EVALUATION OF NUTRIENT CONTENT AND COOKING CHARACTERISTICS OF LOW FAT BEEF BURGER

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Abstract

The current study was carried out to utilize brown lentil and wheat bulgur for preparation of healthy beef burger in order to enhance the chemical, cooking and sensory properties of beef burger. The chemical analysis of the raw materials showed that, the highest protein content was noticed in raw brown lentil and bulgur wheat respectively. The germination process led to a slight decrement in protein content and ether extract. Cooking process of germinated brown lentil resulted in significant decrement in phytic acid and trypsin inhibitor. The results showed that soluble and insoluble dietary fiber in cooked brown lentil were significantly higher than that found in raw, germinated brown lentil and wheat bulgur. The results showed a significant increase in the moisture retention, fat retention and cooking yield compared with the control. Results revealed that the incorporation of brown lentil to beef burger formulas caused a highly significant increase in water holding capacity (WHC) value when compared with control. The TBA values in mixtures containing brown lentil (0.16 - 0.29 mg malonaldehyde /kg wet weight of product) were lower than that of control sample (0.58 mg malonaldehyde /kg wet weight of product). The highest protein and fiber content were noticed in beef burger blends prepared by brown lentil, bulgur and meat blend than that found that in control. Mineral contents (Zn, Fe, Ca and K) of beef burger like blends were significantly higher than that found in control sample. In general, the tested beef burger seemed to be more preferable by consumer with respect to all organoleptic properties. Finally, it is recommended to incorporate dried brown lentil and bulgur mixtures as meat replacer to prepare a beef burgers at lower cost with improving health, cooking properties and sensory parameters.

Keywords: Brown lentil- Beef burger - Cooking measurements - Germination process -Sensory evaluation

INTRODUCTION

Meat and meat products occupy a prominent position in the human diet because of their high quality protein and essential amino acids content and good source of vitamins, minerals and other ingredients. However, many consumers believe that the consumption of meat and meat products is unhealthy because of their high animal fat, cholesterol and other ingredients (Hygreeva *et al*., 2014). Bulgur is a valuable cereal product and a very famous industrially processed ancient wheat product. And also bulgur is a very important pre-cooked wheat product due to its storability, high nutritional value, ease preparation and low cost. Bulgur is usually produced by soaking, cooking, dehulling, drying and grinding of wheat (Bayram *et al*., 2004). Generally, durum wheat is preferred for bulgur production, but some researchers choose to use oats, corn, triticale, barley, rye and soybean instead of durum wheat. Legumes play an important role in human nutrition since they are rich sources of protein, calories, certain minerals and vitamins. In African diets legumes are also, the major contributors of protein and calories for economic and cultural reasons. Also, legumes are the second most important source of food and fodder, green manures and forages. In comparison of cereal grains, legumes are good source of proteins, dietary fibers, low glycemic indexes, low levels of fat (2-5%), and high amounts of carbohydrates (55-60%). Germinated legumes utilization improved nutrient characteristics and increase the protein content of the blends (Marero *et al*., 1988). It is generally known that the germination process improves the nutritional quality of legumes, not only by the reduction of antinutritive compounds, but also by augmenting the levels of free amino acids, available carbohydrates, dietary fiber and other components. Proteins can act as free radical reducing agents, metal ion chelators, free radical scavengers and thus prevent oxidative damage to biomolecules, such as lipids and protein (Petchiammal and Hopper,2014). Lentil (*Lens culinaris* Medic.) is a pulse crop that belongs to the family Leguminosae. Lentils are rich in proteins, have 18 of the 20 amino acids including all 8 essential amino acids and provide a number of essential minerals and vitamins. Thus, lentils occupy an important place in the human diet, especially in developing countries, as a rich source of protein, vitamins and minerals (Anoma *et al*., 2014). Several studies on the effect of germination on legumes found that germination can increase protein content and dietary fiber, reduce phytic acid content and increase mineral bioavailability (Ghavidel and Prakash, 2007). Kaushik *et al*., (2010) found that germination improves calcium, copper, manganese, zinc, riboflavin, niacin and ascorbic acid content. The reasonable addition of the dietary fibers in some formulations could improve the nutritional properties and the sensory quality, and reduce the production costs of the meat products. Indeed, these fibers are generally known by their high water holding capacity (WHC) and by their high nutritional value (Besbes *et al*., 2008). A high intake of fiber is recommended for the prevention of some diseases, such as colon cancer, cardiovascular problem, obesity, hyperglycemia, as well as gastrointestinal unrests. Thus, the aim of the current research is to evaluate the effect of incorporating brown lentil into beef burger like production by replacing of meat on the quality physico-chemical (water holding capacity, pH and thiobarbituric acid (TBA) and sensory characteristics, cooking measurements (moisture retention, fat retention, shrinkage ,cooking yield and cooking loss) of beef burger .

