



## EFFECT OF ADDITION OF FULL FAT AND DEFATTED FLAXSEED FLOUR ON THE QUALITY OF PAN BREAD

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**ABSTRACT:** Full flaxseed flour (FFF) and Defatted flaxseed flour (DFF) are rich sources of some valuable biochemical compounds such as phenolics, flavonoids and dietary fiber. Effect of FFF and DFF at different addition levels (5, 10 and 15%) on the flour characteristics, dough rheological properties, bread chemical composition, physical and sensory characteristics of pan bread were investigated. The results of Mixolab analysis showed that flour water absorption and dough stability were decreased as FFF or DFF addition levels increased. Fortification of wheat flour with FFF and/or DFF up to 15% increased the crude protein from 12.05 to 14.47%, crude fiber from 0.37 to 1.38% and ash from 3.64 to 5.54% while, caloric values of the obtained bread were decreased. The results also showed that wheat flour could be fortified with FFF or DFF up to 10% for preparing high quality pan bread without any changes in its physical and sensory characteristics.

**Key word:** Full fat flaxseed, defatted flaxseed, fortification, pan bread, sensory evaluation.

### INTRODUCTION

Flaxseed or linseed (*Linum usitatissimum* L.) has been used in many foods and medicinal products for long times. It has been used in various forms such as flour, oil and seeds. Flaxseed and flaxseed oil are considered as healthy due to their contents of various bioactive compounds (El-Demery *et al.* 2015). It is cultivated in more than 50 countries; however, Canada is the main flax producer, followed by China, United States and India. Utilization of flaxseed in food and in food products has been increasing due to its high content of essential omega-3 fatty acid, alpha-linolenic acid, dietary fiber and natural phenolic antioxidants (Kasote, 2013).

Flaxseed is classified as a functional food because of its high fiber (27.3/100 g), protein (18.3/100 g), potassium (813 mg/100 g), linolenic acid (22.8/100 g) and lignan contents (6.1 to 13.3 mg/g) (Johnson *et al.*, 2000). It has a unique fatty acid profile. It is high in polyunsaturated fatty acids (73% of the total

fatty acids), moderate in monounsaturated fatty acids (18%) and low in saturated fatty acids (9%). Linoleic acid, and omega-6 fatty acid, constitutes about 16.

Per cent of total fatty acids, whereas  $\alpha$ -linolenic acid (ALA) constitutes about 57% the highest of any oil seeds (Thompson *et al.*, 1995; Kaur *et al.*, 2013). Furthermore, flaxseed contains substantial amounts of phenols (mainly p-coumaric, vanillic, sinapic and ferulic, which are present as glycosides with ester and ether bonds) and flavonoids such as flavone C- and flavone O-glycosides of flavones and tannins (Kajla *et al.*, 2014; Seczyk *et al.*, 2017).

Bread is one of the most widely consumed as human meal in the world. Bread making technologically is one of the oldest technology known (Selomulyo and Zhou, 2007). It is an important staple food in a majority of countries which basically made of hard and/or soft wheat flour, yeast, fat, sugar, salt and water (Badifu *et al.*, 2005). Bread is the cereal product that is naturally low in protein and nutritionally not a balance diet because it is low content of the

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essential amino acid lysine (Gimai *et al.*, 2003; Agu *et al.*, 2010). Bread nutritional value improvement using whole grains or other seeds has become popular due to its positive health effects. Recently, functional foods are gaining importance as they render benefits beyond their nutrition and energy values in promoting health and preventing certain chronic diseases, cancer, diabetes, autoimmune disorders, arthritis, and arrhythmia (Shahidi, 2002). A growing interest was observed in the use of flaxseed as functional ingredients in food industry to improve the quality of various cereal-based products such as bread, pasta, muffins, bagels, cookies and cakes (Kajla *et al.*, 2014; Mercier *et al.*, 2014).

This study aimed to evaluate the effect of addition full flaxseed flour (FFF) and defatted flaxseed flour (DFF) on the nutritional, functional and sensory characteristics of pan bread.

## MATERIALS AND METHODS

### Materials

Flaxseed (*Linum usitatissimum* L.) was obtained from Agricultural Research Center, Giza, Egypt. Wheat flour (72% extraction) and other components were purchased from local market, Zagazig City, Sharkia Governorate, Egypt.

