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CHEMICAL, RHEOLOGICAL AND SENSORY PROPERTIES OF WHEAT- OAT FLOUR COMPOSITE CAKES AND BISCUITS

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ABSTRACT

The effect of using Oat flour to improve the functional properties of cake and biscuit was explored. Oat flour in the cake and biscuit formulation was replaced at four levels, 25, 50, 75 and 100% with whole meal wheat flour(wmwf). Biscuit and cake containing only whole meal wheat flour was used as control. Raw materials, prepared cake and biscuits were analyzed for their proximate composition, baking quality of cake (weight, volume, specific volume) and biscuit (diameter, thickness, spread ratio, weight, volume, specific volume), color, texture, stalling and sensory evaluation. Rheological properties of mixed oat flour with whole meal wheat flour were studied.

Results revealed that, the chemical composition of oat flour and whole meal wheat flour resulted in a significant increase in fibre and ash contents and a decrease in protein and carbohydrate content compared to whole meal wheat flour. Farino graph parameters showed that water absorption, dough weakening and arrival time increased as Oat Flour level increased in the blends. While dough stability and mixing tolerance index were decreased by adding Oat flour to whole meal wheat flour at all levels replacement. The adding of Oat flour to Whole meal wheat flour led to increased of transmission temperature, temperature of peak viscosity and peak viscosity.

Cake weight produced from Whole meal wheat flour with oat flour were lower than compared to control, while, its volume and specific volume of cake produced from Whole meal wheat flour with oat flour was increased as the level of oat flour increased in cake. Cake produced from Whole meal wheat flour with oat flour at different levels (25, 50, 75 and 100%) caused a noticeable decrease in alkaline water retention capacity values compared with control at the same storage period. Results also showed that Hunter color parameters (L, a*andb*) of biscuits and cakes were lightness were increased as mixing level of oat flour*

increased. This result was confirmed with the obtained sensorial results. Moreover, sensory evaluation of biscuits and showed that all samples were acceptable, but sample which contained oat flour had superior sensory characteristics, nutritional value and was suitable for Diabetic and Obesity.

Key words: Oat flour, whole meal wheat flour, rheological properties, biscuit, cake**.**

INTRODUCTION

Cereals and their products constitute an important part of the human diet, providing a high proportion of carbohydrates, proteins, fats, dietary fibre, B-group vitamins and minerals. More and more foods are made from whole grain (Okarter *and Liu* 2010). Consumption of whole grain foods has been associated with decreased risk of cardiovascular disease and certain cancers, favourable effects on blood lipids and glucose, improved insulin resistance, and higher intakes of dietary fibre and micronutrients (McKeown *et al*., 2002). Among cereals, oat grains *(Avenal sativa)* are well known for their health benefits and have been used to produce functional foods. The health benefits of oat are related to its components including β-glucan, proteins, unsaturated fatty acids, vitamins, minerals and phytochemicals. Oat is a perfect source of soluble dietary fiber ß-glucan, a nonstarchy polysaccharide available in the cell walls of the aleurone layer in bran. The most important beneficial effects of ß-glucan are their contribution to a lowering of serum blood cholesterol as well as moderating blood glucose in diabetics (McMullen, 2000; Webster, 1996). However, the use of oats in baked products has been limited due to the inability of oat flour to form cohesive, viscoelastic dough that can retain gas, as that found in the gluten network of wheat dough. Addition of wheat gluten to oat flour improves the processing properties of the dough and the quality of the final product (Salmenkallio-Marttila *et al*., 2004; Flander *et al*., 2007). The addition of oat products to wheat flour affects water absorption and rheological properties of dough. Oat products incorporated into bread may decrease its volume; however, they improve the structure of crumb together with taste, aroma and nutritive value of the final product Oats are an excellent food for lowering cholesterol and reducing risk of heart disease because of the high soluble fiber content. Almost one third of total fatty acids present in oats are polyunsaturated which are required for good health. Oats are rich in B vitamins, minerals and contain the antioxidant avenathramide. Oat bran is

rich in ß-glucan, and these viscous polysaccharides lower the rate of carbohydrate and lipid absorption. Oats are a good choice for diabetics and people conscious about their weight. Phenol compounds in oats are bioavailable and have anti-inflammatory, antiatherogenic, and antioxidant properties (Lifschitz *et al*., 2002; Bratt *et al.* 2003; Dykes *and Rooney*. 2007). In this sense, the purposes of the present study consisted in evaluating the use of oat flour as innovative functional food ingredient in bakery products (biscuit and cake) and study the effect of oat flour and their chemical constituents on the rheological, baking quality and sensory properties, of the final product.

