Original Article

Effect of Partial and Total Replacement of Sheep Fat with Recycled Chicken Fat on the Quality Characteristics of Burgers Produced From Aged Ewe Meat

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Abstract

Among the challenges facing the meat industry is the issue of partially or fully replacing chicken fat with animal fat (specifically thigh fat and tail fat), which has implications for the chemical and physical properties of refrigerated aged ewe meat. This experimental study involved six treatments: T1 as the positive control treatment with 100% rump fat, T2 the negative control treatment with 100% thigh fat, while T3, T4, T5, and T6 incorporated chicken fat at replacement rates of 25, 50, 75, and 100%, respectively. Each treatment was replicated three times and was preserved at five intervals to examine the effects of storage duration. The chicken fat samples were found to have a decrease in saturated and an increase in unsaturated fatty acids. An increase in saturated fatty acids was noted in the rump and tail fats while the percentage of unsaturated fatty acids decreased in the same fat samples. There was an increase in saturated fatty acids and a decrease in unsaturated fatty acids in treatments T1 and T2, while, the replacement treatments (T3, T4, T5, and T6) showed the opposite results. The replacement treatments showed a significant decrease in MDA, FFA, and PV, while T1 and T2 exhibited an increase in all oxidation indicators. In terms of physical characteristics, treatments T3, T4, T5, and T6 recorded a rise in WHC and a decrease in weight loss, cooking loss, and diameter shrinkage. All replacement treatments showed significant improvements across all sensory evaluation qualities.

Keywords: animal fat, fat replacement, chicken fat, burger, aged ewe meat, recycling

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Introduction

Significant attention is paid worldwide to particular human health issues such as diabetes, heart ailments, and obesity, which are often linked to specific lifestyles [10].

Excessive consumption of saturated fat (SFAs) and cholesterol increases the risk of cardiovascular diseases. In general, red meat contains 30–40% SFAs, 40–50% monounsaturated fatty acids (MUFAs), and 5–10% PUFAs [2, 12, 17]. Chicken fat is characterized by its lower saturated fat content than sheep and cow fat, making it a more suitable option for supporting public health.

Furthermore, utilizing these by-products contributes to reducing waste and environmental pollution, thereby enhancing the sustainability of the poultry production sector by converting what is considered waste into nutritional components with high functional and economic value [22, 23]. Research indicates that chicken fat contains a significant amount of unsaturated fatty acids, especially monounsaturated and polyunsaturated fatty acids, which help reduce harmful cholesterol levels and enhance cardiovascular health compared to saturated fats present in sheep fat. It is advisable to utilize chicken fat, particularly when sourced from poultry that was fed plant-based ingredients abundant in unsaturated fatty acids, such as flaxseed oil [29]. Older ewes, often slaughtered between five and six years of age, are one of the available sources of aged meat on the market. They are characterized by a pronounced toughness, fibrous texture, and high percentage of insoluble collagen, which reduces consumer preference and limits its marketing potential as a high-quality fresh product [26].

Given the importance of finding fat substitutes and the scarcity of studies in this field, this research aimed to provide a comprehensive evaluation of the components and methods used in developing fat substitutes, with a focus on chicken fat as a healthy alternative to sheep fat. It explores the health and functional potential of chicken fat and analyze its impact on the sensory and physical properties of food products. It also highlights the challenges associated with the use of chicken fat, such as improving its functional properties and ensuring its stability in various food applications. Chicken fat is a promising alternative to sheep fat in food products because it contributes to the reduction of saturated fat while maintaining product quality. However, its successful use depends on innovation in developing appropriate processing technologies that balance

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health benefits and sensory quality. This study evaluated how replacing sheep fat with chicken fat affects the chemical, physical, and sensory attributes of aged ewe meat burgers

Materials and Methods

This study was conducted at the Animal Production Department, Agricultural College, University of Anbar. It involved five clinically healthy local female ewes, aged approximately 6 years, with an average live body weight of 25-30 kg. The ewe carcasses were purchased immediately after slaughter at the Hit County abattoir in the Al-Anbar province of Iraq, and their thigh portions selected for experimental investigation. The meat was removed from the bone after the fat was removed, and then separated in accordance with the ethical guidelines of animal use. A 10 kg boneless meat portion was refrigerated for 10-12 hours to eliminate rigor mortis.

The meat was then cut with a knife into small pieces of 3-4 cm^3 to facilitate subsequent mincing with an electric mincer using sterile gloves. The pieces were homogenized to ensure an even distribution of the thigh components as they were a composite of various carcasses. Simultaneously, three types of fat, namely ewe, ewe leg fat, and chicken fat weighing 2.5 kg each, were prepared for use in this investigation. The other components of the mixture included salt (15 $g.kg^{-1}$), garlic (2.8 $g.kg^{-1}$), breadcrumbs (25 $g.kg^{-1}$), and a mixture of spices (6.5 $g.kg^{-1}$).

The components, along with the additives, were separately diced using an electric grinder equipped with a disc featuring approximately 6.8 mm diameter holes, and repeated twice to ensure consistency. Burger discs, each weighing 100 g, were randomly formed.

The study was conducted in a laboratory with six treatments, each repeated three times. Ninety burger samples were prepared using a fixed mixture ratio of 80% meat and 20% fat. The fat type was varied while maintaining the same weight ratio of the mixture.

The six treatments were as follows:

T1: burgers made from aged ewes + 20% ewe tail fat

T2: burgers made from aged ewes + 20% ewe leg fat

T3: burgers made from aged ewes + 15% ewe leg fat and + 5% chicken fat

T4: burgers made from aged ewes + 10% ewe fat and + 10% chicken fat

T5: burgers made from aged ewes + 5% ewe leg fat and + 15% chicken fat

T6: burgers made from aged ewes + 20% chicken fat

The variables observed included pH, cooking loss, water-holding capacity, and tenderness of emulsion-type burgers. The samples were divided into five groups, each containing 18 items, to be prepared for specific required tests on days 1, 4, 8, 12, and 16. The final samples were stored at 4 °C for no longer than 16 d before being prepared for testing and analysis.

The physical and chemical properties, oxidation indicators, microbiological analysis, and sensory evaluation of the manufactured burger samples were studied and analyzed over five selected days. Statistical analysis was performed using SAS statistical software (SAS, 2004) [7]. A significant difference between the means was determined by Duncan's multiple range test (Duncan, 1995) at the $P \leq 0.05$ significance level.

