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Sensory evaluation of hamburger with soy meat as a partial substitute for beef

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ABSTRACT

The present research focused on the sensory acceptance evaluation of hamburger meat formulated with soy meat as a partial substitute for beef. The applied experimental design was a full 2^2 factorial design, with factors including the percentage of soy meat at levels of 40% and 50%, and the amount of seasoning at two levels of 2% and 2.5%. The bromatological characterization involved determining the percentages of protein, fat, nitrites, nitrates, and conducting microbiological analysis for total coliforms. The sensory evaluation included hedonic multiple comparison tests, which were applied to regular hamburger consumers. A significant number of judges, specifically 30 panelists, were involved to ensure objectivity in the results. The attributes evaluated in these tests were color, taste, and texture, which allowed for the identification of organoleptic changes in the substitution of plant-based meat. The statistical analysis indicated that the substitution of soy meat was not acceptable; however, formulation 1 received favorable evaluations. The quality evaluation criteria were measured using a scale of liking or disliking, depending on the attribute being evaluated.

Keywords: *soy meat, beef, hamburger, sensory analysis, hedonic tests.*

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Evaluación sensorial de hamburguesa con carne de soja como sustituto parcial de la carne de vacuno

RESUMEN

La presente investigación se enfocó en la evaluación de aceptación sensorial de carne de hamburguesa formulada con carne de soja como sustituto parcial de la carne de res. El diseño experimental aplicado fue un diseño factorial completo 2^2, con factores que incluyen el porcentaje de carne de soja en niveles del 40% y 50%, y la cantidad de condimento en dos niveles del 2% y 2.5%. La caracterización bromatológica involucró determinar los porcentajes de proteína, grasa, nitritos, nitratos y realizar análisis microbiológicos para coliformes totales. La evaluación sensorial incluyó pruebas múltiples de comparación hedónica, que se aplicaron a consumidores regulares de hamburguesas. Un número significativo de jueces, específicamente 30 panelistas, participaron para garantizar objetividad en los resultados. Los atributos evaluados en estas pruebas fueron color, sabor y textura, lo que permitió la identificación de cambios organolépticos en la sustitución de la carne a base de plantas. El análisis estadístico indicó que la sustitución de carne de soja no fue aceptable; sin embargo, la formulación 1 recibió evaluaciones favorables. Los criterios de evaluación de calidad se midieron utilizando una escala de gusto o disgusto, dependiendo del atributo evaluado.

Palabras clave: *carne de soja; carne de res; hamburguesa; análisis sensorial; pruebas hedónicas.*

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INTRODUCTION

Hamburger meat represents one of the markets with the highest number of sales and global growth. It is estimated that by 2050, the human population will reach 9 billion inhabitants, and the demand for meat will increase by 50-73% (Bonny et al., 2017). Therefore, the search for alternative protein products is necessary to meet the future needs of consumers. The consumption of plant-based products has generated a growing demand in recent years, driven by consumer concerns to replace foods that deplete natural resources (Dumont et al., 2013). Processes for the development of sustainable livestock production promote viable methods in favor of the ecosystem, nutrient cycles, among others, thus helping to generate eco-friendly alternatives (Zhang et al., 2021).

According to (Totosaus, 2007), meat products present two main issues: high fat content and sodium chloride. On the other hand, soy protein is a complete source of amino acids, such as isoleucine, leucine, lysine, methionine, cysteine, phenylalanine, valine, and histidine. However, the content of methionine and tryptophan, which are essential amino acids, is relatively low. Therefore, it is important to complement the diet with a combination of other foods to make the protein as complete as that from animal sources (Jiménez, 2006). Thanks to these properties, soy meat has become a popular option for those seeking to reduce their consumption of animal-based meat and opt for more sustainable plant-based alternatives (Torres y Torres & Tovar-Palacio, 2009).

Sensory evaluation is a discipline that has been developed with the aim of harnessing and enhancing the capacity of our senses to evaluate products and experiences (Severiano Pérez & Severiano-Pérez, 2019). What sets this type of analysis apart is that the person in charge of conducting it uses their own analytical instruments: the five senses (Cevallos-hermida et al., 2018).

This research focuses on the partial substitution of beef with soy meat in hamburgers, as well as the evaluation of its sensory acceptance. The objective is to obtain relevant information to determine formulations that are well-received in the local market and, at the same time, serve as a plant-based alternative to animal-based meat, providing a protein-rich option for consumers.

MATERIALS AND METHODS

The type of research conducted was descriptive and experimental in nature, and it was carried out at the Meat Laboratory of the Technical University of Machala.

