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Feasibility of producing cinnamon breakfast cake using fiber compounds, isomalt sweetener, and cinnamon essential oil

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ABSTRACT

The importance of functional foods, Except for their nutritional role, is due to providing physiological benefits or reducing the risk of chronic diseases. Cake is a popular product among consumer meals. Therefore, reducing the amount of sucrose in the cake by making it functional with citrus fiber and essential oils is an effective step in the grain industry. The breakfast cakes containing isomalt, orange fiber and cinnamon essential oil were prepared in 8 groups. The physicochemical, color and sensory properties of breakfast cakes were investigated. The results showed that the pH of the prepared cakes was not significantly different from the control group (p>0.05). While the variables of orange fiber, isomalt, and cinnamon essential oil were effective in maintaining the moisture content of cakes (p<0.05). As expected, the fiber content of breakfast cakes increased with the addition of orange fiber (p<0.05). The fat and protein content of the treatments was lower than the control sample. The protein of the treatments did not have a significant difference(p>0.05); however, they showed a significant difference with the control treatment(p<0.05), but their ash was significantly higher than these groups (p<0.05). A significant decrease in sucrose content was reported by replacing part of it by isomalt (p<0.05). Improvement in baking volume and weight loss of breakfast cakes containing orange fiber, isomalt, and cinnamon essence was also reported (p<0.05). Examining the color index of breakfast cakes showed an increase in the L* and b* values while the a* value decreased (p<0.05). Sensory evaluation showed an increase in the acceptability of cakes containing orange fiber, isomalt, and cinnamon essential oil compared to the control sample. Considering the total results, the breakfast cake containing 2% orange fiber, 2% isomalt, and 0.1% cinnamon essence was introduced as the best treatment in this research.

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1. Introduction

The positive relationship between food and health has attracted numerous scientific researches to find out the importance of foods or their ingredients on specific functions of the body. The term "extra-beneficial food" refers to food with useful functions, which has become one of the most important topics of research and innovation in the food industry [1]. Large quantities of bakery products are consumed around the world. There are several reasons for this amount of popularity, including the variety of flavors, easy availability, shelf life, and cheap price among other processed foods. Cakes are among these products and are usually rich in carbohydrates, calories and fat, but poor in fiber, vitamins and minerals. A promising way to solve this challenge is the use of food fibers and antioxidants in cakes [2]. Many studies have shown that fruits and vegetables contain large amounts of dietary fiber, which helps human physiological activities by reducing cholesterol levels, reducing blood fat and high blood pressure, and maintaining the health of the digestive system [3]. *Rutaceae* are the most widely consumed cultivated fruits in the world. Among the types of fruit trees, orange is one of the most well-known and studied trees around the world. Orange by-product contains many nutrients such as essential oil, protein, fiber, vitamins C and so on. During the production of orange juice, only 50% of the gross weight of the fruit is converted into water. The rest are considered by-products [4]. These side products are rich in fiber, which can be used in food production and production of products with higher added value [3]. Studies have shown that Due to its effect on the structure of the cake, fiber causes changes in the rheological properties and texture of the product, including dough viscosity, porosity, height, softness and hardness.]5[.

Due to the increasing concern of consumers regarding the use of healthy and natural products and due to the harmful effects of some chemical preservatives and the negative reaction of consumers to these preservatives, several biological, physical and chemical preservative techniques have been developed to increase the shelf life of food and preserve The safety of the customer and at the same time the change of its sensory quality has been established]6[.Cinnamon *zeylanicum Cinnamomum* Mainly from the bark and leaves of an evergreen tree of the family *Lauraceae* Obtained. This material is rich in various bioactive compounds such as fiber, minerals, protein and phenolic content and has high antioxidant activity. Many studies have shown the therapeutic effects of cinnamon, which include antioxidant, antidiabetic, antimicrobial, Anti-virus, anti-fungal, anti-tumor, anti-hypertensive, anti-fat, protection of the digestive system and modulation of the immune system [7 and 8].In addition to the health benefits, it has been shown that the unique durability properties of this material can lead to the improvement of texture, consistency and stability in production and even increase the preservation of food.]9[.

On the other hand, the increase in the prevalence of obesity due to the change in human lifestyle and food patterns has caused an increase in obesity, chronic diseases and heart diseases. Therefore, the production of healthier and low-calorie food products has become an important issue in the food industry. Consuming fibrous compounds, natural sweeteners, non-metabolizable sweeteners (such as acesulfame potassium) or low absorption sweeteners (such as isomalt) is a good way to produce healthier foods.]10[.Absorption of alcoholic sugars in the body is very slow and incomplete and the energy resulting from their consumption is low. Among polyols, isomalt is the only bulking sweetener that is exclusively derived from sucrose, which is metabolized in the digestive system by only 50% and provides energy equivalent to 2 kcal/gram.]11[.

Breakfast is often known as the most important meal of the day, and in recent years, it has played a role in weight control, cardiometabolic risk factors, and cognitive function. An epidemiological study conducted by the American Heart Association has shown the consequences of preventing cardiovascular diseases in people who eat breakfast. Meanwhile, breakfast cereals are one of the mentioned items that are increasingly accepted in most developing countries and are gradually being replaced due to their convenience, nutritional value, occupational needs and cheaper prices, especially among urban dwellers. Most of the traditional diets]12[.Therefore, this study aimed Feasibility of production of cinnamon breakfast cake was done using fiber compounds, isomalt sweetener and cinnamon essence.