Fatty Acid

Fat content was determined using a Soxhlet extraction device for lipid extraction [3]. Chromatographic examination of the samples was conducted by evaluating fatty acid compounds using a Shimadzu gas chromatograph (GC-2010) manufactured in Japan. A flame ionization detector (FID) was utilized under the specified conditions as presented in **Table 1**, employing a SE-30 capillary column measuring 30 m in length and 0.25 mm in diameter [31].

Table 1. Specified conditions of the flame ionization detector

Parameters	Temperature
Injection zone temperature	280 °C
Detector temperature	310 °C
Separation column temperature	120 – 290 (10 °C/min)
Gas flow rate	100 KPa

Water holding capacity

To measure the water-holding capacity, 50 g of burgers were mixed homogeneously with 50 ml of distilled water for one minute [4].

Weight loss percentages

Using the method described by [11].

Cooking loss

Weight loss for burgers was estimated using the method described by [25].

Diameter shrinkage

The percentage of diameter shrinkage was measured using the method described in [11].

Oxidation indicators

Malondialdehyde (MDA): To estimate lipid oxidation in tissues, the amount of malondialdehyde, a product of lipid oxidation in various tissues, was measured by determining the value of thiobutyric acid (TBA) [30].

Free Fatty Acid (FFA) and peroxide value (PV): determined with certain modifications [7].

Sensory Evaluation

All the burgers samples made from the ewes were subjected to sensory evaluation after being prepared and cooked in an oven at 165 °C. The evaluation process involved several faculty members and graduate students from the College of Agriculture of the University of Anbar. The evaluators received comprehensive information regarding the evaluation methodology employed in this study, considering various factors that could influence the evaluation score, including the time of the test (10:00 AM), the cooking temperature, the interval between cooking and testing, the consumption of drinking water between tests, and the size of the sample presented for evaluation [24]. The sensory evaluation form included evaluations for flavor, tenderness, juiciness, texture, and overall acceptability, based on a scale of 1 to 8.

Results and Discussion

This study investigated the physical and chemical properties, oxidation indicators, microbiology, and sensory evaluation of the burger samples for five different durations.

Fatty acids

In the experiment, the fatty acid analysis revealed significant differences in lipid composition. Table 2 shows that chicken fat recorded the lowest concentrations of palmitic acid and stearic acid (saturated fatty acids), at 13.08% and 7.06%, respectively. In contrast, ewe leg fat recorded the highest concentrations of both fatty acids, at 21.45% and 15.34% respectively. In comparison, tail fat was 17.65% and 12.05%, respectively. The table indicates that chicken fat contains lower levels of these two fatty acids than ewe fat (from tail and leg areas), suggesting that the substitution reduces the amount of saturated fatty acids. Oleic acid is a monounsaturated fatty acid and the most common polyunsaturated fatty acid found in chicken fat. It is considered a health benefit (it contributes to lowering harmful cholesterol), thereby enhancing the nutritional value of the product.

The table also shows that chicken fat had the highest concentration of this fatty acid, reaching 32.98%, whereas ewe tail fat recorded 28.08%, followed by ewe leg fat at 21.78%. Furthermore, chicken fat had the highest level of polyunsaturated fatty acids, with concentrations of 12.65%, 3.05%, and 2.05%, respectively, compared to other fats. These are important health indicators as they include omega-3 and omega-6 fatty acids. Furthermore, comparison made with the existing literature that studied chicken fat and revealed good agreement (Table 2).

Table 2. Fatty acid percentages of the fats used in the experiment

Fatty acid	Current work			Previous work		
	Chicken fat	Tail fat	Leg fat	[23]	[8]	[15]
Palmitic acid C16:0	13.08^{c}	17.65^{b}	21.45^{a}	24.18	18.55	18.18
Stearic acid C18:0	7.06^{c}	12.05^{b}	15.34^{a}	5.69	8.31	5.25
Oleic acid C18:1	32.98^{a}	28.08^{b}	21.78^{c}	36.15	33.67	39.22
Linoleic acid (C18:2, n-6)	12.65^{a}	5.98^{b}	3.13^{c}	22.55	19.31	25.57
Linolenic acid (C18:3, n-3)	3.05^{a}	1.05^{b}	0.58^{c}	1.63	2.25	3.16
Arachidonic acid (C20:4)	2.05^{a}	1.11^{b}	0.88^{c}	-	-	-

Means with different superscript letters within a row or column differ significantly at $P \leq 0.05$.

The statistical analysis results presented in Table 3 indicate variations in the percentage of fatty acids among the experimental treatments (partial and total fat replacement). Treatment T1 exhibited an increase in the two fatty acids, palmitic acid and stearic acid (both of which are saturated fatty acids), achieving values of 35.65% and 14.61%, respectively. In contrast, T6 demonstrated a lower percentage of these acids when compared to the other experimental treatments, with values of 17.43% and 5.87%, respectively. Furthermore, the other replacement treatments (T3, T4, and T5) showed a notable decrease in the two acids relative to the control treatments (T1 and T2). Regarding oleic acid, T6 recorded the highest percentage of this acid, reaching 39.11%, whereas T2 exhibited the lowest at 24.67%.

Table 3 also shows the other experimental treatments registering significant increase in the two fatty acids, particularly in replacement treatments T3, T4, and T5, compared with the two control treatments. Concerning the fatty acids linoleic acid (C18:2, n-6), linolenic acid (C18:3, n-3), and arachidonic acid in the experimental treatments, treatment T6 recorded the highest percentages in them. The remaining experimental treatments also exhibited a significant increase, especially in the replacement treatments T3, T4, and T5, compared with the two control treatments. These findings align with the results reported when 30% of chicken fat was substituted with pork fat.