MATERIALS AND METHODS

Materials:-

Brown lentil (*Lens culinaris* Medic.) and wheat bulgur were purchased from the local market at Giza. Beef meat was purchased from the local butcher shop at Giza Governorate, Egypt. Other ingredients: spices (cinnamon, pink, black pepper, laura paper and love), onion, garlic, salt and refined sunflower oil were obtained from the local market at Giza. Amyloglucosidase, pepsin and protease were obtained from Sigma Company, USA.ɑ Amylase was obtained from Fluka Biochemika Company., U.S.A.

Preparation of raw materials

Germination process of brown lentil seeds was carried out according to the method of Marero *et al*., (1988). Brown lentil seeds were washed and cleaned with tap water before soaking for 12 hr at room temperature (28°C). After 12 hr, soaking seeds were placed under wet muslin cloth and left to germinate for 48 hr at room temperature (28°C) without direct contact with sun light. Germinated brown lentil seeds were boiled with sufficient amounts of water, till they became tender and well cooked. Wheat bulgur was soaked in a sufficient amount of water until they became tender. All such materials were milled with kitchen machine.

Formulation of beef burger like:

The formulations were prepared by Experimental Kitchen, Food Technology Research Institute, Agricultural Research Center. The beef burger formulated by replacing meat with 0% (control), 10%, 20%, 30%, 40% and 50% of cooked germinated brown lentil. The ingredient percentages of beef burger formulations are shown in Table (1). The ingredients of each formulated beef burger like were homogenized in Braun Cutter Machine (CombiMax 700 ,USA), then homogenized with meat mixture and formation of beef burger by piston burger manual about 60 gm weight, 9 cm diameter and 0.95-0.98 cm in thickness. The prepared beef burger was packaged individually in polyethylene film to help maintaining the shape of beef burger prior to freezing. The samples were frozen at –18 °C prior to analysis.

Table 1. Ingredient percentages of beef burger formulations (g /100g).

Ingredients / Beef burger	Minced meat (gm)	Cooked germinated brown lentil (gm)	Wheat bulgur (gm)	Spices (gm)	Onion (gm)	Garlic (gm)	Salt (gm)
control	75	--	15	1	6	1	2
10%CGBL*	67.5	7.5	15	1	6	1	2
20% CGBL	60.0	15.0	15	1	6	1	2
30% CGBL	52.5	22.5	15	1	6	1	2
40% CGBL	45.0	30.0	15	1	6	1	2
50% CGBL	37.5	37.5	15	1	6	1	2

CGBL*= Cooked Germinated Brown Lentil

Cooking characteristics

Moisture and fat retention, shrinkage, cooking loss and cooking yield of the beef burger blends were determined according to El-Magoli *et al.*, (1996). The detail procedures are described below:

$$\text{Moisture retention (\%)} = \frac{\text{(percent yield x \% moisture in cooked beef burger)}}{100}$$

$$\text{Fat retention (\%)} = \frac{\text{(cooked weight x percent fat in cooked beef burger) x 100}}{\text{(raw weight x percent fat in raw beef burger)}}$$

$$\text{Shrinkage(\%)} = \frac{\text{(Raw thickness – Cooked thickness)+ (Raw diameter – Cooked diameter) x 100}}{\text{Raw thickness + Raw diameter}}$$

Cooking loss was calculated according to the following equation:

Cooking loss = [(weight of raw sample – weight of cooked sample) ÷ weight of raw sample] × 100.

$$\text{Cooking yield} = \frac{\text{(cooked weight x 100)}}{\text{Raw weight}}$$

Methods:-

Moisture, ether extract, crude protein, crude fiber and ash were evaluated according to A.O.A.C, (2000) procedures. Total carbohydrates content was calculated by differences. All determinations were performed in triplicate. Soluble and insoluble dietary fiber contents were estimated according to Prosky *et al.*, (1984). Phytic acid content was determined according to the method of Wheeler and Ferrel, (1971). Trypsin inhibitor was estimated according to the method of Kakade *et al.*, (1969). Ash obtained from one gram of each sample was dissolved in 100 ml HCl (1N) and used for the germination of zinc, iron, calcium and potassium by using a Pye Unicum

