

Preparation and Characterization of Microwave-made Oat and Fruit Cupcakes

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Abstract The development of new products is increasingly being studied to meet the demands of today's consumer market which seeks products with sensory and nutritional quality associated with health benefits. In this sense, fruits, vegetables and cereals have stood out, since in addition to preventing some diseases when consumed properly combined with healthy habits, they can be used as ingredients in various products such as those of breadmaking. The objective of this study was to develop and evaluate chemical, physicochemical and sensory characteristics of microwave-made cupcakes of oats and fruits. Two cupcake formulations were made, one with oats, banana and apple and the other with oats, pineapple and mint. The analyses were moisture, protein, lipids, ash, carbohydrates, pH, titratable acidity, soluble solids, reducing, non reducing and total sugars, as well as sensory analysis performed by the emotional test of acceptance and purchase intent using the hedonic scale. The results indicated that the products are presented as a good source of energy and protein, low-fat and good acceptance and purchase intent, especially the oat cupcake with banana and apple suggesting an alternative to the baking industry.

Keywords: cupcake, oats, chemical and physicochemical properties, sensory evaluation

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1. Introduction

The demand for foods that help in promoting health and thereby potentiate the prevention of some diseases is currently on the increase. Accordingly, foods considered functional have gained more and more space in the meals of consumers. Although the term functional food does not have a universal definition, according to the American Dietetic Association (ADA) all foods are functional in some physiological level [1], because they provide nutrients or other substances that furnish energy, sustain growth, or maintain/repair vital processes. However, functional foods move beyond necessity to provide additional health benefits that may reduce disease risk and/or promote optimal health. Functional foods include conventional foods, modified foods (ie, fortified, enriched, or enhanced), medical foods, and foods for special dietary use [2].

Some of the foods that have these functionality are fruits, vegetables and cereals. Oat constitutes a healthy basis for food products [3]. Oat has gained relevance in human nutrition because it is one of the few cereals with a high content of soluble fibre -namely β -glucan-, and is a good source of proteins, vitamins, and minerals [4]. In

addition oats contain large amounts of antioxidants such as vitamin E, various phenolic compounds and avenanthramides [5]. Current public health recommendations aimed at reducing the risk of coronary heart disease in the United Kingdom (UK) suggest including oats and oat-based products as part of a healthy diet [6].

Furthermore, there is a demand for products that not only provide functionality but also convenience, and microwave foods are increasingly available on the market, since they require less cooking time compared to conventional ovens.

The present study aimed to process and characterize microwave-prepared cupcakes of oat and fruits, aiming to produce a product that adds functionality, practicality and is well accepted by consumers.

2. Materials and Methods

2.1. Obtaining Raw Materials

The ingredients used in the formulation of cupcakes were oats in thin flakes, wheat flour, eggs, vegetable oil, brown sugar, baking soda, baking powder, chia (*Salvia hispanica* L.), banana (*Musa paradisiaca* L.), apple

(*Malus domestica* Borkh), pineapple (*Ananas comosus* (L.) *merril*) and mint (*Mentha* sp.), all purchased at local shops in the city of Barra do Garças-MT and taken to the Food Technology Laboratory of the Federal Institute of Mato Grosso, Barra do Garças Campus, where they were stored until processing time.

2.2. Processing Cupcakes

Two types of oat and fruit cupcakes were prepared, one with banana and apple and the other with pineapple and mint. The rest of the ingredients were the same for the two assays. The formulation is shown in Table 1.

Table 1. Ingredients used in the cupcakes preparation

Ingredients	Quantity (g)
Wheat flour	65
Oats in thin flakes	65
Brown sugar	120
Oil	60
Eggs	150
Chia	5
Baking powder	5
Sodium bicarbonate	3
Banana	450
Apple	450
Pineapple	450
Mint	20

The ingredients were mixed manually in stainless steel container with the aid of spatula during 5 minutes. The homogeneous dough was placed on silicone shapes with dimensions of 7×6×3 cm. They were then taken to the high power microwave oven (Electrolux-MTD30) where they remained for five minutes. The products were cooled at room temperature, removed from the shapes and properly stored until analysis.

2.3. Chemical and Physicochemical Analysis

Analysis were performed in the Food Analysis Laboratory, belonging to the Institute of Exact and Earth Sciences, Federal University of Mato Grosso. Samples were crushed and homogenized for further analysis, performed in triplicate. All reagents used were of appropriate degree of purity for analysis (P.A).

The contents of moisture, lipids, ash, pH, titratable acidity and soluble solids were carried out in accordance with Instituto Adolfo Lutz [7]. Analysis of protein, reducing sugars, non-reducing and total sugars were carried out according to A.O.A.C. [8].

