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Replacing Animal Fats in Frozen Beef Burger with Some Vegetable Sources and their Effect on Some Chemical and Physical Properties

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ABSTRACT

The study aimed to find out the effect of molecular substitution of some plant sources, namely oatmeal and chia, instead of animal fat, on the manufacture and preservation of low-fat burger patties stored by freezing at a temperature of (-18 ± 2 C) during the storage period for a period of (60) days and follow-up of their characteristics during the storage period by (1, 30, 60) days during which the chemical characteristics were monitored, which included (pH, peroxide number, and percentage of free fatty acids), As well as following up the physical tests (cooking yield, shrinkage and water holding capacity) and comparing the manufactured burger with the commercial Mersin burger available in the market. The study was conducted on four treatments of veal burger product, the first treatment was control (without replacement), the second treatment was the replacement of animal fat by (50%) with oatmeal powder, the third treatment was the replacement of animal fat by (50%) with chia powder, and the fourth treatment was a commercial beef product. The results showed a significant decrease in the peroxide values and the percentage of free fatty acids for the replacement treatments compared to the control treatment and the commercial Berger treatment as for the physical properties, the characteristic of the ability to water holding capacity, as well as the characteristic of the cooking yield, and the decrease in the shrinkage rate in diameter during cooking increased in the replacement treatments compared to the control treatment and the commercial burger. The results showed a clear and remarkable improvement for all the studied traits.

استبدال الدهون الحيوانية في بيرجر اللحم البقري المجمد ببعض المصادر النباتية وأثرها في بعض الصفات الكيميائية والفيزيائية

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قسم علوم الأغذية، كلية الزراعة، جامعة تكريت، تكريت، العراق

الخلاصة

هدفت الدراسة الى معرفة تأثير الاستبدال الجزيئي لبعض المصادر النباتية وهي دقيق الشوفان والشيا عوضاً عن الدهن البقري في تصنيع وحفظ اقراص بيرجر قليل الدهن خزنت بالتجميد على درجة حرارة (-18 ± 2 درجة مئوية) خلال فترة التخزين لمدة (60) يوم ومتابعة صفاتها خلال مدة التخزين بواقع (1، 30، 60) يوم تم خلالها متابعة الصفات الكيميائية التي شملت (الاس الهيدروجيني ورقم البيروكسيد ونسبة الاحماض الدهنية الحرة) وكذلك متابعة الاختبارات الفيزيائية (حاصل الطبخ، الانكماشية بالقطر والقدرة على الاحتفاظ بالماء) ومقارنة البيرجر المصنع مع البيرجر التجاري نوع Mersin المتوفر في بالأسواق. أجريت الدراسة على أربع معاملات لمنتج بيرجر لحم العجل البقري المعاملة الأولى السيطرة (بدون استبدال) والمعاملة الثانية استبدال الدهن الحيواني بنسبة (50 %) بمسحوق الشوفان والمعاملة الثالثة استبدال الدهن الحيواني بنسبة (50 %) بمسحوق الشيا والمعاملة الرابعة منتج لحم بقري تجاري. بينت النتائج انخفاض معنوي في قيم البيروكسيد ونسبة الاحماض الدهنية الحرة لمعاملات الاستبدال بالمقارنة مع معاملة السيطرة ومعاملة البيرجر التجاري، اما بالنسبة للخواص الفيزيائية فقد ارتفعت صفة قابلية حفظ الماء وكذلك صفة حاصل الطبخ وانخفاض نسبة الانكماشية بالقطر اثناء الطبخ في معاملات الاستبدال بالمقارنة مع معاملة السيطرة والبيرجر التجاري. حيث أظهرت النتائج تحسن واضح وملحوظ لجميع الصفات المدروسة.

الكلمات المفتاحية: بيرجر لحم بقري، مسحوق شيا، مسحوق شوفان، المؤشرات الكيميائية.

