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USE OF APRICOT KERNELS PROTEIN ISOLATE IN BURGER INDUSTRY

Shaimaa Abbas Dhaher[1], Fatima Faiq Juma[1] and Aswan H. Bayar[2*]

[1]Dept. of Home Economic, College of Education for women, University of Baghdad, Iraq
[*2]Dept. of Food Science, College of Agricultural Engineering, University of Baghdad, Iraq
*Email: aswan@coagri.uobaghdad.edu.iq

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ABSTRACT

The current study was conducted with the aim of fortifying meat burger with the protein isolate extracted from defatted sweetened and unsweetened apricot kernels.

The antimicrobial activity of defatted apricot kernels and protein isolates of sweetened and unsweetened kernels against some pathogenic microbes was studied, and it was characterized by its effect on gram-positive bacteria more than gram-negative bacteria. As for its effect on yeast, the inhibition diameter was 4.5 mm at a concentration of 200 mg for the unsweetened protein isolate. As for its effect on mold, the inhibition percentage was between 56.05-65.21% for all samples at a concentration of 100 mg.

The sweetened and unsweetened protein isolate was used in the manufacture of meat burger with a replacement rate of 5%, 10% and 20%, and the shrinkage ratio was measured by diameter of the burger, where the best shrinkage rate was in the burger replaced with 20% of the sweetened isolate, which was 16.25% compared to the control model 18.75%, and the holding capacity of water and fat was measured, and burger which replaced with unsweetened isolate gave the highest value. The number of microorganisms was also measured and a sensory evaluation was conducted for these models. All samples were similar to the control model until 20% of the local sweetened protein isolate was replaced.

***Keywords*:** Apricot kernels, Protein isolates, Bacteria, Yeast.

Introduction

Apricots are stone fruits belonging to the Rosaceae family and to the genus *Prunus* of the Armeniaca division, which includes 3 to 12 different species: *P. ansumaxima*, *P. armeniaca* L., *P. brigantiacavill*, *P. mandshuricakoehne*, *P. xdasycarpaehrh*, *P. holosericea* (batal) kost, *P. mume* (sieb) , *P. siberica* L. (Zhebentyayeva *et al.*, 2012). Apricot originates from China and Japan and is also cultivated in semi-tropical regions around the world, and its main cultivation areas are Southern Europe, Southern Africa, Australia, Iran and Turkey (Yiğit *et al*., 2009).

Apricot kernels contain large amounts of oil, proteins, fibers, phenols, minerals and biologically active compounds in addition to the cyanogenic glycoside amygdalin (B17), whose accumulation leads to enhancing the bitter taste, Glucose, benzaldehyde and hydrocyanic acid (Deng *et al.,* 2021).

Several studies have been conducted to benefit from apricot kernels in the food industry, as the kernels represent up to 16% of the weight of the whole fruit, contain 41.5% protein and are a good source of amino acids important to humans (Elkot *et al.,* 2017).

In a study (Jaafar, 2021) mentioned that the most effective antibacterial activity against gram-positive bacteria in methanol extracts of sweet and bitter apricot kernels, and aqueous extracts of bitter apricot kernels. The activity of methanol extract from bitter kernels against gram-negative bacteria and antifungal activity was also observed**.**

Other study indicated that the extracts of apricot kernels have antimicrobial activity, as the areas of inhibiting the growth of microorganisms were recorded in which the volume of extract 100 µl was used (Horozić *et al*., 2020).

The increasing demand around the world for sources of protein that are relatively cheap and can be incorporated into food products to increase their value, and therefore apricot kernels can be a better alternative to protein isolates that contain a high percentage of proteins (Gupta *et al.,* 2020), after removing the oil from the apricot kernels. The protein is isolated for use in food supplements, where it has good biological and functional properties, in addition to its ability to digest, and it has a low blood sugar index (Saini *et al.,* 2021).

