriptive research reports the results of the analyses carried out on the best treatment T2 of the husk infusion (National husk variety, with 60% dehydrated chamomile, 5% dehydrated mint, 25% National cocoa husk and 10% Stevia), which were compared with a control that had 100% national cocoa husk. It is observed that the values reported for ash and protein for treatment T2 were 8.21% ash and 16% protein, respectively, while for the control were: 8.41% ash and 16.2% protein, thus confirming the presence of protein and ash in the cocoa hulls in greater quantities.

(Soto, 2012)mentions that the results of ochratoxin were negative for all the samples analyzed, which means that there was no ochratoxin or that the amount was not detected by the applied method. In the present investigation for the determination of the shelf life of the infusion, an accelerated time test was used at three different temperatures (18, 25 and 35 °C), During approximately 72 days, the mold and yeast count was carried out by the shelf life study for which an evaluation time of 30 days at refrigeration temperature of the infusions was used, for which 7 controls were carried out for each of the treatments, an initial one (day 1) on (day 5), (day 10), (day 15), (day 20), (day 25) and finally (day 30), using the following parameters: organoleptic characteristics, degradation products, microbiological count, as an approximate indicator, defined T2 (National cocoa husk variety 25%, dehydrated chamomile 60%, dehydrated mint 5% and stevia 10%) as the best treatment.

Conclusions

The descriptive comparative study of the use of agroindustrial waste, cocoa husk (*Theobroma cacao L.*) National in the preparation of an infusion with medicinal plants such as dehydrated mint (*Menta arrensis*) and dehydrated chamomile (*Matricaria chamomilla L.*) using Stevia (*Stevia rebaudiana*) as sweetener showed that an infusion with excellent organoleptic attributes and with beneficial characteristics for the consumer can be obtained.

When characterizing the cocoa husk, it was determined that it has a higher amount of polyphenols with an average value of 11.41 mg Gallic Acid/g and in the medicinal plants, dehydrated chamomile obtained a higher amount of polyphenols with a value of 6.61 mg Gallic Acid/g compared to 4.74 mg Gallic Acid/g in mint, however, this value presents a lower amount in relation to the cocoa husk.

When comparing the values obtained for pH, acidity and % moisture, it was observed that, in the infusion, the variety and percentages of husk had a significant influence on the values obtained.

In relation to the sensory properties, it was determined that T2 was selected as the best treatment in which it was noted that the level of husk had an influence on Treatment 2 (T2) when evaluated by the tasters in terms of color, aroma, flavor and acceptability.

The shelf life of the infusion estimated by means of an accelerated time test at three different temperatures (18, 25 and 35 °C), for approximately 96 days, through the count of molds and yeasts as an indicator for the evaluation, defined T2 (with 60% dehydrated chamomile, 5% dehydrated mint, 25% national cocoa husk, and 10% Stevia) as the best treatment, for which it was determined in a time of 72 days.

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