2- Materials and methods

2-1- Materials: The raw materials of this research include Nol flour, vanilla, salt and baking powder from Golha company (made in Iran),

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milk powder from Shrek Pegah (made in Iran), eggs from Talong company (made in Iran), liquid oil from Laden company (made in Iran) and cinnamon essential oil from Magnolia company (made in Iran), orange fiber from Inter Fiber (Made in Poland) and Isomalt from the company Merck (Made in Germany) was purchased. Also, all the chemicals required for this study are from the company Merck were prepared

2-2- Preparation of breakfast cake: In order to produce the cake, according to Table 1, raw materials including flour, isomalt, cinnamon essence, liquid oil, eggs, table salt, vanilla, baking powder and citrus fiber were weighed. A two-step mixing method was used to prepare the dough. In this method, in the first step, all the solid materials were poured into the blender along with the desired citrus fiber and cinnamon essence and mixed at low speed for about half a minute.Virgin- Made in England) and then while mixing, little by little water was added to the mixture until a dough was formed. In the second step, the speed was increased and the remaining water, oil and egg were added to the blender according to the formulation and mixed for 90 seconds with medium speed. Then pour into the prepared molds and put the samples in the rack oven tray with a central rotation system at a temperature of 180 degrees Celsius for 30 minutes in the oven.Mama- Made in Turkey) were placed. After the desired time, the tray was removed from the oven and after cooling at room temperature for one hour, they were evaluated [13].

Table 1. Formulation of breakfast cake according to the percentage of flour weight

Compound	orange fiber	Flour	egg	vanilla	Milk powder	baking powder	isomalt	oil	water
Percent	5-15	72	0.5	0.5	2	1.34	25 (% sauger)	57	25

Table 2. Research treatments

Treatment Code	Formulation
T_0	Control (commercial breakfast cake)
T_1	Breakfast cake + 1% orange fiber + 1% isomalt + 0.1% cinnamon essence
T_2	Breakfast cake + 1% orange fiber + 2% isomalt + 0.1% cinnamon essence
T_3	Breakfast cake + 1% orange fiber + 1% isomalt + 0.2% cinnamon essence
T_4	Breakfast cake + 1% orange fiber + 2% isomalt + 0.2% cinnamon essence
T_5	Breakfast cake + 2% orange fiber + 1% isomalt + 0.1% cinnamon essence
T_6	Breakfast cake + 2% orange fiber + 2% isomalt + 0.1% cinnamon essence
T_7	Breakfast cake + 2% orange fiber + 1% isomalt + 0.2% cinnamon essence
T_8	Breakfast cake + 2% orange fiber + 2% isomalt + 0.2% cinnamon essence

2-2-Exams

1-2-2- Cake physicochemical tests: Moisture content of cakes based on weight difference at 120 degrees Celsius [14], protein content by Kjeldahl method [15], fat content by Randall extraction method [15], sugar content using Fehling's reagent based on Iranian National Standard No. [15] , pH with the device pH meter and ash of the samples was done based on the weight difference at a temperature of 550 degrees Celsius [16].

2-2-2- fiber cake test: First, the sample was degreased with petroleum ether. 3 grams of fat-free sample (m) was poured into the crucible of the device and 200 ml of 0.25 normal sulfuric acid was added to it. Boiling was done for 30 minutes, and after this step, the acid was discharged by the vacuum of the device. Again, 200 ml of 0.313 normal soda was added to the ingredients in the crucible and boiled for 30 minutes. Then the resulting mixture was discharged under the vacuum of the machine. After that, the material inside the crucible was washed several times with water and finally the crucible was placed at a temperature of 100 degrees Celsius until a constant weight was reached.IN_2). After weighing, the crucible was placed in a 550°C oven and turned into ash. After cooling, the crucible was weighed (IN_1) The

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amount of fiber was calculated and reported from the following relationship [17].

$$100 \times \frac{(W2-W1)}{m} = \text{fiber (percentage)}$$

3-2-2- Cake volume test: To measure the specific volume of gluten-free cake samples, the method of replacing volume with grain was used. For this purpose, at a time interval of 2 hours after baking, pieces with dimensions of 2 x 2 x 2 cm were prepared from the geometric center of the cake. Then, the volume of the graduated cylinder was replaced with rapeseed to the amount of 250 ml, and then the specific volume was determined [18].

4-2-2-cake drop test: Cake dough samples were weighed before and after baking, and then the percentage of weight loss was calculated according to the difference in weight before and after baking [18].

5-2-2-Cake colorimetry test: To measure the surface color of the standard AACC No. 14-30 was used, so that the final products were placed on a white plate (reference) and then their color was measured using a colorimeter. To measure the color of the cake core, the separated cake core in the form of a uniform paste is placed on the bottom of the special cell of the machine and factors L^*، a* And b* The samples were determined and read from the device [19].

6-2-2-Cake sensory evaluation test: The sensory characteristics were evaluated by the five-point hedonic method with a scoring method with a numerical scale. In terms of sensory evaluation of the cake, one slice of each treatment was given to eight trained evaluators and the evaluators gave points to the cakes in terms of taste, aroma, color, texture and overall acceptance according to the provided questionnaire. 18 [.

2-3- Statistical analysis: In order to analyze the data obtained from the research, using the software SPSS Version 22 was done. After analyzing the data obtained from the experiment, the mean of the data were compared using Duncan's test at the probability level of 95%. Amounts P Less than 0.05 was considered a significant difference between the two groups. Variance in treatment groups as standard deviation (SD) Expressed.

3-Research findings

- Humidity results: Table 3 showed the significant effect of the type of treatment on the moisture content of the cake containing cinnamon essence, isomalt and orange fiber ($P<0.05$). The highest moisture content in the treatment of T_8 and the treatment of T_6 reported ($p<0.05$). The lowest moisture content is also in the treatments of T_1، T_2 and T_3 reported without significant difference from each other ($p<0.05$).

- pH results: According to Table 4, none of the variables had a significant effect on the pH of cake samples ($p>0.05$).

- Protein results: The examination of the protein content of the treatments (Table 3) showed that the studied variables had no significant effect on the protein cake containing cinnamon essence, isomalt and orange fiber ($p>0.05$). The protein content of all the treatments containing fiber, isomalt and cinnamon essential oil was reported to be the same without any significant difference from each other.$p>0.05$).

