Effect of using some Legumes on the Sensory evaluation, Chemical composition on Suitable Burgers for Diabetic Patients

تأثير استخدام بعض البقوليات على الخصائص الحسية والكيميائية لبرجر يناسب مرضى السكرى

ا.د/ طلعت محمد سحلول

قسم الاقتصاد المنزلى –كلية التربية النوعية

جامعة دمياط

ا.د/ نجلاء مسعد شنشن

قسم الاقتصاد المنزلى –كلية التربية النوعية

جامعة دمياط

ا.د/ رشا محمود عرفة

قسم الاقتصاد المنزلى –كلية التربية النوعية

جامعة دمياط

ا/ هبه نور الدين عبد الصمد

الباحثة بقسم الاقتصاد المنزلى –كلية التربية النوعية

جامعة دمياط

المجلة العلمية لكلية التربية النوعية – جامعة دمياط

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Sahloul ,Talaat[1]. Shanshan, Naglaa.[2] ,Arafa,Rasha[3].
Nour-El din, Heba[4].
[1, 2,3] Home Economics Dept., Fac. of Specific Education, Damietta Uni., Egypt.
[4] Desert Research Center - Matrouh- Egypt.

ABSTRACT

The current study aims to study the effect of using some legumes (sweet lupine, chickpea, and fab bean) on the sensory evaluation, chemical composition, amino acids, and bioactive components of burgers suitable for diabetic patients. For this purpose, burgers were prepared by adding three levels of sweet lupine, chickpeas, and faba bean powders (10%, 20%, and 30%) replacement respectively, by studying the sensory properties of these samples. As well as, study the effect of sweet lupine, chickpea, and faba bean (30%) on the chemical composition, amino acids, and antioxidant activity of cooked burgers. The results obtained from the sensory tests indicated that sensory evaluation was decreased gradually with increasing levels of sweet lupine, chickpea and faba bean. Generally, the sensory evaluation showed an acceptance of supplemented burger samples with 10%, 20%, and 30% sweet lupine, chickpea, and faba bean. For the results of chemical compositions of cooked burgers, the results showed that supplemented burgers with 30% sweet lupine, chickpea and faba bean led to, a significant ($p \leq 0.05$) increase in both moisture, total carbs and crude fiber and a significant decrease in protein, fat, and ash be compared with the control (un- fortified burgers). The results of amino acids of cooked burgers showed an increase in essential and non-essential amino acids compared with the control (un- fortified burgers). Also, the results of bioactive components of cooked burgers showed, a significant ($p \leq 0.05$), increase in antioxidants, total phenolic and flavonoid contents be compared with the control (un-fortified burgers).

It can be recommended that, add legumes (sweet lupine, chickpea, and faba bean) powder and their combination into a diet for diabetic patients.

Key words: sweet lupine, chickpea, faba bean, sensory evaluation, chemical compositions, amino acids, antioxidants, diabetic patients

INTRODUCTION

Diabetes Mellitus (DM) is a chronic hyperglycemia that may result from inadequate insulin synthesis or from peripheral tissues' inability to respond to the presence of insulin. It is the most prevalent endocrine condition in the world and is linked to a higher risk of morbidity and mortality (**Tungmunnithum *et al*.,2022 and Helal *et al*., 2023).**

World Health Organization (WHO) informed that 422 million people suffered from diabetes all over the world (95% of them with type 2 diabetes), whereas the same organization predicted earlier in the 2000s that 330 million people would have diabetes in 2030 and 783 million by 2045 **(Hinault *et al*., 2023).** Diabetes causes many harmful effects on body such as risk of cardiovascular diseases increased the risk of nonalcoholic fatty liver disease damage in the eyes, kidneys, and nervous system and two- to three-fold increased risk of strokes so the suggested opinion is to control early glucose levels in the blood for the protection of future complications of diabetes **(Hinault *et al*.,2023).** Legumes are plant crops belonging to the *Fabaceae* family and known for their rich content of secondary metabolites, antioxidant properties and series of health and environmental benefits from a nutritional, and well known for their rich content of protein, carbohydrates, fat, fibers, and vitamins that are greatly contribute to livestock growth along with various benefits due to natural phytochemicals, also considered low glycaemic index(GI),phenolic compounds which can effective on reducing the postprandial glucose and insulin response by increasing the efficiency of insulin and glucose receptors **(Myrtsi *et al*.,2023; Tatke andWaghmare, 2024 and Sharma *et al*.,2024).** Legumes are included in the diet of insulin- dependent diabetics consumption of legumes helps to prevent osteoporosis and reduce body lipid accumulation and overcome the deficiency of lysine this balanced nutritional blend can be an alternative for type 2 diabetic patients that’s due to consumption of legumes with high phenolic content and antioxidant which correlated with a number of positive health benefits **(Mitrus *et al*.,2023 ; Sahu *et al*.,2024 and Drabo *et al*.,2024) .**Legumes starch is characterized by a higher percentage of slowly digestible resistant starch (RS) resulting in low glycemic index and acting as functional foods. The hypoglycemic effects of legumes have been further supported by the high contents of dietary fibers (DF) **(Sahu *et al*.,2024).** The hypoglycemic mechanism of legume diabetic peptides mainly includes reducing glucose absorption, promoting pancreatic β-cells proliferation, enhancing insulin