Table 3. Fatty acid % content impact due to the partial and total substitution of chicken fat in refrigerated burgers

Fatty acid	Current work						Literature
	T1	T2	T3	T4	T5	T6	[18]
Palmitic acid C16:0	30.25^{b}	35.65^{a}	24.08^{c}	22.16^{d}	19.08^{e}	17.43^{f}	24.38
Stearic acid C18:0	11.55^{b}	14.61^{a}	9.00^{c}	8.34^{d}	7.60^{e}	5.87^{f}	5.83
Oleic acid C18:1	**28**.70^{e}	**2**4.67^{f}	3**4**.08^{d}	36.22^{c}	38.10^{b}	39.11^{a}	37.61
Linoleic acid (C18:2, n-6)	8.08^{e}	5.15^{f}	**14**.08^{d}	16.05^{c}	**17**.55^{b}	18.81^{a}	25.10
Linolenic acid (C18:3, n-3)	1.35^{e}	1.08^{f}	2.00^{d}	2.46^{c}	2.66^{b}	3^{a}	1.32
Arachidonic acid (C20:4)	0.89^{e}	0.45^{f}	1.**55**^{d}	1.70^{c}	1.**83**^{b}	1.95^{a}	-

Different letters within a row indicate a significant difference at P≤0.05 between treatments.

Physical characteristics

Water-holding capacity

Table 4 illustrates the impact of the interaction between the experimental treatments (partial and total fat replacement) and storage duration on water-holding capacity (WHC). A notable increase at P≤0.05 was evident in T6 during the initial storage duration (1 d), achieving 77.296%, surpassing the performance of the other treatments. Conversely, the lowest WHC was noted under the influence of the interaction between treatments and storage duration in T1 and T2 during the fifth duration (16 days), reaching 50.863% and 50.263%, respectively. Furthermore, the same table shows that all replacement treatments (T3, T4, and T5) exhibited a higher moisture percentage than the two control treatments (T1 and T2). Regarding the individual effects of the treatments, T6 demonstrated the highest WHC percentage, significantly exceeding the other experimental treatments (P≤0.05), reaching 69.65%. In contrast, treatments T1 and T2 had the lowest WHC percentages compared to the other, at 58.642% and 58.384%, respectively. The other replacement treatments showed a significant increase in moisture content relative to the controls (T1 and T2).

Concerning the individual effects of storage duration, the same table indicates that the first duration (1 d) recorded the highest moisture content, reaching 65.63%, significantly outperforming the others. The fifth duration (16 d) recorded the lowest moisture content, at 61.532%. This finding aligns with the observations made when beef fat was substituted with chicken skin strips in the production of chicken sausages, which recorded increases in moisture and WHC of the meat [32]. This enhancement in WHC is also consistent with the findings when chicken and duck skin were utilized as substitutes for pork fat in sausages made from chicken breast [14]. The high proportion of unsaturated fatty acids in chicken fat may account for this phenomenon [22].

The melting point of fat plays a crucial role in determining the characteristics of meat products such as burgers. Poultry fat has a relatively low melting point (28–33 °C) in contrast to sheep or cow fat, which melts at higher temperatures (45–55 °C). This lower melting point results in more fluid consistency for poultry fat, enhancing its distribution and uniformity during the mixing process, and aids in the creation of a more stable emulsion of fat, water, and protein. In contrast to ruminant fat, which tends to aggregate and create voids that can lead to moisture loss, poultry fat effectively fills these voids, thereby minimizing moisture leakage during processing or cooking and enhancing the water-retention capacity of the product. Research has demonstrated that fats with low melting points, such as poultry fat, yield more stable emulsions and enhance the functional properties of the product, particularly with respect to moisture retention, WHC, and weight and cooking losses.

Additionally, poultry fat is characterized by a higher concentration of phospholipids, which are surface-active agents that aid in the stabilization of emulsions within meat mixtures because of their capacity to bind water and fat. This action prevents phase separation during mixing and heating, thereby improving the texture and stability of the product and significantly boosting WHC. Furthermore, the elevated phospholipid levels in chicken fat enhance its emulsifying capabilities and positively influence the final product characteristics, such as moisture retention, WHC, weight loss, diameter shrinkage, and cooking loss [5, 27].

Table 4. Influence of partial and total replacement of chicken fat and storage periods in refrigerated burgers on water holding capacity %

Treatment	Days					
	1	4	8	12	16	Average Treatment
T1	67.52^{g}	61.443^{l}	58.483^{o}	54.9^{q}	50.863^{s}	58.642^{e}
T2	67.223^{g}	61.859^{l}	57.96^{o}	54.616^{q}	50.263^{s}	58.384^{e}
T3	70.296^{e}	64.943^{i}	60.563^{m}	56.686^{p}	53.043^{r}	61.106^{d}
T4	74.296^{c}	69^{f}	64.306^{i}	60.316^{m}	56.516^{p}	64.887^{c}
T5	75.366^{b}	70.516^{e}	67.083^{g}	63.583^{j}	59.609^{n}	67.232^{b}
T6	77.296^{a}	73.033^{d}	69.576^{f}	65.736^{h}	62.609^{k}	69.65^{a}
Average duration	72^{a}	66.799^{b}	62.995^{c}	59.306^{d}	55.484^{e}	**SEM 0.670**

Average significance level for storage durations and their interaction at P≤0.05

Different letters within a row and column indicate significant differences (P≤0.05) between storage durations and treatments, respectively.

Weight loss

Table 5 presents the influence of the interaction between the different treatments (partial and total fat replacement) and storage duration on weight loss. A notable reduction at P≤0.05 was noted in T6 during the 1-day storage duration, reaching 1.316%, the lowest weight loss of all the treatments. In contrast, the most significant weight loss was observed under the interaction effect in T2 during the fifth storage period (16 d), reaching 3.449%. Additionally, the same table indicates that all replacement treatments (T3, T4, and T5) exhibited the lowest weight loss compared to the two control treatments (T1 and T2).

Concerning the individual effects of the treatments, T6 demonstrated the least weight loss relative to the others, achieving 2.119%, whereas T2 had the highest at 2.746%, surpassing all experimental treatments. Regarding the individual effect of storage duration, the first period (1 d) recorded the lowest weight loss compared to the subsequent experimental periods, reaching 1.548%, while the sixth period (16 days) recorded the highest percentage loss of 3.113%.