#### Preparation of flaxseed flour

The cleaning of flaxseed was performed manually to remove damaged seeds, dust particles, seeds of other grains/crops and other impurities such as metals and weeds. Then, seeds were powdered using a laboratory mill (Moulinex, France). The full fat flaxseed flour (FFF) was sieved through a 60 mesh screen until fine powder was obtained and kept at 4°C in polyethylene bags until used.

#### Preparation defatted flaxseed flour

Defatted flaxseed flour was prepared according to the method used by Siddiq *et al.* (2009). Briefly, an exactly weighed amount of flaxseed flour or ground flaxseed was placed in a conical flask, and *n*-hexan was added in the ratio of 10:1 (solvent: flour). The mixture was stirred for 16 hr., then filtered by filter paper. More *n*-hexan was added to wash fat traces, and the mixture was filtered using filter paper again.

The defatted flaxseed flour (DFF) was dried in open air at room temperature (about 26°C). Full fat flaxseed (FFF) or DFF were stored in airtight plastic containers and were kept in a refrigerator until used.

#### Wheat-flaxseed flour blends

Wheat flour (72% extraction), with a moisture content of 13.26 g/100 g, was used for preparing wheat-flaxseed flour blends. FFF or DFF was added to wheat flour at levels 5, 10 and 15 g/100 g. Each treatment, containing both types of flours, was mixed thoroughly by sieving 3 times to achieve uniformity in distribution of flour particles. Wheat-flaxseed flour blends were stored at 4°C in polyethylene bags until used for bread making.

#### Dough rheological properties

Dough rheological was performed using Mixolab device (Chopin, tripette Renaud, Paris, France) according to the method of AACC (2002a). Sample of 50 grams was placed into the Mixolab bowl and mixed. After tempering the solids, the water required for optimum consistency was added. Special attention was carried to the determination of the water absorption; in order to ensure the complete hydration of all the components (Bonet and Rosell, 2006). The running parameters of the Mixolab device during the tests are: mixing rate 80 rpm, temperature of the first plateau 30°C, duration of the first plateau 8 min., temperature of the second plateau 90°C, first temperature gradient 4°C/min, duration of the second plateau 7 min, second temperature gradient 4°C/min, temperature of the third plateau 5°C and duration of third plateau 5min as described by Simona *et al.* (2013).

#### Pan bread preparation

The straight dough method for pan bread making was carried out according to the method described by AACC (2002b) with different ratio of ingredients as follows: The ingredients consisted of wheat flour (500g), water according to require, dry yeast (20g), salt (20g), sugar (50g), and corn oil (60ml). After fermentation dough was placed in greased baking pans and baked at 220°C in the baking oven for 20 min., Baked loaves were cooled to room temperature

and stored overnight in polyethylene bags before quality evaluation.

#### Determination of bread volume, specific volume and density

Bread volume was determined using the method of rapeseed displacement (AACC, 2000). The average weight (g) of pan bread was determined individually within one hour after baking by using a 2-decimal digital weighing scale. Bread specific volume (ml/g) and density (g/cm<sup>3</sup>) were calculated according to the methods of AACC (2002b) and Shogren *et al.* (2003), respectively using the following equations:

Specific volume (ml/g) = volume (cm<sup>3</sup>) / weight (g)

Density (g/cm<sup>3</sup>) = loaf weight / loaf volume

#### Weight loss

The dough and the baked loaf bread were weighed and per cent weight loss calculated as shown in the following equation below:

Weight loss (%) = Weight of dough - weight of bread loaf / Weight of dough

#### Colour Measurement

Colour attribute (L\*, a\* and b\*) of bread samples was performed using Hunter lab colour analyzer (Hunter lab colour Flex EZ, USA) according to Roa *et al.* (2011). The colour intensity (C), hue angle (hab) and total colour difference ΔE were calculated in comparison to untreated (control) sample: where hab 0°C for red hue and hab = 90°C for yellow hue. The results were calculated using the following equations:

$$C^* = (a^{*2} + b^{*2})^{0.5}$$

$$\text{hab} = \tan^{-1} (b^*/a^*)$$

$$\text{WI} = 100 - [(100 - L^*)^2 + a^{*2} + b^{*2}]^{0.5}$$

$$\Delta E = [(L - L_0)^2 + (a - a_0)^2 + (b - b_0)^2]^{0.5}$$

Where L<sub>0</sub>, a<sub>0</sub> and b<sub>0</sub> were the L, a, and b values of the control sample

#### Chemical analyses and calories value of pan bread

Moisture, crude fat, total fiber, ash and crude protein contents were determined according to

the methods described in AOAC (2008). Total carbohydrate was calculated by difference.