Sample selection

The sample used is based on plant-origin protein obtained from soybeans (Glycine max) through physical processes such as grinding and thermal processes like cooking (Del Castillo et al., 2009). This protein will be incorporated into the formulation as a partial substitute for beef, providing the following nutritional properties indicated in Table 1.

Table 1. Nutritional properties of soy meat

Soy meat

Nutritional Information		Per 100 g
Energy	Kcal	365
Protein	g	48,7
Fat	g	2,6
Carbohydrates	g	36,8

Source. (Torres y Torres & Tovar-Palacio, 2009)

Hamburger meat was prepared with partial substitution of beef and soy meat, the latter being a rich source of plant-origin protein (Jiménez, 2006). The raw materials were obtained from suppliers in the production areas of the province.

Experiment design

In the research design stage, a descriptive method was chosen, aiming to select treatments that are statistically significant for the appropriate observation and description of their analytical variables (Del Castillo et al., 2009). In this regard, the applied experimental design corresponded to a complete 2^2 factorial design (Rojas et al., 2012). The factors were % of soy meat with levels 40% and 50% and seasoning quantity with two levels of 2% and 2.5%, as detailed below:

Treatments

F1 = 40% soy meat, 60% beef, with 2% hamburger seasoning.

F2 = 40% soy meat, 60% beef, with 2.5% hamburger seasoning.

F3 = 50% soy meat, 50% beef, with 2% hamburger seasoning.

F4 = 50% soy meat, 50% beef, with 2.5% hamburger seasoning.

2.3 Experimental Phase

During the experimental phase, the necessary steps to obtain the soy-based hamburger as a substitute for beef will be described in detail.

a) **Raw material reception stage:** To ensure product traceability, all relevant information was recorded in the Raw Material Entry Register (Cedeño & Álvarez, 2023).

b) **Input weighing stage:** A proper weighing process of products and inputs was carried out, providing information about possible variations that may arise (González Hernández, 2015).

c) **Grinding stage:** Beef, fat, and other ingredients and inputs were subjected to grinding, achieving the correct integration of components (Food and Agriculture Organization, 2014).

d) **Second weighing stage:** At this stage, the product obtained from the grinding process was weighed to proceed with the dosing of soy meat according to the pre-established treatments (Valdiviezo Carguacundo, 2010).

e) **Dosing stage:** It substantiates the weighing and production in the required quantities, aiming to ensure the quality of the product in question (Harold & Rojas, 2014). Soy meat was added to the previously obtained mixture.

f) **Homogenization stage:** Homogenization of the food product involves the breaking down of globules and fat particles, resulting in a smoother texture or, in some cases, a more viscous one (Martín-orúe, 2014)

g) **Molding stage:** This process was carried out to give the kneaded meat the appropriate shape, size, and texture.

Bromatological Characterization

Through bromatological analysis, we were able to determine the nutritional characteristics as well as the technical properties of the product (Zapata et al., 2014).

Protein Analysis

The method involves heating the treatment samples in a digester along with a digesting mixture of sulfuric acid and distilled wáter (Pan, 2011). The samples acquired a dark green color, to which caustic soda is added to decompose the organic nitrogen, resulting in a brown color. Three drops of an indicator sample are applied, which produces a green color. Then, boric acid is added drop by drop as a titrant, changing the color from green to peach. In this way, the percentage of protein is determined in relation to the amount of boric acid used (Kirk et al., 1996).

Fat Analysis

The determination of fat content involved obtaining an organic residue from the sample after its fat or ether extract had been extracted. This process was carried out using an extraction apparatus that utilizes ether and heat, as described by Pearson in 1993 and adapted from the standard (INEN 1344, 1996).

Nitrites and Nitrates Analysis

Nitrite has been shown to be highly effective in inhibiting the growth of C. Botulinum, especially at a pH close to 6.0, making it an efficient preservative. Meat samples were treated following the procedure recommended by the International Organization for Standardization (ISO 2019 e ISO 3001, 1975). For their analysis, a UV-Visible spectrophotometric method based on the diazotization technique was used. Studies have indicated that the optimal nitrite concentration varies between 15 and 150 ppm, depending on the producto (Vila et al., 2010). For the determination of nitrates, the cadmium reduction method was used, as indicated by (Loza et al., 2020). The permissible maximum limits are 125 mg/kg and 300 mg/kg for added and residual nitrates, respectively, especially in sodium nitrate.