Apricot kernel protein isolate was used in dairy products such as ice cream. An isolate evaluation of protein added to different types of ice cream showed excellent properties. This did not affect the flavor, texture, melting property and shape of these products. Sweet apricot protein isolate is used in ice cream to replace the tangible protein of solid liquid milk and not the fat in the mixture. Non-fat solid liquid milk was replaced by sweet apricot protein (90%) at levels of 5, 10 and 15% in the preparation of ice cream mixtures. Substitution by 5% increased the pH value, specific

gravity and viscosity. The resistance to solubility gradually increased with increasing level of sweet apricot protein isolates. A 10% replacement resulted in the highest overall sensory scores and required performance. Analytical data showed that sweet apricot protein isolate can be used up to 15% in ice cream production (Masoud, 2008).

In a study, ground apricot kernel powder was used in pasta by replacing at 5%, 10%, 15% and 20%. The results of the study indicated that pasta samples with ground apricot kernels, for all levels of addition, contain more protein Thus, pasta acceptable in terms of physical, chemical and sensory properties can be produced by incorporating ground apricot kernels in wheat flour up to the level of 15% by weight of the flour (Eyidemir and Hayta, 2009).

Materials and Methods

Preparation of defatted apricot kernels

The fat was removed by mixing the sweetened and unsweetened ground apricot kernels with petroleum ether 40-60 °C, and the ratio was 1:10 (g/ml) with stirring by a magnetic stirrer for 24 hours (Rezig *et al*., 2013).

Preparation of the protein isolate

The protein isolate was prepared by mixing the defatted sample with a solution of 1M NaOH, the ratio was 1:10 (g/ml) and left for half an hour. The mixture was filtered and the pH was adjusted to 5, then the filtrate was centrifuged at 10000xg for 20 minutes at 4°C. The mixture was dried at 30°C for 24 hours (Čakarević *et al.*, 2019).

Antimicrobial activity of defatted apricot kernels and protein isolate against bacteria and yeasts

Firstly, the microbe's isolates were activated: 4 types of bacteria, including *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Salmonella typhimurium* and a type of yeast *Candida albicans*, by transferring a loop full from the bacterial culture to the NB medium, and the tubes were incubated for 18 hours at 37°C, (Al-Delaimy and Ali, 1970). In the case of yeast isolates, they were activated in the PDB medium and the tubes were incubated for 24 hours at 28°C.

Secondly, the filter paper discs diffusion method mentioned by Faleiro *et al.,* 1997) was adopted, by spreading 0.1 ml of the activated bacteria with a sterile glass diffuser on a medium (NA), while for yeasts, 0.1 ml of them was spread on the medium. (PDA), where 4-6 sterile discs were prepared in each dish with a diameter of 5 mm, and each disc was loaded with 10 microliters from defatted apricot kernels. The dishes were incubated for 24 hours at 37 ° C. for the bacteria, as for the yeasts, they were incubated for 48 hours and at 28 °C. The diameter of the clear zone surrounding the disc and free of growth was measured, the diameter of which is directly proportional to the inhibitory activity of the samples.

Study of the inhibitory activity of defatted and isolated apricot kernels against the mold *Aspergilus fusarum* The suspension of the mold was prepared according to (Al-Ani, 2005) and described by (El-Ghaouth *et al.*, 1991). The number of spores in the suspension was calculated using a hemocytometer slide.

The stock solution was prepared from the mold suspension at a concentration of 10000 µg/ml, 1.2 and 3 ml were withdrawn from it and added to 99.98 and 97 ml of PDA sterilized media and cooled to 45-50 °C, respectively. So that the nutrient medium (the final mixture) had the concentrations 100, 200 and 300 µg/ml and in the same order, while the nutrient medium was left without adding the samples as a control and the media was poured into sterile Petri dishes. The effectiveness of the different extracts on the radiological growth of the test molds was tested using the Poisoned food method technique) (Dixit *et al.,* 1976), then plates were inoculated with a loop full of mold spore suspension in the center of the dish, the dishes were incubated at 28 °C and after the incubation time the mold culture diameter was compared with the diameter of the treatment. Mold colony growth for the samples is calculated by the percentage of inhibition as in the equation :

Inhibition percentage = mold colony growth rate in the control-mold colony growth rate in the treatment / mold colony growth rate in the control× 100

Burger manufacturing

The burger was manufactured by using minced pure beef 85%, salt 1.5%, and filler 5% and cold water for kneading; the meat was replaced with the sweetened and unsweetened protein isolate (0%, 5%, 15% and 20%)these burger samples were labeled as (A, B, C, E, F, G and H),were mixed well and formed into discs with a weight of 100 gm for each disc. They were placed in the refrigerator for 4 hours until they were grilled using a hot plate and some physical tests were conducted for them (Abdul Rahim, 2010).