2.4. Sensory Analysis

Sensory analysis was performed in the Sensory Analysis Laboratory of Food of the Institute of Exact and Earth Sciences, of the Federal University of Mato Grosso and followed the rules established by Instituto Adolfo Lutz [7]. Affective tests of acceptance by hedonic scale and purchase intent tests were carried out with 100 untrained judges aged 18 to 50 with availability and interest in participating in the tests.

For the affective test of acceptance, a structured hedonic scale of 9 points, ranging from "extremely liked" (9) to "extremely disliked" (1), was used to evaluate the following parameters: color, taste, aroma, texture and overall acceptance. Consumer purchase intent was

assessed using a scale of 5 (five) points ranging from "would definitely buy" (5) to "would definitely not buy" (1).

2.5. Statistical Analysis

Data were subjected to analysis of variance (ANOVA) and the study of differences between means detected by Tukey test ($p < 0.05$).

3. Results and Discussion

3.1. Chemical and Physicochemical Analysis

Table 2 presents the values of the chemical analysis of cupcakes. Results were expressed as mean and standard deviation.

Table 2. Chemical analysis carried out on the products (%)

	Product	
	BA	PM
Moisture	42.82±1.0 ^b	51.51±1.6 ^a
Proteins	2.1±0.1 ^a	2.0±0.3 ^a
Lipids	2.80±0.4 ^a	2.53±0.8 ^a
Ash	1.55±0.2 ^a	1.23±0.1 ^a
**Carbohydrates	50.73	42.73

* In the same row, means with the same letters do not differ significantly at $p < 0.05$. BA = oat cupcake with banana and apple; PM = oat cupcake with pineapple and mint.

** Obtained by difference.

The moisture content found in the cupcake with banana and apple was 42.82% while that of pineapple with mint was 51.51%, with a significant difference between them at $p < 0.05$. In a study of preparation of chocolate cake with yacon and inulin flour, [9] found values close to the studied (42.57%) for standard formulation. The determination of moisture is one of the most important measurements and is used in food analysis because it is related to its stability, quality and composition, and can affect the storage, packaging and processing [10].

The amount of protein found in the samples were 2.1% for BA and 2.0% for PM, with no significant difference at $p < 0.05$. These values were similar to those found by [11], who found 2.3% protein when preparing carob gluten-free cupcakes.

The values obtained in the analysis of lipids were 2.80% for the BA and 2.53% for the PM, with no significant difference at $p < 0.05$. However, in a study of the chemical composition of oat cake with addition of amaranth, [12] found values above the present study, 9.89% lipids for formulation with 22% amaranth, according to the authors this is due mainly to the Amaranth lipid content being 8% [13]. Thus it can be concluded that the products of this study have relatively low lipid levels when compared with those of other authors.

The ash content found in BA was 1.55% and 1.23% in PM, with no significant difference between them ($p < 0.05$). Studying the chemical characteristics of cupcakes added with different concentrations of banana peel flour, [14] found values above those in the present study (2.49 and 2.41%) in ash content, according to the authors, different results may be found due to the different varieties of bananas used.

Table 3 shows the values of physicochemical analysis of cupcakes.

Table 3. Physicochemical parameters of cupcakes

Product	pH	Parameters	
		Acidity (%)	Soluble Solids (°Brix)
BA	6.85±0.03 ^a	0.55±0.05 ^a	9.0±0.01 ^b
PM	6.56±0.06 ^a	0.55±0.06 ^a	10.0±0.01 ^a

*In the same column, means with the same letter do not differ significantly at $p < 0.05$. BA = oat cupcake with banana and apple; PM = oat cupcake with pineapple and mint.

The values found in the analysis of pH and acidity were 6.85 and 0.55 for BA and 6.56 and 0.55 for PM, respectively, with no significant difference between them ($p < 0.05$). These values were similar to those found by [15], who on studying cookies made with *Moringa oleifera* leaf found 6.75 and 6.67 for analysis of pH and values above those of this study for acidity, obtaining 1.56 and 1.65 for standard formulation and a formulation with 9.09% of *Moringa oleifera* leaf powder. For the soluble solids analysis, the values were 9 and 10 °Brix, respectively, for the BA and PM, with a significant difference at $p < 0.05$.

Table 4 shows the values of the analysis of reducing, non-reducing and total sugars of cupcakes.

