Effect of Roasting Process on Chemical and Nutritional Quality of Soybean Seeds (*Glycine max*)

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Abstract:

The present study aimed to investigate the nutritional analysis of the two varieties soybean seeds namely Giza 111 and Giza 22. The proximate chemical composition, caloric value, minerals (Mn, Mg, Zn, Fe, Cu, Se, Ca, Na, K, P and S), total phenolics and total flavonoids were determined in raw control (C) and roasted (R) soybean seeds flour (**SBSF**) and defatted raw and roasted soybean seeds flour (**DSBSF**). In the dry weight basis (**SBSF**) and (**DSBSF**) contained moisture 1.95-8.03 %, ash 5.40-7.20%, protein 30.58-48.14%, crude oil 2.30-22.27%, crude fiber 4.85-7.87%, total carbohydrates 32.44-37.95% and caloric value 364.18-466.31 Kcal/100g. In the present study the (**DSBSF**) recorded higher content of total phenolics and total flavonoids than (**SBSF**). The mineral content analysis of both (**SBSF**) and (**DSBSF**) recorded high values in Mg, Ca, K, P and S. The sensory evaluation scores of burger were observed to be significantly higher in burger with 10% incorporation of defatted roasted soybean seeds flour (**DRSBSF**) Giza 111 as compared with other treatments. Consequently, it recommended utilizing and consumption in different food formula in order to consider a source of protein, oil and fiber.

Keywords:

Soybean seeds, Nutritional, Proximate chemical composition, Mineral composition, Total phenolics, Total flavonoids, Burger**.**

1. Introduction:

Soybean (*Glycine max L.*) belong to fabaceae family usually referred to as soybean as a popular foodstuff and crop plant used especially in traditional cocking by South Asian people. Soybean is a major source of high quality protein and oil (**Grieshop** and **Fahey 2001**; **Bellaloui *et al*.**, **2010**). The quality of soybean seed is important for human and animal nutrition. Oil concentration of soybean seed ranges from 83 g/kg to 279 g/kg with a mean of 195 g/kg (**Wilson, 2004**). Soybean is a common vegetable oils that contains a significant amount of unsaturated acids: α-linolenic acid, known as omega-3 acid, linoleic, ϒ-linolenic and arachidonic acid, known as omega-6, oleic acid known as omega-9 acid, very important in the human nutrition (**Nikolic *et al*., 2009** and **Olguin *et al*., 2003**). Saturated fatty acids, palmitic and stearic

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acids in soybean seeds are considered a cardiovascular risk factor in human diets (**Kris-Etherton *et al.*, 1993**). Grain legumes, like soybean is one of the most important oil and protein crops of the world (**Islam *et al.*, 2007**). Soybean contain (40 – 45%) protein with a good source of all indispensable amino acids; hence the seeds are the richest in food value of all plant foods consumed in the world (**Kure *et al.*, 1998** and **Serrem *et al.*, 2011**). Soybean protein is an attractive food ingredient due to its high nutritional value and its desirable flavor in foods (**Ma *et al.*, 2015**).

The protein content of soybean is about 2 times of other pluses, 4 times of wheat, 6 times of rice grain, 4 times of egg and 12 times of milk. Soybean has 3% lecthin, which is helpful for brain development it is also rich in calcium, phosphorous and vitamins A, B, C and D, it has been referred to as the protein hope of the future (**Islam *et al.*, 2007**). Generally, proteins are used in various food formulations in order to improve their nutritional performance. Proteins, essential amino acids and health promoting polypeptides are also used to impart desirable sensory characteristics such as structure, texture, flavor and color in formulated food products (**Timilsena *et al.*, 2016**).

Soybeans are rich source of dietary fiber, flavonoids, isoflavones, soya saponins, other antioxidant compounds and most B-vitamins that exert positive health benefits especially in terms of prevention of most chronic diseases, osteoporosis and cancer (**Mahmoodi *et al.*, 2014**).

Alam *et al.*, 2013 reported that the chemical composition of wheat flour soybean seeds were 5.50% moisture, 39.20% protein, 6.40% crude fiber, 10.10% crude fat, 2.53% ash and carbohydrates 36.89%.