MATERIALS AND METHODS

Materials:

Whole meal wheat flour, oats flour, yoghurt, eggs, skim milk powder, sucralose, baking powder, salt, and vanilla were purchased from local markets, Cairo, Egypt.

Methods:

- **Chemical composition:**

Moisture, ash, crude protein, fat and crude fiber contents were determined in raw materials and samples (cakes and biscuits) according to the methods outlined in A.O.A.C. (2000). Carbohydrates were calculated by difference as mentioned as follows:

Carbohydrates = 100 – (% protein + % fat + % ash + % crude fiber).

- **Rheological properties of dough:**

a. Pasting properties of flours:

The viscoelastic properties of the prepared wholemeal, oat and their blends flours as show in Table (1) were examined using a amylograph test according to the method described in AACC (2000).

b. Farinograph parameters of dough:

Farinograph parameters of dough were carried out according to A.A.C.C (2000).

Table (1): Mixture of blends from whole meal wheat flour and oats

Ingredients (gm)	Control	1	2	3	4
Whole wheat	100	75	50	25	--
Oat flour	--	25	50	75	100

Preparation and evaluation of sponge cakes:

Sponge cakes were prepared according to Bennion and Bamford. (1997) with some modifications as follows: (Table 2) Whole meal wheat flour (100 g) and baking powder (3 g) were mixed together; whole fresh eggs (125 g) and sugar (100 g) were whipped for 6 min using a mixer at high speed, then vanilla and butter were added. Flour mixture was added gradually on mixture and beaten for 3 min using the mixer at low speed. Cake were poured in baking pan, then placed in a preheated oven and baked at 180°C for 35 min. Cakes were allowed to cool for 60 min in the pans at room temperature. Low calorie cakes were prepared using Yogurt, sucralose and eggs were whipped at medium speed using a kitchen mixer (Moulinex, Model HM1010, Beijing china) for 7 min then vanilla was added. In a medium bowl, whisk together whole meal wheat flour, baking powder and salt. In a separate bowl, whisk together yoghurt, Sucralose, eggs and vanilla were mixed well with wheat flour and passed through a stainless steel screen and then added to the mixture. Sample of cake was placed into rectangular metallic pans and baked at 180°C in an electric oven for 35 min. Cakes were removed from the pans and left at room temperature for one hour. The cakes were then sealed in polyethylene bags to be prevented from becoming dry.

Preparation and evaluation of biscuit:

The biscuits were prepared by mixing 100 g whole meal wheat flour and their blends containing 25, 50, 75 and 100% oat flour. Biscuit formula was as follows: 100g flour, 35 g sucrose, 28 g shortening, 0.93 g salt, 1.11 g sodium bicarbonate and 1 g vanellia.

Biscuit preparation:

Fat and sugar were mixed until fluffy. Whole eggs and powdered milk were added while mixing and then mixed for a total of about 30 min. Vanilla, baking powder and salt were mixed thoroughly and added to the cream mixture where they were all mixed together to form a dough. The dough was rolled and cut into shapes of 5 cm diameter. Baking was carried out at 185ºC for 20 min. Biscuit samples were cooled and stored in polyethylene bags until needed.

