Meat Research
Vol 4, Issue 4: 1-7, Article 99, October 2024
ISSN: 2790-1971
https://doi.org/10.55002/mr.4.4.99
http://www.bmsa.info/meatresearch

[1]Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh;

*Corresponding Author:

MM Rahman

E-mail: mmrahman.as@bau.edu.bd

Keywords:

Edible oil
Raw chicken meat
Meat color
Microbial count
Shelf life

Article Info:

Received: August 22, 2024
Accepted: October 15, 2024
Published online: August 31, 2024

Research Article

Effects of edible oil on the quality of chicken meat in short-term preservation

MM Hasan[1], M Shahiduzjaman[1], MA Hashem[1], M Khan[1], MM Rahman[1]*

Abstract

This study aimed to evaluate the influence of various oils namely olive, mustard, sesame, and soybean on the quality and preservation of raw beef stored under refrigerated conditions at 4±1ºC. The meat was stratified into five experimental groups: T_0 (Control), T_1 (1% Olive oil), T_2 (1% Mustard oil), T_3 (1% Sesame oil), and T_4 (1% Soybean oil). Assessments were systematically performed on days 0, 3, 6, and 9 to determine a wide range of parameters including physicochemical characteristics (pH, water-holding capacity), oxidative stability (TBARS), drip loss, cooking loss, color value (L*, a*, b*), microbial safety (TVC, TCC, TYMC), and proximate composition (DM, EE, CP, Ash). The incorporation of oils resulted in a statistically significant ($P<0.05$) impact on the physicochemical properties, oxidative defense mechanisms, microbial proliferation, and sensory attributes when compared to the control group. Notably, throughout the storage period, oil-treated samples exhibited significantly reduced pH levels and higher water retention capacities ($P<0.01$) relative to the control. Among the oils tested, olive oil (T_1) demonstrated superior oxidative stability, as evidenced by its significantly lower TBARS ($P<0.01$) values and diminished microbial counts. Moreover, the sensory profile of the T_3 group (sesame oil) was notably enhanced, particularly in terms of color, though the control group maintained good color retention. In conclusion, the study determined that olive oil was the most effective in prolonging the shelf life and sustaining the quality of refrigerated beef, surpassing the effects observed with mustard, sesame, and soybean oils.

Introduction

As the global population rises, governments face the significant challenge of addressing the complex food requirements of societies with limited animal protein availability. Protein is a crucial nutrient for human health, and common sources include poultry, beef, and mutton etc. Bangladesh is also facing the same problem as she has limited resources to fulfill the huge demand of animal protein (Liza et al., 2024; Rahman et al., 2023). Meat is widely recognized for its high nutritional value, being an excellent source of quality protein and essential amino acids necessary for a healthy diet. It provides a variety of micro and macro nutrients. It is particularly rich in animal proteins, essential fatty acids, minerals, trace elements, and B vitamins (Sagar et al., 2024; Sajib et al., 2023; Singh et al., 2011). However, the high saturated fat content in red meat leads to recommendations for limited consumption among those at risk for cardiovascular diseases or obesity. Despite this, fat plays a crucial role in human nutrition, enhancing flavor, tenderness, juiciness, appearance, texture, and shelf life of meat products. Consequently, the meat industry faces the challenge of creating low-fat options without sacrificing sensory qualities. Poultry, especially chicken, is favored globally due to its affordability, availability, and lack of religious restrictions (Prabakaran, 2012). Chicken is popular for its nutritional benefits, including low fat and high polyunsaturated fatty acid content. Fresh meat is highly perishable due to its biological makeup (Hashem et al., 2024; Smith et al., 2010) and is often contaminated with microorganisms during processing, leading to undesirable quality changes, particularly from lactic acid bacteria, a key contributor to spoilage (Muela et al., 2010). Spoilage of meat and meat products typically arises from either microbial growth or chemical deterioration, with lipid oxidation being a significant factor in the processed meat industry, as it greatly affects quality. Meat and meat products generally spoil due to two main factors: microbial growth and chemical deterioration. In the case of chemical deterioration, lipid oxidation is particularly significant in the processed meat industry, as it is a key contributor to quality decline in oxidation adversely affects not only the sensory properties of meat such as color, texture, odor, and flavor but also its nutritional content (Nunez de Gonzalez et al., 2008). Lipid peroxidation is a complex process that occurs in aerobic cells, involving the reaction of molecular oxygen with polyunsaturated fatty acids (Williams et al., 2006). Microbial contamination can cause food poisoning and spoilage, leading to public health concerns and economic losses. Additionally, oxidative rancidity generates harmful substances like lipid peroxides and malondialdehyde (MDA), which can induce oxidative damage and increase the risk of mutations and cancer. Key factors like color, microbial growth, and lipid oxidation significantly impact the shelf life and consumer acceptance of fresh meat (Disha et al., 2000).