INTROUCTION

Meat is an important food for humans. As it is a high-value source of many nutrients, This value is mainly based on the presence of full nutritional value proteins because they contain the essential amino acids necessary for building body tissues, as well as containing a group of vitamins such as group B and mineral elements such as iron and phosphorus. **(**Ursachi *el al*., 2020). Because of the chemical nature of meat and its products and the nutritional components they contain, they are exposed to damage during storage, and damage is either chemical or microbial, which are the two factors affecting the quality of food, and minced meat is most susceptible to microbial contamination and fat oxidation during manufacturing and storage processes, because the process of chopping is not limited only to the expansion of the surface area and exposing the meat to air, but accelerates the loss of internal components of the muscles (Nam and Ahn, 2003).

The common chemical damage is the oxidation of fat, as foods containing a high percentage of fat such as meat and their products to oxidation during long time storage that lead to a decrease in the nutritional value and a change in sensory traits such as color change, taste and smell (Karwowska and Dolatowski, 2007). Food safety, prolonging its shelf life, preserving its nutritional value and reducing the percentage of losses during its circulation, display and storage are important matters that attract the attention of consumers and industry alike, Recent studies have been interested in human food, its components and methods of preparation because of its direct impact on his health, and interest has increased recently in antioxidants and natural ones, especially because the process of fat oxidation has an impact on the physiological processes of body systems on the

one hand and in the quality of food on the other, Due to the oxidation process, fatty substances become rancid, and oxidative rancid is the main cause of food spoilage (Antonini *el al*,. 2020).

The fat content is a great importance in determining the technological qualities of food by influencing the nutritional qualities as well as the qualities of texture, flavor and caloric density (Heck *el al*., 2017). and health awareness regarding the negative effects of high consumption of dietary fat, led to the improvement of dietary habits by reducing fat consumption, although the consumer wants to consume foods with low fat calories or do not contain fat calories and also wants good-tasting foods because many foods made with fat substitutes do not compare in quality or palatability with similar foods with full fat flavor, Therefore, food manufacturers continue to search for an ideal fat substitute with a taste or function similar to conventional fat and without a negative health impact (Badar *el al*,. 2021). In recent years, natural additives of plant origin have been sought for possessing both antioxidant and antimicrobial effectiveness, which serve to maintain the quality of meat and prevent economic loss (Zaki, 2018), Phenolic compounds are one of the most prominent natural antioxidants, which include phalanonides, tannins, carotenoids, natural phenolic acids, vitamins and other natural components of food, which are often found in all plant parts such as leaves, flowers, fruits, stems, roots and seeds that can be used as natural additives in food preservation such as meat and others, which are accepted by the consumer because they are natural and enter into human food (Santos-López *el al*,. 2017).

Therefore, the current study aimed to use oat powder and chia powder as a partial substitute for beef fat in the manufacture of beef burger and meat burger preservation by freezing, studying chemical, qualitative and organoleptic changes and comparing the manufactured burger with the commercial Burger available in the markets.

MATERIAL AND METHODS

Beef burger manufacture

This study was conducted in the laboratories of the College of Agriculture /University of Tikrit in 2022, veal meat (thigh) was purchased from the local markets of the city of Tikrit, and the physical separation process of the thigh was carried out to separate lean from the fat and bone, after kept in the refrigerator for 24 hours at 4 degrees Celsius. Then lean was cut into small pieces to facilitate the mincing process. The lean beef was minced twice, with diagonal holes (8 mm then 5 mm) The beef fat was also minced. Oat flour and chia flour were used for the study. They were bought from markets in Salah Al-Din Governorate.

Also, a local burger product was used for the study. It was bought at markets in Salah Al-Din Governorate.

The treatment was prepared after calculating the quantities of the incoming materials and preparing it them according to table (1). The burger patties were manufactured with a weight of 100 g, then each patty was placed in a polyethylene bag and it was well closed and stored in freezing (-18 ± 2 m) for 60 days, during which follow up on changes in some chemical components and physical and sensory characteristics were monitored during the storage periods of 1, 30 and 60 days.