secretion, and sensitivity through signaling pathways associated with diabetes, and inhibiting carbohydrate-digesting enzymes (α-amylase and α-glucosidase) **(Chandran *et al*.,2023).**

The present study was designed to investigate the effect of the consumption of sweet lupine, chickpeas, and faba bean on the sensory evaluation, chemical composition, amino acids, and antioxidants of cooked burgers.

MATERIAL AND METHODS

MATERIALS

- Sweet lupine, chickpea and faba bean seeds were obtained from the local market in Shubrahur village, Sinbelawain, Dakahlia, Egypt

-Fresh beef meat was obtained from a local butcher from Shubrahur village, Sinbelawain, Dakahlia

- The ingredients of the burger (fresh onion, powdered grits, whole eggs, salt, and spice mixture) were obtained from a local market in Shubrahur village, Sinbelawain, Dakahlia

METHODS

-Preparing of seeds powder

Seeds were cleaned by hand to remove the foreign materials.Raw seeds of (Sweet lupine, chickpea and faba bean) were washed well and soaked in tap water for 12 hr after that, the seeds were dried at (40- 50° C) for 12 hr in a hot air oven then, whole ground to obtain seeds flour and filling it's in polyethylene bags and keeping it at room temperature until used according to **(Al Baz *et al.*,2021).**

- Preparing of meat

The meat was washed with clean water; trimmable fat was removed by knife, and ground it by using a house mincer.

-Preparing of burgers

The components of the burgers were made from (fresh beef, fresh onion, powdered grits, whole eggs, salt and spice mixture) and mixed with all ingredients (100g beef meat ,6.5% fresh onion,10%powderd grits,6% whole eggs ,1.5%salt and 1% spice mixture) then shaped in circular burger form of 10cm and 0.5cm thickness and about 100g each piece was separated from the other using butter paper then packaged in polyethylene bags and frozen next, it

were grilled at 200°C for 20minutes until golden brown on both sides **according to the methods of (Shadia, 2009).**

- Sensory evaluation

Control of burgers and treated beef burgers were evaluated for (color, smell, taste, texture, and overall acceptability) by (17) specialized arbitrators from the Home Economics Department , Faculty of Specific Education, Damietta University on 4/12/2022.The evaluation was carried out according to the method of **(Shadia,2009).**

Chemical analysis of cooked burgers (%on dry weight basis)

Moisture, carbohydrate, protein, fat, crude fiber, and ash were determined according to the method described in AOAC (2012). Available carbohydrates content of the sample was calculated by the difference as mentioned by **Fraser and Holumes (1959).**

The available carbohydrates (on dry basis) = 100 – (%Ash + %Fat +%Protein + %Fiber).

Amino acids of cooked burgers

Amino acids were determined after hydrolyzing the defatted samples as well as its formulated samples with 6 NHCl at 110 °C for 22 h in a nitrogen atmosphere using Beckman amino acid analyzer **(**Model 118/119 CL) according to the method described by **Moore and Stein (1963)**.