SP1900 Atomic Absorption spectroscopy techniques as described by A.O.A.C, (2000). The caloric values were estimated according to the method reported by El-Adawy *et al.*, (2004) using Atwater factors which was based on that the caloric value produced by one gram of proteins, carbohydrates and fats were 4 Kcal, 4 Kcal and 9 Kcal, respectively. The pH was measured on a suspension resulting from blending a 10g sample with 100 mL distilled water for 2 min, using a pH meter (Tecnopon mod. M PA210, Piracicaba, Brazil). Water holding capacity (W.H.C) of beef burger sample was measured according to the method described by Honikel, (1998). The sample (0.3g) was carefully flattened in a glass plate and covered with shells filter paper (whatman No. 41) then pressed for 10min using a mass of one kg weight. Two zones were formed on filter paper, their surface area was measured using planimeter. The W.H.C. was calculated as cm^2/0.3g by subtracting the area of the internal zone from that of the outer. The distillation of thiobarbituric acid (TBA) method was performed as described by Tarladgis *et al.*, (1960). The TBA values of prepared beef burger blends were estimated by colorimetric method at 538 nm using digital spectrophotometer Spekol 11 No. 849101 (as mg malonaldehyde / kg sample).

Sensory evaluation:-

The sensory characteristics of the cooked beef burger samples were carried out by well trained 20 panelists of Food Technology Research Institute (FTRI). Panelists were asked to evaluate color, odor, texture, taste, tenderness, appearance and overall acceptability, of cooked samples according to the method described by Miller *et al.*, (1993).

Statistical analysis:

Data analysis was performed using SAS, (1987), software. All data were expressed as mean± standard deviation. Analysis of variance was used to test for differences between the samples. Least Significant Differences (LSD) test was used to determine significant differences ranking among the mean values at $P< 0.05$.

RESULTS AND DISCUSSION

Chemical composition of raw, germinated and cooked germinated brown lentil and wheat bulgur:-

Data presented in Table (2) shows that crude protein content was significantly higher in ungerminated brown lentil than that found in wheat bulgur. These results are in agreement with that reported by Zia-UL-haq *et al.*, (2011). Consequently, the lentil could be considered the best source of nutritive value, due to its higher crude protein content. The same Table showed that the highly significant ether extract content was noticed in the wheat bulgur (2.85%), which agreed with that found by

Anoma *et al.*, (2014) and Bayram *et al.*, (2004). The same data showed that the germinated brown lentil possessed a lack of light crude protein content than the ungerminated ones. These results are agreed with Ghavidel and Prakash, (2007) who reported that nutrients loss may be attributed to leach of soluble nitrogen, mineral and other nutrients into water. Also, who reported that, during germination of legume seeds, significant changes in the composition of protein could modify the nutritional value. The ether extract and total carbohydrate content of the germinated brown lentil seemed to be significant low than that found in the ungerminated ones could regard to the germination process. Protein and ether extract contents showed a significant decrement pattern as a result of cooking process in the present study (Table2). The decrease in protein may be attributed to the solubility of these components in water during boiling and the loss percent was varied according to the degree of solubility in water for each compound.

Table 2. The major chemical compositions of raw, germinated and cooked germinated brown lentil and wheat bulgur (on dry weight basis).

Sample	Moisture	Crude protein	Ether extract	Ash	T.C*
Ungerminated brown lentil	$10.14^{d} \pm 0.052$	$28.8^{a} \pm 0.022$	$0.81^{b} \pm 0.052$	$5.54^{a} \pm 0.042$	$54.71^{c} \pm 0.052$
Germinated Brown lentil	$12.25^{b} \pm 0.032$	$28.0^{b} \pm 0.041$	$0.75^{c} \pm 0.012$	$5.60^{a} \pm 0.042$	$53.40^{d} \pm 0.062$
Cooked germinated brown lentil	$10.20^{a} \pm 0.062$	$27.8^{c} \pm 0.032$	$0.54^{d} \pm 0.032$	$5.70^{a} \pm 0.052$	$55.76^{b} \pm 0.042$
Wheat bulgur	$10.9^{c} \pm 0.050$	$9.90^{d} \pm 0.032$	$2.85^{a} \pm 0.042$	$1.13^{b} \pm 0.042$	$75.22^{a} \pm 0.052$

T.C*= Total carbohydrates calculated by difference.

