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Influence of Addition Sweet Lupine Flour on Quality and Antioxidant Characteristics of Biscuits

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ABSTRACT

This research was suggested the influence of difference replacement levels (4, 8, and 12 %) of sweet lupine flour (SLF) as partially substitute for wheat flour (WF) in produce biscuits on rheological properties of biscuit dough's , chemical composition, amino acids, physical, sensory and antioxidant characteristics of produced biscuits. The results of rheological properties for tested biscuit dough's showed that by increasing the replacement levels (4, 8 and 12%) of SLF led to increase of water absorption (%), arrival time (min), dough development (min), dough stability (min), elasticity (B.U), proportional number (R/Ex) and energy (cm2) , while, the degree of softening values (B.U) and extensibility (mm) were decreased as compared with control sample. The chemical composition of produced biscuit samples showed a significant increase in crude protein, ash and crude fiber contents and non-significant difference in crude fat and total soluble carbohydrates contents at level 4% SLF and but noticed a significant difference at levels 8 and 12% of SLF as compared with the control sample. In addition, the increase of all amino acids also showed a significant increase in total polyphenols, total flavonoids and %DPPH free radical scavenging activity in produced biscuits contained SLF as compared with the control sample. The physical characteristics of produced biscuit samples was showed a non-significant difference of width up to level 8% SLF but showed a significant decrease at the level 12% SLF, while, showed a significant increase in thickness, on the other hand, showed a significant decreased in weight, spread ratio and spread percentage as at difference replacement levels (4, 8, and 12 %) of SLF compared with the control sample. The results of organoleptic properties (appearance, color, taste, odor, crispness, texture and overall acceptability) for produced biscuit samples were showed that the produced biscuits by partially replacement of wheat flour with SLF up to level 8 % had a good sensory properties and acceptability when compared with control sample. Therefore, can be used of SLF in fortified biscuits and placed on the market as a functional food.

Keywords*:* Biscuits, Sweet lupine flour, Influence, Addition; Quality, antioxidant characteristics

INTRODUCTION

In most parts of the world lupines have a traditionally been used primarily as foodstuffs and interest nutritional values of lupine as food ingredients has increased as people have become more of health benefits (Thambiraj, *et al.,* 2015), in addition the lupine has a higher content of essential amino acids, protein, fiber and low fat contents as compared soy bean (Ba¨hr, *et al.,* 2015).

The consumption of lupine may have health benefits result to lupine seeds were contained a high amounts of phenolic, carotenoid, phytosterol and tocopherol compounds which have anti-oxidant, anti-microbial, anti-carcinogenic and anti- inflammatory activities because of their high anti-oxidant capacity and protection against highly prevalent diseases (Rumiyati, *et al.,* 2013 ;Khan, *et al.,* 2015; and Van Hung, 2016).

The potential health benefits of lupine nutritional components were increased the potential of lupine incorporation as food additives in various food products such as pasta (Jayasena and Nasar-Abbas, 2012), cake (Abdelrahman, 2014), breads (Villarino *et al.,* 2015), muffins (Rumiyati *et al.,* 2015).

In developing functional bakery products such as breads and biscuits it's important to development of products with physiological effectiveness and consumer's acceptance in terms of appearance, taste and texture (Siró *et al.,* 2008).

In many countries of the world, biscuits are one of the most important popular bakery products. They are high of carbohydrates, fat and calories but low of fiber, vitamins, and minerals which make it un nutritional for daily use. Biscuits, which were categorized as miscellaneous food category products, consist of three major components, flour, sugar and fat (O'Brien *et al.,* 2003).

Several studies were performed about the effect of the addition of vegetables and cereals flour on the functional characteristics of breads and biscuit dough's and final products quality have been reported in the last 30 years. A most of the legumes tested, it's worth to mention the addition of chickpea or germinated chickpea flour (Fernandez and Berry, 1989; Iyer and Singh, 1997 and Saleh *et al*. 2012,), germinated pea flour (Sadowska *et al.,* 2003), lupine flour (Pollard *et al.,* 2002), defatted soybean (Saleh *et al*. 2012 and Banureka and Mahendran, 2009) watermelon rind powder (El-Badry *et al.,* 2014) to wheat flour for production of breads and biscuits.

The aim of this research was to study the influence of difference replacement levels (4, 8, and 12 %) of sweet lupine flour (SLF) as partially substitute for wheat flour (WF) rheological properties of biscuit dough samples , chemical composition, amino acids, physical, sensory and antioxidant properties of produced biscuits.

MATERIALS AND METHODS

Materials:

Sweet lupine seeds used in this investigation were obtained from local market in Cairo, Egypt. Wheat flour (72% extraction) was obtained from the South Cairo Mills Company, Cairo, Egypt. Additives used; Sugar (Sucrose), Shortening, skimmed milk powder and vanillin extract were purchased from the local market in Cairo, Egypt. Bicarbonate ammonium and bicarbonate sodium and other chemicals which used in this study were purchased from el-Gamhouria Company for Trading Chemicals and Drugs, Cairo, Egypt.