Table (2): Formulations of sponge cake and their ingredient after replacing oat, yoghurt and sucralose

Ingredients (gm)	Control	1	2	3	4
Whole wheat flour	100	75	50	25	--
Oat flour	--	25	50	75	100
Ground Sugar	75	-	-	-	-
Yoghurt	-	50	50	50	50
Butter	10	-	-	-	-
Baking powder	3	3	3	3	3
Eggs	125	125	125	125	125
vanilla	1	1	1	1	1
Sucralose	-	5	5	5	5
Salt	0.5	0.5	0.5	0.5	0.5

Table (3): The recipe formulation of biscuit

Ingredients (gm)	Control	1	2	3	4
Whole wheat floor	100	75	50	25	--
Oat flour	--	25	50	75	100
Skimmed milk powder	5	5	5	5	5
Shortening	10	10	10	10	10
Sucrose	30	-	-	-	-
Baking powder	3	3	3	3	3
Eggs	27.5	27.5	27.5	27.5	27.5
vanilla flavor (ml)	1	1	1	1	1
Sugar replacer	5	5	5	5	5
Salt	0.5	0.5	0.5	0.5	0.5

Color determinations:

The color values of cake and biscuits samples were measured. Hunter a*, b* and L* parameters were measured with a color difference meter using a spectro- colourimeter (Tristimulus Colour Machine) with the CIE lab color scale (Hunter, Lab Scan XE - Reston VA, USA) in the reflection mode. The instrument was standardized each time with white tile of Hunter

Lab Colour Standard (LX No.16379): X= 72.26, Y= 81.94 and Z= 88.14 (L*= 92.46; a*= -0.86; b*= -0.16) (Sapers, and Douglas, 1987).

The Hue (H)*and Chroma (C)* were calculated according to the method of (Palou, et al., 1999) as follows:

- H* = tan-1 [b*/a*] (1)
- C* = square root of [a^2* + b^2*] 0.5 (2)

Baking Quality of Cakes and biscuits:

Volume (cm3) and weight (gm) of three cake and biscuit samples of each treatment were recorded. Specific volume (gm/ cm3) was calculated by dividing of the volume to weight according to the method described in A.A.C.C. (2000).

Sensory evaluation of cake and biscuit:

Cake samples were assessed by 15 panelists using a sensory rating scale of 1 (poor) to 9 (excellent) for some sensory parameters (color, taste, odor, texture, appearance and overall acceptability).

The subjective evaluation of biscuit was carried out for the external sensory characteristics. Biscuits were evaluated for color, appearance, flavor, taste, crispiness, and overall acceptability. Judgments were made through rating products on a 9 point Hedonic Scale with corresponding descriptive terms ranging from 9 “like extremely” to 1 “dislike extremely”, according to the method described by Meilgaard *et al*., (2007) to find out the most suitable treatment for cookies production.

Freshness of cakes

Freshness of cakes was tested after wrapping in polyethylene bags and storage at room temperature for 1, 3 and 5 days. It was determined using Alkaline Water Retention Capacity test (AWRC) according to the method of Yamazaki (1953), modified by Kitterman and Rubenthaler (1971).

Statistical analysis

The obtained results were evaluated statistically using the analysis of variance as reported by McClave and Benson (1991).

RESULTS AND DISCUSSION

Chemical composition of raw materials:

The results of chemical analysis of investigated raw materials used in the work are shown in Table (4). Protein content of raw materials were

Table (4): Chemical composition of raw material

Composition	Whole wheat flour	Oat flour	Skim milk powder	LSD at 0.05
Moisture	12.92[a]	10.74[b]	3.15[c]	0.794
Protein	14.66[b]	13.87[b]	29.33[a]	1.139
Fat	2.88[b]	6.85[a]	1.04[c]	0.369
Fiber	3.59[b]	11.13[a]	ND	1.071
Ash	1.58[b]	1.69[b]	4.28[a]	0.120
Carbohydrates	77.29[a]	66.46[b]	65.35[b]	2.135