Antioxidant activity of cooked burgers

a- Determination of DPPH radical scavenging activity

Radical scavenging activity of tested compounds ability was assayed using the method of **Burits and Bucar, (2000).** 25 gram of each samples were dissolved in 100 ml of methanol 98%. Methanol extract was filtered with a man No. 1(Grade 589/2) filter paper. One ml of sample extract was added to reaction solution DPPH (1ml) (0.2mM). The mixture was shaken forcibly and left at room temperature for 30 min., then the absorbance of the solution was measured spectrophotometrically (JASCO, Corporation Model V-730, S.N. A112961798 Tokyo, Japan) at 517 nm. % DPPH radical scavenging activity = (Ac–As)/ Ac ×100 …….. (1) As: is the absorbance of the sample; Ac: is the absorbance of control in the absence of the sample.

b- Determination of total phenol content (TPC)

Total phenolic content (TPC) of the sample extracts were determined calorimetrically using Folin-Ciocalteau reagent according to the method described by **Mythili, (2014)** 25 gram of each samples were dissolved in 100 ml of methanol 98%. Methanol extract was filtered with a man No. 1 (Grade 589/2) filter paper. One ml (1 ml) of extract sample was mixed with Folin-Ciocalteu reagent (1ml with distilled water at a rate of 1:10) for 3 min then; 3 ml of 2% sodium carbonate (1 M) was added. The mixture was left at room temperature for 15 min, the polyphenols were determined by an automated UV-VIS spectrophotometer (JASCO, Corporation Model V-730, S.N. A112961798, Tokyo, Japan) at 765 named the results were calculated using a Gallic acid calibration curve (0–100 mg/l).

c- Determination of total flavonoid content (TFC)

The total flavonoid content (TFC) of sample extracts was determined according to the method described by **Ebrahimzadeh *et al.* (2010) and Nabavi *et al.*, (2009).** 25 gram of each samples were dissolved in 100 ml of methanol 98%. Methanol extractwas filtered with a Whatman No. 1 (Grade 589/2) filter paper. The sample extracts **(**1 ml**)** was mixed separately with 1.5 ml methanol, 0.1ml of 10% aluminium chloride, 0.1ml of 1 M potassium acetate and 2.8ml of distilled water. They then left at room temperature for 10min. The absorbance of the mixture was measured at 415nm on a UV/visible spectrophotometer (JASCO, Corporation Model V-730,S.N. A112961798, Tokyo, Japan). The quercetin (µg/ml) was used as a standard for the calibration curve. Equivalent quercetin content in the test samples was determined using the standard linear equation (A=0.022X+0.006; R2= 0.999).

Statistical analysis

Results were expressed as means ± standard deviation (n = 3) and Anova variance analysis with average comparison Ducan Multiple Range set to *(P<0.05)* **(Duncan,1955).** All the statistical processing was done by the Statistical Package for Social Science (SPSS, V21.0) for Windows (SPSS, Inc., Chicago, IL, USA).

RESULT AND DISCUSSION

Sensory evaluation of the burgers fortified with different levels of sweet lupine, chickpea, and faba bean 10%, 20%, and 30%.

As shown in Tables (1, 2, and 3) which demonstrated the sensory evaluation (smell, taste, texture color, acceptability, and total score) of burger products fortified with different levels of sweet lupine, chickpea, and faba bean seeds powder 10%, 20%, and 30% respectively.

The results obtained from the sensory testes indicated that, sensory evaluation was decreased gradually with increasing the levels of sweet lupine, chickpea, and faba bean. Generally, the result of the total score of the sensory evaluation demonstrated that, burgers that were supplemented with ratios (10%,

20%, and 30%) of sweet lupine, chickpea, and faba bean were acceptable. Thus, the ratio (30%) was used in the chemical composition, amino acids and antioxidant of cooked burgers.

The results are consistent with the study of **Fibri and Frost, (2020) and Yaseen and Ahmed,(2021)** informed that, due to nutritional and functional effect legume's powder it has been utilized in the manufacture of various food products including meat products as hamburger which have been met with some textural and sensory challenges. It was found that, successfully produced a produced a new product with significant nutritional value, cooking features and acceptable sensory-textural properties of hamburger with content of chickpea or lupine powder had sensory properties similar to the control and was rated close to very good.

The study by **Othman *et al*., (2020)** reported that legume seed flour replacement of up to 50% has a good effect on the sensory properties of food products and would serve as a functional food because of the high superior nutritionally.

