Production and Evaluation of Low Fat Cake Containing Flaxseed and Okra gums as a Fat Replacer

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Received: 20 May, 2014 *Revised: 10 June, 2014* *Accepted: 15 June, 2014*

ABSTRACT

Fat was replaced in cakes with flaxseed and okra gums at 25 up to 100%. The results indicated that the proximate chemical composition of the replacement cakes showed a significant increase ($P \leq 0.05$) in moisture as the replacement levels of both gums increased relative to a significant lowered in fat content. The caloric value of replaced cakes with both gums showed a significant lowered which was more pronounced in flaxseed replacement cakes rather than okra gum cakes being 21.11 and 19.33% at 100% replacement, respectively. Replacement with both gums at different levels significantly lowered the weight, volume, height and specific volume of cakes. Okra gum-replaced cakes exhibited better physical properties than flaxseed-replaced cakes. The texture profile analysis (TPA) showed that both gums added tenderness and resilience to the cakes up to 75% and 100% replacement which was more pronounced in okra gum-replaced cakes rather than those replaced with flaxseed. The sensory evaluation of cakes showed that the colour and flavour of okra gum-replaced cakes were highly acceptable up to 100% replacement level, where, the texture and overall acceptance were accepted by the panelists up to 75%. Flaxseed gum-replaced cakes were highly accepted up to 75% replacement levels. Both gums used in the present study were very successful in producing highly acceptable tender cakes thus allowing production of potentially healthier food items.

Keywords: flaxseed gum, okra gum, fat replacers, bakery products, TPA, physical properties, sensory evaluation.

INTRODUCTION

Dietary fat is a major energy source, which is essential for growth and development, and provides essential fatty acids needed for maintaining structure of cell membrane and for prostaglandin synthesis. In addition, fat aids in the absorption of fat-soluble vitamins and other phytoch-emicals (ADA Reports, 2005). Fat is a major source of energy supplying about 9kcal/g, while protein and carbohydrate supply only 4kcal/g for each **(**O´Brien, 2004**)**.

As one of nutritional components of diets, fat delivers pleasing taste, flavour and good 'mouth-feel' in foods. Several studies have documented that excessive consumption of foods high in fat leads to health problems including obesity and heart disease (Jongbin *et al.*, 2010). Obesity has become a public health concerning threating conditions. In the countries of WHO European Region the prevalence of obesity has raised 3-folds since the 1980s **(**WHO, 2007). Today in the United States, more than 23 million children and adolescents are overweight or obese (Ogden *et al.,* 2010).

The health-conscious public, demands high-quality and low-calorie products that are low in fat and sugar. However, altering amounts of ingredients to reduce caloric content may compromise texture, mouth feel, flavour and appearance (Pong *et al*., 1991 & Khalil, 1998**)**.

Fat replacers are used to provide some or all of the functional properties of fat, while providing fewer calories than the fat being replaced, and are used in a variety of products from baked goods to frozen desserts. Fat replacers are most useful when they help with calorie control and when their use encourages the consumption of foods delivering important nutrients **(**ADA Reports, 2005**)**. Carbohydrate-based fat mimetics are based on carbohydrate, such as cellulose, microcrystallie cellulose, dextrin, maltodextrins, gums, fiber, and modified starch. These fat replacers can provide up to 4 kcal/g, but, because they are often mixed with water, they typically provide only 1 to 2 kcal/g, and, some (such as cellulose) provide zero calories. They are used mainly as thickeners and stabilizers and are typically used in a variety of foods (Conforti & Archilla, 2001).

Other than contributing to the appearance and aroma, shortening (fat) provides a tender and soft texture to cakes by assisting in the entrapment of air during creaming and in leavening action (Kalinga & Mishra, 2009). When shortening is completely removed from a cake formulation, volume decreases, the crumb becomes less tender and the cell structure becomes uneven (Kim *et al*., 2001). One option is available for reducing fat in the cake by partial replcaing of fat with fat replacers such as carbohydrate-based fat replacers.