significantly different and showed very wide range being 13.87% for oat flour and reached 29.33% for skim milk powder. With respect to fat content all samples were low in their fat content except oat flour (6.85%), followed by Whole meal wheat flour (2.88%). The lowest fat percentage was found in the skim milk powder (1.04%). Remarkable high ash content was noticed for all samples. The highest ash percentage was found in the skim milk powder (4.28%) followed by oat flour (1.69%). Among the tested raw materials, oat flour showed the highest crude fiber content (11.13%), while skim milk powder showed the lowest content (-). Data in the same Table proved that carbohydrate content reached the maximum for Whole meal wheat flour (77.29%) and the minimum for skim milk powder (65.35%). Such findings were also obtained by Pedo *et al*., (1999); Czubaszek and Karolini-Skaradziñska. (2005); Salehifar and Shahedi (2007) ; Nazni *et al*., (2010); Majzoobi *et al.* (2012) and El Shebini *et al*.,(2013 & 2014).

Farinograph characteristics of wheat flour-oat flour dough

Data presented in (Table 5) show the effect of adding Oat Flour at four levels (25, 50, 75 and 100%) to Whole meal Wheat Flour on the rheological properties of dough as evaluated by a farinograph. As shown in table 5, water absorption increased as Oat Flour level increased. This increase is due to the high fiber content of Oat Flour. Fiber is characterized by its high water holding capacity as reported by Hussein *et al*., (2010). Kawka and Gąsiorowski (1995) demonstrated that water absorption of a wheat-and oat mixture increased with the increasing share of oat bran. This product showed a higher water binding ability than wheat flour, as it contains more non-cellulose polysaccharides (β-glucans and pentozanes). Also, Duchoňová *et al*. (2013) pointed out that water

Table (5): Farinograph parameters of blends from whole meal wheat flour and oats

Samples	Water absorption (%)	Arrival time (min)	Dough development time(min)	Dough stability (min)	Mixing tolerance index(BU)	Dough weakening (BU)
Control	67.5	1.0	6.0	14	60	100
1	69.7	1.5	4.5	10	50	110
2	72.0	2.0	3.0	5	40	120
3	74.3	2.5	2.5	2	30	140
4	76.5	3.0	3.0	2	20	160

Where:Control, 1, 2, 3, 4 see Table **2**

absorption increased as Oat Flour level increased in dough. In this study, as the oat level in the flour increased, the time needed for the preparation of a good dough was decreased, due to a weaker formation of gluten matrix. Since pentosans and ß-glucans benefit from high water binding capacities, their presence in the oat flour caused slightly higher water absorption capacities, for doughs made of oat as part of the formula, in comparison with control. This decrease in dough development increased and sustained levels of high-fat bran by removing fat, according to research results Sudha *et al*. (2007) and Peymanpour *et al*.,(2012). On the other hand, dough weakening and arrival time were increased, while dough stability and mixing tolerance index were decreased by adding Oat Flour to wheat flour at all levels replacement. These results are in harmony with those obtained by Oomah (1983), D'Appolonia (1984), Lee *et al*. (1995) and Zhang *et al*. (1998).

Amylograph characteristics of wheat flour-oat flour dough:

The pasting properties of Whole meal wheat flour and their blends with Oat Flour at 25, 50, 75 and 100% levels are summarized in (Table 6). The adding of Oat Flour to Whole meal wheat flour led to increased of transmission temperature, Temperature of peak viscosity and peak viscosity. The peak viscosity indicates the water holding capacity of starch (BU). It can be affected by the molecular structure of amylopectin (Shibanuma *et al*., 1996), starch water concentration, lipids, residual proteins (Whistler *and Bemiller*. 1997), granule size (Fortuna *et al*., 2000), and instrument operating conditions (Bateyand Curtin 2000). Pasting properties of starch

Table (6): Amylograph parameters of blends from wholemeal wheat flour and oats

Samples	Transmission Temperature (°C)	Temperature of peak viscosity (°C)	Peak viscosity (BU)
Control	57	69	380
1	54	78	1700
2	60	85.5	1080
3	54	75	660
4	60	90	3280

Where:control, 1, 2, 3, 4 see Table 2

are affected by amylose and lipid contents and by branch chainlength distribution of amylopectin. Amylopectin contributes to swelling of starch granules and pasting, whereas amylose and lipids inhibit the swelling (Tester and Morrison, 1997). Furthermore, the amylopectin chain-length and amylose molecular size produce synergistic effects on the viscosity of starch pastes (Jane *and Chen* 1992).