Microbiological Analysis

Total Coliform Determination

The samples were analyzed using Petrifilm plates to detect the presence of coliforms. Coliforms form colonies with a red color, and the presence of gas bubbles is often observed. Sometimes, the gas can alter the shape of the colonies, causing them to contour around the bubble. The plates were incubated for 24 hours at a temperature of 30 to 35°C.

Sensory Analysis

In a study on hamburger meat, sensory evaluations were conducted to determine its qualitative characteristics, such as taste, color, texture, and acceptability. The evaluation involved 30 panelists who were regular consumers of processed meats. The meat was cooked and cut into 3-4 cm pieces, and each sample was presented to the panelists on labeled plates with random codes at room temperatura

(Rodriguez, 2013). Water was provided to cleanse the palate between samples. The analysis of the evaluation included the acceptance or rejection of the samples and comparisons between them (Hleap-Zapata et al., 2017). The panelists evaluated whether they accepted or rejected each sample and also made comparisons to identify differences between the samples.

Color, Flavor, and Texture Analysis

Color is crucial in meat products to detect visual anomalies. Standards are used to enhance visual evaluations (Sánchez, 2013). Visual appearance is the main characteristic in product selection, and meat color is considered the most relevant factor associated with freshness (Chamorro, 2010). Color was evaluated based on previously established natural characteristics.

Regarding the flavor of hamburger meat, it combines three elements: smell, aroma, and taste. Flavor distinguishes foods, and it can be perceived as sweet, salty, bitter, or sour when tasted with eyes closed and nose blocked (Vélez Jiménez, 2013).

Texture property was analyzed through touch, sight, and hearing, manifesting its attributes during the deformation of the food. In studies on the textural properties of meat products, a gel with soy protein and carrageenan has been used. These studies have shown that this gel improves water retention and thermal stability of processed meat products, regardless of their fat content (Soto-Simental et al., 2016).

Acceptance/Rejection Testing

Variables are quality characteristics that are quantified on a numerical scale, whereas attributes are quality characteristics expressed as acceptable or not acceptable. The objective of this test was to identify the organoleptic changes that occur when substituting beef with soy meat. Due to the particularities of this product, an acceptance/rejection test was opted for instead of using a hedonic scale (Oviedo, 2019).

Multiple Comparison Test

This type of test is suitable for evaluating different samples, assessing variations made in a formulation, or ingredient substitution, as in this case with soy meat. Therefore, the objective of this test was to identify the organoleptic changes that occur when replacing beef with soy meat (Saltos Bastidas, 2012).

RESULTS AND DISCUSSION

Initial Characteristics of Beef and Soy Meat.

Table 2 shows the bromatological characteristics of the raw materials used, beef, and soy meat.

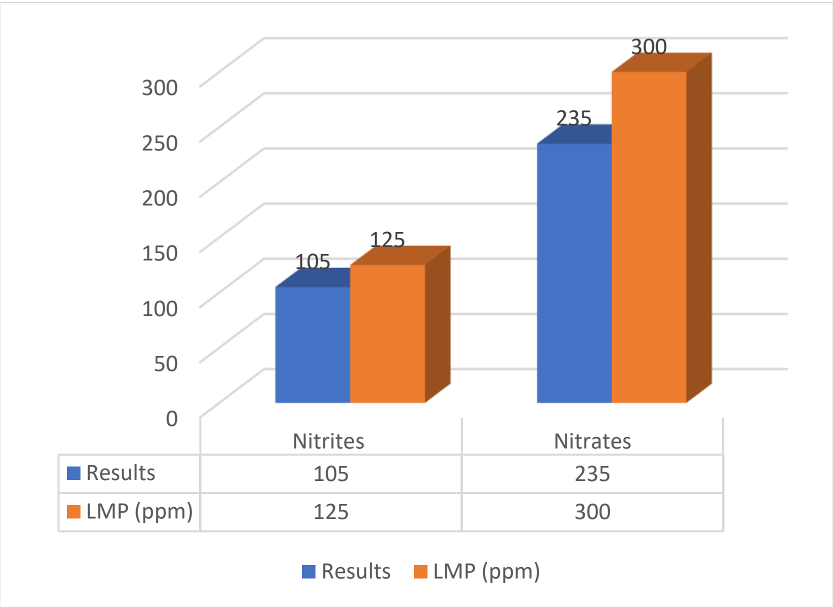
***Tabla 2.* Bromatological composition of beef and soy meat**

	Beef	*Soy*
Components	(%)	(%)
Humidity	60	45,5
Protein	17,7	50
Fat	21	2
Ashes	1,3	2,5

When examining Table 2, it can be observed that the mineral content or ash in the beef burgers is 2.5%, which is a higher value compared to beef. This value exceeds the allowed limit according to the INEN 786 standard.

