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Production of cookies with partial substitution of wheat flour for pole bean and castilla bean flour

Produção de biscoitos com substituição parcial da farinha de trigo por farinha de feijão verde e feijão castelha

Elaboración de galletas con sustitución parcial de harina de trigo por harina de fréjol de palo y fréjol castilla

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ABSTRACT

Background: The substitution of flours was proposed to determine which is more suitable for cookie production, utilizing the processing of pole and castilla beans. **Methods**: A randomized design (DCA) was used to create 8 treatments and a control, applying substitution percentages of 10%, 20%, 30%, and 40%. Treatments were sensorially evaluated by a panel of 30 untrained judges, followed by statistical analysis. **Results**: The treatment containing 40% castilla bean flour and 60% wheat flour was best rated with the following means: 3.70 in color, 3.70 in aroma, 3.77 in taste, and 3.83 in texture. Physicochemical tests resulted in carbohydrate content of 53.81%, ash content of 0.93%, fiber content of 1.90%, fat content of 23.15%, moisture content of 10.03%, protein content of 12.08%, and a pH of 6.74. The product did not exceed the maximum limits set by the INEN 2085 standard. **Conclusions**: It was identified that the combination of castilla bean and wheat flour is beneficial for enhancing the nutritional contribution in cookie production, rendering them suitable for human consumption.

Keywords: cookie, flour, pole bean, castilla bean, sensory evaluation.

RESUMO

Antecedentes: A substituição de farinhas foi considerada para testar qual é a mais adequada para a produção de biscoito, usando o processamento de feijão pole e castilla. **Métodos**: Desenho aleatório (RWD) para a formulação de 8 tratamentos e um controle, nos quais foram aplicadas porcentagens de substituição de 10%, 20%, 30% e 40%. Os tratamentos foram avaliados sensorialmente por um painel de 30 juízes não treinados e foi realizada uma análise estatística. **Resultados**: O tratamento contendo 40% de farinha de feijão castilla e 60% de farinha de trigo foi o melhor avaliado com as seguintes médias: 3,70 para cor, 3,70 para aroma, 3,77 para sabor e 3,83 para textura. Os testes físico-químicos resultaram em um teor de carboidratos de 53,81%, cinzas de 0,93%, fibra de 1,90%, gordura de 23,15%, umidade de 10,03%, proteína de 12,08% e pH de 6,74. O produto não excedeu os limites máximos estabelecidos pela INEN 2085. **Conclusões**: Foi identificado que a combinação de castela e farinha de trigo é útil para melhorar a contribuição nutricional na produção de biscoitos, tornando-os adequados para o consumo humano.

Palavras-chave: biscoito, farinha, feijão-caupi, feijão-caupi, avaliação sensorial.

RESUMEN

Antecedentes: Se planteó la sustitución de harinas para comprobar cuál es más apta para la elaboración de galleta, utilizando procesamiento de los fréjoles de palo y castilla. **Métodos**: Diseño al azar (DCA) para la formulación de 8 tratamientos y un testigo, en el cual se aplicaron porcentajes de sustitución 10%, 20%, 30% y 40%. Los tratamientos fueron evaluados sensorialmente mediante un panel conformado por 30 jueces no entrenados y se realizó un análisis estadístico. **Resultados**: El tratamiento que contenía una concentración del 40% de harina de fréjol castilla y un 60% de harina de trigo, fue el mejor evaluado con las siguientes medias: 3,70 en color, 3,70 en aroma, 3,77 en sabor y 3,83 en textura. Las pruebas fisicoquímicas dieron como resultado un contenido de carbohidratos del 53,81%, ceniza del 0,93%, fibra del 1,90%, grasa del 23,15%, humedad del 10,03%, proteína del 12,08% y un pH de 6,74. El producto no excedió los límites máximos establecidos en la norma INEN 2085. **Conclusiones:** Se identificó que la combinación de harina de fréjol castilla y de trigo es útil para mejorar el aporte nutricional en la producción de galletas, lo que las hace aptas para el consumo humano.

Palabras clave: galleta, harina, fréjol de palo, fréjol castilla, evaluación sensorial.