Total caloric content was determined according to Lawrence (1965) by using the following equation:

$$\text{Total caloric (Kcal/100g)} = (\text{protein content} \times 4) + (\text{fat content} \times 9) + (\text{carbohydrate content} \times 4).$$

Determination of total phenolic compounds was determined according to Singleton *et al.* (1999) and Dewanto *et al.* (2002).

#### Sensory Evaluation

The staff members of the Food Science Department, Zagazig University, were asked to evaluate the prepared pan bread samples. Panelists were asked to rate each sensory attribute of the pan bread (Aroma, taste, crust colour, crumb colour, crumb texture and over all acceptability) using 9-point hedonic scale according to the following scoring system; 1 extremely dislike, 5 neither like nor dislike, and 9, extremely like (Hooda and Jood, 2005).

#### Statistical Analysis

All the data of the present study were subjected to analysis of variance (ANOVA) using SAS Software (SAS, 1990). Difference between means were calculated by the least significant difference (LSD) at p < 0.05. All measurements were carried out in triplicate.

## RESULTS AND DISCUSSION

#### Flour Characteristics

Mixolab device was used to describe dough behavior during mixing and heating in a single test, simulating the mixing and baking processes. The Mixolab parameters are dough consistency during mixing (C1), mixing stability, protein weakening as a function of mechanical work and temperature (C2), starch gelatinization (C3), amylase activity and hot gel stability (C4) and starch retrogradation in the cooling phase (C5). Mixolab characteristics of wheat flour and wheat flour containing different levels of full fat flaxseed flour (FFF) and defatted flaxseed flour (DFF) are presented in Table 1. Water absorption and dough stability were decreased with addition of wheat flour by FFF and DFF. C1 and C2 values were slightly

**Table 1. Mixolab measurement properties of flour fortification with full fat flaxseed flour and defatted flaxseed flour**

Mixolab parameter Sample	Flour moisture (%)	Water absorption (%)	Dough stability (min)	C1 (Nm)	C2 (Nm)	C3 (Nm)	C4 (Nm)	C5 (Nm)
Control (Flour 72%)	13.26	59.00	10.18	1.06	0.531	1.907	1.796	3.295
Bread with FFF 5%	12.96	55.90	10.33	1.056	0.515	1.724	1.747	3.201
Bread with FFF 10%	12.60	52.90	10.00	1.079	0.489	1.568	1.618	3.005
Bread with FFF 15%	12.25	52.00	9.08	1.144	0.47	1.48	1.497	2.817
Bread with DFF 5%	13.14	56.90	10.08	1.128	0.541	1.768	1.765	3.194
Bread with DFF 10%	12.91	57.80	9.50	1.119	0.525	1.704	1.584	2.889
Bread with DFF 15%	12.59	58.00	9.38	1.089	0.505	1.667	1.519	2.637

affected by fortification flour with FFF and DFF. Mixolab C1 and C2 values are related to gluten quality; higher values indicate weaker gluten properties (Koksel *et al.*, 2009). It was found that C1 values in bread samples fortified with FFF and DFF were higher than that in the control sample. C3 and C4 values were decreased by addition of FFF and DFF. Decreased viscosity peak (C3) with less starch components addition. These results are in line with those found by Hadnadev (2011) who found lower viscosity peak with lower starch content.

### Physical Characteristics of Pan Bread

Physical characteristics (volume, weight and specific volume) of pan bread were affected by FFF and DFF addition (Table 2). In general, loaf volume and specific volume were decreased in all samples compared to the control (2725 cm<sup>3</sup> and 3.13, respectively) except for specific volume of 5% FFF, it was increased. Similar effect was observed with bread density while, the decrease in specific volume may be due to the lower gluten content in the flaxseed bread. Lower specific volume values of bread with the addition or partial replacement of wheat flour with non-glutinous flour may be due to the lower gluten in the additives which gives less active gluten network and gas trapping and that might be strongly related to higher bread hardness reported in a previous section of bread texture (Dervas *et al.*, 1999; Doxastakis *et al.*, 2002).