Figure 3 presents the results of nitrite and nitrate levels in the hamburger. It has been verified that the concentration of nitrites and nitrates in the product is below the permissible maximum limits, indicating that it is suitable for consumption.

Figure 1. *Content of nitrites and nitrates in the prepared hamburger*



Microbiological Analysis

Total Coliform Determination

Table 3 presents the results of the total coliform evaluation. For cooked foods, the standard sets a limit of 104 CFU/g, and the data obtained in this study fall within the recommended ranges (María Laura Arias, 2018). According to bibliographic studies, a cooking time of approximately 15 minutes is optimal to ensure the absence of total coliforms in meat products (Noguera & Gigante, 2018).

Table 3. Determination of Total Coliforms.

Microorganism	***m.UFC/g***	***M.UFC/g***	***UFC/g***
Total Coliforms UFC/g	9	93	40

Characteristics of the Obtained Formulations

In the factorial design, formulations were determined to conduct the research, considering two factors: percentage of soy meat and seasoning concentration, each with two levels.

The following formulations were obtained to proceed with the sensory analysis of each treatment:

F1 = 40% soy meat, 60% beef, with 2% hamburger seasoning.

F2 = 40% soy meat, 60% beef, with 2.5% hamburger seasoning.

F3 = 50% soy meat, 50% beef, with 2% hamburger seasoning.

F4 = 50% soy meat, 50% beef, with 2.5% hamburger seasoning.

Table 3. *Factorial combination of the experiment**.***

Factor A (% soy meat)		***B1= 2%***	***B2= 2,5%***
LEVELS	A1= 40%	A1*B1	A1*B2
	A2= 50%	A2*B1	A2*B2

Sensory Analysis of the Obtained Formulations

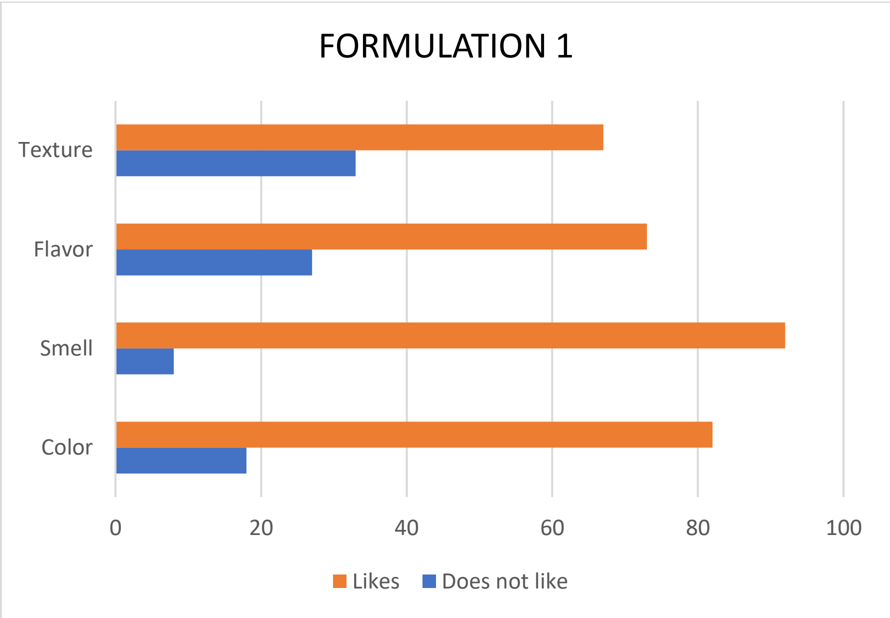
With the participation of 30 untrained panelists, a sensory analysis of acceptance/rejection and multiple comparison was conducted, and the following results were obtained for the 4 established formulations:

Acceptance/Rejection Tests

Evaluation of Color, Taste, Smell, and Texture of Formulation 1 Hamburger

According to Figure 12, the four sensory attributes evaluated were texture, smell, taste, and color. With 40% soy meat, 60% beef, and 2% hamburger seasoning, the "acceptance" evaluation obtained the highest percentage, indicating that the reduced amount of soy meat did not significantly impact the sensory evaluation of the hamburger. This suggests that soy meat does not have attributes that lead to rejection (Del Castillo et al., 2009). The sensory attributes of this variant were practically similar to those of commonly consumed hamburgers.

