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Quality Characteristics of Gluten-Free Cookies Prepared from Oat and Unripe Banana Flour Blends

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THE present study was carried out to develop quality characteristics of gluten-free cookies prepared from oat and unripe banana flour blends. Oat flour (OF) got substituted with unripe banana flour (UBF) at the levels of 25, 50, 75, and 100% in terms of the physicochemical and sensory evaluation of cookies.The obtained results revealed that the gross chemical composition showed that of contained moisture (6.99%), crude protein (16.65%), crudef at (9.13%), ash (1.82%), crude fiber (10.87%), total carbohydrates (65.33 %), and caloric value (410.14 kcal/100g). While, *UBF* contained 6.79, 4.80, 5.16, 2.95, 13.03, 84.93%, and 363.56 kcal/100g for moisture, crude protein, crude fat, ash, crude fiber, total carbohydrates, and caloric value, respectively. It should be noticed that the increase of UBF in cookies led to the increased proportion of ash, crude fiber, total carbohydrate, and the decreased proportion of crude fat, crude protein, and caloric value compared to control. Physical parameters including weight, thickness, diameter, and spread ratio in cookies with 25% and 50% UBF didn't differ significantly compared to the control; these ratios recorded the best results. High levels of UBF caused harder cookies. Regarding cookies colors, results observed that the brightness (L*) and yellowness values (b*) in cookies had gradually declined with the increasing levels of UBF, whereas, redness (a*) value had increased, which means that the UBF resulted in darker cookies when the addition was higher. The total score for overall palatability was acceptable for all cookies, but samples of cookies containing 25 and 50% UBF had a higher total score than the other samples. In conclusion, the current study confirms that unripe banana flour can be used up to 50% in the production of a gluten-free diet -such as cookies- with improving the nutritional, sensorial, and physicochemical quality of these products.

Keywords: Oat, Unripe banana, Cookies, Gluten-free, Functional food.

Introduction

Lately, there has been a continuous and consistent ascent in shopper interest inwheat-free foods *(Triticum aestivum)* to lessen the danger of a problem known as celiac disease. Studies recommended that celiac disease can be treated by dodging the utilization of gluten (Cahyana et al., 2020). In 2007, the Food and Drug Administration (FDA) introduced a labeling requirement for gluten-free foods to fulfill the interest for high-quality gluten-free cookies/bread with comparable quality with wheat flour-dependent on cookies and bread. Accordingly, the "Gluten-free" law is defined as any food containing lower than 20 ppm of gluten (Rai et al., 2014; Bascunan et al., 2017).Oat flour is naturally without gluten, ensuing clinical investigations have demonstrated that utilization of moderate or even large amounts of oat can be endured by most adult celiac patients (Rasane et al., 2015). As a result, without gluten items like pasta, biscuit, and snacks have been created for celiac patients from oats (Ballabio et al., 2011).

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Oat (*Avena sativa* L.) is interesting among cereals because of its rich nutritious parts and multifunctional attributes. Oats are an excellent source of dietary fiber, especially β-glucan (Chauha et al., 2018). β-glucan is a profoundly thick, soluble fiber found; fundamentally, in the endosperm cell mass of the oats. β-glucan is composed of glucose particles with mixed b-(1-4) and b-(1-3) bonds, this exceptional substance structure is answerable for physical properties, like viscosity and solubility, just as the ability to influence the metabolism of cholesterol (Butt et al., 2008 and Othman et al., 2011). In addition, the FDA revealed that foods containing 0.75g β-glucan or 1.7g soluble fiber per serving may reduce the danger of coronary disease (Choo & Aziz, 2010). There is also evidence that oat grains and their water-soluble fiber improved fasting, postprandial blood glucose levels, and insulin response in patients with diabetes mellitus (Hou et al., 2015 and Schlozman & Glei, 2017). Also, it may eliminate constipation; reduce the risk of hypertension, obesity, cardiovascular diseases, and colon cancer (Chen & Raymond 2008; Arendt & Dal Bello 2011 and Ekströmet al., (2017). Besides, the majority of people suffering from celiac disease can tolerate oats (Othman et al., 2011). Oat has picked up extensive consideration for its high contents of proteins and its unsaturated fatty acids. Oats also have folates, zinc, iron, selenium, copper, manganese, carotenoids, betaine, choline, just as the vitamin E-like compounds, tocotrienols, and tocopherols (Bocchiet al., 2021). According to Palfi and Knežević (2018) oats give a one-of-a-kind mix of antioxidant compounds which incorporate wax alcohol and acid esters; avenanthramides; and oat saponins, these oat extracts have been appeared to inhibit the arrangement of receptive oxygen species in vitro, which oxidize and advance the atherogenicity of LDL-cholesterol.