- Fat results: The results (Table 3) showed that the type of treatment was not significant on the fat content of the cake containing cinnamon essence, isomalt and orange fiber ($p>0.05$). The highest amount of fat was observed in the control seed ($p<0.05$). While the fat content in all the treatments produced with different levels of fiber, isomalt and essential oil was reported to be the same without significant differences from each other ($p>0.05$).

- Ash results: Examining the ash content of the samples (Table 3) also showed that the type of treatment was significant on the ash content of the cake containing cinnamon essence, isomalt and orange fiber ($p<0.05$). The highest amount of ash in the treatment of T_8 and the lowest amount of ash in T treatment$_0$ reported ($p<0.05$).

- Results of sugar (sucrose): During the examination of the sugar content of the samples (Table 3), it was observed that the highest sugar content was related to the treatment of T_0 and the lowest sugar content in treatments containing the highest concentration of isomalt, i.e. T_2، T_4 reported.

Table 3. The results of the physicochemical functional cake properties

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Treatment	Moisture (%)	pH	Protein (%)	Fat (%)	Ash (%)	Sucrose (%)
T_0	24.39 ± 0.38 ^{e}	7.47 ± 0.14 ^{a}	13.94 ± 0.27 ^{a}	19.25 ± 0.28 ^{a}	2.26 ±0.09 ^{b}	19.63 ± 0.09 ^{a}
T_1	25.16 ± 0.48 ^{d}	7.36 ± 0.12 ^{a}	13.77 ± 0.53 ^{b}	19.27 ± 0.19 ^{a}	2.30 ± 0.02 ^{ab}	19.06 ± 0.26 ^{b}
T_2	24.18 ± 0.18 ^{e}	7.49 ± 0.09 ^{a}	13.7 7± 0.10 ^{b}	19.20 ± 0.27 ^{a}	2.21 ± 0.04 ^{ab}	18.24 ± 0.21 ^{c}
T_3	25.08 ± 0.23 ^{e}	7.46 ± 0.04 ^{a}	14.00 ± 0.46 ^{b}	19.18 ± 0.27 ^{a}	2.25 ± 0.04 ^{ab}	19.12 ± 0.27 ^{b}
T_4	24.13 ± 0.09 ^{d}	7.42 ± 0.10 ^{a}	13.77 ± 0.44 ^{b}	19.21 ± 0.24 ^{a}	2.21 ± 0.06 ^{ab}	18.15 ± 0.21 ^{c}
T_5	27.39 ± 0.45 ^{bc}	7.44 ± 0.08 ^{a}	13.77 ± 0.20 ^{b}	19.22 ± 0.15 ^{a}	2.27 ± 0.03 ^{ab}	19.04 ± 0.09 ^{b}
T_6	26.97 ± 0.03 ^{b}	7.46 ± 0.08 ^{a}	13.65 ± 0.30 ^{b}	19.32 ± 0.03 ^{a}	2.17 ± 0.04 ^{ab}	18.15 ± 0.22 ^{c}
T_7	26.64 ± 0.28 ^{c}	7.39 ± 0.15 ^{a}	13.59 ± 0.27 ^{b}	19.19 ± 0.23 ^{a}	2.26 ± 0.03 ^{ab}	18.79 ± 0.14 ^{b}
T_8	26.07 ± 0.28 ^{a}	7.42 ± 0.08 ^{a}	13.71 ± 0.20 ^{b}	19.14 ± 0.04 ^{a}	2.17 ± 0.10 ^{a}	18.20 ± 0.11 ^{c}

*Differences in lowercase letters indicate a significant difference between treatments (p <0.05).

- Fiber results: Figure 1 showed the significant effect of the type of treatment on the fiber content of the cake containing cinnamon essence, isomalt and orange fiber (p<0.05). The highest fiber content in the samples containing the highest fiber of oranges, i.e. T treatments$_5$، T_6، T_7 and T_8 reported (p<0.05). The lowest moisture content of the control treatment T_0 reported (p<0.05).

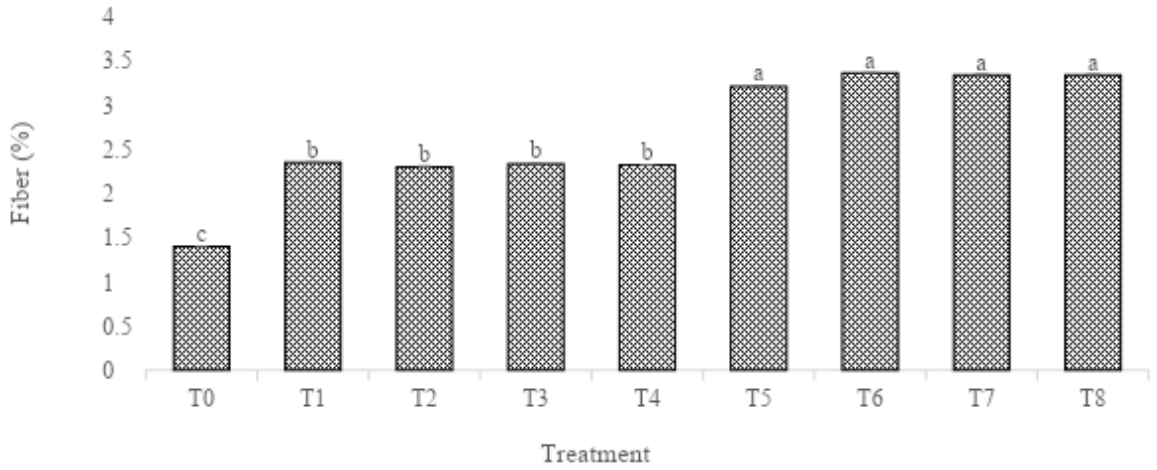

Fig 1. The results of the fiber content of functional cakes

- Specific volume results: According to Figure 2. The type of treatment was significant on the specific volume of the cake containing cinnamon essence, isomalt and orange fiber (P<0.05). The highest specific volume in the treatment of T_8 It was observed and the lowest specific volume in the control treatment (T_0) reported (p<0.05).