Technological Methods:

Preparation of Sweet lupine flour (SLF):

Sweet lupine seeds were cleaned by removing foreign matter, soaked for 48 hours, and dried at 50±5°c for 12 hr. till it's moisture content reached about 9%, and then the dehydrated sweet lupine seeds were ground in a laboratory disc mill (Braun ag Frankfurt type: km 32, Germany) and sieved through 63 mesh sieves to get sweet lupine flour according to the method described by Pollard *et al.,* (2002).

Processed of Biscuit (Marie):

The straight dough's processed was performed in biscuits preparation according to the method by Saleh *et al*. (2012). The ingredients used in preparation of different biscuits formula were presented in Table (1).

Table 1. Amounts and percentages of ingredients used in proparation of biscuit samples at different replacement levels

Ingredients (g)	Amounts and percentages of ingredients at different replacement levels							
	Control		4% SLF*		8% SLF		12% SLF	
	g	%	g	%	g	%	g	%
wheat flour	350	66	336	62	322	58	308	54
Sweet lupine flour	-	-	14	4	28	8	42	12
Sucrose	117	22.08	117	22.08	117	22.08	117	22.08
Shortening	50.50	9.53	50.50	9.53	50.50	9.53	50.50	9.53
Skimmed milk powder	5.30	1	5.30	1	5.30	1	5.30	1
Ammonium bicarbonate	5	0.95	5	0.94	5	0.94	5	0.94
Sodium bicarbonate	2.15	0.43	2.15	0.40	2.15	0.40	2.15	0.40
Vanillin extract	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01
Water	As Require							
Total Ingredients	530	100	530	100	530	100	530	100

SLF *sweet lupine flour

Biscuit making procedure as following:-

Shortening and sucrose were firstly creamed by using the laboratory mixer for 10 min. Sodium and ammonium bicarbonate were dissolved in part of water and added to prepared creamed mixture. As creamed processed was continued, the flour, skimmed powder, and vanillin extract were stirred together and added alternately for the creamed mixture. The full produced dough's were thinly rolled on a sheeting board to uniform thickness and cut using a circular mold (5.1 cm in diameter). The dough pieces were baked in grease pans at 230±5°C for 7 min in an air oven. After baking, biscuits were cold at an ambient temperature (20±2°C) for 30 min and then packed in polyethylene bags according to the method described by Saleh *et al*. (2012).

Analytical Methods:

1. Dough rheological characteristics:

A. Farinograph test:

The dough characteristics of produced biscuit samples with different additives were determined by farinograph (Barabender Duis Bur G type 810105001, No.971026, Germany) as described in the A.A.C.C. (2002) as follows:

Water absorption (%):

The amount of water required for the dough to have consistency of 500 bare bender unit line.

Arrival time (min):

It's the time in minutes for the curve to reach the 500 B.U. line after the mixture has been start and water adding.

Dough development time (min):

It's the time in minutes from the first addition of water for development of dough's maximum consistency, measured to the nearest half- minute.

Dough stability (min):

It's the time in minutes elapsing when top of the curve interacts with first 500 B.U. line until leaves that line.

Degree of softening (B.U):

Difference in B.U from 500 B.U line for center of the curve measure after 12 minutes from leaving the 500 B.U line.

B. Extinsograph test:

The dough characteristics of produced biscuit samples were estimated by extinsograph (Barabender Duis Bur G type 860001 No. 946003, Germany) according to the method described in the A.A.C.C. (2002) as following:

Dough extensibility (E):

The total length base of extensogram curve measure in millimeters.

Dough resistance to extension (R):

The height of extinsograph curve measure in bare bender units (B.U) after 5 min from the start.

Proportional number (R/E):

It's the obtained by dividing of the resistance to extension by extensibility.

Dough energy (cm2):

The area under the curve measure with a plan meter in cm^2.

2. Chemical analysis:

Chemical composition:-

Moisture, crude protein (N×5.7), crude fat, ash and crude fiber were determined in the samples accordance by A.O.A.C., (2005).Total soluble carbohydrates were calculated by difference as following:

100-(Protein+ Fat+ Ash+ Fiber)

Determination of the Amino Acids profile.

The amino acids profile of watermelon rind powder was determined as described by Cosmos and Simon-Sarkadi (2002) using automatic amino acid analyzer (model: AAA 400).Amino acid score (AAS) was calculated accordance to the FAO/WHO (1985) as follows:

$$\text{AAS\%} = \frac{\text{mg of Amino acid in 1 g of tested protein}}{\text{mg of Amino acid in 1 g of reference protein}} \times 100$$

Total polyphenols:

Total polyphenols content was conducted according to the modified Folin– Ciocalteu colorimetric method of Singleton *et al.* (1999).