Lipid oxidation, which begins in the unsaturated fatty acids of cell membranes, is a leading cause of meat spoilage and reduced shelf life (Devatkal et al., 2010; Sadakuzzaman et al., 2021 and 2024). This process can alter important quality characteristics, including color, flavor, odor, texture, and nutritional value (Fletcher et al., 2001). Nowadays, various meat preservation methods have emerged, with refrigeration using natural preservatives being the most effective globally. While refrigeration has been used for centuries to prolong meat's shelf life, significant advancements in technology have mainly happened in the last hundred years. This method is commonly employed to ensure quality and safety during storage, distribution, and sales. Consequently, the practice of freezing meat in Bangladesh has surged significantly over the past twenty years. The texture of meat is influenced by the inherent mechanical properties and intricate arrangement of its proteins, water, and cellular components. Tenderness and chewiness are affected by factors like the distribution of connective tissue and the elasticity of muscle myofibrils within sarcomere units. Juiciness relies on the water retained by muscle proteins and structural elements. Various factors influence the mechanical properties of meat collagen and the distribution of connective tissue. Marinades with salt and polyphosphates enhance texture and yield, as sodium chloride causes meat to swell and improves its water holding capacity. Polyphosphates amplify salt's effects, reducing cooking losses in poultry. While studies have shown that marination improves the sensory qualities of cooked meat products (Vieira, 2009; Akter et al., 2009; Klinic, 2009; Prejsnar et al., 2018), there is still limited understanding of how these changes impact texture. Both biochemical and structural research (Hindi et al., 2013) have explored the effects of marination and mechanical processing on meat, but the specific influence on texture remains less clear. Oil can serve as an effective meat preservative by creating a barrier against oxygen, (Das et al., 2022) thereby reducing oxidation and spoilage. It can help retain moisture and enhance flavor while also inhibiting microbial growth. Some oils, especially those with antioxidant properties, further extend shelf life. However, it's essential to consider the type of oil and its compatibility with the specific meat products to ensure optimal preservation results. Prior to my experiment on chicken meat with various types of oil especially with olive oil in Bangladesh, there was limited research conducted in this area. Enriching meat with different oils can be recommended as a natural preservative. The goal of preservation is not only to slow spoilage but also to maintain the food's wholesomeness, nutritional value, and inhibit microbial growth. Oil acts as a natural preservative by creating a barrier against air, helping to delay oxidation, deterioration, and mold growth. Based on the above discussion the present study was conducted with the following objectives to evaluate the impact of oil on inhibiting microbial growth, including bacteria and fungi, which contribute to spoilage. To analyze how oil preservation affects the nutritional content of the meat, to compare the effectiveness of different types of oils (e.g., olive, mustard, soybean) in preserving meat.

Materials and Methods

Place of Experiment

The experiment was conducted in the laboratory of the Department of Animal Science at Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh.

Experimental Samples:

Boneless chicken broiler meat of 4 kg obtained by slaughtering of poultry by halal method was procured from Sheshmor Market, Bangladesh Agricultural University, Mymensingh. The meat samples were immediately transferred to the Animal Science Laboratory. Oils used for this research were collected from the "KR Market" in Mymensingh Sadar.