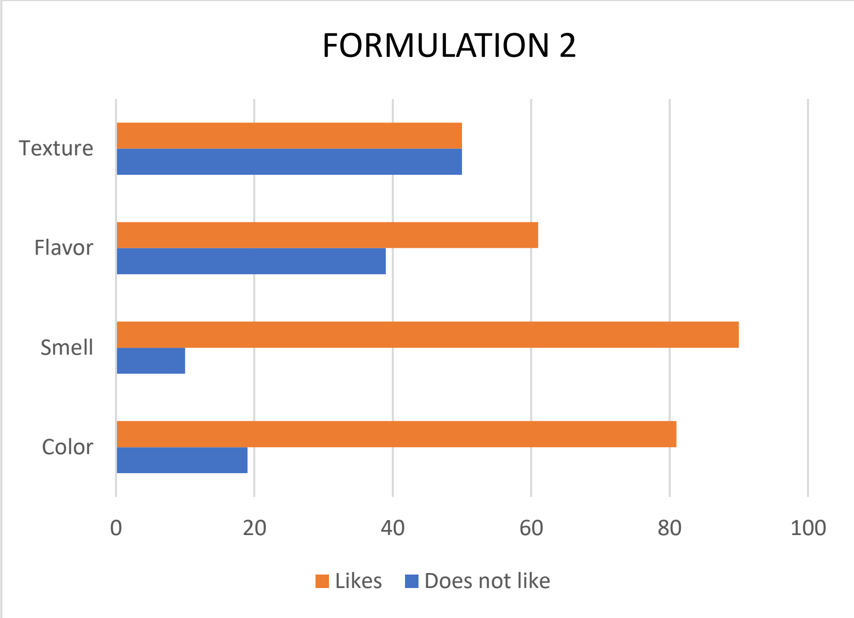
Figure 2. Evaluation of the color, taste, smell and texture of formulation 1 hamburger meat



Evaluation of Color, Taste, Smell, and Texture of Formulation 2 Hamburger

Figure 3 presents the acceptance/rejection responses for formulation 2, which consists of 40% soy meat, 60% beef, and 2.5% hamburger seasoning. The attribute with the highest acceptance is the smell, likely due to the higher addition of seasonings. The attributes of color and taste show similar levels of acceptance, indicating that the lower percentage of soy meat substitution did not significantly affect these characteristics.

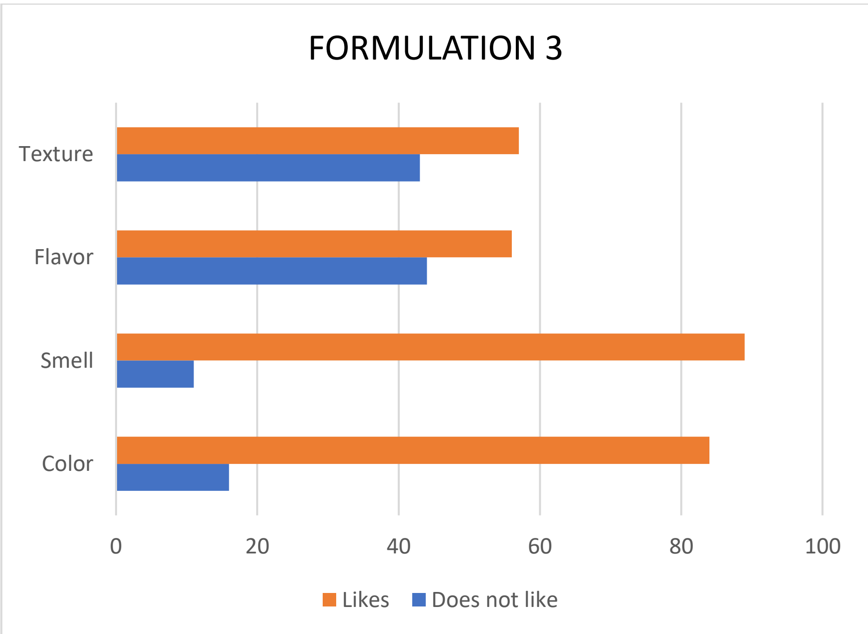
Figure 3. Evaluation of the color, taste, smell and texture of the hamburger meat of formulation 2



Evaluation of Color, Taste, Smell, and Texture of Formulation 3 Hamburger

Formulation 3, consisting of 50% soy meat, 50% beef, and 2% hamburger seasoning, showed good acceptance in color and smell. However, the responses regarding taste and texture were mixed, suggesting that it could be a viable option for potential consumers, but improvements may be needed to enhance its taste and texture.