Total flavonoids:

Total flavonoids content was analyzed according to the method described by Bahorun *et al*. (2004).

DPPH free radical scavenging activity assay was estimated according to the method of Hatano *et al.* (1988).

3. Physical Analysis:

Produced biscuit samples were analyzed physical characteristics such as width, thickness and spread ratio accordance to A.A.C.C. (2002) as the following: a) Width (W): Six biscuit were placed horizontally (edge to edge) in a row and taken their average diameter using digital venire caliper with 0.01 mm accuracy. b) Thickness: Six biscuits were placed one another and taking their average thickness using digital venire caliper with 0.01 mm accuracy. c) Spread Ratio: The spread ratio was calculated as the average diameter/thickness.

4. Sensory Evaluation of Produced Biscuits:

The organoleptic quality characteristics such as appearance, color, taste, odor, crispness, texture and overall acceptability for produced biscuits were carried out by ten experience judges from the staff of Food Sci. and Techno. Dept., Faculty of Agriculture, Cairo, Al-Azhar University. A panel of ten members was asked to evaluate the quality of biscuits using a composite scoring test. The standard recipe that was processed from wheat flour (72% extraction) as the control. The tested biscuit samples were presented in a randomized order to the panelists to evaluate the tested organoleptic characteristics using a scale ranged from 10 as excellent to 3 as very poor accordance to the method by (Hooda and Jood, 2005).

Statistical analysis:

All data were statistically analyzed by SPSS (version 16.0 software Inc. Chicago, USA) of completely randomize design as describe by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1. Rheological characteristics of biscuit dough samples as affected by partial substitution of wheat flour with SLF:

The rheological characteristics of biscuit dough samples prepared by using substitution of wheat flour by 4, 8 and 12 % SLF were evaluated by both farinograph and extinsograph apparatus.

A. Farinograph characteristics of prepared biscuit dough samples as affected by partial substitution of wheat flour with SLF.

Farinograph characteristics of prepared biscuit dough samples as affected by substitution of wheat flour with different levels (4, 8 and 12 %) SLF were presented in Table (2) and Figure (1). From the obtained results, it could be observed that by increasing the substitution levels of wheat flour with SLF in the prepared biscuit dough's from 4 to 12 % the water absorption was increased (64.12 to 69.25%) as compared with control sample (60.86%). This increase in water absorption may be due to the increase in protein and fiber contents of SLF and also, the SLF can bind the maximum amount of water in the process of gel formation according to these found by (Pollard *et al.,* 2002).

Table 2. Farinograph characteristics of biscuit dough samples as affected by partial substitution of wheat flour with SLF.

Samples	Farinograph characteristics of prepared biscuit dough samples				
	Water absorption (%)	Arrival time (min)	Dough development (min)	Dough stability (min)	Degree of softening values (B.U.)
Control	60.86	0.5	1.0	2.0	100
4% SLF	64.12	1.5	1.5	3.0	80
8% SLF	67.91	2.0	2.0	5.5	70
12% SLF	69.25	3.5	3.0	4.0	60

SLF *sweet lupine flour

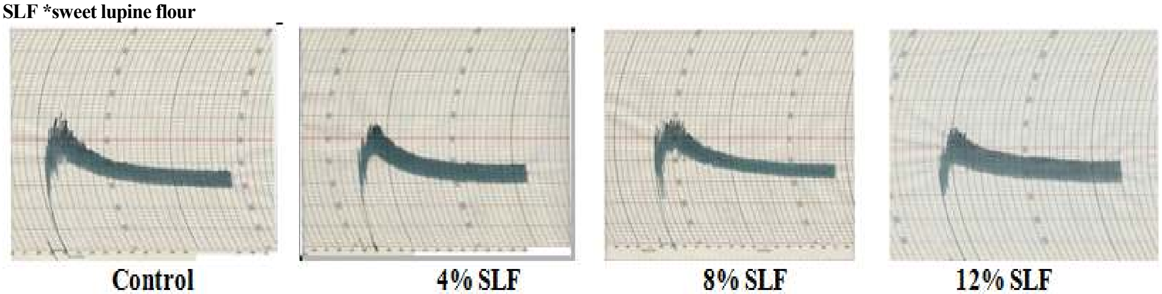

Fig. 1. Farinograph Properties of prepared Biscuit dough's as affected by partial substitution of wheat flour with SLF.

Also, the arrival time of all blends with SLF was increased from 1.5 to 3.5 min by the increasing levels of SLF from 4 to 12% in the blends as compared with control sample (0.5 min.). Concerning the dough development time, as shown in Table (2) and Figure (1), it could be observed that, by increasing the substitution levels with SLF from 4 to 12%, the dough development time showed increased from 1.5 to 3.0 min as compared with control sample (1.0 min.).

