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Effect Of Replaced Animal Fat With Sesame Oil On The Quality Of Frozen Beef Burgers

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Abstract

The study included preparing a low-fat beef burger, replacing animal fat with sesame oil. The oil was extracted from sesame seeds (Sesamum indicum L.), determine of its content of saturated and unsaturated fatty acids by Gas Chromatography Mass Spectrometry (GC/MC). The replacement rates were 25%, 50%, 75% and 100%. The fat and cholesterol content of the burger replaced with vegetable oil were studied. Store the burger patties by freezing at (-18 ± 2) °C for 90 days, during the follow-up of the changes in the chemical indicators, which included thiobarbituric acid and free fatty acids. The physical traits included water holding capacity, cooking yield, retained moisture, and retained fats, during the storage period 30, 60 and 90 days. The results showed that there was a significant decrease (P≤0.05) in the burger fat content and cholesterol concentration in the burger patties replaced with vegetable oil, significant decrease (P≤0.05) in the percentage of free fatty acids and the value of thiobarbituric acid for both fat source and replacement ratios, while these indicators increased with the progress of the storage period. The source of the fat, the percentage of replacement and the storage period have a significant effect, a significant increase was observed in the cooking yield, retained moisture, retained fat and water holding capacity by increasing the replacement of animal fat with sesame oil, while the values of all transactions decreased with the progress of the storage period.

Keywords: animal fat, sesame oil, tba, ffa.

Introduction

Meat and meat products are the main sources of fat in food, it was characterized by its high content of saturated fatty acids and cholesterol, causes many diseases, including types of cancer, obesity and heart disease, to avoid these diseases is to reduce saturated fats in food (Moon et al., 2008; Siri-Tarino et al., 2010; Akesowon, 2015). Animal fats play important functional, sensory and nutritional roles in many food products including processed meat, animal fats in food products in two ways were used, it was either part of meat or added to meat products to provide the desired flavor and texture (Jiménez-Colmenero, 2007; Dransfield, 2008; Youssef and Barbut, 2009).

Reducing the level of fat by replacing it with vegetable oils and fibers, results in healthy food products because they were free of cholesterol and the proportion of unsaturated fatty acids compared to saturated fatty acids is high (Yang et al., 2009; Akesowan, 2015). Vegetable oils are a major source of monounsaturated fatty acids, contains powerful antioxidants, some oils were used in the preparation of some meat products with low fat content, including sesame oil, a good source of Omega 6. Sesame husks contain a good proportion of sesamolin, which have various biologically active and health-promoting effects (Moazzami et al., 2007). Sesame oil has anti-inflammatory activity and anti-proliferative effect on cancer cells caused by tocopherol homologues (Rangkadilok et al., 2010). Sesame oil, although it contains 85% of unsaturated fatty acids, the most stable antioxidant vegetable oil, as a result of the difference in vegetable oils in their physical properties such as color and smell, content of unsaturated fatty acids, it will affect the nutritional qualities of meat products, due to its anti-oxidant properties, therefore, it was added to meat products to extend the shelf life of these products (Lee et al., 2015).

The fat content of red meat has decreased significantly in the past few decades according to BMPA (2017) reports, it was noted that the relationship between high levels of cholesterol and low levels of polyunsaturated fatty acids and saturated fatty acids leads to an increase in heart disease, make the consumer to avoid foods with high fat content, places great emphasis on increasing the purchase of foods that are low in fat (Miles, 1996; Jalal et al., 2013; Mendiratta et al., 2013).

The study aimed to replace animal fat in beef burger with sesame oil in different levels, and studying the effect of replacement rates for some qualitative traits during the storage period of the manufactured burger discs.

Materials and Methods

Meat: The beef (thigh cut) was purchased from the local market in Basra.

Fat: Beef fat was purchased from the local market in Basra.

Sesame seeds: Sesame seeds were obtained from the local market in Basra.

Salt: Use UAE-made salt purchased from local markets.

Spice mix: The mixture of spices for making the burger was purchased from the local markets in Basra.

Garlic: Fresh, local garlic was bought from the market, peeled and mashed.

Filler material: Wheat bran obtained from grain mills in Basra Mill was used in the study, which was ground and sieved until a fine powder was obtained.

Frying oil: The sunflower oil (Al-Dar) was used, produced by Al-Ittihad Food Industries Ltd., a volume of 900ml, Iraqi-made, purchased from the local markets.

Extraction of sesame oil: Taking a weight of 1,250 gm of sesame seeds and squeezing them using an Iranian-made device supplied by NiriOrganic company that operates by hydraulic pressure, approximately 500 ml of oil was obtained.

Fatty Acids diagnosis: The fatty acids in sesame oil were diagnosed using a gas chromatograph connected to a mass spectrometer type GC-MS QP210 Ultra, SHIMADZU, Japan, and the injection process was carried out with an automatic injector type SHIMADZU, AOC-20I+S. The separation conditions in both GC and MS were as follows:-

Gas chromatography	Mass spectrometer
Column oven temp. : 40.4 C°	**Ion source temp. :** 200.00 C°
Injection temp. : 280.00 C°	**Solvent cut time :** 3.00 min
Injection mode : Split	**Start time :** 3.00 min
Flow control mode : linear velocity	**End time :** 26.00 min
Pressure : 49.5 kpa	**ACQ Mode :** Scan
Total flow : 34.0 ml/min	**Event time :** 0.50 sec
Column flow : 1.00 ml/mi	**Scan speed :** 1250
Linear velocity : 36.1 cm/sec	**Start m/z :** 30.00
Purge flow : 3.0 ml/min	**End m/z :** 600.00
Split ratio : 30.0	

Preparation of formulas and treatments: 8 kg of beef was minced using an electric mincing machine with holes with a diameter of 3 mm, divide the meat according to Table (1). attended the treatments after calculating and preparing the quantities of incoming materials. The burger discs were manufactured and placed in vacuum-packed polyethylene bags, separate each disc from the last piece of wax paper, it was stored by freezing at (-18 ± 2) °C for 90 days, changes in chemical indicators and physical properties were monitored, during storage periods 0, 30, 60 and 90 days.

Table (1): Quantity of materials needed to prepare the proportions of the mixtures used in preparing the beef burger (g/ kg).

Items	Replacement of animal fat with vegetable oil				
	Control	5%	10%	15%	20%
Meat	765	765	765	765	765
Animal fat	200	150	100	50	-
Vegetable oil	-	25	50	75	100
Flour	13	13	13	13	13
Wheat bran	-	25	50	75	100
Salt	10	10	10	10	10
Spice mix	10	10	10	10	10
Garlic	2	2	2	2	2

Chemical content of burger

Fat: The percentage of fat was estimated by Soxhlet using hexane solvent, according to the method used in A. O. A. C (2007).