Table 1: Percentages of materials used in the preparation of veal burger mix

Treatment	Veal	Animal fat	Oat flour	Chia flour	Salt	Garlic	Spices
Control Burger B1	800 g	200 g	---	---	1.5 %	0.25 %	0.5 %
Replace with oat powder 50% B2	800 g	100 g	100 g	---	1.5 %	0.25 %	0.5 %
Replace with chia powder 50% B3	800 g	100 g	---	100 g	1.5 %	0.25 %	0.5 %
Commercial Burger B4	---	---	---	---	---	---	---

Chemical tests:

pH : Determine pH using pH Meter Shanghai, China Model No. PHS-1705.

peroxide number: Estimate the peroxide number according to (Richards *el al*., 1998) method and according to the following equation:

Peroxide value = (Na2S3O4 ml ×N ×1000) / (Wt.of Sample, gm)

Percentage of free fatty acids

Free fatty acids (FFA) were estimated according to the method (Al-Aswad, 2000) and according to the following equation:

Free Fatty Acid % = Titration (A−B) ×N ×282 ×100 / 1000 × Wt of Sample, gm

A = number of milliliters of KOH swabbed with the fat or oil sample.

B = the number of milliliters of KOH anointed with the plank sample.

282 = molecular weight of oleic acid.

Physical tests: Cooking yield

The percentage of cooking yield was calculated according to the equation mentioned in (Akwetey and Yamoah, 2013).

Shrinkage by diameter: Deflation was measured according to the method of (Purchas and Barton, 1976).

Water holding capacity: The ability of the meat to hold water was estimated using the method (Dolatowski and Stasiak, 1998).

Statistical analysis

The data were analysed using the factorial experiment design to study the effect of the treatments, the number of days of storage and the interaction between them, and the significant differences between the averages were compared using Duncan's multinomial test (Duncan, 1955) and below the level of significance (0.05), and the statistical program was used SAS (2010) In the statistical analysis according to the following mathematical model:

Yijk = μ + Ai + Bj + ABij + eijk

As:

Yij = observed j value for genotype i

μ = the overall mean for the trait studied

Ti = effect of i coefficients

eij = the random error that is normally and independently distributed with a mean of zero and an equal variance of s2e.

RESULTS AND DISSCUSION

Table (2) shows the effect of using plant sources instead of animal fats on the pH of the beef burger treatments. It is clear from the results that the pH value was not affected significantly ($P < 0.05$), as it reached 5.47% in the B1 treatment, while in the replacement treatments it recorded 5.37, 5.45% for each of the B2 treatment, and B3 treatment, respectively, while B4 treatment recorded higher The percentage of the pH value is 6.045%. It was clear from the results of the statistical analysis that the pH values increased significantly ($P < 0.05$) with the progression of the storage period for the beef burger treatments, so the highest increase was recorded in the B4 treatment from 6.045% to 6.165, 6.285% after 30, 60 days, as for the B1 treatment of 5.47% to 5.975% at the end of the storage period, and the least increase value was recorded in the B2 treatment, and it was from 5.37% to 5.825%, while for the B3 treatment from 5.455% at the beginning of storage to 5.915%. These results were close to what he found (Szpicer *el al*., 2018).

The results in Table (2) show that there is a significant effect ($P < 0.05$) of the vegetable source and the storage period on the peroxide number values in beef burgers partially replaced by animal fat with vegetable fibers, as the peroxide value decreased in burgers partially fat replaced compared to the control treatment and for all treatments as it decreased In the treatment of replacement with B2, it recorded 1.805 milliequival / kg compared to the B1 treatment, which recorded 2.55 milliequival / kg, while the treatment of replacement with B2 recorded 1.815 milliequival / kg, while the treatment of B4 recorded 1.975 milliequival / kg. The reason for this decrease is due to the content of oats and chia on substances that have antioxidant activity and thus reduce fat oxidation, and this is reflected in the decrease in peroxide values (Ibrahim, 2018).