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The study demonstrates the feasibility of incorporating bean flours into cookie production, offering a practical solution to enhance nutritional content and diversify product offerings in the food industry
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INTRODUCTION

The bakery industry has been generally valued as one of the traditional industries in the world. As the years go by, the sector generates innovation through facilities, new technologies, equipment and raw materials for an extensive elaboration of products with different properties and characteristics, creating new consumer inclinations (Lideres, 2019). In Ecuador there is a low production of wheat, only 1% is consumed locally, corresponding to 7 thousand metric tons, but about 700 thousand to 800 thousand metric tons are needed, which leads to 99% of wheat imports (Cadena, 2022). In this aspect, plus the high consumption of wheat flour in the industries, generates a problem for the bakery sector, which must rely on international suppliers, since demand far exceeds domestic supply. With respect to this demand problem, it could be solved with the use of flours from grains, such as: pole beans and castilla beans; however, their production is limited, in addition to the lack of information about their nutritional value, which leads to the low demand for them. It should be noted that both are not used by the bakery industries to create added value, therefore, there are no cookie products with these two types of grains. Therefore, the main cookie industries work with a specialized production based on wheat flour, without taking into account the nutritional value that other flours Retrieved form native crops can offer.

An alternative that could cover the unsatisfied demand for wheat flour could be the combination of flours such as pole bean and castilla bean.

Dried beans are used as food for human consumption (Ehlers & Hall, 1997). In Africa and India, the liquor from castilla bean seeds is used medicinally for colds (Siddhuraju & Becker, 2007). The remains of castilla beans are used as green manure in crops for soil improvement (Ehlers & Hall, 1997). Moreover, it is also used in cattle feed (Timko et al., 2008).

The pol bean is a grain, which is located in different parts of the world, specifically in Africa, Asia and America. According to research by the Food and Agriculture Organization of the United Nations (FAO) states that about five million hectares of this bean planted in the world, so that it becomes the sixth most important legume that is part of animal and human nutrition, providing proteins, carbohydrates and minerals (FAO, 2018). It is characterized by having a high nutritional value in protein, lower in fat and moderate portions of fiber, carbohydrates and minerals, which makes it a fundamental piece, leading it to the incorporation of a healthy diet for people. Table 1 shows the nutritional values of pole beans.

Table 1. Nutritional value of pole beans in 100 g.

Description	Unit	Quantity
Calories	Cal	336
Humidity	G	14
Proteins	G	19,5
Fats	G	1,4
Carbohydrates	g	64,4
Ash	mg	3,7
Calcium	mg	100
Phosphorus	mg	400
Iron	mg	4,5
Thiamine	mg	0,61
Ascorbic acid	mg	4

Source: own elaboration with research data

Castilla bean is a grain crop from the African continent, however, this bean is distributed in tropical and subtropical territories, so that the crop can withstand high temperatures and times of drought compared to other beans. This species stands out among others because it contains a significant value in components such as protein and carbohydrates. Table 4 specifies the nutritional value of castilla beans.

Table 2. Nutritional value of the castilla bean

Components	Percentage%
Proteins	23
Carbohydrates	56
Fats	1,3
Fiber	4
Ash	3,5

Source: own elaboration with research data

Cookies contain a high energy value that is acquired at the moment of preparing the dough with main ingredients such as: flour, vegetable or animal shortening, sugar and different edible flavorings (González & Valencia, 2013). Therefore, it is established a low water index and a considerable number of fat, between 12-26%, and sugar of approximately 10-38%, likewise, a higher caloric density that exceeds 400 Kcal; being data that vary depending on the type of cookie (Hernández et al., 2014).

In Peru, a study was conducted on "Preparation of sweet biscuits partially substituting wheat flour with raw and precooked pigeonpea (Cajanus cajan L) flour" (Caldas, 2021). The aim of this study was to evaluate the effect of the substitution of raw and precooked pigeonpea flour, from 10% to 40%, on the characteristics of biscuits. Eight samples, including a control, were obtained for organoleptic evaluation. The treatment that received the highest score from the panelists was then subjected to physico-chemical and farinographic analyses in order to demonstrate its nutritional value and the characteristics of the flours used in the accepted treatment. The results showed that the sweet biscuit selected on the basis of the sensory evaluation was the treatment that replaced 30% of the wheat flour with precooked pigeonpea flour. This treatment showed a higher acceptance, presented a higher nutritional value and showed favorable characteristics for making biscuits.

The research on the ''Elaboration of cookies fortified with Phaseolus vulgaris L. (Castilla bean) and Bactris gasipaes HBK (Pijuayo) flour for human consumption" for the development of precooked flours of the two species reached a yield of 40.4% of pijuayo and 40.54% of castilla bean, presented favourable results in the elaboration of cookies with the formulation of 15% where it is possible to use percentage in the optimal pijuayo and castilla bean flour. After 60 days of storage, the finished product did not show relevant figures in the composition of the cookie both in the microbiological and physicochemical analysis, which means that the product is qualified for consumption (Cavero, 2010).

