Dosing in Three Levels of Apricot Seed Oil and Its Affects on Some Fresh and Frozen Sheep Meat Traits

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ABSTRACT
Its impact on some characteristics of frozen meat from Iraqi sheep. The experiment was carried out at the Animal Production Field of the College of Agriculture, Tikrit University, from August 22, 2023, to December 2, 2023. Fifteen lambs were used, divided into three groups (five lambs per group) with similar average weights (24.40 kg). The treatments were randomly assigned, and a collective feeding system was employed using a single formula of concentrated feed at 3% of the live animal's weight. The results indicated a significant difference ($P \leq 0.05$) in the moisture content favoring the first treatment over the second and third treatments. Conversely, the third treatment showed a significant increase ($P \leq 0.05$) in fat percentage, ash content, and protein content compared to the first treatment. The administration of apricot oil at 0.0020% of the live animal's weight led to a reduction in lipid peroxidation and post-thaw loss after two months of freezing. The results also showed significant differences in the free fatty acid profiles (Palmitic, Stearic, Oleic, Linolenic, Linoleic, and Myristic) in the frozen meat samples, with the third group of animals showing significant superiority ($P \leq 0.05$) over the other groups after two months of freezing.

1. Introduction

Sheep farming significantly contributes to food security and rural family welfare in Iraq. It serves as an essential food source for dairy and meat production in Iraq (FAO, 2018). The Awassi sheep breed, raised in various regions including southeastern Turkey, Syria, and Iraq, is studied for its production performance and crossbreeding with local breeds. It has also been introduced in countries like Australia, India, Macedonia, Ethiopia, Spain, and New Zealand, reflecting its production importance. The lamb meat is highly valued for its high protein, mineral, and vitamin content, crucial for human nutrition (Corazzin et al., 2019). Lamb meat, a significant protein source, indicates societal advancement and its nutritional benefits (Kalalou et al., 2004). Despite consumer interest in healthier food options and fatty acid composition, the economic significance of slaughter remains paramount (Verbeke & Viaene, 2000). Research aims to enhance sheep feed with vegetable oils like apricot seed oil, which can improve feeding cost-effectiveness, appetite, and nutrient absorption, thus enhancing digestive functions in animals (Al Jabouri, 2020).

2. Materials and Methods

2.1 Carcass Measurements:

After the experimental period, the lambs were fasted for 12 hours and then weighed using an electronic field scale at 10 AM, with this weight recorded as the final body weight. Each group of lambs was then slaughtered at the field abattoir of the College of Agriculture. Post-slaughter, the heads, legs, and skins were removed, and the carcasses were eviscerated. The weights of the slaughter by-products were recorded.

2.2 Cold Carcass Weight:

The hot carcass weight was noted before the carcasses were moved to an adjacent cooling room, where they were hung on special iron hooks in a chiller set to 4°C for 22 hours, as described by Field et al. (1963). On the following day, the carcasses' cold weights were measured using an Ingco vertical electronic scale (Chinese origin). The percentage weight loss after cooling was calculated using the following equation:

Percentage Loss % = ((Hot Carcass Weight - Cold Carcass Weight) / Hot Carcass Weight) * 100

2.3 Physical Separation of Rib Section Tissues:

Post-butchering, the primary and secondary cuts were weighed. The rib sections were then frozen at -18°C. Subsequent weight measurements of these sections were followed by a physical separation of tissues (meat, fat, bone) using a sharp knife. Each tissue type's weight and proportions were recorded using an electronic benchtop scale. The meat and fat were then mixed and minced three times to homogenize the meat sample components using a Silver Crest electric meat grinder. The physical separation was conducted in the meat laboratory.

2.4 Chemical Analysis of Meat Samples:

Samples from the minced meat were collected for each experimental treatment and stored at -18°C for two months. After this period, they underwent chemical and physical examinations.