Table 5. Influence of partial and total replacement of chicken fat and storage periods in refrigerated burgers on weight loss %

Treatment	Days					
	1	4	8	12	16	Average Treatment
T1	1.676^{s}	2.42^{kl}	2.866^{g}	3.126^{d}	3.326^{b}	2.683^{b}
T2	1.759^{r}	2.41^{l}	2.893^{g}	3.216^{c}	3.449^{a}	2.746^{a}
T3	1.646^{s}	2.306^{m}	2.763^{h}	3.08^{e}	3.206^{c}	2.6^{c}
T4	1.53^{t}	2.099^{o}	2.453^{jk}	2.87^{g}	3.03^{f}	2.396^{d}
T5	1.363^{u}	2.029^{p}	2.233^{n}	2.539^{i}	2.876^{g}	2.208^{e}
T6	1.316^{v}	1.906^{q}	2.123^{o}	2.46^{j}	2.789^{h}	2.119^{f}
Average duration	1.548^{e}	2.195^{d}	2.555^{c}	2.882^{b}	3.113^{a}	**SEM 0.063**

Average significance level for storage durations and their interaction at P≤0.05

Different letters within a row and column indicate significant differences (P≤0.05) between storage durations and treatments, respectively.

Cooking loss

The effect of the interaction between experimental treatments (partial and total fat replacement) and storage duration on cooking loss was also investigated, as shown in Table 6. A notable reduction (P≤0.05) was identified in T6 during the fifth storage period (16 days), achieving 14.87%, the lowest cooking loss among the treatments. Conversely, the highest cooking loss was in the T2 interaction effect during the initial period (1 d), reaching 33.286%. Additionally, all replacement treatments (T3, T4, and T5) exhibited the lowest cooking loss compared to the two control treatments (T1 and T2).

In terms of the individual effects of the treatments, T6 demonstrated the lowest cooking loss relative to the others, reaching 18.74%, while T2 exhibited the highest at 27.283%, surpassing all experimental treatments. Regarding the individual effects of storage period, the first (1 d) recorded the highest cooking loss compared to the subsequent experimental periods, reaching 29.484%, whereas the sixth period (16 days) recorded the highest weight loss, reaching 19.284%.

Table 6. Influence of partial and total replacement of chicken fat and storage periods in refrigerated burgers on cooking loss %.

Treatment	Days					
	1	4	8	12	16	Average Treatment
T1	33.183^{b}	29.73^{d}	26.413^{g}	24.636^{k}	22.07^{p}	27.206^{b}
T2	33.286^{a}	29.669^{d}	26.55^{f}	24.806^{j}	22.103^{p}	27.283^{a}
T3	30.673^{c}	26.456^{g}	24.103^{m}	22.17^{o}	20.753^{r}	24.831^{c}
T4	28.56^{e}	24.209^{l}	21.863^{q}	20.09^{s}	19.303^{t}	22.805^{d}
T5	26.303^{h}	22.53^{n}	19.033^{u}	18.35^{v}	16.606^{x}	20.564^{e}
T6	24.9^{i}	20.746^{r}	17.26^{w}	15.923^{y}	14.87^{z}	18.74^{f}
Average duration	29.484^{a}	25.557^{b}	22.537^{c}	20.996^{d}	19.284^{e}	**SEM 0.512**

Average significance level for storage durations and their interaction at P≤0.05

Different letters within a row and column indicate significant differences (P≤0.05) between storage durations and treatments, respectively.

Diameter shrinkage

Table 7 shows the relationship between the experimental treatments (partial and total fat replacement) and storage duration with respect to their impact on diameter shrinkage. A notable reduction at P≤0.05 was identified in T6 during the fifth storage period (16 days), achieving 19.86%, the lowest weight loss in comparison to the other treatments. Conversely, the most significant diameter shrinkage was observed under the T2 interaction effect during the same period (16 days), reaching 36.746%. Additionally, the same table indicates that all replacement treatments (T3, T4, and T5) exhibited the least weight loss relative to the two control treatments (T1 and T2).

In terms of individual effects of the treatments, T6 had the smallest diameter shrinkage compared to the others, reaching 23.988%, whereas T2 exhibited the maximum shrinkage, attaining 30.878%, surpassing all experimental treatments. Concerning the individual effect of storage duration, the first period (1 d) recorded the highest diameter shrinkage compared to the subsequent periods, reaching 33.416%, whereas the sixth period (16 d) had the lowest, at 23.5%.

Table 7. Influence of partial and total replacement of chicken fat and storage periods on diameter shrinkage % in refrigerated burgers

Treatment	Days					
	1	4	8	12	16	Average Treatment
T1	36.206^{b}	34.653^{e}	30.743^{h}	26.13^{q}	24.533^{s}	30.561^{b}
T2	36.746^{a}	34.743^{d}	30.74^{h}	26.196^{p}	24.52^{s}	30.878^{a}
T3	35.23^{c}	33.71^{f}	30.163^{i}	28.56^{l}	26.726^{m}	30.481^{c}
T4	33.433^{g}	30.133^{ij}	28.533^{l}	26.663^{n}	24.136^{t}	28.58^{d}
T5	30.123^{j}	28.773^{k}	25.753^{r}	23.92^{u}	21.223^{w}	25.958^{e}
T6	28.76^{k}	26.313^{o}	23.86^{v}	21.15^{x}	19.86^{y}	23.988^{f}
Average duration	33.416^{a}	31.387^{b}	28.298^{c}	25.436^{d}	23.5^{e}	**SEM 0.483**

Average significance level for storage durations and their interaction at P≤0.05

Different letters within a row and column indicate significant differences (P≤0.05) between storage durations and treatments, respectively.

The higher moisture content and water-holding capacity (WHC), along with reduced weight loss, cooking loss, and diameter shrinkage in beef burgers when sheep or beef fat is substituted with poultry fat, can be attributed to the distinct physical and chemical characteristics of the latter. It possesses higher levels of unsaturated fatty acids, rendering it softer and more fluid than the ruminant fat. This enhanced the capacity of the mixture to distribute and retain water within the protein matrix during mixing and processing. Furthermore, poultry fat typically has a relatively high moisture content and demonstrates superior emulsifying properties, leading to a more uniform and stable product with respect to water retention. Research suggests that these combined factors enhance the functional properties of the product and elevate the moisture content and WHC compared to products containing ruminant fat [15].