Peñafiel's study in 2022 was based on four treatments and a control, where they used fixed percentages of 70% brown rice flour and 30% carob and pigeon pea flour. As a result, treatment 1 with concentrations of 70% brown rice flour + 5% carob and 25% pigeon pea flour was the best qualified sample in organoleptic attributes. In addition, nutritional and microbiological properties were evaluated over a period of 0, 10 and 20 days. The nutritional and microbiological values obtained are within the parameters established by INEN 2085. The purpose of this study was to carry out the physicochemical and microbiological analyses within a period established by the researcher, which corresponds to the treatment of greater acceptance by the sensory panelists in order to determine the nutritional properties and shelf life of the product.

The main objective of this study was to identify products that could partially replace the raw material, specifically flour from pole beans and castilla beans. This would allow for innovation in the healthy snack market. Additionally, a sensory analysis was conducted to determine the appropriate formulation for cookie production. Finally, a microbiological and physicochemical analysis was conducted to estimate the shelf life and nutritional value of the most acceptable cookie.

MATERIALS AND METHODS

The present research was carried out through an experimental design, where different percentages of flour of pole beans and castilla beans were used, with the purpose of obtaining the treatment that presents the best acceptability in its organoleptic properties in order to later carry out the respective physicochemical and microbiological analyses.

Raw material and production of bean flour and castilla bean flour:

Based on the authors Caldas (2021) and Cavero (2010) it is possible to obtain a greater precision of the study that was carried out in this thesis with the purpose of being able to determine each one of the processes to elaborate the bean flours of pole and castilla beans, following each one of the parameters established for the production of the cookies, following a flow diagram.

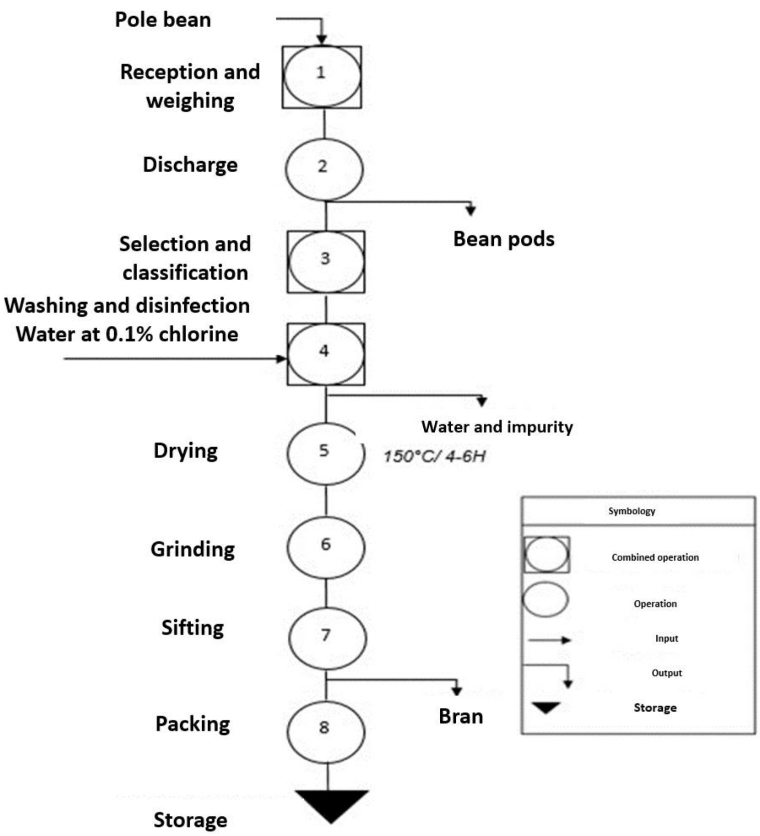
A balance of matter or mass was carried out on the flour of pole bean and castilla bean, to determine the yield of the process. Likewise, the cookie with the best treatment followed the following production:

Flour from pole beans

- Reception and weighing: the pole bean pods were acquired in good condition. This raw material was obtained in the Rocafuerte canton market. Subsequently, 10 kg of pole beans were used for weighing.
- Shelling: in this process, the beans that are attached to the pod are removed, which was done manually.
- Sorting: the beans were sorted based on criteria such as color, size, and texture, and those with defects were removed from the production line.

