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Extraction and application of essential oils from feijoa as a preservative in the production of fine dough sausages

Extracción y aplicación de aceites esenciales de la feijoa como conservante en la elaboración de embutidos de masa fina

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Abstract
In the present work, the extraction of essential oils from feijoa (Acca Sellowiana) is proposed to be applied in the elaboration of a fine paste sausage as a substitute for chemical additives, such as nitrites, looking for an option free of side effects. Within our research through various bibliographical sources, we found important data about the origin of feijoa, varieties, different applications, nutritional composition and a highlighted antioxidant capacity; as well as the sausages of fine pasta, its history, ingredients and preparation methods. With this information, we perform the respective laboratory tests described in the different stages of experimentation of this work were carried out. From the extraction of the essential oils, to, the different formulations of mortals using a variable percentage of oils in each sample to be evaluated, hedonic classification tests were also carried out with the presence of 70 judges and finally tests of estimation of useful life, both in controlled environment (refrigeration at an estimated temperature between 0 - 4 ° C) and in an uncontrolled environment (variable temperature and humidity of the city of Guayaquil). Among the results obtained through the tests carried out on the different samples of the mortise type sausage which were subjected to various formulations, using different percentages of the essential oils described above, it was concluded that, of these samples, one, achieved an acceptability of 31.82 %, both in the case of hedonic tests, as well as in laboratory tests. The formulation prepared for the same verifies that it is a type I bologna and meets all the requirements of NTE standards INEN 1529-5, 1529-8, 1529-14 and 1529-15 thus confirming the complete safety of the product, finally, in the tests of estimation of useful life, it was possible to confirm that feijoa oils, fulfill the function of preservative in sausages of fine pasta, by comparison with other products of the same class, but with a heterogeneous chemical formulation to that described in our work

key words
Feijoa - Essential oils - Sausages - Mortadella - Preservative.

Resumen
En el presente trabajo se plantea realizar la extracción de aceites esenciales de la feijoa (Acca Sellowiana) para ser aplicados en la elaboración un embutido de pasta fina a manera de sustitución de los aditivos de origen químico, como son los nitritos, buscando así una opción libre de efectos secundarios. Dentro de nuestra investigación a través de diversas fuentes bibliográficas, se remarcan datos importantes acerca del origen de la feijoa, variedades, diferentes aplicaciones, composición nutricional y potencial capacidad antioxidante; así como también sobre los embutidos de pasta fina, su historia, ingredientes y métodos de preparación. Con esta información se procedió a realizar las respectivas pruebas de laboratorio descritas en las diferentes etapas de experimentación de este trabajo. Desde la extracción de los aceites esenciales, hasta, las diferentes formulaciones de mortadelas usando un porcentaje variable de aceites en cada muestra a valorar, también se realizaron pruebas de clasificación hedónicas con presencia de 70 jueces y finalmente pruebas de estimación de vida útil, tanto en ambiente controlado (en refrigeración a una temperatura estimada entre 0 – 4 °C) como en un ambiente no controlado (temperatura y humedad variable de la ciudad de Guayaquil). Dentro de los resultados obtenidos mediante las pruebas realizadas a las distintas muestras del embutido tipo mortadela los cuales fueron sometidos a varias formulaciones, usando distintos porcentajes de los aceites esenciales antes descritos, se concluyó que, de estas muestras, una, logro una aceptabilidad del 31.82%, tanto ante las pruebas hedónicas, como en las realizadas dentro de laboratorio. La formulación elaborada para la misma verifica que es una mortadela tipo I y cumple con todos los requisitos de las normas NTE INEN 1529-5, 1529-8, 1529-14 y 1529-15 confirmando así la completa inocuidad del producto, finalmente, en las pruebas de estimación de vida útil, se logró corroborar que los aceites de feijoa, cumplen con la función de conservante en los embutidos de pasta fina, mediante la comparación con otros productos de la misma clase, pero con una formulación química heterogénea a la descrita en nuestro trabajo.

Palabras clave
Feijoa – Aceites esenciales – Embutidos – Mortadela – Conservante.