Malondialdehyde (MDA)

The results of the interaction between the experimental treatments (partially and fully replacing fat) and storage duration is shown in Table 8. The highest value observed under this interaction occurred in T2 during the fifth period (16 days), reaching 1.624 mg MDA kg^{-1} meat. Conversely, the lowest values were during the initial period of the experiment (1 d), with readings of 0.285, 0.278, 0.284, 0.281, 0.277, and 0.276 mg MDA kg^{-1} meat for treatments T1, T2, T3, T4, T5, and T6, respectively. Furthermore, it is evident from the interaction

factors that the highest ratios were recorded for treatments T1 and T2, in contrast to the replacement (T3, T4, T5, and T6), which exhibited a significant decline during the storage period. Regarding individual treatment effects, T6 demonstrated the lowest MDA percentage, achieving a value of 0.703 mg MDA kg^{-1} meat, while T2 exhibited the highest among the experimental treatments, reaching 0.689 mg MDA kg^{-1} meat.

Additionally, all replacement treatments experienced a significant reduction in MDA levels compared to the control treatments (T1 and T2). In terms of the individual effects of the storage periods, the first period (1 day) recorded the lowest MDA percentage relative to the other experimental periods, at 0.28 mg MDA kg^{-1} meat, whereas the fifth period (16 days) recorded the highest at 1.386 mg MDA kg^{-1} meat. It is also noted that longer storage durations correlate with increased MDA percentages.

Table 8. Influence of partial and total replacement of chicken fat and storage periods on MDA (mg MDA kg^{-1} meat) in refrigerated burgers

Treatment	Days					
	1	4	8	12	16	Average Treatment
T1	0.285^{n}	0.446^{l}	0.663^{h}	1.231^{e}	1.578^{b}	0.840^{b}
T2	0.278^{n}	0.445^{lm}	0.668^{h}	1.333^{d}	1.624^{a}	0.869^{a}
T3	0.284^{n}	0.444^{lm}	0.663^{h}	1.115^{f}	1.429^{c}	0.787^{c}
T4	0.281^{n}	0.45^{l}	0.632^{i}	1.067^{g}	1.337^{d}	0.753^{d}
T5	0.277^{n}	0.444^{lm}	0.577^{j}	1.051^{g}	1.224^{e}	0.714^{e}
T6	0.276^{n}	0.426^{m}	0.543^{k}	1.05^{g}	1.223^{e}	0.703^{f}
Average duration	0.28^{e}	0.442^{d}	0.624^{c}	1.141^{b}	1.386^{a}	**SEM 0.045**

Average significance level for storage durations and their interaction at P≤0.05

Different letters within a row and column indicate significant differences (P≤0.05) between storage durations and treatments, respectively.

Free fatty acid (FFA)

Table 9 depicts the interaction effects between the experimental treatments (partial and total fat replacement) and storage duration on FFA. The highest value observed occurred in T2 during the fifth storage period (16 days), reaching 0.912 %. Conversely, the lowest values were noted across all experimental treatments during the initial storage period (1 d), with values of 0.183, 0.183, 0.186, 0.186, 0.185, and 0.184 % for treatments T1, T2, T3, T4, T5, and T6, respectively. Furthermore, the highest ratios were associated with treatments T1 and T2, in contrast to the replacement treatments (T3, T4, T5, and T6), which exhibited a significant decline throughout the storage period. Regarding the individual effects of treatments, T6 demonstrated the lowest FFA percentage among the experimental treatments, at 0.478%, while T2 exhibited the highest, reaching 0.531%.

Additionally, all replacement treatments experienced a significant reduction compared to the two controls (T1 and T2). In terms of the individual effects of storage period, the first period (1 d) recorded the lowest FFA percentage compared to the others, at 0.184%, whereas the fifth (16 days) recorded the highest, reaching 0.863 %. It can also be noted that longer storage periods correlated with higher FFA percentages.

Table 9. Influence of partial and total replacement of chicken fat and storage periods on FFA% in refrigerated burgers

Treatment	Days					
	1	4	8	12	16	Average Treatment
T1	0.183^{r}	0.284^{pq}	0.535^{l}	0.723^{g}	0.897^{b}	0.524^{b}
T2	0.183^{r}	0.285^{p}	0.542^{k}	0.733^{f}	0.912^{a}	0.531^{a}
T3	0.186^{r}	0.284^{pq}	0.525^{m}	0.693^{h}	0.875^{c}	0.512^{c}
T4	0.186^{r}	0.283^{pq}	0.504^{n}	0.676^{i}	0.853^{d}	0.500^{d}
T5	0.185^{r}	0.283^{pq}	0.486^{o}	0.623^{j}	0.823^{e}	0.480^{e}
T6	0.184^{r}	0.281^{q}	0.483^{o}	0.622^{j}	0.822^{e}	0.478^{f}
Average duration	0.184^{e}	0.283^{d}	0.512^{c}	0.678^{b}	0.863^{a}	**SEM 0.026**

Average significance level for storage durations and their interaction at P≤0.05

Different letters within a row and column indicate significant differences (P≤0.05) between storage durations and treatments, respectively.

Peroxide value (PV)

Table 10 outlines the influence of the interaction between experimental treatments (partial and total fat replacement) and storage duration on PV. The highest value observed under the interaction effect was in T2 during the fifth period (16 days),

reaching 9.333 meq^{-1} fat, whereas the lowest was in T6 during the initial storage period, at 1.11 meq^{-1} fat. Furthermore, the highest percentages were recorded in T1 and T2, in contrast to the replacement treatments (T3, T4, T5, and T6), which exhibited a significant decline during the storage period. Concerning the individual effects of the treatments, T6 demonstrated the lowest percentage in PV compared to the others, at 5.075 meq^{-1} fat, whereas T2 showed the highest percentage among the remaining treatments, reaching 5.637 meq^{-1} fat. Additionally, all replacement treatments experienced a significant reduction compared with the control treatments (T1 and T2).

Regarding the individual effects of storage period, the first period (1 d) recorded the lowest PV at 1.183 meq^{-1} fat, while the fifth period (16 days) recorded the highest, reaching 9.083 meq^{-1} fat. Also, there was a positive correlation between storage periods and PV percentages. This may be attributed to the lower levels of oxidation indicators (MDA, FFA, and PV) present in the replacement treatments containing chicken fat (T3, T4, T5, and T6). The reduction in the redox indices in the replacement coefficients (T3, T4, T5, and T6) could be linked to the role of vitamin E in sustaining the intracellular redox balance, which is crucial for preventing damage to phospholipids in cell membranes.