### Bread Colour

Colour analysis of processed food is an important field, always related strongly to market and consumers acceptability as it controls the first impression of any food product (Yoo *et al.*, 2006). Table 3 shows colour values of crumb and crust of control and flaxseed bread samples. It was found that the control bread was lighter in colour than bread of FFF or DFF, where L value was the highest in both crust and crumb samples (51.36 and 73.05, respectively). These results are in coincidence and confirmed with that obtained by Sariconban and Imaz (2010); Abou-Zaid *et al.*, (2012). Regarding the crumb colour, increasing the percentage of FFF and DFF to wheat flours decreased L\*, b\* and WI values and increased a\* values compared with the control. Subjective evaluation confirmed that the FFF and DFF bread samples were darker, more red (a-values) than control samples. These results are in agreement with those obtained by Ahamed (1999) and Kenny *et al.* (2000).

### Chemical Composition of Full Fat and Defatted Flaxseed Flour

Proximate composition: protein, crude fiber, crude fat, ash, carbohydrate and moisture of full flaxseed and defatted flaxseed flour are shown in Table 4. It is clear that the defatted flaxseed flour had higher moisture, crude protein, ash, and crude fiber contents (6.77, 28.63 6.95 and 8.8%, respectively) compared to full fat flaxseed flour. It means that the utilization of full fat flaxseed flour and defatted flaxseed flour in some bakery products increase their content of fiber.

**Table 2. Effect of addition full flaxseed flour and defatted flaxseed flour on physical properties of pan bread**

Sample	Parameter	Loaf weight before	Loaf weight after	Weight loss(g)	Loaf volume(g/cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )	Specific volume (cm <sup>3</sup> /g)
Control		904.04 <sup>g</sup>	871.71 <sup>f</sup>	32.33g	2725 <sup>a</sup>	0.32 <sup>d</sup>	3.13 <sup>b</sup>
Bread with 5% FFF		936.68 <sup>f</sup>	841.61 <sup>g</sup>	95.07 <sup>a</sup>	2685 <sup>c</sup>	0.31 <sup>d</sup>	3.19 <sup>a</sup>
Bread with 10% FFF		943.53 <sup>d</sup>	890.59 <sup>e</sup>	52.94 <sup>b</sup>	2380 <sup>d</sup>	0.37 <sup>c</sup>	2.67 <sup>d</sup>
Bread with 15% FFF		977.16 <sup>b</sup>	925.40 <sup>b</sup>	51.71 <sup>c</sup>	2230 <sup>g</sup>	0.41 <sup>b</sup>	2.41 <sup>f</sup>
Bread with 5% DFF		940.44 <sup>e</sup>	890.96 <sup>d</sup>	49.48 <sup>f</sup>	2695 <sup>b</sup>	0.33 <sup>d</sup>	3.02 <sup>c</sup>
Bread with 10% DFF		962.39 <sup>c</sup>	912.18 <sup>c</sup>	50.21 <sup>e</sup>	2285 <sup>e</sup>	0.40 <sup>b</sup>	2.50 <sup>e</sup>
Bread with 15% DFF		1008.77 <sup>a</sup>	958.13 <sup>a</sup>	50.66 <sup>d</sup>	2245 <sup>f</sup>	0.43 <sup>a</sup>	2.34 <sup>g</sup>

The same letters in the column means insignificant differences.