Baking quality of cakes

The physical characteristics of the produced cakes are presented in(Table 7). Cake volume and specific volume produced from Whole meal wheat flour with oat flour were higher in volume than of the control. This effect may be due to high fiber content in oat flour. Fiber is characterized by their high water holding capacity. From the same table, specific volume of cake produced from Whole meal wheat flour with oat flour had higher values compared with that of control samples. On the other hand, the volume and specific volume of cake produced from Whole meal wheat flour with oat flour increased as the level addition of oat flour increased in cake compared to those of the control.

Table (7): Physical properties and baking quality of cake

Samples	Weight (g)	Volume (cm^3)	Specific volume (cm^3/g)
Control	235	640	2.72
1	221	720	3.26
2	205	832	4.06
3	217	800	3.69
4	208	688	3.31

Color Attributes of Cakes

Color is one of the most important sensory attribute that affect directly the consumer preference of any product. Special attention should be given to bakery products to attract the consumer attention. The color parameters of cake samples were evaluated using a Hunter laboratory colorimeter. The effects of oat flour addition on the browning degree during baking are evident from (Table 8). The increase of a* and b* corresponds to the increase in redness and yellowness, respectively, which occurs in the beginning of nonenzymic browning. Products with more intensive green and blue color notes are formed only later, as a result of secondary reactions. Table 8 showed that cake products from whole meal wheat flour and oats were whiter than control cakes, where lightness (L*), redness (a*) and yellowness (b*) that of cakes produced from whole meal wheat flour and oats increased compared to the control cakes. Such findings are inagreement with Kim *et al*. (1997), Kordonowy and Young (1985) Ramy *et al.*, (2002) and Hussein *et al*.(2016).

Table (8): Color values of cake

Cake samples	Crust			Crumb		
	L	a	b	L	a	b
Control	33.35	16.14	20.14	52.07	8.10	33.41
1	36.95	17.24	25.75	55.46	7.20	30.45
2	31.55	15.63	19.97	46.62	10.03	31.88
3	39.69	18.36	30.13	54.94	8.03	34.97
4	42.89	16.23	30.88	47.94	7.12	29.13

Organoleptic Properties of Cake

The organoleptic properties of cakes produced from Whole meal wheat flour and its supplemented mixtures with oat flour at different levels (25, 50, 75 and 100%) were evaluated for color, taste, flavour, texture, appearance and overall acceptability in (Table 9). A significant difference in color, taste, flavour, texture, appearance and overall acceptability was observed in all cake samples containing oat flour when compared with control cake sample. Cakes prepared with oat flour at 100% level showed significantly lower sensory scores than those prepared with 25% or 50% levels. No significant differences at $P < 0.05$ were noted with cake contained 50% oat flour and between the controls for taste, texture and appearance.

Oat flour seem to be a promising functional ingredient with a great potential to be used as emulsifiers in different food products including dairy, beverages, baking, sweets, or in products for feeding, which require a prolonged emulsion stability.

Table (9): Organoleptic characteristics of cake

Samples	Parameters					
	Color (9)	Flavor (9)	Taste (9)	Texture (9)	General Appearance (9)	Overall acceptability (9)
Control	7.11 b	8.51 a	7.25 b	7.05d	7.15 c	7.44 c
1	8.42 a	8.60 a	8.26 a	8.15 b	8.25 b	8.36 b
2	8.61 a	8.11 b	8.55 a	8.68 a	8.73 a	8.82 a
3	8.72 a	7.50 c	8.14 a b	7.75 c	8.41 a	8.13 b
4	8.85 a	6.85d	7.36 b	7.35 c	7.21 c	7.16 c
LSD at 5%	**0.641**	**0.447**	**0.415**	**0.382**	**0.422**	**0.418**

Chemical composition of cakes

Data presented in (Table 10) showed the chemical composition of cakes produced from whole meal wheat and oats flour and control cake. Cake produced with oat flours it were characterized with their higher content of moisture, ash, fiber and total carbohydrate and their lower content in protein compared with control. Generally, oats flours seem to be a natural source of protein, elements, rich in dietary fiber which have an antioxidant activity with low glycaemic index, and thermally stable during food processing. Therefore, oats flours could be presented as a functional safe ingredient in the food industry. These results are in agreements with those obtained by Pedo *et al*., (1999); Czubaszek and Karolini-Skaradziñska (2005); Nazni and Pradheepa (2010); Salehifar and Shahedi (2007).