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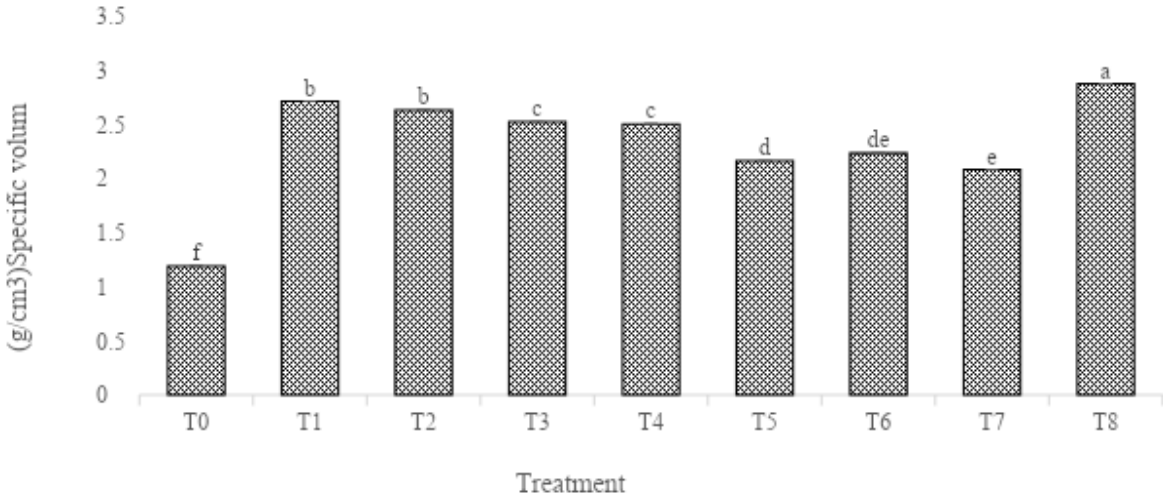

Fig 2. The results of the specific volume of functional cakes

- The results of baking: The results (Figure 3) showed that the type of treatment had a significant effect on the decrease in the baking rate of the cake containing cinnamon essence, isomalt and orange fiber (p<0.05). The highest specific volume in the treatment of T_0 and followed by the treatment of T_1 It was observed and the lowest percentage of cooking decrease in T_7 reported (p<0.05). No significant difference was reported among other treatments (p>0.05).

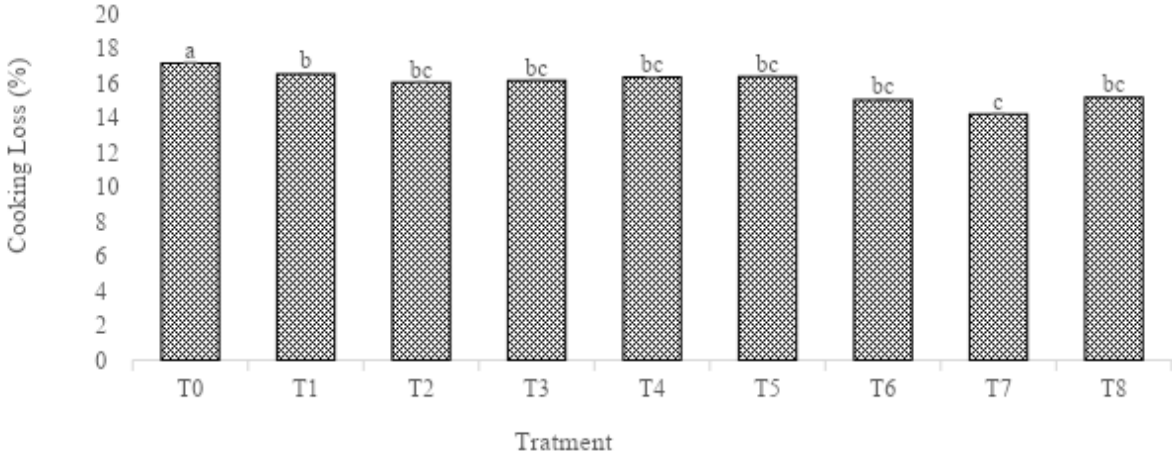

Fig 3. The results of the cooking loss of functional cakes

- Colorimetry results: According to the results of Table 4, Type of treatment brightness index (L*), Red (a*) and jaundice (b*) The cake contained significant amounts of cinnamon essence, isomalt and orange fiber (p<0.05). The highest and the lowest respectively Brightness index In the treatment of $T_7$and the treatment of T_4 was observed (p>0.05).

Also, checking the results of redness showed the lowest order Redness index In the treatments containing the highest concentration of orange, i.e. treatments of T_5، T_6، T_7 was observed (p>0.05). the most Redness index in treatment T_0 reported (p>0.05).

Examining the results also showed the yellowness of the samples respectively the most Jaundice index In the treatments containing the highest concentration of orange, i.e. treatments of T_2 And the least Jaundice index related to treatment T_0 Was (p>0.05). No significant difference was reported between other treatments (P<0.05).

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Table 4. The results of colorimetric functional cake

Treatment	L*	a*	b*
T_0	71.96 ± 0.66 ^{abcd}	6.72 ± 0.55 ^{a}	33.23 ± 0.38 ^{c}
T_1	72.15 ± 0.30 ^{abc}	7.46 ± 0.42 ^{ab}	33.68 ± 0.71 ^{ab}
T_2	70.88 ± 0.55 ^{cd}	8.07 ± 0.48 ^{ab}	34.84 ± 0.14 ^{ab}
T_3	71.91 ± 0.65 ^{bcd}	7.33 ± 0.39 ^{ab}	33.78 ± 0.37 ^{ab}
T_4	70.70 ± 0.59 ^{d}	8.05 ± 0.65 ^{bc}	34.34 ± 0.13 ^{bc}
T_5	73.01 ± 0.71 ^{bc}	8.47 ± 0.1 ^{cd}	34.20 ± 0.96 ^{cd}
T_6	72.61 ± 0.79 ^{ab}	8.77 ± 0.43 ^{bc}	34.52 ± 0.84 ^{bc}
T_7	73.35 ± 0.61 ^{a}	8.42 ± 0.34 ^{cd}	34.46 ± 1.24 ^{cd}
T_8	72.71 ± 1.36 ^{ab}	9.05 ± 0.86 ^{a}	34.51 ± 0.94 ^{a}

*Differences in lowercase letters indicate a significant difference between treatments (p <0.05).