Flaxseed gum, which comprises about 8% of the seed, yields L-galactose, D-xylose, L-arabinose, L-rhamnose and D-galacturonic acid by acid hydrolysis (Warrand *et al.*,2005). Flaxseed gum has good water holding capacities, water binding ability with rheological properties similar to those of guar gum (Fedeniuk & Biliaderis, 1994). Flaxseed gum also shows weak gel properties, so that it can be used to replace most of the non-gelling gums for food and non-food applications (Chen *et al*., 2006).

Okra is known for its viscous mucilaginous solution that results when it is crushed and extracted in water. This solution, called okra gum, it has many potential applications ranging from the pharmaceutical field to the food industry. As for the food industry, okra gum has been used as a thickening for soups and stews. In addition, okra gum can be used as egg white and fat substitutes in baked and frozen desserts (Jewkes, 2008 & McWilliams, 2012). Okra mucilages had a good emulsifying capacity and showed better whipping ability comparable to egg albumin (El-Mahdy & El-Sebaiy, 1988). Okra polysaccharides (gums) are a random coil polysacchrides consisting of galactose, rhamnose, and galacturonic acid (Tomada *et al.,* 1980). These water extracted polysaccharides, are highly viscous solution with slimy appearance (Ramadas & Tharanathan, 1987).

The present work was undertaken to examine the effect of different levels of flaxseed and okra gums on the physical, chemical, textural profile analysis and sensory properties of cakes.

MATERIALS AND METHODS

Materials:

Wheat flour (72%extraction), sugar, egg, baking powder, vanillin and bicarbonate were purchased from the local market in Alexandria city and butter, (Lurpak) from Oral Foods Amba, Dc-8260 Vebe Geh, Denmark. Fresh immature pods of okra were purchased from a local market in Alexandria city. Flaxseeds were obtained from Food Technology Research Institute (FTRI), Agriculture Research Center (ARC), Giza, Egypt.

Preparation of okra gum

Okra gum, derived by water extraction from immature pods of the okra plant (*Hibiscus escutentus* L.), was prepared according to the method described by Romanchik *et al.,*(*2002*) with some modifications as follows:

Seeds were removed from okra pods using a knife as they contain small traces of fat. In a covered saucepan 150g okra was boiled in 474g distilled water for 15 min. The mixture was strained to remove okra, and then cooled at room temperature, where the final measured viscosity was 136 m pas*s (Millipascal) at 100 RPM (Spindle RV 02). The viscosity of the final gum solution was measured using a Brookfield DV-11+Pro Viscometer.

Preparation of flaxseed gum

Flaxseed gum was extracted according to the method described by Bhatty (1993) with some modifications. Flaxseeds were mixed with water (1:20 w/v) and stirred for 30 min. at 100ºC then left for 8hr. at room temperature. The extract was separated by filtration using glass wool. The gum solution was then concentrated on a rotary evaporator at 40˚C, where the final measured viscosity was 46.4 m pas*s (Millipascal) at 100 RPM (Spindle RV 02). The viscosity of the final gum solution was measured using a Brookfield DV-11+Pro Viscometer.

Cake preparation

Cakes were prepared using the method followed by Shaltout *et al*. (2004). The formulation of cake consisted mainly of: One hundred gram flour (72%extraction), 100g sugar, 100g butter, 100g egg, 2.5g baking powder and 3g vanillin (Table 1). The procedure of processing was as follows: The ingredients (i.e. flour, baking powder, vanillin) were weighed and sifted together. The butter and sugar were creamed for 1min on low speed in Goldi mistral (model HM301) and then they were creamed for additional 1 min at the high speed. Eggs were added gradually while creaming and the whole mixture was creamed for additional 2 min on the high speed. After scraping down the mixing bowel, the batter was mixed again for 1 min at the high speed.

Table 1: Formulations of low-fat cake prepared using fat replacers

Ingredient	Control	25%		50%		75%		100%	
	(gm)	A	B	A	B	A	B	A	B
Flour	100	100	100	100	100	100	100	100	100
Sugar	100	100	100	100	100	100	100	100	100
Butter	100	75	75	50	50	25	25	—	—
Fat replacer	—	25	25	50	50	75	75	100	100
Egg	100	100	100	100	100	100	100	100	100
Baking powder	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Vanillin	3	3	3	3	3	3	3	3	3

Replacement level: 25%, 50%, 75%, 100%

(A) low-fat cakes prepared with okra gum, **(B)** low fat cakes prepared with flaxseed gum

The cake batter was immediately deposited into rectangular pans (size 23.8X8.8cm, bottom diameter 4cm), and baked at 170˚C ± 10˚C for 25min. in preheated oven. The cakes were allowed to cool for 1 hr. and were then removed from the pan. The cooled cakes were packed in polypropylene bags at room temperature before physical, chemical and sensory analyses were performed. For low-fat applications, the fat replacers(okra gum and flaxseed gum) were added in the creaming phase to replace 25, 50, 75 and 100% of butter used in cake formula as shown in Table (1).