Van Eys *et al.*, 2004 reported that the content of soybean seeds were ranged protein from 32 to 43.6%, fat from 15.5 to 24.7%, ash from 4.5 to 6.4%, fiber from 10 to 14.9% and carbohydrate content from 31.7 to 31.85% on dry matter and the content of minerals (Ca, P, Mg, K and Na) were (2.62, 5.70, 2.80, 15.93 and 0.29); respectively.

Polyphenols had contradicting positive effect on human health and it had been reported that they had anticarcinogenic and antioxidant properties (**Gamez *et al.*, 1998**). It is generally believed that antioxidants scavenge free radicals and reactive oxygen species and can be extremely important inhibiting oxidative mechanisms that lead to degenerative diseases (**Madhujith** and **Shahidi 2005**). While flavonoids are consider as antioxidants scavenge radicals and inhibit the chain initiation or break the chain propagation (the second defense line). Flavonoids as well as vitamin C showed a protective activity to α-atocopherol in human LDL and they can also regenerate vitamin E, from the -chromanoxy radical (**Davey *et al.*, 2000**).

Formulation of foods from low lysine staples fortified with legumes has been proposed as a practical and sustainable approach to improving the protein nutritional value of food for young children in developing countries (**FAO/WHO/UNU, 1994** and **Young, 2001**).

Soybean has been utilized after various kinds of processing such as soak, germinations, fermentation and heating. Thermal treatment, which is indispensable for eating soybean, greatly changes functional properties (**Iida *et al.*, 2002**).

Heat processing has been reportedly capable of reducing the ruminal degradability of crude protein with a concomitant increase out flow and balance of amino acids to intestine (**Petit *et al.*, 1999**).

Soybeans are consumed in various types of foods through diverse processing methods such as conventional cocking with high moisture content, fermentation, frying, baking and roasting. Roasting is a thermal processing method that uses dry heat treatment and causes phenolic compounds to degrade and become bound to polymer structures depending on the roasting conditions (**Oliviero *et al.*, 2009**). Additionally there is increased antioxidant activity, flavor and brown color during the roast processing because of Maillard reaction products (**Lee** and **Lee 2009**).

The objective of this research was to assess the effect of roasting treatment on chemical and mineral composition, total phenolics, total flavonoids and nutritional quality of soybeans were also investigated.

2. Materials and Methods:

2.1. Materials:

Five kilograms of each of the two varieties soybean seeds namely: Giza 111 and Giza 22 were procured from Agricultural Research Center, Giza, Egypt, during summer (**2016**).

2.1.1. Sample Preparation:

Soybeans were cleaned from dirt by sorting out contaminants such as sands, sticks and leaves then washed, roasted and milled using attrition mill and sieved into fine flour. Samples were stored in glass containers at 4^oC in the refrigerator until analysis.

2.1.2. Raw Soybean Seeds

The samples were ground for 3 min in laboratory mill.

2.1.3. Roasted Soybean Seeds (RSS):

Roasted soybean seeds refers to soybean seeds roasted at 200oC for 15 min using an electrical drying oven (Model D-63450. Hanau. Germany).

2.1.4. Defatted Soybean Seeds Flour (DSBF):

The prepared soybean seeds flour was defatted using n-hexane as described by (Barnes, 1983).

2.2. Methods:

2.2.1. Determination of Proximate Chemical Composition and Caloric Value:

Moisture, crude protein, crude oil, crude fiber and ash were determined as described in the (AOAC, 2000) methods. The total carbohydrates were calculated by difference according to (Pellet and Sossy 1970). The caloric value (energy) determined according to (Wilson et al., 1974) and (Seleet, 1990) as follows:

$$\text{Energy (Kcal/100g)} = (\text{protein content}\times4) + (\text{fat content}\times9) + (\text{carbohydrate content} \times 4).$$

2.2.2. Determination of Minerals Contents:

The samples were wet acid-digested using a nitric acid and perchloric acid mixture (HNO3; HCSO4; 2 : 1 v / v). The amounts of iron, zinc, copper and manganese in the digested sample were determined using a GBC Atomic Absorption 906 A, as described in (AOAC, 1990). Sodium and potassium were determined by a flame photometer 410, calcium and magnesium were determined by titration with version 0.0156 N according to (Jakson, 1967). Phosphorus, sulphur and selenium were determined according to the methods described by (AOAC, 1990).