Freshness of Cake

The effect of storage period at room temperature on freshness of cake was evaluated in (Table 11). The cake sample producing from oat flour at level (100%) had the highest values of alkaline water retention capacity which were declined during 0, 24, 48 and 72 hrs of storage to 315, 385, 241 and 231%, respectively. However, cake produced from Whole meal wheat flour with oat flour at different levels (25, 50, 75 and 100%) caused a noticeable decrease in alkaline water retention capacity values at the same storage period. Such effect might be related to the difference in quantitative distribution of protein fractions and physicochemical properties of starch of oat flour.

Table (10): Chemical composition of cake on (dry basis)

Samples	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	Carbohydrate (%)
Control	25.96^{d} ±1.34	1.33^{b} ±0.02	16.09^{a} ±0.95	8.79^{b} ±0.21	1.28^{e} ±0.09	66.14^{a} ±2.15
1	$27.52^{c,d}$ ±0.70	1.34^{b} ±0.04	15.99^{a} ±0.82	$9.12^{a,b}$ ±0.35	1.95^{d} ±0.12	66.79^{a} ±2.66
2	29.17^{c} ±0.24	1.34^{b} ±0.04	15.89^{a} ±0.78	9.47^{a} ±0.25	2.62^{c} ±0.13	67.43^{a} ±2.21
3	32.66^{b} ±0.56	1.35^{b} ±0.03	15.79^{a} ±0.95	9.80^{a} ±0.27	3.28^{b} ±0.15	68.06^{a} ±1.56
4	34.89^{a} ±0.56	1.36^{a} ±0.03	15.69^{a} ±0.88	10.13^{a} ±0.31	3.94^{a} ±0.18	68.70^{a} ±2.25
LSD at 0.05	1.9924	0.031	1.032	1.098	0.452	3.254

Table (11): Effect of oat flour on the rate of decrease of cake samples during storage period

Samples	Storage time (hrs.)						
	AWRC at zero Time	**AWRC After 24hrs.**	**R.D% After 24hrs.**	**AWRC After 48hrs.**	**R.D% After 48hrs.**	**AWRC After 72hrs.**	**R.D% After 72hrs.**
Control	315	285	9.52	241	23.49	231	26.67
25%	329	306	6.99	289	12.16	258	21.58
50%	334	315	5.69	308	7.78	271	18.86
75%	345	322	6.67	316	8.41	282	18.26
100%	357	337	5.60	325	8.96	295	17.37

Baking quality of biscuits

The effect of replacing whole meal wheat flour with oat flour on the baking quality of biscuits is shown in (Table 12). Biscuit thickness is significantly increased with increasing mixing level of oat flour ($p < 0.05$), while the volume showed a significant increase upon addition of oat flour generally. This effect may be due to the higher fiber content in oat flour as well

as the emulsifying properties as reported by Ballesteros *et al*. (2014) and El-Shebini *et al*.(2014). Meanwhile, diameter and spread ratio were increased significantly compared to the control as affected with oat flour. Also, this result agreed with El-Shebini *et al*. (2013) who stated that the addition of doum fruit flour to wheat flour led to increase the volume of biscuit.