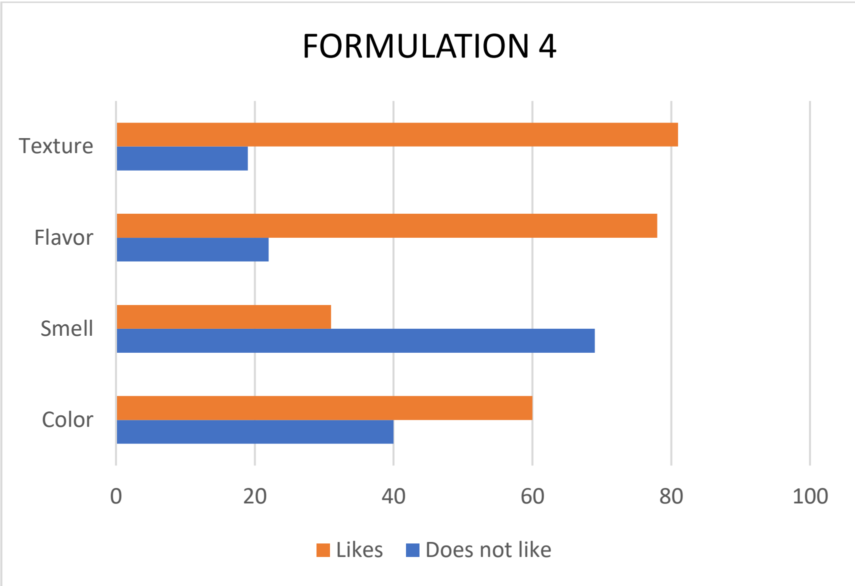
Figure 4. Evaluation of the color, taste, smell and texture of the hamburger meat of formulation 3



Evaluation of the color, taste, smell and texture of the hamburger meat of the formulation 4.

Formulation 4, composed of 50% soy meat and 50% beef with 2.5% hamburger seasoning, significantly affects the taste according to the evaluators. However, the texture, smell, and color are still accepted by the majority of consumers.

Figure 5. Evaluation of the color, taste, smell and texture of the hamburger meat of formulation 4



Analysis of Variance

An analysis of variance was conducted to examine the effects of the various levels of the two factors under investigation on the dependent variable. Table 4 presents the results of the analysis of variance for the four formulations studied.

Table 4. Analysis of variation of the experiment

Source	*Mean*	*Variance*	*N*
F1 = 40% soy meat, 60% beef, with 2% hamburger seasoning.	80,05556	0,84259	3
F2 = 40% soy meat 60% beef with 2.5% hamburger seasoning	70,21111	0,30037	3
F3 = 50% soy meat 50% beef with 2% hamburger seasoning	71,97407	0,04868	3
F4 = 50% soy meat 50% beef with 2.5% hamburger seasoning.	63,5563	0,25106	3
F= 383,10 ***p=5,60365E-9***			

Upon analyzing Table 4, a significant and evident difference ($p < 0.05$) can be observed among the four studied experiments. Notably, Formulation 1 exhibits the highest mean in the "Likes" category, with a value of 80%, suggesting that the combination of 40% soy meat, 60% beef, and 2% hamburger seasoning is the most widely accepted.

Multiple Comparison Test

The objective of this test was to evaluate the organoleptic changes that occur when substituting beef with soy meat in hamburgers. For this evaluation, regular consumers of hamburgers from the Faculty of Chemical and Health Sciences participated.

The test was performed on the following 4 formulations:

F1: 40% soy meat, 60% beef, with 2% hamburger seasoning.

F2: 40% soy meat, 60% beef, with 2.5% hamburger seasoning.

F3: 50% soy meat, 50% beef, with 2% hamburger seasoning.

F4: 50% soy meat, 50% beef, with 2.5% hamburger seasoning.

Table 5. Results of the multiple comparison test for hamburger meats in the four studied formulations:

	Attribute			
Sample	**Color**	**Flavor**	**Smell**	**Texture**
Control	1,1 (50)	1,22 (55)	1,60 (72)	2,02 (91)
F1	1,84 (83,33)	1,60 (72,22)	2,11 (94,94)	1,48 (66,67)
F2	1,18 (53,57)	1,35 (61,11)	1,97 (88,89)	1,1 (50)
F3	1,97 (88,89)	1,23 (55,56)	1,97 (88,89)	1,23 (55,56)
F4	1,35 (61,11)	1,47 (66,67)	1,72 (77,78)	1,84 (83,33)

It can be observed that the panelists did not experience significant alterations and correctly identified the control sample, as the average values obtained for the four studied attributes fall within the "slight" category.