2.2.3. Determination of Total Phenolics:

The total phenolics content of samples were determined using modified Folin-Ciocβlteu colorimetric method (Singleton et al., 1999). Samples extracts (25µg each) were dissolved in 80% methanol and further dilution were performed to obtain readings within the standard curve made with gallic acid. The extracts were oxidized by Folin-Cioc βlteu reagent (120µl) and after 5 min; 340µl of Na CO was added for neutralization. The samples were kept for 90 min in the dark followed by the reading of the absorbance at 750 nm. The results were expressed as milligram of gallic acid equivalents/100 g sample (mg GAE/100 g sample).

2.2.4. Determination of Total Flavonoids:

The aluminium chloride colorimetric assay was used for flavonoids determination, as described by (Marinova et al., 2005) . Extraction of flavonoids in the samples (n=3) was achieved by homogenizing 2.00g of the sample in 50 ml distilled water. The mixture was transferred into a rotary shaker for 12h to ensure full extraction. Thereafter, the mixture was filtered and the extract made up to 50 ml precisely, 1 ml of extracts or standard solution of catechin (20, 40, 60, 80 and 100 mg/l) was added to test tubes containing 4 ml of redistilled water. To this mixture 0.3 ml of 5% NaNO was added. After 5 min, 0.3 ml 10% AlCl was added. Immediately, 2 ml 1M NaOH was added and the total volume was made up to 10 ml with redistilled water. The solution was mixed thoroughly and the absorbance of both blank and standard was read at 510 nm using UV–Visible spectrophotometer Model UV 1601 version 2.40 (Shimadzu). Total flavonoids content was expressed as mg catechin equivalents (mg catechin/100g sample D.W).

2.2.5. Preparation of Burgers Substituted with 10% and 20% of Defatted Soybean seeds flour (DSBF):

The fresh meat was cut into small cubes approximately 2 cm3 minced in a commercial blender for 3 min on the lowest settings. Then mixed the minced burger meat formula (100% meat, 90% meat + 10% **DSBSF**, 80% meat + 20% **DSBSF**), afterward the minced meat was seasoned (onion 6.6 g, garlic 6.6 g, spices 6.6 g, starch 6.6 g, salt 15 g).Then mixed again for another 2 min.

The doughs (100 g) were shaped in a petri dish (10.00 cm in diameter, 1.00 cm thick).The burgers were stored under 18^{o}C.Then fried for 2-3 mins.

2.2.6. Cooking Properties:

Cooking loss was calculated according to the (American Meat Science Association, 1978).Reduction in diameter and increase in thickness were performed according to the method described by (Sanchez-Zapata et al., 2010)

2.2.7. Sensory Characteristics:

The fried products were evaluated for their cohesiveness, colour, odor, taste, tenderness, juiciness and overall acceptability by a panel of the judges from the staff of Home Economic Department, Nutrition and Food Science, Faculty of Specific Education, Assiut University, using a 10-point hedonic scale, where 10 represents the highest score.

2.2.8. Statistical Analysis:

The data collected were analyzed with analysis of variance (ANOVA) Procedures using the Duncan test. Differences between means were compared by LSD at 5% level of significant (Gomez and Gomez 1984).

3. Results and discussion:

Fig. (1): Moisture content (g/100g D. W) of raw control (C) and roasted (R) two varieties soybean seeds

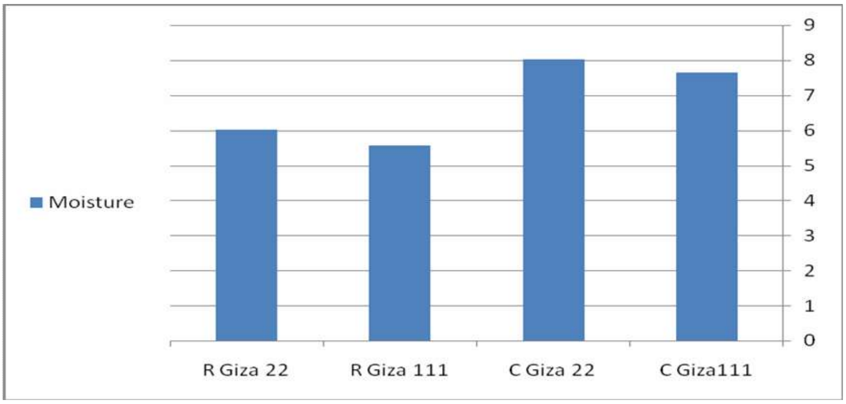

Fig. (2): Moisture content (g/100 g D. W) of defatted raw control (C) and roasted (R) two varieties soybean seeds

