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Article

Generation of aromatic candles from different percentages of recycled edible oil

Generación de velas aromáticas a partir de diferentes porcentajes de aceite comestible reciclado

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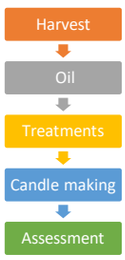
Abstract

The purpose of this work is to use recycled oil in different proportions to make aromatic candles and carry out quality tests to select the best proportion. 3 batches of candles were made, mixing 60%-40%, 70%-30%; and 80%-20% from recycled oil and soy wax respectively. The evaluation consisted of 7 tests: Visual inspection, burning times, Candle Pond. Flame height, Sensory rating scale, Combustion afterglow check, Combustion and post combustion smoke. The results obtained show that the proportion of 70% recycled oil and 30% soy wax is the one that presents very similar characteristics to conventional candles, however, the use of other mixtures is not ruled out since depending on the characteristics. Whatever the client wants in a candle, such as a longer duration or lighting, the other proportions can be used.

Generation of aromatic candles from different percentages of recycled edible oil

Objetives

Metodology



Contributions

Use and reduction of residual oil

Business model

Reduction in the environmental impact of this waste

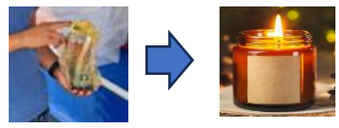
Aromatic candles, Recycled oil, Candle evaluation

Resumen

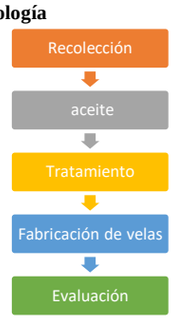
El propósito de este trabajo es utilizar aceite reciclado en diferentes proporciones para elaborar velas aromáticas y realizar pruebas de calidad para seleccionar la mejor proporción. Se fabricaron 3 lotes de velas, mezclando 60%-40%, 70%-30%; y 80%-20% de aceite reciclado y cera de soya respectivamente. La evaluación consistió en 7 pruebas: Inspección visual, tiempos de combustión, Charca de la vela. Altura de la llama, Escala de calificación sensorial, Comprobación de posluminicencia de combustión, Humo de combustión y poscombustión. Los resultados obtenidos muestran que la proporción de 70% de aceite reciclado y 30% de cera de soja es la que presenta características muy similares a las velas convencionales, sin embargo, no se descarta el uso de las otras mezclas ya que dependiendo de las características que desee el cliente en una vela, como es una mayor duración o iluminación, se pueden utilizar las demás proporciones.

Generación de velas aromáticas a partir de diferentes porcentajes de aceite comestible reciclado

Objetivo:



Metodología



Contribuciones

Aprovechamiento y disminución del aceite residual

Modelo de negocio

Disminución en el impacto ambiental de estos residuos

Velas aromáticas, Aceite reciclado, Evaluación en velas

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Introduction

At first, seed oil was a product that only a few had the possibility of obtaining, however, after the industrial revolution its manufacturing method was systematized, in such a way that, over the years, various varieties have emerged. industrialization processes such as cold pressing or temperature application; the use of solvents, which was introduced at the beginning of the 19th century, the chemical, physical, odorization and stabilization refining processes, which allowed the oil extracted from seeds, fruits or oleaginous plants, to give rise to a wide variety of oils available to the general public.

Currently, edible oils constitute an important component in the population's diet; their variety and consumption depend on the availability of each country and region (Valenzuela B., Sanhueza C., & Nieto K., 2002).

Nowadays, fried foods are widely accepted due to their easy and quick preparation, as well as their flavor. Frying is a complex physicochemical process where the product to be fried is subjected to high temperatures no higher than 180 °C, modifying the surface and waterproofing it to control the loss of water inside, improving in most cases the flavor, appearance, texture and color.

The best oil for frying should be a product with a liquid consistency at room temperature, that does not deteriorate due to heat applied continuously or intermittently, that does not impart a bad taste or odor to the product being fried, that does not have the effects negative effects from a nutritional point of view attributed to saturated and hydrogenated fatty acids and that their cost is reasonable Nowadays, fried foods are widely accepted due to their easy and quick preparation, as well as their flavor.

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Oils with high contents of monounsaturated fatty acids (oleic acid) are ideal for use in frying, both industrial and home where the practice of reusing the oil is more frequent (Esquivel Ramírez, Castañeda Ovando, & Ramírez Godínez, 2014).

