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EFFECT OF MECHANICALLY EXTRACTED SESAME CAKE SUPPLEMENTATION ON THE BIOCHEMICAL AND QUALITY CHARACTERISTICS OF BISCUITS

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Abstract:

Sesame (Sesamum indicum, L.) is considered as one of economically important crop over the entire world and it is the main oil seed crop cultivated in Saudi Arabia. The aim of this study was to evaluate the nutritional quality and consumer acceptability of composite biscuits produced from blends of wheat (Triticum aestivum) and sesame cake flour (SCF). Three composite flour blends were formulated according to the following percent ratios, 100:0 wheat flour (negative control), 80: 20%, 70:30% and 60:40% wheat flour and SCF respectively to produce composite biscuit. The physicochemical and sensory attributes of the composite biscuit samples were investigated using standard methods and a ten member trained panelists on a 10-point Hedonic scale: where 10 = extremely liked the characteristics of the biscuit. The results of the study showed that substitution of wheat with sesame flour up to 30%, significantly (p<0.05) improved the physical properties of the biscuit with reduction in spread ratio from 9.33 to 8.21 cm. In addition, the protein, crude fat, fiber, ash of the composite biscuit showed increases while the carbohydrate and moisture contents exhibited decreases in content. The mineral elements content of the composite biscuit increased significantly (p<0.05) with increased sesame flour substitution. Whole wheat bread (control) was most preferred for all the organoleptic attributes evaluated followed by the 80:20% composite biscuit whereas the 60:40% biscuit exhibiting the least preference. Therefore, SCF (20%) supplementation with wheat flour biscuit has the ability to improve the physicochemical, sensory characteristics and micronutrient contents of the composite biscuits.

Keywords: *Biscuit, mechanical extraction, Sesame cake flour, Sensory characteristics*

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INTRODUCTION:

The increasing of the consumer demand for food product quality with taste, safety, convenience and nutrition lead to increasing the competition in the market to getting the natural, healthy and functional products, one of this products these products isbiscuits [1]. Efforts are being made to improve the biscuits nutritive value and functionality by modifying their composition. Increased mineral contents and protein for quality and availability is often achieved by increasing the ratio of wheat grain with different supplementations [2]. Biscuits have become one of the most appropriate snacks for elderly and young due to many reasons such as, low price, more convenient and ability to serve as a vehicle for important micronutrients [3-4]. Biscuits are rich in fats, carbohydrates, but low in vitamin fiber, and minerals which make it unhealthy food for routine use [5]. Sesame seeds are considered rich source multiple micronutrients such as; copper, manganese, calcium, phosphorus, iron, zinc, vitamins, [6-7]. Sesame seeds also contain lignans (sesame and sesamolin) with cholesterol lowering effect, and thus can prevent high blood pressure [8-10]. Therefore, the present study has been carried out to produce biscuit supplemented with SCF and to evaluate their chemical composition, physical properties and sensory characteristics, for the possible alternate functional food in Saudi Arabia.

MATERIALS AND METHODS:

Materials.

Wheat flour (72% extraction rate) and baking ingredients were obtained from local markets. Sesame seeds were cultivated in Jizan, Saudi Arabia. Chemicals and reagents were analytical grade.

Mechanical extraction of sesame cake flour

This work is performed at the Food Technology Research Institute, Agricultural Research Center, Cairo, Egypt. Defatted sesame seed flour was produced using the method of Chinma et al., [11]. One kilogram of seeds was manually sorted to remove stones, metals and other extraneous materials such as dust and fine plant residues followed by winnowing. Thereafter, the winnowed seeds were washed with clean tap water, drained and sun dried in a single layer on stainless steel trays, placed on elevated platforms for 6 hours. The sesame seeds were toasted using oven at 60ºC for 12 hr. The sesame seeds were then dry milled into flour using (MLW, type: SKI 100, Watt, West Germany) mill. The dry sesame flour was finally put in the mechanical extraction unit (Fred`s Carver Inc., Model 2759, USA) and after complete oil extraction, sieved through a 0.5 mm mesh screen and packed into clean plastic containers until needed for further use.

Preparation of biscuit.

Biscuit was prepared according to the method illustrated by Omobuwajo [12]. Basic dough formula consisted of 100g wheat flour, defatted sesame flour (sesame flour added at level 20, 30 and 40% as partial substitution for wheat flour based on preliminary trials), 30 g fat (milk butter), 32 g sucrose, 2g full fat powdered milk, 0.50 g salt (NaCl), 0.40g sodium bicarbonate, 0.20g vanilla and various proportions of water to make required consistency of dough. The biscuits were baked at 170-180°C for 20 min. The biscuits were allowed to cool, subjected to organoleptic, physical and chemical evaluations.