The results indicated that the storage period had a significant effect ($P < 0.05$) on the peroxide values in beef burgers, which partially replaced the fat with vegetable fibers. It was observed that the peroxide value increased with the progression of the storage period. It increased from 2.55 mEq / kg at the beginning of the storage period to 3.06, 3.85. mmeq/kg in a storage period of 30, 60 days in the B1 treatment, while the highest rise in peroxide values was recorded in the B4 treatment, as it recorded 1.975 meq/kg at the beginning of the storage period to 3.95 mmeq/kg at the end of the storage period in the records of lower substitution treatments. An increase in the peroxide values, as the two treatments of B2 and B3 recorded 1.815 and 1.805 mequival / kg at the beginning of the storage period to 2.85, 2.765 mequival / kg at the end of the storage period, respectively. The reason for the high peroxide values during storage is the result of oxidation of the fat, which produces peroxides, aldehydes and ketones, which give the smell and rancid flavor to the meat.

The results in Table (2) show that there is a significant effect ($P < 0.05$) of the vegetable source on the percentage of free fatty acids in the meat burger, partially replacing the animal fat with vegetable fibers. For free fatty acids in the burger replaced with B3, it recorded 0.305% compared to the B1 treatment of 0.51%. As for the B4 treatment, the highest percentage of free fatty acids was recorded at 0.585%, while the B2 replacement treatment recorded 0.475%. The reason may be due to the fact that the replacement treatments contain phenolic compounds and flavonoids that act as antioxidants (Makky, 2021). It was observed from the results of the statistical analysis a significant increase ($P < 0.05$) in the percentage of free fatty acids affected by the storage period, as the highest percentage was recorded in the B1 treatment from 0.51% at the beginning of storage to 0.625, 0.81% after 30, 60 days, while the replacement treatment recorded with B3, the lowest

percentage of increase in free fatty acids increased from 0.305% to 0.655, 0.76% after 30, 60 days, followed by the replacement treatment with B2 from 0.475% at the beginning of storage to 0.77% at the end of the storage period, while a B4 treatment was recorded from 0.585 to 0.585 0.82 at the end of the storage period. These results were close to (Al-Asadi, 2021).

Table (2) effect of substitution ratios on some chemical tests of beef burgers

Characteristics	The time/ Treatment	0 day	30 day	60 day
pH	Control Burger B1	5.47 ± 0.01 g	5.69 ± 0.04 f	5.975 ± 0.015 c
	Replace with oat flour 50% B2	5.37 ± 0.02 g	5.475 ± 0.085 g	5.825 ± 0.015 d e
	Replace with chia flour 50% B3	5.455 ± 0.025 g	5.72 ± 0.04 e f	5.915 ± 0.035 c d
	Commercial Burger B4	6.045 ± 0.035 b c	6.165 ± 0.055 a b	6.285 ± 0.045 a
Peroxide Number	Control Burger B1	2.55 ± 0.05 d	3.06 ± 0.05 b	3.85 ± 0.05 a
	Replace with oat flour 50% B2	1.815 ± 0.005 g	2.15 ± 0.06 e	2.85 ± 0.05 c
	Replace with chia flour 50% B3	1.805 ± 0.005 g	2.135 ± 0.015 e	2.765 ± 0.045 c
	Commercial Burger B4	1.975 ± 0.005 f	2.585 ± 0.025 d	3.95 ± 0.04 a
Free Fatty Acids	Control Burger B1	0.05 ± 0.51 e f	0.035 ± 0.625 d	0.01 ± 0.81 a
	Replace with oat flour 50% B2	0.015 ± 0.475 f	0.61 ± 0.675 b c d	0.04 ± 0.77 a
	Replace with chia flour 50% B3	0.025 ± 0.305 g	0.035 ± 0.655 c d	0.03 ± 0.76 a b
	Commercial Burger B4	0.025 ± 0.585 d e	0.005 ± 0.735 a b c	0.02 ± 0.82 a

* Similar letters in one column mean that there are no significant differences between them at the (P < 0.05) probability level
B1: control B2: Replace with oat powder 50% B3: Replace with chia powder 50% B4: Commercial Burger.