**Table 3. Effect of fortification FFF or DFF on colour characteristics of pan bread crust and crumb samples**

Sample	Colour parameter	L*	a*	b*	C*	h <sub>ab</sub>	WI	Differences ΔE
<b>Crust samples</b>								
Control		51.36 <sup>a</sup>	10.94 <sup>c</sup>	22.33 <sup>a</sup>	24.87 <sup>a</sup>	88.74 <sup>a</sup>	45.37 <sup>a</sup>	0.00 <sup>g</sup>
Bread with FFF 5%		34.11 <sup>e</sup>	11.83 <sup>a</sup>	15.03 <sup>d</sup>	19.13 <sup>c</sup>	88.18 <sup>f</sup>	31.39 <sup>f</sup>	18.75 <sup>c</sup>
Bread with FFF 10%		32.62 <sup>g</sup>	10.93 <sup>d</sup>	13.64 <sup>g</sup>	17.48 <sup>f</sup>	88.12 <sup>g</sup>	30.39 <sup>g</sup>	20.66 <sup>a</sup>
Bread with FFF 15%		34.02 <sup>f</sup>	10.32 <sup>e</sup>	13.91 <sup>f</sup>	17.32 <sup>g</sup>	88.20 <sup>e</sup>	31.78 <sup>e</sup>	19.29 <sup>b</sup>
Bread with DFF 5%		36.91 <sup>b</sup>	10.97 <sup>b</sup>	16.08 <sup>b</sup>	19.47 <sup>b</sup>	88.31 <sup>b</sup>	33.98 <sup>b</sup>	15.74 <sup>f</sup>
Bread with DFF 10%		35.77 <sup>d</sup>	10.23 <sup>g</sup>	15.68 <sup>c</sup>	18.72 <sup>d</sup>	88.27 <sup>d</sup>	33.10 <sup>d</sup>	16.96 <sup>e</sup>
Bread with DFF 15%		35.82 <sup>c</sup>	10.25 <sup>f</sup>	14.81 <sup>e</sup>	18.01 <sup>e</sup>	88.28 <sup>c</sup>	33.34 <sup>c</sup>	17.28 <sup>d</sup>
<b>Crumb samples</b>								
Control		73.05 <sup>a</sup>	0.89 <sup>f</sup>	17.02 <sup>a</sup>	17.04 <sup>a</sup>	89.16 <sup>a</sup>	68.11 <sup>a</sup>	0.00 <sup>g</sup>
Bread with FFF 5%		64.37 <sup>b</sup>	0.38 <sup>g</sup>	15.45 <sup>b</sup>	15.45 <sup>b</sup>	89.06 <sup>c</sup>	61.16 <sup>c</sup>	8.84 <sup>f</sup>
Bread with FFF 10%		55.7 <sup>f</sup>	1.58 <sup>d</sup>	15.22 <sup>c</sup>	15.30 <sup>c</sup>	88.92 <sup>e</sup>	53.13 <sup>f</sup>	17.46 <sup>b</sup>
Bread with FFF 15%		57.12 <sup>d</sup>	2.13 <sup>b</sup>	13.26 <sup>e</sup>	13.43 <sup>e</sup>	88.96 <sup>d</sup>	55.07 <sup>d</sup>	16.41 <sup>d</sup>
Bread with DFF 5%		63.97 <sup>c</sup>	1.12 <sup>e</sup>	4.74 <sup>g</sup>	4.87 <sup>g</sup>	89.10 <sup>b</sup>	63.64 <sup>b</sup>	15.27 <sup>e</sup>
Bread with DFF 10%		56.84 <sup>e</sup>	1.97 <sup>c</sup>	14.46 <sup>d</sup>	14.59 <sup>d</sup>	88.95 <sup>d</sup>	54.44 <sup>e</sup>	16.45 <sup>c</sup>
Bread with DFF 15%		54.66 <sup>g</sup>	3.08 <sup>a</sup>	12.91 <sup>f</sup>	13.27 <sup>f</sup>	88.91 <sup>e</sup>	52.76 <sup>g</sup>	18.97 <sup>a</sup>

The same letters in the column means insignificant differences.

**Table 4. Chemical composition of full flaxseed flour and defatted flaxseed flour**

Analysis	Moisture	Protein	Fat	Ash	Total fiber	Carbohydrate
FFF	3.96 <sup>b</sup>	26.23 <sup>b</sup>	48.38 <sup>a</sup>	5.82 <sup>b</sup>	8.5 <sup>b</sup>	5.55 <sup>b</sup>
DFF	6.77 <sup>a</sup>	28.63 <sup>a</sup>	0.24 <sup>b</sup>	6.95 <sup>a</sup>	8.8 <sup>a</sup>	8.58 <sup>a</sup>

#### **Chemical composition of pan bread fortified with full fat flaxseed or defatted flaxseed flour**

It could be also noticed that the utilization of FFF and DFF in pan bread decreased gradually, its content of carbohydrates and caloric value as the level of addition was increased (Table 5). The highest caloric value and carbohydrate content were found in control bread (304.62 and 49.30%, respectively) while, the lowest were found in bread fortified with 15% DFF (269.15 and 34.75%, respectively). Protein content was ranged between 12.05 in control bread to 14.47% in bread of 15% FFF. The increase in protein, ash and fiber contents in pan bread samples were due to their higher contents in FFF and DFF than in flour. The decrease in carbohydrates and caloric value in pan bread samples were due to the highest fiber contents in FFF and DFF. These results are in agreement with those obtained by **Hussain *et al.* (2012)** who had reported significant improvement in the proximate composition (ash, crude protein, fat and crude fiber) of full fat flaxseed flour supplemented whole wheat flour.

#### **Sensory Evaluation**

Sensory evaluation is considered to be one of the limiting factors for consumer acceptability. The results of sensory evaluation of control and flaxseed bread samples are shown in Table 6. It was noticed that bread sample fortified with 5%

FFF had the highest sensory scores in taste, crust colour, aroma and overall acceptability being 8.67, 8.45, 8.62 and 8.66, respectively. Therefore, addition of FFF and DFF enhanced most of sensory attributes of pan bread and were acceptable until level of 10%. Similar results were found by **Pourabedin *et al.* (2017)** who reported that crust colour was evaluated as the best for the bread with 10% flaxseed and no significant differences were found for the crumb colour of 10%, 20%, and control samples. Also, **Kaur *et al.* (2013)** stated that flaxseed can be used to improve the nutritive value of bakery products as well as for improving sensory properties.

#### **Conclusion**

This study demonstrated the effect of full fat and defatted flaxseed flour on the physico-chemical and sensorial quality of pan bread. From the obtained results it can be concluded that water absorption and dough stability were decreased while the protein and dietary fiber contents of the bread samples were increased with fortification wheat flour with FFF and DFF. As the flaxseed addition level increased the caloric values of the obtained bread were decreased. Bread sample fortified with 5% FFF had the best sensory scores in taste, crust colour, aroma and overall acceptability. Fortification of pan bread with flaxseed flour can be accepted up to 10% without change in its sensory quality.

**Table 5. Proximate analysis and caloric value of pan bread containing substituted flour with different levels of full flaxseed flour or defatted flaxseed flour**

Sample	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Fiber (%)	Carbohydrate (%)	Caloric value (K.cal./100g)
control	34.64 <sup>f</sup>	3.64 <sup>g</sup>	6.58 <sup>g</sup>	12.05 <sup>g</sup>	0.37 <sup>g</sup>	49.30 <sup>a</sup>	304.62 <sup>a</sup>
Bread with full flaxseed flour (5%)	36.16 <sup>d</sup>	4.19 <sup>e</sup>	10.16 <sup>c</sup>	12.19 <sup>f</sup>	0.58 <sup>f</sup>	36.72 <sup>c</sup>	287.08 <sup>d</sup>
Bread with full flaxseed flour (10%)	35.50 <sup>e</sup>	4.28 <sup>d</sup>	10.68 <sup>b</sup>	12.40 <sup>e</sup>	0.91 <sup>e</sup>	36.05 <sup>d</sup>	289.92 <sup>c</sup>
Bread with full flaxseed flour (15%)	33.67 <sup>g</sup>	5.54 <sup>a</sup>	11.19 <sup>a</sup>	13.45 <sup>c</sup>	1.26 <sup>c</sup>	34.89 <sup>f</sup>	294.07 <sup>b</sup>
Bread with defatted flaxseed flour (5%)	36.74 <sup>a</sup>	3.81 <sup>f</sup>	8.37 <sup>d</sup>	12.58 <sup>d</sup>	0.98 <sup>d</sup>	37.52 <sup>b</sup>	275.73 <sup>e</sup>
Bread with defatted flaxseed flour (10%)	36.56 <sup>b</sup>	4.57 <sup>e</sup>	8.37 <sup>dd</sup>	13.76 <sup>b</sup>	1.31 <sup>b</sup>	35.43 <sup>e</sup>	272.09 <sup>f</sup>
Bread with defatted flaxseed flour (15%)	36.53 <sup>c</sup>	4.84 <sup>b</sup>	8.03 <sup>f</sup>	14.47 <sup>a</sup>	1.38 <sup>a</sup>	34.75 <sup>g</sup>	269.15 <sup>g</sup>
LSD	0.0175	0.0175	0.0175	0.0175	1.2850	0.0166	0.0175

Total carbohydrate is obtained by difference. Total carbohydrate=100-(%moisture + % ash+ % protein + % fat+ % crude fibre)

**Table 6. Sensory evaluation of pan bread fortified with full fat flaxseed flour or defatted flaxseed flour**

Sample	Taste (9)	Crust colour (9)	Crumb colour (9)	Aroma (9)	Texture (9)	Overall acceptability (9)
Control	8.57 <sup>a</sup>	8.33 <sup>cd</sup>	8.63 <sup>a</sup>	8.55 <sup>b</sup>	8.23 <sup>a</sup>	8.65 <sup>a</sup>
Bread with full flaxseed flour 5%	8.67 <sup>a</sup>	8.45 <sup>b</sup>	8.56 <sup>a</sup>	8.62 <sup>a</sup>	8.17 <sup>a</sup>	8.66 <sup>a</sup>
Bread with full flaxseed flour 10%	7.33 <sup>c</sup>	8.20 <sup>e</sup>	7.33 <sup>c</sup>	7.49 <sup>f</sup>	7.43 <sup>c</sup>	7.83 <sup>c</sup>
Bread with full flaxseed flour 15%	6.17 <sup>e</sup>	8.15 <sup>e</sup>	6.57 <sup>e</sup>	7.17 <sup>g</sup>	6.01 <sup>e</sup>	6.90 <sup>e</sup>
Bread with defatted flaxseed flour 5%	8.13 <sup>b</sup>	8.37 <sup>bc</sup>	8.47 <sup>b</sup>	8.33 <sup>c</sup>	8.07 <sup>b</sup>	8.67 <sup>a</sup>
Bread with defatted flaxseed flour 10%	7.79 <sup>ab</sup>	8.25 <sup>de</sup>	7.33 <sup>c</sup>	7.97 <sup>d</sup>	7.43 <sup>c</sup>	7.93 <sup>b</sup>
Bread with defatted flaxseed flour 15%	6.67 <sup>d</sup>	8.10 <sup>a</sup>	6.67 <sup>d</sup>	7.75 <sup>e</sup>	6.33 <sup>d</sup>	7.67 <sup>d</sup>
LSD	0.332	0.087	0.087	0.091	0.087	0.087

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## تأثير إضافة دقيق بذور الكتان الكامل ومنزوع الزيت على جودة خبز القالب

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يعتبر دقيق الكتان الكامل وايضا منزوع الزيت مصدرًا جيدًا لبعض المركبات الحيوية مثل الفينولات والفلافونويدات والألياف الغذائية، تم دراسة تأثير إضافة دقيق الكتان الكامل ودقيق الكتان منزوع الزيت بنسب إضافة ٥ و ١٠ و ١٥% على خواص الدقيق والصفات الريولوجية للعجين والتركيب الكيماوى والخواص الفيزيائية والحسية للخبز الناتج ولقد أوضحت نتائج المكسولاب انخفاض امتصاص الدقيق للماء وكذلك انخفاض ثبات العجين بزيادة نسبة الإضافة، أدى تدعيم الدقيق بإضافة دقيق الكتان الكامل أو منزوع الزيت حتى مستوى ١٥% إلى زيادة محتوى البروتين من ١٢,٠٥ إلى ١٤,٤٧% وزيادة محتوى الألياف الخام من ٠,٣٧ إلى ١,٣٨% وكذلك زيادة محتوى الرماد من ٣,٦٤ إلى ٥,٤٥% فى حين انخفضت السرعات الحرارية للخبز الناتج، ولقد أظهرت النتائج أنه يمكن تدعيم دقيق القمح باستخدام دقيق الكتان سواء الكامل أو منزوع الزيت حتى محتوى إضافة ١٠% لإنتاج خبز مرتفع الجودة وبدون أى تغيرات فى الخواص الفيزيائية والحسية.

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