Preparation of Sample

Approximately 2 kg of fresh chicken meat was used for preparation. First, the meat was thoroughly washed with fresh water, and all visible fat, tendons, skin, and separable connective tissues were carefully trimmed off with a sharp knife.

Experimental Layout

The meat was then mixed with 1% of various oils according to the experimental design. There were four treatment groups: T_0 (Control group), T_1 (1% olive oil), T_2 (1% mustard oil), T_3 = (1% sesame oil), and T_4 (1% soybean oil). The meat was packed separately in zipper bags, with the required samples set aside for the experiment, while the remaining meat was placed in the refrigerator. The sample were taken from each treatment at 0, 3^{rd},6^{th} and 9^{th} days respectively for different analysis.

Analysis of Different Characteristics of raw chicken meat Samples in the Laboratory

Instrumental color Analysis

Instrumental color measurement was conducted on meat from the longissimus muscle. Color was assessed using a Konica Minolta Chroma Meter (CR 410, Konica Minolta Sensing, Inc., Osaka, Japan), a Miniscan Spectro colorimeter set to the CIE Lab system, which includes L*, a*, and b* values (International Commission on Illumination, 2014). Here, L* indicates lightness, a* indicates redness, and b* indicates yellowness. The analysis focused on the medial surface (bone side) of the meat 24 hours post-mortem (Rahman et al., 2020). Prior to measurement, the colorimeter was calibrated using a specific whiteboard. Each color value was the average of three measurements taken from a meat area of 4–5 cm^2 to ensure a representative evaluation. The L* value ranges from 0 (black) to 100 (white), while both a* and b* values range from −60 to +60; a* indicates green when negative and red when positive, while b* indicates blue when negative and yellow when positive.

Proximate Analysis

Proximate composition, including Dry Matter, Crude Protein, Ether Extract, and Ash, was determined according to AOAC (1995) methods. Crude protein was determined using the micro Kjeldahl method. Ether extract content was determined using a Soxhlet apparatus with diethyl ether. Ash content was determined by pre-ashing the samples and then heating them in a muffle furnace.

Physicochemical Analysis

The pH meter is calibrated with standard buffer solutions at pH 4 and 7, ensuring proper stabilization and adjustments. A fresh piece of meat is prepared by cutting it into sections, exposing fresh muscle tissue while avoiding fat and connective tissue. The electrode is inserted into the muscle, and the pH reading is allowed to stabilize before being recorded. After measuring, the electrode is rinsed with distilled water and stored according to the manufacturer's instructions. To measure the water holding capacity (WHC) of meat, a fresh sample is prepared, weighed, and placed into centrifuge tubes. The samples are centrifuged at around 10,000 RPM for 10 minutes to expel excess water. To assess the drip loss of meat, a fresh sample is prepared, weighed to determine its initial weight, and placed in a container to refrigerate for 24 hours. After this period, the meat is removed, allowed to reach room temperature, and then weighed again to find its final weight.

Biochemical Analysis

Lipid oxidation was evaluated by using the 2-thiobarbituric acid (TBA) method. Chicken breast meat samples (5 g) were mixed with 25 ml of a 20% trichloroacetic acid solution and vortexed for 60 seconds, then filtered through Whatman filter paper number 4. The filtrate (2 mL) was combined with 2 mL of a 0.02 M TBA solution and incubated at 100°C for 30 minutes, then cooled with tap water. Absorbance was measured at 532 nm using a UV-VIS spectrophotometer, and the TBA value was reported as mg of malonaldehyde per kg of meat sample.