Banana is perhaps the most cultivated tropical fruit in the world. Overall, more than a thousand assortments of bananas are delivered. The production of banana assortments relates to around 15% of the total fresh fruit produced in the world, reaching about 110 million tons of bananas per year (Falcomer et al., 2019). Nonetheless, right around 31% of all bananas collected is lost because the majority of the population consumes ripe bananas and it is a climate fruit. Ripe bananas are susceptible to mechanical damage and perishable during the ripening process, making their storage and transport difficult (Jiang et al., 2015). Nearly 20% of banana creation isn't popularized because of size and appearance defects, raising their losses. Along these lines, green banana flour creation has been offered as an answer for high paces of waste among banana crops by the two analysts and authorities of different nations to provide a means of effectively utilizing fruits rejected as unsuitable for sale or export (Cahyana et al., 2020). According to Falcomer et al. (2019), most people are familiar with yellow bananas and consume them regularly for their nutritional profile, but do not usually consume green and unripe bananas due to the typical hardness and their high astringency. Green bananas vary slightly in taste, texture, and composition. Green banana (*Musa paradisiaca* L.) has plenty of resistant starch (RS), representing over 70% of the dry weight of the peeled banana fruit (Wang et al., 2017). Resistant starch is a type of starch that can't be digested in the small intestine because of its high degree of crystalline intrinsic structure (Choo & Aziz 2010 and Zhang et al., 2017). Consequently, it is classified as a type of dietary fiber which is fermented in the large intestine, producing short-chain fatty acids (Bello-Pérez and Agama-Acevedo, 2019). These short-chain fatty acids make the climate of the colon more acidic by bringing down the intestinal pH, thus less desirable for bacteria's growth (Murphy et al., 2008), that helps in treating inflammatory bowel disease, preventing intestinal disease (Wang et al., 2017) which reduces the risk of colorectal cancer (Higgins and Brown 2013) and cardiovascular diseases (Norhidayah et al., 2014), also alleviates constipation (Wang et al., 2014). Green bananas contain high measures of basic minerals, such as potassium, and different vitamins, e.g., A, B1, B2, and C (Choo and Aziz 2010). They are an important source of polyphenols (flavonoids, anthocyanins, tannins) that show antioxidant capacity. The existence of large quantities of bioactive compounds such as flavonoids and carotenoids related to dietary fiber (known as antioxidant dietary fiber) has been important as it is correlated with the anticipation of constant degenerative infections (Bello-Pérez and Agama-Acevedo, 2019). In this context, Zandonadi et al. (2012) indicated that the use of green bananas in the production of gluten-free food could improve the nutritional, sensory, and mechanical quality of these products. On the other hand, De Gouveia and Zandonadi (2013) and Campuzano et al. (2018) proposed that green banana flour be used as a functional ingredient for gluten-free bakery products, just as giving more affordable products – at a lower cost – to the general population.