On the other hand, **Youssef *et al*.,(2021)** recommended that, prepared burgers from bean and chickpeas 50% as meat replacer to prepare a beef burgers the sensory evaluation showed that, burger 50% of both types had the highest degree of sensory evaluation, lower cost with improving health and cooking properties compared to the control group.

As said by **ELKatry and ElSawy (2021) and Bahmanyar *et al.*, (2021) Sharma and Giri, (2022),**investigated, the physicochemical, nutritional and sensorial characteristics of beef burgers formulated with seeds powder resulted in, improved overall acceptability, and taste of sensory attributes and can be utilized as a functional food ingredient

Also reported **Basiri *et al*., (2022) and Abdel-Aal, (2024)** indicate that, legume powder were used in the formulations food products, these results would be acceptable by consumers confirmed better rankings in all attributes evaluated sensory evaluation.

Table (1): Sensory evaluation score of the burgers fortified with different levels of sweet lupine

Treatment	Smell	Taste	Texture	Color	Acceptability	Total Score
Control	19.40 ± 0.21^{a}	19.52±0.25 ^{a}	20.00±0.21 ^{a}	18.08±0.77 ^{a}	19.25±0.22 ^{a}	95.77±1.12 ^{a}
10% SLP	18.72±0.29^{ab}	18.27±0.48 ^{b}	18.03±0.66 ^{b}	18.03±0.23 ^{a}	18.30±0.32 ^{b}	92.27±1.64^{ab}
20% SLP	18.40±0.41 ^{b}	17.98±0.50 ^{b}	18.01±0.66 ^{b}	18.40±0.34 ^{a}	18.07±0.50 ^{b}	91.33±1.33 ^{b}
30 %SLP	18.17±0.32 ^{b}	17.38±0.57 ^{b}	17.08±0.24 ^{b}	17.70±0.40 ^{a}	17.70±0.44 ^{b}	88.79±1.88 ^{b}

SLP=sweet lupine powder. Values are expressed as mean ± SD. Different letters on the same column represent statistically significant ($p \leq 0.05$) difference among means

Table (2): Sensory evaluation score of the burgers fortified with different levels of chickpeas

Treatment	Smell	Taste	Texture	Color	Acceptability	Total Score
Control	19.40 ± 0.21[a]	19.52±0.25 [a]	18.09±0.36 [a]	18.08±0.77 [a]	19.25±0.22 [a]	95.77±1.12 [a]
10% CPP	18.59±0.37 [b]	18.52±0.42[ab]	18.37±0.33 [ab]	18.17±0.37 [a]	18.30±0.41 [b]	91.95±1.76 [b]
20 % CPP	18.50±0.39 [b]	17.33±0.72 [b]	18.15±0.35 [ab]	18.23±0.36 [a]	18.05±0.41 [b]	91.03±1.60 [b]
30 % CPP	18.47±0.40 [b]	17.57±0.38 [b]	17.93±0.33 [b]	18.17±0.38 [a]	17.95±0.43 [b]	90.58±1.71 [b]

CPP =Chickpea powder. Values are expressed as mean ± SD. Different letters on the same column represent statistically significant ($p \leq 0.05$) difference among means.

Table (3): Sensory evaluation score of the burgers fortified with different levels of faba bean

Treatment	Smell	Taste	Texture	Color	Acceptability	Total Score
Control	19.33±0.40 [a]	19.33±0.21 [a]	20.00±0.40 [a]	18.71±0.34 [a]	19.13±0.30 [a]	95.43±0.33 [a]
10% FBP	18.05±0.74 [a]	18.00±0.54 [ab]	18.00±0.47 [a]	18.13±0.65 [a]	18.32±0.44 [a]	91.03±0.57 [b]
20 % FBP	18.00±0.99 [a]	18.00±0.91 [ab]	18.00±0.66 [a]	17.73±0.74[ab]	18.06±0.30 [ab]	89.00±0.72 [c]
30 % FBP	17.06±0.32 [b]	17.04±0.35 [b]	17.53±0.41 [b]	17.04±0.21 [b]	17.05±0.27 [b]	87.33±0.31 [d]

FBP =faba bean powder. Values are expressed as mean ± SD. Different letters on the same column represent statistically significant ($p \leq 0.05$) difference among means.