- Washing and disinfection: The beans were washed with abundant water, in order to eliminate any impurities or solid residues that could affect the quality of the product. In addition, hypochlorite was used as a food disinfectant.
- Drying: the beans were placed on a stainless steel tray and then placed in an oven at a temperature of 150°C for approximately four to six hours.
- Milling: once the drying time was over, the dried beans were cooled and then processed by a manual mill; this procedure was carried out three times in order to reach the appropriate particle size.
- Sifting: after crushing the beans, a sifter of different sizes was used in this process to obtain a fine flour without lumps.
- Packaging: the flour Retrieved from the pole beans was packaged in airtight bags.
- Storage: the final product was stored in a dry and clean place at room temperature, to be used later in the preparation of cookies and different analyses.

Figure 1. Flow diagram of pole bean flour



Source: own elaboration with research data

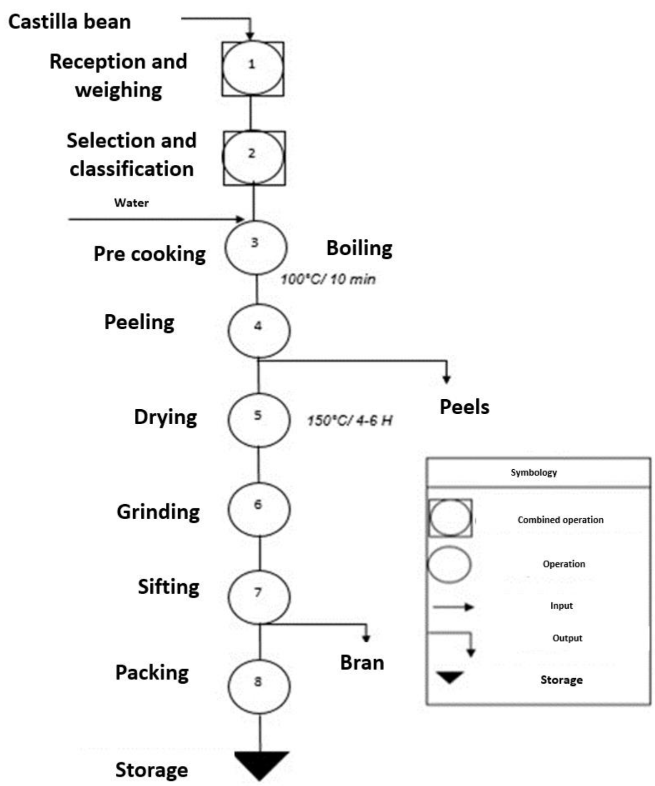
Castilla bean flour

- Receipt and weighing: 10 kg of castilla beans were received at the Esmeraldas municipal market, where quality control was carried out by verifying the condition of the raw material.
- Selection and classification: the beans were classified according to their characteristic color and good condition.
- Pre-cooking: the beans were immersed in water at a boiling temperature of 100°C for 10 minutes.
- Peeling: the bean shells were removed by hand.
- Drying: the beans were placed in an oven and subjected to a temperature of 150°C for four to six hours.
- Milling: once the drying time was over, the beans were cooled and then taken to the mill to obtain the castilla

bean flour.

- Sifting: this process was carried out to obtain a fine flour without lumps.
- Packaging: the flour obtained was packaged in airtight bags.
- Storage: the bags were stored in a cool, dry place, free of any contaminants that could affect the final product.

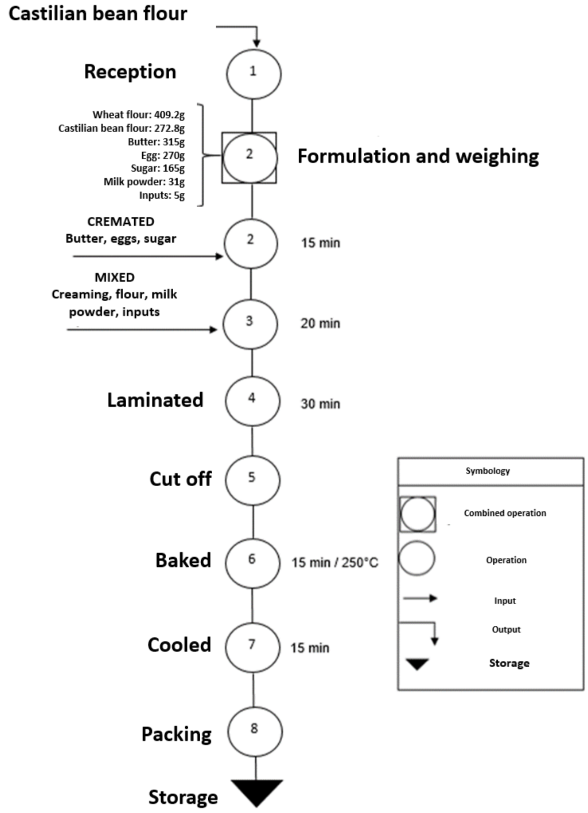
Figure 2. Flow diagram of castilla bean flour