2.4.1 Moisture Content Estimation:

To estimate the moisture content percentage, a 10-gram meat sample was taken using a sensitive digital scale for all experimental treatments. The sample was placed in a heat-resistant Parks glass dish containing pre-weighed filter paper, then dried in a Smart brand oven at 65°C for 4 hours. Post drying, weights were recorded every 15 minutes until a stable final weight was achieved, as stated by AOAC (2008). After removal from the oven, the samples were allowed to cool for 10 minutes, and their weights were recorded. The moisture content percentage was then calculated as follows:

Moisture Content % = ((Post-Drying Weight - Pre-Drying Weight) / Pre-Drying Weight) * 100

2.4.2 Protein Content Estimation:

The Kjeldahl method was used to estimate the crude protein content in the minced meat samples (frozen for two months) for all treatments, using a Swiss-made Kjeldahl Semi-micro apparatus, following the procedure by Houba and Van Dijk (2000). A specific weight of the minced meat (0.5 grams) was taken, placed into a flask with 0.5 ml of concentrated sulfuric acid, and supplemented with an equal amount of a mixture of potassium sulfate and copper sulfate. The digestion process then commenced, heating the contents for 2 hours. After the digestion completed and the mixture turned into a clear blue liquid, it was transferred entirely to the distillation flask of the Kjeldahl device, which contained a 40% sodium hydroxide solution. The distillation flask's end was connected to a boric acid solution-containing flask (20% concentration) with a few drops of Bromocresol Blue indicator added. The distillation was continued until 25 ml of the distillate was collected, then titrated with 0.1 N hydrochloric acid. A blank was prepared using the same chemicals to calculate the nitrogen percentage, and thus the protein content was estimated using the following formula:

Protein Content % = (6.25 * 0.014 * Volume of HCl Consumed (ml) / Sample Weight (g)) * 100

2.4.3 Fat Content Estimation:

The fat content in the minced meat samples was estimated according to the method described by AOAC (2006). After drying the minced meat in an oven and calculating the moisture content, the samples were wrapped in filter paper, numbered, and weighed. They were then placed in a glass Soxhlet extractor and 250 ml of petroleum ether was added per the extractor's cup size. The device was operated for 7 hours, after which the samples were removed from the Soxhlet extractor and allowed to stand for 15 minutes under laboratory conditions. Subsequently, the samples were placed in an oven at 65°C for 30 minutes to ensure the evaporation of solvent residues and remaining fat content, after which their weights were recorded. The fat percentage was calculated using the following formula:

Fat Percentage %=(Post-Extraction Sample Weight−Pre-Extraction Sample WeightPre-Extraction Sample Weight)×100\text{Fat Percentage \%} = \left(\frac{\text{Post-Extraction Sample Weight} - \text{Pre-Extraction Sample Weight}}{\text{Pre-Extraction Sample Weight}}\right)

\times 100Fat Percentage %=(Pre-Extraction Sample WeightPost-Extraction Sample Weight−Pre-Extraction Sample Weight)×100

2.4.4 Ash Content Estimation:

Following the calculation of moisture content and extraction of fat from the minced meat samples, the dry and defatted meat samples were weighed and placed in a known-weight porcelain dish. The samples, along with the dish, were placed in a Smart brand oven at 65°C for 30 minutes to ensure moisture loss. The weights were recorded, and then the samples and dishes were placed in a muffle furnace at no less than 550°C for 6 hours, according to AOAC (2006) method. Afterward, the samples were allowed to cool for 10 minutes, and their weights were recorded. The ash content was calculated using the following formula:

Ash Percentage %=(Weight of Empty Dish−Weight of Dish with AshSample Weight)×100\text{Ash Percentage \%} = \left(\frac{\text{Weight of Empty Dish} - \text{Weight of Dish with Ash}}{\text{Sample Weight}}\right)\times 100Ash Percentage %=(Sample WeightWeight of Empty Dish−Weight of Dish with Ash)×100

2.5 Estimation of Free Fatty Acids in Frozen Meat Sample:

2.5.1 Fat Extraction from Meat Samples:

The fat content in the meat samples was estimated according to the method described by AOAC (2006). Approximately 10 grams of minced meat sample was placed in a Soxhlet extractor, and 250 ml of hexane was added according to the cup's weight. The extraction process lasted for 5 hours. After collecting the solvent, the flask was placed in an oven at 60°C for 30 minutes to ensure evaporation of the residual solvent and remaining fat substances. The flask was then removed from the oven and allowed to cool before being weighed.