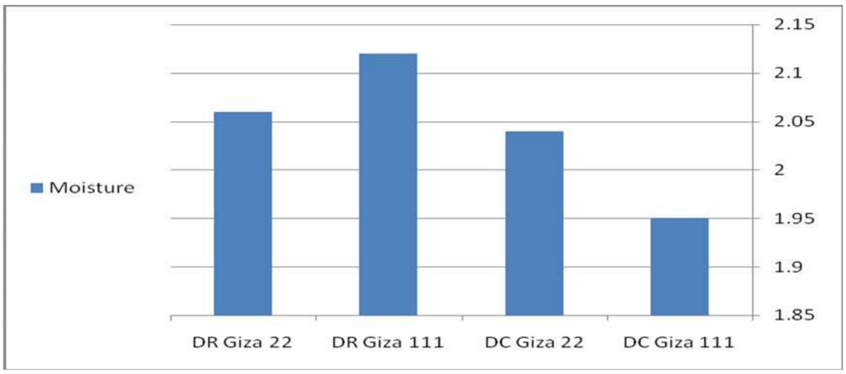

Table (1): Mean values of proximate chemical composition, total phenolics and total flavonoids of two varieties Soybean seeds (g/100g) on dry weight basis*

Constituents %	Treatments of Soybean seeds							
	Raw (C)		Roasted (R)		Defatted raw		Defatted roasted	
	Giza 111	Giza 22	Giza 111	Giza 22	Defatted G 111	Defatted G22	Defatted G111	Defatted G22
Moisture	7.64	8.03	5.56	6.01	2.12	2.06	1.95	2.04
Protein[a**]	30.58	31.89	32.28	32.17	46.16	47.92	47.67	48.14
Crude oil	18.76	18.09	22.15	22.27	3.76	2.30	3.25	3.36
Ash**	5.40	5.50	5.60	5.70	5.80	6.90	6.70	7.20
Crude fiber**	7.87	7.44	7.53	5.56	6.39	4.93	5.01	4.85
Carbohydrates[b**]	37.39	37.08	32.44	34.40	37.89	37.95	37.37	36.45
Caloric value[c] (Kcal/100g)	440.72	438.69	458.23	466.31	370.04	364.18	369.41	368.60
Total phenolics (mg/100g)	2.42	2.22	2.81	11.40	2.26	1.71	2.65	3.71
Total flavonoids (mg/100g)	76.77	73.43	68.78	76.77	116.82	140.19	120.16	86.78

*Mean of three replicates.
** Calculated on dry weight basis.
(a) Protein= % Nitrogen × 6.25.
(b) Carbohydrate: calculated by difference.
(c) Calories: Calculated as Kcal/100 g dry matter.

3.1. Proximate chemical composition, total phenolics and total flavonoids of two varieties soybean seeds:

The data of proximate chemical composition, total pahenolics and total flavonoids of two varieties soybean seeds are presented in Table (1) and Fig. (1, 2). The data in Fig. (1) revealed that a significant variation (5.56-8.03%) in moisture content among two varieties soybean seeds control (C) and roasted (R) (Giza 111, Giza 22). However, the moisture content in Fig. (2) were recorded (1.95, 2.04, 2.06 and 2.12%) for defatted roasted and defatted control soybean seeds (Giza 111, Giza 22).