1. Introduction

The primary objective of this project is to achieve the efficient extraction of essential oils present in the fruit known as feijoa (Acca sellowiana), also called "Brazilian guava," and subsequently apply it to a fine sausage product, such as mortadella, to determine its action as a natural preservative additive. Finally, we will compare it to another chemical-based additive, such as nitrites, to assess its effectiveness.

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Essential oils are liquid fractions that are volatile. In this research, the extraction was carried out through hydrodistillation, and once distilled, these oils contain all the substances responsible for the plant's aroma. Essential oils are important in the cosmetics industry (for fragrances and perfumes), pharmaceuticals (as flavorings), and in food (as flavorings and condiments). In the case of meats, they are used as preservatives, which is the focus of this research.

By researching, creating, and experimenting with different formulations of mortadella with the addition of feijoa essential oils, we aim to provide a natural option without long-term side effects, as is the case with nitrites, which are known to be carcinogenic. The goal is to demonstrate that not only do these oils help preserve the final product, but they also do not alter the characteristics of mortadella, such as its smell, taste, color, and more.

Finally, after various formulations and experiments, the product's safety was validated through laboratory tests. As for the shelf-life tests applied to the final product, it was confirmed that feijoa essential oil as a natural preservative in fine sausages is ineffective compared to chemical preservatives like nitrites.

1.1 Feijoa

Feijoa, scientifically known as Acca sellowiana, is a plant botanically related to guava. It originates in South America, particularly in southern Brazil, Uruguay, the highlands of western Paraguay, and northeastern Argentina.

This fruit enjoys high acceptance in both national and international markets, whether consumed fresh or processed in agro-industrial products. For this reason, maintaining consistent production has become essential for farmers to supply the market steadily.

1.2 History

In 1854, Fredrich Sellow began collecting feijoa (hence the name sellowiana) in southern Brazil near Uruguay, where it was known as Nyandua-pishá. The name "feijoa" was given in honor of G. de Silva Feijoo, the director of the Natural History Museum of San Sebastián. [1]

Initially, the plant was used as an ornamental species, mostly in home decorations due to its foliage, fragrance, and flowers. In 1890, it was introduced and cultivated on the coast of the French Riviera by Edouard André. In 1899, Trabut brought feijoa to Algeria, and the following year, it was grown in the Nikita Botanical Garden in Yalta. By 1903, it had been introduced to Batoum on the Black Sea coast, and in 1900, it was imported to Santa Barbara, California, by Franceschi, where it was well-received, leading to the development of the "Coolidge" variety. [1]

Feijoa was established in New Zealand in 1908, where it is still cultivated today. After World War II, small plantations were established in Italy, North Africa, and Portugal. However, feijoa remained relatively unknown in Brazil, where it is referred to as "goiabeira do mato," "goiabeira serrana," or "goiaba do campo" in Portuguese. In English, it is known as "guavasteen," "fig guava," "Brazilian guava," or "pineapple guava." In the early 20th century, Nicanor Restrepo introduced feijoa to a farm in the El Poblado neighborhood of Medellín, Colombia, and in 1930, it was brought to Palmira, though it did not adapt well. In 1935, Antonio María Tamayo successfully introduced it to the municipality of Tibasosa (Boyacá), from where it spread to neighboring towns. In Florida, USA, the Coolidge variety was cultivated, but with poor results. However, it was concluded that feijoa adapts well to mild and cold climates between 13°C and 21°C, such as the Bogotá savanna and regions in Cundinamarca and Boyacá. [1]

As mentioned earlier, for many years, the plant was used only ornamentally, appreciated for its flowers and pleasant fragrance. However, as its organoleptic properties became more widely known, feijoa began to be consumed fresh, canned, or processed. Additionally, it has been used to make jams, flavors, nectars, wines, and even perfumes.