- Sensory evaluation results: according The results presented in Table 5, the least Score the taste in treatment T_0 was observed (p<0.05). No significant difference was reported among other treatments. In other treatments, no significant difference was reported in terms of scores by the sensory testers, and all of them had maximum scores (p>0.05).

The olfactory evaluation showed (Table 5) the type of treatment fragrance The cake contained significant amounts of cinnamon essence, isomalt and orange fiber (p<0.05). The highest and the lowest score of aroma and odor was obtained by T treatment, respectively$_6$ and the treatment of T_3 allocated (p<0.05).

The sensory results of color and texture also showed the lowest score of texture in T treatment$_0$ was observed (p<0.05). Among other treatments, the variable type had no effect on the texture of the cake samples and all of them obtained the maximum taste score from the sensory evaluators.p>0.05).

A significant difference in the type of different treatments was observed on the sensory evaluation of the general acceptability of the samples (Table 5). The highest score General acceptance In the treatment of T_2 was observed (p<0.05) and the lowest General acceptance In the treatment of T_0 and followed by the treatment of T_8 was observed (p<0.05).

Table 5. The results of Sensory evaluation functional cake

Treatment	Flavor	Order	Color	Texture	General acceptance
T_0	2.67 ± 0.58 ^{b}	3.67 ± 0.58 ^{ab}	3.67 ± 0.58 ^{b}	5.00 ± 0.00 ^{a}	3.33 ± 0.58 ^{c}
T_1	4.67 ± 0.58 ^{a}	4.33 ± 0.58 ^{ab}	4.33 ± 0.58 ^{a}	4.67 ± 0.58 ^{b}	4.33 ± 0.58 ^{ab}
T_2	5.00 ± 0.00 ^{a}	4.67 ± 0.58 ^{ab}	4.67 ±0.58 ^{a}	4.67 ± 0.58 ^{b}	5.00 ± 0.00 ^{a}
T_3	4.67 ± 0.58 ^{a}	3.33 ± 0.58 ^{b}	4.67 ± 0.58 ^{a}	4.67 ± 0.58 ^{b}	4.33 ± 0.58 ^{ab}
T_4	4.67 ± 0.58 ^{a}	4.33 ± 1.15 ^{ab}	4.67 ± 0.58 ^{a}	4.67 ± 0.58 ^{b}	4.33 ± 0.58 ^{ab}
T_5	4.33 ± 0.58 ^{a}	4.67 ± 0.58 ^{ab}	4.33 ± 0.58 ^{a}	4.33 ± 0.58 ^{b}	4.33 ± 0.58 ^{ab}
T_6	5.00 ± 0.00 ^{a}	5.00 ± 0.00 ^{a}	4.67 ± 0.58 ^{a}	4.33 ± 0.58 ^{b}	4.67 ± 0.58 ^{ab}
T_7	4.33 ± 0.58 ^{a}	3.67 ± 0.58 ^{ab}	4.67 ± 0.58 ^{a}	4.67 ± 0.58 ^{b}	4.33 ± 0.58 ^{ab}
T_8	4.33 ± 0.58 ^{a}	4.00 ± 1.00 ^{ab}	4.67 ± 0.58 ^{a}	4.33 ± 0.58 ^{b}	4.00 ± 0.00 ^{b}

*Differences in lowercase letters indicate a significant difference between treatments (p<0.05).

4- Discussion

- Checking the results of moisture content: Moisture includes the amount of free and continuous water in the food texture, so that this index in food plays an important role in the

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crispiness and duration of storage of products. Bread moisture is one of the important factors in determining the freshness, shelf life and staleness of bread [20]. According to the results presented in Table 3, the use of orange fiber, isomalt and cinnamon essence had a positive effect on maintaining the moisture content of breakfast cakes. At higher levels, the use of fiber, isomalt and cinnamon essential oil was more evident in maintaining the moisture content, so that the highest moisture content in these treatments is T_8 And T_6 (moisture content was equal to 27.64 and 27.39 percent, respectively). In justifying the obtained results, it can be said that isomalt is a moisture absorbing substance and shows some degree of moisture absorption in the environment [21]. Because sugar alcohols tend to retain water in their structures due to their hydroxyl groups. For this reason, the samples containing high amounts of substitution had a higher percentage of moisture. In addition, sugar increases the temperature of starch gelatinization and protein denaturation, and as a result, by increasing the amount of substitution and reducing sugar, gelatinization was done more easily and at a lower temperature, and as a result, creating a gel state is a good opportunity to preserve and increase the moisture content of the product. Calculated [22]. According to the results Akesowan (2009) while investigating the use of a mixture of erythritol and sucralose as a substitute for sucrose in cake formulation showed that these compounds, having the chain structure of amylopectin and amylose and their hydrophilic head, can absorb a large amount of moisture and maintain it during baking [23]. The results showed that the use of orange fiber had a significant effect on increasing the percentage of moisture and water absorption of breakfast cake samples. It is noteworthy that citrus fiber limits the amount of available water, as a result of which the separation of water in the tissue is reduced. This property is related to the presence of hydroxyl bonds in the structure of the fibers. Also, citrus fiber not only has a high water holding capacity, but also binds water very tightly. This ability is considered an important advantage because it can retain water during cooking [24].