-Each value (an average of three replicates) is followed by the standard deviation.

Ash content of the brown lentil was increased significantly than found in the wheat bulgur.

Data presented in Table (3) show dietary fiber contents (*i.e.*, soluble , insoluble and total dietary fiber) of the raw, germinated and cooked germinated brown lentil. There results revealed that the highest significant in total dietary fiber amount was noticed in case of germinated cooked brown lentil. On the other hand, the germination and cooking process lead to a slightly increment in insoluble and total dietary fiber content of brown lentil. Brown lentil (as found in Table 3) contained the highest amounts of total, soluble and insoluble dietary fiber compared to that found in wheat bulgur. These results agreed with those obtained by Zia-UL-haq *et al.*, (2011) who reported that lentils is excellent source of protein and also rich in important vitamins, minerals, soluble and insoluble dietary fiber.

Table 3. Soluble, insoluble and total dietary fiber , phytic acid and trypsin inhibitor of raw, germinated and cooked germinated brown lentil and wheat bulgur

Sample	SDF%	IDF%	TDF%	Phytic acid (mg/100gm sample)	% Reduction	Trypsin inhibitor (TIU mg/gm sample)	% Reduction
Ungerminated Brown lentil	1.45^{b}± 0.052	19.0^{a}± 0.032	20.45^{c}± 0.052	114.5^{a}± 0.032		31.30^{a}± 0.052	
Germinated Brown lentil	1.72^{a}± 0.032	19.21^{a}± 0.052	20.93^{b}± 0.052	63.2^{b}± 0.052	44.80	11.56^{b}± 0.012	63.06
Cooked germinated brown lentil	1.65^{a}± 0.012	19.52^{a}± 0.042	21.17^{a}± 0.032	14.5^{c}± 0.022	77.05	2.56^{c}± 0.032	77.85
Wheat bulgur	1.20^{c}± 0.052	5.60^{b}± 0.042	6.80^{d}± 0.022	0.056^{d}± 0.052		ND	

-Each value (an average of three replicates) is followed by the standard deviation
SDF= Soluble Dietary Fiber **, IDF=** Insoluble Dietary Fiber and **TDF=** Total Dietary Fiber

Also, Megat *et al.*, (2016) reported that total dietary fiber (TDF) was significantly increased in legumes after germination. This indicates that germination process affect the level of total dietary fiber during the period of soaking before the actual phase of germination. Cooking process, which is followed the germination process, showed in Table (3), it could be noticed that the germination process followed by cooking process lowered the phytic acid value in the brown lentil by 77.05% in the germinated brown lentil. This results are in agreement with El- Adawy *et al.*, (2004) showed that during the period of soaking prior to germination, the reduction in phytates content during germination of different legume seeds apparently as a result of a large increase in phytase activity. Because germination is mainly a catabolic process that supplies important nutrients to the growing plant through hydrolysis of reserve nutrients. The current study put the effect of germination and cooking processes on trypsin inhibitor (TI) under the spot of lights as found in Table (3). The present study showed that, raw brown lentil contained high amount of TI (31.30 TIU mg/g sample) than germinated and cooked brown lentil (11.56 and 2.56 TIU mg/g sample, respectively) but it was more sensitive to germination process. Moreover, it could be concluded that the germination process followed by cooking process seemed to give a high reduction percent for TI in the brown lentil by (63.06 and 77.85%, from the raw material values, respectively). This trend is concurrent with that found by Marero *et al.*, (1988) who reported that the level of antinutritional factors-trypsin inhibitor activity and phytates were considerably reduced with germination process. The maximum reduction of trypsin inhibitor activity was caused by cooking process. Also, Siddhuraju *et al.*, (2002) reported that the inactivation of trypsin inhibitor legumes could be attributed to the destruction of disulphide (–S–S–) bonds.

Cooking and physiochemical characteristics of the beef burger samples

The cooking characteristics in Table (4) showed significant variations among the beef burger blends for moisture retention, fat retention, shrinkage, cooking yield and cooking loss. Data presented in Table (4) shows that fat and moisture retention were significantly higher in the tested beef burger blends than that found in control sample.