Physical properties of Burger through the manufacturing stages

Shrinkage in diameter

The percentage of shrinkage in diameter was measured according to the method used in (Dosh *et al*., 2016) using Vermeer in three specific locations, and with four replicates for each treatment. The percentage of shrinkage was calculated according to the equation :

Diameter reduction (%) = R1–R2/R1x100

R1 = diameter of the Burger sample before cooking.
R2 = diameter of the Burger sample after cooking.

Water Holding Capacity (WHC)

The water holding capacity of the Burger samples (A, B, C, E, F, G and H) was estimated according to the method used by (Arifin *et al.,* 2021) by mixing 1g of the sample with 10 ml of water through a mixer for 1 minute, then centrifugation at 5000 xg for 10 minutes, and the water holding capacity was calculated according to the following equation:

WHC % = W3–W2–W1/W1x100

W1 = weight of the sample
W2= weight of the dry tube
W3 = Weight of the sample after removing the water

Oil Holding Capacity (OHC)

The oil carrying capacity of the Burger samples (A, B, C, E, F, G and H) was estimated according to the method used by (Bouaziz *et al*., 2020) with some modification by mixing 1g of the sample with 10 ml of vegetable oil by a mixer for 1 minute, the samples were left for half an hour and then centrifugation was carried out at 5000 x g for 20 minutes, and the oil holding capacity was calculated according to the following equation:

OHC=O2-O1/O0

O0 = Weight of dry sample

O1 = weight of the tube + weight of the dry sample before adding the oil

O2 = weight of the tube + weight of the sample after adding the oil

Burger's Microbial Assays

(i) Preparing the decimal dilutions

According to (Anderwa, 1992) 1 gm of burger samples was taken and 9 cm^3 of sterile 0.1% peptone water solution was added, mixed well with a Vortex device for two minutes to prepare the 10^{-1} dilution, from which the rest of the decimal dilutions were prepared in suitable dilution tubes from 10^{-3}-10^{-7}.

(ii) Total Count

1 ml of each dilution was transferred to empty, sterilized dishes, then the nutrient medium was added and mixed well, then left until solidification and incubated upside down at 37°C for 24-48 hours (Al-Nasiri, 2020).

(iii) Coliform Bacteria Count

Mac Conkey Agar nutrient medium was used and incubated for 24-48 hours at 37°C, and colonies were counted (Al-Nasiri, 2020).

(iv) Molds and yeasts

The method of pouring plate was used by using PDA and incubated at 30°C for 5 days (Al-Nasiri, 2020).

Burger sensory evaluation

Sensory evaluation was conducted by 10 specialists in the field of food processing. The characteristics of the product were estimated after grilling, which are color, flavor, juiciness, freshness and degree of general acceptance (Tahir, 1979). The following table represents the scores of the burger sensory attributes assessment form.

Table 1 : Scores of the Burger Sensory Attributes Assessment Form

Degree	Color	Flavor	Juiciness	Freshness	General acceptance
7	Very accepting	Strong	Very juicy	Very fresh	Very accepting
6	accepting	Medium	Juicy	Fresh	accepting
5	Little accepting	little	Little juicy	Little fresh	Little accepting
4	medium	No flavor	Medium	Medium	medium
3	Little unaccepting	Little unaccepting	Little dry	Little hard	Little unaccepting
2	unaccepting	Medium unaccepting	Dry	Hard	Unaccepting
1	Very unaccepting	Very unaccepting	Very dry	Very hard	Very unaccepting

Statistical analysis

The Statistical Analysis Systemprogram -SAS (2018) was used in data analysis to study the effect of different treatments on the studied sensory traits according to a complete random design (CRD), and the significant differences between the means were compared with the Least Significant Difference-LSD test.