Table 4. Reducing, non-reducing and total sugars

Product	Sugars (g glucose.g sample ⁻¹)		
	Reducing	Non-reducing	Total
BA	2.63±0.09 ^a	2.67±0.21 ^a	5.44±0.14 ^a
PM	2.54±0.01 ^a	2.57±0.15 ^a	5.25±0.17 ^a

* In the same column, means with the same letter do not differ significantly at $p < 0.05$. BA = oat cupcake with banana and apple; PM = oat cupcake with pineapple and mint.

Studies on reducing, non-reducing and total sugars of cupcakes are scarce in literature. The amount of reducing, non reducing and total sugars found in BA were 2.63; 2.67 and 5.44 g glucose.g sample⁻¹ respectively. In PM, the values were 2.54; 2.57 and 5.25 g glucose.g sample⁻¹ respectively. There was no significant difference between the samples in all the analysis performed at $p < 0.05$.

3.2. Sensory Analysis

Table 5 shows the means of the attributes evaluated in cupcakes such as color, aroma, texture, flavor, global acceptance, as well as purchase intent. Averages above 7.0 were obtained for all attributes, which corresponds to "Like Moderately" in a structured scale of 9 points, highlighting the attribute flavor which reached a value of 8.01 for BA which corresponds to "Like Very Much" on the hedonic scale. To be considered a product with good acceptance, the averages should exceed 6 on the hedonic scale of 9 points, which is the quality and marketing threshold [16].

Table 5. Sensory evaluation of oat cupcakes with fruits

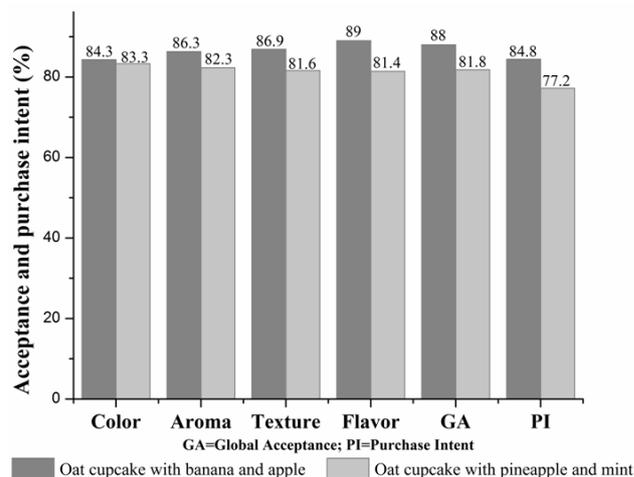
	Product	
	BA	PM
Color	7.59±1.5 ^a	7.50±1.4 ^a
Aroma	7.77±1.3 ^a	7.41±1.5 ^a
Texture	7.82±1.4 ^a	7.34±1.6 ^b
Flavor	8.01±1.4 ^a	7.33±1.8 ^b
Global Acceptance	7.92±1.2 ^a	7.36±1.6 ^b
Purchase Intent	4.24±0.9 ^a	3.86±1.1 ^b

*In the same line, means with the same letter do not differ significantly at $p < 0.05$. BA = Oat cupcake with banana and apple; PM = oat cupcake with pineapple and mint.

Attributes such as aroma and taste are probably the most important characteristics that influence the sensory properties of food products containing different added ingredients [17].

In evaluating purchase intent, there was no significant difference between BA and PM samples at $p < 0.05$. The BA had the highest value (4.24) corresponding to "probably buy" in a structured 5-point scale, while PM obtained 3.86 corresponding to "might buy/probably not buy" on the 5-point scale.

Figure 1 shows the percentages for acceptance analysis and purchase intent of cupcakes. For the attributes color, aroma, texture, flavor and overall acceptance between both samples, the values exceeded 80% acceptance. According to [18], for a product to be accepted in terms of their sensory properties, it is necessary to obtain an acceptability rate of at least 70%.

**Figure 1.** Acceptance and purchase intent of cupcakes.

Therefore, when you look at Figure 1, it can be seen that BA can be considered more accepted by the judges, because its values were higher when compared to PM, both for acceptance, as well as purchase intent.

To develop a new product, one of the key points is to assess its acceptability in order to predict its behavior on the consumer market [19].

4. Conclusions

The development of these products made it possible to observe that both have the potential to be used as functional foods, due to the ingredients present such as oats, fruit and chia seed, furthermore, they are practical and easy to prepare.

The cupcakes presented considerable protein content and low lipid content.

Through sensory analysis, it was observed that cupcakes were well accepted by the judges, and presented a good purchase intent as well, with the oat cupcake with banana and apple standing out, suggesting the marketing of this new product, which becomes an alternative for bakery industries.

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