As shown from the obtained data in Table (2) and Figure (1), with the increasing proportion of substitution level of SLF in prepared blends from 4 to 12% led to an increase in the dough stability (min), which was increased from 3.0 to 4.0 min as compared with control sample (2.0 min.)

On the other hand, from the obtained results in Table (2) it could be observed that the degree of softening values (B.U.) decreased by the increasing level (4, 8 and 12%) SLF (80, 70 and 60 B.U., respectively) as compared with control sample (100 B.U). This result may be due to the presence of fibrous SLF that weakened the dough. These results were accordance with those mentioned by Abdelrahman, (2014).

Generally, by increasing the substitution levels of wheat flour with SLF from (4 to 12%) in the preparation of biscuit dough samples led to an increase of water absorption (%), arrival time (min), dough development (min) and dough stability (min), while, the degree of softening values (B.U.) were decreased as compared with control sample.

B. Extinsograph characteristics of prepared biscuit dough samples as affected by partial substitution of wheat flour with SLF.

Regarding the extensogram parameters such as elasticity, extensibility, proportional number and energy of biscuit dough's as affected by partial substitution of wheat flour with SLF was presented in Table (3) and Figure (2). As given the obtained data in Table (3) and Figure (2), it could be showed that an increase in elasticity of biscuit dough's containing 4, 8 and 12% of SLF (365, 440 and 490 B.U., respectively) as compared to the control sample (320 B.U.) This increase in elasticity of the biscuit dough's containing SLF may be due to the higher content of crude protein of SLF. This result is accordance with the data obtained by Hegazy and Faheid, (2006) and Saleh *et al*. (2012).

Table 3. Extinsograph characteristics of prepared biscuit dough samples as affected by partial substitution of wheat flour with SLF.

Samples	Extinsograph characteristics of prepared biscuit dough samples			
	Elasticity (B.U)	Extensibility (mm)	Proportional number(R/Ex)	Energy (cm^2)
Control	320	125	2.00	20.0
4% SLF	365	114	2.51	24.0
8% SLF	440	105	3.48	40.0
12% SLF	490	90	4.71	34.0

SLF *sweet lupine flour

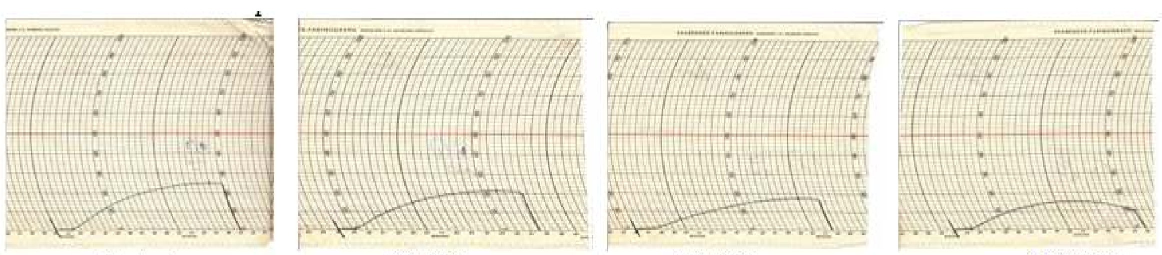

Fig 2. Extinsograph characteristics of prepared biscuit dough samples as affected by partial substitution of wheat flour with SLF.

On the other hand, from Table (3), it could be observed that the substitution of wheat flour with different levels of SLF (from 4 to 12%) caused a gradual decrease in the extensibility of biscuit dough's (from 114 to 90 mm) when compared with biscuit dough's control (125mm).

At the same data in Table3 and Figure2, the proportional number (R/Ex) of biscuits dough containing SLF it was increased by increasing the substitution levels (4, 8 and 12%) of SLF it was recorded (2.51, 3.48 and 4.71 R/Ex) as compared with dough control sample (2.00 R/Ex). This result may be due to the higher protein content and its effect on resistance to extension of the dough. These results were accordance the data obtained by Pollard, *et al.,* (2002) and Fenn *et al.,* (2010).

The same behavior in (Table3 and Figure 2), it was noticed in blends containing different ratio of SLF, the dough energy (cm^2) was gradually increase from 24.0 to 34.0 cm^2 as the substitution levels increase from 4 to 12% of the SLF, as compared with dough control sample (20.0 cm^2). The obtained results in this present study agree with Pollard, *et al.,* (2002) and Abdelrahman, (2014).

Generally, by increasing of replacement levels (4, 8 and 12%) of SLF in the prepared biscuit dough's led to increase in elasticity (B.U), proportional number (R/Ex) and energy (cm^2). While, showed a decrease in extensibility (mm) of prepared biscuit dough's as compared with control sample.

2. Chemical composition of produced biscuits as affected by partial substitution of wheat flour with SLF.

The chemical composition of the produced biscuits as affected by different replacement levels (4, 8 and 12 %) of SLF comparing to control sample (without addition SLF) was listed in Table (4).