Table (12): Effect of replacing whole meal wheat flour with oats flour on baking quality of biscuit

Samples	Weight (g)	Volume (cm^3)	Specific volume (v\w)	Diameter (cm)	Thickness (cm)	Spread ratio
Control	11.2	19.50	1.74	6.40	0.64	10.00
1	11.3	22.50	1.99	6.70	0.66	10.15
2	11.01	23.50	2.13	6.85	0.67	10.22
3	11.00	24.50	2.23	7.12	0.71	10.03
4	11.05	25.50	2.31	7.25	0.76	9.54

Color attributes of biscuits

Color is one of the most important sensory attribute that affect directly the consumer preference of any product. Special attention should be given to bakery products to attract the consumer attention. The color parameters (L*, a*and b*) of biscuit samples were evaluated and presented in Table 13. Scale range of whiteness (L*) is from 0 black to 100 white; a* scale extends from a negative value (green hue) to a positive value (red hue) and b* scale from negative blue to positive yellow. Oat flour were darker than whole meal wheat flour and mixture from whole meal wheat biscuits with Oat flour where lightness (L*) and yellowness (b*) decreased but redness (a*) increased as rate of Oat flour used in mixture increased. All formulas caused a noticeable darker color for the crust of biscuits (L* and b* values were decreased) and the redness (a values) of crust were increased as a result of Oat flour addition compared to control sample (100% whole meal wheat flour).

Table (13): Effect of mixing whole meal wheat flour with oats flour on color values of biscuits

Biscuit samples	L	A	B
Control	67.59	5.55	33.26
1	65.85	6.30	34.53
2	67.13	5.62	32.54
3	65.77	5.45	30.42
4	63.57	8.27	32.32

Sensory evaluation

The effects of adding oat flour to with whole meal wheat flour on the sensory properties of biscuits were evaluated and presented in Table (14). The obtained results indicated that, increasing oat flour in biscuit led to decrease the sensory scores of color, texture, odor, taste, appearance and overall acceptability.

The mean sensory scores of control and mixed biscuits with oat flour are shown in Table (14). Significant differences ($P < 0.05$) in color were observed between control and supplemented samples, whereas increasing of oat flour decreased significantly the color score due to their dark nature.

Table (14): Effect of mixing whole meal wheat flour with oats flour on organoleptic characteristics of biscuit

Samples	Parameters					
	Color (7)	**Crispness (7)**	**Taste (7)**	**Texture (7)**	**Aroma (7)**	**Overall acceptability (7)**
Control	6.13 ^{a}	5.30 ^{c}	5.25 ^{b}	5.05 ^{c}	6.15 ^{a}	5.44 ^{b}
1	5.22 ^{b}	5.60 ^{b}	5.55 ^{b}	5.17 ^{c}	5.85 ^{a}	5.66 ^{b}
2	6.12 ^{a}	5.61 ^{b}	5.95 ^{a}	5.69 ^{b}	5.73 ^{b}	5.82 ^{b}
3	6.15 ^{a}	5.82 ^{b}	6.14 ^{a}	5.75 ^{b}	5.41 ^{b}	6.13 ^{a}
4	5.17 ^{b}	6.15 ^{a}	6.36 ^{a}	6.35 ^{a}	5.21 ^{c}	6.46 ^{a}
LSD at 5%	**0.359**	**0.317**	**0.435**	**0.346**	**0.398**	**0.438**

Proximate composition of biscuits

Proximate composition of biscuits of different mixing level with oat flour (25, 50,75 and 100%) were presented in Table (15).The results of the proximate chemical analysis indicated that, biscuit from 100% whole meal wheat flour containing 1.56% ash, 17.22 % crude protein, 13.54% fat, 3.15% fiber and 64.53% carbohydrate. The results of chemical composition of biscuit are in agreement with those obtained by Hussein *et al*.,(2010), and El-Shibiny *et al*.,(2014).

Therefore, increasing mixing level of oat flour with whole meal wheat flour led to decrease the nutritional value of biscuits where protein, fat, ash, fiber and carbohydrate ranged between (16.94 -16.21%), (14.32-16.73%), (1.59- 1.65%), (4.94- 9.64%) and (62.21-55.96%), for biscuits, respectively. It was possible to observe also that the biscuits of mixed oat flour with whole meal wheat flour showed some similarity with those found by- El-Shibiny *et al*.,(2014).

Table (15): Chemical composition of biscuit .