Methods

Proximate chemical composition

Moisture, crude fat, crude protein (Nx5.7), and ash were estimated according to the methods of the AOAC (2000). Carbohydrates conten was calculated by difference and all determinations were carried out in triplicate. Caloric value of products was calculated according to the following equation:

E=4 (Total carbohydrate %+ protein %) + 9 (fat %)

Where E=Calories per 100g product.

Physical properties of cake

The pH of cake was measured according to the method of AOAC (2000) using Micro Processor pH Meter (HANNA instruments pH 2011). Cake was weighed after removal from the pan. Cake volume was measured by rapeseed displacement after cooling for 1hr. at room temperature (~25ºC) (AACC, 1983). The height (cm) was measured in the center of the cake. The specific volume of each cake was determined as the ratio of the volume to its weight (Pong *et al*., 1991).

Sensory evaluation

Eight trained panelists in Food Science Department, Faculty of Agriculture, Saba basha, Alexandria University were asked to judge the cakes for colour, flavour, texture and overall acceptance (Mansour *et al,* 2003**)**. A 5-point hedonic scale was used to rate the sensory properties. The 5 choices on the hedonic scale were: like extremely, like very much, like moderately, dislike moderately, dislike very much. Every panelist was asked to test and check how much did he/she likes the characteristic under test and also to show their attitude by checking the point that best described their feeling about the characteristic. After that, their ratings were given numerical values ranging from 5(for like extremely) to 1(for dislike extremely).

Texture profile analysis

Crumb texture was measured by a universal testing machine (Cometech, B type, Taiwan), provided with software. An Aluminum 40 mm diameter cylindrical probe was used in a "Texture Profile Analysis" (TPA) double compression test to penetrate to 50% depth, at 1mm/s speed test. Firmness (N), gumminess (N), chewiness (N), adhesiveness (N.s), cohesiveness, springiness and resilience were calculated from the TPA graphic. Both, springiness and resilience, give information about the after stress recovery capacity. While, the former refers as to retarded recovery, the latter concerns instantaneous recovery (immediately after the first compression, while the probe goes up). Texture determinations were carried out, after removing the crust, in (40*40*30) mm-sized samples (Bourne, 2003**)**.

Statistical analysis

Data of physical measurements, chemical analysis and sensory evaluation of cake products were analyzed by analysis of variance using General Linear Model (GLM) procedure within a package program of Statistical Analysis System (SAS 2001). Means were separated using Duncan's test (Duncan, 1955) at a degree of significance ($P \leq 0.05$). The factorial analysis was used to evaluate the effects of fat replacer type and level on the physical properties, proximate chemical composition and sensory characteristics of cake products.

RESULTS AND DISCUSSION

Proximate chemical composition and caloric value

The proximate chemical composition and caloric value of cake made with flaxseed and okra gums as a fat replacer are shown in Table (2). Results show that the moisture content of the cakes increased significantly as the replacement level increased. Cakes containing okra gum at levels ranged from 25% to 100% showed significantly ($P \leq 0.05$) higher moisture content as compared to cakes containing flaxseed gum and the control. It was reported by Romanchik *et al*. (2002) that the moisture content of fat-free chocolate bar cookies containing okra gum and fat-free chocolate bar cookies containing apple sauce did not differ significantly. However, both fat-free products contained greater moisture 3 times than full fat control cookies. Cakes replacement with flaxseed gum at levels of 75% and 100% had lower fat content than those replacement with the same level of okra gum being (11.03, 3.40%) and (12.10, 6.54%), respectively. It was noted that compared to the control samples, cakes replacement with flaxseed and okra gums at all levels exhibited lower fat content. Both types of gum replacers used in the present study did not significantly affect the protein and ash contents. The apparent total carbohydrates significantly ($P \leq 0.05$) increased with elevating the fat level replacement compared to the control samples.