Cholesterol estimation: The cholesterol concentration in Berker meat was estimated by preparing the sample according to the method mentioned by Al-Obaidi (1999), modified by Al-Salihi (2012), using the kits supplied by the French company Biolabo SA, then the optical absorbance was measured at a wavelength of 560 nm. The cholesterol content was calculated according to the following equation:

$$Cholesterol\ (mg/g) = \frac{\text{Sample absorbance value}}{\text{Standard Cholesterol Absorption Value}} \times 5.17\ mmol/L$$

Chemical indicators:

Thiobarbituric acid (TBA): Thiobarbituric acid was estimated according to the method reported in Soltanizadeh and Ghiasi-Esfahani (2015). The absorbance was measured at a wavelength of 532 nm and the TBA value was calculated according to the following equation:-

TBA=Absorbance × 5.4

Free fatty acids (FFA): The acid value was estimated and from it the percentage of free fatty acids in the beef burger was calculated, according to the method mentioned in Al-Tai and Al-Mousawi (1992), the acid value was calculated as follows:-

$$Acid\ value = \frac{\text{Number of milliliters of sodium hydroxide x 5.16}}{\text{sample weight}}$$

$$Free\ fatty\ acids = \frac{\text{Acid value}}{2}$$

Physical properties:

Water Holding Capacity: The water holding capacity was estimated according to the method used in Al-Tai and Al-Mousawi (1992). The water holding capacity was calculated according to the following equation-:

Water holding capacity (ml) = Total water volume (ml) – Amount of water in the included cylinder (ml).

Cooking Yield: The percentage of cooking yield was calculated according to the equation mentioned in Ibrahim et al., (2018).

$$Cooking\ yield\ \% = \frac{\text{The weight of the cooked burger discs}}{\text{The weight of the uncooked burger discs}}$$

Moisture retention: The percentage of retained moisture was estimated according to the method mentioned in Ibrahim et al. (2018) and according to the following equation:-

$$Moisture\ retention = \frac{\text{Weight of the burger discs after cooking x moisture percentage in the burger after cooking}}{\text{Weight of the burger discs before cooking x moisture percentage in the burgers before cooking}} \times 100$$

Fat retention: The percentage of retained fat in the Berker discs was estimated by calculating the percentage of fat in the Berker discs before cooking and after cooking, from which the percentage of retained fat was calculated according to the method mentioned by Ibrahim et al. (2018) and according to the following equation:-

$$Fat\ retention = \frac{\text{Weight of the burger discs after cooking x fat percentage in the burger after cooking}}{\text{Weight of the burger discs before cooking x fat percentage in the burgers before cooking}} \times 100$$

Results and Discussions

Percentage of oil yield: The percentage of oil in sesame seeds was 46%, and the percentage of oil yield was 44.5%. The result was slightly lower than what Junpeng et al. (2019) found. when extracting sesame oil, the oil yield was 46.81%, sesame oil has a yellow color and a natural oil smell (sesame smell).

Fatty acids in sesame oil diagnosis: The results in Figure (1) and Table (2) show the determination and characterization of the quantity and quality of fatty acids in sesame oil by Gas Chromatography Mass Spectrometry (GC/MS) technique, as 19 peaks of fatty acids appeared in the oil, serialized with their name and percentage of each acid. The highest peak was No. 5 represented by Methyl 9-cis,11-trans-Octadecadienoate (Oleic acid), constituted the highest percentage of 52.96% of total fatty acids, it was followed by peak No. 6, as shown in the table, represented by 9-Octadecenoic acid, with a percentage of 25.05%, then the fatty acid (palmitic acid) Hexadeconoic acid methyl in the top No. 2, the proportion of 11.04%, followed by the fatty acid Octadecanoic acid in the top No. 7, the proportion of 7.19%, as for the other fatty acids, their percentages vary, fatty acids appeared in very small percentages, and the results showed that the total percentage of unsaturated fatty acids amounted to 78.76%.

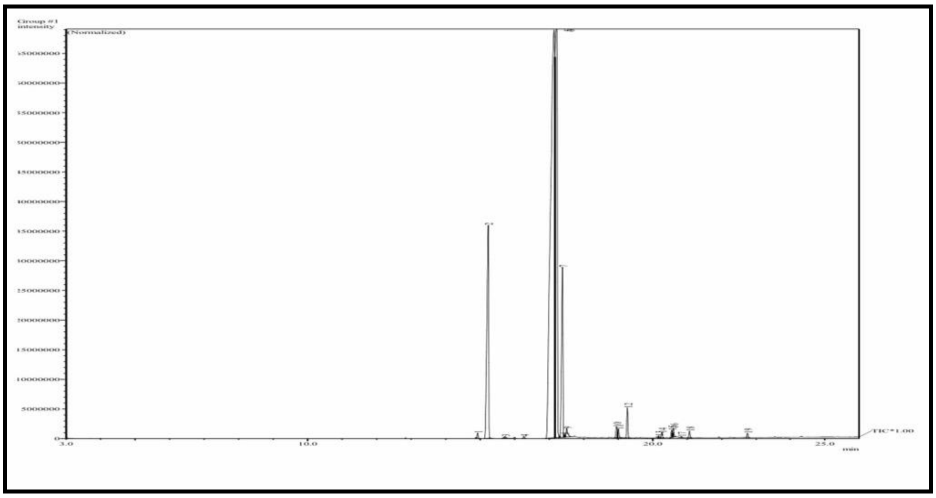

Figure (1): Gas chromatogram of fatty acids present in sesame oil.

Table (2): Fatty acids in sesame oil diagnosed by GC/MC technique.

Peak	R.Time	Area	Area%	Name
1	14.926	2072930	0.18	7-Hexadecenoicacid,methylester,(Z)-
2	15.231	124955813	11.04	Hexadecanoicacid,methylester
3	15.719	698249	0.06	n-Hexadecanoicacid
4	16.266	825064	0.07	Hexadecanoicacid,15-methyl-,methyl ester
5	17.139	599313830	52.96	Methyl9-cis,11-trans-octadecadienoate
6	17.212	283490944	25.05	9-Octadecenoicacid(Z)-,methylester
7	17.386	81310980	7.19	Octadecanoicacid,methylester
8	17.442	959646	0.08	9,12-Octadecadienoicacid(Z,Z)-
9	17.508	4883689	0.43	cis-Vaccenicacid
10	18.952	4992387	0.44	Oxiraneoctanoic acid, 3-octyl- ,methylester,cis-
11	19.007	3386778	0.30	cis-11-Eicosenoic acid, methylester
12	19.266	10853656	0.96	Methyl18-methylnonadecanoate
13	20.174	805829	0.07	Oleoylchloride
14	20.262	2098412	0.19	7-Hexadecenoicacid,methylester,(Z)-
15	20.550	3086828	0.27	Cyclopropaneoctanoicacid,2-[[2-[(2-ethylcyclopropyl)methyl]cyclopropyl]methyl]-,m
16	20.598	3245740	0.29	13-Octadecenal,(Z)-
17	20.826	428430	0.04	Octadecanoicacid,2,3-dihydroxypropylester
18	21.066	2513315	0.22	Docosanoicacid,methylester
19	22.743	1613362	0.14	Tetracosanoicacid, methylester
		1131535882	100.00	

