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Zero-lactose sherbet with honey: Sensory analysis and economic viability

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Abstract

The objective of this study was to develop a zero-lactose sherbet sweetened with honey by means of sensory analysis and to calculate its economic viability. Using a simplex-centroid mix design, nine mixes were prepared. Microbiological analyses were performed to ensure the safety of the judges in the sensory analysis. The sensory analysis was performed in two stages: the order-preference test of the formulations obtained in the experimental design and the affective acceptance test of the most preferred sample in the order-preference test. The acceptability index was also used. The economic viability was calculated by comparing its cost with the cost of the standard sherbet formulation. In the order-preference test, the sample with 13.80 g/100 g honey, 2.25 g/100 g emulsifier, and 0.85 g/100 g neutral alloy was the most preferred. In the affective test, all the attributes had an acceptability index greater than 80%, classifying the ice cream as having good sensory acceptance since it is necessary for the index to be above 70%. The zero-lactose sherbet sweetened with honey costs 40% more than the traditional sherbet. Therefore, we can conclude that the development of zero-lactose ice cream sweetened with honey is a product sensorial and accepted by consumers. Despite the cost of production, consumers prefer healthier products even if they have to pay a higher price.

Keywords: acceptability; lactose intolerance; healthy eating; production cost.

Practical Application: Zero-lactose ice cream with good sensory acceptability sweetened with honey.

1 INTRODUCTION

Ice cream, frozen products obtained from an emulsion of fats and proteins or a mixture of water and sugars, is a trendy type of food worldwide and is consumed after and between meals (Bedford, 2022). The growing awareness of the relationship between diet and health has led consumers to demand ice cream that meets their physical and mental well-being needs (Díaz et al., 2020).

Edible ice creams are given different names according to their manufacturing process, presentation, and composition, which can be quite variable, with 8–20% fat, 8–15% nongreasy milk solids, 13–20% sugar, and 0–0.7% emulsifier and stabilizer. The composition can vary according to the region and in different markets (De Souza & de Oliveira Magalhães, 2010).

There is also Ordinance No. 267 of 2003 from ANVISA, which classifies edible ice creams. Among that classification, there are sherbets, which are products made basically with milk and/or dairy products and/or other food raw materials and which contain a small portion of protein and fat; the protein and fat can be totally or partially of nondairy origin, and at least 1% fat and 1% protein must be present in the composition (Brasil, 2003).

Ice cream and/or sherbet based on milk is unsuitable for consumption by people who are lactose intolerant. According to a study, approximately 37 million people have lactose intolerance and/or unpleasant symptoms when drinking a glass of milk. This corresponds to approximately 50% of the world's adult population (Furlan & Fernandes, 2022). Lactose intolerance is caused by a deficiency in the enzyme lactase, which is responsible for the breakdown of the lactose carbohydrate present in dairy products and their derivatives (Mattar & Mazo, 2010).

In addition to the lactose present in milk, sucrose has been the main sugar traditionally used in the production of ice cream, and for many years, sucrose was the only sweetener used; however, currently, there is a tendency to mix sucrose with other sweetening agents to obtain adequate sweetness (Santos, 2009). With that in mind, as a substitute for sucrose, honey can be used, which is a natural sweetener that can add unique value to ice cream due to its characteristic aromatic profile, in addition to having positive effects on consumers' health, as it acts in the prevention of chronic diseases, diabetes mellitus, cardiovascular diseases, and atherosclerosis (Vallianou et al., 2014). These pharmacological properties are often related to bioactive compounds, mainly phenolic compounds (Waheed et al., 2019).

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Because of the above, the objective of this study was to develop and analyze zero-lactose sherbet-sweetened honey using sensory analysis and economic viability (EV) calculations.

2 MATERIALS AND METHODS

2.1 Preparation of ice cream

To produce sherbets, Piracanjuba® zero-lactose semi-skimmed milk UHT, bee honey from the flowering liana vine (apiary Sabor de Mel), Pro Sorvete® ice cream flavor base, Biomix® emulsifier, and Selecta® neutral mixture of neutral alloy (sugar and starch) were used.