Concerning the caloric value, a gradual significant decrease was observed as the substitution level in both types of gums increased being more pronounced in flaxseed gum at 100% (413.63 kcal) than okra gum at 100% (423.14 kcal) as compared to the controls. The percentages of lowered in calorie in both types of gum replacers at 100% was 21.11 and 19.33% for flaxseed and okra gums, respectively. It was reported by Hussein *et al.* (2011) that the calorie of cakes was significantly ($P \leq 0.05$) decreased as the fat replacer levels increased, where the fat replacer used was artichoke at (0, 25, 50 and 75%).

Physical properties

The physical properties of cake made with flaxseed and okra gums as a fat replacer are shown in Table (3). The pH of both gum replacements of final products was not significantly different from the control. It ranged between 7.1 and 7.3 for cake containing flaxseed gum and 7.21 and 7.24 for cake containing okra gum. Meanwhile, it was observed that as the proportion of flaxseed and okra gums increased (25, 50, 75 and 100%), the cakes became lower in weight, volume and height than did those of the control.

The specific volume of baked cake indicates the amount of air that can remain in the final product. A higher gas retention and higher expansion of the product leads to a higher specific volume (Gomez *et al*., 2008). The samples with flaxseed had significantly lower specific volume as compared to that of the control (Table 3). On the other hand, samples with okra gum had significantly higher specific volume comparing to their control.

Table 2: Proximate chemical composition and caloric value of cake made with flaxseed and okra gums as fat replacers

Parameters %	Fat type	Level of replacement				
		Control	25%	50%	75%	100%
Moisture	Flaxseed	18.59±1.67^{e}	20.57±0.43^{e}	28.10±0.51^{b}	29.48±0.17^{b}	31.94±0.51^{b}
	Okra	20.30±0.31^{e}	25.22±0.41^{cd}	29.00±1.00^{b}	30.80±0.30^{b}	37.61±0.39^{a}
Crude fat	Flaxseed	25.55±0.5^{a}	21.48±0.46^{b}	17.14±0.22^{c}	11.03±0.16^{e}	3.40±0.21^{g}
	Okra	25.74±0.30^{a}	20.80±0.30^{b}	16.65±0.05^{c}	12.10±0.26^{d}	6.54±0.21^{f}
Crude protein	Flaxseed	4.97±0.07^{cd}	4.80±0.35^{d}	5.05±0.13^{cd}	5.00±0.22^{cd}	5.40±0.07^{bcd}
	Okra	6.55±0.19^{a}	5.70±0.70^{abc}	5.95±0.17^{ab}	6.32±0.20^{a}	6.35±0.19^{a}
Ash	Flaxseed	0.65±0.02^{b}	0.66±0.07^{b}	0.79±0.10^{b}	0.69±0.07^{b}	0.81±0.08^{b}
	Okra	1.57±0.40^{a}	1.30±0.31^{ab}	1.00±0.11^{ab}	1.15±0.33^{ab}	2.10±1.00^{a}
Carbohydrate	Flaxseed	68.82±0.15^{f}	73.10±0.20^{e}	77.02±0.40^{d}	83.32±0.41^{b}	90.44±0.35^{a}
	Okra	66.30±0.12^{f}	72.24±0.74^{e}	76.44±0.18^{d}	80.51±0.35^{c}	84.30±1.30^{b}
Caloric value	Flaxseed	524.35±0.83^{a}	504.73±2.14^{b}	482.47±0.79^{c}	452.38±0.74^{d}	413.63±0.82^{f}
Kcal/100g	Okra	524.54±3.55^{a}	501.44±1.28^{b}	479.39±0.37^{c}	455.91±1.88^{d}	423.14±4.91^{e}

Means in a columns or rows not sharing the same superscript are significantly different at ($P<0.05$).