Results and Discussion

Preparation of defatted apricot kernels

Petroleum ether solvent 40-60°C was used to remove fat from sweetened and unsweetened apricot kernel powder, where the protein content was 29.88 and 35.61%, respectively.

Preparation of the protein isolate

The protein isolate was prepared from apricot kernels after defatting process, as it was found that every 100 gm of sweetened kernels gives (48 gm dry weight) of defatted apricot kernels powder, and this powder gives approximately (13 gm dry weight) of protein isolate, while 100 gm of unsweetened kernels gives (45 dry weight) of defatted apricot kernels powder, which gives approximately (12 g dry weight) of protein isolate, in other words that every 100 g of sweetened and unsweetened apricot kernels gives 13 g and 12 g of protein isolate, respectively.

Antimicrobial activity

Table (2) shows the results of inhibition of pathogenic microbes that cause food spoilage and pathogenic organisms transmitted through food. The highest level of inhibition was observed in the unsweetened protein isolate at a rate of 10.11 mm in *Salmonella typhimurium* (gram-negative bacteria), followed by *Staphylococcus aureus* (gram-positive) at a rate of 10.5 mm at 400 mg concentration, while the inhibition zone of gram-negative bacteria *Pseudomonas aeruginosa* and *Esherichia coli* was 9.25 mm and 8.25 mm in diameter, respectively. The diameter of inhibition for *Candida albicans* and *Aspergillus fusarum* was 12.5 mm and 85.04%, respectively.

It was observed in the protein isolate of sweetened apricot kernels that the highest inhibition was for the Gram-positive bacteria *Staphylococcus aureus* with a diameter of 8.25 mm, followed by the Gram-negative bacteria *Salmonella typhimurium* with a diameter of 6.05 mm, while the inhibition zone of the Gram-negative bacteria *Pseudomonas aureus* and *Esherichia coli* was 6 mm and 4.25 mm, respectively. While it was noted that the diameter of the yeast *Candida albicans* was 8 mm, and the inhibition percentage of *Aspergillus fusarum* was 79.11%.

Table 2 : Inhibitory activity of defatted and isolated sweetened and unsweetened apricot kernels against some pathogenic microbes

	Concentration mg	Inhibition zone rate (mm)			
		Sweetened Protein isolate	Unsweetened Protein isolate	Sweetened defatted powder	Unsweetened defatted powder
Pseudomonas aeruginosa	200	-	-	-	-
	250	3.2	4.75	3	3.5
	300	4.5	7.25	3.25	6.5
	400	6	9.25	5.02	8.5
Staphylococcus aureus	200	-	-	-	-
	250	-	-	-	-
	300	6.5	9.25	4.25	7.02
	400	8.25	10.5	6.12	9.22
Salmonella typhimurium	200	-	-	-	-
	250	-	4	-	-
	300	5.61	9.5	5.10	8.32
	400	6.05	10.11	5.91	9.21
Esherichia coli	200	-	-	-	-
	250	3.5	4.5	3.0	3.1
	300	3.12	6.19	3	3.32
	400	4.25	8.25	4	5
Candida albicans	200	-	4.5	-	-
	250	5.2	10	4.5	6
	300	6.5	11	6.11	10
	400	8	12.5	7.21	10.6
Aspergillus fusarum	100g/ml	62.01%	65.21%	56.05%	60.10%
	200g/ml	73.15%	68.31%	62.53%	77.67%
	300g/ml	79.11%	85.04%	68.21%	80%

With regard to the inhibitory effect of unsweetened defatted apricot kernels, the highest inhibition zone of Gram-positive bacteria *Staphylococcus aureus* was 9.22 mm and Gram-negative bacteria *Salmonella typhimurium* was 9.21 mm, followed by Gram-negative bacteria *Pseudomonas aeruginosa* and *Esherichia coli* with a diameter of 5 mm 8.5 mm, respectively. While the diameter of the inhibition zone of *Candida albicans* was 10.6 mm and the inhibition percentage of *Aspergillus fusarum* was 80%.

