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Development of Bitter Chocolate Bonbon Stuffed with Almond (*Prunus amygdalus var. dulcis*) and Its Physicochemical Evaluation and Sensory Acceptance

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Abstract: Objective: Develop and evaluate bitter chocolate bonbons filled with granulated flour/almond cream, cinnamon powder and decaffeinated coffee essence. Methodology: Two formulations of bitter chocolate bonbons (73% cocoa) stuffed with granulated flour (F1) almond cream (F2), cinnamon powder, and coffee essence were made; no sweeteners. Physicochemical analyses of protein, fat, ash, dry matter, moisture and pH were performed. The nutritional content was estimated according to the regulations. In addition, an evaluation of subjective sensory acceptance was performed with 5-point hedonic scale, with 100 untrained judges who rated the attributes of aroma, texture, taste and color, a descriptive and inferential statistical analysis of the sum of ranges Mann-Whitney (Sigma Stat 4.0). Results: A bonbon with a characteristic chocolate color was obtained as a final product, with a firm texture. The interior obtained a soft beige color with creamy texture and almond pieces. The aroma was chocolate and coffee. The bonbon was characterized by the fat content (67 g) and protein content (21.9 g). Sensory evaluation favored F2 with 89% acceptance, the range of values found for the different attributes of the two formulations was 4 to 4.4, and there was no statistical difference ($p > 0.05$). Conclusions: We obtained a bitter chocolate bonbon (73% cocoa) without sweetener, it was characterized nutritionally, and both formulations obtained an important acceptance.

Key words: Chocolate bonbon, almond, functionality, acceptance evaluation.

1. Introduction

It is denominated chocolate to the homogeneous product made from the mixture of two or more of the following ingredients: cocoa paste, cocoa butter, sweetened cocoa, regardless of whether they use ingredients such as dairy and food additives [1]. There are different types of chocolate, among which the bitter chocolate must contain ≥ 22% of cocoa butter, ≥ 18% of defatted cocoa, ≤ 40% of total cocoa solids and ≤ 5% of vegetable fat different from the cocoa butter [1]. The content of sugars should be less than 40% [1, 2].

Bitter chocolate contributes 449-534 kcal per 100 g of product, it is rich in minerals such as calcium and phosphorus and vitamins of the B complex [3]. In addition, it provides nervous system stimulating substances such as caffeine, anandamide, theobromine, phenylalanine and serotonin and polyphenols such as flavonols [4].

In Europe, chocolate consumption ranges between 10 and 7 kg per capita per year, with Switzerland standing at an annual consumption of 8.9 kg, while in Mexico consumption ranges between 600 g and 700 g per capita [5].

In Mexico, 16.5 thousand tons of table chocolate, 64 thousand of chocolate candies and 49.9 thousand of chocolate powder are sold [6]. Most sweets and powders do not meet the percentage of cocoa solids indicated in NOM-186-SSA1/SCFI-2013 to be considered chocolate [1].

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For the development of the bonbon, the inclusion of the almond was considered, since it is a fleshy oily drip-shaped seed with an eburnealcolor, a matt aspect [7]. It has an oblong shape, which is covered by a brown tegument with a rough texture [8]. The consumption of 100 g of almonds contributes 575 kcal, 21.22 g of protein, 49.2 g of lipids and 21.67 g of carbohydrates. It is rich in minerals and vitamins. Its moderate consumption is considered as a cardiovascular protector, which helps to maintain optimal levels of the lipid profile, decreases the glycemic index consumed regularly and is a source of antioxidants [9].

Several studies show that the consumption of polyphenols in bitter chocolate improves endothelial function, since it increases the ability to activate the enzyme nitric oxide synthetase, which improves blood pressure, mainly systolic, insulin sensitivity and levels of blood glucose [10-12].

It has been proven that the inclusion of sweeteners, mainly sucrose and fructose, reduces the content of polyphenols and their bioavailability [13]; the product proposed in this research, will not contain any sweetener, neither natural nor artificial.