Vegetable oil is a fatty liquid extracted from the seeds of some plants; they contain three types of fatty acids: saturated, monounsaturated and polyunsaturated. Saturated fats are harmful to health because they are very dense, clogging the arteries causing vascular problems.

They are found in a greater proportion in animals; In vegetables they appear in smaller quantities in coconut, palm and cocoa oils. Monounsaturated fatty acids are found in higher proportions in olive, canola, high monounsaturated safflower and high monounsaturated sunflower oils).

Polyunsaturated fatty acids, such as omega 3 (alpha linolenic acid), and omega 6 (linoleic acid), predominate in soybean, corn, flaxseed, high polyunsaturated safflower and sunflower oils, help protect heart arteries from buildup. of fat, thereby preventing risks of cardiovascular diseases; so, it will always be better to choose the oil that has a lower percentage of saturated fatty acids (PROFECO, 2010).

Oils degrade when overheated or reach their smoke point, which causes the generation of potentially toxic substances for consumption, so it is advisable not to reuse or mix with new oil. Likewise, they represent a problem for the environment since they contaminate the water, capturing the oxygen that aquatic organisms need to survive, and they also prevent the penetration of sunlight (Sanaguano Salguero, Bayas Morejón, & Cabrera Carranza, 2019).

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However, the burned oil is discarded into the drain not only by industrial activity, but also by domestic activity (Albarracín, y otros, 2010).

These practices cause pipe clogging problems, encouraging the proliferation of harmful fauna. Furthermore, mixed with other waste such as soap and detergent, it adheres to the municipal drainage pipes, reducing the flow, favoring flooding in the rainy season (Ceballos Bernal, 2021).

Otros problemas que originan las grasas y aceites son en el tratamiento de las aguas residuales, la contaminación del suelo y de cuerpos de agua donde son descargadas, debido a su alta estabilidad y al ser inmiscibles en el agua permanecen en la superficie dando lugar a la aparición de natas y espumas que entorpecen el tratamiento biológico o fisicoquímico.

According to the Federal Consumer Prosecutor's Office, in Mexico the per capita consumption of oil in 2019 was 10 liters per year (Ceballos Bernal, 2021). It is known that one liter of oil can contaminate 40 thousand liters of water (González Canal & González Ubierna, 2015), so it is recommended that the residual oil, once it cools, be stored in tightly closed bottles and taken away. to a recycling place (PROFECO, 2019).

Currently, strategies have been developed that lead to the use of oil, such as the production of biodiesel, candles, soaps, among other derived products (Aquino Rivera, Ramírez Ramírez, Soriana Cabanillas, & Chang Yong, 2021; Chivilchez Palomares, Mendoza Panihuara, Muñiz Espinoza, Najarro Pastor, & Villena Lopez, 2019).

Recycling these oils is of great help because it reduces the impact on the environment, as well as promoting the proper management of these resources and generating environmental awareness among citizens (Bravo Bonete, 2023)

Due to the aforementioned, the purpose of this work is to use recycled oil in different proportions to make aromatic candles and carry out quality tests to select the best proportion. 3 batches of candles were made, mixing 60%-40%, 70%-30%; and 80%-20% from recycled oil and soy wax respectively.

The evaluation consisted of 7 tests: Visual inspection, burning times, Candle Pond. Flame height, Sensory rating scale, Combustion afterglow check, Combustion and post combustion smoke.

The results obtained show that the proportion of 70% recycled oil and 30% soy wax is the one that presents very similar characteristics to conventional candles, however, the use of other mixtures is not ruled out since depending on the characteristics. Whatever the client wants in a candle, such as a longer duration or lighting, the other proportions can be used.

Methodology

A quantitative investigation was carried out to determine the best proportion of recycled edible oil and soy wax in the manufacture of scented candles.

With regard to its evaluation, seven quality tests are carried out, which were selected based on the standards established in the ASTM F-2417 standard “Standard specifications for consumer candles”, as well as those recommended by various manufacturers and specialists. who are dedicated to this business model. The procedure of the research work is shown in Figure 1.