It was observed that in the sweetened apricot kernels, the highest inhibition was for the gram-positive bacteria *Staphylococcus aureus* with a diameter of 6.12 mm, and the lowest inhibition was for the gram-negative bacteria *Esherichia coli* with a diameter reached 4 mm. Also, the diameter of *Candida albicans* reached 7.21 mm, and the percentage of inhibition for *Aspergillus fusarum* was 68.21%.

It was mentioned by (Yiğit *et al.,* 2009) in studying the effect of water and methanol extracts of bitter (Zerdali) and sweet (Hasanbey) apricot kernels against six species of bacteria that cause diseases in humans and yeast, with inhibition zone between 8 to 15 mm for *Escherichia coli*, *Staphylococcus aureus*, *Candida albicans* and *Candida parapisilosis*, while the aqueous extract of bitter apricot kernels showed inhibition of *Candida glabrata* and the rest did not.

The results confirmed that both sweet and bitter apricot kernels are sources of potentially rich antimicrobial agents.

Manufacture of Burger by using protein isolate and measurement of physical properties during the manufacturing stages

Shrinkage in diameter

The results in table (3) show the measurement of shrinkage in diameter for the Burger samples after grilling, it is clear the decrease in diameter for the control was 18.75%, while the decrease in diameter for (B, C and E) in which the meat was replaced with sweetened protein isolate with ratio (2.5, 5 and 10%) was 22.5, 21.25 and 16.25%, respectively.

As for the samples (F, G and H), in whichthe meat was replaced with unsweetened protein isolate with ratio(2.5, 5 and 10%), the decrease in diameter reached 21.25, 20 and 17.5%, respectively, where the B sample had the highest decrease in diameter, and E sample had the lowest decrease 16.25% which is lower than the control.

In a study of the modified beef burger with partial replacement of meat with protein isolate from pumpkin seeds at rates (0, 10 and 20%) by (Al-Kargoly, 2020) showed that the modified samples with replacement (10 and 20%) were better than the control model, where the shrinkage rate of the two models was 16.6%, While the control model has a shrinkage of 25%.

Another study of chicken sauce substituted with vegetable protein indicated that the shrinkage in sauce to which chicken was added by 20% was 0.92%, and to which chicken was added by 60%, the shrinkage in diameter reached 10.93%, while no shrinkage was observed In the embodiment where soy protein isolate was used, the use of vegetable proteins as a substitute for meat significantly changed the shrinkage of samples and gluten in retaining the mesh structure after cooking (Kamani *et al.,* 2019). A study of soy protein was used in beef burger, indicated that the shrinkage rate was 24.26 ± 0.17b% compared to the control

model, in which the shrinkage amounted to 27,042 ± 0.31% (Al-Azab *et al.*, 2019), while (Al -Fauzi *et al.,* 2021) mentioned that in the study of duck meat burger, in which the meat was replaced with 5% soy protein isolate, the shrinkage rate ranged between 12.76 ± 2.57%. It occurs due to the partial evaporation of water from the burger and the drainage of melted fats and juices.

Table 3 : Measurement of shrinkage in Diameter (%)

Sample	Shrinkage in diameter (%)
A(Control)	18.75
B (5% sweetened protein isolate)	22.5
C(10% sweetened protein isolate)	21.25
E(20% sweetened protein isolate)	16.25
F(5% unsweetened protein isolate)	21.25
G (10% unsweetened protein isolate)	20
H (20% unsweetened protein isolate)	17.5

Water and Fat Holding Capacity

Table (4) shows the preponderance of water and oil holding for the Burger samples, where the highest water holding capacity in H sample was 61%, followed by G sample by 54%, and the lowest water holding capacity was in the control which is due to the increase in water absorption due to the ability of the protein isolate to swell and expose new binding sites**.**

As for the ability to hold fat, it was the highest percentage of G sample with a percentage of 39%, followed by H sample with a percentage of 33%, while the control reached the lowest in fat absorption.

In a study of Burger's modified meat by partial replacement of meat with the protein isolate of pumpkin seeds by 10 and 20%, found that the highest water holding capacity was in the sample with a replacement of 10%, which was 54.52%, while the water holding capacity of the control and the meat substituted by 20%, amounting to 28% and 23.2%, respectively (Al- Kargoly, 2020).