The maximum and minimum levels of the variable components of the mixtures used in the sherbet formulations were sensorially preestablished by the researchers involved. Using the simplex-centroid type mix design (Jiao et al., 2018), nine mixtures were established (Table 1). The concentration of honey varied from 11.04 to 14.31 g/100 g, that of emulsifier varied from 2.25 to 4.51 g/100 g, and that of neutral alloy varied from 0.34 to 1.35 g/100. The sum of the fixed ingredients, milk (81.41 g/100 g), cream-flavored ice cream base (1.69 g/100 g), honey, emulsifier, and neutral alloy contents totaled 16.9 g/100 g in all formulations.

All the ingredients were initially homogenized in an industrial blender (Siemsen, D560484, Jaraguá do Sul, Brazil) to produce sherbets, forming a syrup. Soon after, the syrup was placed in an ice cream mixer (Everest, Horizontal Type, São Carlos, Brazil) that incorporated air at a temperature of -7°C for 4 min. Then, the experimental sherbets were packaged in 10 L high-density polyethylene containers with a lid and stored at -18°C.

2.2 Microbiological analyses

Microbiological analyses were carried out to ensure the safety of the sensory analysis tasters, according to the analyses described in RDC No. 724 of July 1, 2022, of the National Health Surveillance Agency – ANVISA (Brasil, 2022), which describes the technical regulations for the microbiological standards for food, in topic 21 – (a) edible ice creams and special products based on milk and dairy products (ice cream and popsicles with or without icing, sandwiches, and ice cream cake) and the like. The samples were tested for coagulase-positive *Staphylococci* and *Salmonella* sp. and their coliform count at 45°C.

Table 1. Concentrations of the variable components (honey, emulsifiers, and neutral alloy) were generated by designing mixtures of the simplex-centroid type.

Experiment	Emulsifier		Neutral alloy		Honey	
	Real	Pseudo	Real	Pseudo	Real	Pseudo
1V	0.1333	0.0000	0.0200	0.0000	0.8467	1.0000
2V	0.2666	0.6896	0.0200	0.0000	0.7134	0.3104
3V	0.1333	0.0000	0.0800	0.3104	0.7867	0.6896
4C1	0.2666	0.6896	0.0800	0.3104	0.6534	0.0000
5C1	0.1333	0.0000	0.0500	0.1552	0.8167	0.8448
6C1	0.2666	0.6896	0.0500	0.1552	0.6834	0.1552
7C1	0.2000	0.3448	0.0200	0.0000	0.7801	0.6552
8C1	0.2000	0.3448	0.0800	0.3104	0.7201	0.3448
9C2	0.2000	0.3448	0.0500	0.1552	0.7501	0.5000

To carry out the experiments, the actual concentrations were multiplied by 750 g (average total mass used as the calculation basis).

2.3 Sensory analysis

The samples used in the sensory analyses were from the same batch as those of the microbiological analyses, thus ensuring the safety of the tasters. The sensory analysis was carried out in two stages: an order-preference test of the nine different formulations obtained by the experimental design, performed by 50 untrained judges, and an effective test of acceptance and purchase intention of the most preferred sample in the order-preference test, carried out with 100 untrained judges.

The order-preference test was carried out with 50 tasters in a sensory analysis laboratory with individual booths. The nine different formulations were presented simultaneously to the tasters, and all the samples were coded with randomized three-digit numbers. The order of presentation of the samples was randomized to minimize the position error. Each sample consisted of a sherbet ball of approximately 30 g that was served in disposable white polystyrene thermal cups with a capacity of 100 mL, and water was served to cleanse the palate between samples.

After determining the most preferred sample, an affective acceptance test was carried out for the most preferred sample, evaluating the attributes of color, flavor, texture, odor, and overall evaluation/impression using a nine-point structured hedonic scale (9 – I liked it very much, 5 – I neither liked nor disliked it, and 1 – I disliked it very much). The purchase intention was assessed using a 5-point scale that indicates the taster's opinion (1 – certainly would buy, 3 – maybe would buy/maybe would not buy, and 5 – would certainly not buy). The test was carried out with 100 tasters in a sensory analysis laboratory with individual booths. The sample (approximately 30 g) was served in a Styrofoam cup, and water was provided.

The results of the order-preference test, acceptance test, and purchase intention were calculated using the results' averages, obtaining the tasters' preference, acceptance, and purchase intention percentage.

All the judges signed a free and informed consent form, and the project was submitted and approved by the Ethics Committee for Research with Humans of the Instituto Federal Goiano through number 06664919.7.0000.0036.

2.4 Acceptability index

The acceptability index (AI) (or degree of acceptance) was also calculated for the formulation of the most preferred zero-lactose sherbet sweetened with honey according to the equation proposed by Dutcosky (2013) (Equation 1). The decision criterion for the index to be well accepted is 70% or more (Dutcosky, 2013):

$$IA = \frac{A}{B} * 100 \quad (1)$$

where:

A: average grade obtained for the product;

B: maximum grade given to the product.

2.5 Cost and economic feasibility analysis

The cost of the formulation under study was calculated by adding all the unit costs of each of the ingredients used in the formulation. The formulation cost per liter of sherbet was calculated by dividing the cost of the formulation under study by the final yield of the sherbet in liters. This calculation did not consider surveys regarding labor or indirect manufacturing costs.

The EV of the honey-sweetened zero-lactose sherbet was verified by comparing the cost with the cost of the standard sherbet formulation (cream-flavored sherbet made with whole milk with lactose present and sweetened with sugar) (Equation 2):

$$EV = \frac{\text{cost per litre of the sherbet formulation under study}}{\text{cost per litre of the standard sherbet formulation}} \times 100 \quad (2)$$

3 RESULTS AND DISCUSSION

3.1 Microbiological and sensory analysis

All the formulations of zero-lactose sherbet sweetened with honey showed adequate sanitary quality without posing risks to consumers, considering that all the samples had negative results for all the quantified microorganisms. Therefore, it can be said that the production process of zero-lactose sherbet sweetened with honey followed the standards of hygienic-sanitary conditions, meeting the requirements of good manufacturing practices.

Acceptance and preference regarding sensory analysis are different concepts, preference being the expression of the highest degree of liking. Acceptance is an experience characterized by a positive attitude, that is, the fact that an individual or population is favorable to the consumption of a product (Pereira et al., 2017); therefore, carrying out these tests is essential in developing a new product.

In the order-preference test, the study population consisted of a sample of 50 untrained tasters, 12 of whom were females and 38 males, students of technical and higher education, regularly enrolled, aged between 14 and 28 years, who liked cream sherbet, and who had no allergies or intolerance to any ingredient in sherbet.

Figure 1 shows that the samples with higher amounts of emulsifier and smaller amounts of honey were the least preferred by the tasters (samples 4C1 and 6C1). In comparison, the samples with lower amounts of emulsifier and higher amounts of honey were the most preferred (samples 1V and 5C1).

Emulsifiers are chemical substances with hydrophobic and hydrophilic parts, which allow the formation of an emulsion to reduce the surface tension between the phases (Tirado Perez Godoy, 2017). They are used to promote uniformity during mixing, reduce the mixing time of the syrup, control agglomeration and regrouping of fat during the freezing stage (stabilize the fat emulsion), and facilitate the distribution of air bubbles, producing an ice cream with body and a typical creamy texture (Souza et al., 2010).

However, the concentrations of emulsifiers need to be studied well, as doses above those recommended can cause shrinkage of the ice cream and a greasy taste, in addition to very slow melting and changes in desirable body characteristics and texture (Berger, 1990), resulting in rejection of the product by the consumer, as occurred in this study for samples with larger amounts of emulsifier.

Regarding the honey content, the higher the honey content in the sherbet, the greater its acceptance, which occurred because Brazilian consumers prefer sweeter flavors (Hansen et al., 2008). In addition, according to Green and Nachtigal (2015), cold tends to numb the taste buds, making them less sensitive to the perception of sweet tastes, in which case more honey is needed to produce the desired effect at low temperatures.

Finally, we can conclude that through the order-preference analysis, sample 5C1, with 13.80 g/100 g honey, 2.25 g/100 g emulsifier, and 0.85 g/100 g neutral alloy, was the sample most preferred by the tasters. Although the tasters preferred the sample with one of the highest amounts of honey, we can see that the percentage of sweetening substance used (in this case, honey) was only 13.8%. This content contradicts what Berger (1990) claims, recommending adding 14–16 g of sugar/100 g of a mixture of ingredients (14–16%).

This lower amount of sweetening substance in the honey-sweetened zero-lactose sherbet is mainly due to the use of zero-lactose milk. The lactose disaccharide (formed by D-glucose + D-galactose) is found naturally in milk (Dominici et al., 2022) and has a sweetness relative to sucrose of 0.16 (Romero-Velarde et al., 2019); however, in this study, zero-lactose milk was used, that is, the sugars are in their free form and consequently have a greater sweetness relative to sucrose, being 0.32 and 0.74 for D-glucose and D-galactose, respectively (Romero-Velarde et al., 2019). Therefore, it is important to note that D-glucose and D-galactose have a greater sweetening power than lactose, thus reducing the need for other sweetening agents.

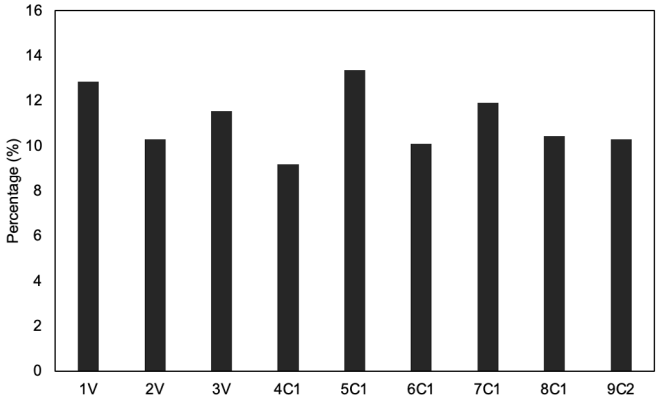

Figure 1. Judges' preferences in the order-preference test of zero-lactose sherbet sweetened with honey.

In the acceptance practical test, performed with the most preferred sample in the order-preference test, the study population consisted of a sample of 100 untrained tasters, 45 of whom were females and 55 males, students of technical education or from higher education, regularly enrolled, aged between 15 and 34 years, who liked cream sherbet, and who had no allergies or intolerance to any ingredient in sherbet.

The five attributes assessed through the affective acceptance test (Table 2) received scores above 7 and an AI above 80%. Gonçalves et al. (2018) affirmed that for a good result, the acceptance index must be above 70%; thus, it can be concluded that the tasters liked and approved of the developed sherbet.

Color was the attribute that obtained the highest average score (8.1) because the sherbet has a cream flavor, which is yellowish, making the taster associate it with honey. According to Pathare et al. (2013), color can make a food immediately accepted or rejected by the consumer without even tasting it. This is because the consumer expects the product to have the color that characterizes it. After all, they associate the product's flavor with the color they see and do not consume it if the color is different in shade or intensity than expected.

The analysis of the flavor attribute showed that the honey-sweetened zero-lactose sherbet received an average score of 7.3, corresponding to being moderately liked on the hedonic scale, and an 81.11% AI, the lowest score of the evaluated attributes. Honey was one of the first sources of sugar for humans in the history of humankind. Despite its rich nutritional composition and medicinal properties, the annual per capita consumption of honey in Brazil is between 200 and 300 g, which is much lower than those in other countries such as Switzerland and Germany, which consume 1.0–1.5 kg/per person/year (Cheung & Gerber, 2009; Colli et al., 2020).

Even though Brazil is one of the largest producers of honey in the world, its consumption is still very low, and many consumers use honey only as a medicine (Gomes et al., 2019), which justifies the note received regarding the flavor attribute for the developed sherbet.

Analyzing Figure 2, we calculate the intent to purchase the tasters about the zero-lactose sherbet sweetened with honey. If we add the positive buying attitudes (would certainly buy and probably would buy), we obtain a percentage of 77%; this behavior is associated with the high acceptability rate of the sample (above 80% in all attributes).

Table 2. Judgments were obtained in the affective test of acceptance of zero-lactose sherbet sweetened with honey.

Attributes	Average grade	Acceptance according to a grade scale	Acceptability index (%)
Color	8.1	Really enjoyed	90.00
Odor	7.6	I liked it moderately/ very much	84.44
Flavor	7.3	I liked it moderately	81.11
Texture	7.6	I liked it moderately/ very much	84.44
Global Printing/ assessment	7.7	I liked it moderately/ very much	85.56

3.2 Cost and economic feasibility analysis

In the cost analysis, only the raw materials used were considered, and the estimated value per liter of zero-lactose sherbet sweetened with honey was approximately R$1.67, with honey and zero-lactose milk being the main contributors to this value.

When analyzing the EV, we noted that producing zero-lactose sherbet sweetened with honey is 39% more expensive than producing a sherbet with lactose and sweetened with sugar. However, this is not an inconvenience, as according to a survey conducted in 2018 by the Federation of Industries of the State of São Paulo, 71% of respondents indicate that they prefer healthier products, even if they have to pay dearly for them (Cruz, 2018).

Brazil has great growth potential in the consumption of healthy foods. According to Mintel (2016), 76% of the population seeks healthy foods. For various reasons, many experience dietary restrictions throughout their lives so that their health is not compromised. The restriction to certain types of food can vary in intensity according to each person and the individual's health condition. Therefore, it is important that when discovering a certain food restriction, one finds the pleasure and flavors of foods that may not have been in their daily lives (Loth et al., 2016).

Brazilians avoid some ingredients such as sodium, sugar, and saturated or trans fats (Monteiro et al., 2020). This information reflected sales in 2016, in which R$ 93.60 billion was spent on healthy food and beverages, reaching the fifth position in the rankings in this sector. The average growth rate was recently 12.3% per year, and the forecast is an annual growth of 4.4% until 2021 (Gomes et al., 2019).

Knowing that people today are looking for food that, in addition to being tasty, is healthy and nutritious, we can conclude that even though it is 40% more expensive than a sherbet with lactose and sweetened with sugar, it is feasible to produce zero-lactose ice cream sweetened with honey.

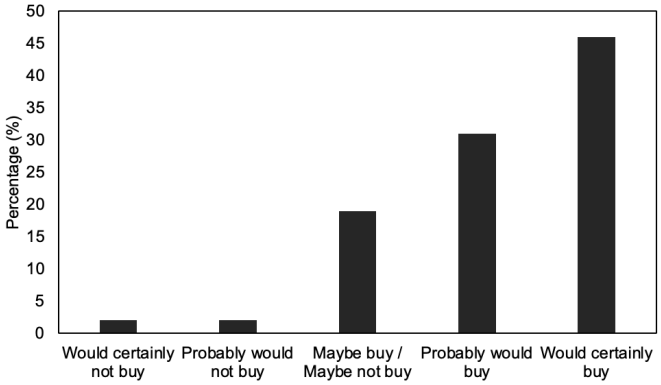

Figure 2. Intent to purchase the tasters in relation to the zero-lactose sherbet sweetened with honey.

4 CONCLUSION

Therefore, we can conclude that the developed zero-lactose ice cream sweetened with honey is a product sensorial accepted by consumers and a good option for lactose-intolerant people, besides having the benefits of honey, which is extremely important in human nutrition. Although the cost of production is higher than that of traditional sherbet, consumers prefer healthier products, even if they have to pay dearly for them.

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