Table 3: Physical properties of cake made with flaxseed and okra gums as fat replacers

Parameters	Fat type	Level of replacement				
		Control	25%	50%	75%	100%
pH	Flaxseed	7.30±0.00	7.10±0.00	7.10±0.00	7.10±0.00	7.10±0.00
	Okra	7.24±0.00	7.21±0.00	7.24±0.00	7.23±0.00	7.23±0.00
Weight (g)	Flaxseed	$104.35±0.00^{c}$	$98.09±0.00^{d}$	$94.75±0.00^{e}$	$91.03±0.00^{e}$	$93.27±0.00^{e}$
	Okra	$113.17±0.00^{a}$	$107.98±0.00^{b}$	$104.69±0.00^{c}$	$99.06±0.00^{d}$	$98.26±0.00^{d}$
Volume (cm^3)	Flaxseed	$220.00±0.00^{b}$	$215.00±0.00^{c}$	$203.00±0.00^{d}$	$177.00±0.00^{de}$	$170.00±0.00^{de}$
	Okra	$237.00±0.00^{a}$	$235.00±0.00^{a}$	$232.00±0.00^{a}$	$224.00±0.00^{ab}$	$220.00±0.00^{b}$
Height (cm)	Flaxseed	$4.50±0.00^{a}$	$4.00±0.00^{b}$	$3.80±0.00^{c}$	$3.40±0.00^{c}$	$3.30±0.00^{c}$
	Okra	$4.50±0.00^{a}$	$4.50±0.00^{a}$	$3.80±0.00^{c}$	$3.40±0.00^{c}$	$3.30±0.00^{c}$
Specific	Flaxseed	$2.11±0.00^{c}$	$2.19±0.00^{b}$	$2.14±0.00^{c}$	$1.94±0.00^{d}$	$1.82±0.00^{e}$
volume (cm^3/g)	Okra	$2.11±0.00^{c}$	$2.18±0.00^{b}$	$2.22±0.00^{a}$	$2.26±0.00^{a}$	$2.24±0.00^{a}$

Means in a columns or rows not sharing the same superscript are significantly different at (P<0.05).

Generally speaking, okra gum added as a fat replacer provided better physical properties to cakes rather than flaxseed gum.

More specifically, as the level of replacement increased the viscosity of the batter decreased, resulting in less air bubble incorporation during mixing and less air holding capacity during baking (Vassiliki & Vassiliki, 2013).

Texture profile analysis

Texture profile analysis (TPA) is a very useful technique for investigating food products where tenderness and elasticity (resilience) are the main textural properties of a cake and related to quality (Vassiliki & Vassiliki, 2013). In the present study, the TPA parameters of cakes containing flaxseed and okra gums replacements were measured by the texture analyzer using double compression tests that shown in Table (4).

Hardness was defined as the maximum force of the first compression of the product at the point of 50% compression (1mm/s speed test). The hardness or firmness values of cakes replacement with both flaxseed and okra gums, showed a dramatic significant (P≤0.05) decrease with the increase in replacement levels being more pronounced in cakes replaced with okra gum than flaxseed gum. However, cohesiveness determined from the area of work during the second compression divided by the area of work during the first compression (Bourne, 2002), ranged between (0.42- 0.60) in flaxseed gum and (0.66- 0.76) in okra gum which had higher values than cakes replaced with flaxseed gum but no significant differences were observed between samples with both replacers and their controls.

Gumminess was calculated as the product of hardness and cohesiveness, whereas chewiness is defined as the energy required masticating soiled food

Table 4: Texture profile analysis of cake made with flaxseed and okra gums as fat replacers