Box 1

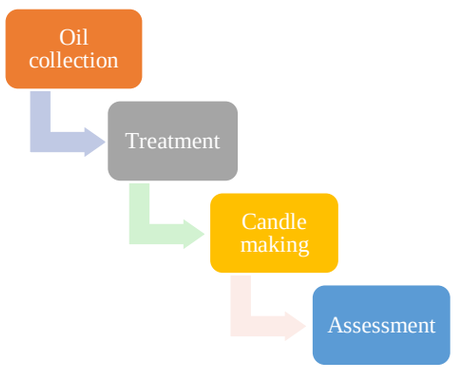

Figure 1
Research project methodology
Own elaboration

Oil treatment and treatment

The oil was collected from several establishments that are dedicated to the sale of Mexican snacks (Fig. 2). The use of burnt oil or oil from flour is not recommended since it will be more difficult to eliminate the smell.

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In addition, to separate the residue from frying, it is advisable to strain and filter through a mesh funnel, then use decanting in cold, a process that consists of adding water to the filtered oil, stirring quickly until it reaches a cloudy yellow color, letting it rest until the separation of the phases is observed and taking it to the freezer, once the water is frozen, decant the oil, achieving a separation of impurities in a more optimal, fast and efficient way. Due to the rancid smell that these oils have, it is necessary to deodorize them. The most used processes are maceration and filtration with granulated activated carbon, which was used in this case (Bravo Bonete, 2023).

Box 2

Figure 2

Oil collection from a Mexican snack

Own elaboration

Candle making

In this project, three batches of 200 gr candles were manufactured with the following proportions: the first 60% recycled oil and 40% low-melting soy wax; the second, 70% recycled oil and 30% soy wax; and the third, 80% recycled oil and 20% soy wax. Each lot consists of 6 candles. In the process of making the candles, the one used by Aquino Rivera et al. was taken into account. al (2021), (figure 3)

Box 3

Figure 3

Aromatic candle manufacturing process

Product evaluation

The evaluation of the product was carried out by applying 7 tests to observe its quality.

The American Society for Testing and Materials (ASTM) are the ones who can assure consumers that their products are safe to use; these experts update standards regularly to reflect new technological advances and safety practices.

From this they protect the consumer and offer great advantages to the manufacturer.

The quality tests carried out on the candles are as follows:

Visual and physical inspection.

Parameters that the manufacturer considers necessary are analyzed. To value these items, different methodologies can be used using equipment for this purpose. However, it can be done based on the manufacturer's perception using parameters that he considers best for his product, and its evaluation would be on arbitrary scales, depending on the objectives he wishes to achieve (Fischer, 2021).

A scale was used to weigh the candles one by one to measure the amount of wax burned during each burning cycle. The color, texture and check for impurities and integrity of the wick were evaluated using a specific scale, and to measure hardness, pressure was applied with the fingers in different sections, in addition to checking cracks, openings and the integrity of the wick of each candle.

Combustion times

Defined as the process of evaluating the performance of finished candles from first to last burn to ensure that they burn at a normal rate, do not produce an abnormal amount of soot, and are safe for the end user (Candlescience, 2024).

Common scented candles on the market made with soy wax have a burn time of 50 hours on average (S|M The Beauty, 2021). Candles must be burned in 4-hour cycles, they must be spaced a minimum of 20 cm apart (Bravo Bonete, 2023).

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Always trim the wick to 6 mm (1/4) inch with sharp scissors before lighting the wick, taking measurements of the diameter of the melted wax around the wick and the depth of the pool every hour with a vernier caliper, and always extinguish the candle after each 4-hour cycle (Candlescience, 2024).

With the above, the duration of each candle was also determined, likewise, the amount of wax burned per hour was measured to analyze how long it takes for the candle to burn that amount of wax (James, s.f.).

Sail Pond

To evaluate the diameter of the candle pool, checks are made every hour during the burning cycle. For the third hour it must be at least 6 mm from the edge of the container, but after 4 hours it must cover the entire diameter of the pond or leave a small margin of distance to consider. For the depth of the candle pool, it must be between 6 to 13 mm, although it can be influenced by various factors such as the number of wicks or type of wax.

The pond for the first burning cycles may not completely reach the edges, but for burning cycles greater than or equal to four the diameter of the container should already be completed (Candlescience, 2024).

Flame height

This test was carried out at room temperature in a clean, closed room without drafts.

The candles were placed 10 cm away from each other, lit, and the height of the flame was measured at the beginning and end with a vernier caliper. The behavior of the flame was recorded every hour until the end of the 4-hour cycle. For a standard candle, the height is one inch (approx. 2.5 cm) high, however, some flames up to two inches (approx. 5 cm) may be considered normal (Bravo Bonete, 2023). Over the course of the burning cycle, the flame tends to be stable, with slight disturbances.