The utilization of accommodation snacks is growing recently, due to hustle and bustle in developing countries' ways of life and financial developments (Abdullah et al., 2016). Cookies have thus become one of the most desirable in these nations, snacks. Cookies may be graded as ready-to-eat and easy foods. Traditionally, the process of making cookies is very straight forward, with basic ingredients consisting of flour, eggs, and sugar. Cookies are commonly known as flat, hard, and crunchy food (Bolarinwa et al., 2019). Considering all that, the aim of the present study is the development of a cookie's formulation containing green banana and oat flour that contribute to the gluten-free cookies production - as a functional food - and evaluate the effect of substituting various amounts of green banana and oat flour on physicochemical and sensory characteristics of the gluten-free cookies.

Materials and Methods

Materials

Green bananas of Sindihi CV. (*Musa paradisiace* L) harvest of 2020 was obtained (about 30kg) from Horticulture Research Institute, El-Kanater El-Khairia, Ministry of Agriculture, Egypt. All ingredients used in the cookies' formulation (oat flour, sugar powder, butter, eggs, vanilla, and baking powder) were commercially available and obtained from the local market from Damietta Governorate, Egypt.

Methods

Preparation of green banana flour

Fresh green bananas were washed with water and subjected to steaming for 15 min at 82°C. Bananas were peeled and cut into pieces for 3 mm thickness and pre-treated with 0.5% (w/v) citric acid solution for 10 min (To reduce the enzymatic browning) and 1% Calcium chloride (for preservative and act as firming agent) for 15min are used for drying processes. Pieces were dried for 12 hr at 60°C in an oven dryer. After drying ground into flour using a grinder, Banana flour was packed into pouches and then stored at room temperature (Sunitha et al., 2017).

Formulation and preparation of cookies

The cookies were prepared with slight modification by using the AACC method (AACC, 2000). The control and the other experimental formulations are presented in Table 1. In a large mixing bowl, the butter and powder sugar were mixed by an electric mixer on medium speed for 30s, and then add the beaten eggs and vanilla until mixed. Add flour and baking powder until dough combined. The dough was refrigerated at least for1 h. The dough was sheeted to a uniform thickness of 5 mm and cut into circular shapes of 60 mm diameter. Baking was carried out at 180ºC for 15 min. Cookie samples were cooled and stored in air-tight containers before physical and chemical evaluation. Cookies were made from oat flour to serve as a control.

TABLE I. Formulation of cookies.

Ingredients (g)	Control	1	2	3	4
Oat flour	100	75	50	25	-
Green banana flour	-	25	50	75	100
Butter	50	50	50	50	50
Sugar	40	40	40	40	40
Egg	30	30	30	30	30
Baking powder	1	1	1	1	1
Vanilla	1	1	1	1	1

Gross chemical composition

Oat, unripe banana flours composition and cookies were analyzed for moisture, ash, crude protein, crude fiber and crude fat contents, while total carbohydrates were calculated by difference according to AOAC (2016). The caloric value was calculated according to the following equation :

Caloric value = 4 (protein%+ carbohydrates %) + 9 (fat %)

Physical evaluation of cookies

The physical parameters of three cookies were evaluated in terms of weight, diameter (D), thickness (T), and spread ratio (diameter/thickness) according to the standard method. After cooling the cookies for 30 min, diameter and thickness measurements were taken using a vernier caliper. Then cookies are put in plastic bags, and kept in a freezer at -18ºC for further physical and chemical analysis.

Hardness

The hardness of the cookies was measured using a Texture Analyzer (Comtech, B type, Taiwan). A test speed of 1 mm/s was used for all tests. Three replicates of each formulation were conducted. breaking strength. Cookies were broken using the three-point bending rig probe. the experimental conditions were supports: 50mm apart, a 20mm probe travel distance. the force at break (N) was measured (Bourne, 2003).

Color analysis

Color changes of cookies were quantified in the L*, a*, b* color space. The International Commission on Illumination (CIE) parameters L*, a* and b* were measured with a (Minolta CR 3600, Minolta Camera, Co., Osaka, Japan). The calorimeter was calibrated with a standard white ceramic plate (L = 95.97, a = - 0.13, b = - 0.30) prior to reading. Corresponding L* value (lightness of color from zero (black) to 100 (white); a* value (degree of redness (0–60) or greenness (0 to -60); and b* values (yellowness (0–60) or blueness (0 to - 60) were measured for all the samples.

Sensory analysis

Sensory evaluation of cookies was done as described by AACC (2000) using 10 panelists of staff members from the Department of Horticultural Crops Tech. Res., Food Technology Research Institute, Agricultural Research Center, Giza, Egypt. Samples of the cookies were prepared one day earlier before the evaluation, cooled for 1-2hr at room temperature (25±3ºC). Sensory attributes for color, taste, flavor, texture,and overall acceptability were evaluated.

Statistical analysis

All samples were analyzed in triplicates and the mean values were expressed. Analysis was assessed using the Statistical Analysis Software for Windows (SAS, 2008). The significant difference between the mean values were determined by using the analysis of variance (ANOVA) and Duncan's multiple range test was conducted at a significance level of $p<0.05$. Sensory data scores were analyzed by analysis of variance with mean separation by LSD ($P < 0.05$).

Results and Discussion

Gross chemical composition and caloric value of oat and unripe banana flours

The obtained results are presented in Table 2 and it could be observed that Oat flour (OF) contained 6.99, 16.65, 9.13, 1.82, 10.87, 65.33 %, and 410.14 kcal /100g for moisture,crudeprotein, crudefat, ash, crude fiber, total carbohydrates, and caloric value, respectively. Barbara et al. (2020) indicated that oat flour contained 12.37% moisture, 13.27% protein, 1.83% ash, and 12.9% dietary fiber. Meanwhile, Youssef et al. (2016) revealed that the chemical composition of oat flours ranged between 9.96 - 10.47% moisture, 11.61 -13.62% crude protein, 7.23 -8.92% crude fat, 3.535 - 5.875%, crude fiber, 2 -2.15% ash, and 69.435 - 75.625% carbohydrates, while the caloric values of oat flours were 412.5 and 414.01 kcal /100 g for both red and common oat. On the other hand, the results in the same Table 2 appeared that unripe banana flour(UBF) contained moisture (6.79%), crude protein (4.80%), crude fat (5.16%), ash (2.95%0, crude fiber (13.03%), total carbohydrates (84.93%) and caloric value (363.56 kcal/100g). Khalil et al. (2017) found that UBF contained 12.05% moisture, 4.2% crude protein, 0.43 % fat, 2.5% ash, 6.3% crude fiber, and 86.57% of total carbohydrates.While, Bezerra et al. (2013) found that protein, fat, ash, fiber, and carbohydrates of UBF were 4.41%,0.45%,1.08%, 8.49%, and 86.9%, respectively. Türker et al. (2016) illustrated that UBF is viewed as a reasonable organized item for use in food processing, it has a high fiber, carbohyd rate, and mineral content, appearing, consequently, a high potential as an ingredient in the formulation of several foodstuffs (Bezerra et al., 2013).

Gross chemical composition and caloric value of cookies with oat and unripe banana flours

Results presented in Table 3 showed the gross chemical composition of control (cookies with oat flour OF) and formulas (cookies with unripe banana flour UBF), it was found that moisture contents of control were less than formulasF1,F2,F3, and higher than F4 (3.69, 4.85,5.80, 4,73 and 3.46%, respectively).From the same Table, it could be observed that ash content was 1.57, 1.26, 1.63, 2.12, and 2.37% for control, F1, F2, F3, and F4, respectively. The same Table 3 appeared that, crude protein content of control (19.54%), F1 (17.88%), F2 (14.58%), F3 (10.14%), and F4 (9.35%), while crude fat content of control was higher than treatments F1, F2, F3, and F4 which were 24.95, 21.72, 18.61, 16.38 and 12.55%, respectively. The data in Table 3 showed that crude fiber contents of control were less than formulas F1, F2, F3, and F4 (10.22, 10.90, 11.01, 11.66, and 12.58%, respectively). Meanwhile, the content of total carbohydrates in control and cookies formulas were 50.23, 54.29, 59.36, 66.61, and 72.24% for control, F1, F2, F3, and F4, respectively. On the other hand, the caloric value of control was 503.70 kcal/100g while it ranged from 439.42 to 484.16 kcal/100g in different cookies for mulas. Concerning the previous results, it should be noticed that the increase of UBF in cookies led the increased proportion of ash, crude fiber, total carbohydrate, and the decreased proportion of crude fat, crude protein, and caloric value compared to control. Bezerra et al. (2013) reported that the crude fiber content in the cookies increased due to the greater amount of fiber provided by the green banana flour.

TABLE 2. Gross chemical composition and caloric value of oat and unripe banana flours (% On dry weight basis).

Components	OF	UBF
Moisture content	6.99±.12	6.79 ±.11
Crude protein	16.65 ±.14	4.80 ±.09
Crude fat	9.13 ±.31	5.16 ±.025
Ash	1.82 ±.18	2.95 ±.14
Crude fiber	10.87 ±.17	13.03 ±.25
Total carbohydrates*	65.33 ±.40	84.93 ±.17
caloric Value (Kcal)	410.14 ±2.15	363.56 ±.96

Each value represents the mean ± SD. OF: oat flour. UBF: unripe banana flour
* Total carbohydrates were calculated by differences .

TABLE 3. Gross chemical composition and caloric value of cookies with oat and unripe banana flours (% Ondry weight basis).

Components(%)	Control cookies (OF)	Formulas cookies with UBF			
		F1	F2	F3	F4
Moisture content	3.69±.29	4.85±.23	5.80±.21	4.73±.19	3.46±.21
Ash	1.57±.17	1.26±.05	1.63±.08	2.12±.05	2.37±.06
Crudeprotein	19.54±.23	17.88±.17	14.58±.37	10.14±.16	9.35±.22
Crudefat	24.95±.05	21.72±.55	18.61±.38	16.38±.31	12.55±.12
Crude fiber	10.22±.19	10.90±.14	11.01±.13	11.66±.40	12.58±.36
Total carbohydrates*	50.23±.41	54.29±.87	59.36±.36	66.61±.37	72.24±.25
Caloric value (kcal)	503.70±.49	484.16±2.07	463.29±1.48	454.50±2.22	439.42±1.22

Each value represents the mean±SD.* Total carbohydrates were calculated by differences.
OF: oat flour. UBF: unripe banana flour.Control: 100% OF. F1: 25%UBF +75%OF.
F2: 50%UBF +50%OF. F3: 75%UBF +25%OF. F 4: 100%UBF

Physical properties of cookies with oat and unripe banana flours

The results of weight (g), thickness (mm), diameter (mm), spread ratio, and hardness (N) of cookies with oat and unripe banana flours could be seen in Table 4. There were no significant (P≤0.05) differences between the values obtained for the weight (g), thickness (mm), and diameter (mm) of cookies supplemented with 25 and 50% UBF and the control (100% oat flour) cookies. However, these parameters decreased significantly in the case of cookies supplemented with more than 50% UBF. Moreover, the spread ratio in cookies with 25% and 50% UBF didn't differ significantly as compared to the control. While, spread ratio in cookies with 75% and 100% of UBF was higher than the control. These results were consistent with Hassan (2002) who found that the addition of resistant starches by 50% to wheat flour led to cookies with high spread ratio and low thickness than control.

On the other hand, hardness values (N) for all formulas had increased gradually with the increasing amount of UBF added to be 14.99, 17.16, and 17.67 as compared to the control, except the formula containing 25% of UBF that showed no significant differences with the control. That means blends containing more than 50% of UBF produced a harder cookie that required more force to compress. In the present study increa se in hardness may be due to a higher amount of fiber in the UBF. The results are in line with Sandhu et al. (2018) who confirmed that with the increase in the level of oatmeal flour from 0 to 30% in cookies, a significant increase in cookies hardness was observed; this may be due to a higher amount of fiber in the oatmeal. Also, similar results were reported by Singh et al. (2008) which indicated that a significant increase in dough hardness was observed due to an increase in fiber content after the addition of sweet potato flour.

Color plays an important role in consumer's acceptability of the product. Table 5 showed the color attributes of cookies with oat flour (OF) and unripe banana flour (UBF). The color of cookies was assessed in terms of lightness (L*), redness (a*), and yellowness (b*). The cookies containing UBF had significantly lower L* values (54.69–50.35) than the control (57.79). The lowest L* value was observed in 100% UBF cookies. This was attributed to a Mail lard reaction causing browning during baking at high temperatures. On the other hand, the a* values are indicative of the red or green color (positive value indicates red and negative value indicates green). The results in the same Table 5 revealed that all cookies were in redness (positive a*). But the cookies treated with UBF were significantly different with control (OMF) for a* value, redness of formulas cookies showed a slight increase from lowest value (4.55) observed in 25% UBF to highest value (5.25) found in 100% UBF.The b* color value indicates the yellow or blue colors (a positive value indicates yellow and a negative value indicates blue). The data indicated that the substitution of oat flour for UBF (25, 50,75, and 100%) resulted in significantly lowered b*

TABLE 4. Physical properties of cookies with oat and unripe banana flours.

Parameters	Control cookies (OF)	Formulas cookies with UBF (%)			
		F1	F2	F3	F4
Weight (g)	19.04±0.11[a]	18.82±0.13[a]	18.70±0.20[ab]	18.38±0.32[b]	17.54±0.39[c]
Thickness (mm)	7.22±0.08[a]	7.14±0.16[a]	6.96±0.20[a]	6.28±0.43[b]	5.92±0.21[c]
Diameter (mm)	66.20±0.83[a]	63.80±2.58[ab]	61.40±2.07[bc]	59.60±2.40[cd]	57.80±2.38[d]
Spread ratio	9.16±0.16[b]	8.93±0.43[b]	8.82±0.33[b]	9.49±1.00[a]	9.76±0.86[a]
Hardness (N)	10.99±1.30[c]	13.44±1.54[bc]	14.99±2.05[ab]	17.16±1.48[a]	17.67±1.88[a]

Mean values in the same row which are not followed by the same letter are significantly different (p≤0.05).
OF: Oat flour. UBF: unripe banana flour. Control: 100% OF. F1: 25%UBF +75%OF. F2: 50%UBF +50%OF. F3: 75%UBF +25% OF. F4: 100% UBF.

values (15.30 –12.40) from the control (17.02). The yellowness of composite treats diminishes might be because of the debasement of precarious yellow compounds during baking. The difference in cookies color can be credited to the pigmentation of flours, which will rely upon the plant source, extraction technique, molecule size, and the drying time/temperature relationship. As is notable, the flour tone is frequently impacted by its polyphenolic content. Regarding the previous results, it could be observed that the brightness (L*) and yellowness values (b*) in cookies had gradually declined with the increasing levels of UBF, whereas, redness (a*) value had increased, which means that the UBF resulted in darker cookies when the addition was higher.

Sensory characteristics of cookies with oat and unripe banana flours

Table 6 presented the sensory characteristics of prepared cookies with oat and unripe banana flours. The data showed that most formulations were acceptable in all sensory evaluation attributes (color, taste, flavor, texture, and overall palatability) and no significant variations (P<0.05) between the formulas supplemented with 25 and 50% of cookies with OMF and UBF when compared with control. Whereas substitution with high levels from UBF by 75 and 100% caused a significant difference (P<0.05) in the same sensory evaluation attributes as compared to the control. Although results observed that cookies containing 100% UBF had the highest hardness score that led to a reduction in overall palatability, but the results of the acceptance test showed that consumers like most of the formulas. The total score for overall palatability ranged from 7.40 to 9.25, it should be noticed that formulas of cookies containing 25 and 50% UBF had a higher total score for overall palatability than the other formulas. Generally, it means that the mixture of oat and unripe banana flours can be used in the preparation of cookies. These results align with Păucean et al., (2015) who found that sensory evaluation showed that rice flour substitution with high levels from quinoa flour led to a steady decrease in the sensory scores for overall acceptability. In another study; Zafar & Tusneem Kausar (2019) showed that sensory evaluation of cookies demonstrated that supplementation of guava flour improves all sensorial parameters. Ishartati et al. (2019) indicated that the most preferred product by panelists is the level of substitution of Mamaliga apple flour 25% and 30%. Also, Al-Lami et al. (2020) showed that sensory evaluation was best when mixed quinoa and rice by 50:50, which was characterized by acceptable characteristics.

The costing of cookies with oat and unripe banana flours

Table 7 shows the cost of cookies with oat and unripe banana flours. After adding 30% of energy and labor consumption, as well as 10% of packing and packaging to each formula, the results showed that F4 had the lower cost (42.81 pounds) followed by F3, F2, and F1 (45.93, 49.05, and 52.18 pounds) respectively, while the control had the highest cost (55.30 pounds). Results appeared that by increasing the percentage of the addition of green banana flour, the final cost of the product decreases compared to the control.

TABLE 5. Color attributes of cookies with oat and unripe banana flours.

Attributes	Control cookies (OF)	Formulas cookies with UBF			
		F1	F2	F3	F4
L*	57.79±0.24ᵃ	54.69±0.14ᵇ	52.72±0.17ᶜ	51.89±0.31ᵈ	50.35±0.25ᵉ
a*	4.17±0.12ᵉ	4.55±0.15ᵈ	4.70±0.70ᶜ	5.17±0.51ᵇ	5.25±0.14ᵃ
b*	17.02±0.11ᵃ	15.30±0.20ᵇ	13.65±0.25ᶜ	13.73±0.47ᶜ	12.40±0.10ᵈ

Mean values in the same row which are not followed by the same letter are significantly different (p≤0.05).
OF: oat flour. UBF: unripe banana flour. Control: 100% OF. F1: 25%UBF +75%OF. F2: 50%UBF +50%OF. F3: 75%UBF +25% OF. F4: 100% UBF

TABLE 6. Sensory characteristics of cookies with oat and unripe banana flours.

Sensory Characteristics	Control Cookies (OF)	Formulas cookies with UBF			
		F1	F2	F3	F4
Color	9.35±0.58[a]	9.10±0.5[a]	8.10±0.3[b]	7.50±0.7[c]	6.50±0.8[d]
Taste	8.85±1.00[a]	8.85±0.9[a]	8.85±0.3[a]	7.95±0.9[b]	7.55±0.6[b]
Flavor	9.00±1.15[a]	8.90±0.5[a]	8.85±0.5[a]	8.35±0.8[ab]	8.00±0.9[b]
Texture	9.30±0.82[a]	9.00±0.6[a]	8.70±0.7[a]	7.90±0.9[b]	7.60±1.0[b]
Overall palatability	9.10±0.70[a]	9.25±0.5[a]	8.90±0.6[a]	7.95±0.7[b]	7.40±0.8[b]

Mean values in the same row which are not followed by the same letter are significantly different (p≤0.05).
OF: Oat flour. UBF: unripe banana flour. Control: 100% OF. F1: 25%UBF +75%OF.F2: 50%UBF+50%OF.
F3: 75%UBF +25% OF. F4: 100% UBF

TABLE 7. The costing of cookies with oatmeal and unripe banana flour.

Ingredients	Weight (g)	Cost (LE)	Formula No.	Cost of final product(LE)
			Control	55.30
OF	600	19.20		
UBF	600	10.28	**F1**	52.18
Butter	300	14.40		
Sugar	240	2.40	**F2**	49.05
Egg	105	2.50		
Baking powder	1	1	**F3**	45.93
Vanilla	0.5	0.50		
			F4	42.81

OF: oatmeal flour. UBF: unripe banana flour. Control: 100% OF. F1: 25% UBF +75% OF. F2: 50% UBF +50% OF. F3: 75% UBF +25% OF. F4: 100% UBF

Conclusion

The current study confirms that unripe banana flour can be used up to 50% in combination with other cereals to produce a gluten-free product such as cookies. This strategy might be improving the sensorial and physicochemical quality of these products. In addition to ameliorating the nutritional status of people experiencing degenerative illnesses related to the present changing ways of life and climate.

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خصائص جودة الكوكيز خالي الجلوتين المحضر من خليط دقيق الشوفان والموز غير الناضج

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استهدفت الدراسة تحسين خصائص جودة الكوكيز خالي الجلوتين المجهز من دقيق الشوفان ودقيق الموز غير الناضج. تم استبدال دقيق الشوفان بدقيق الموز غير الناضج بمستويات ٢٥، ٥٠، ٧٥، ١٠٠٪. أظهرت النتائج أن التركيب الكيميائي لدقيق الشوفان يحتوي على الرطوبة (٦,٩٩٪)، البروتين الخام (١٦,٦٥٪)، الدهون الخام (٩,١٣٪)، الرماد (١,٨٢٪)، الألياف الخام (١٠,٨٧٪)، الكربوهيدرات الكلية (٦٥,٣٣٪) وقيمة السعرات الحرارية (٤١٠,١٤كيلو كالورى/١٠٠جرام). بينما احتوى دقيق الموز غير الناضج على ٦,٧٩، ٤,٨٠، ٥,١٦، ٢,٩٥، ١٣,٠٣، ٨٤,٩٣٪ و٣٦٣,٥٦ كيلو كالوري/١٠٠جم لنفس المكونات وقيمة السعرات الحرارية على التوالي. كما لوحظ من النتائج أن زيادة دقيق الموز غير الناضج في الكوكيز أدت إلى زيادة نسبة الرماد والألياف الخام والكربوهيدرات الكلية وانخفاض نسبة الدهون الخام والبروتين الخام وقيمة السعرات الحرارية مقارنة بكوكيز الشوفان (الكنترول). لم تختلف القياسات الفيزيائية كالوزن والسمك والقطر ونسبة الانتشار في الكوكيز المجهز بنسبة ٢٥٪ و٥٠٪ من دقيق الموز غير الناضج مقارنة بكوكيز الشوفان وسجلت هذه النسب أفضل النتائج ، بينما أدت المستويات العالية من دقيق الموز غير الناضج إلى الحصول على كوكيز أكثر صلابة. اما قياسات اللون في الكوكيز فقد لوحظ من النتائج أن قيم السطوع (L*) والصفرة (b*) في الكوكيز قد انخفضت تدريجيًا مع زيادة مستويات دقيق الموز غير الناضج بينما زادت قيم الاحمرار (a*) مما يعني أن مستويات الاضافة العالية لدقيق الموز غير الناضج ينتج كوكيز داكن اللون. كانت نتائج التقييم الحسي مقبولة لجميع المعاملات ولكن معاملات الكوكيز التي تحتوي على ٢٥و ٥٠٪ من دقيق الموز غير الناضج قد حصلت على درجة إجمالية أعلى من العينات الأخرى. تستنتج الدراسة امكانية استخدام دقيق الموز غير الناضج بنسبة تصل إلى ٥٠٪ في إنتاج منتج غذائي خالي من الجلوتين مع مراعاة الجودة الغذائية والحسية والفيزيائية للمنتجات.

الكلمات المفتاحية: الشوفان - الموز غير الناضج - كوكيز - خالي من الجلوتين - أغذية وظيفية.