Chemical Composition of cooked burgers fortified with 30% sweet lupine, chickpea, and faba bean seed powder

The chemical composition components of cooked burgers fortified with 30% SLP, CPP and FBP seed were analyzed for proximate composition including moisture, protein, total carbohydrates, fat , crude fiber, and ash on a dry basis shown in Table **(4)**

Data presented in Table **(4)** and implied that, the chemical composition which included moisture, protein, total carbohydrates, fat crude fiber, and ash of cooked burgers and control (un-fortified burgers) were 44.06±٠.21, 20.91 ± 1. 23 , 59.99±0.86, 8.64±0.45, 2.60 ±0.03, and 7.86±0.15 respectively. Also showed a significant increase ($P \leq 0.05$), in moisture (%) ,and total carbs (%). Also, crude fiber showed, a significant increase in sweet lupine and non – a significant increase in chickpea and faba bean be compared with the control. However a significant decrease ($P \leq 0.05$), in protein (%) and fat As well as, ash declared a significant decrease in all parameters compared with the control (un-fortified burgers).

These findings are in agreement with some previous studies by **Maray *et al*.,(2023) ; Landge *et al*., (2023) and Vignesh *et al*.,(2023)** and with the chemical composition of meat analogues formulate with legume powder as contains 20-45% protein, 1-3% fat, 55-65% carbohydrate, 10-15% fiber and 4-6% ash.

In the same line**,** these results are agreed with the studies which conducted by **Sharma and Giri, (2022) ; Estivi *et al*.,(2023) and Guzmán *et al*.,(2024)** who studied the chemical composition of legume seeds to formulate meat analog products as chickpea and lupine powders content of moisture, ash, protein, fat, crude fiber and total carbohydrates respectively, the carbohydrate fraction of legumes is primarily composed of starch (65%–72%) and DF (10%–20%).

Similar results were obtained by of **Schmidt *et al*., (2023); El-Badrawy and Mostafa ,(2023), and Kim *et al*.,(2023)** reported that, the faba bean seed contain high contents of protein (44.6%), crude fiber (3.48), fat (1.3%), and ash (6.3%) on a dry weight basis also،conducted the differences in the chemical composition could be attributed to the geographical location, handling and processing or the variety of the faba bean.

Also **Schmidt *et al*.,(2023) and Abdel-Aal ,(2024)** noted that dry seed legumes flour are consisted mainly of carbohydrates (15–68%), proteins (15-40%), and dietary fiber (15-35%) depending on the legume a varied content of lipids especially in fab beans and chickpea. Resistant starch is also present mainly this fraction may comprise 30.3% and 24.2% of the total fiber.

The current findings for the proximate composition of dried legumes chickpea and faba beans are in corroboration with **Naz *et al*.,(2023)and Tawalbeh *et al*., (2023)** The composition dry seed has been described by several authors in the past protein content between 22.70% and 50.66% of dry matter (DM) and fat content ranged from 0.70% to 3.50% DM. However, in addition to the resistant starch content from 40.00% to 44.30% DM moreover carbohydrates, moisture and dietary fibres **(Bangar and Dhull.,(2022) ; Krause *et al*.,(2023) and Abdel-Aal ,(2024).**

Table (4): Chemical composition of cooked burgers fortified with 30% sweet lupine, chick peas, and faba bean (% on dry weight basis).

Samples		Chemical composition of cooked burgers (% on dry weight basis)				
	Moisture (%)	Total carbs (%)	Protein (%)	Fat (%)	Crude fiber (%)	Ash (%)
Control	44.06±٠.21^{b}	20.91±١,٢٣^{d}	59.99±٠,٨٦^{a}	8.64±٠,٤٥^{a}	2.60±٠,٠٣^{d}	7.86±٠,١٥^{a}
30% SLP	50.28±١,٣٦^{a}	28.11±٢,١٠^{c}	54.14±٠,٢٥^{b}	5.52±٠,٣٠^{b}	5.13±٠,٠٨^{a}	7.10±٠,٠٤^{b}
30% CPP	45.90±١,٠٧^{b}	40.72±٠,٧٩^{a}	42.63±٠,٥٨^{d}	6.63±٠,١٦^{b}	3.65±٠,٠٦^{c}	6.37±٠,٠٦^{c}
30% FBP	46.43±0.46^{b}	38.26±١,٩٩^{b}	47.10±٠,٠٦^{c}	3.52±٠,٠٥^{c}	4.51±٠,٠٥^{b}	6.61±٠,٠٤^{c}