CONCLUSIONS

The statistical analysis of the results supports the hypothesis that replacing beef with soy meat in hamburgers is not well accepted by potential consumers, particularly concerning its sensory attributes of texture, taste, and color.

Formulation 1 achieved the highest sensory attributes, with an 80% acceptance rate, based on the results of the sensory evaluation.

Incorporating more than 40% soy meat in the hamburger significantly impacted the texture and odor of the meat product.

A hamburger seasoning content exceeding 2% resulted in an excessive taste and odor in the final product.

A microbiological analysis of the obtained product was performed to assess whether the soy meat complied with the microbiological requirements set by the relevant standards.

BIBLIOGRAPHIC REFERENCES

Bonny, S. P. F., Gardner, G. E., Pethick, D. W., Allen, P., Legrand, I., Wierzbicki, J., Farmer, L. J., Polkinghorne, R. J., & Hocquette, J. F. (2017). Untrained consumer assessment of the eating quality of European beef: 2. Demographic factors have only minor effects on consumer scores and willingness to pay. *Animal*, *11*(8), 1399–1411. https://doi.org/10.1017/S1751731117000076

Carlos, L., & Cedeño, E. (2023). *La inocuidad, en el proceso de recepción de mercancías en restaurantes. Caso Bahía de Caráquez. Safety, in the process of receiving merchandise in restaurants. Case of Bahía de Caráquez. 4*(6), 244–261.

Cevallos-hermida, C. E., Salazar-yacelga, J. C., & Gallegos-murillo, P. L. (2018). *Uso de pruebas afectivas, discriminatorias y descriptivas de evaluación sensorial en el campo gastronómico*. *4*, 253–263.

Chamorro, D. F. H. R. (2010). Mioglobina Factor Principal del cual Depende el Color de la Carne. *Universidad Autónoma Metropolitana Xochimilco*, *2009*, 1–9. http://www.ciap.org.ar/Sitio/Archivos/Mioglobina Factor Principal del cual Depende el Color de la Carne.pdf

Del Castillo, M. D., Amigo-Benavent, M., & Silván, J. M. (2009). Capítulo 16. Componentes de la soja como ingredientes funcionales en lácteos. *Funcionalidad de Componentes Lácteos*, 353–376. https://core.ac.uk/download/pdf/93126865.pdf

Dumont, B., Fortun-Lamothe, L., Jouven, M., Thomas, M., & Tichit, M. (2013). Prospects from agroecology and industrial ecology for animal production in the 21st century. *Animal*, *7*(6), 1028–1043. https://doi.org/10.1017/s1751731112002418

Food and Agriculture Organization. (2014). *Fichas técnicas Procesados de carnes*. 1–17.

https://www.fao.org/3/au165s/au165s.pdf

González Hernández, M. (2015). *Características sensoriales y composición no volátil de vinos tintos: avances en la exploración de la calidad*. 1–399. https://dialnet.unirioja.es/servlet/tesis?codigo=46984

Harold, B., & Rojas, P. (2014). *"Elaboración de un producto cárnico funcional reemplazando la proteína cárnica por proteína vegetal"*.

Hleap-Zapata, J. I., Burbano-Portillo, M. Y., & Mora-Vera, J. M. (2017). Physicochemical and sensory evaluation of sausage with inclusion of quinoa flour (Chenopodium quinoa W.). *Biotecnología En El Sector Agropecuario y Agroindustrial*, *15*(Special Issue 2), 61–71. http://www.scielo.org.co/pdf/bsaa/v15nspe2/1692-3561-bsaa-15-spe2-00061.pdf

INEN 1344. (1996). Carne y productos cárnicos. Chorizo. Requisitos. *Instituto Ecuatoriano de Normalización (INEN) 1 344:96*, 1–11. http://181.112.149.204/buzon/normas/1344.pdf

Jiménez, A. D. L. (2006). *Valor Nutritivo de la Proteína de Soya*.

Kirk, R. S., Egan, H., & Sawyer, R. (1996). *Composición y análisis de los alimentos de Pearson*. Grupo Patria Cultural S.A. DE C.V. https://books.google.com.ec/books?id=HYTwPgAACAAJ

Loza, R., Trigo, M., & Valeros, L. (2020). Vigilancia de nitritos y nitratos presentes en salchichas expendidas en los mercados: Rodríguez y Villa Fátima de la ciudad de La Paz. *Revista Con Ciencia*, *8*(14/08/2020), 67–76. http://www.scielo.org.bo/pdf/rcfb/v8n1/v8n1_a06.pdf

María Laura Arias, E. M. B. (2018). *RELACION ENTRE EL RECUENTO TOTAL BACTERIANO Y COLIFORMES TOTALES*. 73–76.