The data given in Table (1) recorded that protein content ranged from (30.58% to 32.28%) in control (C) and roasted (R) soybean, likewise, the highest protein content were recorded for (DSBSF) of control and roasted two varieties soybean seeds with values (46.16%, 47.67%, 47.92% and 48.14%); respectively. The crude oil in control (C) and roasted (R) of two varieties soybean seeds were recorded (18.76%, 18.09%, 22.15% and 22.27%) for control and roasted (Giza 111, Giza 22) while (**DSBSF**) recorded low level of crude oil were (3.76%, 2.30%, 3.25% and 3.36%) as a result of defatting. Ash content were (5.40%, 5.50%, 5.60% and 5.70%) in control and roasted soybean seeds (Giza 111, Giza 22); likewise defatted roasted two varieties soybean seeds were (5.80%, 6.90%, 6.70% and 7.20%); respectively. The crude fiber content was recorded a significantly higher values (5.56-7.87%) in control and roasted (Giza 111, Giza 22) soybean seeds than (**DRSBSF**) (4.85-6.39%). Carbohydrate content ranged between (32.44-37.39%) in control and roasted Giza 111, Giza 22 while, the total carbohydrates content in (**DRSBSF**) was higher (36.45-37.95%) Kcal/100g when compared to the varieties soybean seeds (C) and (R) Giza 111 and Giza 22. The caloric values of control (C) and roasted (R) soybean seeds were (440.72, 438.69, 458.23 and 466.31) Kcal/100g dry matter. While, (**DRSBSF**) were recorded (370.04, 364.18, 369.41 and 368.60) Kcal/100g. The data is in agreement with (**Kanchana *et* al., 2015**), (**Cadioli *et al.,* 2011**) and (**Muttakin *et al.*, 2015**). Our results are in agreement with those obtained by (**Banureka** and **Mahendran 2009**) and (**Joel-Ndife *et al.*, 2011**) and (**Alam *et al.*, 2013**).

The total phenolic contents in control, roasted Giza 111 and Giza 22 soybean seeds flour were higher than defatted control and (**DRSBSF**). The phenolics were decreased from (2.42, 2.22, 2.81 and 1.40) mg/100g D. W in control Giza 111, Giza 22 and roasted Giza 111, Giza 22 to reach (2.26, 1.71, 2.65 and 3.71) mg/100g D. W in defatted control and defatted roasted soybean seeds flour Giza 111 and Giza 22; respectively. The flavonoids content on defatted control and defatted roasted two verities (**SBSF**) were significantly higher (116.82, 140.19, 120.16 and 86.78) mg/100g D. W than flavonoids content in control and roasted soybean seeds flour Giza 111, Giza 22 (76.77, 73.43, 68.78 and 76.77) mg/100g. As a result of defatting the content of total phenolics was decreased in defatted control and defatted roasted soybean seeds flour (**DRSBSF**) as compared with (**SBSF)**, this could be attributed to extraction of the oil from two varieties (**SBSF**) using n-hexane. Also as a result of defatting the flavonoids content was increased in defatted control and (**DRSBSF**) when compared with (**SBSF**). Plant phenolics have multiple biological effects as they constitute one of the major groups of compounds acting as primary antioxidant or free radical terminator (**Zarena, 2009**).

Table (2): Mean values of mineral content of two varieties Soybean seeds (mg/kg)*

Constituents %	Treatments of Soybean seeds							
	Raw (C)		Roasted (R)		Defatted raw		Defatted roasted	
	Giza 111	**Giza 22**	**Giza 111**	**Giza 22**	**Defatted G 111**	**Defatted G22**	**Defatted G111**	**Defatted G22**
Mn	63.723	63.525	60.059	58.395	20.201	18.827	19.19	19.265
Mg	2864.6	2744.4	2548.1	2411.1	968.3	930.7	960.2	926.3
Zn	105.01	110.45	108.83	117.91	29.768	30.357	28.875	30.353
Fe	161	142.34	139.57	130.60	56.17	46.58	46.10	44.24
Cu	47.05	45.71	47.43	38.51	11.94	12.84	12.20	12.78
Se	0.3717	0.3923	0.3132	0.2136	0.0145	0.1096	0.0261	0.0682
Ca	3558.2	1693.3	3093.1	1790.9	1056.6	906.67	1012.6	889.74
Na	281.22	163.26	229.30	125.41	224.46	118.75	155.13	113.93
K	11322.63	10888.97	12247.18	10764.12	10324.42	12045.60	9119.83	13686.73
P	4282.74	4223.29	4615.03	4671.43	4643.62	4848.31	4940.62	4494.16
S	5609.76	4305.14	1354.01	1585.04	1746.70	1715.78	2803.44	1895.07

3.2. Mineral content of two varieties raw and roasted Soybean seeds:

The mineral content in mg/kg of the raw (C), roasted (R) and defatted two varieties soybean seeds are outlined in Table (2). The data revealed that the raw (C) and roasted (R) soybean seeds are considered a rich source of Mn, Mg, Fe, Ca, Na, K and S. The trace element Cu, Zn and Se act as cofactors of antioxidants enzymes that protect the body from oxygen free radicals that are produced during oxidative stress (**Barakat, 2009**).