Table 4 : Water and fat holding capacity for burger samples

Sample	WHC%	FHC%
A(Control)	**24**	**19**
B (5% sweetened protein isolate)	**30**	**23**
C(10% sweetened protein isolate)	**47**	**31**
E(20% sweetened protein isolate)	**52**	**29**
F(5% unsweetened protein isolate)	**32**	**22**
G (10% unsweetened protein isolate)	**54**	**39**
H (20% unsweetened protein isolate)	**61**	**33**

In another study about meat was replaced with vegetable protein indicated that the increase in the replacement of beef causes an increase in the water content of sausages, as the water absorption in the control samples was 86.58 ± 1.33%, while the replacement by 10, 20, 30 and 40 increased the water holding capacity by 86.67 ± 1.50, 87.53 ± 0.97 ab, 89.02 ± 0.96b, and 89.14 ± 1.75b %, respectively. The reason for the increase in the water holding capacity is that the substituted samples contained water-soluble vegetable proteinmore than beef, in addition to containing less fat and thus causes an increase in the holding capacity of water (Hidayat*, et al*., 2018).

Microbial test of Burger samples

Table (5) and (6) shows the results of the microbial test of burger samples with the protein isolate, as there weren't any growth of colon bacteria, yeasts and molds, the total number of bacteria on the first day in the control was 4.2 x 10^5 as well as sample B 3.5 x 10^5, while the number in Sample C was 4.7 x 10^4, followed by sample G, which amounted to 2.7 x 10^4. On the third day, the highest number was in sample E, which amounted to 3.3 x 10^4, while the highest number was in the first week of sampleA (control), which amounted to 5.4 x 10^7. The number of bacteria increased in the second and fourth week for all samples, while no growth of colon bacteria and fungi appeared in the second and fourth week.

Table 5 : Total Count for burger samples (cfu/ml)

Samples	First Day	Third Day	First Week	Second Week	Fourth Week
	Total Count	Total Count	Total Count	Total Count	Total Count
A	^{5}10×4.2	^{6}10×3.5	^{7}10×5.4	^{8}10×6.3	^{9}10×5.7
B	10×3.5^{5}	^{5}10×2.7	^{5}10×4.2	^{6}10×5.4	^{7}10×7.3
C	^{4}10×4.7	^{5}10×2.9	^{5}10×4.7	^{6}10×4.9	^{7}10×5.7
D	^{4}10×2.8	^{4}10×2.6	^{4}10×3.9	^{5}10×4.1	^{6}10×4.6
E	^{4}10×1.8	^{4}10×3.3	^{4}10×3.8	^{5}10×4.6	^{6}10×4.7
F	^{4}10×3.4	^{5}10×5.1	^{5}10×5.6	^{6}10×6.5	^{7}10×7.9
G	^{4}10×2.7	^{5}10×2.3	^{5}10×3	^{5}10×4.2	^{6}10×6.8

Table 6 : Coliform and molds and yeast count for burger samples (cfu /ml)

Samples	First Day		Third Day		First Week		Second Week		Fourth Week	
	Coliform	Molds and yeast	Coliform	Molds and yeast	Coliform	Molds and yeast	Coliform	Molds and yeast	Coliform	Molds and yeast
A	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
B	N	N	N	N	N	N	N	N	N	N
C	N	N	N	N	N	N	N	N	N	N
D	N	N	N	N	N	N	N	N	N	N
E	N	N	N	N	N	N	N	N	N	N
F	N	N	N	N	N	N	N	N	N	N
G	N	N	N	N	N	N	N	N	N	N

A represents the control, B adding 5% sweet isolate, C adding 10% sweetened isolate, D adding 20% sweetened isolate, E adding 5% unsweetened isolate, F adding 10% unsweetened isolate, G adding 20% unsweetened isolate. N=Nil=No growth

In a research thyme was used in meat burgers indicated that the control had a greater number of microbes than beef burgers consisting of Shirazi thyme, and the least number of microbes, which can be attributed to the high antibacterial properties. For the microbes produced by thymol and carvacrol, while the number of microbes increased during storage, but not outside the standard range, a relatively good relationship was observed between the pH and the total number of microbes, it was found that the control had the lowest pH and the highest microbial count (Hashemi Gahruie *et al*., 2017).