Microbiological Analysis

Microbial assessment of meat ensures food safety and quality by identifying and quantifying microorganisms, including pathogens and spoilage organisms. Samples are prepared by blending 10 g of chicken meat with sterile diluent, creating a homogenized suspension, and performing serial dilutions. For bacteriological analysis, media like Plate Count Agar (PCA), MacConkey Agar (MA), and Potato Dextrose Agar (PDA) are prepared, sterilized, and used to culture microorganisms. The Total Viable Count (TVC), Total Coliform Count (TCC), and Yeast-Mould count are then determined by spreading diluted samples on the respective agar plates, incubating, and counting colonies, with results expressed as CFU/g of chicken meat.

Statistical Model and Analysis

The statistical model used for the experiment was a factorial design with two factors, A (Treatments) and B (Days of Intervals). Data analysis was performed using SAS Statistical Discovery software, and the significance of differences among treatment means was determined using the DMRT test.

Results and Discussion

Proximate analysis

The Dry Matter (DM) content showed in (Table.1) no significant differences across treatments, days of interval, or the interaction between treatment and days of interval, with mean values ranging from 25.13 to 25.46 across all groups. The most preferable DM content was observed in the T_4 group, while the lowest was found in the T_3 group, indicating it was less preferable. DM content increased over the storage period due to decreased moisture loss, with the most preferable content observed on day 0 and the least preferable on day 9, although it was still accepted by consumers. Similar findings were reported by Purnomo and Rahardiyan (2008) for Indonesian traditional meatballs and by Naveena et al. (2008) for extracts of pomegranate peel and rind, while a decrease in DM content was noted in low-fat chicken nuggets by Santhi and Kalaikannan (2014).

Table.1 shows a significant difference in crude protein (CP) content across treatments and days of interval, with values ranging from 19.98 to 21.15. The control group had the lowest CP content, and highest cp% in T_1 group which decreased over the storage period, with the most preferable content on day 0 and the least preferable on day 9, though it was still accepted by consumers. Similar results were reported by Disha et al. (2020) Suradkar et al. (2013), Bhosale et al. (2011), and Yadav et al. (2018) for various meat products with different ingredients.

Table 1 shows a significant difference in ether extract (EE) content across treatments and days of interval, but no interaction between the two. EE values ranged from 2.66 to 2.99, with the control (T_0) group having the most preferable content. EE decreased over the storage period, reaching 2.66% after 9 days in all treatments. Similar findings of reduced fat content were reported by Verma et al. (2013), Suradkar et al. (2013), and Zargar et al. (2014) in different meat products.

Table shows a significant difference in ash content across treatments and days of interval, but no interaction between the two. The mean ash content ranged from 1.27 to 1.46 across all groups, with the most preferable content observed in the T_1 group. The lowest ash content, considered more favorable for consumers' health, was found in the control group. Ash content increased significantly with the storage period, with the most preferable content on day 0 and the least preferable on day 9, though it was still accepted by consumers. Similar trends were reported by Zargar et al. (2017), Servili et al. (2016), and Bhosale et al. (2011) for various meat products.

Table 1. Effect of different types of edible oil on proximate parameters (Mean ± SE) in chicken meat at different day intervals