As shown in the obtained results (Table 4), in produced biscuit samples contained (4, 8 and 12%) of SLF it could be noticed that a significant increase ($P \leq 0.05$) in crude protein (13.62, 15.19 and 16.76%, respectively), ash (1.86, 2.18and 2.57%, respectively) and crude fiber (2.01, 2.10 and 2.19%, respectively) when compared with control sample (12.05, 1.42 and 1.91%, respectively). These results of a significant increase of crude protein, ash and crude fiber contents may be due to the SLF was content of crude protein (39.33%), ash (5.44%) and crude fiber (9.12%), as compared with wheat flour (0.70 and 1.11%, respectively). On the other hand, from the obtained results in (Table 4) it was showed non-significant difference in crude fat and total soluble carbohydrates between biscuit samples contained 4% SLF (2.19 and 80.32%, respectively) and control sample (2.10 and 82.52%, respectively), while, noticed a significant difference in samples contained (8 and 12%) of SLF (2.28 and 2.37%, respectively) for crude fat, and (78.25and 76.11%, respectively) for total soluble carbohydrates when compared with control sample. Obtained Results in the present research agree with Pollard, *et al.,* (2002) and Abdelrahman, (2014).

Table 4. Proximate Chemical composition of row materials and produced biscuits as affected by partial substitution of wheat flour with SLF.

Chemical Composition (%)	SLF*	wheat flour	Replacement levels (M± SE.)			
			Control	4% SLF	8% SLF	12% SLF
Moisture	9.10±0.38	10.12±0.11	35.70±0.30[a]	35.77±0.29[a]	35.81±0.22[a]	35.85±0.30[a]
crude Protein	39.33±0.20	10.66±0.15	12.05±0.28[a]	13.62±0.32[b]	15.19±0.29[c]	16.76±0.30[d]
crude Fat	2.71±0.10	1.53±0.13	2.10±0.11[a]	2.19±0.15[ab]	2.28±0.17[bc]	2.37±0.10[c]
Ash%	5.44±0.15	0.70±0.08	1.42±0.28[a]	1.86±0.27[b]	2.18±0.23[c]	2.57±0.27[d]
crude Fiber%	9.12±0.11	1.11±0.10	1.91±0.22[a]	2.01±0.22[b]	2.10±0.22[c]	2.19±0.22[d]
Total soluble Carbohydrates%	43.40 ±0.49	85.45±0.49	82.52±0.46[a]	80.32±0.42[ab]	78.25±0.49[bc]	76.11±0.52[c]

SLF* sweet lupine flour .M± SE: Means± standard error for Chemical Composition; the means within the same row having different superscript are significantly varied (P ≤ 0.05).

Finally, it could be seen that the replacement levels of the SLF increased from 4 to 12% in produced biscuits formula caused to a significant increase in crude protein, ash and crude fiber contents while showed non-significant difference in crude fat and total soluble carbohydrates content at level 4% of SLF but noticed a significant increased (P≤0.05) at the substitution levels 8 and 12% of SLF as compared with the control sample.

The nutritional protein quality of produced biscuits as affected by partial substitution of wheat flour with SLF:

The nutritional protein quality of SLF and produce biscuits samples were evaluated according to its content of essential amino acids, in comparison to the reference protein pattern of FAO/WHO (1985), as presented in table (5).

Table 5. protein quality of produce biscuit samples

Amino acids	FAO/WHO (1985) g/100g protein	SLF g/100g protein	Replacement levels (M± SE.)			
			Control	4% SLF	8% SLF	12% SLF
Essential amino acids (I.A.As)						
Threonine	4.7	3.76	3.11	3.26	3.41	3.56
Valine	6.6	4.32	4.02	4.19	4.36	4.53
Isoleucine	5.4	4.12	3.88	4.04	4.20	4.36
Leucine	8.6	8.70	3.94	4.29	4.64	4.99
Phenyl alanine	9.3	3.18	5.03	5.16	5.29	5.43
Methionine	6	2.38	1.75	1.85	1.95	2.05
Tyrosine		4.61	1.90	2.09	2.27	2.46
Lysine	7	6.50	7.80	8.06	8.32	8.58
Total I.A.As	47.60	37.57	31.43	32.94	34.44	35.96
Amino acids score (%)		78.93	66.02	69.20	72.35	75.55
Non- Essential amino acids (D.A.As)						
Aspartic		12.04	4.64	5.05	5.19	5.34
Serine		5.71	3.10	3.37	3.64	3.91
Glutamic		17.22	28.14	29.79	30.14	30.64
Proline		7.83	9.33	9.72	10.11	10.45
Glycine		3.91	3.15	3.35	3.60	3.75
Alanine		3.26	2.97	2.92	3.05	3.11
Arginine		6.35	2.11	2.48	2.65	2.82
Total D.A.As		56.32	53.44	56.68	58.38	60.07
Total amino acids		93.89	84.87	89.62	92.82	95.98