The results in Table (3) indicate that the ratio of cooking yield in beef burgers was affected significantly (P < 0.05) by vegetable fibers, as it was observed that the ratio of cooking yield was high in all substitution treatments compared to the B1 treatment and B4, and the highest ratio of cooking yield was when replacing meat with B4. The results indicated that the percentage of cooking yield increased significantly (P < 0.05) in the replacement treatments, as it was noted that the percentage of cooking yield increased in burgers that partially replaced animal fat with vegetable fibers, in burgers replaced with B3 it reached 77.585%, while it reached 75.985% in burgers replaced with B2, while it reached 75.985%. In the B1 treatments and the B4 treatment, 70.635 and 71.40%, respectively. The reason for this increase in the percentage of cooking yield may be due to the fact that the addition of oats and chia powder led to an improvement in the ability

to retain water by the added fibers, and thus the percentage of weight loss during cooking decreases, which corresponds to the increase in the percentage of cooking yield of the burger to which the fibers were added. These results agreed with (Bis-Souza *el al*., 2018).

The results showed that the percentage of cooking yield was affected significantly ($P < 0.05$) by the storage period, as it was noticed that the percentage of cooking yield decreased in the prepared burger with the progression of the storage period, as it reached 75.985% in beef burgers partially replaced with oatmeal fat at the beginning of storage to 69.48% at the end. Storage period, while the treatment of replacing B3 recorded the lowest percentage decrease in all treatments, reaching 77.585% at the beginning of storage to 73.22, 71.285% after 30, 60 days of storage, compared to the B1 treatment, which reached 70.635% at the beginning of storage to 64.14% in The end of the storage period, while the B4 treatment recorded 71.40% at the beginning of storage to 67.055, 65.77% after 30, 60 days of freezing storage, where the general average decrease in the percentage of cooking yield is noted in the rise in the replacement treatments compared to the control and commercial burger treatments, and the reason may be due This decrease led to an increase in the breakdown of the flesh tissue cells and the exit of the largest amount of exudate liquid during the defrosting and cooking period. These results agreed with (Al-Qatifi, 2019).

The results show in Table (3) the effect of the plant source and the storage period on the percentage of shrinkage by diameter in the beef burger, partially replacing the animal fat with vegetable fibers, in the treatment of replacing with B3, it decreased to 20.355%, while the shrinkage rate in the treatment of B4 reached 23.955%. The liberation of water and fat, as well as the denaturation of meat protein, are among the main reasons for reducing the shrinkage rate during cooking, and the expanding materials added to the burger mixture have the ability to form a gel in addition to retaining a certain amount of moisture and fat so that they limit the shrinkage in the beef burger. These agreed with (Bis-Souza *el al*., 2018).

The results showed a significant increase in the percentage of shrinkage in diameter ($P \leq 0.05$) in the beef burger with the progression of the storage period, as it increased in the B1 treatment from 28.635% at the beginning of storage to 30.165, 35.815% for the period 30, 60 days of freezing storage, but in the B2 replacement treatments, It was 20.20% at the beginning of storage to 30.565% at the end of the storage period while the treatment of replacing B3 recorded the lowest rate of increase from 20.353% at the beginning of the storage period to 28.50% at the end of the storage period. As for the treatment of B4, it increased from 23.955 at the beginning of the storage period to 28.625%. The reason for the difference in the percentage of shrinkage in diameter may be attributed to the fact that the addition of non-meat materials reduces the incidence of change in diameter and increases the ability of the meat to retain water. I agreed (Botella-Martinez *el al*., 2022). The results in Table (3) show the effect of replacing animal fats with vegetable fibers in the manufacture of beef burgers. The results showed that there was a significant effect ($P < 0.05$) for plant sources, as it was observed that the water carrying capacity increased in the replacement treatments compared to the control treatment. while the B1 treatment recorded 49.49%, while the ability to retain water in the two B2 substitution treatments, and the B4 treatment recorded 50.095 and 59.905%, respectively. These results were similar to (Szpicer el al., 2020).