Proximate analysis of ingredients and biscuit samples.

The moisture, fats, crude protein, fiber and ash contents of the biscuits blends were determined by the method of AOAC [13]. Total carbohydrate was determined according to: Carbohydrate = 100% - (% protein + % moisture + % ash + % fat + % crude fiber). Minerals content was estimated by atomic absorption spectrophotometer (model 3300, Perkin-Elimer, Beaconsfield, UK) and the digestion was performed according to the procedure outlined by A.O.A.C. [14].

Determination of amino acids composition.

Amino acids composition of SCF was determined by using amino acid analyzer (Biochrom 30) according to the method outlined in AOAC [13]. The sample weighed and digested with 25 ml of 6N HCl at 110°C for 24 h. One ml of the solution was filtered through 0.45 μm. Amino acids were expressed as g/100 g protein on dry weight basis.

Physical properties of biscuit

Biscuit samples were evaluated for diameter (cm), thickness (cm) and spread ratio as described by Gaines [15]. Six biscuits edge-to-edge were used for the evaluation and the average was noted. Diameter and thickness were measured using a Vernier Caliper. Spread ratio was calculated by dividing diameter by thickness.

Sensory evaluation of biscuit.

Sensory analysis of fresh produced biscuit samples was carried out by panelists from Food Technology Research Institute, Cairo, Egypt (10 persons; 6 females and 4 male) according to the method of Sudha et al. [16]. Six parameters were examined *i.e.*, appearance, color, odor, texture, taste and overall acceptability. The panelists were provided with biscuits on a white plate.

Statistical Analysis

For analysis data, mean values and standard deviation are reported. The data obtained were subjected to one-way analysis of variance (ANOVA) at *P*<0.05.

RESULTS AND DISCUSSION:

The chemical composition of wheat flour and sesame cake flour are given in (Table 1). In general, (SCF) contain high levels of protein, ash, crude fiber and fat content as compared to wheat flour. The moisture, protein, fat and carbohydrates contents of sesame were 6.79%, 21.81%, 49.55% and 10.94% respectively. This result of moisture is higher than the finding by Zebib et al., [17] and Akinoso [18], who had reported moisture content of 3.75 and 4.81% for sesame respectively. While protein was reported higher values of 34.41 and 26.79% and Anilakumar et al., [19] had reported the lower protein value of 18.3% for sesame. This variation in protein for sesame could be due to variety, storage condition, growing climate of sesame. The fat content of sesame was 49.55%. Nevertheless, Akinoso [18], and Zebib et al., [17] had reported fat levels of 47.73, 47.37 and 43.3%, respectively. The carbohydrates content was 10.94%. This result is slightly higher than the finding by Akinoso [18] who reported 9.65% carbohydrates.

Table 1: Chemical composition of wheat flour and SCF

Types of raw materials	Moisture content (%)	Fat content (%)	Ash content (%)	Protein content (%)	Fiber content (%)	Carbohydrate content (%)
Wheat flour	11.90±0.10^a	1.01±0.064^c	0.60±0.02^b	10.75±0.09^b	0.72±0.17^b	5.00±0.23^a
SCF	6.79±0.36^b	49.55±0.48^b	2.37±0.02^a	21.81±0.53^a	8.52±0.13^a	10.94±1.18^b

Values are mean ±SD of triplicate independent analysis.

Table 2: Mineral contents of wheat flour and SCF produced by mechanical extraction

Types of raw materials	Minerals (mg/100g)					
	Mg	Zn	Ca	Fe	P	K
Wheat flour	130.18±3.04^c	2.07±0.27^b	35.48± 0.81^c	3.08± 0.28^b	321.95±3.86^b	362.24±4.67^c
SCF	351.71±0.20^a	5.31±0.35^a	129.42±1.14^b	2.73± 0.11^b	213.52±3.39^c	868.71±2.17^a

Values are mean ±SD of triplicate independent analysis.

Values in the same column carrying different superscribe litter are significant different at (P<0.05).