As the wax content decreases, heat tends to accumulate in the candle pool, but in the center of the candle, so the flame is expected to move more during combustion (Candlescience, 2024)

Sensory rating scale

To evaluate this item, different methodologies can be used that will allow it to be achieved, either in a more sophisticated way with the necessary equipment or in a simpler way, as an arbitrary scale.

In this case, the perception of the aroma that people feel when smelling the candle would be evaluated, where the expected parameters will depend on the objectives that the manufacturer wishes to achieve and with their chosen scale.

In this test, 5 people participated who did not have any condition that affected their sense of smell. They evaluated the aroma, intensity and persistence of each candle in the different groups, following a scale from 1 to 5, with their eyes closed so that They didn't know which lot they were evaluating (Fischer, 2021)

Combustion afterglow check:

It was carried out at the end of each burning cycle, before extinguishing them with the same container lid and then removing the lid and measuring the time in seconds to determine the duration that the core of the wick completely extinguishes. without releasing smoke. A value close to 1s is the best in the area of accident prevention and indicates better quality of the candle (Candlescience, 2024).

Combustion and post-combustion smoke:

This test was carried out in a clean room free of air currents at room temperature, the smoke, its color and persistence generated by the candles that were lit at a distance of 10 cm during the burning cycle and when blowing out the candles. Since recycled edible oil is being handled, it is expected to find some soot and coloration or duration in the smoke emitted.

For soy wax, a white soot is expected, easy to see with the naked eye. If the duration of this is long (we are talking more than 30s) or large columns of soot appear, it is due to a load of certain aromatic oils or poor treatment of the oil, indicating poor quality (Candlescience, 2024).

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Results

Quality Test 1. Visual and Physical Inspections

In this quality test, 5 characteristics were evaluated, color, hardness, surface texture, integrity of the wick, impurities, on scales of 1-5 (Figure 4).

Box 4

Figure 4

Value scale for the Visual and Physical Inspections test

Own elaboration

In batch 1, candles with 60% recycled oil and 40% soy wax, an average value of 2.83 was found and the reason is because the batch contained slight impurities around the bottle, in addition to a slightly porous surface.

In batch 2, candles with 70% recycled oil and 30% soy wax, the average value was 3.33, the result of this is a function of the wick, which was not completely centered.

Lot 3, candles made with 80% recycled oil and 20% soy wax, the average value was 3.23 in the same way as lot 2, the wick was not completely centered.

Quality Test 2: Burn Time

The duration of an average scented candle is 50 hours.

The results obtained for each batch produced were batch 1: 42 hours, batch 2 38 hours and batch 3 41 hours, considering the aspect that these candles were handcrafted with recycled oil and the production conditions (temperature, humidity) were not controlled, the average hours of each batch are within an acceptable duration range.

However, it is important to highlight that batch 1 is the longest lasting.

Quality Test 3: candle pond

The results obtained from this test in the first burning cycle (first 4 hours) are shown in table 1.

Box 5

Table 1

Candle Pond Results

Batch	Diameter (mm)	Depth (mm)
1	45	31.33
2	57.33	15.83
3	55.50	15.50

Own elaboration

For batches 1 and 3, the pond is within an acceptable range, given that the diameter of the bottle is 60 mm, batch 1 is considered outside the established range.

The depth indicator must be between 6 and 13 mm, except for lot 1, which has a much higher value than expected; the others have an acceptable depth, since the difference is just under 3 mm. Based on the results, batch 2 is the one with the greatest amount of wax burned per burning cycle, which is why the duration is shorter.

Quality Test 4: Flame height

The results of this test are shown in table 2. Of the 3 lots, the one that stands out is the third because it has the highest flame height, however none of the 3 reaches the established indicator of 2.5 cm; It is important to mention that, for small candles like the ones made, the flame height can be as little as half an inch, so they are within the expected range.

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Box 6

Table 2

Flame height test result

Batch	Height (mm)
1	10.52
2	11.39
3	12.38

Quality Test 5: Sensory Rating Scale

The parameters that were evaluated in this test were: candle uniformity, intensity, satisfaction and persistence of the aroma, on a scale from 1 to 5, where 1 is the lowest and 5 is the highest. From the qualifications for each of the aspects, an average was determined for each lot, which can be seen in table 3.