Noncommunicable diseases, also known as chronic diseases, are long-lasting and usually evolve slowly. The main types of noncommunicable diseases are cardiovascular diseases, cancer, chronic respiratory diseases, obesity and diabetes [14]. These diseases represent a true epidemic that is increasing due to the aging of the population and the current lifestyles that accentuate sedentary lifestyle and poor diet [15].

Food is one of the main risk factors for the development of these noncommunicable diseases. The increase in the consumption of hypercaloric foods [14], added sugars and other sweeteners, sodium, saturated fats and trans fats, as well as the reduction of simple pure water intake, fruits and vegetables constitute the main problems of the food industry. In addition, the advertising of industrialized foods is increasingly frequent, and this psychologically attributes to the intake of this type of food, which are mostly nutritional and abundant in fat and simple carbohydrates [16].

According to the epidemiological bulletin of the National System of Epidemiological Surveillance (SINAVE), publications of the General Directorate of Epidemiology; in week 17 of the year 2019, there are registered 15,980 cases of obesity, 2,017 cases of ischemic heart disease, 183 cases of diabetes mellitus type 1 and 7,909 cases of type 2 diabetes mellitus in Jalisco [17].

2. Materials & Methods

The present study was carried out in the Gastronomy and Physical Chemistry of Food Laboratories, in the University Center of Biological and Agricultural Sciences of the University of Guadalajara, located in Zapopan, Jalisco, Mexico. The study was prospective, comparative, experimental and transversal.

2.1 Formulations

Two formulations were made of bitter chocolate (73% cocoa), essence of decaffeinated arabica coffee, cinnamon powder and almond. Formulation 1 (F1): with 48% bitter chocolate and granulated almond flour, while formulation 2 (F2): with 40% bitter chocolate and almond cream.

2.1.1 Making of Chocolates Bonbons

It begins with the reception of raw materials. To make the almond flour (F1), the whole almonds are placed with skin on a comal and roasted for 2 minutes and 10 seconds. A trituration is performed in a blender for 6 minutes. The almond cream (F2) is made by roasting the whole almonds with skin for 2 minutes and 10 seconds and grinding for 15 minutes. Melted chocolate is added to a water bath in the molds and refrigerated for 10 minutes, then the cinnamon and coffee essence are added to the F1 and F2, making a homogeneous mixture and chocolate is added to the molds, and then it is cooled for 2 hours at 5 ± 2 °C.

And the dosing and cooling process is repeated; this with the aim of achieving the desired coverage percentage for each formulation. Finally, refrigerate again for 2 hours at 5 ± 2 °C.

In Fig. 1 the flowchart of the chocolate making process is shown.

2.2 Sensory Acceptance Evaluation

An acceptance evaluation of hedonic scale of 5 points was carried out; in which 1 represents "I extremely dislike", 3 "I do not like or dislike" and 5 "I like it extremely". The attributes of aroma, texture, flavor and color were evaluated with 100 untrained judges from 18 to 70 years of age. They were given a sample of 5 g filled bonbon, packed in individually cellophane paper. The sample was delivered at room temperature (30 ± 7 °C). The results obtained were collected in the Microsoft Excel 2016 program and subjected to descriptive and inferential statistics (Mann-Whitney rank sum test, significance level of 0.05), and the Sigma Stat 4.0 statistical program was used.

2.3 Physicochemical and Nutrimental Evaluation

The most accepted formulation was analyzed in duplicates for crude protein [18], fat [19], dry matter and moisture [20] as well as ash [21]. In addition, a nutritional estimate was made according to the database of the USDA (United States Department Agriculture) [22, 23-25] and according to the Mexican System of Equivalent Foods [26], and it was determined for a portion of 15 grams almond-filled bonbon chocolate. The nutritional table was prepared based on Mexican regulations for labeling [27].