2.5.2 Fatty Acid Esterification:

Samples were prepared and subjected to a fatty acid esterification process using a solution prepared from 250 microliters of 9-Fluorenylmethyl Chloroformate mixed with 1 ml of oil, after adding 25 microliters of sodium phosphate solution (0.05 M; pH 9.3). The mixture was vigorously shaken for 30 minutes and then allowed to stand for 10 minutes at 40°C. A volume of 100 microliters of the reactive mixture was then injected into a High-Performance Liquid Chromatography (HPLC) system.

2.5.3 Chromatographic Analysis of Meat Sample Models:

The fatty acid compounds in all models of frozen minced meat samples were analyzed using an HPLC system equipped with a solvent delivery system (Sykam, German-made). A fluorometric detector was used at excitation and emission wavelengths of 265 nm and 315 nm, respectively. The analytical column was a C18-0 DS (250 mm x 4.6 mm), with a gradient of acetonitrile-water from 85-15% over 0-4 minutes, 87-13% over 5-8 minutes, and 97-3% over 9-14 minutes. The column oven temperature was maintained at 50°C. The mobile phase was filtered and degassed before being pumped at a flow rate of 1.5 ml/min, and data on free fatty acids were recorded.

2.6 Peroxide Value Test for Frozen Meat Samples:

The peroxide value was estimated using the method described by Egan et al. (1981). A 2-gram sample of the extracted fat from the minced meat, obtained via the Soxhlet extraction system, was used. To this, 30 ml of a mixture containing 3 parts glacial acetic acid and 2 parts chloroform was added, along with 0.5 ml of saturated potassium iodide solution, 30 ml of distilled water, and 1 ml of starch indicator (1%). The mixture was then titrated with 0.01N sodium thiosulfate until the blue color disappeared. The peroxide value in the frozen meat was calculated using the following formula:

Peroxide Number (meq/kg)=(1000×0.01×Number of milliliters of sodium thiosulfateSample Weight (g))\text{Peroxide Number (meq/kg)} = \left(\frac{1000 \times 0.01 \times \text{Number of milliliters of sodium thiosulfate}}{\text{Sample Weight

(g)}}\right)Peroxide Number (meq/kg)=(Sample Weight (g)1000×0.01×Number of milliliters of sodi um thiosulfate)

2.7 Measurement of Thaw Loss for Frozen Meat Samples:

The weight loss after thawing was estimated based on the method described by Young et al. (1997). A sample of minced meat, frozen for two months at -18°C, weighing between 2-3 grams, was placed in a refrigerator at 4°C for 24 hours to thaw. After thawing, the samples were dried and excess surface liquid was removed using filter paper. The weights were recorded before and after thawing. The percentage of thaw loss was calculated using the following formula:

Thaw Loss %=(Post-Thaw Weight−Frozen WeightFrozen Weight)×100\text{Thaw Loss \%} = \left(\frac{\text{Post-Thaw Weight} - \text{Frozen Weight}}{\text{Frozen Weight}}\right) \times 100Thaw Loss %=(Frozen WeightPost-Thaw Weight−Frozen Weight)×100

2.8 Statistical Analysis:

In this study, the Statistical Analysis System (SAS, 2012) was used to analyze data and variables to assess the effect of oil on different trial parameters and studied traits according to a completely randomized design (CRD). Significant differences between means were compared using Duncan's multiple range test (1955, Duncan).

Mathematical Model for the Design:

Yij=μ+Ti+eijY_{ij} = \mu + T_i + e_{ij}Yij=μ+Ti+eij Where:

- YijY_{ij}Yij: Observed value for treatment iii and observation jjj.
- μ\muμ: Overall mean.
- TiT_iTi: Effect of treatment iii.
- eije_{ij}eij: Random error, normally distributed with a mean of zero and variance σe2\sigma^2_eσe2.

This comprehensive analysis provides a detailed methodological framework for evaluating the impact of treatments on the properties of frozen meat, assessing peroxide values, thaw loss, and statistical significance, offering insights into the effects and interactions within the experiment.

3. Results and Discussion:

3.1 Chemical Properties of Frozen Meat:

3.1.1 Moisture Content:

Results from Table (1) indicate significant differences in the moisture content of frozen minced meat samples over two months. The moisture contents were 75.36%, 69.12%, and 66.56% for treatments T3, T2, and T1, respectively. Treatment T1 exhibited a significantly higher moisture content (75.36%), compared to the second (69.12%) and third groups (66.56%), which recorded progressively lower moisture levels. Treatment T2 was significantly higher than T3 ($P \leq 0.05$), which recorded the lowest moisture in the frozen meat. This superiority could be due to the direct effect of apricot seed oil in reducing moisture content in the lamb meat dosed in the first group.