Fat: The results in Figure (2) show the effect of fat source and replacement ratio on the percentage of fat in a beef burger, it was observed that the percentage of fat in the burger was significantly affected ($P \leq 0.05$) by changing the fat source, the percentage of fat decreased when animal fat was replaced with sesame oil, in the control treatment (20% animal fat), the percentage of fat was 23.63%, and in the treatment containing 20% sesame oil, 12.12%. The percentage of fat decreased with an increase in the replacement ratio from 22.63% in the control treatment to 19.66% at the replacement rate of 25%, it continued to decline to 17.26%, 15.37% and 12.12% at the replacement rates of 50%, 75% and 100%, respectively, these results are in agreement with Carvalho et al. (2021) when preparing a low-fat beef burger by replacing 50% animal fat with vegetable oils, four treatments were prepared, the first control treatment, second, replace animal fat with algae oil, the third treatment: Replace animal fat with wheat germ oil, fourth treatment: Replace animal fat with a mixture of algae oil and wheat germ oil, it was observed that the fat content decreased from 10.38% in the control treatment to 6.39%, 6.93% and 7.49% in the treatments, respectively.

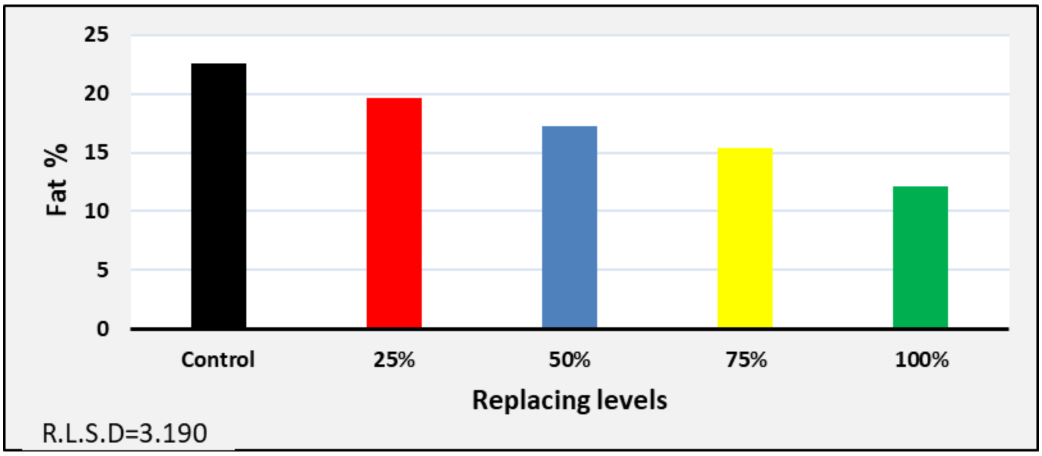

Figure (2): Effect of fat source and replacement ratio on the percentage of fat in a beef burger.

Cholesterol: Figure (3) indicates the effect of fat source and replacement ratio on cholesterol concentration in beef burger, the results of the statistical analysis showed that the source of fat had a significant effect (P<0.05) on the cholesterol content of the burger. The highest value of cholesterol was in the control treatment (20% fat), as it reached 78.82 mg/100 g, as for the lowest cholesterol content, it was 61.31 mg/100g in the completely replaced treatments with sesame oil.

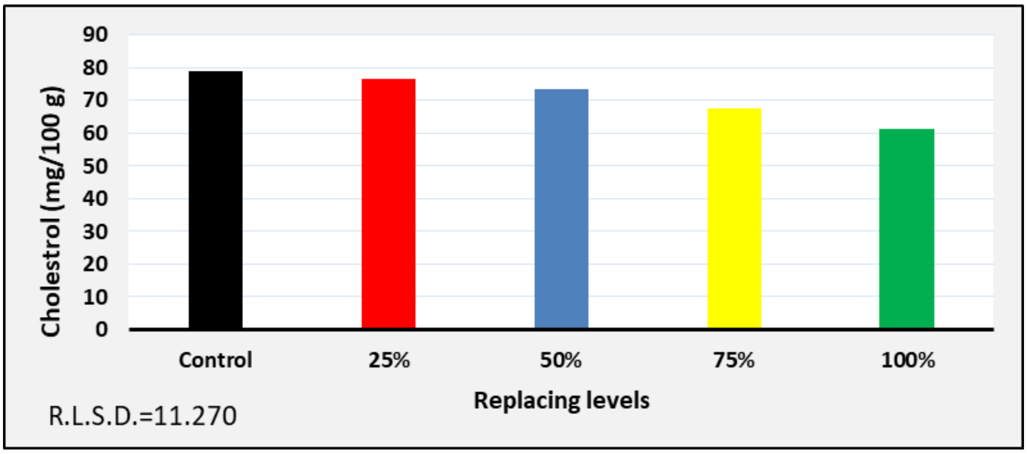

Figure 3: Effect of fat source and replacement ratio on cholesterol concentration in beef burger.

The results of the statistical analysis showed that there was a significant (P≤0.05) difference in cholesterol concentration between treatments with an increase in the replacement ratio. The cholesterol percentage decreased with an increase in the replacement ratio, reaching 76.64 mg/100 g at a replacement rate of 25%, it decreased to 73.37 mg/100g at the 50% replacement ratio and 67.48 mg/100g at the 75% replacement ratio, continued to decline until it reached 61.31 mg / 100 g at a replacement rate of 100%, due to the fact that vegetable oils are free of cholesterol, when increase the replacement of animal fat with vegetable oils, it leads to a decrease in the concentration of cholesterol, agreed with Franco et al. (2019), when preparing low-fat Frankfurt sausage by replacing animal fat with flaxseed oil at 25 and 50%, they found that there is a clear difference in cholesterol content between the control and the replacement treatments, the cholesterol content in the control treatment was 25.08 mg/100 g, it decreased to 20.12 mg/100 g in the treatment in which the fat was replaced by 25% flaxseed oil, the cholesterol content decreased more when the percentage of fat was replaced by 50%, as it reached 17.23 mg / 100 g.