1.3 Characteristics

One of the main characteristics of feijoa is its extraordinary ability to adapt to various climatic zones, as demonstrated by the different regions where it is cultivated, ranging from temperate to hot and humid climates. [2]

eijoa is a bushy shrub that can grow from 0.9 m to 6 m in height. It has pale gray bark; its branches are extended and swollen at the nodes and are covered with white hairs in their juvenile stage. Its leaves have short petioles, are opposite, evergreen, elliptical, smooth, and shiny on the upper surface, leathery, and measure 2.8 cm to 6.2 cm in width. They are finely veined and have silvery down on the underside. The flowers are 4 cm wide, bisexual, and either solitary or grow in clusters. They have four fleshy, concave, and oval petals, white on the outside and purplish-red inside. The stamens are erect, 1.6 cm to 2 cm long, numerous, and are purple with golden-yellow, rounded tips. [3]

The fruit maintains an ovoid shape and slightly resembles a pear, with a length ranging from 4 cm to 6 cm and a width of 2.8 cm to 5 cm, with the calyx segments attached at the apex. It has a thin skin covered with very fine whitish hairs until maturity, after which it

turns an opaque green or yellowish, and sometimes has a red or orange tint. Its fragrant smell is strong and long-lasting, even well before it ripens. Finally, the flesh is white, thick, and translucent in its central part, where it holds the seeds. Its taste is semi-acidic or sweet, resembling a combination of pineapple and guava or pineapple and strawberry. Generally, it contains 100 small, hard, oblong seeds, which are noticeable when consuming the fruit.. [4]

1.4 Varieties

Plants grown from seeds of different sources show significant variation in their characteristics.

Among the most significant varieties, we have:

Hehre

In Los Angeles, it is said that H. Hehre obtained seeds from Argentina, and among the plants he grew, one was considered superior to the others, with earlier production. This variety was named "Hehre." Its fruit is large, slender-pyriform, yellow-greenish, curved, with thin skin and finely granular pulp, juicier, with more and larger seeds than normal. It is sweet but not aromatic. The plant is upright, compact, vigorous, with lush foliage, but it only produces moderate yields. [2]

Andre

The original layering from Brazil, its size varies from medium to large, it is light green, oblong, with thick pulp, few seeds, rich flavor, rough surface, and very aromatic. The plant is upright, spreading to intermediate. This variety produces heavy harvests. [5]

Besson

Seeds originating from Uruguay in 1899, its size varies from small to medium, the fruit is smooth with red or brown cheeks, oval-shaped, with medium-thick pulp, very juicy and with thin skin, containing numerous seeds. Its flavor is aromatic and rich. These plants can be either upright or spreading. This variety grows in northern India. Both Besson and Andre are the most planted varieties in France. [5]

1.5 Nutritional Composition of Feijoa

Every 100 grams of Feijoa, or Brazilian guava, provides 61.0 kcal and contains:

Table 1.
Nutrients in feijoa.

Nutrients	Amount
Water	89.94 g
Protein	0,98 g
Carbohydrates	12.92 g
Fiber	6.4 g
Sugar	8.2 g
Lipids	0.6 g

Table 2.
Fatty acids in feijoa.

Fatty Acids: 0.423g	Amount
Saturated fatty acids	0.148 mcg
Monounsaturated fatty acids	0.081 mcg
Polyunsaturated fatty acids	0.194 mcg

Table 3.
Antioxidants in feijoa.

Antioxidants:	Amount
Beta carotene	2 mcg
Beta cryptoxanthin	3 mcg
Lycopene	5 mcg
Lutein and Zeaxanthin	27 mcg

Table 4.
Minerals in feijoa.

Minerals:	Amount
Calcium	17 mg
Iron	0.14 mg
Magnesium	9 mg
Phosphorus	19 mg
Potassium	172 mg
Sodium	3 mg
Zinc	0.06 mg
Copper	0.036 mg
Manganese	0.084 mg
Iodine	100 mcg

Table 5.
Vitamins in feijoa.