Parameters	DI	Treatments						Level of significance		
		T_0	T_1	T_2	T_3	T_4	Mean	Treat	DI	T×DI
DM (%)	0	24.63±0.65	25.22±.97	24.96±0.74	25.71±0.54	24.69±1.28	25.04^a	NS	NS	NS
	3	25.22±o.79	25.03±1.17	25.05±0.2	24.97±0.86	25.05±0.97	25.06^a			
	6	25.13±0.08	25.40±0.87	25.92±0.81	25.46±1.15	25.14±0.48	25.41^a			
	9	25.55±0.91	26.05±1.57	25.51±0.62	25.75±1.12	25.64±0.91	25.70^a			
	Mean	25.13^a	25.42^a	25.36^a	25.47^a	25.13^a				
CP (%)	0	21.40±0.23	21.69±0.47	21.51±0.86	21.81±0.18	21.17±0.98	21.51^a	*	**	NS
	3	19.57±0.58	21.13±0.64	20.93±0.61	20.65±0.84	21.23±0.39	20.70^b			
	6	19.82±0.41	21.07±0.31	20.72±0.30	20.92±0.12	20.95±0.50	20.69^b			
	9	19.13±0.63	20.70±0.45	20.55±0.45	20.17±0.42	19.93±0.95	20.10^c			
	Mean	19.98^b	21.15^a	20.93^a	20.89^a	20.82^a				
EE (%)	0	2.37±0.29	2.55±0.08	2.62±0.09	2.70±0.13	2.51±0.16	2.55^c	*	**	NS
	3	2.63±0.12	2.58±0.16	2.71±0.16	2.71±0.04	2.57±0.18	2.64c			
	6	2.13±0.08	3.02±0.07	2.86±0.12	2.81±0.06	2.67±0.06	2.84^b			
	9	2.87±0.11	3.24±0.09	3.24±0.07	3.73±0.08	3.66±0.09	3.35^a			
	Mean	2.67^c	2.85^b	2.86^b	2.99^a	2.85^b				
Ash (%)	0	1.13±0.03	1.12±0.07	1.15±0.06	1.14±0.13	1.10±0.04	1.13^b	**	**	NS

	3	1.24±0.07	1.23±0.04	1.36±0.05	1.15±0.05	1.42±0.11	1.28^{c}
	6	1.42±0.03	1.26±0.08	1.41±0.11	1.36±0.04	1.66±0.09	1.42^{b}
	9	1.88±0.05	1.47±0.07	1.60±0.11	1.64±0.18	1.69±0.26	1.65^{a}
	Mean	1.41^{a}	1.27^{c}	1.38^{ab}	1.32^{bc}	1.46^{a}	

The mean in each row having different superscripts varies significantly at values P < 0.05. Again, mean values with the same superscript in each row did not differ significantly at P>0.05. T_0 = (Control group), T_1 = (1% olive oil), T_2 = (1 % mustard oil), T_3 = (1% sesame seed oil) and T_4 = (1% soya bean oil), DI=Day Intervals, Treat= Treatment, T×DI=Interaction of Treatment and Day Intervals. *Means significant at 5% level of probability, ** means significant at 1% level of probability, NS means non-significant

Instrumental color value

The lightness (L*) of fresh broiler meat ranged between 40 and 60, with the most preferable color observed (Table 2) in the T_1 group (42.89) and the least preferable in the T_0 group (40.40). The most desirable color was noted on the 3rd day (47.83), and the least preferable color on day 0 (39.21). Significant differences were found in L* values across treatment groups (P < 0.01), days of interval (P < 0.01), and the interaction between the two (P < 0.01). For redness (a*), the standard value is between 5 and 10, with the T_4 group showing the most preferable color (4.46) and the T_0 group the least preferable (2.78). The most preferable redness was found on day 0 for T_3 (6.25), and the least preferable on day 6 (2.98). Significant differences were observed in a* values for treatment groups (P < 0.01), days of interval (P < 0.01), and their interaction (P < 0.05). For yellowness (b*), the standard value is between 5 and 15, with the most preferable color observed at T_1 on day 3 (11.22) and the least preferable at T_0 (5.95). The most preferable color was seen at T_1 on day 3, and the least at day 9 (6.53). Significant differences in b* values were found for treatment groups (P < 0.01), days of interval (P < 0.01), and their interaction (P < 0.05). Overall, meat color significantly influences consumer purchasing decisions. T_1 treatment had higher L*, a*, and b* values compared to other treatments, with values decreasing over the storage period. This decline in color is attributed to pigment and lipid oxidation, as well as non-enzymatic browning between lipids and amino acids. Similar findings were reported by Kumar and Tanwar (2011), Singh et al. (2011), Tushar et al. (2023), Kandeepan et al. (2010), Chidanandaiah and Sanyal (2009), and Kilinc (2009), and Zargar et al. (2017) found that 12% carrot incorporation led to higher color scores.