SLF* sweet lupine flour

As shown in table (5), the SLF content of essential amino acids (Threonine, Valine, Isoleucine, Leucine, Phenyl alanine, Methionine and Lysine) it was recorded (3.76, 4.32, 4.12, 8.70, 3.18, 2.38, 4.61 and 6.50 g/100g protein respectively) it was at considerable value for these amino acids score was nearly with the reference protein pattern (FAO/WHO 1985). In Addition, the SLF contained a considerable amount of non-essential amino acids (Aspartic, Serine, Glutamic, Proline, Glycine, Alanine and Arginine) it was recorded (12.04, 5.71, 17.22, 7.83, 3.91, 3.26 and 6.35 g/100g protein, respectively).

As given in table (5), it could be observed that the amino acids score (%) of produced biscuits were gradually increased by replacement levels (4, 8 and 12%) of SLF, it was presented (69. 20,72.35 and 75.55%, respectively) when compared with control sample (66.02%), this result may be due to the highest of % Amino acids score in SLF (78.93%). These results are in accordance with those mentioned by Iqbal, *et al*., (2006) and Abdelrahman, (2014).

Generally, the incorporation of available SLF into the produced biscuits at replacement different levels (4, 8 and 12%) led to increase of all amino acids in produced biscuits contained SLF as compared with the control sample.

Antioxidant properties of produced biscuits as affected by partial substitution of wheat flour with SLF:

As shown in the obtained results in (Table 6), in produced biscuit samples contained (4, 8 and 12%) of SLF it could be noticed that a significant increased (P≤0.05) in total polyphenols (29.23, 49.02 and 70.73 mg/100g, respectively), total flavonoids (9.65, 17.20 and 24.88 mg/100g, respectively) and % DPPH free radical scavenging activity (4.69, 7.64 and 11.05%, respectively) when compared with control sample (6.08, 1.98 mg/100g and 1.74%, respectively), may be due to the SLF had a higher content in total polyphenols (518.44 mg/100g) and total flavonoids (190.75 mg/100g) also, the %DPPH free radical scavenging activity of SLF recorded (73.12%). The obtained result in the present research was agreed with (Rumiyati *et al.,* and 2013 Khan *et al.,* 2015).

Finally, it could be seen that the replacement levels of the SLF increased from (4 to 12%) in produced biscuits formula cased to a significant increase (P ≤ 0.05) in total polyphenols, total flavonoids and %DPPH activity which having a numerous beneficial effects in human health.

Table 6. Antioxidant properties of SLF and produced biscuits as affected by partial substitution of wheat flour with SLF (on dry weight):

Antioxidant properties	SLF*	Replacement levels (M± SE.)			
		Control	4% SLF	8% SLF	12% SLF
Total polyphenols(mg/100g)	518.44±2.54	6.08±2.55 ^{a}	29.23±0.29^{b}	49.02±0.22 ^{c}	70.73±0.30 ^{d}
Total flavonoids(mg/100g)	190.75±1.77	1.98±2.55 ^{a}	9.65±0.32^{b}	17.20±0.29^{c}	24.88±0.30^{d}
DPPH (%)	73.12±0.15	1.74±0.15 ^{a}	4.69±0.15 ^{b}	7.64±0.17 ^{c}	11.05±0.10 ^{d}

SLF* sweet lupine flour M± SE: Means± standard error for Antioxidant properties; the means within the same row having different superscripts are significantly varied (P ≤ 0.05).

3. Physical characteristics of produced biscuits as affected by partial substitution of wheat flour with SLF:

Physical characteristics of biscuits (Width, Thickness, Weight, Spread ratio and % Spread) were measured and listed in Table (7). As shown in Table (7), it could be noticed that non-significant difference (P≤0.05) of width up to levels 8% of SLF (5.90 cm), but showed a significant decreased at the level 12% SLF (5.70), as compared with the control sample (6.15 cm).

The same data obtained in (Table 7) also showed it could be seen that the replacement levels of the SLF increased from (4 to 12%) in produced biscuits formula cased to a significant increase (P ≤ 0.05) in thickness from (0.74 to 0.85 cm) as compared with the control sample (0.70 cm).

From the obtained data in (Table 7), it could be observed that the substitution of wheat flour with different levels (from 4 to 12%) of SLF caused a significant decreased (P≤0.05) in weight from (7.05 to 6.10 g), as compared with the control sample (7.45 g).