Vitamins:	Amount
Vitamin C	32.9 mg
B1 (Thiamine)	0.006 mg
B2 (Riboflavin)	0.018 mg
B3 (Niacin)	0.295 mg
B5 (Pantothenic Acid)	0.233 mg
B6 (Pyridoxine)	0.067 mg
B9 (Folic Acid)	0.0023 mg
Vitamin K	0.0035 mg
Vitamin E	0.16 mg

Table 6.
Sugars in feijoa.

Total sugars: 8.2g	Amount

Sucrose	2.93 g
Glucose	2.32 g
Fructose	2.95 g

1.6 Fruit Properties

The high content of ascorbic acid, commonly known as vitamin C, is one of the main characteristics in terms of nutritional composition, although the content is not as high as in guava [6]. Feijoa also contains a significant portion of the vitamins that make up the B-complex. This fruit includes folic acid or vitamin B9, which helps in the production of blood cells and is linked to pregnancy, highly recommended for preventing fetal malformations and anemia in pregnant women. It is also an important nutrient for men and women at any stage of their development, as it protects healthy cells and helps prevent hypertension, [7]. It aids in treating symptoms often associated with menopause and reduces the risk of developing colon cancer, cervical cancer, and in some cases, breast cancer.

Among the nutrients in feijoa are trace elements like iodine in amounts of 50 to 100 µg per 100 g of total weight, surpassing other fruits and nearly matching the values found in marine fish. This benefits the proper functioning of the human body, preventing diseases like goiter. It also contains a large number of antioxidants that help eliminate free radicals—highly reactive substances that introduce oxygen into cells, causing oxidation of their parts, changes in their composition, accelerating aging, and causing DNA alterations. For this reason, feijoa is known as the "fruit of eternal youth."

1.7 Essential Oils

Essential oils are the volatile liquid fractions that are usually distilled by steam and contain all the substances responsible for the plant's aroma. These are important in the cosmetic (fragrances and perfumes), pharmaceutical (flavoring), and food (flavoring and seasoning) industrie [8]

In general, essential oils are a complex mixture of up to more than 100 components, which may include:

- Low molecular weight aliphatic compounds (alkanes, alcohols, aldehydes, ketones, esters, and acids),
- Monoterpenes,
- Sesquiterpenes, and
- Phenylpropanoids.

Most of these have a pleasant smell, although there are certain oils with strong, relatively unpleasant odors, such as those of onion and garlic, which contain sulfur compounds [9]

2. Materials and Methods

Choosing the appropriate techniques for collecting relevant and necessary data for the research is crucial, as the results we need to obtain depend on them. Since this is an experimental study, various experiments were carried out, along with laboratory analyses, hedonic tests, and product observations to demonstrate the effectiveness of the subject of study..

2.1 Essential Oil Extraction from Feijoa

In the field of essential oil extraction, there are many methods to achieve this process. Among them, simple hydrodistillation or water distillation was chosen, which involves directly submerging the botanical material in water and bringing it to a boil, thereby obtaining hydrosols and essential oils from feijoa. It is important that distilled water is used in this process to avoid impurities in the final product.

2.2 Hedonic Classification Tests

This test, conducted on the product, aims to identify its characteristics. It was carried out with a panel of 70 judges, who were not required to be trained. In this case, 70 students from the Bachelor of Gastronomy program were randomly selected. They were given small samples of the product, along with water to ensure the reliability of the tests, and hedonic scale charts for the judges to rate the samples. [10]

2.3 Laboratory Tests

For the safety of the bologna-type sausage with feijoa essential oils as preservatives, laboratory analyses were performed on the samples accepted by the public. These analyses included:

- Physicochemical: Protein, smell, taste, color, pH.
- Microbiological: Mesophilic aerobes, Staphylococcus aureus, Escherichia coli, and Salmonella.

2.4 Shelf-Life Estimation

Shelf-life estimation tests were conducted by the researchers in two ways: one under normal environmental conditions in the city of Guayaquil, and the other under standard home refrigeration conditions. The goal was to determine the margin of action of the essential oils under opposing conditions.

3. Results

The process began with the extraction of essential oils from feijoa, followed by the formulation of the bologna using the same oils, continuing with hedonic tests, calculating its shelf-life, and concluding with the verification of the oils as a preservative in the sausage.