The same Table showed that the highly significant shrinkage was noticed in the control (15.75%) than that found in the beef burger blends. Results in Table (4) showed that the cooking yield was significantly higher in beef burger with brown lentil. Beef burger formulated by replacing of meat with 40% and 50% brown lentil recorded the highest cooking yield (90.29 and 90.79%, respectively) compared to control which had 74.04% and other treatments. This is probably due to the ability of brown lentil hydrocolloidal fiber to create a tridimensional matrix, holding not only water, but also fat added to the formulas, avoiding losses of fat and water during cooking. The high cooking loss from the control could be attributed to the high loss of moisture and fat during cooking. The cooking loss was significantly lower in beef burger blends than control. Dietary fibers decreased cooking loss because of their high ability to keep moisture and fat in the matrix. This statement is supported by the study of Besbes *et al*., (2008) on the incorporation of lemon albedo fibers in beef burger formulation. Obtained results from Table (4) revealed that the incorporation of brown lentil to beef burger formulas caused a high significantly increase in water holding capacity (WHC) value when compared with control. This result is probably due to its ability to absorb large amounts of water. Whereas, the increasing rate in the WHC of burger increased with increasing the added ratio from brown lentil. Butt and Batool, (2010) they reported that the proteins have both hydrophilic and hydrophobic properties therefore; can interact with water and oil in foods. The functional properties of proteins in food system broadly depend on the water-protein interaction. WHC reflects the extent of denaturation of the protein during cooking process. Concerning the thiobarbituric acid (TBA) value for prepared beef burger blends as a good indicator for the amount of malonaldehyde which is the most predominant product of the secondary oxidation in the food lipids, hence it is considered a good chemical constant for quality assurance and for measuring the extent of the secondary oxidation of edible lipids during processing. As shown in Table (4), the TBA values of the tested beef burger formulated by replacing of meat with 10, 20, 30, 40 and 50 % of brown lentil were lower (0.16 - 0.29 mg malonaldehyde /kg wet weight of product) than that of control sample (0.58 mg malonaldehyde /kg wet weight of product). The formation of lower amount of thiobarbituric acid (TBA) in beef burger after processing could be attributed mainly to the auto-oxidation of beef burger lipids and formation of some TBA-reactive compounds, while the reduction in the increment rate of that value for beef burger samples containing brown lentil than the control sample could be attributed to some of antioxidant activity found in lentil seeds flour. The current data are in agreement with Petchiammal and Hopper, (2014). From the obtained results (Table 4), it could be noticed that the replacing of meat with cooked brown lentil resulted in a non-significant increase in the pH values of beef burger when compared to the pH value for the control sample. This results are in agreement with Oroszvári *et al.,* (2006).

Table 4. Moisture and fat retention, shrinkage, cooking loss, cooking yield, water holding capacity , TBA and pH of the suggested beef burger blends.

Beef burger of	% Moisture retention	% Fat retention	% Shrinkage	% Cooking loss	% Cooking yield	WHC (cm^2/0.3g)	TBA(mg malonaldehyde / Kg sample)	pH
control	$54.90^{e}\pm0.057$	$14.86^{d}\pm0.0531$	$15.75^{a}\pm0.057$	$25.96^{a}\pm0.057$	$74.04^{f}\pm0.020$	$1.4^{e}\pm0.052$	$0.58^{a}\pm0.052$	$5.01^{a}\pm0.06$
10%CGBL*	$66.05^{d}\pm0.057$	$15.86^{c}\pm0.0572$	$2.66^{b}\pm0.0057$	$16.14^{b}\pm0.057$	$83.86^{e}\pm0.22$	$2.0^{d}\pm0.037$	$0.29^{b}\pm0.062$	$5.06^{a}\pm0.03$
20% CGBL	$69.69^{c}\pm0.017$	$17.36^{b}\pm0.0581$	$2.21^{c}\pm0.0057$	$12.50^{c}\pm0.18$	$87.50^{d}\pm0.01$	$2.24^{c}\pm0.052$	$0.25^{c}\pm0.021$	$5.03^{a}\pm0.02$
30% CGBL	$78.67^{b}\pm0.057$	$17.54^{b}\pm0.0531$	$1.96^{d}\pm0.026$	$11.53^{d}\pm0.01$	$88.47^{c}\pm0.01$	$2.5^{b}\pm0.057$	$0.21^{d}\pm0.071$	$5.03^{a}\pm0.08$
40% CGBL	$81.16^{a}\pm0.057$	$18.73^{a}\pm0.0545$	$1.82^{e}\pm0.0152$	$9.71^{e}\pm0.057$	$90.29^{b}\pm0.011$	$2.6^{a}\pm0.052$	$0.18^{e}\pm0.056$	$5.04^{a}\pm0.06$
50% CGBL	$81.23^{a}\pm0.057$	$18.75^{a}\pm0.0572$	$1.78^{f}\pm0.0057$	$9.21^{f}\pm0.011$	$90.79^{a}\pm0.05$	$2.6^{a}\pm0.032$	$0.16^{f}\pm0.052$	$5.08^{a}\pm0.06$