The water-holding capacity of the beef burger was significantly affected ($P < 0.05$) by the storage period, as the water-holding capacity decreased with the progression of the storage period, in all treatments, as it decreased significantly in the B1 treatment from 49.49% at the beginning of the storage period to 44.20, 39.50% after passing 30, 60 days, In the replacement treatments, the treatment with B3 recorded the least decrease from 57.45% at the beginning of storage to 50.20% at

the end of the storage period, while the B4 treatment recorded from 59.905% to 57.065, 51.62% for the period 30 and 60 days, while the water holding capacity decreased in the treatment Substitution with B2 from 50.095% to 44.415% at the end of the freezing storage period. These results were similar to (Ibrahium *el al*., 2015).

Table (3) effect of substitution ratios on some physical properties of beef burgers

Characteristics	The time/ Treatment	0 day	30 day	60 day
Cooking Yield	Control Burger B1	1.595 ± 70.635 c d	0.33 ± 67.09 d e f	1.72 ± 64.15 f
	Replace with oat flour 50% B2	0.665 ± 75.985 a b	0.08 ± 71.91 c	0.90 ± 69.48 c d e
	Replace with chia flour 50% B3	0.395 ± 77.585 a	0.10 ± 73.22 b c	0.405 ± 71.285 c
	Commercial Burger B4	0.406 ± 71.40 c	0.285 ± 67.055 d e f	3.11 ± 65.77 e f
Deflation	Control Burger B1	28.635 ± 0.015 d	30.165 ± 0.025 C	35.815 ± 0.005 a
	Replace with oat flour 50% B2	20.20 ± 0.01 k	23.015 ± 0.005 I	30.565 ± 0.045 b
	Replace with chia flour 50% B3	20.355 ± 0.005 j	23.16 ± 0.01 h	28.50 ± 0.02 e
	Commercial Burger B4	23.955 ± 0.005 g	25.985 ± 0.025 f	28.625 ± 0.045 d
W.H.C	Control Burger B1	49.49 ± 0.40 f	44.20 ± 0.07 h	39.50 ± 0.40 i
	Replace with oat flour 50% B2	50.095 ± 0.015 e	46.695 ± 0.025 g	44.415 ± 0.045 h
	Replace with chia flour 50% B3	57.45 ± 0.04 b	56.315 ± 0.105 c	50.20 ± 0.08 e
	Commercial Burger B4	59.905 ± 0.085 a	57.065 ± 0.055 b	51.62 ± 0.16 d

* Similar letters in one column mean that there are no significant differences between them at the (P < 0.05) probability level
B1: control B2: Replace with oat powder 50% B3: Replace with chia powder 50% B4: Commercial Burger.

CONCLUSION

Partial replacement of animal fats with oats powder by 50% and chia powder by 50% for meat products made from veal meat represented by the burger product had a significant effect on the burger content. The results showed a significant decrease in the values of peroxide and free fatty acids, and thus the storage period of the product could be increased through a decrease in fat oxidation for the replacement treatments. The replacement also led to an improvement in the physical characteristics of the product in terms of the ratio of cooking yield and shrinkage in diameter, and the percentage of the ability to water holding capacity compared to the burger. Factory and commercial. Therefore, the study recommends the use of oatmeal and chia powder as a substitute for beef fat in the manufacture of burgers.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest associated with this manuscript.

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