In this regard, Rosell et al. (2001), during the investigation of hydroquids on pulp, they showed that the presence of abundant hydroxyl groups in the structure of gums and fibers increase water absorption by creating hydrogen bonds with water molecules [25]. On the other hand, according to the studies, due to the hydrophilic nature of the extracts and essential oil compounds obtained from plants, hydrogen bonds have been established with water, and with its stability in the system, it has caused the preservation of moisture during cooking and preservation of moisture, which helps to delay staleness. is also effective [26]. According to the obtained results, Ccak-Pietrzak et al. (2019) showed that by increasing the content of Cistus tea leaf extract[1] The moisture content of bread increased [27].

-result discussion pH: Check the test results pH (Table 3), the non-significant effect of using three variables of orange fiber, cinnamon essence and isomalt on pH He showed the prepared breakfast cakes. On average pH Breakfast cakes were equal to 7/44. Isomalt is exclusively derived from sucrose and the raw material for its production is sugar beet or sugar cane, so pHProducts in which isomalt is used are very similar to pH It is the products in which sucrose is used [28]. The use of orange fiber at the level of 2% due to the reason of more water absorption and the effect on the mobility of some hydrogen ions. pH It reduced breakfast cakes [24], but this reduction was not significant due to the low percentage of the used surface. The results obtained from this study with the research results Masood et al. (2002) who showed that the use of apple fiber at levels of 5, 10 and 15% caused a decrease in pH It was caked, it did not match [29].

- Checking the protein results: Examining the protein content of breakfast cakes showed that the amount of protein was higher in the control treatment and that there was no significant difference in other treatments (Table 3). This is due to the replacement of fiber, isomalt and essential oil with part of the protein in the wheat flour used in the research. In other words, the high amount of protein in the control sample is due to the presence of gluten protein in the consumed flour and its dilution in the treatments containing fiber [30]. One of the important roles of sucrose is to delay the gelatinization of starch and the denaturation of proteins, so the vital role of sucrose in the production of cakes during heating is to increase the thermal resistance of

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proteins. Therefore, when the amount of sucrose in the formulation is reduced, the protein is denatured and unstable at a lower temperature and more easily, and its amount is reduced [31]. Lee et al. (2007), in a research, investigated the physicochemical and sensory properties of bread enriched with pumpkin powder and stated that increasing the levels of pumpkin consumption from 5 to 15% causes a decrease in the amount of protein in the samples compared to the control sample [32]. also Movahhed et al. (2014), studied the effect of adding sugar beet pomace fiber on the chemical composition of toast. According to the results, with the increase in sugar beet pomace fiber consumption levels, the amount of protein in the produced toasts decreased compared to the control sample [33].

- Checking fat results: The results of the fat test (Table 3) showed that the highest fat content was reported in the control sample (19.24%). and other treatments, the amount of fat is lower than the control sample, but without significant difference from each other (19.17% on average). The reason for this reduction is due to the replacement of part of the wheat flour with different levels of fiber, isomalt and essential oil [30]. Khuram Wasim Aslam et al. (2014) while investigating the addition of mango waste fiber in cake formulation, Movahhed et al. (2014) while investigating xanthan gum in bread dough, also Khormaeepour et al. (2019) reported results similar to this result during the enrichment of sponge cake with lemon peel powder and the use of stevia as a sugar substitute. They stated that the fat content of the sponge cake with the addition of fiber waste, the artificial sweetener stevia, due to replacement A part of wheat flour decreased [33, 34 and 35].

- Checking the ash results: Examining the results of ash (Table 3) showed an increase in the ash of treatments containing different levels of fiber, isomalt and essential oil of breakfast cakes compared to the control sample. which can be due to the presence of mineral compounds and salts and fibrous compounds and even cinnamon essential oil. Because this fiber has a large amount of insoluble fiber (equivalent to 50% of the total nutritional fiber) and insoluble salts (such as iron, calcium, magnesium, potassium, sodium, and zinc), these compounds are very effective in increasing the ash of the production breakfast cake [24]. . Khormaeepour et al. (2019) also showed an increase in sponge cake ash by increasing the amount of orange powder and even stevia [35]. also Turabi et al. (2010) announced that adding fiber-rich orange pulp to the cake is effective in increasing the amount of ash in the product [36]. The use of isomalt in the formulation of cakes reduces the amount of ash, which can be due to the replacement of sucrose with isomalt in the formulation of cakes [37]. According to these results Russia Et al (2015) showed that replacing sugar with sucralose reduced the ash of biscuits [38].

- Check sugar results: Examining the results of sucrose (Table 3) as expected, it was the highest in the control sample (19.63%). The use of isomalt reduced the amount of sucrose in the samples, and the increase in the use of a higher level of isomalt was more evident. Manisha And Colleagues (2012) observed a significant decrease in the amount of sucrose in low-calorie cake containing stevioside and sorbitol, which was consistent with the results of this study [37]. also Youssef et al. (2012), during the nutritional evaluation of wheat biscuits and wheat biscuits enriched with citrus peel powder, showed similar results [39]. Khormaeepour et al. (2019) also showed that the amount of sugar in the sponge cakes of the control sample was higher than other treatments, and the reason for this was the higher sugar in the formulation of these samples compared to the sample containing stevia and orange powder [35].

-Fiber results check: Examination of the fiber results (Figure 1) showed The highest fiber content in the samples containing the highest fiber of oranges, i.e. T treatments$_5$، T$_6$، T$_7$ and T$_8$ (respectively equal to 3.21, 3.36, 3.34 and 3.34) without significant difference from each other. This result was reported as expected. The reason for this is the increase in the presence of about 70% of orange nutritional fiber, such as soluble and insoluble fibers]24[. According to the results obtained, Martinez et al. (2012), Khuram Wasim Aslam et al. (2014), during the investigation of the use of fiber in the cake formulation, were consistent. They report that the addition of fiber in the formulation of various types of cakes leads to an increase in the fiber content of the product[24 and 34].