Thiobarbituric acid (TBA): Figure (4) indicates the effect of fat source, replacement ratios and storage period on the value of thiobarbituric acid in beef burger, it was noticed that the source of fat had a significant effect (P≤0.05) on the acid values, the highest value of acid in the control treatment (20% fat) was 0.46 mg malonaldehyde/kg. The lowest values of acid in the treatment in which animal fat was replaced with sesame oil by 100%, which amounted to 0.28 mg malonaldehyde/kg. The reason for the lower acid values in the treatments replaced with vegetable oils compared to the control treatment may be due to the vitamin E content of these oils, which is an antioxidant.

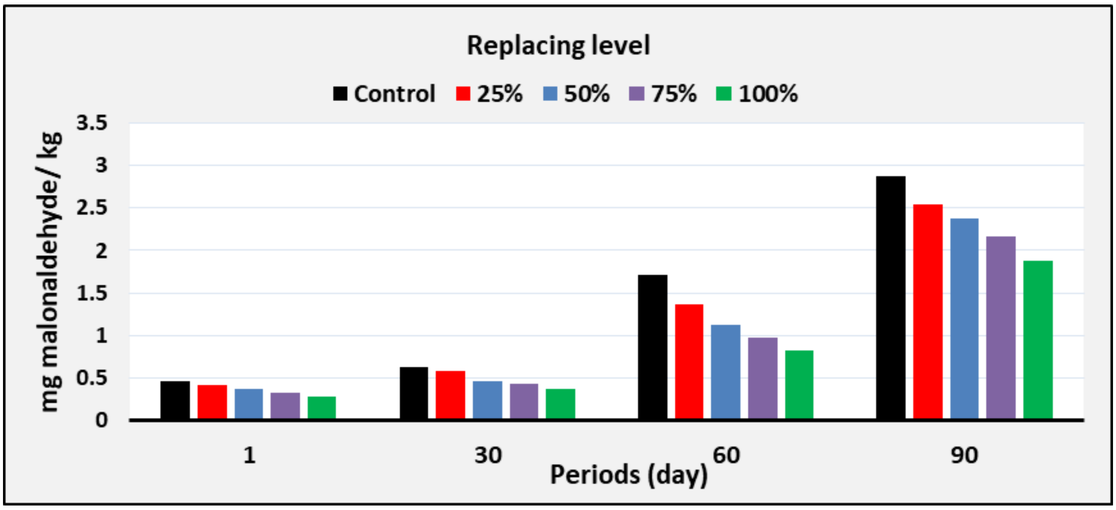

Figure (4): Effect of fat source, replacement ratios and storage period on the value of thiobarbituric acid in beef burger. R.L.S.D: for triple interference effect: 0.4772

The results of the statistical analysis showed that the values of TBA decreased significantly (P≤0.05) with an increase in the proportion of replacement with sesame oil. The highest value of TBA at the proportion of 25% replacement was 0.42 and decreased to 0.37 mg malonaldehyde/kg and 0.32 and 0.28 mg malonaldehyde/kg at Replacement rate of 50%, 75% and 100%, respectively.

As for the effect of storage period, the results of the statistical analysis showed that the value of TBA increased significantly (P≤0.05) with an increase in the storage period of 90 days. At the control treatment, it increased from 0.46 mg malonaldehyde / kg before storage to 0.63 mg malonaldehyde / kg after 30 days and then to 1.72 mg malonaldehyde / kg after 60 days and reached 2.87 mg malonaldehyde / kg at the end of storage after 90 days, when replacing animal fat with sesame oil, the acid values before storage were 0.42, 0.37, 0.32 and 0.28 mg malonaldehyde / kg, and at the end of the storage period they rose to 2.55, 2.37, 2.17 and 1.88 mg malonaldehyde / kg. The reason for the increase in acid values is due to the oxidation of fats during storage, which leads to the formation of peroxides, aldehydes and ketones (Al-Halafi and Al-Mousawi 2016). These results are in agreement with Ibrahium et al. (2015), at their study, preparing a low-fat beef burger by adding a mixture of flaxseed oil and rice bran instead of beef fat, as four treatments were prepared from burger, the first treatment was the control treatment of 20% fat, the second treatment replaced the fat with 50%, the third treatment replaced the fat with 75%, and the fourth treatment replaced the fat with 87.5%, the product was stored by freezing for three months, and the thiobarbituric acid values were monitored during storage, the acid values gradually decreased with the increase in the percentage of replacement, and the values increased with the progression of the storage period. The results also agreed with Al-Baydani and Al-Mousawi (2019), as they found a high percentage of TBA with the progression of the storage period of the meat burger.

Free Fatty Acids (FFA): Figure (5) shows the effect of fat source, replacement rate and storage period on the percentage of free fatty acids in beef burger, the results of the statistical analysis showed that the source of fat had a significant effect (P≤0.05) on the percentage of free fatty acids in burger discs. The highest percentage of free fatty acids was in the treatment to which animal fat was added by 20%, reaching 0.48%. The lowest percentage was in the transactions in which the fat was replaced by 100% with sesame oil, as it reached 0.35%. These percentages were before storage.

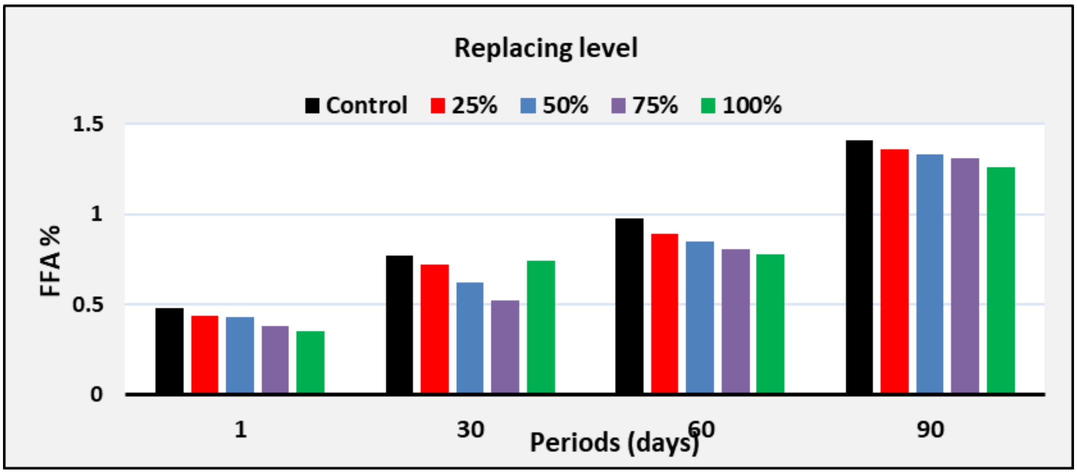

Figure (5): Effect of fat source, replacement rate and storage period on the percentage of free fatty acids in beef burger. R.L.S.D: for triple interference effect: 0.160

The results of the statistical analysis showed that the percentage of free fatty acids decreased significantly (P≤0.05) with an increase in the replacement ratio, as it decreased from 0.48% in the control treatment to 0.44%, 0.43%, 0.38% and 0.35% at the replacement ratio of 25%, 50% and 75% and 100%, respectively. The reason for the decrease in FFA is due to the decrease in the fat content by increasing the percentage of replacement, and thus reducing the decomposition of the fat.