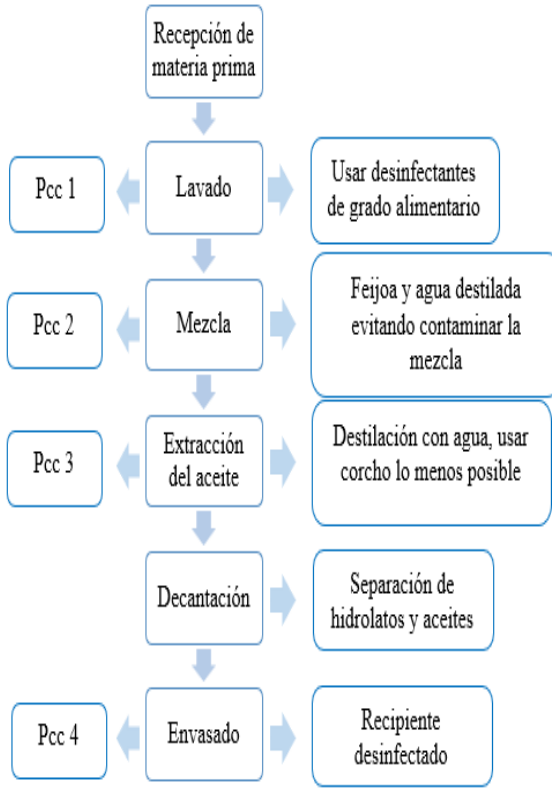

Figura 1. Diagrama de flujo de extracción de aceites

Raw Material Reception: Ensure the condition of the fruits for extraction, discarding any that are bruised or decomposing, and remove any impurities.

Washing: Thoroughly clean each feijoa.

Mixing: Extract the fruit pulp, add distilled water, and strain..

Oil Extraction: In the same heat-generating flask, add the mixture of distilled water and feijoa pulp, which will be placed on a stove. This flask will be connected via a hose directly to the condenser, which will allow the vapor passing through it to condense into a liquid state, thanks to the refrigerant substance circulating inside, ultimately releasing both hydrosols and feijoa oil into a collection container.

Decanting: ransfer the substances obtained in the collection container to a decanter and let them sit for 24 hours to efficiently separate the hydrosols from the essential oils.

Packaging: Once the oils and hydrosols have been separated, package the oil in a previously disinfected container.

3.1 Basic Scheme of a Distillation Apparatus

A simplified diagram of the assembly of a distillation apparatus is presented. This setup is not final since several issues arose during the tests, requiring us to adapt to the emerging needss.

Three zones can be distinguished:
Steam Generation and Distillation Zone: Since the raw material and distilled water share the same flask, both functions occur here. The flask is sealed with a stopper, through which a glass rod passes, allowing the steam to pass through.

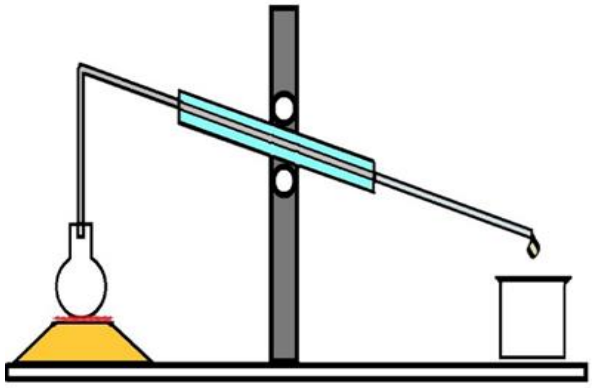

Figura 2. Basic Distillation Apparatus Scheme

Condensation Zone: The condenser is sealed with a stopper, which is penetrated by a glass rod connecting to the distillation flask. The condenser receives all the steam and transforms it from vapor to liquid through a refrigerant substance that passes through it, in this case, counter-current water.

Collection Zone: In the final stage of the process, a container is needed to collect the final distillation product.