3.1.2 Fat Content:

As observed in Table (1) there were significant differences in the fat content estimates of the frozen minced meat samples. The third treatment group significantly outperformed the first group, recording 10.11% fat content compared to 8.31% in the first group and was not significantly different from the second group at 9.85%. The higher fat content in the third group could be attributed to the apricot seed oil dosage, which seemed to have a pronounced effect in retaining fat levels and reducing fat oxidation in the meat frozen for two months.

3.1.3 Ash Content:

Table (1) also shows significant differences in ash content estimations of the frozen minced meat samples. Treatment T3 recorded the highest ash content at 2.57%, significantly higher (P≤0.05) than T1, which had 1.35%, and not significantly different from T2 with 1.52%. This result might indicate mineral retention facilitated by the dietary treatments, especially with higher dosages of apricot seed oil.

3.1.4 Protein Content:

The protein content results indicated significant differences among the treatment groups for the frozen minced meat samples. Treatment T3 showed the highest protein content at 19.97%, significantly higher than T2 and T1, which recorded 18.58% and 14.09% respectively. Treatment T2 also significantly surpassed T1 in protein content (P≤0.05). The potential reason could be that administering apricot seed oil to the lambs in Treatment T3 directly impacted protein retention during freezing, which could enhance the quality, palatability, and nutritional value of the frozen meat. Maintaining a higher protein level and reducing fat content are crucial goals that enhance both the nutritional value for consumers and the economic value of the product.

Table (1): Effect of Administering Different Levels of Apricot Seed Oil on the Chemical Properties of Meat Frozen for Two Months.

Adjectives	Mean ± standard error			Moral level
	T1	T2	T3	
Moisture %	75.36 ± 0.32 a	69.12 ± 0.59 b	66.56 ± 0.55 c	*
Fat %	8.31 ± 0.30 b	9.85 ± 0.48 a	10.11 ± 0.35 a	*
Ash %	1.35 ± 0.08 b	1.52 ± 0.15 a	2.57 ± 0.28 a	*
Protein %	14.09 ± 0.00 c	18.58 ± 0.02 b	19.97 ± 0.03 a	*

Mean ± Standard Error.

*- Different letters indicate a significant difference (P≤0.05).

NS - Indicates no significant differences in the treatment for the studied attribute. T1-- Group one (control). T2-- Group two, administered apricot kernel oil at a quantity of 0.0015% of the live animal weight. T3-- Group three, administered apricot kernel oil at a quantity of 0.0020% of the live animal weight.

3.2 General Characteristics of Frozen Meat:

3.2.1 Thaw Loss Percentage in Frozen Meat:

The results in Table (2) showed significant differences in the treatments regarding the thaw loss percentage in minced meat frozen for two months, which were 11.95%, 8.02%, and 6.60% for groups T1, T2, and T3, respectively. The first group had a significantly higher (P≤0.05) thaw loss percentage of 11.95% compared to the second and third groups, which had 8.02% and 6.60%, respectively. This superiority might be due to the apricot kernel oil administered to the lambs in the third group, which resulted in the lowest thaw loss percentage, indicating its positive effect on retaining moisture during the thawing of frozen meat over two months.

3.2.2 Peroxide Value in Frozen Meat:

Table (2) also showed significant differences in the treatments regarding the peroxide value in minced meat frozen for two months. The first group had a significantly higher (P≤0.05) peroxide value of 5.81% compared to the second and third groups, which had 4.51% and 4.04%, respectively. Additionally, the second group had a significantly higher (P≤0.05) peroxide value than the third group, which recorded the lowest peroxide value. This reduction in peroxide value in the third group might be attributed to the antioxidant properties of the apricot kernel oil used, which is rich in vitamins and carotenoids that act as antioxidants, leading to a notable decrease in the peroxide value in frozen meat.

Table (2): The Effect of Administering Varying Levels of Apricot Kernel Oil on the General Characteristics of Frozen Meat for Two Months.