Table 10. Influence of partial and total replacement of chicken fat and storage periods on PV (meq^{-1} fat) in refrigerated burgers

Treatment	Days					
	1	4	8	12	16	Average Treatment
T1	1.24^{s}	3.75^{o}	5.746^{j}	8.063^{f}	9.24^{b}	5.607^{b}
T2	1.23^{s}	3.74^{o}	5.743^{j}	8.14^{e}	9.333^{a}	5.637^{a}
T3	1.20^{t}	3.446^{p}	5.633^{k}	7.92^{g}	9.206^{b}	5.481^{c}
T4	1.18^{u}	3.444^{p}	5.339^{l}	7.686^{h}	9.003^{c}	5.330^{d}
T5	1.14^{v}	3.241^{q}	5.153^{m}	7.156^{i}	8.866^{d}	5.111^{e}
T6	1.11^{w}	3.176^{r}	5.075^{n}	7.163^{i}	8.853^{d}	5.075^{f}
Average duration	1.183^{e}	3.466^{d}	5.448^{c}	7.688^{b}	9.083^{a}	**SEM 0.296**

Average significance level for storage durations and their interaction at P≤0.05

Different letters within a row and column indicate significant differences (P≤0.05) between storage durations and treatments, respectively.

Research indicates that alpha-tocopherol supplements can diminish lipid oxidation within tissues and enhance meat quality during storage. They also play a role in alleviating fatty liver inflammation and in the prevention of certain metabolic disorders, including diabetes [6, 10]. Within the poultry sector, the use of alpha-tocopherol supplements has been shown to diminish abdominal fat accumulation in broiler chickens, achieved not only through metabolic modification, but also by decreasing lipid oxidation. This process enhances the integrity of cell membranes in adipose tissue and mitigates oxidative damage that leads to fat deposition. Furthermore, research conducted on chickens revealed that the adding vitamin E results in a notable increase in n-3 fatty acids and a reduction in the n-6/n-3 ratio [20].

A research study has shown that oxidation is a significant factor that leads to a reduction in both productive and reproductive performance in chicken flocks. To mitigate these adverse effects, antioxidants are incorporated into poultry feed, sourced either from natural feed components or external supplements. Vitamin E is regarded as a fundamental antioxidant and has been demonstrated to bolster the antioxidant defense system [28].

A separate investigation aimed at assessing alpha-tocopherol levels in various meats revealed that chicken thigh exhibited the highest concentration, followed by chicken breast and pork shoulder, while the lowest concentrations were found in the longissimus dorsi muscle of sheep meat [16]. Vitamin E (alpha-tocopherol) is one of the most potent antioxidants present in chicken fat and tissues. It is a fat-soluble vitamin. Adequate levels of vitamin E in chicken fat improve its oxidative stability, thereby decreasing the likelihood of rancidity and quality degradation during storage or heat processing [9]. In these processes, vitamin E is transformed into tocopheryl, a relatively stable radical that does not participate in oxidation reactions. Furthermore, vitamin E aids in decelerating the breakdown of oxidized substances such as lipid peroxides. In the presence of vitamin C, alpha-tocopherol is restored from its oxidized state, thereby preserving its antioxidant efficacy [13, 19].

This finding aligns with an earlier observation that noted a distinct reduction in oxidation indicators in chicken kavurma when chicken fat was used instead of cow fat, which demonstrated a notable enhancement [5]. This effect was linked to the antioxidant substances incorporated into the chicken b, specifically the addition of 80 mg/ton of selenium and 300 mg/ton of BHA-BHT, along with vitamin E supplementation. Furthermore, the inclusion of vitamin E in poultry feed can mitigate fat oxidation during storage [21].

Sensory evaluation

Table 11 show the sensory evaluation of the samples used in this experiment. Treatment T2 had the lowest flavor compared to the other experimental treatments, reaching 5.75, whereas T6 had the highest, at 8.50. It was also noted that the chicken fat

replacement treatments recorded the highest values, especially with the exception of T3, which did not differ from each other, reaching 6.5 for both treatments.

The tenderness test results indicated that treatment T2 exhibited the lowest tenderness among all experimental treatments, with a score of 5.5. Conversely, T6 had the highest tenderness, at 8. Additionally, it is observed that the chicken fat substitution treatments, along with T2, showed higher tenderness levels compared to the control treatment T2.

In terms of juiciness of the burger samples, the highest value was in T6, reaching 8.5, whereas T2 had the lowest, at 4.5. This indicates that all samples, except T2, had high juiciness.

In regard to texture, **Table 11** shows that the T5 and T6 burger samples were classified as 2 (fine), whereas T2 was rated 4 (rough). The other experimental parameters were classified as 3 (acceptable).

For overall acceptability of the processed burgers stored for two days, all experimental treatments scored within the acceptable range of seven, indicating that all samples were acceptable, with the highest acceptability observed across all treatments. This aligns with the findings that all chicken kavurma samples, after replacing beef fat with chicken fat, showed significant improvement compared to the control on the first day of storage [5]. However, these treatments showed a significant decline as the storage time increased. The study tested five treatments, i.e., control and those replacing chicken fat with beef fat at 25%, 50%, 75%, and 100% for chicken kavurma samples frozen for 90 days.

The results also agree with those of [18], who found that using chicken waste (belly fat and skin) as alternative fats improved all sensory properties, especially in sausages where chicken fat, fat, and chicken skin were added together, compared to other treatments stored in the freezer for 135 days. Chicken waste improves all sensory properties when chicken fat and skin are added to sausages frozen for 135 days [27].

Table 11. Influence of partial and total replacement of chicken fat and storage periods on sensory evaluation in refrigerated burgers

Attribute Treatment	Flavor	Tenderness	Juiciness	Texture	Overall acceptability
T1	6.50	7	7	3.5	5.5
T2	5.75	5.5	4.5	4	5
T3	6.50	7	7	3.5	6.5
T4	7.25	7.25	7.5	3	7
T5	8	7.50	7.75	2.5	7.25
T6	8.50	8	8.50	2	7.5

Conclusion

The results of this study suggest that partial and total substitution of animal fat with chicken fat improves the quality of meat from aged ewes in terms of health, rheological, and sensory aspects, while also mitigating the effects of storage periods on the product. There are numerous challenges associated with the use of sheep fat, including its high price and health risks. However, chicken fat has emerged as an economically feasible, healthier, and more viable alternative that aligns with the principles of sustainable development on eradicating poverty and hunger, and promoting health and well-being.