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SCF had high concentration of calcium, magnesium, Zinc, Iron, phosphorus and potassium (Table 2) There is significant differences (P<0.05) in minerals between different raw materials (wheat flour and sesame flour). The total minerals were higher in SCF than in wheat. SCF mineral contents were 351.71, 5.31, 129.42, 2.73, 213.52 and 868.71 mg/100g for Mg, Zn, Ca, Fe, P and K respectively. This result is similar to the finding of Adeola et al., [20]. They reported that magnesium, zinc and phosphorus content of sesame was 342.78, 5.23 and 352.68 mg/100g, respectively. However, they reported higher value for calcium (1111.61 mg/100g) and potassium (476.64mg/100g) but lower value of iron (8.33mg/100g).

The results in Fig. 1 show that, the amino acids contents in SCF extracted by mechanical method for essential amino acids; isoleucine, leucine, lysine, methionine, cysteine, phenylalanine, tyrosine, threonine, valine and tryptophan were 73.64, 125.26, 63.31, 47.56, 154.24, 126.61, 116.88, 69.09, 77.75, and 172.23 mg/g dry weight respectively. The amino acids percentage in SCF extracted by mechanical was lower because of not complete the removing of oil from seeds after finishing the extraction process.

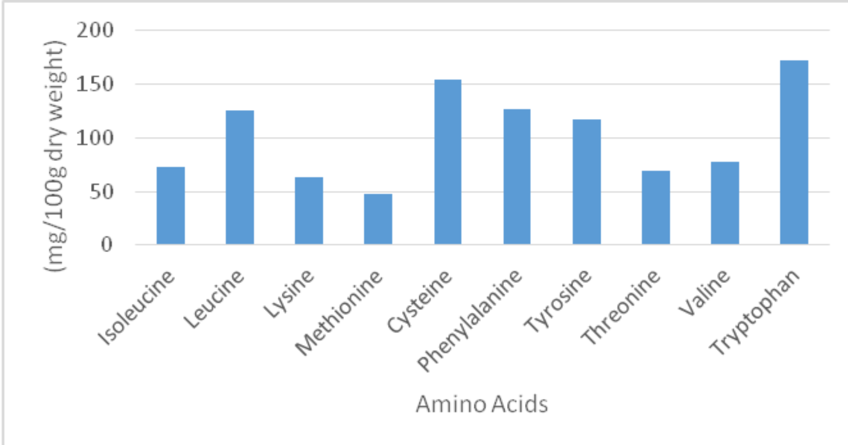

Fig. 1: Essential amino acids contents of SCF produced by mechanical extraction

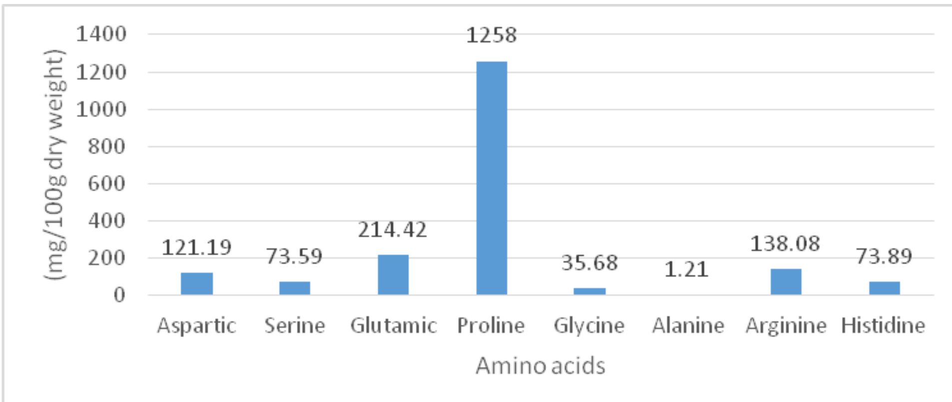

Fig. 2: Non-essential amino acids content of SCF produced by mechanical extraction

The data in Fig.2 indicate the non-essential amino acid proline reached to the maximum value 1258 mg/100 g dry weight for the sesame cake mechanically extracted followed by non- significant difference the amino acid glutamic 214.42 and then with significantly decreased in arginine, aspartic, serine, histidine, glycine and alanine, which represented by 138, 121.19, 73.89, 73.59, 35.68 and 1.21 respectively. The results of our study was agreement with the results of the previous study by Ramachandran et al., [21] who reported that, the sesame cake is rich with high contents of some of amino acids as methionine, tryptophan, cysteine, lysine, phenylalanine, arginine and glycine. On the other hands, Namiki [22] reported the protein in sesame seeds has low amino acids contents especially lysine which represent by 21 mg/g protein and high in methionine, cysteine, arginine and leucine represented by 36, 25, 140 and 75 mg/g protein respectively. And this maybe back to the types of soil, varieties, fertilization factors, types of seeds and extraction methods.