Source: own elaboration with research data

- Reception: the raw material and other inputs were inspected to ensure that they were in optimum condition.
- Weighing: the corresponding weighing was carried out according to Table 7, which establishes the percentages of the flours used in the cookie formulation.
- Creaming: in this process the ingredients such as: sugar, eggs and butter were placed in a bowl to be beaten for 15 minutes until a smooth and creamy consistency was achieved.
- Mixing: the flours, powdered milk and other ingredients are mixed and then the cream is added; all the ingredients are mixed for 20 minutes until a homogeneous mass is obtained.
- Laminating: at this stage, the dough is rolled out with a wooden rolling pin before moving on to the next process.
- Cutting: with the help of a circular mold, the dough was cut into individual parts, which were then placed on a tray with waxed paper.
- Baking: the trays containing the cookie dough were placed in the oven at a temperature of 250°C for 15 minutes.
- Cooling: the cookies were cooled for 15 min to room temperature.
- Packaging: the cookies were packaged in Ziploc bags with their respective labels.
- Storage: each bag of cookies was stored at room temperature.

Figure 3. Best Treatment Cookie Flowchart



Source: own elaboration with research data

The treatments considered were classified into: factor A corresponds to the percentages of flour in bean base, changing to wheat flour, and factor B is related to the types of beans such as: pole beans and castilla beans. In addition, in each factor, the levels were established as detailed. The following are the levels for each factor:

Factor A levels

-a1 : 10% of bean flour in wheat flour

-a2 : 20% of bean flour in wheat flour

-a3 : 30% of bean flour in wheat flour

-a4 : 40% of bean flour in wheat flour

Factor B levels

-b1 : Pole bean meal

-b2 : Castilla bean meal

For the experimental design, a Completely Randomized Design (CRD) was developed, which consists of the comparison of two or more treatments that are randomly selected and their experimental units must be homogeneous (Díaz, 2006). It should be noted that, in this research we worked with eight treatments and one more as a control. It was evaluated through a sensory test, which was made up of thirty people who were judges without previous training. Then, for the experimental values of each treatment, 682 grams of flour were used in general, using the previously mentioned formulation adjusting the percentages of the flours of the two types of beans to replace wheat flour; the other inputs were models in all the formulations for the eight types of cookies, together with the control treatment, partially replacing wheat flour by bean flours with their respective percentages of 10, 20, 30 and 40% for the manufacture of the cookies. Table 3 shows the experimental quantities:

Table 3. Experimental quantities

Ingredients (g)	Treatments								
	a0	a1b1	a2b1	a3b1	a4b1	a1b2	a2b2	a3b2	a4b2
Flours									
Wheat flour	682	613,8	545,6	477,4	409,2	613,8	545,6	477,4	409,2
Bean flour stick	-	68,2	136,4	204,6	272,8	-	-	-	-
Bean flour castilla	-	-	-	-	-	68,2	136,4	204,6	272,8
Total		682	682	682	682	682	682	682	682
Other inputs									
Baking powder	2	2	2	2	2	2	2	2	2
Powdered milk	31	31	31	31	31	31	31	31	31
Essence	1	1	1	1	1	1	1	1	1
Sugar	165	165	165	165	165	165	165	165	165
Salt	2	2	2	2	2	2	2	2	2
Egg	270	270	270	270	270	270	270	270	270
Butter	315	315	315	315	315	315	315	315	315

Source: own elaboration with research data

Sensory Analysis

Samples of sensory studies that facilitated the determination of the most acceptable sample were carried out with the collaboration of 30 untrained judges, students of the *Pontificia Universitaria Católica del Ecuador, Esmeraldas*, aged between 18 and 25 years old. Each judge was given ten grams of product for each of the nine treatments where they rated the attributes of the cookies, such as: color, smell, flavor and texture, by means of a tasting sheet shown in Annex 1 through the hedonic scale of five categories.

Physicochemical Analysis

The cookie with the highest acceptance was subjected to physicochemical tests in the laboratory of Seidlaboratory Cia. Ltda. In order to determine the nutritional value such as: humidity, ash, fiber, protein, carbohydrates, pH.

Microbiological Analysis

The analysis of the shelf life of the most accepted cookie was established, in order to examine if there is the presence of microorganisms that affect the quality of the product that will be presented after a few days, in which the following analyses were performed: determination of mold, yeast and mesophilic aerobes in a period of 0, 7 and 14 days to determine the count of colony-forming units in the most accepted cookies.