-Each value (an average of three replicates) is followed by the standard deviation**.**

CGBL*= Cooked Germinated Brown Lentil.WHC= water holding capacity. **TBA=** thiobarbituric acid

Data presented in Table (5) showed that the moisture content of beef burger blends (10, 20,30,40,50 % and control were ranged from 47.10 to 52.23%. Also, the same table showed that the ether extract and ash content of control beef burger were ranged from 3.50 to 0.17 % respectively. The same table revealed that the changes in crude protein, crude fiber and ash contents of all produced beef burger blends. The highest significant differences of crude fiber content in the beef burger blends compared to control sample. The high level of fiber in tested burger can be useful in decreasing cholesterol level in human, was due to the highest proportion of brown lentil ingredient in these blends. These results agree with Zia-UL-haq *et al.,* (2011), they reported that the addition of lentil to products changed their chemical parameters, increases their dietary fiber content, reduces energy value, and increases the nutritional value. The highest decrease of total carbohydrate and caloric value were found in 50% and, it represented 19.27 % and 174.95 Kcal, respectively from the result in the same table, it could be noticed that , total carbohydrates content was high in control and treatments control and 10 % than the other treatments. The same Table showed that significant differences in caloric values were found among all the burger blends. The highest amount was noticed in case of burger processed from control blend.

Table 5. Chemical composition and caloric values of the produced beef burger blends (on fresh weight basis).

Beef burger	Moisture	Crude protein	Ether extract	Ash	Crude fiber	T.C*	Caloric value (Kcal/100gm)
Control	52.23[a] ±0.07	19.10[f] ±0.08	3.50[a] ±0.01	0.17[f] ±0.01	1.02[f]±0.01	23.98[a]±0.07	203.82[a]±0.012
10%CGBL*	51.52[b] ±0.14	19.42[e] ±0.06	2.35[b]±0.01	0.59[e] ±0.01	2.60[e] ±0.06	23.52[b] ±0.12	192.91[b]±0.052
20% CGBL	50.71[c] ±0.06	19.75[d] ±0.11	2.18[c] ±0.02	1.02[d] ±0.01	4.13[d] ±0.07	22.21[c] ±0.13	187.46[c]±0.054
30% CGBL	49.20[d] ±0.07	20.06[c] ±0.14	2.01[d] ±0.14	1.45[c] ±0.01	5.78[c] ±0.06	21.50[d] ±0.20	184.33[d]±0.06
40% CGBL	48.20[e] ±0.10	20.39[b] ±0.14	1.84[e] ±0.04	1.88[b] ±0.04	7.37[b] ±0.06	20.32[f]e ±0.21	179.40[e]±0.06
50% CGBL	47.10[f] ±0.03	20.71[a]±0.01	1.67[f] ±0.01	2.30[a] ±0.03	8.95[a] ±0.05	19.27[f]±0.02	174.95[f]±0.07

T.C*= Total carbohydrates calculated by difference.

-Each value (an average of three replicates) is followed by the standard deviation.

CGBL*= Cooked Germinated Brown Lentil

Results in Table (6) showed that the significant differences in minerals content were found among all the beef burger blends. The same Table showed that the mineral contents of Fe, Zn, Ca and K in beef burger blends were significantly higher than that found in control. The same table showed that the iron content of the beef burger blends analyzed varied from 2.54 to 5.03 mg/100g. These values are higher than that (1.93 mg/ 100 g) reported for control blend. This content of iron will contribute to approximately cover 19.30 to 50.3% and 12.86 to 33.53% iron requirement per day for both children and adults, respectively. The beef burger blends recorded the highest zinc content (table 6) while the lowest zinc content (3.88mg/100g) was found with control. Also, the amount of zinc will contribute to approximately cover 38.8 to 54.8% and 25.86 to 29.86% zinc requirement per day for both children and adults, respectively.