3. Results

3.1 Formulation

Bonbon filled with a characteristic chocolate color exterior was obtained, a firm texture, although it melts in the mouth. The interior obtained was soft color, similar to the almond color and a granular or creamy texture with almond pieces, according to the formulation. The aroma was mostly chocolate and coffee (Fig. 2).

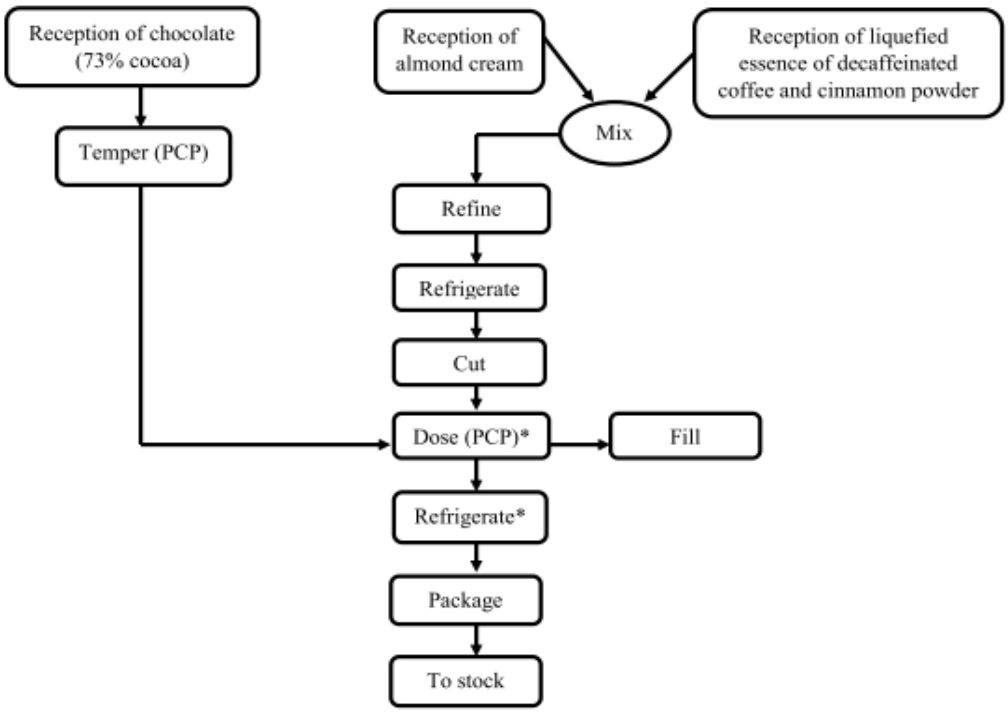

Fig. 1 Flowchart of the elaboration of chocolate.

Fig. 2 Chocolate bonbon filled with almond cream.

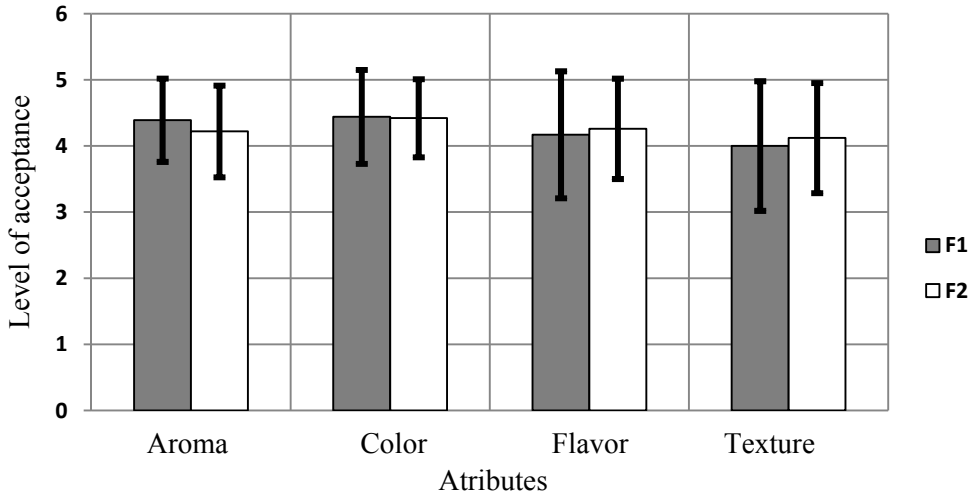

Fig. 3 Level of acceptance of the bonbons (average and standard deviation).