Statistical analysis

Once the results were compiled, a simple analysis of variance was performed for each organoleptic aspect with a significance level of ▪=0.05 based on the hypotheses H0 and H1, presented below:

$$H_{0,}: \mu_0 = \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7 = \mu_8$$

$$H_1: \text{There is } \mu_i \neq$$

A simple analysis of variance (ANOVA) and a Tukey's multiple comparison test at a 0.05% confidence level were performed to find significant differences between the means of the research treatments. The experimental data were processed using the Infostat statistical program.

RESULTS AND DISCUSSION

The balances obtained in Tables 4, 5 and 6 show the material balances of the process of obtaining the best-treated bean meal, bean meal and cookie.

Table 4. Balance of matter of pole bean flour

Process movement				Yield %	
Operations	Input (Kg)	Output (Kg)	Continous (Kg)	Operation	Process
Reception	10	0	10	100	100
Shelling	10	1,08	8,920	89,200	89,20
Selection	8,92	0,53	8,390	94,058	83,90
Washing	8,39	0,025	8,365	99,702	83,65
Drying	8,365	2,48	5,885	70,353	58,85
Milling	5,885	0,8	5,085	86,406	50,85
Sieving	5,085	0,32	4,765	93,707	47,65
Packaging	4,765	0,05	4,715	98,951	47,15
Stored at	4,715	0	4,715	100	47,15

Source: own elaboration with research data

A low value was identified in the hulling stage, due to the loss of the hulls after the detachment of the grains (10.8%); on the other hand, a high value of loss in drying (24.8%), leaving a yield per process of 47.15%.

Table 5. Balance of matter of castilla bean flour

Process movement				Yield %	
Operations	Input (Kg)	Output (Kg)	Continous (Kg)	Operation	Process
Reception	10	0	10	100	100,00
Selection	10	0,2	9,800	98,000	98,00
Precooking	9,8	0,1	9,700	98,980	97,00
Shelling	9,7	1,8	7,900	81,443	79,00
Drying	7,9	2,125	5,775	73,101	57,75
Grinding	5,775	0,4	5,375	93,074	53,75
Sieving	5,375	0,27	5,105	94,977	51,05
Packaging	5,105	0,08	5,025	98,433	50,25
Stored at	5,025	0	5,025	100	50,25

Source: own elaboration with research data

Meanwhile, for the castilla bean flour, high and low values of losses were obtained in the two corresponding stages, such as: peeling (18%) and drying (21.25%). With respect to the precooking process, this helps the separation of the bean hull and facilitates milling, thus having a higher yield of 50.25%. The balance of matter of the best-treated cookie process yielded the following results:

Table 6. Balance of matter of the most popular cookie process

Process movement				Yield %	
Operations	Input (g)	Output (g)	Continuous (g)	Operation	Process
Heavy	1468	0,025	1467,975	100	100,00
Cremation	750	0,8	749,2	99,893	51,04
Mixing	1465,2	16,6	1448,6	98,867	98,68
Laminate	1448,6	0,25	1448,35	99,983	98,66
Cut	1448,4	85,34	1363,01	94,108	92,85
Baking	1363,0	185,6	1177,41	86,383	80,21
Cooling	1177,4	0,025	1177,385	99,998	80,20
Packaging	1177,4	0,0125	1177,3725	99,999	80,20
Stored at	1177,4	0	1177,3725	100	80,20

Source: own elaboration with research data

The significant losses obtained in the mixing (1.13%) and baking (12.64%) stages are reflected, resulting in a yield in the production line with a value of 80.20% for the production of the cookie using castilla bean flour as raw material.

The analysis of variance showed that the p-values corresponding to each organoleptic aspect were lower than the nominal significance value proposed, so we proceeded to perform Tukey's multiple comparison test.

Table 7. Tukey's multiple comparison test

N°	Treatments	Color	Aroma/Smell	Taste	Texture	Average
0	Witness 100% HT	2.97 bc	3.47 abc	2,90 b	3,10 a	3.11 abc
1	10%HFC + 90%HT	3.13 abc	3.53 abc	3.37 ab	3,57 a	3.40 abc
2	20%HFC + 80%HT	2,90 c	3.07 bc	3.07 ab	3,13 a	3.04 abc
3	30%HFC + 70%HT	2,77 c	3.10 abc	2,93 b	3,20 a	3.00 abc
4	40%HFC + 60%HT	3,70 a	3,70 a	3,77 a	3,83 a	3,75 a
5	10%HFP + 90%HT	3.20 abc	2,93 c	2,77 b	3,10 a	3.00 abc
6	20%HFP + 80%HT	3.27 abc	3.30 abc	3,00 b	3,53 a	3.28 abc
7	30%HFP + 70%HT	3.60 ab	3.57 ab	3.40 ab	3,43 a	3.50 ab
8	40%HFP + 60%HT	3.20 abc	3.17 abc	2,97 b	3,33 a	3.17 abc

Source: own elaboration with research data

The means established in the nine treatments can be seen, and in each one of these the evaluated attributes are presented, for which, the color characteristic shows that treatment four stands out with a higher mean of 3.70, as opposed to treatment three that obtained a mean of 2.77 with a lower acceptability.