3.2 Equipment and Tools

Table 7.
Equipment and utensils for essential oil extraction.

Equipment and Utensils	Use	Image
Universal stand	Iron utensil that allows holding several containers.	

Wire gauze	Square-shaped wire gauze, with the central part covered in asbestos to achieve better heat distribution.	
Electric stove	Equipment that provides heat, allowing the mixture to begin boiling.	
Distillation flask	Glass container that holds the mixture from which the oil will be extracted.	
Condenser or cooler	Distillation equipment, which functions, as its name suggests, to cool the liquids passing through it.	
Flat-bottom flask	Used as a container to collect hydrosols and oil.	
Decanter	Used in liquid separation.	
Hoses	Allow water circulation, which helps the condenser cool the vapors passing through it.	
Stoppers	Cap the flasks and prevent vapor leaks between the equipment.	
Glass rod	Glass cylinder through which vapors will pass.	

3.3 Fine paste sausage preparation

o begin sausage preparation, the proper functioning of the machinery to be used must be verified in advance. The machinery should be clean, disinfected, and in good condition to avoid potential issues and interruptions during the production process.

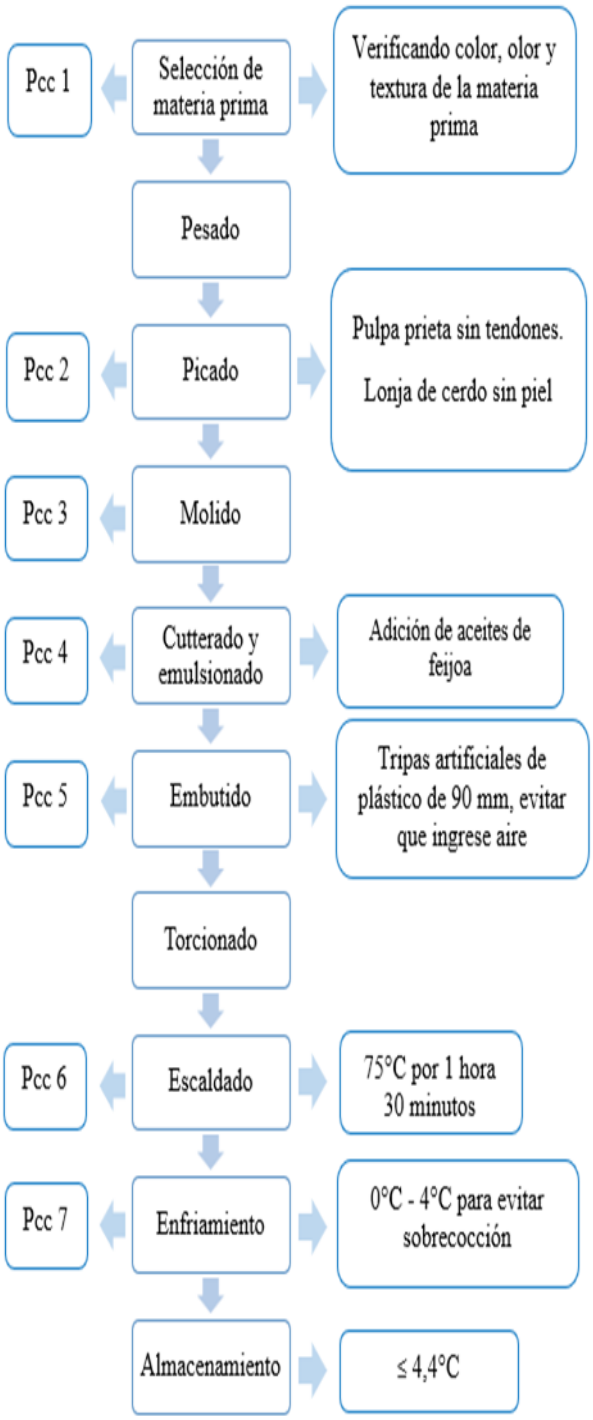

Figura 3. Flow diagram of bologna

Raw material selection: For the preparation of bologna, the following will be used: beef pulp, pork loin, seasonings, starch, ice, feijoa essential oils, and artificial casings of 90 mm diameter.