3.2 Sensory Acceptance

From the attributes evaluated by the hedonic scale it was identified that the color presented a very similar average for both formulations: 4.44 (F1) and 4.42 (F2), followed by the aroma, flavor and texture, the last one with an average of 4 (F1) and 4.12 (F2). That said, all the attributes received a rating equal to or greater than 4, which in the acceptance scale means "I like it" (Fig. 3).

During the evaluation of the specific flavors, the judges identified with different levels of intensity: for F1 the chocolate, bitter and coffee and for the F2 chocolate, bitter, coffee and almond (Fig. 4).

In F1 79% of the judges would buy the product, while in F2 89% would buy it, therefore, the acceptance of F2 is 11.236% higher than F1. F2 was more accepted by the judges; therefore, it remained the final product.

Sensory evaluation favored F2 with 89% acceptance, although there was no statistical difference ($p > 0.05$) in the evaluated attributes (Fig. 2), and the product lays in the "like" category.

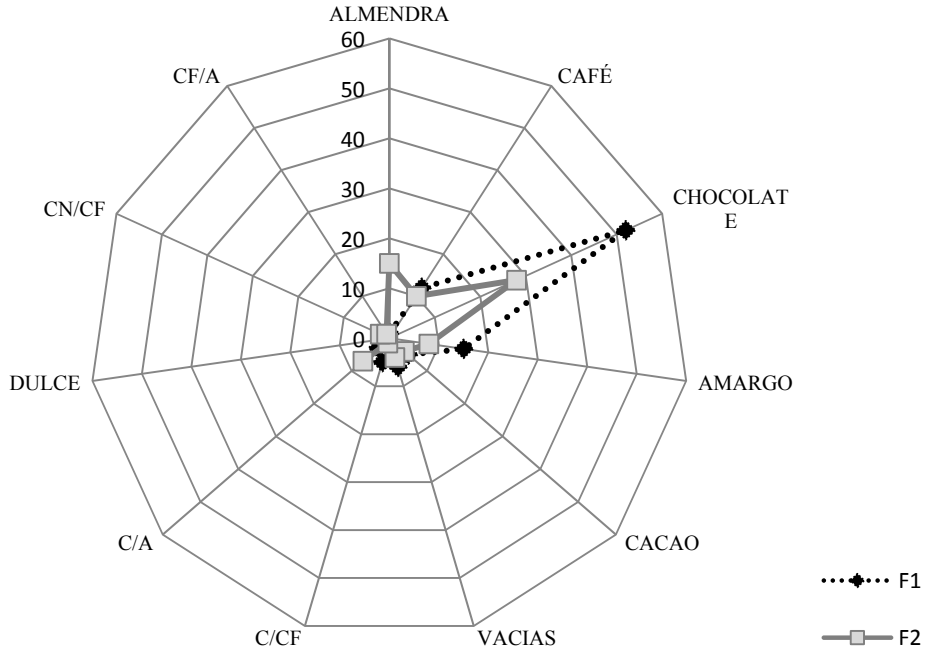

Fig. 4 Level of intensity of the predominant flavors of the bonbon.
CF/A: coffee/almond, CN/CF: cinnamon/coffee, C/A: cinnamon/almond, C/CF: chocolate/coffee.

Table 1 Average and standard deviation of physicochemical analyses.

Analyses	Average and D. E.
Protein	16.8615 ± 0.8428
Dry matter and moisture	7.8098 ± 0.0520
Ash	2.5396 ± 0.0167
Fat	42.9935 ± 7.7467
pH	7 ± 0

Table 2 Nutritional estimation of almond-filled bonbons.