The use of chicken fat allows producers to generate additional economic value from components that were once considered waste. This resource opens up new opportunities in manufacturing, processing, and distribution, leading to extra income that supports the primary goals of sustainable development. Using poultry waste (poultry fat) as an alternative can reduce production costs by up to 25% and increase the value of meat products. The use of chicken fat aligns with the goal of providing an affordable, low-cost energy source that can be integrated into food manufacturing, helping expand food distribution, especially for low-income groups, and decreasing dependence on animal sources that produce greenhouse gases.

References

1. AOAC International (1995). Official methods of analysis (16th ed.). Washington, DC, USA.
2. Chaosap, C., Sivapirunthep, P., & Adeyemi, K. D. (2024). Influence of age at slaughter and sex on carcass characteristics, meat quality, fatty acids, and ribonucleotides in white-tailed yellow native chickens. Tropical Animal Health and Production, 56(8), 313. https://doi.org/10.1007/s11250-024-04121-9
3. da Silva, S. L., Amaral, J. T., Ribeiro, M., Sebastião, E. E., Vargas, C., de Lima Franzen, F., ... & Campagnol, P. C. B. (2019). Fat replacement by oleogel rich in oleic acid and its impact on the technological, nutritional, oxidative, and sensory properties of Bologna-type sausages. Meat Science, 149, 141-148. https://doi.org/10.1016/j.meatsci.2018.11.020
4. den Hertog-Meischke, M. J. A., Van Laack, R. J. L. M., & Smulders, F. J. M. (1997). The water-holding capacity of fresh meat. Veterinary Quarterly, 19(4), 175-181. https://doi.org/10.1080/01652176.1997.9694767
5. Dikici, A., Nacak, B., Yel, N., Zaimoğulları, K., İpek, G., & Özer, M. (2022). Quality characteristics and oxidative stability of chicken kavurma formulated with chicken abdominal fat as beef fat replacer. Journal of the Hellenic Veterinary Medical Society, 73(3), 4525–4534. https://doi.org/10.12681/jhvms.27738
6. Ebhohimen, I. E., Okanlawon, T. S., Osagie, A. O., & Izevbigie, O. N. (2021). Vitamin E in human health and oxidative stress related diseases. Vitamin E in Health and Disease-Interactions, Diseases and Health Aspects, 11, 23. https://doi.org/10.5772/intechopen.99169
7. Egan, H., Kirk, R. S., & Sawyer, R. (1981). Pearson's chemical analysis of foods (8th ed.). London: Longman Scientific & Technical.