In the same way, also, by increasing substitution levels (from 4 to 12%) of SLF led to a significant decreased (P≤0.05) in spread ratio and percent spread from (7.85 and 89.20% to 6.60 and 75.0) as compared with biscuits control (8.80 and 100%). Reduced spread ratios of prepared biscuit samples contained (4, 8 and 12%) of SLF may be due to the fact that composite flours apparently form aggregates with increased number of hydrophilic sites available for competing of limited free water in biscuit dough's, these hydrophilic sites occurs during dough mixing led to increase of dough viscosity, thereby limiting cookie spread and top grain formation during baking (Rababah *et al.,* 2006).These results are accordance with those found by Pollard, *et al.,* (2002) and Abdelrahman, (2014)).

Finally, difference replacement levels (4, 8, and 12%) of SLF as partially substitute for WF in produce biscuits it could be seen that non-significant difference (P≤0.05) of width up to level 8% of SLF but showed a significant increased (P≤0.05) at the level 12% of SLF, while, showed a significant increase (P ≤ 0.05) in Thickness, on the other hand, showed a significant decreased (P≤0.05) in Weight, spread ratio and percent spread as at difference replacement levels (4, 8, and 12 %) of SLF compared with the control sample.

Table 7. Physical characteristics of produced biscuits as affected by partial substitution of wheat flour with SLF

Physical properties	Replacement levels (M± SE.)			
	Control	4% SLF	8% SLF	12% SLF
Width (cm)	6.15±0.08^{a}	6.00±0.05^{ab}	5.90±0.07^{ab}	5.70±0.09^{b}
Thickness(cm)	0.70±0.06^{a}	0.74±0.04^{b}	0.79±0.05^{c}	0.85±0.07^{d}
Weight (g)	7.45±0.10^{d}	7.05±0.09^{c}	6.50±0.06^{b}	6.10±0.05^{a}
Spread ratio	8.80±0.11^{d}	7.85±0.10^{c}	7.25±0.08^{b}	6.60±0.06^{a}
% Spread ratio	100.0±0.06^{d}	89.20±0.04^{c}	82.39±0.05^{b}	75.0±0.07^{a}

SLF* sweet lupine flour .M± SE: Means± standard error for Physical Characteristics; the means within the same row having different superscript are significantly varied (P ≤ 0.05).

4. Sensory of produced biscuit samples as affected by partial substitution of wheat flour with SLF

The sensory quality criteria (appearance, color, taste, odor, crispness, texture and overall acceptability) of produced biscuits partially substituted of wheat flour with SLF levels (4, 8 and 12 %) were evaluated. The means sensory scores of produced biscuits partially substituted of wheat flour with SLF samples are presented in Table (8).

Table 8. Sensory evaluation of produced biscuits partially substituted of wheat flour with SLF:

Sensory properties	Replacement levels (M± SE)			
	Control	4%SLF*	8%SLF	12%SLF
Appearance	9.4±0.77^{a}	9.4±0.72^{a}	9.0±0.70^{a}	8.6±0.80^{b}
Color	9.5±0.71^{a}	9.5±0.80^{a}	9.2±0.71^{a}	8.3±0.96^{b}
Taste	8.7±0.65^{a}	8.8±0.79^{a}	8.5±0.69^{a}	8.3±0.90^{b}
Odor	8.9±0.83^{a}	9.0±0.74^{a}	8.8±0.60^{a}	8.7±0.99^{b}
Crispness	9.3±0.66^{a}	9.3±0.73^{a}	9.0±0.71^{a}	8.5±0.96^{b}
Texture	9.3±0.90^{a}	9.5±0.75^{a}	8.9±0.70^{a}	8.3±0.90^{b}
Overall acceptability	9.2±0.40^{a}	9.3±0.60^{a}	8.9±0.69^{a}	8.4±0.92^{b}

SLF* sweet lupine flour M± SE: Means± standard error for Sensory evaluation; the means within the same row having different superscript are significantly varied (P ≤ 0.05).

From the obtained data (Table 8), it could be seen that there was no significant variation *($P \leq 0.05$)* between samples containing (4 and 8%) of SLF for all organoleptic properties (9.4, 9.5, 8.8, 9.0, 9.3, 9.5 and 9.3, respectively), for 4 % SLF and 9.0, 9.2, 8.5, 8.8, 9.0, 8.9 and 8.9, respectively), for 8% SLF when compared to the control sample (9.4, 9.5, 8.7, 8.9, 9.3, 9.3 and 9.2, respectively). On the other hand, the level replacement of 12% SLF was showed significant decreased *($P \leq 0.05$)* for all organoleptic properties (8.6, 8.3, 8.3, 8.7, 8.5, 8.3 and 8.4, respectively) as compared with control sample or produced biscuits containing 4 and 8 % SLF. The mentioned data was accordance with Hooda and Jood, (2005) and Abdelrahman, (2014).

General, it could be showed that the produced biscuits by partially replacement of wheat flour with SLF up to the level 8 % had a good sensory properties and acceptability when compared with control sample.