Weighing: Weigh all ingredients, taking care to follow the bologna formulation precisely.

Chopping: The meat is then processed. The beef pulp should be fresh and free of tendons. Once cleaned, it is cut into small pieces, as well as the pork loin, to obtain better results from the grinder.

Grinding: The grinding process depends directly on the type of product being made. Since it is fine paste products, pre-cutting was done using a double-edged blade and a 3mm disc.

Cutting and mixing: Since the product is a fine paste sausage, it is necessary to pass the meat mixture through a cutter where various additives are added, including flavorings, texturizers, and preservatives. Ice is also added to prevent the temperature from rising during the process. This step lasts approximately 3 minutes.

Stuffing: The meat mixture is passed to the stuffer, where the 90mm diameter polyamide casing is ready.
Portioning: Once the meat mixture is stuffed into the aforementioned casings, the bologna is portioned, making anything from 90 to 100 grams balls to a 1-kilogram bologna.

Poaching: The poaching process in bologna preparation is carried out at temperatures of 75°C. The time depends on the thickness of the casing, with the standard value being one minute per millimeter of casing diameter.

Cooling: After the poaching time, the product must be subjected to a "thermal shock," which consists of submerging the sausages in ice water to lower their temperature and prevent overcooking.

Storage: For the various effects carried out during this stage of experimentation, it was decided that one batch of sausages would be stored in refrigeration, while the other would be kept in common environmental conditions in the city of Guayaquil, aiming to determine through observation the effect of feijoa essential oils on the shelf life of the sausages.

3.4 Equipment and utensils

Table 8.
Equipment for fine paste sausage preparation

Equipment	Use	Image
Meat grinder	Grinds meat into small pieces. It contains a motor that provides the power to grind, making the job easier.	

Cutter or food processor	Ideal for grinding meats and emulsifying the mixture.	
Refrigerator	Preserves food, extending its shelf life.	
Stuffer	Facilitates the process of stuffing the emulsion or mixture into the casings.	
Stove	Cooks the product.	

Table 9.
Utensils for fine paste sausage preparation.

Utensils	Use	Image
Scale	Weighs ingredients to ensure the correct quantities are used.	
Analytical scale	A highly sensitive scale used to weigh ingredients in very small proportions.	
Pot	Used for poaching the bologna.	
Digital thermometer	Indicates the temperature, thus controlling the water temperature for ideal cooking.	
Knife	Used for cutting, peeling, or deboning any food item.	
Tying string	Keeps the sausages tightly closed to maintain their shape during cooking.	
Cutting board	An indispensable kitchen tool for performing mise en place.	
Bowls	Used to hold different products, whether liquid or solid.	
Small bowls	Used to hold smaller quantities of liquids or solids.	
Spoon	Used for tasting or serving any product, food, or ingredient.	

3.5 Bologna control formulation

Table 10.
Base bologna formulation.

Ingredients	Amount	Unit	%
Beef (pulp)	1,200	Kg	58,98 %
Pork fat (loin)	0,300	Kg	14,75 %
Ice	0,360	Kg	17,70 %
Starch (cornstarch)	0,060	Kg	2,95%
Soy protein powder	0,040	Kg	1,97%

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Salt	0,032	Kg	1,57%
Monosodium glutamate	0,008	Kg	0,39%
Nitrite	0,0002	Kg	0,01%
Erythorbate	0,0004	Kg	0,02%
Ascorbic acid	0,0006	Kg	0,03%
Phosphates	0,008	Kg	0,39%
Cinnamon powder	0,0002	Kg	0,01%
Liquid smoke	0,00004	l	0,00%
Colorant (natural red)	0,005	l	0,25%
Water	0,02	l	0,98%

Analysis: For the preparation of the control fine paste sausage, a base bologna recipe was implemented, adding the preservative chemicals commonly used in the food industry. The result was a bologna with the color, smell, and texture of a conventional bologna.