Table 6. Minerals salts profile (mg/100g on dry weight basis) and estimated of contribution to RDA for children and adult of the beef burger

Beef burger	Iron	Zinc	Calcium	Potassium
Control	1.93[f] ±0.07	3.88[f] ±0.08	8.47[f] ±0.01	333[e] ±0.01
Contribution to RDA for children (%)	19.3 0	38.80	1.058	195.8
Contribution RDA to for adult (%)	12.86	25.86	1.058	95.14
10% CGBL*	2.54[e] ± 0.14	4.19[e] ±0.06	17.94[e] ±0.01	360[e] ±0.01
Contribution to RDA for children (%)	25.40	41.90	2.24	211.76
Contribution RDA to for adult (%)	16.93	27.93	2.24	102.8
20% CGBL	3.17[d] ±0.06	4.42[d] ±0.11	27.43[d]±0.02	388.2[d] ±0.01
Contribution to RDA for children (%)	31.70	44.20	3.42	228.35
Contribution RDA to for adult (%)	21.13	29.46	3.42	110.91
30% CGBL	3.79[c] ±0.07	4.94[c] ±0.14	36.91[c]±0.14	415.8[c] ±0.01
Contribution to RDA for children (%)	37.90	49.40	4.61	244.58
Contribution RDA to for adult (%)	25.26	32.93	4.61	118.80
40% CGBL	4.42[b] ±0.10	5.17[b] ±0.14	46.39[b]±0.04	443[b] ±0.04
Contribution to RDA for children (%)	44.20	51.70	5.79	260.58
Contribution RDA to for adult (%)	29.46	34.46	5.79	126.57
50% CGBL	5.03[a] ±0.03	5.48[a] ±0.01	55.86[a]±0.01	470[a]±0.03
Contribution to RDA for children (%)	50.30	54.80	6.98	276.47
Contribution RDA to for adult (%)	33.53	29.86	6.98	134.28

-Each value (an average of three replicates) is followed by the standard deviation**. CGBL*= Cooked Germinated Brown Lentil**

Item	**Iron**	**Zinc**	**Calcium**	**Potassium**
RDA for children(mg/day)	10	10	800	170
RDA for adult(mg/day)	15	15	800	350

RDA=Recommended Dietary Allowance (2011)

These results are in agreed with Zia-UL-haq *et al.*, (2011) who reported that the lentil cultivars contained good amounts of calcium, zinc and iron, but potassium constituted the major mineral. These results revealed that lentils may provide a sufficient amount of minerals to meet the human mineral requirement. Calcium content of the beef burger blends analyzed seems to be higher in the blends 10,20,30,40 and 50% than the control. The calcium content of the control sample (8.47mg /100g) is much lower than beef burger blends. However, regarded the low contribution (1.058 to 6.98 %) of the calcium content of the blends to the recommended dietary requirements per day, it can be suggests that meat is not a good source of calcium. Potassium was found in highest amount, the consumption of 100 g of blend will allow to cover about 195.8 to 276.47 % and 95.14 to 134.28% of potassium requirement per day for children and adult respectively. This will highly contribute to the regulation of heart beat, neurotransmission and water balance of the body. Palatability of foods is measured by different sensory properties, such as color, odor, texture, appearance, tenderness and taste express their overall acceptability. On the other hand, control beef burger recorded the lowest odor, texture, appearance, tenderness, taste and overall acceptability. Addition of brown lentil in any percent improved sensory scores compared to the control. The results are in agreement with those of Miller *et al.*, (1993).

Table 7. Sensory characteristics of the prepared beef burger

Beef burger	Color (10)	Odor (10)	Texture (10)	Appearance (10)	Tenderness (10)	Taste (10)	Overall acceptability (60)
Control	8.8^{a} ±0.79	7.6^{c} ±0.89	7.2^{b} ±1.54	7.5^{b} ±0.53	6.5^{c} ±0.53	7.4^{b} ±0.52	45.0^{c} ±0.520
10% CGBL*	9.1^{a}±0.737	9.45^{a} ±0.83	9.1^{a} ±0.74	9.3^{a} ±0.82	9.3^{ab} ±0.82	8.9^{a} ±1.24	55.15^{a} ±0.069
20% CGBL	9.1^{a} ±0.87	9.35^{ab} ±0.90	9.2^{a} ±0.92	9.4^{a} ±0.84	9.4^{a} ±0.83	9.2^{a} ±1.14	55.65^{a} ±0.267
30% CGBL	9.2^{a}±0.788	9.35^{ab} ±0.82	9.5^{a} ±0.66	9.4^{a} ±0. 74	9.2^{ab} ±0.74	9.2^{a} ±0.82	55.85^{a} ±0.29
40% CGBL	9.2^{a} ±0.78	9.0^{ab} ±0.68	9.5^{a}±0.56	9.5^{a} ±0.42	9.1^{ab} ±0.72	9.6^{a}±0.82	55.90^{a} ±0.082
50% CGBL	8.6^{a}±1.07	8.70^{b} ±0.79	8.5^{a} ±0.70	9.5^{a} ±0.63	8.2^{ab} ±0.73	8.9^{a} ±0.98	52.40^{b} ±0.11

Each value (average of 10 replicates) within the same column, each value is followed by the standard deviation.
CGBL*= Cooked Germinated Brown Lentil

CONCLUSION

Generally, it could be concluded that the incorporation of brown lentil into beef burger, as a good functional and nutritional properties meat replacer, at the tested levels; 10%, 20%, 30%,40% and 50% of meat weight used in beef burger formulations resulted in producing burger without detrimental effect on the sensory attributes besides improving physiochemical properties and cooking measurements of the product. Beef burger with brown lentil-added showed the highest cooking yield, moisture and fat retention. This could be attributed to the high retention of moisture and fat during cooking. It could be concluded that the reducing beef fat levels with the addition of brown lentil produced a highly acceptable beef burger product with improved nutritional content and cooking.

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تقييم المحتوى الغذائى وخصائص الطهى البرجر البقرى منخفض الدهن

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لقد أجريت الدراسة الحالية للاستفادة من العدس البنى وبرغل القمح لإعداد برجر بقرى صحى من أجل تحسين الخصائص الكيميائية وخواص الطهى والخواص الحسية للبرجرالبقرى. وأظهر التحليل الكيميائي للمواد الخام أن أعلى نسبة من البروتين لوحظت فى العدس البني الخام وبرغل القمح على التوالى. كما أدت عملية الإنبات إلى انخفاض معنوي طفيف في محتوى البروتين والمستخلص الاثيرى.كما أدت عملية طبخ العدس البني المنبت إلى انخفاض معنوى في حامض فيتيك ومثبط التربسين. وأظهرت النتائج أن الألياف الغذائية القابلة للذوبان وغير القابلة للذوبان في العدس البني المطبوخ كانت أعلى بكثير من تلك الموجودة في العدس الخام والمنبت وبرغل القمح .واظهرت النتائج الى وجود زيادة معنوية فى القدرة على الاحتفاظ بالرطوبة والاحتفاظ بالدهن مقارنة مع الكنترول. اوضحت النتائج ان ادماج العدس البنى لخلطات البرجر ادى الى زيادة معنوية فى القدرة على الاحتفاظ بالماء بالمقارنة بالكنترول. وكانت قيم الثيوباربيتوريك اسيد فى الخلطات المحتوية على العدس البنى (٠,١٦ –٠,٢٩ ملليجم مالونالدهيد/ كجم من وزن المنتج الرطب) اقل من العينة الكنترول (٠,٥٨ ملليجم مالونالدهيد /كجم من وزن المنتج الرطب). .وقد لوحظت أعلى نسبة معنوية من البروتين والألياف في خلطات البرجر البقرى التي أعدت من مزيج العدس البني والبرغل واللحم من التى وجدت فى الكنترول. وكانت محتويات المعادن (الزنك، الحديد، الكالسيوم والبوتاسيوم) اعلى فى خلطات البرجر من تلك الموجودة فى العينة الكنترول. و بشكل عام كانت خلطات البرجر اكثر تفضيلا لأنها أظهرت أعلى درجة قبول فيما يتعلق بجميع الخصائص الحسية. وأخيرا،اوصى بانتاج خلطات مجففة من العدس البنى والبرغل وعرضها فى الاسواق المصرية لإعداد برجر بقرى صحى ، ولتحسين قياسات الطهي والخصائص الحسية.

الكلمات الافتتاحية: العدس البنى– البرجر البقرى– خصائص الطهى–عميلة الانبات– التقيم الحسى