Mean ± Standard Error

Adjectives	Mean ± standard error			Moral level
	T1	T2	T3	
Loss after melting %	11.95 ± 0.43 a	8.02 ± 0.25 b	6.60 ± 0.37 c	*
Peroxide level %	5.81 ± 0.03 a	4.51 ± 0.09 b	4.04 ± 0.01 c	*

***- Different letters indicate a significant difference (P≤0.05**

NS - Indicates no significant differences in the treatment for the studied attribute. T1-- Group one (control). T2-- Group two, administered apricot kernel oil at a quantity of 0.0015% of the live animal weight. T3-- Group three, administered apricot kernel oil at a quantity of 0.0020% of the live animal weight.

3.3 Free Fatty Acids in Frozen Meat:

The results in Table (3) showed significant differences in the three experimental treatments regarding the free fatty acid content in minced meat samples frozen for two months. The third group had a significantly higher (P≤0.05) level of palmitic acid, reaching 18.95%, compared to the second and first treatments, which were 17.53% and 15.55%, respectively. Additionally, the second treatment was significantly higher (P≤0.05) than the first group at 17.53%.

Table (3) also indicated that the third group had a significantly higher (P≤0.05) level of stearic acid at 8.16%, compared to the second and first treatments, which were 7.69% and 6.13%, respectively. Moreover, the third group had a significantly higher (P≤0.05) level of oleic acid at 19.36%, compared to the second and first treatments, which were 18.48% and 16.23%, respectively, with the second group being significantly higher (P≤0.05) than the first at 18.48%.

Furthermore, the third group had a significantly higher (P≤0.05) level of linoleic acid at 10.17%, compared to the second and first treatments, which were 9.26% and 7.84%, respectively. The same trend was observed for linolenic acid, where the third group had a significantly higher (P≤0.05) level at 1.14%, compared to the second and first treatments, which were 0.95% and 0.55%, respectively.

Finally, Table (3) indicated that the third group had a significantly higher (P≤0.05) level of myristic acid at 2.91%, compared to the second and first treatments, which were 2.45% and 1.88%, respectively. This superiority might be due to the effect of the apricot kernel oil administered to the

lambs in the third group, which helped maintain the natural levels of these fatty acids in the frozen meat.

Table (3): The Effect of Administering Varying Levels of Apricot Kernel Oil on the Percentage of Free Fatty Acids in Frozen Meat for Two Months (%).

Mean ± Standard Error.

Percentage of free fatty acids in meat	Mean ± standard error			Moral level
	T1	T2	T3	
Palmatic %	15.55 ± 0.22 c	17.53 ± 0.04 b	18.95 ± 0.09 a	*
Stearic %	6.13 ± 0.04 c	7.69 ± 0.08 b	8.16 ± 0.02 a	*
Oleic %	16.23 ± 0.14 c	18.48 ± 0.09 b	19.36 ± 0.08 a	*
Lenolic %	7.84 ± 0.04 c	9.26 ± 0.06 b	10.17 ± 0.02 a	*
Linolenic %	0.55 ± 0.01 c	0.95 ± 0.00 b	1.14 ± 0.02 a	*
Myristic %	1.88 ± 0.06 c	2.45 ± 0.04 b	2.91 ± 0.03 a	*

***-**

Different letters indicate a significant difference (P≤0.05).

NS - Indicates no significant differences in the treatment for the studied attribute. T1-- Group one (control). T2-- Group two, administered apricot kernel oil at a quantity of 0.0015% of the live animal weight. T3-- Group three, administered apricot kernel oil at a quantity of 0.0020% of the live animal weight.

5. Conclusions

From this study, we conclude that administering lambs with different levels of apricot kernel oil (0.0020%, 0.0015%) of the live animal weight significantly helped retain the moisture and fat percentage in frozen meat, thereby increasing the juiciness and tenderness of the meat. The results also showed that the third group significantly (P≤0.05) excelled in protein percentage in frozen meat, reaching 19.97%. This suggests that the protein compounds present in apricot can improve the quality of red meat. Moreover, it reduced the lipid peroxide in the meat and decreased the thaw loss percentage, which can be particularly beneficial for meat processing industries requiring longer storage periods. Additionally, it had a clear impact on the percentage of free fatty acids, with the third treatment showing superiority in some of the six types of free fatty acids present in the frozen meat of the animals used in the study, namely Palmitic, Stearic, Oleic, Linoleic, Linolenic, and Myristic acids.

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