The percentage of acids increased significantly (P≤0.05) with the progression of the frozen storage period from 0.48% before storage to 1.41% after 90 days of freezing storage in the control treatment. The FFA values increased from 0.44%, 0.43%, 0.38%, and 0.35% at the replacement ratios of 25%, 50%, 75% and 100% before storage to 1.36%, 1.33%, 1.31% and 1.26% at the end of the storage period. The reason for the increase in the percentage of free fatty acids in the frozen-stored burger discs with the increase in the storage period is due to the lipolysis by lipase enzyme and the activity of lipolytic bacteria, as the free fatty acids are products of the hydrolysis of fats by the enzyme (Al-Mousawi and Al-Adari, 2017). These results agreed with Soyer and Ertas (2007) when they studied the percentage of free fatty acids in beef soy, as the fat was added in three percentages of 10%, 20% and 30%, it was noticed that the percentage of FFA increased with the increase in the percentage of fat and during the storage periods, it increased from 2.73% before storage to 3.29% after 60 days for the percentage of adding 10% fat and from 3.35% to 5.45% when The percentage of adding 20% fat and from 4.10% to 6.90% when the percentage of added fat is increased to 30%.

Water Holding Capacity: The results in Figure (6) show the effect of fat source, replacement ratio, and storage time on the water holding capacity of beef burger, it was noticed from the results that the water holding capacity was significantly (P≤0.05) affected by the source of fat. The lowest water holding capacity in the control treatment containing 20% animal fat was 14.52 ml, the highest value was in the treatment in which animal fat was replaced by 100% (20% sesame oil) amounted to 17.14 ml. The reason why the water holding capacity is affected by the source of fat is due to the formation of an emulsion between water, fat and protein, and the attraction between the water molecules with the protein occurs as a result of the difference in charges. There are two types of water present in meat: Free water, which can be separated easily from meat, and Bound water, which is difficult to separate from meat because it is chemically bound to protein molecules (Taher, 1990).

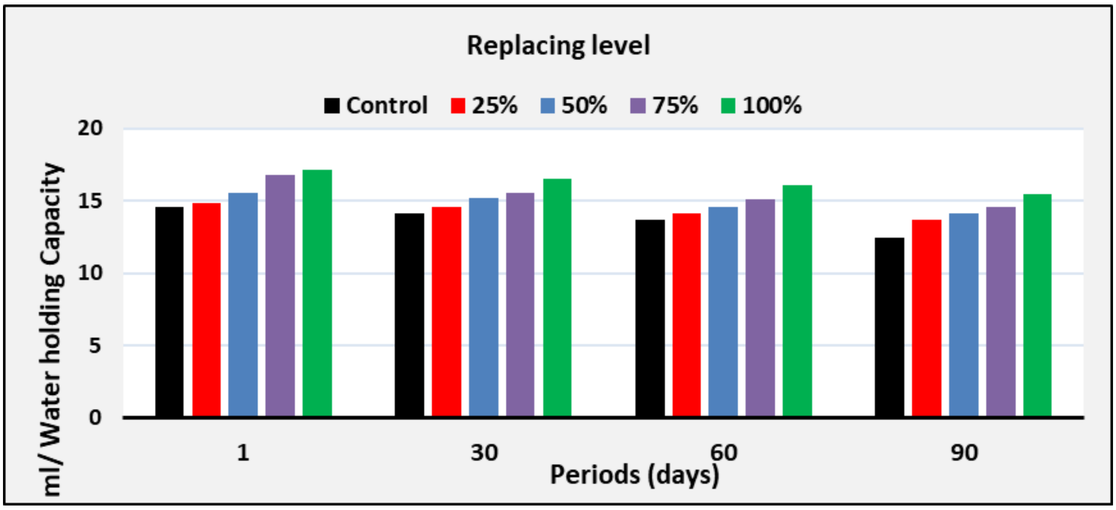

Figure (6): Effect of fat source, replacement ratio and storage period on the water holding capacity of beef burger. R.L.S.D: for triple interference effect: 0.1842

The results in the figure showed that the water holding capacity of the burger increased significantly (P<0.05) with the increase in the percentage of fat replacement with vegetable oils. The water holding capacity reached 14.83 ml at a replacement rate of 25% and rose to 15.54 ml at a 50% replacement rate, then to 16.76 ml at a 75% replacement rate and 17.14 ml at a 100% replacement rate. The reason for the high water holding capacity by increasing the percentage of replacement is that wheat bran is a filling material rich in fibers that have the ability to absorb and retain large quantities of water. These results agreed with Lee et al. (2015) when studying the effect of replacing animal fat with a mixture of vegetable oils on the quality characteristics of pork pellets, they found that the water holding capacity increases with the increase in the replacement of animal fat with a mixture of vegetable oils, six treatments were prepared, the first treatment was 20% control, and the second treatment replaced the fat with 50% of the mixture of oils, and the other four treatments completely replaced the fat with a mixture consisting of grape seed oil, olive oil and canola oil in different proportions. The results showed that the water holding capacity in the control treatment amounted to 73.15% and began to rise with an increase in the replacement rates, reaching 87.73, 89.82, 80.27, 87.18 and 74.49% in the above mentioned treatments, respectively. The results indicated that the water holding capacity decreased significantly (P≤0.05) with the progression of the storage period, at the control treatment it decreased from 14.52 ml before storage to 12.43 ml at the end of storage and from 14.83, 15.54, 16.76 and 17.14 ml to 13.72 ml, 14.14, 14.53 and 15.48 ml at the end of the storage period at the replacement rates of 25 and 50, 75 and 100%, respectively. The reason for this decrease may be due to the effect of freezing and the formation of ice crystals that affect the tissue cells and destroy them, and thus the release of a greater amount of exuded liquid during the thawing and cooking period (Taher, 1990). These results are in agreement with that of Ibrahium et al. (2015) when preparing low-fat beef burgers by replacing animal fat with flaxseed oil and rice bran during a freeze-storage period, they noticed a decrease in the water holding capacity with the progression of the storage period, as the values of WHC before storage were 83.36% for the control treatment, it decreased to 80.22% at the 10% replacement rate, 80.27% at the 15% replacement rate, and reached 81.20% at the 17.5% replacement rate, and the WHC decreased for the treatments during the storage period. At the third month of storage, they amounted to 80.81, 77.48, 78.27 and 79.41% for the control treatment and the substituted treatments at rates of 10, 15 and 17.5%, respectively.