The average for lot 1 is 3.91, this result is mainly because the people who participated in the evaluation found the aroma slightly overpowering. In batch 2, 3.66 was obtained, and in batch 3, 3.33, because the evaluators perceived a slightly persistent aroma in both batches.

Box 7

Table 3

Average Sensory Rating Scale Test Results

Batch	Average Sensory Rating
1	3.91
2	3.66
3	3.33

When reviewing the values obtained from each batch with the test blank, the following is observed:

Batch 1 presents light gray smoke, in an average quantity, which has a slight duration and does not leave soot residue.

Batch 2 releases a medium amount of smoke, gray in color and lasts very little, it does not generate visible soot.

Batch 3. exhibits dark gray smoke, in moderate quantity, lasting longer than the other batches, but does not leave visible soot residue.

In general terms, the 3 lots are within an acceptable range, however, lot 2 has more stable parameters.

Quality Test 6: Combustion Afterglow Check

The Combustion Afterglow time for Batches 1, 2 and 3 respectively in seconds is 2.542, 4.736 and 3.217, these parameters are within a safe interval which is 10s, based on the results obtained with the comparison blank, However, the time of 1s is expected by the standard.

It is worth mentioning that this time does not affect the quality of the candle, but it is essential to consider the use and place that the consumer will give it.

Prueba de Calidad 7: Humo de Combustión y Poscombustión

Four aspects were evaluated in this test, quantity, color, smoke persistence, and soot residue, using scales of 1-5, where 1 is the lowest and 5 is the highest.

The Table 4 shows the scale used to evaluate this test.

Box 8

Table 4

Value scale for the Combustion and Afterburning Smoke

Amount of smoke	Smoke color	Smoke persistence	Soot residue
1= Null 2= Very little 3=Medium 4= Faor 5= Large	1= White 2=Light gray 3=Gray 4=Dark gray 5= Black	1= Nothing 2= very light 3=Slightly 4= Moderately 5= Persistent	1= Yes 2= No

Conclusions

Regarding the individual characteristics of each batch, we can see that batch 1 consumes less wax per burning cycle, because it has a low flame, causing wax to accumulate on the edges of the bottle, this probably causes customer dissatisfaction. However, its afterglow time is the best, which helps prevent accidents, and the smoke parameters are acceptable.

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Batch 2 is the one that consumes the most wax per burning cycle, causing its lifetime to be shorter than the others, but its flame is more stable, which causes the burning of the wax to be uniform, without wax on the edges or with the risk of flame drowning, its afterglow time is the second best, and its smoke parameters are stable.

Lot 3, although it is also one of those that consumes the least wax and therefore lasts the longest, its flame is very high, causing the pool of the candle to be larger and can drown the flame, probably causing the user to have You have to remove the wax from the container constantly to avoid it, its afterglow time is acceptable, although it is the candle that has a greater amount of smoke than the others.

Finally, based on the results obtained from the quality tests applied to the different batches, it is concluded that batch 2 is the best, (a mixture of 70% recycled oil and 30% soy wax), generating candles that allows to guarantee a better user experience so that the difference with respect to a conventional aromatic candle is almost zero and at the same time, take advantage of the greatest amount of recycled edible oil without compromising its quality.

However, it is not ruled out, if greater illumination of the candle is preferred, it can be a lot 3 or if the user requires a longer duration of the product, it is feasible to go for lot 1, this will depend on the needs to be covered.

Declarations

Conflict of interest

The authors declare no interest conflict. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

Author contribution

*Ramos-González, Luz María***:** contribute with the idea, in the coordination of the Project, supervision in the experimental part and writing of the article

*Cruz-Orduña, María Inés***:** Contribution with the analysis of the results, translation into English, support in the supervision of the experimental part of the project

*Bautista-De León, César***:** Contributed to the brainstorming that gave rise to the Project in the collection of oil, in the experimental part of the work

Escamilla-Rodríguez, Frumencio: Support in the collection and treatment of the oil, also in the supervision of the experimental part, and in the final review of the writing of the article.

Availability of data and materials

The data supporting this study's findings are available from the corresponding author, [R-G.L.M.], upon reasonable request.

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Abbreviations

ASTM	American Society for Testing and Materials
PROFECO	By its acronym in Spanish, Federal Consumer Attorney's Office

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Antecedents

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