3.6 Formulation of bolognas for hedonic tests

To begin experimentation, different formulations were tested. In all trials, the same preparation process was applied, where only the percentage of feijoa essential oil varied among the bolognas to determine which was the most conclusive. The formulations are as follows:

Table 11.
First bologna experiment.

Ingredients	Amount	Unit	%
Beef (pulp)	0,450	kg	58,04%
Pork fat (loin)	0,113	kg	14,51%
Ice	0,135	kg	17,41%
Starch (cornstarch)	0,023	kg	2,90%
Soy protein powder	0,015	kg	1,93%
Salt	0,012	kg	1,55%
Monosodium glutamate	0,003	kg	0,39%
Feijoa essential oils	0,0001	l	0,01%
Ascorbic acid	0,0002	kg	0,03%
Cinnamon powder	0,0001	kg	0,01%
Liquid smoke	0,00002	l	0,002%
Colorant (natural red)	0,005	l	0,64%
Water	0,02	l	2,58%

Analysis: In the preparation of the first sample, 0.1 ml of feijoa essential oil was applied per 1 kg of meat mixture, represented by a drop of the oil measured with an insulin syringe. However, the flavor was comparable to the base bologna, with the oil not being perceived at all, prompting continued testing until the ideal formulation was found that would provide preservative qualities without altering the final product.

Table 12.
Second bologna experiment

Ingredients	Amount	Unit	%
Beef (lean pulp)	0,450	kg	58,02%
Pork fat (rind)	0,113	kg	14,50%
Ice	0,135	kg	17,41%
Starch (cornstarch)	0,023	kg	2,90%
Soy protein powder	0,015	kg	1,93%
Salt	0,012	kg	1,55%
Monosodium glutamate	0,003	kg	0,39%
Feijoa essential oils	0,0003	l	0,04%
Ascorbic acid	0,0002	kg	0,03%
Ground cinnamon	0,0001	kg	0,01%
Liquid smoke	0,00002	l	0,002%
Natural red colorant	0,005	l	0,64%
Water	0,02	l	2,58%

Analysis: For the second sample, 0.3 ml (three drops) of feijoa essential oil per 1 kg of meat mass was added to the mixture. In this sample, a slight change in texture was noticed without the essential oils altering other inherent characteristics of the mortadella, such as smell, color, or taste.

Table 13.
Third bologna experiment

Ingredients	Amount	Unit	%
Beef (lean pulp)	0,450	kg	58,00%
Pork fat (rind)	0,113	kg	14,50%
Ice	0,135	kg	17,40%
Starch (cornstarch)	0,023	kg	2,90%
Soy protein powder	0,015	kg	1,93%
Salt	0,012	kg	1,55%
Monosodium glutamate	0,003	kg	0,39%
Feijoa essential oils	0,0005	l	0,06%
Ascorbic acid	0,0002	kg	0,03%
Ground cinnamon	0,0001	kg	0,01%
Liquid smoke	0,00002	l	0,002%
Natural red colorant	0,005	l	0,64%
Water	0,02	l	2,58%

Analysis: In the third sample, the mixture was altered with 0.5 ml (five drops) of essential oil per 1 kg of meat mass. In this third sample, there were noticeable changes: a slight fruity tone in the aroma and a mild bitterness in the sample, which led to the product being rejected.

4. Conclusions

- Although there are different methods for extracting essential oils, due to the conditions in which the work was conducted, it was concluded that the most effective method for this research was hydrodistillation, as it did not alter the fruit's properties. However, this does not imply that other methods are ineffective.

- During the development of the tests, it was determined that the sample containing 0.3 ml, which represents 0.04% of feijoa essential oils, was the most preferred and, at the same time, did not alter the organoleptic properties of the final product.

- Under uncontrolled conditions, the unproductivity of feijoa essential oils against nitrites was tested. However, under refrigeration, it was shown to be slightly effective against nitrites. After eight days from the production of the sausages, they deteriorated more slowly and uniformly, but not to the extent of matching the changes observed in the control sample.

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