- Check the results of special volume: One of the important factors in the appearance and marketability of the product is the size of the cake and it is considered as one of the important features in its evaluation. Examining the changes in the specific volume of cakes with the replacement of orange fiber, isomalt and cinnamon essence showed an increase in the specific volume of the treatments compared to

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the control sample (Figure 2). The volume of the reference sample is attributed to the role of eggs used in the dough and its effect on improving aeration, which was also changed by replacing orange fiber. It should be mentioned that the consumed fiber also has a special effect on the volume of the product, so that the compounds mentioned in the above amounts cause an increase in the viscosity of the dough, a decrease in the speed of gas release and its preservation in the early stages of cooking, and due to the confinement of carbon dioxide gas and water vapor in the air cells. causing an increase in the volume of the product [41]. On the other hand, replacing sugar with isomalt also helped to increase the volume of cakes because isomalt is a dietary sweetener and bulking agent that has the same function as sucrose in terms of properties and characteristics. Studies have shown that isomalt has low solubility, low moisture absorption properties, and requires minimal changes in formulation and production method for proper baking. Products prepared with isomalt taste similar to sucrose and have a longer shelf life [42]. According to reports, among polyols, isomalt is the only bulking sweetener that is exclusively derived from sucrose [21]. Being the specific volume of the sample T_8 It is justifiable. Masoodet al. (2002) also showed that the use of apple fiber at levels of 5, 10 and 15% increased the specific volume of cakes [29]. also Michalak-Majewska et al. (2017) showed a decrease in the increase in specific volume of bread rolls enriched with red onion powder, which was not consistent with the results of this research, and they reported the reason for this was the replacement of onion powder with flour proteins [43].

- Checking the results of baking: According to the results presented in Figure 3, the highest rate of baking decrease was observed in the control treatment. The addition of three variables, orange fiber, cinnamon essence and isomalt significantly reduced the cooking loss of the samples. High viscosity reduces the diffusion of water and the stability of the presence of water in the system, as a result, the percentage of weight loss during cooking decreases in high viscosity. The low viscosity in the paste has made the air bubbles easily come to the surface and eventually be transferred to the environment. As a result, weight loss increases during cooking [44]. The reduction of viscosity in the dough causes the bubbles to move, as a result of which gas will be released to the external surface and water evaporation will increase. If a high volume of produced gas is removed from the system, it will lead to an increase in weight loss. The presence of fibrous compounds in the dough reduces the displacement of water and as a result reduces the weight loss [45]. Reducing the baking time by adding apple fiber in oil cake [46] and pear fruit in sponge cake [47] and carrot powder in oil cake [48] has also been reported by other researchers.

- Check colorimetry results: Color is one of the important qualitative aspects of unprocessed and processed products. Color, along with taste and texture, plays an important role in the acceptability of products and is the first factor that increases customer attention. The color of food surface is the most important factor in rejecting or accepting food in all food processes. Therefore, it is a quality index that indicates abnormalities or defects in all food products [49 and 50]. Maillard reactions and caramelization are important reactions that are observed in the processing of bakery products. Color crust is associated with both Maillard reaction and caramelization products. The Maillard reaction is a chemical reaction between an amino acid and a reducing sugar, while caramelization is a complex group of reactions that occur when sugars are exposed to high temperatures in the absence of amino acids. Browning of the crust occurs when the cooking temperature is higher than 110 degrees Celsius [51]. Component L* It indicates the brightness of the samples and its range varies from zero (pure black) to 100 (pure white). According to the presented results (Table 4), the treatments containing a higher percentage of orange fiber and isomalt had less brightness. Studies have shown that using sweeteners instead of sugar increases the brightness of the color of the cake. Because by reducing the amount of available water and increasing the percentage of dry matter, the Maillard reaction decreases, in fact, the speed of browning reduction is related to the mechanism of the participants being immobile in low humidity levels; Due to the fact that the control sample contains sucrose and sucrose is converted into glucose and fructose by heat, and since these sugars (monosaccharides) participate in the Maillard and caramelization processes, the control sample has a higher browning index than other treatments. 52. On the other hand, with the increase in heat, sucrose turns into anhydrous sugars, including glucosan and cellulose, which cause the formation of inverted sugars and finally cause the formation of hydroxymethylfurfural and create effective

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compounds in color. Another point is that as a result of reducing water and increasing temperature, compounds such as caramel, caramel, and caramel are formed, and these compounds also play an effective role in creating color [53]. On the other hand, the total amount of light reflected from the surface of the sample (indexL*) is inversely proportional to the particle size. Another point is that the white color of the used orange fiber can be another effective factor in increasing the brightness of the color of breakfast cakes [54]. However, the use of cinnamon essential oil has a negative effect on this parameter due to the concentration of flavonoid compounds and their excessive participation in the Maillard reaction [55]. According to these results, Savitha et al. (2008) showed that increasing the amount of sucrose replacement by sucralose-maltodextrin mixture causes the color of the biscuit to become lighter [56]. also Lin et al. (2005) showed that the use of artificial sweeteners as a substitute for sugar increases the brightness of the color of the cake shell [57].

Redness-Greenness Index (a*) varies between -120 and +120 and positive values are equivalent to red color. The treatments containing the highest amount of orange fiber and isomalt had a higher amount of redness (Table 4). The reduction of the redness index is also attributed to the reduction of the Maillard reaction and the light color of the fiber. Dehkhoda et al. (2016) showed the amount of index a* At Cake samples were reduced by using isomalt in their formulation. And they reported the reason for this is the reduction of caramelization and Maillard reaction caused by the reduction of sugar in these products [58].Mushtaq et al. (2010) also reduce the index a* They reported in cakes containing xylose as a substitute for sucrose and cited the lack of an active carbon group in xylose and the inability to participate in the Maillard reaction [59].

Despite the reduction of Maillard reaction and caramelization of the yellowness index in the treatments containing isomalt, orange fiber and cinnamon oil essence, an increase in the yellowness index was observed (Table 4), which could be due to the yellow color of the oil essence [60]. The et al. (2012) also increase the parameters of the parameter b* showed in bread prepared with coriander powder [61].

- Checking the results of sensory evaluation:

Evaluation of organoleptic properties is one of the important indicators in product acceptance by consumers. Sensory evaluation is the measurement of the quality of a product based on the information received from the five senses of sight, hearing, taste and touch, which is the best method to check the marketability of new food products in the early stages of formulation. The examination of the taste results (Table 5) showed that all the treatments obtained the maximum taste score from the sensory evaluators and showed a significant difference with the control sample and were more desirable. Examining the results of aroma and smell (Table 5) showed the treatment T_2 They had the highest acceptability and maximum score. While in other treatments containing orange fiber and isomalt as well as cinnamon essential oil, no significant difference was observed. The lowest acceptability was reported in the control treatment. Examination of the texture of the treatments (Table 5), the reduction of the most acceptable texture in the treatments containing orange fiber and isomalt as well as cinnamon essence Compared to the control sample, it showed that the highest level of acceptability was related to the control sample. The use of three variables, orange fiber and isomalt, as well as cinnamon essential oil increased the acceptability of the color of the treatments compared to the control sample (Table 5). In general, the positive effect of the use of orange fiber, isomalt and cinnamon essence on the overall acceptance of the cake by sensory evaluators was reported compared to the control sample. and the highest acceptability in treatment T_2reported.

According to the results of this research, Khormaeepour et al. (2019) while investigating the addition of lemon peel and stevia in sponge cake, Cleanliness et al. (2017) while investigating the effect of adding orange fiber in the formulation of muffin cake, Khaledi et al. (2019) during the investigation of the effect of adding mango fiber on sponge cake showed the results according to this research [35, 30 and 62].

5- General conclusion

In this research, the effect of orange fiber, isomalt and cinnamon essential oil in different proportions on the physicochemical properties, color and sensory characteristics of breakfast cake was investigated. According to the obtained results, the use of orange fiber, isomalt and cinnamon essential oil has an effect on the amount of pH There were no samples. While at higher levels of using fiber, isomalt and cinnamon essence, it was very evident to maintain the moisture content of the treatments.

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As expected, treatments containing orange fiber contained more fiber and the use of higher levels of orange fiber increased the fiber content of the cake samples. A decrease in fat content and a decrease in protein content, as well as an increase in ash content, were observed in the treatments containing orange fiber, isomalt and cinnamon essential oil. Also, the reduction of sucrose was more evident in treatments containing a higher percentage of isomalt. An increase in the specific volume of cakes containing orange fiber, isomalt, and cinnamon essential oil, as well as a decrease in the baking time of these samples compared to the control sample, were reported. The use of orange fiber, isomalt, and cinnamon essential oil was reported. In the formulation of breakfast cake, the brightness and redness index decreased while the yellowness index increased. During the sensory evaluation, it was observed that the acceptability of cakes containing orange fiber, isomalt, and cinnamon essential oil increased compared to the control sample, which, in general, according to all the results of the treatment T_2 (breakfast cake containing 2% orange fiber, 2% isomalt, 0.1% cinnamon essence) was introduced as the best treatment in this research.

6-Resources

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ویژگی‌های فیزیکوشیمیایی

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چکیده

اهمیت غذاهای فراسودمند جدای از نقش تغذیه‌ای آن‌ها، به دلیل فراهم‌سازی مزایای فیزیولوژیکی و یا کاهش خطر بروز بیماری‌های مزمن می‌باشد. کیک محصولی پرطرفدار در میان وعده‌های غذایی مصرفی می‌باشد. بنابراین کاهش حجم ساکارز کیک در کنار فراسودمند کردن آن با فیبر مرکبات در کنار اسانس‌های گیاهی گامی موثر در صنعت غلات به حساب می‌آید. کیک‌های صبحانه حاوی ایزومالت، فیبر پرتقال (در سه سطح ۰، ۱ و ۲ درصد) و اسانس روغنی دارچین (در سه سطح ۰، ۰/۱ و ۰/۲ درصد) در ۸ گروه تهیه شدند. خصوصیات فیزیکوشیمیایی، شاخص رنگی و حسی کیک‌های صبحانه بررسی شد. نتایج نشان داد pH کیک‌های تهیه شده تفاوت معناداری با گروه شاهد نداشتند ($p>0.05$). درحالیکه متغیرهای فیبر پرتقال، ایزومالت و اسانس دارچین در حفظ محتوی رطوبتی کیک‌ها موثر بودند ($p<0.05$). مطابق با انتظار محتوی فیبر کیک‌های صبحانه به دلیل افزودن فیبر پرتقال افزایش نشان داد ($p<0.05$). محتوی چربی و پروتئین تیمارها نسبت به نمونه شاهد کمتر بود.پروتیین تیمارها با هم اختلاف معنی دار نداشتند با این حال با تیمار شاهد اختلاف معنی دار نشان دادند، ولی خاکستر آن‌ها بطورمعناداری بالاتر از گروه شاهد گزارش شد ($p<0.05$). کاهش معنادار محتوی ساکارز با جایگزینی بخشی از آن با ایزومالت در تیمارها گزارش شد ($p<0.05$). بهبود حجم پخت و کاهش اُفت وزنی کیک‌های صبحانه حاوی فیبر پرتقال، ایزومالت و اسانس دارچین نیز گزارش شد ($p<0.05$). بررسی شاخص رنگی کیک‌های صبحانه نشان دهنده افزایش مولفه L* و b* بود درحالیکه مولفه a* کاهش یافت ($p<0.05$). بررسی ارزیابی حسی افزایش مقبولیت پذیرش کیک‌های حاوی فیبر پرتقال، ایزومالت و اسانس روغنی دارچین نسبت به نمونه شاهد نشان داد($p<0.05$). بطورکلی با در نظر گرفتن مجموع نتایج بدست آمده، تیمار کیک صبحانه حاوی ۲ درصد فیبر پرتقال، ۲ درصد ایزومالت، ۰/۱ درصد اسانس دارچین به عنوان تیمار برتر این تحقیق معرفی شد.

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