In a research which apricot kernel extract was used in beef burger, where the total number of bacteria in the control of beef burger was 4×10^6 and increased after 7, 14, 21 and 30 days, reaching 7.3×10^6 and 13.6×10^6 and 14.6×10^6 and 15×10^6, respectively. As for the burger to which apricot kernel extract was added, it reached 2.3×10^6 on the first day, and the number decreased at 7, 14 and 30 days to 1×10^6, 1×10^6 and 2×10^6, respectively (Mohamoud, 2016).

Sensory evaluation of Burger samples after grilling

Table (7) represents the results of sensory evaluation of Burger meat substituted with sweetened and unsweetened protein isolate with a percentage (5, 10 and 20%) for the samples (B,C,E,F,G,H) and their comparison with the control A in terms of color, flavor, juiciness, tenderness and general acceptance at the level (P<0.05).

(i) Color

The results of the table show the superiority of the two samples B and C by 6.50 for both, as for the samples D, E, F and G, the color reached 6.20, as observed the superiority of the results over the control, which amounted to 5.10**.**

(ii) The flavor

It is clear that from the table (7) sample B has outperformed all samples, reaching 6.50, followed by sample C, which reached 6.40, where the two samples outperformed the control, which reached 5.80, and sample G was the lowest among others 3.60.

(iii) Juicy

It is clear from the results of the table that the sample B and C outperformed all samples, as it reached 6.40 and 6.30, respectively, compared to the control A, which amounted to 6.20.

(iv) Freshness

The results indicate that the E-sample outperformed all samples, as it reached 6.40, compared to the control, which reached 6.30.

(v) General acceptance

It is clear from the results of table (7) that the values of samples B and C were equal in general acceptance, reaching 6.40 for both, the values of the two samples outperformed the control, which amounted to 5.90, while sample G was the lowest, with general acceptance reaching 3.50.

Table 7 : Results of sensory evaluation for burger samples

Samples	Mean±				
	Color	**Flavor**	**Juicy**	**Freshness**	**General Acceptance**
A	**0.40± 5.10**b	**0.29± 5.80**ab	**0.13± 6.20**a	**0.33± 6.30**ab	**0.18± 5.90**a
B	**0.16± 6.50**a	**0.16± 6.50**a	**0.16± 6.40**a	**0.29± 6.20**ab	**0.16± 6.40**a
C	**0.16± 6.50**a	**0.22± 6.40**a	**0.26± 6.30**a	**0.21± 6.30**ab	**0.16± 6.40**a
D	**0.44± 5.00**b	**0.20± 5.80**ab	**0.27± 5.90**ab	**0.17± 5.90**ab	**0.21± 5.70**a
E	**0.24± 6.20**a	**0.22± 5.60**bc	**0.17± 6.10**a	**0.30± 6.40**a	**0.27± 6.10**a
F	**0.24± 6.20**a	**0.34± 4.90**c	**0.22± 5.40**b	**0.34± 5.60**b	**0.37± 4.90**b
G	**0.20± 6.20**a	**0.40± 3.60**d	**0.26± 5.30**b	**0.21± 6.00**ab	**0.30± 3.50**c
LSD	*** 0.817**	*** 0.778**	*** 0.621**	*** 0.776**	*** 0.713**

Means with different letters within one column significantly differ among then at (P<0.05).

As (Al-Kargoli, 2020) said that replacing meat with pumpkin seed protein by 10 and 20% as a vegetable protein led to an improvement in its characteristics such as color and juiciness and was close to the control in the rest of samples, as replacing it was less economically cost. While in another study in which beef was replaced with vegetable protein in a ratio of 10, 20, 30 and 40% indicated that the appearance and general consumer acceptance differed significantly with higher levels of beef substitution, while texture and flavor parameters did not affect significantly by substituting bovine meat, where the replacement of 30% is the best and closest to the control (Hidayat *et al*., 2018).

In a study, chicken sauce was replaced with soy protein, noted that the significant differences were in taste only, and there were no differences in color, smell and general acceptance between chicken sauce and chicken-free soy sauce (Kamani *et al*., 2019).

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