Cooking Yield: Figure (7) shows the effect of fat source, replacement ratios and storage time on the percentage of cooking yield in beef burger. The results of the statistical analysis showed that the source of fat had a significant effect (P≤0.05) on the percentage of yield, as it increased in the control treatment (20% fat) from 65.58% to 78.88% in the treatment replaced by 100% sesame oil. The reason for the discrepancy in the cooking yield is due to the loss that occurred during cooking, and from the results it became clear that the highest percentage of loss by cooking was in the control treatment containing 20% animal fat.

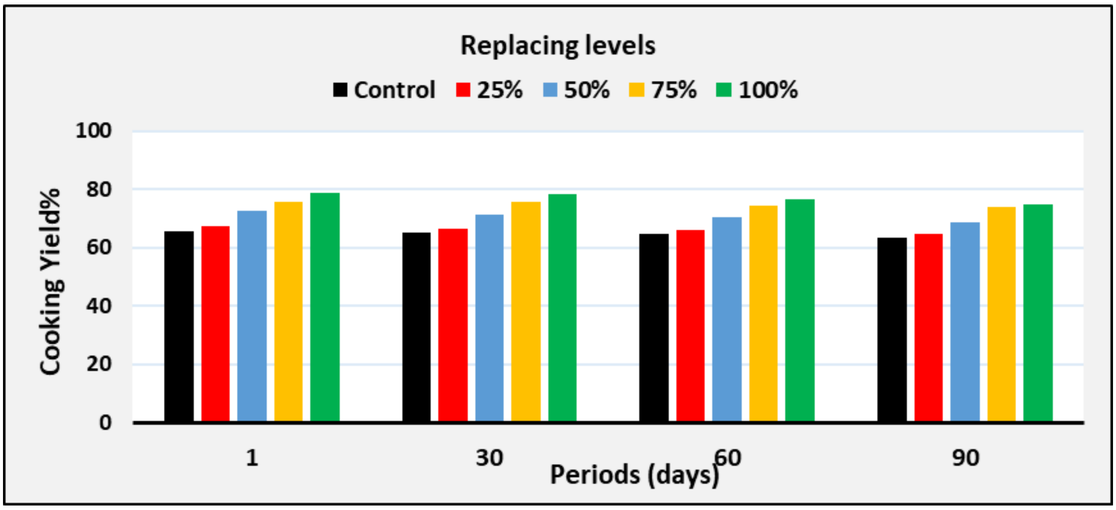

Figure (7): Effect of fat source, replacement ratios and storage period on the percentage of cooking yield in beef burger. R.L.S.D: for triple interference effect: 2.2861.

The percentage of the yield was significantly affected (P≤0.05) by the replacement percentage, as it was noticed from the results that the percentage of the yield increased with the increase in the percentage of replacement, it increased from 65.56% in the control treatment (without replacement) to 67.46% at the replacement percentage of 25%, and when the replacement percentage of 50% increased to 72.77 Then it rose to 75.76% when replacing 75% and reached 78.88% when replacing 100% oil. The reason for the high percentage of cooking yield is that the substituted treatments have a higher ability to retain moisture and fats, the percentage of loss during cooking is low, and this is reflected in the percentage of the cooking yield. These results agreed with Afshari et al. (2017) as they noticed a higher cooking yield with a lower animal fat content in beef burger. The percentage of the yield in the control treatment was 66.38% and rose to 73.74% in the treatment in which the fat was completely replaced by vegetable oil with breadcrumbs.

The results showed a significant (P≤0.05) decrease in the yield of the continuous freezing storage period. In the control treatment, the proportion of the cooking yield decreased from 65.58% before storage to 65.17% after 30 days and decreased to 64.64% after 60 days and to 63.33% after 90 days. A day of freezing storage As for the treatment replaced by 25, 50, 75 and 100%, the percentage of cooking yield during the storage period ranged from 67.46 to 74.89%. The reason for this decrease is due to the increased loss in cooking, in addition to the loss that occurred during defrosting, and the loss of part of the moisture during the storage period.

Moisture retention: Figure (8) shows the effect of fat source, replacement rate and storage period on the percentage of retained moisture in beef burger beef. 40.66% in the control treatment and 55.66% when replacing 100% with sesame oil.

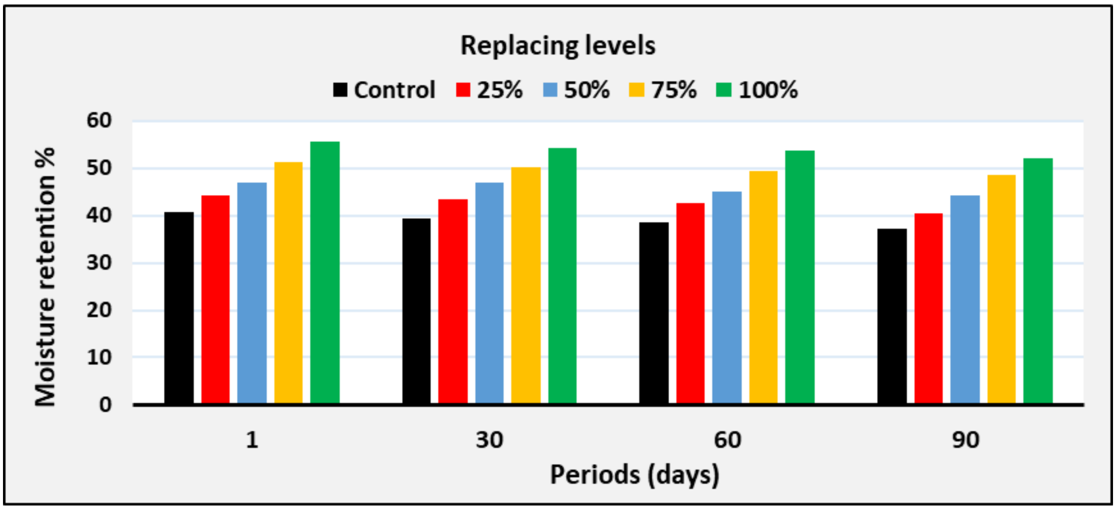

Figure (8): Effect of fat source, replacement ratio and storage time on the percentage of moisture retention in the beef burger. R.L.S.D: for triple interference effect: 1.6003

The results of the statistical analysis showed that the percentage of retained moisture increased significantly (P≤0.05) with the increase in the percentage of animal fat replaced with sesame oil, increased from 40.66% in the control treatment to 44.23% at a 25% replacement rate, then it rose to 47.02% at the 50% replacement rate and to 51.22% at the 75% replacement rate, continued to rise until it reached 55.66% when replacing 100% with sesame oil, these results were in agreement with Heck et al. (2017) When they prepared three treatments, the first treatment was the control treatment and the second treatment replaced 50% of the fat with chia seed oil, and the third treatment replaced 50% of the fat with flaxseed oil. The results showed that the percentage of retained fat increased from 60.1% in the control treatment to 61.5% in the second treatment and 62.1% in the third treatment. The reason for the high percentage of retained moisture may be due to the increase in the percentage of replacement due to the increase in the ability of wheat bran added with oils to retain water and thus the percentage of loss during cooking decreases.