Martín-orúe, S. (2014). *Departament de Ciència Animal i dels Aliments Facultat de Veterinària Universitat Autònoma de Barcelona*. 314. https://ddd.uab.cat/record/128029/export/ht

Noguera, F., & Gigante, S. (2018). Principios de la preparación de alimentos. In *Principios de la preparación de alimentos*.

Oviedo, Á. (2019). Pruebas de análisis sensorial para el desarrollo de productos de cereales infantiles en Venezuela Sensory analysis tests for the development of infant cereal products in Venezuela. *Publicaciones En Ciencias y Tecnología*, *13*(2019), 27–37. http://doi.org/10.13140/RG.2.2.21791.51361

Pan, R. (2011). Determinación de nitrógeno por el Método Kjeldahl. *ITW Reagents*, 12. https://www.itwreagents.com/uploads/20180122/A173_ES.pdf.

Rodriguez, L. (2013). Elaboración De Una Guía Para La Selección, Entrenamiento Y Monitoreo De Jueces Sensoriales Para Productos De Confitería. *Universidad de San Carlos de Guatemala*, 3–19. http://biblioteca.usac.edu.gt/tesis/06/06_3427.pdf

Rojas, C., Tripaldi, P., Pérez, A., & Quinteros, P. (2012). Diseño experimental y métodos de decisión multicriterio para optimizar la composición del helado mantecado. *Scientia Agropecuaria*, *1*, 51–60. http://www.redalyc.org/articulo.oa?id=357633701007

Saltos Bastidas, L. S. (2012). *Estudio sensorial*. 1–46. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwitr-qHruPrAhVHrFkKHRTsBDcQFjAAegQIBBAB&url=http%3A%2F%2F192.188.53.14%2Fbitstream%2F23000%2F707%2F6%2F98253%2520%2528Cap.4%2529.pdf&usg=AOvVaw00KjQ4R1cCjKr_vd66_vj7

Sánchez, R. (2013). La química de los colorantes en los alimentos. *Química Viva*, *12*, 234–246. http://www.redalyc.org/articulo.oa?id=86329278005

Severiano Pérez, P., & Severiano-Pérez, P. (2019). ¿Qué es y cómo se utiliza la evaluación sensorial? *INTER DISCIPLINA*, *7*(19), 47. https://doi.org/10.22201/ceiich.24485705e.2019.19.70287

Soto-Simental, S., Valera-Quezada, E., Hernández-Chavez, J. F., Güemes-Vera, N., & Ayala-Martínez, M. (2016). Efecto de grasa, agua añadida, carragenina y fosfatos en un producto emulsionado con carne de carpa (Cyprinus carpio). *Agrociencia*, *50*(4), 413–427.

Torres y Torres, N., & Tovar-Palacio, A. R. (2009). La historia del uso de la soya en México, su valor nutricional y su efecto en la salud. *Salud Pública de México*, *51*(3), 246–254. https://doi.org/10.1590/s0036-36342009000300016

Totosaus, A. (2007). Productos cárnicos emulsionados bajos en grasa y sodio. *Nacameh*, *1*(1), 53–66. http://cbs.izt.uam.mx/nacameh/v1n1/v1n1p053.html

Vélez Jiménez, L. M. (2013). DEL SABER Y EL SABOR. UN EJERCICIO ANTROPOFILOSÓFICO SOBRE LA GASTRONOMÍA. *Escritos*, *21*(46), 171–200.

http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0120-12632013000100007&lng=en&nrm=iso&tlng=es

Vila, F., Santos, D., María De Fátima, C., & Dinh, M. U. (2010). Cuantificación Espectrofotométrica De Nitritos En Embutidos De Carne Producidos En Angola. *Revista Cubana de Química*, *22*(3), 99–102. https://www.redalyc.org/pdf/4435/443543720014.pdf

Zapata, J. I. H., Erazo, Y. V. R., & Sarria, S. D. (2014). Comparación bromatológica, microbiológica y sensorial de dos formulaciones de salchichas elaboradas con carne de conejo (Oryctolagus cuniculus). *Acta Agronomica*, *63*(1). https://doi.org/10.15446/acag.v63n1.37631

Zhang, T., Dou, W., Zhang, X., Zhao, Y., Zhang, Y., & Jiang, L. (2021). Trends in Food Science & Technology The development history and recent updates on soy protein-based meat alternatives. *Trends in Food Science & Technology*, *109*(September 2020), 702–710. https://doi.org/10.1016/j.tifs.2021.01.060