Table 2. Effect of different types of edible oil on instrumental color value (Mean ± SE) in marinated chicken meat at different day intervals

Parameters	DI	Treatments						Level of significance		
		T_0	T_1	T_2	T_3	T_4	Mean	Treat	DI	T×DI
	0	36.75±1.89	37.23±2.01	46.52±0.69	38.15±1.52	37.40±2.37	39.21^{c}			
	3	45.70±1.32	48.72±1.08	59.31±1.10	47.07±1.94	38.33±2.02	47.83^{a}	**	**	*
L*	6	45.18±1.98	41.17±1.73	38.57±4.57	49.60±1.22	42.99±1.38	43.50^{b}			
	9	40.81±0.89	44.43±1.10	36.75±1.34	47.19±3.58	42.90±0.49	42.41^{b}			
	Mean	42.11^{b}	42.89^{b}	45.29^{a}	45.50^{a}	40.40^{c}				
	0	5.26±0.29	3.71±0.24	3.98±0.06	6.25±0.05	5.43±0.34	4.92^{a}			
	3	2.22±0,21	3.02±0.09	3.93±0.41	5.51±0.34	5.40±0.05	4.01^{b}	**	**	*
a*	6	1.54±0.34	3.85±0.73	4.42±0.30	1.56±0.09	3.50±0.10	2.97^{c}			
	9	2.08±0.06	3.42±0.10	4.44±0.58	1.41±0.16	3.5±0.35	2.98^{c}			
	Mean	2.78^{d}	3.50^{c}	4.19^{b}	3.68^{c}	4.46^{a}				
	0	6.39±0.51	9.96±0.67	11.04±0.11	8.97±1.43	10.94±0.56	9.46^{a}			
	3	5.57±0.32	11.22±0.65	9.27±0.43	9.05±0.70	10.10±0.49	9.04^{a}	**	*	*
b*	6	6.53±0.50	4.73±0.22	10.67±1.09	6.04±0.41	6.62±0.24	6.92^{b}			
	9	5.34±0.04	4.82±0.19	8.91±0.32	6.92±0.41	6.67±0.67	6.53^{b}			
	Mean	5.95^{d}	7.68^{c}	9.97^{a}	7.74^{c}	8.58^{b}				

The mean in each row having different superscripts varies significantly at values P < 0.05. Again, mean values with the same superscript in each row did not differ significantly at P>0.05. T_0 = (Control group), T_1 = (1% olive oil), T_2 = (1 % mustard oil), T_3 = (1% sesame seed oil) and T_4 = (1% soyabean oil), DI=Day Intervals, Treat= Treatment, T×DI=Interaction of Treatment and Day Intervals. *Means significant at 5% level of probability, ** means significant at 1% level of probability, NS means non-significant

Physico-chemical properties

pH

The pH of chicken meat treated with different oils during refrigerated storage (4°C) varied between 5.39 and 6.08. T_1 (5.53) consistently had the lowest ph (Table3), which decreased over time due to lactic acid accumulation from microbial activity and thaw loss. Bacteria and mold, which decrease during storage, release pH-lowering components. The control samples showed a slight increase in pH, likely due to bacterial consumption of acids from protein breakdown as glucose was depleted. Similar results were reported by Singh et al. (2014); Akhter et al. (2022)

Water holding capacity

The WHC (Water Holding Capacity) of chicken meat treated with various oils, as well as the control group, after 9 days of refrigerated storage ranged from 93.65 to 94.44 (Table3), with values fluctuating between 92.60 and 95.24 on different days. The control group showed significantly lower WHC compared to the oil-treated samples. WHC declined gradually over the storage period in all treatments. The T_1 group exhibited the highest WHC, indicating it was the most favorable for consumer health.