The percentage of retained moisture decreased significantly (P≤0.05) with the progression of the period of freezing storage. In the control treatment, the percentage of retained moisture before storage decreased by 40.66% and decreased to 39.45% after 30 days, then it decreased to 38.63 and 37.18% after 60 and 90 days of freezing storage, and the retained moisture percentage decreased from 44.23, 47.02, 51.22 and 55.66% before freezing to 43.42, 46.88, 50.18 and 54.22% after 30 a day, down to 40.55, 44.08, 48.58 and 52.12% at the end of the freeze storage period for each of the replacement percentages: 25, 50, 75 and 100%, respectively. The reason for the decrease in the percentage of retained moisture during the storage period is due to the loss that occurred during defrost and during cooking, so this is reflected in the percentage of retained moisture.

Fat retention: Figure (9) shows the effect of fat source, replacement ratio, and storage period on the percentage of fat retained in beef burger. Burger replaced with 100% sesame oil, which amounted to 78.56%. The reason for this discrepancy is that animal fat melts when cooking and separates, and thus its loss is greater (Heck et al., 2017).

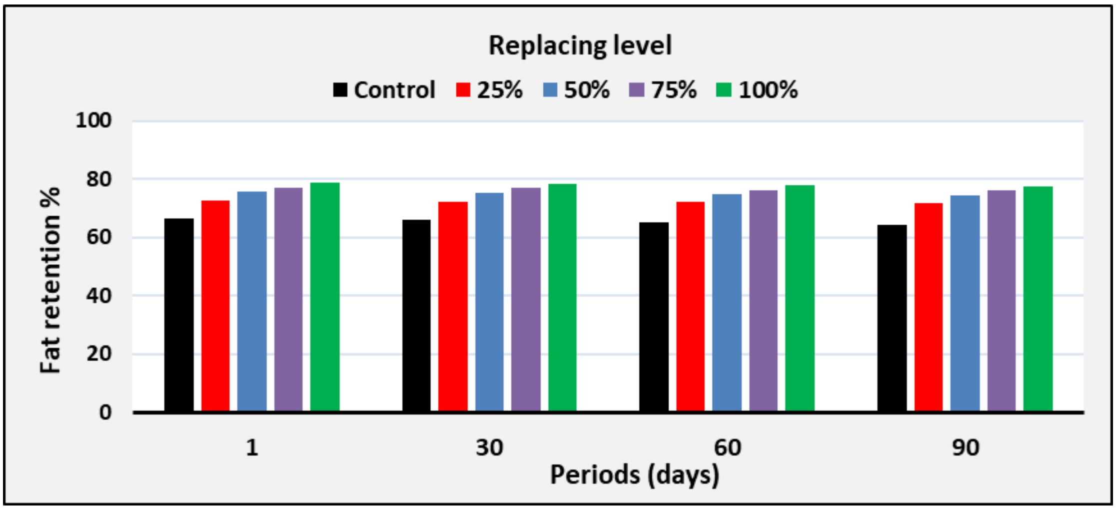

Figure (9): Effect of fat source, replacement percentage and storage period on the percentage of fat retention in the beef burger. R.L.S.D: for triple interference effect: 4.8009.

As for the effect of the percentages of replacing fat with vegetable oil on the percentage of retained fat, it increased significantly (P≤0.05) with the increase in the percentages of replacement, at the treatment that was replaced with olive oil, it increased from 66.57% (without replacement) to 72.63, 75.52, 77.12 and 78.56% at a replacement rate of 25, 50, 75 and 100%, respectively, these results are in agreement with Ali et al. (2011) When preparing low-fat meat burgers using potato chips, they found that the percentage of retained fat increases with the increase in the percentage of replacement. The percentage of fat retained was 59.6% in the control treatment, and it rose to 71.2, then 73.5 and 82.2%, and reached a limit of 91.4% at the replacement rates of 25, 50, 75 and 100%, respectively. These results are also in agreement with Heck et al. (2017) The percentage of retained fat increased to 85.8% and 88.4% in the treatments in which the fat was replaced by chia seed oil and flaxseed oil, respectively, compared to the control treatment 53.8%. The reason is due to the thermal stability of the emulsion produced from fine oil particles with the meat protein in addition to the interconnection of the protein matrix, which led to the retention of fat during cooking and thus the high percentage of retained fat.

The storage period affected the percentage of retained fat, as the percentage of retained fat decreased significantly (P<0.05) in the control treatment from 66.57% before storage to 64.43% at the end of the storage period and in the treatments in which the fat was replaced by sesame oil. The percentage of retained fat increased from 72.63, 75.52, 77.12% and 78.56% to 71.56, 74.18, 76.06 and 77.52% at the end of the freeze storage period for the replaced percentages of 25, 50, 75 and 100%, respectively. The reason for this decrease is due to the weakness of the protein matrix as a result of the formation of ice crystals between the tissues during the storage period and thus the ease of fat exudation from the muscle tissues, in addition to the change in the weight of the burger discs before and after cooking, as calculating the percentage of retained fat depends on the weight of the discs before and after cooking.

Reference

Afshari, R.; Hosseini, H.; Mousavi Khaneghah, A. and Khaksar, R. (2017). Physico-chemical properties of functional low-fat beef burgers: Fatty acid profile modification. LWT, 78: 325–331. https://doi.org/10.1016/j.lwt.2016.12.054

Akesowan, A. (2015). Optimization light pork burgers formulated with canola oil and linseed/sun flower seed/almond (LSA) mix. J. of Animal and Plant Sciences.25 (1): 268-277. http://www.thejaps.org.pk/docs/v-25-01/36.pdf

Al-Baidhani, A.M.S. and Al-Mossawi, A.H.J. (2019). Chemical indicators of Ostrich (Struthio Camelus) Linnaeus,1758 Meat Burger Frozen Storage. Basrah Journal of Agricultural Sciences.32(2):16-22.

Al-Hilfi, A.Z.H. and Almosawi, A.H.J. (2016). Effect of Addition Peptides Prepared from shrimp by Product Purified Using Gel Filteration in Beef Patties During Cooling Storage.Basrah Journal of Agricultural Science :29(1):57-69.

Ali, R. F. M. ; El-Anany, A.M. and gaafar A. M. (2011). Effect of potato flakes as fat replacer on the quality attibutes of low fat beef patteies. Avance Journal of Food Science and Technology, 3(3) :173-180.