SLP = sweet Lupine powder. CP P = chickpea powder.
FBP = faba bean powder. Values are expressed as mean ± SD. Different letters on the same column represent statistically significant (P≤0.05) difference among means

Amino acids of cooked burgers fortified with 30%sweet lupine, chickpea, and faba bean seed powder

Amino acid composition is an important factor in the determination of protein nutritional values data in Table **(5)** illustrates that, essential amino acids histidine, isoleucine, leucine, threonine, lysine, methionine, cysteine, phenylalanine, tyrosine valine, and non-essential amino acids as aspartic acid, serine, alanine, arginine, proline and glycine of burger fortified with 30% sweet lupine, chickpea, and faba bean seeds powder.

Results analysis of amino acids expressed as mg amino acid/100 mg (%) of the burger are presented in Table **(5).** The highest value in amino acids composition of cooked burgers fortified with 30% SLP, CPP, and FBP were recorded in glutamic acid followed by aspartic acid and leucine as compared with the control (unfortified burgers) from the same table it could be noticed that also, tyrosine, histidine, and cysteine were recorded the lowest values of amino acids of the fortified burgers. The total essential amino acids of the control burger and fortification burger are 44.35, 38.09, 42.76, and 43.31. Similarly to, the total of non-essential amino acids is 37.19, 45.69, 37.31, and 43.48 respectively .

Commonly, there are some minor variations in the quantity of a few amino acids such as aspartic acid, glutamic acid, serin, glycine, histidine, arginine, threonine, alanine, proline ,tyrosine, valine, methionine, cysteine, isoleucine, leucine ,phenylalanine and lysine this result is agreement with those observed in studies of **Lemus-Conejo *et al*.,(2023); Kim *et al* .,(2023)and Tawalbeh *et al*., (2023)**

These results agree with other similar studies by **Al-Dalain *et al*.,(2023)** indicated that, the amino acids profile of supplemented chicken burgers with 10%,20% and 35 % powdered sweet lupine , chickpea and beans compared with (control treatment) resulted in, legumes are deficient in sulphur containing amino acids may be due to the high quality protein

The obtained results are in agreement with those reported by **Tomczak *et al*.,(2023) and Rodríguez-Martín *et al*.,(2024)** reported that ,the amino acids profile of supplemented chicken burger with 20% powdered sweet lupine and chickpea compared with its un-supplemented one (control treatment) resulted in the amino acid deficiencies in legumes are rich in sulphur-containing amino acids.

Table (5) Amino acids composition of cooked burgers fortified with 30% sweet lupine, chickpea and faba bean.

Amino acids	Control	Sweet lupine 30%	Chickpea 30%	Faba bean 30%
Results (g/100 protein)				
Essential amino acids (E.A.A)				
Histidine	3.58	2.80	3.08	3.22
Isoleucine	4.88	5.25	5.23	4.66
Leucine	7.72	7.91	8.63	8.48
Threonine	4.62	3.89	4.09	4.08
Lysine	4.19	3.49	4.20	5. 05
Methionine	2.57	2.03	2.16	1.90
Cysteine	3.27	2.11	2.73	2.53
Phenylalanine	5.89	4.28	5.13	5.44
Tyrosine	1.40	1.45	1.43	2.10
Valine	6.23	4.88	6.08	5.85
Total E.A.A%	44.35	38.09	42.76	43.31
Non-essential amino acids				
Aspartic acid	6.80	9.42	6.90	8.48
Glutamic acid	9.85	12.47	10.03	11.93
Serine	2.75	5.50	3.18	3.59
Glycine	4.75	5.57	4.02	4.60
Alanine	4.49	4.36	4.30	4.46
Proline	3.14	4.56	3.12	3.64
Arginine	5.41	3.81	5.76	6.78
Total Non E.A.A%	37.19	45.69	37.31	43.48

Essential amino acid (E.A.A.).Values are expressed as mean ± SD. Different letters on the same column represent Statistically significant (P≤0.05) difference among means.