Parameters	Fat type	Level of replacement				
		Control	25%	50%	75%	100%
Hardness	Flaxseed	$4.71±0.00^{a}$	$2.65±0.00^{e}$	$2.01±0.00^{f}$	$3.33±0.00^{c}$	$3.68±0.00^{b}$
(Firmness)	Okra	$3.34±0.06^{c}$	$1.62±0.03^{g}$	$2.57±0.02^{e}$	$1.99±0.04^{f}$	$3.11±0.01^{d}$
Cohesiveness	Flaxseed	$0.48±0.00^{bc}$	$0.60±0.00^{ab}$	$0.45±0.00^{bc}$	$0.47±0.00^{bc}$	$0.42±0.00^{c}$
	Okra	$0.74±0.06^{a}$	$0.69±0.03^{a}$	$0.66±0.02^{a}$	$0.69±0.03^{a}$	$0.76±0.01^{a}$
Gumminess	Flaxseed	$2.26±0.00^{a}$	$1.59±0.00^{c}$	$0.91±0.00^{f}$	$1.55±0.00^{c}$	$1.56±0.00^{c}$
	Okra	$2.16±0.06^{a}$	$1.06±0.03^{e}$	$1.76±0.02^{b}$	$1.28±0.03^{d}$	$2.31±0.02^{a}$
Chewiness	Flaxseed	$1.41±0.00^{b}$	$1.11±0.00^{c}$	$0.55±0.00^{e}$	$0.87±0.00^{d}$	$0.97±0.00^{cd}$
	Okra	$1.48±0.06^{b}$	$0.86±0.03^{d}$	$1.36±0.02^{b}$	$1.03±0.05^{cd}$	$1.81±0.02^{a}$
Springiness	Flaxseed	$0.63±0.00^{bcd}$	$0.69±0.00^{abcd}$	$0.60±0.00^{cd}$	$0.56±0.00^{d}$	$0.62±0.00^{cd}$
	Okra	$0.77±0.06^{abc}$	$0.85±0.03^{a}$	$0.74±0.02^{abc}$	$0.78±0.04^{abc}$	$0.80±0.01^{ab}$
Resilience	Flaxseed	$0.39±0.00^{abc}$	$0.34±0.00^{abcd}$	$0.23±0.00^{cd}$	$0.20±0.00^{d}$	$0.37±0.00^{abcd}$
	Okra	$0.42±0.06^{ab}$	$0.52±0.03^{a}$	$0.29±0.02^{bcd}$	$0.37±0.04^{abcd}$	$0.48±0.01^{a}$

Means in a columns or rows not sharing the same superscript are significantly different at (P<0.05).

Table 5: Sensory characteristics of cake made with flaxseed and okra gums as fat replacers

Parameters	Fat type	Level of replacement				
		Control	25%	50%	75%	100%
Colour	Flaxseed	4.90±0.14[a]	4.71±0.18[ab]	4.43±0.20[abc]	3.57±0.30[bcd]	3.90±0.26[bcd]
	Okra	4.00±0.40[abcd]	4.14±0.34[abcd]	4.00±0.31[abcd]	4.14±0.34[abcd]	3.43±0.30[d]
Flavour	Flaxseed	4.71±0.18[a]	4.43±0.20[a]	4.30±0.30[a]	3.90±0.34[ab]	3.30±0.18[b]
	Okra	4.14±0.34[ab]	4.71±0.18[a]	3.90±0.40[ab]	4.14±0.26[ab]	3.30±0.18[b]
Texture	Flaxseed	4.71±0.18[a]	4.43±0.20[ab]	4.30±0.40[ab]	4.00±0.22[ab]	3.14±0.14[c]
	Okra	3.90±0.34[b]	4.57±0.20[ab]	4.00±0.22[ab]	4.14±0.14[ab]	2.90±0.26[c]
Over all acceptance	Flaxseed	4.90±0.14[a]	4.30±0.30[ab]	4.14±0.26[ab]	4.30±0.18[ab]	3.30±0.18[c]
	Okra	4.00±0.40[b]	4.57±0.20[ab]	4.14±0.26[ab]	4.30±0.18[ab]	3.14±0.26[c]

Means in a columns or rows not sharing the same superscript are significantly different at (P<0.05).

to a state of readiness for swallowing (Karaoglu & Kotancilar*,* 2009) was obtained from the product of hardness, cohesiveness and springiness. Gumminess and chewiness values in cakes replaced with flaxseed and okra gums exhibited a similar trend as the hardness values as shown in Table (4). Significant low gumminess and chewiness values were found in all cakes as the replacement level increased in both replacers.

Springiness was defined as the distance to which the sample recovered in height during the time that elapsed between the end of the first compression cycle and the start of the second compression cycle. Springiness of cakes with both gums was not significantly different from the control. Both levels of 75% flaxseed gum and 50% okra gum, exhibited an obvious lower values of springiness than the other levels of both gums and the controls. The resilience (elasticity) shows how well a product "fights to regain its original position ". It is calculated as the area during the withdrawal of the first compression, divided by the area of the first compression. The resilience (elasticity) shows the same trend where no significant differences were observed between the control cake and those containing both gums. As a matter of fact, the resilience at 75% and 50% levels of flaxseed and okra gums, respectively exhibited obvious lower values than the other levels of both gums and their controls.