Samples	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	Carbohydrat (%)
Control	3.12^{b} ±0.03	1.56^{b}±0.02	17.22^{a}±0.90	13.54^{b}±0.41	3.15^{e}±0.05	64.53^{a}±2.17
1	3.26^{b} ±0.02	1.59^{b}±0.01	16.94^{a}±0.72	14.32^{b}±0.35	4.94^{d}±0.06	62.21^{a}±2.52
2	3.33^{b} ±0.03	1.61^{a}±0.02	16.69^{a}±0.75	14.47^{b}±0.35	6.42^{c}±0.07	60.54^{b}±1.91
3	3.61^{a} ±0.03	1.65^{a}±0.02	16.45^{a}±0.85	15.90^{a}±0.42	8.03^{b}±0.07	57.97^{b}±1.76
4	3.85^{a} ±0.03	1.64^{a}±0.03	16.21^{a}±0.77	16.73^{a}±0.37	9.64^{a}±0.07	55.96^{c}±1.95
LSD at 0.05	0.341	0.041	1.141	0.934	0.511	2.742

CONCLUSION

From the obtained results, it could be concluded that oat flour could be used with whole meal wheat flour to prepare cake and biscuit characterized with its good sensorial properties,decrease the nutritional value, in addition to their positive effect on the rheological characteristics and suitable for diabetic and obesity.

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الخصائص الكيميائية والريولوجية والحسية للكيك والبسكويت المصنع من خليط القمح والشوفان

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تم دراسة تأثير استخدام دقيق الشوفان في تحسين الخصائص الوظيفية للكيك والبسكويت حيث تم استبدال طحين القمح الكامل بدقيق الشوفان على أربعة مستويات ٢٥، ٥٠، ٧٥ و ١٠٠٪ واستخدامه في صناعة الكيك والبسكويت. تم استخدام طحين القمح الكامل في صناعة البسكويت والكيك كعينة مقارنة (كنترول). تم دراسة التركيب الكيماوي للمواد الخام والكيك والبسكويت المصنع ، وكذلك الخصائص الريولوجية للخلطات المختلفة من طحين القمح الكامل ودقيق الشوفان وجودة الخبيز في الكيك (الحجم ، الوزن والحجم النوعي) والبسكويت (القطر، السمك، معدل الفرد، الوزن ، الحجم، والوزن النوعي) واللون والقوام والتقييم الحسي والبيات.

أوضحت نتائج التحليل الكيماوي للمواد الخام المستخدمة في صناعة الكيك والبسكويت أن دقيق الشوفان تميز بارتفاع محتواه من الألياف والرماد والدهن بينما تميزطحين القمح الكامل بارتفاع محتواه من البروتين والكربوهيدرات والرطوبة. دلت قراءات الفارينوجراف زيادة نسبة امتصاص الماء وزمن الوصول ودرجة الضعف فى حين قل زمن تطور العجينة وزمن الثبات ومعدل الصمود بزيادة نسبة الشوفان في الخلطة مستويات الاستبدال. اوضحت قراءات الاميلوجراف زيادة في درجة حرارة التحول ودرجة حرارة الجلتنة واللزوجة القصوي بزيادة نسبة دقيق الشوفان في الخلطة.

اوضحت نتائج جودة الخبيز في الكيك انخفاض الوزن وزيادة الحجم والوزن النوعي بينما في البسكويت انخفاض الوزن وزيادة الحجم والوزن النوعي والقطر والسمك ومعدل الفرد بزيادة نسبة دقيق الشوفان في الخلطة. أدت إضافة دقيق الشوفان إلى دقيق القمح الكامل الي تحسين في قيم اللون واطالة فترة الصلاحية وانخفاض في معدل ظاهرة البيات.

أظهرت نتائج التقييم الحسي للبسكويت والكيك إلى أن جميع العينات مقبولة، ولكن العينة التي تحتوي على دقيق الشوفان فقط لها خصائص حسية متفوقة وقيمة غذائية عالية ومناسبة لمرضى السمنة والسكر.

التوصية: