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Seed Sprouts as a Functional Food to Produce Sprout Veggie Burger

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Abstract

The processed meat consumption in Egypt has increased steadily, and this has a negative effect on numerous health and environmental aspects. To chive healthier and population and better environment in Egypt, Replacement of all or part of the processed meat by more sustainable plant protein sources as legumes is a necessity. Therefore, The research investigated the effect of substituting of meat by 100% of sprouted faba bean, lentil, chickpea seeds and whole wheat grain or soy bean flour to produce sprout veggie burger.Prepared sprout veggie burger was subjected to chemical and sensory analysis to evaluate the suitability of sprout veggie burger to consumption. Results showed excellent taste, texture, color, odor and higher protein content (23% and 24%) and essential amino acids for sprout veggie burger made from 50% sprouted faba bean and 50% sprouted lentil with soy bean flour and sprout burger made of 33.3% sprouted faba bean, 33.3% sprouted lentil and 33.3% sprouted chickpea with soya bean flour was also

acceptable and nutritious. Chemical score was calculated for all veggie burger. Methionine was the first limiting amino acid among all veggie burger and valine was the second limiting amino acid. Development of sprout veggie burger from germinated faba bean, lentil and chickpea may be promising in Egyptian human foods for their nutritional advantageous due to high essential amino acids content. In addition, the veggie burger was acceptable by panelist and useful from respect of the human health and has an economic aspect to the market beef burger with 65% meat or market vegetable burger made of soy bean and barley.

Introduction

There has been a significant increase in the production of value added meat products in Egypt. Processed meats especially beef burgers and sausages are common food items to many people in Egypt, as can be seen by the many fast food chains and local burger stands. Processed foods and animal products account for 90% of calories consumed in the typical diet, and these foods lake antioxidants and supportive phytochemicals that abundant in unrefined plant foods ***(USAD Economic Research Service, 2010).Babji et al. (1989)*** described burger to contain a minimum of 65% meat and the rest was comprising of cereal, water binding materials, flavors and spices.

The high consumption of animal meat (source of protein) leads to a high intake of saturated fatty acids which have been shown to correlate with numerous health problems, such as metabolic syndrome, cardiovascular disease and cancer ***(Sinhaet al., 2009 and Babioet al., 2012).*** The high consumption of animal meat also

increase the environmental impact in terms of increased emission of polluting greenhouse gasses in addition, the producing of livestock also has a negative impact on the environment in terms of biodiversity and usage of land ***(Steinfieldet al., 2006 and United Nations FCCC/CP/2015).***Moreover, it is much more costly protein energy than that from some plant-based sources ***(Jayson et al., 2009 and Davis et al., 2010).*** However, it is often argued that producing meat is inefficient since animals consumed more protein than they produce (every kilogram of animal protein produced, animal consume an average of almost 6 kilograms of plant protein from grains and forage) as reported by ***Francione (2004)*** and ***Singer (2009).*** Legumes, on the other hand, have a much smaller impact on the environment and could therefore be a great alternative protein source ***(Esmaillzadeh et al., 2006; Mirmiran et al., 2009 and Davis et al., 2010).*** Legumes (source of protein and carbohydrates) consumption appear to help reduce the risks for coronary heart disease, diabetes, obesity and significantly lower serum cholesterol concentrations ***(Geil and Anderson, 1994 and Leterme, 2002).*** However, the consumption of legumes in human diet is limited due to the presence of certain anti-nutritional factors (α-glactooligosaccharides, phytic acid, condensed tannins, polyphenols and lectins) as repeatedof ***Alonso et al.(1998).*** Germination is one of the methods used to eliminate of various numbers of anti-nutritional factors present in foods ***(Friaset al., 1995; Bau et al., 1997 andHooda and Jood, 2003)***. It is characterized by a changing array of enzymatic activities.

Sprouting seeds of most cereals and legumes have shown to improve the nutrients in human diet and compare well with their row parts counter if not better ***(Kylen and McCready, 1975).*** Seed

germination and production of sprouts are an old habit that was adopted thousands of year's age by the ancient Egyptians **(Abdallah, 2008)**. Seed sprouting is the practice of soaking, draining and leaving seeds until they germinate and begin to sprout. It has been identified as an inexpensive and effective technology for improving the nutritional quality of seeds. As water is introduced, enzyme inhibitors are disabled and the seed explodes to life ***(Frias et al., 1995; Bauet al., 1997 and Schulze et al., 1997).***However, little or no attempts have been made by Egyptian researchers to use sprouted (or germinated) grain and seed for food products.

The concept behind the use of such sprouted grains and legume seeds is that the enzymes produced during sprouting convert starch into more digestible disaccharides as well as the vitamins and minerals content available for digestion increased. In fact the sprouting seed is a "predigests" process. It is well known that germination induces increase in free limiting amino acid and available vitamins with modified functional properties of seed components ***(Hallén et al., 2004; Zielinski et al., 2005 and Khattak et al., 2007).***

Since the quality and quantity of nutrient compounds are important when the sprouts are considered as a new functional food, the present study was undertaken to produce high nutrient and acceptable sprout veggie burger made from sprouted seeds.

Material and Methods

A-Sprout burger experiments:

Raw materials:

Faba bean (*Viciafaba*), chickpea (*Cicerarietinum*), lentil (*Lenusculinaris*) seeds, wheat grains (*Triticumaestivum*), soy bean

flour (SF) in addition to control sample were obtained from Agricultural Research Center (Agronomy and Food Technology Research Institute), Ministry of Agriculture, Giza. While, other ingredients (fresh onion, garlic, eggs, spices, oil and salt) were purchased from the local market.

Seeds and grain sprouts production:

Faba bean; chickpea; lentil seeds and wheat grains were sprouted using the glass jar method as described by ***Cairney (1997)*** and ***Abdallah (2008).*** The sprouting work was carried out in the Horticulture Dep., Faculty of Agriculture, Ain Shams University. The sprouts were taken when their radicals reached the length of the seeds or grains (about 24 hrs. for wheat grains and chickpea and 48 hrs for faba bean and lentil with longer radicals than seeds). Sprouted wheat grains were left on a tray for about 12 hrs under air force van until the grains become dry before grinding, while other sprouts were used fresh.

Sprout veggie burger making procedure:

Sprouted veggie burger patties were formulated to contain about 300g of the following ingredients: 50% dehulls fresh sprouted seeds (about 150g), and 50% (about 150g) other ingredients'including75g fresh onion, about 36± 1g egg white (albumin), 10g salt and 3g spicesand 15g oil and these ingredients were blended together at high speed setting for 30 seconds then mixed with about 11± 1g wheat sprouts or soybean flour, then formed into formal patties shape (about 3 patties) for the mixtures depending on % of sprouted seed to each other by weight (in 150g of fresh sprouts) were as follow (Table 1).

Soya bean and sprouted wheat flours were added to these mixtures each in separate experiment. Then each 80±5g of batter was shaped with manual burger maker to circular-shaped patties. The patties were cooked on a preheated electric grill for 2 minutes on both sides to obtain a ready-to-eat sproutveggie burger according to ***Ou and Mittal (2006).*** Three patties were used from each mixture for sensory evaluation. Sprout veggie burgers have high score by the panelists were selected from both soybean and sprouted wheat flour experiment for chemical analysis.

Sensory evaluation:

Sensory evaluation of cooked sproutveggie burger from both experiments was conducted by 10 panelists. The characteristics of sprout burger include color, taste, texture and odor. Samples were evaluated according to point scale for grading as described by ***Ou and Mittal (2006).*** Sprout veggie burger samples were evaluated by trained judges using 9-point Hedonic ,, slightly, 5= neither like or dislike, 6= liked slightly, 7= liked moderately, 8= liked very much and 9= liked extremely. Scores were collected and analyzed statistically.

Chemical analysis:

In addition to control (vegetarian market burger), eight selected mixtures sprout veggie burgers by the panelists (four from each soy and sprouted wheat flour experiment) were used for chemical analysis. Cooked sprout veggie burger samples plus control were oven-dried at 60˚ C for 48 hrs. then grinded in laboratory wiley mill to pass through a 40 mesh sieve... Iron and zinc were analyzed by atomic absorption spectrophotometer 3300 Perken Elmer,while calcium was analyzed by ICP optima 2000 DV Perkin Elmer according to the method described in the ***AOAC (2012).***

Calculation of protein and nutritional quality of burger samples:

Protein content was determined according to ***AOAC (2012).*** Amino acids determination was performed according to ***AOAC (2012).***Total amino acids scores were calculated based on the whole hen´s egg amino acids profiles ***(Paul and Southgate. 1976).*** Amino acids score was calculated according to ***(FAO/ WHO1973).***

Amount of amino acids per test burger/ amount of amino acids per protein in reference (whit egg).

The essential amino acids score calculated according to ***(FAO/ WHO/UNU 1985).***

The essential amino acids(A/E) ratio ***(Arai,1981 and* Glenncross,2004)**of each essential amino acid (EAA) was calculated as percentage of the total EAA.

A / E Ratio =((individual EAA content/ total EAA content) ×100).

Essential amino acids index (EAAI) for the burger samples were determined from the formula expressed by ***Labuda et al., (1982) and Mente et al., (2002)***: according to the following equation :

$$\text{EAAI} = \sqrt[y]{\alpha\alpha 1/AA1 \times \alpha\alpha 2/AA2 \ldots\ldots\ldots \times \alpha\alpha 11/AA11}$$

Where: aa1 is the A/E ratio in the selected sprout burgersamples ,AA1 is the A/ E ratio in the composition amino acid of hen egg as reference ***(sarwar et a.l, 1985).***

Biological values (BV) wascalculated according to ***Mune - Muneet al., (2011)*** using the following equation of ***Oser (1959).***

BV= 1.09 × EAAI -11.7

Protein efficiency ratio (PER) was estimated according to the following equation purposed by ***Alsmeyer et al., (1974)*****,** equation for legumes

PER = -1.816+0.435(MET) + 0.780(LEU)+0.211(HIS) - 0.944(TYR)
Leu/ Isolucine ratio was also calculated as shown by ***Adeyeye (2013).***

Calculation of other protein quality parameters:

Determination of the ratio of total essential amino acid(TEAA) to the total amino acids (TAA).i.e (TEAA/ TAA), total sulpher amino acids (TSAA), percentage cysteine in TSAA (% Cys/ TSAA), total aromatic amino acids (TARAA), total neutral amino acids (TNAA), total acidic amino acids (TAAA) and total basic aino acids (TBAA) were estimated from the results obtained for amino acids profiles.

Statistical analysis

The data were statistically analyzed by analysis of variance (ANOVA) using completely randomized design and least significant difference (L.S.D) at 0.05 levels according to the method described by ***Snedecor and Cochran (1980).***

Results and Discussion

Sensory evaluation

Results of sensory evaluation of cooked sprout veggie burger samples containing soy bean flour (in 1st experiment) and sprouted whole wheat grain flour (in 2nd experiment) substitution as compared to the control (market vegetarian burger) is shown in Table 1 and 2.

The results of sprout veggie burger taste, texture, color and odor showed that 50% lentil sprouts with 50% faba bean sprouts (M5) and both at 33.3% with added 33.3% chickpea sprouts (M 8) ranked at the top in both experiments (Table 1 and 2) due to excellent texture, color and odor followed by sprouted chickpea 50% with either sprouted lentil 50% (M 6) or sprouted faba bean 50% (M 7) in both experiment with no significant differences in soy bean flour experiment especially for taste evaluation (Table 1) and for color in

sprouted whole wheat grain flour (Table 2). However, all samples (from M 5 to M 8) in both experiments recorded significantly higher values compared with control mixture (M 1). Therefore, dried sprout veggie burger samples selected were from four mixtures (M 5, M 6, M 7 and M 8) of each experiment in addition to market vegetarian burger control (M 1) were chemically analyzed (9 mixtures) to determine minerals, ash, total protein and amino acids content.

Proximate chemical composition of selected mixture sprout veggie burgers

Table (4) shows that moisture, crude protein, ash and mineral contents of selected cooked and dried sprout veggie burger made from four mixed sprouted lentil, chickpea and faba bean with soya bean flour (SM 2, SM 3, SM 4 and SM 5) or whole wheat grain flour (SM 6, SM 7, SM 8 and SM 9) in addition to market vegetarian burger control (M 1). The data tabulated reveal in general that moisture content of sprout burger with soy bean flour and with sprouted whole wheat grain flour were fallen in near range since the moisture content of the flours ranged between 4.1 and 5.2%.

On the other hand, the control market vegetarian burger recorded the highest moisture content (7.2%) may be due to using sieved barley flour with soya bean flour which adsorption more moisture content. The crude protein content of selected sprout veggie burger with soybean flour (especially which that contained faba bean sprouts) was higher (21 - 24%) than the crude protein content of similar sprout burger with sprouted whole wheat grain flour (18.2 - 19.9%).

However, the control (market vegetarian burger) contained 22.3% crude protein. Sproutveggie burger contained 50%sprouted faba bean and 50%sprouted lentil (SM4) or 33.3% sprouted faba

bean with 33.3% sprouted lentil and 33.3% chickpea (SM5) had the highest crude protein content (23 and 24%, respectively) than the veggie control (Table 3). Highest ash content was recorded for soy bean flour sproutveggie burger of SM2-SM5 8.1-7.2 % respectively followed by sprout veggie burger with sprouted whole wheat grain flour ofSM6 - SM9 which were (5.7 and 7.0%) respectively while the control (M1) recorded the highest ash content (8.3%). The increment ash content in soy bean flour sprout burger than sprouted whole wheat grain flour may be due to the higher crude fiber content in whole wheat flour than soy bean flour which in contrast with ash content as reported before by ***Ammar (2012).***

Moreover, the increment of ash content in sprout veggie burger with soy bean recorded highest minerals contents, which ranged from 1280 to 1850 for Ca; 22.0 to 29.8 for Zn and 7 to 120 for Fe mg/kg while sproutveggie burger with sprouted whole wheat flour recorded the lowest minerals contents ranged between 917 to 1139 for Ca; 18.5 to 20.9 for Zn and 55.0 to 64.4 for Fe mg/kg. The minerals content in control treatment were 2146 for Ca, 24.7 for Zn and 182.6 for Fe, these may be due to higher ash content (8.3%) and also due to unsprouted sieved barley flour and mixed spices in control mixture, which usually contained higher minerals.

Amino acids composition of selected mixture sprout veggie burgers

General amino acids profiles

Amino acids composition is presented in Table (6). The obtained data observed that sprout burger with soy bean flour had higher amounts of all amino acids than those found in sprout burger with sprouted whole wheat grain flour. Sprout veggie burger contained faba bean and lentil sprouts with soy bean flour especially selected mixture number four (SM4) had the highest amounts of amino acids than the control (M1) and other mixtures. It could be observed that sprout

veggie burger produced by using soy bean flour with faba beans and lentil sprouts (SM4) had higher amount of essential (indispensable) amino acids than the control, local market vegetarian burger (M1) especially, isoleucine, leucine, lysine, phenylalanine, theronine and valine. In concerning methionine and histidine the both M1 and SM4 contained nearly similar contents.

Concerning non-essential amino acids (dispensable), again sproutveggie burger produced by sprouted faba bean and lentil with soy bean flour (SM4) had higher amount of alanine, arginine, aspartic acid, glutamic acid, glycine, serine and aspartic acid than the control treatment (M1) and other mixtures. On the other hand, cysteine and proline amino acids are higher in the control vegetarian burger (M1) than sprout veggie burger for other treatments from (SM2 -SM9).

Also, the data in Table (6) reveled that sprout burger produced by faba bean sprout and lentilsprout with soy bean flour (SM4) contained adequate amounts of amino acids when compared with the control vegetarian burger (M1) but thatSM4 burger protein was deficient in sulphur-containing amino acids as cysteine. On the other hand, increasing faba bean and lentil sprouts percentage (50%) in the sproutveggie burger with soy bean flour (SM4) increased the above amino acids while decreasing sprouts percentage to 33.3% plus adding sprouted chickpea with soy bean flour (SM5) decreased the amino acids content compared with higher sprout percentage in (SM4). Therefore, the increment of amino acids in (SM4) may be due to both the additionsof soy bean flour and the higher percentage of faba bean plus lentil sprouts.(Legumes).

Moreover Data in Table (6) showed that the predominant amino acids of all burger samples, were non-essential amino acids. The glutamic acid content showed the highest amount, followed by

aspartic acid and argenine in all sprout veggie burger samples. Thisincrement result by seed sprouting was similar to that of ***Kliegman etal. (2007); Roohineja etal. (2009) and Moongngarmand Saetung (2010)***.In the case of essential amino acids, lysine increased by 18.5% and 23% in SM4 and SM2 sprout veggie burgers respectively as compared with local market control veggie burger (M1).

Decarboxylation of glutamic acid increased (Gamma Amino Buteric Acid) GABA synthesis ***(Bak et al., 2006)*** **.**GABA is one of the most interesting compounds in germinated cereal grains, since it can prevent and / or avertdiseases ; it plays a vital role in the central nervous system, as an inhibitory neurotransmitter; and it has a hypotensive effect on blood pressure (Xu et al., 2001).However the concentration of glutamic acid also remarkable increased by 10% and 12% in SM1 and SM2 sprout veggie burger respectively as compared with compared veggie burger (M1).

On the other hand, market control veggie (M1) contains lower Arginine (5.97 g per 100 g) than all sprout veggie burger which contains from 6.41 g in SM6 to 8.1g in SM9 selected sprout veggie burger (Table -6) confirming that sprout veggie burger are best arginine sources than control market veggie burger.

Amino Acid Scores and Quality:

Table (7) contains the EAA scores (EAAS) percentage of the selected mixture sprout veggie burgers based on the whole hens egg profile ***(Paul and Southgate, 1976).***The scoreshad values greater than 95% in histidine and greater 80% in phenylalanine .The least score was Methionine (24.4 to 35.3%) in all selcted mixture sprout veggi burger followed by valine (50 to 60%) and threonine (51.6 to 65.3%) .The sprout veggi burger under discussion showed very good comparison with the EAA profile of the market veggiburger .

However The work of ***Murai et a.,l (1984)*** showed that in calculating EAAI, the A/E ratio was a better indicator for amino acid balance than that based on amino acid content. The A/E ratio (Table 8) of the different selected sprout veggie burger generally showed higher lysine (Lys) in all burgers than that of control veggie burger (M1).The rest of EAA (A/E ratio) were almost similar among sprout veggie burger.

Table (6 and 9) presents parameters on the quality of the protein in the selected sprout veggie burger.Total AA ranged as 70.2g /100g (burger produced by using wheat sprout flour with lentil and chickpea sprout flour SM6) to 84.7 g/100g (burger produced by using soya flour with lentil and chickpea sprout flour), the EAA ranged between 26.4-31.9 g/100 g crude protein (Table 6).The values were Lower than the value of egg reference protein .Similar results of higher EAA in animal sources than that of plant sources was recorded by ***Penaflorida , 1989***. Morever data in Table (9) showed that the total sulpher amino acid (TSAA) recorded the higher value (3.39 g/100g) of SM9 sprout burger sample (burger produced by using sprouted wheat grain flour with faba bean+ chickpea+lentil sprout flour). The value of 3.01 g/100g of SM2 (burger produced by using soya flour with lentil and chickpea sprout flour) was close to the value of 3.10 g/100g of control (M1) (market veggie burger).Other sprout veggie burger recorded less values (2.17 to 2.92 g/100g).

The aromatic AA (ARAA) range suggested for ideal infant protein (6.8 11.8 g/ 100 g crude protein) (FAO/ WHO/ UNU, 1985) was very favorably comparable with the current study (7.44- 8.77 g/ 100g).Showing that the white egg albumin could be used to supplement seed sprout flour for veggie burger production. The percentage ratio of total EAA to the total EAA (TAA) in the sprouts veggie burger samples ranged between 36.67 to 38.15 %.These values were well above the 26% considered adequate for ideal

protein food for children and 11% for adults ***(FAO/ WHO/ UNU, 1985).*** The percentage of EAA/TAA for the sprout veggie burger (from 36.67 to 38.15%) could be favorably compared with market veggie burger control (38.09%).The percentage of total neutral AA (TNAA) to the total AA (TAA) ranged from 61.85 to 63.33% ,indicating that these these formed the bulk of the AA.Totalacid AA (TAA) ranged from 20.10 to 24.68 g/ 100g. crud protein, which was higher than total basic AA (TBAA) (ranged from 10.25 to 12.86 g/100g).However TBAA range made them the third largest group among the sprout veggie burger samples. The Leu/ ILeu ratio was low at 1.66 to 1.76. this is much less than in turkey hen (2.09 to 3.33) ***(Adeyeye and Ayejuyo ,2007),*** but close to the control market veggie burger (1.64).

Most animal proteins are low in Cys,for examples (Cys/ Ta AA)% 26.0- 26.5% in turkey hen meat ***(Adeyeye and Ayejuyo ,2007).***In contrast many vegetable proteins contains substantially moreCys than Meth ***(Adeyeye,2004)*** .Thus for mixed diets containing animal protein, Cys is unlikely to contribute up to 50 % of the TSAA ***(FAO/ WHO,1991).***However the present results of 57.7 to 70.20% Cys/TSAA.Cys has positive effects on mineral absorption particularly zinc ***(Mendoza,2002 and Sandstrom et al., 1989).***The most widely used method for measurement of protein quality is the protein efficiency ratio (PER) test, which is the weight gained by the rats (biological assays) divided by the weight of protein consumed.Nowdays ***,Alsmeyer,(1974)*** equations using AApractical and less expense and time required for the assay test.Alsmeyer equations 1 and 2 were in effective in predicting PER of foods containing little or no meat or poultry. Therefore his equation 3 which used with products that contain grain or yeast origin was used in this study. The values of PER (Table 9) of selected mixture sprout veggie burgers samples were higher than 1.0 in SM2 (using soybean flour with lentil and chickpea), SM4 (using soy bean flour with lentil and

faba bean) ,SM8 (using sprouted wheat grain flour with lentil and faba bean) and SM9 (using sprouted wheat grain flour with,lentil+fababean+chickpea) and higher than control (market veggie 0.968).These results can be compared to cowpea (1.21 value) and pigeon pea (1.82 value) ***(Salunkhe and Kadam, 1989),*** millet (1.62 value) , sorghum (0.27 value) ***(Oyarekua and Kadam, 1989).***

Protein quality can be measured also using biological values (BV) and essential amino acid index (EAAI) .In computating EAAI, values were assigned a maximum of 1.0(100%) and minimum of 0.01(1.0%) ***(Hayashi,et al., 1986).***Scientifically, it is well known that a protein - based food nutritional quality when its BV is high (70 % 100%) and also when the EAAI is above 90% and to be useful as food when the values is around 80% and to be inadequate for food material when its EAAI is below 70% ***(Oser,1959).***In this present study, it is observed that BV value of selected mixture sprout veggie burger and market veggie burger control values (80.2 to 83.9%) with the values reported by ***(Oser,1959).***Also EAAI values (Table 9) ranged between 84.3 to 87.7% which be useful as food according to the values reported by ***(Oser,1959).*** These results agree with***Penaflorida (1989).***

Finally, from the present results, the sprout veggie burger would serve as a functional food because of the much better protein utilization, high essential amino acids content and was acceptable by panelist's evaluation than that of local market barley and soya bean flour burger. In addition, the sprout veggie burgers are the most useful in the respect of the human health, economic aspects and environmentally friends to that of local market beef burger (65% meat).

Table (1) Percentage of sprouted seed in each patties mixture (M)

Mixtures / Ingredients	M1 Control*	M2	M3	M4	M5	M6	M7	M8
Sprouted lentil (SL)	------	100%	------	------	50%	50%	--------	33.3%
Sprouted faba bean (SFB)	------	------	100%	------	50%	-------	50%	33.3%
Sprouted chickpea (SC)	------	------	------	100%	------	50%	50%	33.3%

*Control = market vegetarian burger

Table (2): Sensory evaluations of sprout veggie burger (soy bean flour)

Evaluation tests / Sprouts burger	Taste	Color	Texture	Flavor
M_1 Control*	4.29 ^{c}	4.43 ^{d}	3.14 ^{d}	7.71 ^{a}
M_2 Lentil	6.86 ^{ab}	6.0 ^{c}	6.43 ^{c}	6.14 ^{cd}
M_3 Faba bean	7.14 ^{a}	6.86 ^{abc}	7.43 ^{abc}	7.43 ^{ab}
M_4 Chickpea	5.57 ^{bc}	7.29 ^{ab}	7.0 ^{abc}	5.71 ^{d}
M_5 Faba bean + lentil	8.29 ^{a}	7.43 ^{ab}	7.71 ^{ab}	7.14 ^{abc}
M_6 Chickpea + lentil	7.14 ^{a}	6.43 ^{bc}	6.43 ^{c}	6.86 ^{abc}
M_7 Faba bean + chickpea	7.43 ^{a}	7.43 ^{ab}	6.57 ^{bc}	6.43 ^{bcd}
M_8 Faba bean + lentil+chickpea	8.29 ^{a}	7.86 ^{a}	8.0 ^{a}	7.71 ^{a}

The same letters in each column represents the insignificant difference at P< 0.05

* Vegetarian market burger

Table (3): Sensory evaluations of sprout veggie burger (wheat grain flour).

Evaluation tests / Sprout burger	Texture	Color	Taste	Odor
M_1Control*	4.86 ^{d}	5.43 ^{b}	6.0 ^{bc}	6.71 ^{cd}
M_2Lentil	5.29 ^{cd}	5.57 ^{b}	5.71 ^{bc}	6.43 ^{d}
M_3Faba bean	7.43 ^{b}	7.29 ^{a}	5.57 ^{c}	6.86 ^{bcd}
M_4Chickpea	4.43 ^{d}	5.14 ^{b}	6.14 ^{bc}	5.43 ^{e}
M_5Faba bean + lentil	8.14 ^{ab}	8.14 ^{a}	8.71 ^{a}	8.43 ^{a}
M_6Chickpea + lentil	7.71 ^{b}	7.43 ^{a}	6.43 ^{bc}	6.57 ^{cd}
M_7Faba bean + chickpea	5.86 ^{c}	7.43 ^{a}	7.0 ^{b}	7.71 ^{ab}
M_8Faba bean + lentil +chickpea	8.71 ^{a}	7.86 ^{a}	8.57 ^{a}	7.43 ^{bc}

The same letters in each column represents the insignificant difference at P< 0.05

* Vegetarian market burger

Table (4): Proximate chemical composition of selected mixture sprout veggie burgers (%DB)

Sprout burger (mixtures)	Moisture %	Total protein%	Ash%
M_1 Control	7.2	22.3	8.3
SM_2 Lentil+ chickpea+soya	4.2	19.3	8.1
SM_3Faba bean+ chickpea+soya	4.1	21.0	7.4
SM_4Faba bean + lentil +soya	5.2	23.0	7.4
SM_5Faba bean + chickpea + lentil+soya	4.6	24.0	7.2
SM_6Lentil + chickpea+ wheat	4.6	20.6	5.7
SM_7Faba bean+ chickpea+ wheat	4.4	18.2	6.5
SM_8Faba bean + lentil + wheat	4.5	19.9	7.0
SM_9Faba bean+ chickpea+ lentil + wheat	4.4	18.9	6.9

Each value represents the mean of 3 determinations

Table (5): Mineral content of selected mixture sprout veggie burgers

Sprout burger (mixtures)	Minerals (mg/kg)		
	Ca	Zn	Fe
M_1 Control	2146	24.7	182.6
SM_2 Lentil+ chickpea+soya	1850	29.8	120.0
SM_3Faba bean+ chickpea+soya	1280	24.4	83.4
SM_4Faba bean + lentil +soya	1325	16.2	71.0
SM_5Faba bean + chickpea + lentil+soya	1393	22.0	89.4
SM_6 Lentil + chickpea+ wheat	1139	20.9	64.4
SM_7Faba bean+ chickpea+ wheat	1121	20.0	55.0
SM_8Faba bean + lentil + wheat	917	18.6	62.9
SM_9Faba bean + chickpea + lentil+ wheat	964	18.5	56.7

Table (6): Amino acids content (g/100g) for selected mixture sprout veggie burgers

Amino acids	M1*	SM2*	SM3*	SM4*	SM5*	SM6*	SM7*	SM8*	SM9*	Reference AA of Egg
Essential AA										
Isoleucine	3.86	3.79	3.67	3.92	3.38	3.16	3.47	3.57	3.60	6.30
Valine	3.86	3.99	3.86	4.09	3.42	3.40	3.74	3.87	3.92	6.80
Lysine	4.22	5.19	4.86	5.00	4.30	3.84	4.40	4.57	4.66	7.00
Leucine	6.33	6.53	6.15	6.53	5.63	5.34	5.88	6.28	6.19	8.80
Phenylalanine	5.16	5.45	4.58	5.05	4.75	4.57	5.22	4.62	4.92	5.70
Theronine	3.23	3.17	3.05	3.31	2.88	2.63	2.81	3.17	2.86	5.10
Methionine	1.08	1.14	1.20	1.05	0.83	1.07	0.99	0.92	1.01	3.40
Histidine	2.83	2.65	2.67	2.66	2.34	2.38	2.70	2.51	2.43	2.50
Total	30.57	31.91	30.04	31.61	27.53	26.39	29.21	29.51	29.59	45.60
Non-Essential AA										
Alanine	3.55	3.79	3.62	3.83	3.34	3.21	3.68	3.72	3.65	-
Aspartic acid	8.79	9.80	9.05	9.96	8.80	7.67	8.68	9.15	9.21	-
Serine	3.64	4.20	3.81	4.31	3.84	3.50	3.90	4.12	3.65	-
Glutamic acid	13.28	14.88	12.81	14.61	12.75	12.43	14.34	14.07	14.07	-
Total	29.26	32.67	29.29	32.71	28.73	26.81	30.60	31.06	30.58	-
Conditionally essential AA										
Prolin	5.52	3.79	3.39	3.79	3.13	3.35	3.69	4.22	3.70	-
Glycine	3.50	3.48	3.34	3.53	3.09	2.92	3.30	3.37	3.28	-
Cysteine	2.02	1.87	1.72	1.66	1.34	1.46	1.65	1.56	2.38	2.40
Tyrosine	3.41	3.32	3.34	3.44	2.84	2.87	3.30	3.02	2.91	4.20
Argenine	5.97	7.67	7.62	7.83	6.92	6.41	7.91	7.69	8.10	-
Total	20.42	20.13	19.41	20.25	17.32	17.01	19.85	19.86	20.37	-
Total AA	80.25	84.71	78.74	84.57	73.58	70.21	79.66	80.43	80.54	-

M 1= control (market veggie burger)
SM 2= lentil + chickpea + soya
SM 3= faba bean + chickpea + soya
SM 4= faba bean + lentil +soya
SM 5= faba bean + chickpea + lentil + soya
SM 6= lentil + chickpea+ wheat
S M 7= faba bean + chickpea + wheat
S M 8= faba bean + lentil + wheat
SM 9= faba bean + chickpea + lentil + wheat

Table (7): Essential amino acid score % of selected mixture sprout veggie burgers

Amino acids	M 1*	SM 2*	SM 3*	SM 4*	SM 5*	SM 6*	SM 7*	SM 8*	SM 9*
Isoleucine	61.26	60.16	58.25	62.22	53.65	50.16	55.08	56.67	57.14
Valine	56.76	58.68	56.76	60.15	50.29	50.00	55.00	56.91	57.65
Lysine	60.28	74.14	69.43	71.43	61.43	54.86	62.86	65.29	66.57
Leucine	71.93	74.20	69.89	74.20	63.98	60.68	66.82	71.36	70.37
Phenylalanine	90.52	95.61	80.35	88.60	83.33	80.18	91.58	81.05	86.32
Theronine	65.29	62.17	59.80	64.90	56.47	51.57	55.09	62.17	56.08
Methionine	31.76	33.53	35.29	30.88	24.41	31.47	29.12	27.06	29.71
Histidine	113.20	106.00	106.80	106.40	93.60	95.20	108.00	100.40	97.20

M 1= control (market veggie burger)
SM 2= lentil + chickpea + soya
SM 3= faba bean + chickpea + soya
SM 4= faba bean + lentil +soya
SM 5= faba bean + chickpea + lentil + soya
SM 6= lentil + chickpea+ wheat
S M 7= faba bean + chickpea + wheat
S M 8= faba bean + lentil + wheat
SM 9= faba bean + chickpea + lentil + wheat

Table (8): Essential amino acid (A/E) ratio of selected mixture sprout veggie burgers

Amino acids	M 1*	SM 2*	SM 3*	SM 4*	SM 5*	SM 6*	SM 7*	SM 8*	SM 9*
Isoleucine	11.36	10.76	10.99	11.18	11.13	10.80	10.67	10.97	11.08
Valine	11.36	11.33	11.56	11.67	11.26	11.62	11.50	11.90	12.06
Lysine	12.42	14.73	14.56	14.27	14.16	13.12	13.53	14.05	14.34
Leucine	18.63	18.54	18.42	18.63	18.54	18.25	18.09	19.31	19.05
Phenylalanine	15.19	15.47	13.72	14.41	15.64	15.62	16.06	14.20	15.14
Theronine	9.15	9.00	9.14	9.44	9.48	8.99	8.64	9.74	8.80
Methionine	3.18	3.24	3.59	3.00	2.73	3.66	3.05	2.83	3.11
Histidine	8.33	7.52	8.00	7.59	7.70	8.13	8.31	7.72	7.48

M 1= control (market veggie burger)
SM 2= lentil + chickpea + soya
SM 3= faba bean + chickpea + soya
SM 4= faba bean + lentil +soya
SM 5= faba bean + chickpea + lentil + soya
SM 6= lentil + chickpea+ wheat
S M 7= faba bean + chickpea + wheat
S M 8= faba bean + lentil + wheat
SM 9= faba bean + chickpea + lentil + wheat

Table (9): Calculated nutritional quality of selected mixture (SM) sprout veggie burgers as compared with market veggie control (M1)

Amino acids	M 1*	SM 2*	SM 3*	SM 4*	SM 5*	SM 6*	SM 7*	SM 8*	SM 9*
TEAA+Arg /TAA%	36.54	39.58	37.66	39.44	34.45	32.80	37.12	37.20	37.69
TEAA/TAA%	38.09	37.67	38.15	37.42	37.42	37.59	36.67	36.69	36.74
TNAA/TAA%	61.91	62.33	61.85	62.58	62.58	62.41	63.33	63.31	63.26
TSAA(Meth +Cys)	3.10	3.01	2.92	2.71	2.17	2.53	2.64	2.48	3.39
ArAA(Phe+Tyr)	8.57	8.77	7.82	8.49	7.59	7.44	8.52	7.64	7.83
TEAA/TNAA	61.53	60.44	61.68	59.80	59.78	60.22	57.90	57.95	58.08
Cys/TSAA%	65.20	62.10	58.90	61.30	61.80	57.70	62.50	62.90	70.20
TNAA	13.38	13.80	13.11	13.89	12.06	11.47	12.86	13.37	13.12
TAAA	22.07	24.68	21.86	24.57	21.55	20.10	23.02	23.22	23.28
TBAA	10.19	12.86	12.48	12.83	11.22	10.25	12.31	12.26	12.76
PER	0.968	1.192	0.913	1.002	0.749	0.607	0.657	1.161	1.217
EAAI %	85.8	85.7	87.7	86.1	84.8	86.7	84.3	85.8	86.3
BV %	81.8	81.7	83.9	82.1	80.7	82.8	80.2	81.8	82.4
Leu/I leu.	1.64	1.72	1.67	1.66	1.66	1.69	1.69	1.76	1.72

M 1= control (market veggie burger)
SM 2= lentil + chickpea + soya
SM 3= faba bean + chickpea + soya
SM 4= faba bean + lentil +soya
SM 5= faba bean + chickpea + lentil + soya
SM 6= lentil + chickpea+ wheat
S M 7= faba bean + chickpea + wheat
S M 8= faba bean + lentil + wheat
SM 9= faba bean + chickpea + lentil + wheat

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انبات البذوركأغذية وظيفية لإنتاج برجر نباتى

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الملخص العربي

إزداد فى الآونة الأخيرة إستهلاك اللحوم المصنعة فى مصر ومالها من آثار سلبية على الصحة والبيئة ويعتبر الإستبدال الكلى أو الجزئي للحوم المصنعة ببديل من مصادر البروتين المستدامة مثل البقوليات عملية هامة للحفاظ على الصحة العامة للسكان والبيئة فى مصر ولهذاأجريت تجارب هذه الدراسة لمعرفة تأثير إستبدال اللحوم المصنعة المتواجده فى البرجر المنتشر بالأسواق بإضافة النبت الطازج لبذور البقوليات من حمص الشام والفول البلدى والعدس مخلوطاً مع دقيق نبت حبوب القمح الكاملة مقارنة بدقيق فول الصويا لإنتاج برجر الخضروات النابته. وقد تم إجراء التحليلات الكيمائية والصفات الحسية وفى مقدمتها الطعم لبرجر الخضروات النابته. وذلك مقارنة بالبرجر النباتى الناتج من مخلوط دقيق الشعير ودقيق فول الصويا المتواجد بالأسواق كمقارنة لمعرفة مدى القابلية والصلاحية لبرجر الخضروات النابته للإستهلاك وأظهرت نتائج المقارنة بين برجر الخضروات النابته والبرجر السوقى كمقارنة تفوق نتائج برجر الخضروات النابته الناتج عن مخلوط نبت الفول البلدى ونبت العدس كل منهما بنسبة 50% وكذلك برجر الخضروات النابته الناتج عن مخلوط نبت الفول البلدى ونبت العدس بالإضافة لنبت حمص الشام وكل منهم بنسبة الثلث (33.3%) وكلا النوعين الناتجين من البرجر النابت تم إعدادهما - بالخلط مع دقيق فول الصويا حيث كان محتواهما من البروتين يعادل بنسبة 23% و24% على التوالى وكذلك زيادة فى محتوى الأحماض الأمينية الضرورية بها.

خلصت نتائج البحث الى أن إنتاج برجر الخضروات النابته من نبت بذور الفول ونبت العدس ونبت حمص الشام يعتبر مستقبل جيد لتوفير غذاء آمن غنى فى قيمته الغذائية لتفوقه فى إستهلاك البروتين و الأحماض الأمينية التى زاد محتواها فى نبت البذور بالإضافة إلى تقبله

للإستهلاك وأهميته من وجهة النظر لصحة الإنسان والنواحى الإقتصادية مقارنة بالبرجر الذى يشتمل على اللحوم المصنعة وهذا يوضح أن نبت البذور حقا إرث الأجداد الفراعنة لتحسين جودة غذاء الأحفاد بإنتاج برجر الخضروات النابتة.