For the aroma characteristic, it was identified that treatment four continues to maintain a mean of 3.70, while treatment five presents a lower mean of 2.93. As for the flavor characteristic, it was found that treatment four presented a mean of 3.77, in contrast to treatment five, which continues to be the least accepted with a mean of 2.77.

In relation to the texture characteristic, this indicates that treatment four reached a higher mean of 3.83; in contrast to treatments five and the control, which present similarities in their means of 3.10.

In addition to the above, it was found that treatment four was the one that presented the most adequate formulation for the preparation of the cookies, since it obtained the highest average acceptability in all sensory characteristics.

To determine the nutritional properties, a physicochemical analysis was carried out for treatment 4 with the proportions of 60% wheat flour and 40% castilla bean flour, the product with the highest sensory acceptability in relation to what was evaluated by the judges, where a sample of 218.4 grams of the manufactured product was used.

Table 8. Physicochemical composition at the most accepted treatment.

Physicochemical testing	Method	Unit	Results
Carbohydrates	Calculation	%	53,81
Ash	SEF-C AOAC 923.03	%	0,93
Crude Fiber	SE.MI AOAC 978.10	%	1,90
Total fat	SEF-G AOAC 922.06	%	23,15
Humidity	SEF-H AOAC 925.10	%	10,03
Protein F=5.70	SEF-PDU AOAC 990.03	%	12,08
pH (10%)	SEF-pH AOAC 943.02	·	6,74

Source: own elaboration with research data

According to the data acquired through the physicochemical analysis, highlighting that the chosen cookie has a high content of carbohydrates 53.81%, total fat 23.15% and protein 12.08%; values that, due to the contributions of the inputs and the percentage of the castile bean flour used for the preparation of the cookie, are not within the parameters established by the Ecuadorian technical regulation INEN 2085; on the other hand, the values of humidity 10.03%, pH 6.74, crude fiber 1.90% and ash 0.93%, are within the parameters established by the Ecuadorian technical regulation INEN 2085.

Microbiological analysis showed the following results:

Table 9. *Microbiological analysis in 0, 7 and 14 day periods*

Microbiological testing	Method	Unit	Analysis of startup	Stability of 7 days	Stability of 14 days
Total count of aerobes	SEM-RT (INEN 1529-5)	CFU/g	<10	<10	<10
Molds and yeast	SEM-ML (INEN 1529-10)	MPU/g	<10	<10	<10

Source: own elaboration with research data

Once the tests of the cookie composed of 40% castilla bean flour and 60% wheat flour were carried out, the results were lower than 10 CFU/g and UPM/g for the total count of mesophilic aerobes and molds - yeasts. For this reason, it was evidenced that during the experimental periods the characteristics of the product are preserved and, therefore, it is established that the shelf life is 14 days from the date of preparation.

In the present study, flours of pole beans and castilla beans were produced using a thermal treatment of dehydration of the beans using a convention oven with a time of 4 to 6 hours and a temperature of 150°C, followed by milling and sieving processes. In the case of the castilla bean, an additional precooking stage was carried out before the drying, shelling, milling and sieving stages due to the presence of hulls in the beans. The results indicated that the yield of castilla bean flour was 50.25%, while the yield of pole bean flour was 47.15%.

Comparing these results with those obtained by Caldas (2021), who produced pole bean flour using raw and precooked beans, it is observed that the yield of flour Retrieved form precooked and dried beans was 55.93%, while the yield of flour Retrieved form raw beans was 50.7%. These results suggest that precooking grains could be a strategy to improve the yield of pole bean flour. Likewise, the results acquired by Cavero (2010) were taken into consideration, corresponding to the precooking stage before the drying, hulling, milling and sieving stages, respectively, reaching as results the yields of pijuayo and castilla bean flour of 40.4% and 40.54%. For this reason, and after the results obtained in this study, it can be assured that the precooking stage significantly improves the yield of castilla bean flour.