Antioxidant activity of cooked burgers fortified with 30% sweet lupine, chickpea, and faba bean

The antioxidant activity of sample extracts DPPH radical scavenging of cooked burgers fortified with 30% sweet lupine, chickpeas, and faba bean powder including total phenolic and total flavonoids contents of cooked burgers are presented in Tables **(6), (7),** and **(8).**The determination of the free radical-scavenging activity of antioxidants DPPH are presented in Table **(6)** and results proved that, a significant increase ($P \leq 0.05$) are observed between fortified burgers and the control. The highest values ($P \leq 0.05$) for DPPH scavenging activity are noticed in burgers fortified with 30% CPP (44.28±0.11) as followed by FBP and SLP (34.35±0.99 and 29.26±0.31) compared with the control. However, a DPPH decrease was noticed in control (un- fortified burgers).

The total phenolic and flavonoid contents in the burgers are shown in Tables **(7) and (8).** The results illustrated that, legumes are rich sources of phenolic and flavonoid compounds that's in agreement with **Sharma and Giri, (2022)** mentioned that, the phenolic content in legumes was in the range of 62 to 418 mg /100 g.

The results which obtained from Table **(7)** illustrated that, the concentration of total phenolic content (TPC) of cooked burgers fortified with 30% SLP, CPP and FBP revealed a significant increase ($P \leq .05$) between burgers fortified with 30% SLP, CPP, FBP, and the control (un- fortified burgers). It was obvious that, the highest increase amount of total phenolic was recorded in the burgers fortified with 30% CPP and SLP followed by FBP (75.53±1.27, 71.35 ± 1.53 and 52.42±0.810mg /100g) respectively, whereas, this data also demonstrated, non –a significant increase between burgers fortified with 30% CPP, and SLP seed

The results in Table **(8)** were expressed as the total flavonoid contents (TFC) of burger samples explained a significant increase ($P \leq .05$) between fortified burgers with 30% SLP, CPP and FBP seed for the (TFC) value and the control. The (TFC) contents of fortification burgers were (5.96±0.049, 8.14±0.085and 5.31±0.028mg /100g) respectively and the control. Burgers fortified with 30% CPP were recorded the higher amounts of (TFC) (8.14±0.085mg /100g), followed by SLP and FBP. Although, the lowest amounts of (TFC) were obtained by the control (3.32±0.092 mg /100g) (un-fortified burgers).

These findings are in close agreement with previous findings of **Jat *et al*., (2023)** showed, legumes have a potent natural antioxidants of the DPPH radical scavenging activity as chick pea ,faba bean and sweet lupine increased significantly ($P \leq .05$).

Similar findings were reported by **Boișteanu *et al*., (2023) and Negrão *et al*. (2023)** indicated that, bioactive phenolic compounds exhibit free radical scavenging capacity and the ability to interact with other compounds such as proteins.

The results are in the same line with those described by **Asati *et al*., (2022) ; Joshi *et al*., (2023) and Sabat *et al*.,(2024)** suggested that**,** in vitro antioxidant activity using two deferent methods presented ,a correlation between total phenolic and total flavonoids on one hand and antioxidant activity on the other hand, where it showed the highest values for chickpea and yellow lupine seeds respectively.

One of the previous studies **Naz *et al,* (2023) and Langa *et al*.,(2024)** reported that, the high antioxidants activity of legumes with seed coat was due to large amounts of phenolic and flavonoid compounds located in this part and it can be used as the source of natural antioxidants.

Previously it has been reported that, phenolic content in legumes and split pulses ranged from 19.3 to 344.7 mg RE/ 100 g. It was observed a significantly higher phenolic content as in TPC which established by **Joshi *et al*.,(2023) and Rodríguez-Martín *et al*.,(2024).**

According to **Haque *et al*.,(2023), and AL-Dalain *et al*.,(2023)** explained that ,the values of total phenolic compounds showed raise in the legume powders and the results indicated highly significant differences at(P<0.05) legume powder.

In this respect **Badjona *et al*., (2023) and AL-Dalain *et al*.,(2023), and Miao and Tang,(2024)** cleared that**,** flavonoid content of faba bean cultivars varied between 1.4 and 5.0 mg/g, previous studies showed that the total flavonoid content of 41 faba bean varieties was observed to range from 2.5 to 3.2 mg/g, with two outliers having shown higher concentrations of 4.5–5.3 mg/g.

Table (6): DPPH radical scavenging activities of sample extracts acids of cooked burgers fortified with 30% sweet lupine, chickpea and faba bean.