Chemical composition of biscuit.

The chemical composition of different biscuit samples substituted with defatted sesame cake extracted by mechanical method at levels 20, 30 and 40% are given in Table 3. It was observed that protein, fiber, fat and ash contents increased by increasing the substitution level of sesame flour extracted with mechanical method compared to control sample, this may be attributed to high protein, fiber and fat content in sesame seeds. On the other hands, carbohydrates content was significantly decreasing by increasing the substitution levels. Furthermore, the results indicated that 40% sesame cake had the highest content of protein, fats, fiber and ash (14.71, 21.95, 9.91 and 3.48 g/100 g dry weight respectively) relative to other biscuit samples. The study of the chemical composition of biscuit back to the importance of the fortification with different levels of sesame flour to increase the nutritional values of the final product [23]. These results are in agreement with Gandhi and Srivastava, [24] who reported that the fortification of bread with 10%, 15%, 20% and 25% with sesame cake lead to increase in protein, fiber, fats and ash content, however, other studies reported, low value of substitution with sesame cake lead to non-significant increase in the chemical composition of the final product [25].

Table 3: Effect of fortification with different ratio of SCF produced by mechanical extraction on chemical composition of biscuit

	Control	SCF Substitution level		
		20%	30%	40%
Moisture	3.70±0.180	3.05±0.050	2.81±0.200	2.69±0.130
Protein*	7.46±0.110	10.82±0.060	12.69±0.250	14.71±0.140
Fats*	15.85±0.120	19.69±0.310	20.01±0.150	21.95±0.220
Carbohydrates*	73.41±0.229	61.90±0.075	56.14±0.160	49.95±0.165
Fiber*	1.94±0.110	5.31±0.260	8.23±0.400	9.91±0.410
Ash*	1.35±0.08	2.28±0.080	2.93±0.160	3.48±0.250

Table 4: Effect of fortification with different ratio of SCF produced by mechanical extraction on mineral contents of biscuit

Minerals (mg/100g)	Control (wheat flour 72%)	SCF Substitution level		
		20%	30%	40%
Ca	18.11 ± 0.76^{c}	63.27 ± 0.53^{b}	78.11 ± 1.67^{a}	107.80 ± 1.59^{ab}
P	213.03 ± 3.74^{cd}	237.69 ± 1.61^{b}	253.06 ± 2.81^{ab}	265.12 ± 0.58^{b}
Mg	82.50 ± 3.34^{d}	115.31 ± 3.15^{c}	128.70 ± 2.13^{b}	138.19 ± 1.65^{a}
Fe	1.00 ± 0.05^{bc}	1.44 ± 0.15^{b}	2.52 ± 0.41^{a}	2.95 ± 0.06^{bc}
Zn	0.69 ± 0.076^{c}	1.43 ± 0.16^{b}	2.26 ± 0.18^{a}	2.88 ± 0.22^{a}
K	197.5 ± 0.97^{d}	217.66 ± 3.51^{cd}	251.02 ± 0.58^{b}	353.4 ± 24.7^{a}

Table 5: Effect of fortification with different substitution of SCF produced by mechanical extraction on the physical characteristics of biscuit

	Weight (gm)	Thickness (T) (cm)	Diameter (D) (cm)	Spread ratio (D/T)	Volume (cm^3)	Relative volume (cm^3/gm)	Relative weight (gm/cm^3)
Control	11.75±0.340	0.86±0.080	5.50±0.130	6.39±0.02	19.0±0.400	1.62±0.041	0.62±0.016
20%	9.23±0.110	0.60±0.015	5.60±0.120	9.33±0.09	13.8±0.100	1.50±0.007	0.67±0.003
30%	10.88±0.340	0.67±0.022	5.65±0.150	8.43±0.12	15.8±0.150	1.45±0.032	0.69±0.015
40%	9.10±0.200	0.70±0.020	5.75±0.130	8.21±0.41	12.0±0.050	1.32±0.024	0.76±0.014

The data indicated in Table 4 show increasing contents of calcium, iron and zinc by increasing levels of fortification with sesame cake. Calcium was significantly increased from 0.872 to 0.1295 mg/100 g dry weight with increasing the fortification from 20% to 40% of sesame cake. While, iron and zinc were lower than calcium in their contents, the iron changed from 0.0083 to 0.0158 and zinc from 0.0011 to 0.0042 mg/100 g dry weight of 20% and 40% substitution respectively. These results were agreements with results of Elleuch et al., [26] who reported that increasing of some elements in the sesame cake after extraction and this lead to increasing in mineral contents of the biscuit after fortification. The proximate composition of sesame seeds indicates that it has significant amounts of proteins that can be used to produce composite flour with improved protein content for biscuits production [27, 28].