Nutriment	Amount per	
	100 g	15 g
Energy (kcal)	528	79.2
Protein (g)	13.7	2
Total fat (g) of which	41.9	6.2
Saturated fat (g)	11.6	1.7
Total carbohydrates (g) of which	29.2	4.3
Sugars (g)	11.7	1.7
Dietary fiber (g)	10.7	1.6
Sodium (mg)	9	1.3

Table 3 Recommended nutritional value of some nutrients contained in the bonbon.

Nutriment	Quantity
Vitamin E	118% VNR
Dietary fiber	30% VNR
Calcium	18% VNR

3.3 Physical-Chemical Evaluation

In F2, being the most outstanding formulation, the physicochemical analyses were performed, from which the average and standard deviation of the tests performed in duplicate were obtained (Table 1). It highlights a high fat and protein content.

By nutritional estimation it was obtained that the portion of filled bonbon gives 79.2 kcal (Table 2), it should be noted that the formulation has no added sweeteners or sodium. The nutritional content is presented based on the NOM-051-SCFI/SSA1-2010, which is shown in 15 g and 100 g of product. In Table 3, the nutrients that are present in greater quantity in the bonbons are shown, according to the recommended nutritional value (VNR) in a suggested daily intake for the Mexican population. Percent based on a 2,000 calorie diet.

4. Discussion

The chocolates in all their presentations are a product of great consumption. Lately several articles have been published mentioning their health benefits. And therefore, the food industry is constantly changing in search of innovative products that satisfy the public, but that are foods with a healthy purpose.

In the year 2017, a study was carried out to determine the acceptance of chocolate in the city of Quito, Ecuador. A survey was conducted with 208 people ranging from 25 to 69 years old with various questions [28].

In the study it is shown that 44% of the population prefer to consume chocolate in bonbon presentation, 30% prefer it to be filled with nuts, of which the almond is the most accepted with 37%. This favors the protocol and gives rise to carrying out acceptance surveys of chocolate in Mexico, specifically in the city of Guadalajara, Jalisco.

Another study carried out in Chile [29], which compares chocolates sold in supermarkets in the city of Santiago to know the nutritional content, several physicochemical determinations where carried out, which include proteins, total fats and sodium.

A commercial chocolate with 51% cocoa and whole almonds was chosen, from that study for being the most similar in terms of ingredients to the bonbon of this research.

The bonbon filled with almond cream obtained greater amount of fat and protein (67 g and 21.9 g, respectively) than the commercial chocolate (39.5 g and 9.7 g), however, it has low sodium content (9 mg) with respect to the trademark (40.5 mg). The results of both samples are in 160 g of product.

Richter and Lannes [30] performed sensory and physicochemical evaluations on special bonbons for diets. Two chocolates were formulated: control formulation and special formulation. Both include non-caloric sweeteners depending on being a sweet product also being a light product as well as suitable for people with diabetes.

The sensory evaluation was performed on a hedonic scale of 10 points to 170 people with the age range of 19 to 55 years, in which the texture and flavor attributes were evaluated. And an average of 8.3 was obtained for the attribute “texture” and 8.2 for the attribute “flavor”. Although the bonbons for diets and those of almond cream were evaluated in different scales, both are in the “like” range.

As for the physicochemical analysis, 100 grams of samples were made. The following results were obtained (average): 1.69 ashes, 7.11 protein, 28.33 fats and 6.65 pH.

In contrast, the chocolate filled with almond cream, contains higher content of fat, protein and ash. This chocolate presents a neutral pH 7 [7].

5. Conclusions

- Bitter chocolates (73% cocoa) filled with granulated flour/almond cream, cinnamon and coffee essence were obtained.
- The final product does not contain any type of sweetener, neither artificial nor natural.

- The formulation with almond cream, had greater sensory acceptance and therefore has more chances of commercial success.
- The chocolate was characterized by an energy content of 79 kcal per 15g.

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