Sample types	DPPH radical scavenging %
Control	23.38 ± 1.74^{d}
30%SLP	29.26 ± 0.31^{c}
30%CPP	44.28 ± 0.11^{a}
30%FBP	34.35 ± 0.99^{b}
LSD at 0.05	4.130

SLP= sweet Lupine powder. CPP= chickpea powder FBP= faba bean powder. Values are expressed as mean ± SD. Different letters on the same column represent statistically significant (P≤0.05) difference among means.

Table (7): Total phenolic contents (TPC) of sample extracts of cooked burgers fortified with 30% sweet lupine, chickpea and faba bean

Sample types	Total phenolic contents (TPC) (mg GAE /g sample)
Control	45.37 ± 1.95^{c}
30% SLP	71.35 ± 1.53^{a}
30% CPP	75.53 ± 1.27^{a}
30% FBP	52.42 ± 0.81^{b}
LSD at 0.05	5.894

SLP=sweet Lupine powder. CPP=chickpea powder .FBP=faba bean powder. Values are expressed as mean ± SD. Different letters on the same column represent statistically significant (P≤0.05) difference among means.

Table (8): Total flavonoids content (TFC) of sample extracts of cooked burgers fortified with 30% sweet lupine, chickpea and faba bean powder.

Sample types	Total flavonoids content (TFC) Mg QE/ g sample
Control	3.32±0.092[d]
30%SLP	5.96±0.049[b]
30%CPP	8.14±0.085[a]
30% FBP	5.31±0.028[c]
LSD at 0.05	0.279

SLP: sweet Lupine powder. CPP: chickpea powder FBP: fab bean powder. Values are expressed as mean ± SD. Different letters on the same column represent statistically significant (p≤0.05) difference among means.

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تأثير استخدام بعض البقوليات على الخصائص الحسية والكيميائية لبرجر يناسب مرضى السكرى

طلعت سحلول[١]، نجلاء شنشن[٢]
رشا عرفة[٣] ,هبه نورالدين[٤]
[١، ٢،٣] قسم الإقتصاد المنزلى –كلية التربية النوعية– جامعة دمياط – مصر
[٤] مركز التنمية المستدامة لموارد مطروح –مركز بحوث الصحراء – مطروح –مصر

الملخص

تهدف الدراسة الحالية إلى دراسة تأثير استخدام بعض البقوليات (الترمس الحلو، الحمص والفول) على الخصائص الحسية والكيمائية لبرجر يناسب مرضى السكرى . ولهذا الغرض تم إعداد برجر بإدخال الترمس الحلو، الحمص والفول بنسب (١٠%،٢٠%،٣٠%) إستبدال على التوالي ، كما تم دراسة الخصائص الحسية للبرجر المعد ، وأيضا تم دراسة الخصائص الكيميائية ،الاحماض الامينية ومضادات الأكسدة (DPPH,TPC,TFC) للبرجر المعد بنسبة (٣٠%) استبدال .

وأسفرت النتائج المتحصل عليها من الإختبارات الحسية للبرجر المدعم بالبقوليات عن انخفاض تدريجي فى الصفات الحسية للبرجر مع زيادة نسبة البقوليات ، وبشكل عام أظهر البرجر المدعم بالبقوليات بنسبة (١٠%،٢٠%،٣٠%) قبولا حسيا. كما أشارت النتائج المتحصل عليها من الاختبارات الكيميائية عن حدوث زيادة معنوية ($p\leq0.05$) في مستوى كلا من الكربوهيدرات والألياف ، وحدوث انخفاض معنوي ($p\leq0.05$) فى البروتين، الدهن ،والرماد مقارنة بالكنترول (البرجر الغير مدعم). كما أظهرت النتائج أيضا زيادة في محتوي البرجر المدعم من الأحماض الأمينية (الأساسية وغير الأساسية) ، بالإضافة الي حدوث زيادة معنوية ($p\leq0.05$) في مضادات الأكسدة (TPC,TFC,DPPH) مقارنة بالكنترول (البرجر الغير مدعم).

لذا توصي الدراسة بإدخال البقوليات (الترمس الحلو ، الحمص ، والفول) في إعداد أصناف غذائية لمرضي السكري .

الكلمات المفتاحيه: الترمس الحلو ،الحمص ،الفول ،الخواص الحسية، التركيب الكيميائى، الأحماض الأمينية ، مضادات الأكسدة،مرضى السكر