8. Feddern, V., Kupski, L., Cipolatti, E. P., Giacobbo, G., Mendes, G. L., Badiale-Furlong, E., & de Souza-Soares, L. A. (2010). Physico-chemical composition, fractionated glycerides and fatty acid profile of chicken skin fat. European Journal of Lipid Science and Technology, 112(11), 1277-1284. https://doi.org/10.1002/ejlt.201000072
9. Grau, A., Guardiola, F., Grimpa, S., Barroeta, A. C., & Codony, R. (2001). Oxidative stability of dark chicken meat through frozen storage: Influence of dietary fat and α-tocopherol and ascorbic acid supplementation. Poultry Science, 80(11), 1630-1642. https://doi.org/10.1093/ps/80.11.1630
10. Gulcin, İ. (2025). Antioxidants: a comprehensive review. Archives of Toxicology, 1-105. https://doi.org/10.1007/s00204-025-03997-2
11. Guo, S.-L., & Tsao-Chen, M. (1989). Microflora of Chinese-style sausage and their biochemical characteristics. 35. International Congress of Meat Science and Technology, Copenhagen (Denmark), 20-25 Aug, 478-482. https://agris.fao.org/search/en/providers/122465/records/6471f4b877fd37171a71bdf6
12. Jayedi, A., Soltani, S., Emadi, A., Ghods, K., & Shab-Bidar, S. (2024). Dietary intake, biomarkers and supplementation of fatty acids and risk of coronary events: A systematic review and dose-response meta-analysis of randomized controlled trials and prospective observational studies. Critical Reviews in Food Science and Nutrition, 64(33), 12363-12382. https://doi.org/10.1080/10408398.2023.2251583
13. Karabagias, I., Badeka, A., & Kontominas, M. G. (2011). Shelf-life extension of lamb meat using thyme or oregano essential oils and modified atmosphere packaging. Meat Science, 88(1), 109-116. https://doi.org/10.1016/j.meatsci.2010.12.010
14. Kim, H. S., Lee, S. H., & Kim, H. Y. (2023). Analysis of the replacement effect of added chicken and duck skin fat as a pork back fat replacement in chicken breast emulsion sausages. Journal of the Korean Society of Food Science and Nutrition, 52 (2), 178–185. https://doi.org/10.3746/jkfn.2023.52.2.178
15. Kim, T. K., Lee, M. H., Yong, H. I., Jang, H. W., Jung, S., & Choi, Y. S. (2021). Impacts of fat types and myofibrillar protein on the rheological properties and thermal stability of meat emulsion systems. Food Chemistry, 346, 128930. https://doi.org/10.1016/j.foodchem.2020.128930
16. Leonhardt, M., Gebert, S., & Wenk, C. (1997). Vitamin E content of different animal products: Influence of animal nutrition. Zeitschrift für Ernährungswissenschaft, 36(1), 23-27. https://doi.org/10.1007/BF01618896
17. Li, Z., Lei, H., Jiang, H., Fan, Y., Shi, J., Li, C., ... & Ma, L. (2022). Saturated fatty acid biomarkers and risk of cardiometabolic diseases: a meta-analysis of prospective studies. Frontiers in Nutrition, 9, 963471. https://doi.org/10.3389/fnut.2022.963471
18. Lima, J. L., Assis, B. B., Arcanjo, N. M., Galvao, M. D. S., Olegário, L. S., Bezerra, T. K., & Madruga, M. S. (2020). Impact of use of byproducts (chicken skin and abdominal fat) on the oxidation of chicken sausage stored under freezing. Journal of Food Science, 85(4), 1114-1124. https://doi.org/10.1111/1750-3841.15068
19. Lorenzo, J. M., Batlle, R., & Gómez, M. (2014). Extension of the shelf-life of foal meat with two antioxidant active packaging systems. LWT-Food Science and Technology, 59(1), 181-188. https://doi.org/10.1016/j.lwt.2014.04.061
20. Marcinkowska-Lesiak, M., Zdanowska-Sąsiadek, Ż., Stelmasiak, A., Damaziak, K., Michalczuk, M., Poławska, E., ... & Wierzbicka, A. (2016). Effect of packaging method and cold-storage time on chicken meat quality. CyTA-Journal of Food, 14(1), 41-46. https://doi.org/10.1080/19476337.2015.1042054
21. Niu, Z. Y., Min, Y. N., & Liu, F. Z. (2018). Dietary vitamin E improves meat quality and antioxidant capacity in broilers by upregulating the expression of antioxidant enzyme genes. Journal of Applied Animal Research, 46(1), 397–401. https://doi.org/10.1080/09712119.2017.1309321
22. Özer, C. O., Demir Özer, E., Şen, K., & Var, G. B. (2025). Development of functional flavour enhancers from waste chicken skin. British Poultry Science, 1-8. https://doi.org/10.1080/00071668.2025.2494596
23. Peña-Saldarriaga, L. M., Fernández-López, J., & Pérez-Alvarez, J. A. (2020). Quality of chicken fat by-products: Lipid profile and colour properties. Foods, 9(8), 1046. https://doi.org/10.3390/foods9081046
24. Peryam, D. R. (1990). Sensory evaluation—The early days. Food Technology, 44(1), 86–91.
25. Purchas, R. W., & Barton, R. A. (1976). The tenderness of meat of several breeds of cattle raised under New Zealand pastoral conditions. New Zealand Journal of Agricultural Research, 19(4), 421-428. https://doi.org/10.1080/00288233.1976.10420970
26. Rivera-Bautista, C., Grajales-Lagunes, A., Relling, A., Chay-Canul, A., Vazquez-Valladolid, A., Vargas-Bello-Pérez, E., & Lee-Rangel, H. A. (2023). Effect of age and diet on carcass and meat quality in ewes. Heliyon, 9(11), e22350. https://doi.org/10.1016/j.heliyon.2023.e22350
27. Sahasrabudhe, M. R., Delorme, N. F., Wood, D. F., & Randall, C. J. (1985). Neutral and polar lipids in chicken parts and their fatty acid composition. Poultry Science, 64(5), 910-916. https://doi.org/10.3382/ps.0640910
28. Surai, P. F., Kochish, I. I., & Fisinin, V. I. (2018). Glutathione peroxidases in poultry biology: Part 1. Classification and mechanisms of action. World's Poultry Science Journal, 74(2), 185-198. https://doi.org/10.1017/S0043933918000284
29. Vlaicu, P. A., Untea, A. E., & Oancea, A. G. (2024). Sustainable poultry feeding strategies for achieving zero hunger and enhancing food quality. Agriculture, 14(10), 1811. https://doi.org/10.3390/agriculture14101811
30. Witte, V. C., Krause, G. F., & Bailey, M. E. (1970). A new extraction method for determining 2-thiobarbituric acid values of pork and beef during storage. Journal of Food Science, 35(5), 582-585. https://doi.org/10.1111/j.1365-2621.1970.tb04815.x
31. Zhang, H., Wang, Z., & Liu, O. (2015). Development and validation of a GC–FID method for quantitative analysis of oleic acid and related fatty acids. Journal of Pharmaceutical Analysis, 5(4), 223–230. https://doi.org/10.1016/j.jpha.2015.01.005
32. Zungur, A., Nacak, B., & Serdaroglu, M. (2015). Model Sistem Tavuk Eti Emülsiyonlarında Sığır Karkas Yağı Yerine Tavuk Derisi Kullanımının Emülsiyon Karakteristikleri Üzerine Etkisi. Turkish Journal of Agriculture-Food Science and Technology, 3(12), 941-947. https://doi.org/10.24925/turjaf.v3i12.941-947.505

مقالة أصيلة

تأثير الاستبدال الجزئي والكلي لدهن الأغنام بدهن الدجاج المُعاد تدويره على جودة البرجر المُنتج من لحوم النعاج المُسنّة

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الخلاصة

تواجه الصناعة تحديات بما في ذلك الاستبدال الجزئي أو الكامل لدهن الدجاج بدهن حيواني (وتحديداً دهن الفخذ ودهن الردف) مما يؤثر على الخصائص الكيميائية والفيزيائية للحوم النعاج المُبَرّدة. تضمنت الدراسة التجربة ست معاملات: وهي T1 معاملة السيطرة الموجبة مع دهن الالية بنسبة 100٪ اما T2 كانت معاملة السيطرة السالبة مع دهن الفخذ بنسبة 100٪ بينما تضمنت T3 و T4 و T5 و T6 دهن الدجاج بمعدلات استبدال 25 و 50 و 75 و 100٪ على التوالي، تم تكرار كل معاملة ثلاث مرات وتم حفظها على خمس فترات لفحص آثار مدة التخزين. لوحظ انخفاض في الأحماض الدهنية المشبعة وزيادة في الأحماض الدهنية غير المشبعة في عينات دهن الدجاج. ولوحظت زيادة في الأحماض الدهنية المشبعة في دهون الالية والفخذ. ولوحظ انخفاض كبير في نسبة الأحماض الدهنية غير المشبعة في عينات الدهون نفسها. كانت هناك زيادة في الأحماض الدهنية المشبعة وانخفاض في الأحماض الدهنية غير المشبعة في المعاملات T1 و T2 في حين أظهرت معاملات الاستبدال T3، T4، T5، وT6 نتائج عكسية. أظهرت معاملات الاستبدال انخفاضًا ملحوظًا في MDA وFFA وPV، بينما أظهرت المعاملات T1 وT2 زيادة في جميع مؤشرات الأكسدة. من حيث الخصائص الفيزيائية، سجلت المعاملات T3، T4، T5، وT6 ارتفاعاً في WHC وانخفاضاً في فقدان الوزن وفقدان الوزن عند الطهي وانكماش القطر، أظهرت جميع معاملات الاستبدال تحسناً ملحوظاً في جميع خصائص التقييم الحسي

الكلمات المفتاحية: الدهون الحيوانية، استبدال الدهون، شحم الدجاج، بيركر، لحم النعاج المسنة، اعادة تدوير