Al-Mossawi, A.H.J. and Al-thary R.A.A. (2017). Preparation of Plant Extracts and study its effect on chemical indicators of beef patties during refrigerated and frozen storage .Al-Kufa Journal of Agricultural sciences.9(4):221-241.

Al-Obaidi F A A M (1999). Evaluation of the qualitative and chemical characteristics of the eggs of Japanese quail (Cotwnix japonica). PhD thesis, College of Agriculture, University of Baghdad.

Al-Salihi K G K (2012). The effect of injecting eggs of Japanese quail (Cotwnix japonica) with the hormones testosterone, estrogen and vitamin C on some reproductive, physiological, behavioral and productive traits. Ph. D. thesis, College of Agriculture, University of Basra, Iraq

Al-Tai M.A. and AL-Mossawi U.B.H. (1992). Practical Technology of Meat and Fish. College of Agriculture, Univ. of Basrah Press. P:142.

AOAC Association of Official Analysis Chemists (2007). Official Methods of analysis Association of Official Analysis Chemists (900.02, 927.09, 927.39, 991.20) 18th ed., Rockville, Maryland, USA.

British Meat Producers Association (2006). British quality assured pork sausage. BMPA \Standard Issue.

Carvalho, J., Munekata, P.E.S., Allan, F., Carvalho, L. De, Antonio, M. and Pateiro, M. (2021). Healthy beef burgers : Effect of animal fat replacement by algal and wheat germ oil emulsions: 173.

Dransfield, E. (2008). The taste of fat. Meat Science.80 (1): 37–42.

Franco, D.; Martins, A.J. ; López-Pedrouso, M. ; Purriños, L.; Cerqueira, M.A.; Vicente, A.A.; Pastrana, L.M.; Zapata, C. and Lorenzo, J.,M. (2019). Strategy towards Replacing Pork Backfat with a Linseed Oleogel in Frankfurter Sausages and its Evaluation on Physicochemical, Nutritional, and Sensory Characteristics. Foods. 8(9): 366. doi:10.3390/foods8090366

Heck, R.T.; Vendruscolo, R.G.; de Araújo Etchepare, M.; Cichoski, A.J.; de Menezes, C.R.; Barin, Lorenzo, J. ;Wagner, R.; Campagnol, P.C.B. (2017). Is it possible to produce a low-fat burger with a healthy n − 6/n − 3 PUFA ratio without affecting the technological and sensory properties. Meat Science.(130): 16–25.

Ibrahium, M.I. and Hegazy, A.I. (2015). Effect of Replacing Beef Fat with Flaxseed Oil and Rice Bran on Nutritional Quality Criteria of Beef Burger Patties. Middle East Journal of Applied Sciences. 5 (3) :645–655.

Ibrahim,M. H.; Hassan, M. I. and Hamed, A. M. A.(2018). Application of Lemon and Orange Peels in Meat Products: Quality and Safety .Int.J.Curr.Microbiol.App.Sci. 7(4): 2703-2723.

doi: https://doi.org/10.20546/ijcmas.2018.704.309

Jalal, H.; Mir, S.; Wani, S.A.; Sofi, H.; Pal, M.A. and Rether, F. (2013). Development of low fat meat products. International Journal of Food Nutrition and Safety.4 (3):98-107.

Jiménez-Colmenero, F. (2007). Healthier lipid formulation approaches in meat-based functional foods. Technological options for replacement of meat fats by non-meat fats. Trends in Food Science & Technology.18 (11): 567–578.

Junpeng ,Y.; Qi, Z.; Xin, L.; Xinsheng, W.; Bing, L. and Wenxue, Z. (2019). Steam explosion technology based for oil extraction from sesame (Sesamum indicum L.) seed. Journal of the Saudi Society of Agricultural Sciences. 18(1):1-6.

Kim, T.K.; Yong, H.I.; Jung, S.; Kim, Y.B. and Choi, Y.S. (2020). Effects of replacing pork fat with grape seed oil and gelatine/alginate for meat emulsions. Meat Science. 163, 108079.

Lee, H.J., Jung, E.H., Lee, S.H., Kim, J.H., Lee, J.J. and Choi, Y.Il. (2015). Effect of replacing pork fat with vegetable oils on quality properties of emulsion-type pork sausages. Korean Journal for Food Science of Animal Resources. 35(1); 130–136. https://doi.org/10.5851/kosfa.2015.35.1.130

Mendiratta, S. K.; Shinde, A.T. and Mane, B.G. (2013). Effect of added vegetable (Carrot, Radish and Capsicum) as functional ingredients in mutton nuggets, J. Meat Science and Technology.1 (2):71-76.

Miles, R.S. (1996). Processing of low fat meat products proc. Recin. Meat Conf. 49:17-22.

Moazzami, A.A., Haese, S.L. and Kamal-Eldin, A. (2007). Lignan contents in sesame seeds and products. European Journal of Lipid Science and Technology.109(10): 1022–1027. doi: 10.1002/ejlt.200700057

Moon, S.S.; Jin, S.K.; Hah, K.H. and Kim, I.S. (2008). Effects of replacing backfat with fat replacers and olive oil on the quality characteristics and lipid oxidation of low-fat sausage during storage. J. Food Science and Biotechnology.17 (2): 396 - 401.

Rangkadilok, N.; Pholphana, N. and Mahidol, C. (2010). Variation of sesamin, sesamolin and tocopherols in sesame (Sesamum indicum L.) seeds and oil products in Thailand. Food Chem.122(3):724-30.

https://doi.org/10.1016/j.foodchem.2010.03.044

Siri-Tarino, P.W.; Sun, Q.; Hu, F.B. and Krauss, R.M. (2010). Saturated fat, carbohydrate, and cardiovascular disease. The American Journal of Clinical Nutrition.91 (3): 502–509. doi:10.3945/ajcn.2008.26285

Soltanizadeh, N. and Ghiasi-Esfahani, H. (2015). Qualitative improvement of low meat beef burger using Aloe vera. Meat Science, 99: 75–80. https://doi.org/10.1016/j.meatsci.2014.09.002

Taher , M. A.H. (1990). Meat science. College of Agriculture, University of Basrah, P: 520.

Yang, S.F.; Tseng, J.K.; Chang, Y.Y. and Chen, Y.C. (2009). Flaxseed oil attenuates nonalcoholic fatty liver of hyperlipidemic hamsters. J Agric. Food Chem., 57 (11): 5078 - 5083.

Youssef, M.K. and Barbut, S. (2009). Effects of protein level and fat/oil on emulsion stability, texture, microstructure and color of meat batters. Meat Science.82 (2): 228–233. doi:10.1016/j.meatsci.2009.01.015.