More significant differences were observed in the minerals content defatted of two varieties soybean seeds. The data revealed that defatted raw (C) Soybean seeds Giza 111 and Giza 22 had higher levels of Mn, Mg, Fe, Ca, P and Na than that of defatted roasted (R) soybean seeds while defatted roasted soybean seeds Giza 111, Giza 22 were recorded an increase values in Cu, K and S such data are in a general agreement with (**Van Eys *et al.*, 2004**).

Table (3): Sensory characteristics of burger made from defatted two varieties soybean seeds flour*

Sample		Color (10)	Odor (10)	Taste (10)	Tenderness (10)	Juiciness (10)	Overall Acceptability (50)
Control A		8.00	8.17	8.00	7.92	8.25	40.34
G 111	B_1	8.08	7.33	7.67	8.00	7.50	38.58
	B_2	7.33	7.25	8.25	7.75	7.76	38.25
RG 111	C_1	7.92	7.33	7.67	8.00	8.08	39.00
	C_2	7.25	7.75	8.33	7.92	7.67	38.92
G 22	D_1	7.83	7.17	7.08	7.17	7.33	36.58
	D_2	8.08	6.92	6.83	7.50	7.00	36.33
RG 22	E_1	7.58	7.75	7.58	7.33	73.42	37.66
	E_2	6.58	7.33	7.83	7.33	7.67	36.76

A = Control Burger.
B1 = burgers supplemented with 10% defatted raw soybean seeds flour Giza 111.
B2 = burgers supplemented with 20% defatted raw soybean seeds flour Giza 111.
C1 = burgers supplemented with 10% defatted roasted soybean seeds flour Giza 111.
C2 = burgers supplemented with 20% defatted roasted soybean seeds flour Giza 111.
D1 = burgers supplemented with 10% defatted raw soybean seeds flour Giza 22.
D2 = burgers supplemented with 20% defatted raw soybean seeds flour Giza 22.
E1 = burgers supplemented with 10% defatted roasted raw soybean seeds flour Giza 22.
E2= burgers supplemented with 20% defatted roasted raw soybean seeds flour Giza 22.

3.3. Sensory Characteristics:

The sensory characteristics of burgers prepared with or without incorporation of defatted two varieties soybean seeds is presented in Table (3). The scores for sensory attributes, color, odor, taste, tenderness, juiciness and overall acceptability of burgers differed significantly (P<0.05) between the samples made with 10% and 20% replacement of meat as shown in Table (3). The sensory attributes scores were observed to be significantly higher in burgers with 10% incorporation of defatted roasted Soybean seeds flour Giza 111.

Table (4): Cooking properties of burgers with addition of defatted two varieties soybean seeds:

Treatment		Cooking loss (%)	Reduction in diameter (%)	Increase in thickness (%)
Control	A	37.30±1.321^{b}	2.65±0.08^{a}	0.672±0.003^{b}
DG111	B_1	31.58±0.953^{c}	2.35±0.06^{b}	0.542±0.001^{c}
	B_2	22.18±0.675^{e}	1.35±0.05^{c}	0.292±0.001^{e}
DRG111	C_1	31.16±2.10^{c}	2.05±0.09^{b}	0.522±0.04^{c}
	C_2	21.52±0.962^{e}	0.88±0.04^{d}	0.391±0.002^{d}
DG22	D_1	30.10±2.65^{a}	2.75±0.11^{a}	0.735±0.05^{a}
	D_2	21.37±1.15^{e}	0.75±0.08^{e}	0.223±0.001^{f}
DRG22	E_1	26.29±0.986^{d}	1.65±0.07^{c}	0.523±0.002^{c}
	E_2	21.70±0.865^{e}	0.95±0.04^{d}	0.282±0.001^{e}

*Means having different superscripts within the column are significantly different at (P<0.050).
A = Control Burger.
B1 = burgers supplemented with 10% defatted raw soybean seeds flour Giza 111.
B2 = burgers supplemented with 20% defatted raw soybean seeds flour Giza 111.
C1 = burgers supplemented with 10% defatted roasted soybean seeds flour Giza 111.
C2 = burgers supplemented with 20% defatted roasted soybean seeds flour Giza 111.
D1 = burgers supplemented with 10% defatted raw soybean seeds flour Giza 22.
D2 = burgers supplemented with 20% defatted raw soybean seeds flour Giza 22.
E1 = burgers supplemented with 10% defatted roasted raw soybean seeds flour Giza 22.
E2= burgers supplemented with 20% defatted roasted raw soybean seeds flour Giza 22.