CONCLUSION

The influence on addition of sweet lupine flour (SLF) to biscuits formula instead of wheat flour (WF) at different levels (4, 8, and 12%) on rheological properties of flour dough samples cased to increase of water absorption (%), arrival time(min), dough development (min) dough stability (min), elasticity(B.U), proportional number (R/Ex) and energy (cm^2), while, the decreased of the degree of softening values (B.U) and extensibility (mm) as compared with control sample. Also, for the chemical composition of produced biscuit samples showed a significant increase in crude protein, ash and crude fiber contents and non-significant difference in crude fat and total soluble carbohydrates contents at level 4% SLF and but noticed a significant difference at levels 8 and 12% of SLF as compared with the control sample. In addition, the increase of all amino acids also showed a significant increase in total polyphenols, total flavonoids and %DPPH free radical scavenging activity in produced biscuits contained SLF as compared with the control sample. The physical characteristics of produced biscuit samples was showed a non-significant difference of width up to level 8% SLF but showed a significant decreased at the level 12% SLF, while, showed a significant increase in thickness, on the other hand, showed a significant decreased in weight, spread ratio and spread percentage as at difference replacement levels (4, 8, and 12 %) of SLF compared with the control sample. The results of organoleptic properties (appearance, color, taste, odor, crispness, texture and overall acceptability) for produced biscuit samples were showed that the produced biscuits by partially replacement of wheat flour with SLF up to level 8 % had a good sensory properties and acceptability when compared with control sample. Therefore, can be used of SLF in fortified biscuits and placed on the market as a functional food.

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تأثير إضافة دقيق الترمس الحلو على صفات الجودة و مضادة الأكسدة فى البسكويت

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أجرى هذا البحث لتقييم تاثير استبدال مستويات مختلفة (٤ ، ٨ ، و ١٢٪) من دقيق الترمس الحلو كبديل جزئي لدقيق القمح على الخواص الريولوجية لعجين البسكويت والتركيب الكيماوى والاحماض الامينية والخصائص الفيزيائية والحسية ومضادات الاكسدة فى البسكويت الناتج. وأظهرت النتائج على أن الصفات الريولوجية باستخدام قياسات جهاز الفارينوجراف والأكستنسوجراف لعجين البسكويت من خلال زيادة مستويات الإحلال (٤ و ٨ و ١٢٪) من دقيق الترمس الحلو في استعداد العجين البسكويت لزيادة امتصاص الماء (٪)، زمن الوصول (دقيقة) ، تكوين العجين (دقيقة) ثبات العجين (دقيقة) ، المرونة (BU) ، الرقم النسبي (R / Ex) والطاقة (cm2) ، في حين حدث انخفاض فى قيم درجة الضعف (BU) والمطاطية (مم) بالمقارنة مع عينة الكنترول. أظهر التركيب الكيميائي لعينات البسكويت المنتجة زيادة معنوية في محتوى البروتين الخام والرماد والالياف الخام وتغير غير معنوي في محتويات الكربوهيدرات الكلية الذائبة وفي محتوى الدهون أظهر تغيراً غير معنوي عند مستوى إحلال ٤٪ من دقيق الترمس الحلو لكن حدث زيادة معنوية في مستوى إحلال ٨ و ١٢٪ من دقيق الترمس الحلو مقارنة مع العينة الكنترول، بالإضافة إلى ذلك، فإن الزيادة فى جميع الأحماض الأمينية (الأحماض الأمينية الاساسية والغير اساسية) ، كما أظهرت زيادة كبيرة في الفينولات الكلية والفلافونيدات الكلية وكذلك فى نشاط مضادات الاكسدة في عينات البسكويت المحتوية على دقيق الترمس الحلو بالمقارنة مع عينة الكنترول. أظهرت الخصائص الفيزيائية لعينات البسكويت المنتجة التي استبدلت جزئيا بـدقيق الترمس الحلو (من ٤ إلى ١٢٪) من دقيق القمح عدم حدوث فرق معنوى من العرض حتى ٨٪ من دقيق الترمس الحلو لكنه أظهر زيادة معنوية عند مستوى ١٢٪ من دقيق الترمس الحلو ، بينما أظهر زيادة معنوية في السمك ، من ناحية أخرى ، انخفاض ملحوظ ($P \leq 0.05$) في الوزن ، القابلية للفرد والنسبة الئوية للقابلية للفرد في مستويات مختلفة للإستبدال (٤ و ٨ و ١٢٪) من دقيق الترمس الحلو مقارنة بعينة الكنترول. وقد أظهر صفات الجودة الحسية من (المظهر واللون والطعم والرائحة والقابلية للكسر، والملمس والقبول العام) أن البسكويت التي تم استبدال جزئيا من القمح كان الطحين مع دقيق الترمس الحلو تصل إلى مستوى ٨ ٪ خصائص حسية جيدة بالمقارنة مع عينة الكنترول. ولذلك يمكن استخدام دقيق الترمس الحلو فى انتاج البسكويت ووضعة في السوق كغذاء وظيفي.