Once the processes to obtain the bean and pole bean flours were completed, the cookies were formulated, giving each treatment a partial substitution of 10%, 20%, 30% and 40% of bean and pole bean in order to identify the formula with the best acceptance by the panelists when evaluating the organoleptic characteristics of color, aroma, flavor and texture.

As a result, it was found that the substitution of 40% wheat flour by castilla bean flour resulted in the best acceptance by the panelists in terms of organoleptic characteristics.

However, it is important to note that the results obtained in this study differ from those achieved by Caldas (2021), regarding the optimal formula for the inclusion of pole bean flour in the formulation of cookies. This could be due to the variability in external factors that can affect the sensory quality of baked products, such as baking temperature and baking time. Therefore, it is inferred that the inclusion of castilla and pole bean flour in the formulation of cookies can be a viable and nutritious alternative to improve the nutritional value of cookies; however, additional studies are needed to optimize processing conditions and improve the sensory quality of baked products containing bean flour.

Finally, the physicochemical and microbiological properties of a cookie formulated with castilla bean and wheat flour in different proportions were evaluated. The results indicate that the cookie of treatment 4 presented a high carbohydrate content with 53.81%, a low ash content with 0.93% and a significant amount of fat 23.15%; in addition, the pH value of the cookie was 6.74, which indicates that it is slightly acidic. However, it was observed that both the protein and moisture aspects presented values higher than those established in the NTE - IENENEN 2085 standard.

Thus, in comparison with previous studies, significant differences were found in the physicochemical and microbiological properties of the cookies evaluated. For example, Cavero (2010) and Peñafiel (2022), when evaluating a cookie with pijuayo and castilla bean flour and a cookie formulated with brown rice, carob and pigeon pea flour respectively, obtained results that coincide with those stipulated by the NTE - INEN 2085 standard.

For the microbiological analysis when evaluating the presence of microorganisms in the cookie sample in the time periods of 0,7 and 14 days; results were obtained indicating that the presence of aerobes, molds and yeasts was not detected in the sample, with a value of <10 CFU/g and MPU/g.

The absence of microorganisms in the cookie sample of the present study indicates that good hygienic practices were adequately followed in the processing of the product and its microbiological safety for consumption is guaranteed.

CONCLUSIONS AND FINAL REMARKS

The purpose of this research study was the elaboration of cookies with partial substitution of wheat flour by flour from pole beans and castilla beans. First of all, the processes involved in obtaining the flours for both beans were determined, which in the drying stage were carried out by means of an oven within a period of 4 - 6 hours at a temperature of 150°C for both beans; The processing yield for the pole bean flour was 47.15% and for the castilla bean flour 50.25%; therefore, the pole and castilla beans are excellent for obtaining flours for the manufacture of cookies.

Similarly, we worked with eight treatments using different percentages such as: 10, 20, 30 and 40% for both flours of the two beans with the purpose of combining wheat flour for the production of cookies; therefore, it was verified through an acceptability test that the cookie with the highest acceptability was the treatment four belonging to 60% wheat flour and 40% castilla bean flour catalogued as "I like it" by the judges. Treatment four was elaborated with 60% wheat flour and 40% castilla bean flour, from the nutritional point of view, presenting a carbohydrate percentage of 53.81%, fat of 23.15%, fiber of 1.90%, humidity of 10.03%, ash of 0.93%, pH of 6.74% and protein of 12.08%; thus, the nutritional contribution used was from the castilla bean flour, resulting in a cookie with an excellent source of energy and protein.

In the microbiological analysis of mesophilic aerobes and molds-yeasts, a value of <10 UFC/g and UPM/g was established, in this sense it is understood that the treatment of the analysed cookie is free of microorganisms, allowing a shelf life of 14 days, thus guaranteeing a product suitable for human consumption.

The research study on developing cookies with partial substitution of wheat flour by flour from pole beans and castilla beans demonstrates promising results, particularly in terms of acceptability and nutritional content. However, several limitations and future considerations should be acknowledged. Firstly, while the acceptability test indicates the preference for the 60% wheat flour and 40% castilla bean flour combination, further sensory evaluations may be necessary to assess consumer preferences across diverse demographics. Additionally, the study could benefit from a more comprehensive nutritional analysis, including micronutrient profiles and potential allergens. Moreover, future studies should delve into the sensory attributes and storage stability of the cookies to ensure their quality and safety over an extended period, beyond the initial 14-day shelf life established by microbiological analysis. Addressing these aspects will contribute to a more robust understanding of the feasibility and market potential of cookies incorporating bean flours as alternatives to traditional wheat-based products.

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