3.4. Cooking Properties:

The addition of 10% and 20% defatted raw and roasted Soybean seeds affected the cooking loss of the burgers ($P < 0.05$) Table (4). The cooking loss decreases. This tendency that was observed for the defatted two varieties raw (C) and roasted (R) soybean seeds Giza 111 and Giza 22 indicated that the use of the defatted two varieties soybean seeds has positive effect on the burger as they are rich in protein and fiber. These results are in a good agreement with (**Selani *et al.*, 2015**) which said that the meat grinding during burger processing results in a tender product due to the breakdown of the myofibrils and connective tissue, which, however, promotes weight loss during the cooking process. This factor results in the release of fluids, such as water, water soluble nutrients, color pigments and compounds responsible for flavor and odor (**Meria, 2013**). Burgers with the addition of 10% and 20% defatted raw (C) and roasted (R) soybean seeds showed low reduction in diameter and thickness. This reduction in diameter is a result of meat protein denaturation with the loss of water and fat during cooking (**Lopez-Vargas *et al.*, 2014**).

Conclusion:

In conclusion Soybean seeds are considered a good source of protein, crude oil and fiber which protect the body from diseases so composite burgers with Soybean seeds flour substitutions were found to be nutritionally preferable.

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تأثير المعاملة بالحرارة على التركيب الكيميائي والتغذوي لبذور فول الصويا

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تهدف الدراسة إلى تقدير التحليل التغذوي لنوعين من بذور فول الصويا جيزة ١١١ و جيزة ٢٢ وتم تقدير التركيب الكيميائي الكلي والقيمة السعرية والمعادن (المنجنيز، الماغنسيوم، الزنك، الحديد، النحاس، السلينيوم، الكالسيوم، الصوديوم، البوتاسيوم، الفوسفور، الكبريت) والمواد الفينولية الكلية والمواد الفلافونيديه الكلية في دقيق بذور فول الصويا الخام (الكنترول) والمحمص ودقيق بذور فول الصويا المنزوع الدهن الخام والمحمص.

وعلى أساس الوزن الجاف فإن دقيق فول الصويا ودقيق فول الصويا المنزوع الدهن احتوى معنوياً على رطوبة ١,٩٥ . ٨,٠٣%، رماد ٥,٤٠ . ٧,٢٠%، بروتين ٣٠,٥٨ . ٤٨,١٤%، زيت ٢,٣٠ . ٢٢,٢٧%، آلياف خام ٤,٨٥ . ٧,٨٧%، الكربوهيدرات الكلية ٣٢,٤٤ . ٣٧,٩٥% والقيمة السعرية ٣٦٤,١٨ . ٤٦٦,٣١ كيلوكالوري لكل ١٠٠ جرام.

وفي هذه الدراسة سجل دقيق بذور فول الصويا المحمص المنزوع الدهن أعلى قيم في المركبات الفينولية والمركبات الفلافونيديه وكانت محتويات المعادن في كلاً من دقيق فول الصويا الخام والمحمص مرتفعاً في الماغنسيوم والكالسيوم والبوتاسيوم والفوسفور والكبريت.

ولقد تم ملاحظة أن التقييم الحسي للبرجر كان مرتفعاً معنوياً في البرجر المصنع بنسبة ١٠% من دقيق فول الصويا المحمص المنزوع الدهن عند مقارنته بباقي العينات وبالتبعية فإنه يمكن التوصية بالإستفادة من دقيق فول الصويا المحمص في مختلف فورميلات الغذاء كمصدر للبروتين والزيت والآلياف.

<u>الكلمات المفتاحية:</u>

بذور فول الصويا . التغذية . التركيب الكيميائي . التركيب المعدني . المركبات الفينولية . المركبات الفلافونيديه . البرجر.