Physical properties of biscuit.

Table (5) shows the physical properties of biscuit samples at different blends of SCF. The results indicated that diameter and thickness of biscuit were slightly increased with increasing substitution percentage of SCF compared with control biscuit. The results agree with work done by Hussain et al., [29] who found that diameter and thickness of flaxseed cookies showed gradually increase as the level of flaxseed flour substitution. Moreover, the results of spread ratio of biscuit revealed a reduction in spread ratio from 9.33 to 8.21 cm. It is clear that as the sesame cake flour level increased, spread ratio for different treated biscuits gradually decreased. These results are on the line with the findings of Ganorkar and Jain [30] who found that the reduction in spread ratio might be due to increase in dietary fiber and protein.

Organoleptic characteristics.

Sensory characteristics of sesame cake substitution at different levels; appearance, color, odor, taste, texture and overall acceptability of produced biscuit was studied (Table 6). The results showed that as the sesame cake ratio increased, all of sensory attributes scores decreased and the color of biscuits become darker compared with control. Furthermore, biscuits containing 25% SCF showed maximum sensory scores compared to other samples and non-significantly difference with control biscuit. However, 40% substitution, the product becomes less acceptable to the consumer. The results were similar with the results obtained by Moraes et al., [31] who found that acceptance of flaxseed, as a dietary ingredient of functional food in cakes, revealed consumer acceptance up to 30% supplementation level.

Table 6: Effect of fortification with different substitution of SCF produced by mechanical extraction on sensory evaluation of biscuit

	Appearance (10)	Color (10)	Internal Texture (5)	Particle distribution (5)	Taste (10)	Odor (10)	Overall Acceptability (50)
Control	9.75 ± 0.42^{a}	9.50 ± 0.55^{a}	4.83 ± 0.4^{a}	4.88 ± 0.45^{a}	9.83 ± 0.40^{a}	9.83 ± 0.40^{a}	48.91 ± 0.66^{a}
20%	9.66 ± 0.52^{a}	9.66±0.82a	4.50 ± 0.83^{a}	4.67 ± 4.152^{a}	9.50 ± 0.54^{ab}	9.66 ± 0.52^{a}	47.83 ± 2.60^{a}
30%	8.66 ± 0.82^{b}	9.00 ± 0.10^{ab}	4.16 ± 0.98^{b}	4.13 ± 4.190^{b}	8.50 ± 0.54^{bc}	8.66 ± 0.52^{abc}	43.00 ± 1.41^{b}
40%	8.33 ± 1.03^{bc}	8.50 ± 0.55^{b}	3.00 ± 0.80^{b}	3.20 ± 4.021^{c}	6.83 ± 0.40^{d}	8.00±1.09bc	39.66 ± 2.25^{cd}

Texture is the important factor of biscuit quality because effects on the consumer acceptance and the color of the fortified biscuits attained more dark color as the flaxseed and sesame supplementation was increased [32]. However, the texture was slightly decreased with supplementation but described no undesirable change. The overall quality of the biscuits was significantly reduced by addition of sesame cake flour compared with wheat biscuits, this back to sesame is un-pleasure after taste, nutty flavor, rough surface, dark brownish color, less crisp and gritty mouth feel, making them to score low in sensory evaluation [32]. Similarly, organoleptically acceptable cookies can be prepared by supplementing 20% flax in foods as an ingredient [33]. Furthermore, it was observed that biscuits containing 20 and 30% of sesame meals recorded higher scores in most sensory characteristics compared to the control sample Masoodi and Bashir [34]. Also, sesame seeds can be used to improve the nutritive value of bakery products as well as for improving sensory properties [35].

CONCLUSION:

Based on our results, it could be concluded that SCF can be combined in biscuit as a partial substitution up to 40 % of wheat flour without change in its physical and sensory qualities. Substitution with SCF at 20% recorded the highest score in all sensory attributes relative to other sesame flour biscuit samples.

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