These results may suggest that the gum replacers used in the present study coated the protein and starch granules thus preventing hydration and formation of a continuous gluten-starch network. Consequently, shortening replacement enhance the development of the crumb network, while the replacers may further contribute to this network through hydrogen bonds (Zahn *et al*, 2010). The results also indicate that both gums used in the present study achieved tender and elastic properties in the cakes even at higher levels.

Sensory analysis

Sensory evaluation of cake made with flaxseed and okra gums as a fat replacer are presented in Table (5). It can be observed that all samples produced containing both gums as fat replacers at all levels showed no significant ($P \leq 0.05$) differences in colour as compared to the control and were highly acceptable. As for the flavour, all cakes replaced with both gums exhibited no significant difference ($P \leq 0.05$) as compared to their controls and was highly acceptable up to 75% in flaxseed gum replaced cakes and up to 100% in okra gum replaced cakes. The texture of cakes up to 75% replacement levels with flaxseed and okra gums were evaluated as highly acceptable as compared to their controls. The overall acceptance of cakes at 100% replacement were significantly ($P \leq 0.05$) different from the control and the other replacement levels with both flaxseed and okra gums but were still highly acceptable by the panelists up to 75% replacement.

It can be concluded that flaxseed and okra gums could be used as a successful fat replacer in baked products especially cakes, thus allowing production of potentially healthier food items. Thus, it could be quite worthwhile for commercial applications of healthy food. The increase of fat replacement did not increase hardness of cakes, but improve their textural properties. However, 75% fat replacement with both flaxseed and okra gums resulted in cakes with highly acceptable texture and sensorial properties with lower caloric value.

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إنتاج وتقييم كيك منخفض الدهن يحتوى على صمغ بذور الكتان وصمغ الباميا كبديل للدهن

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تم استبدال الدهن فى تركيبة الكيك بصمغ كل من بذور الكتان وصمغ الباميا بنسب تراوحت من ٢٥٪ الي ١٠٠٪. وأوضحت نتائج الاختبارات الكيماوية حدوث زيادة معنوية فى المحتوى الرطوبى والكربوهيدرات الكلية وانخفاضا فى محتوى الدهن وعدم تأثر البروتين والرماد معنوياً مع زيادة نسب الاستبدال لكلا البديلين ، كما حدث انخفاض معنوىً فى قيم السعرات الحرارية مع زيادة نسب الاستبدال لكلا البديلين وكان ذلك واضحاً فى حالة الاستبدال ١٠٠٪ بصمغ بذور الكتان مقارنة بصمغ الباميا والتى كانت ٢١,١١ و ١٩,٣٣٪ على الترتيب . أوضحت الاختبارات الطبيعية للكيك حدوث انخفاض معنوىً فى الوزن والحجم و الارتفاع والحجم النوعى مع استبدال الدهن بكلا النوعين من الصمغ ، ولكن الخواص الطبيعية للكيك الناتج من الاستبدال بصمغ الباميا كانت أفضل من نظيره الناتج من الاستبدال بصمغ بذور الكتان . من ناحية أخرى أوضحت نتائج تحليل القوام أن كلا البديلين أضافا نعومة ومرونة للكيك عند نسب الإحلال المرتفعة(٧٥ و١٠٠٪) خاصة فى حالة الاستبدال بصمغ الباميا. وأوضحت نتائج التقييم الحسى أن لون ونكهة الكيك الناتج من استبدال الدهن بنسبة ١٠٠٪ صمغ الباميا كان اكثر قبولا فى حين أن القوام والتقبل العام ظلا مقبولين حتى نسبة ٧٥٪ استبدال ،بينما ظل الكيك الناتج من استبدال الدهن بـ٧٥٪ صمغ بذور الكتان مقبولاً . عامة كلا النوعين من الصمغ اثبتا نجاحاً كبديل للدهن فى انتاج كيك مقبول وذات نعومة وجودة عالية ويمكن استخدامهما كبديل للدهن فى انتاج أغذية صحية.