Table 3. Effect of different types of edible oil on Physico-chemical properties value (Mean ± SE) in marinated chicken meat at different day intervals

Parameters	DI	Treatments						Level of significance		
		T_0	T_1	T_2	T_3	T_4	Mean	Treat	DI	T×DI
	0	5.40±0.01	5.39±0.02	5.47±0.03	5.45±0.05	5.39±0.03	5.42^{d}			
	3	5.56±0.04	5.08±0.02	5.4±0.03	5.53±0.02	5.77±0.02	5.56^{c}	*	**	*
pH	6	5.90±0.04	5.57±0.03	5.76±0.05	5.61±0.03	5.39±0.08	5.75^{b}			
	9	6.02±0.04	5.70±0.03	6.08±0.03	5.81±0.04	5.60±0.03	5.93^{a}			
	Mean	5.72^{a}	5.53^{c}	5.74^{a}	5.59^{b}	5.74^{a}				

	0	95.05±0.41	95.74±0.47	95.21±0.41	95.18±0.63	95.05±0.03	95.24^{a}			
	3	94.23±0.71	94.69±0.58	94.77±0.86	94.13±0.56	94.59±0.44	94.48^{b}			
WHC	**6**	93.18±0.93	94.25±0.36	94.26±0.43	93.84±0.68	93.11±0.70	93.73^{c}	*	**	NS
	9	92.15±0.78	93.11±0.84	92.70±0.70	92.85±0.20	92.17±0.30	92.60^{d}			
	Mean	93.65^{c}	94.44^{a}	94.23^{ab}	94.05^{abc}	93.73^{bc}				

The mean in each row having different superscripts varies significantly at values P < 0.05. Again, mean values with the same superscript in each row did not differ significantly at P>0.05. T_0 = (Control group), T_1 = (1% olive oil), T_2 = (1 % mustard oil), T_3 = (1% sesame seed oil) and T_4 = (1% soyabean oil), DI=Day Intervals, Treat= Treatment, T×DI=Interaction of Treatment and Day Intervals. *Means significant at 5% level of probability, ** means significant at 1% level of probability, NS means non-significant

Biochemical properties

Table 4 indicates a significant difference in TBARS values across treatments, storage intervals, and their interaction. The mean TBARS values ranged from 0.181 to 0.213 for all groups, with the T_0 group showing the most favorable (lowest) TBARS value, which is preferable for consumer health. TBARS values increased significantly (P<0.001) during storage in all treatments. Similar results were observed by Chidanandaiah et al. (2009) in meat patties, Yadav et al. (2018) in sausages, and Nassu et al. (2003) in goat meat sausages, Boby et al,.(2021) in meatballs during refrigerated storage, all of which reported an increase in TBARS with prolonged storage.

Table 4. Effect of different types of edible oil on biochemical properties value (Mean ± SE) in marinated chicken meat at different day intervals

Parametes	**DI**	**Treatments**						**Level of significance**		
		T_0	**T_1**	**T_2**	**T_3**	**T_4**	**Mean**	**Treat**	**DI**	**T×DI**
	0	0.083±0.005	0.086±0.008	0.101±0.003	0.104±0.004	0.101±0.003	0.095^{d}			
	3	0.109±0.006	0.105±0.001	0.128±0.005	0.126±0.011	0.120±0.004	0.118^{c}	**	**	**
TBARS	**6**	0.221±0.002	0.211±0.018	0.235±0.016	0.244±0.004	0.235±0.004	0.229^{b}			
	9	0.332±0.011	0.323±0.004	0.333±0.005	0.352±0.005	0.343±0.005	0.336^{a}			
	Mean	0.181^{c}	0.192^{c}	0.209^{b}	0.213^{a}	0.207^{b}				

The mean in each row having different superscripts varies significantly at values P < 0.05. Again, mean values with the same superscript in each row did not differ significantly at P>0.05. T_0 = (Control group), T_1 = (1% olive oil), T_2 = (1 % mustard oil), T_3 = (1% sesame seed oil) and T_4 = (1% soyabean oil), DI=Day Intervals, Treat= Treatment, T×DI=Interaction of Treatment and Day Intervals. *Means significant at 5% level of probability, ** means significant at 1% level of probability, NS means non-significant

Microbiological assessment

The study evaluated the presence of micro-flora (TVC) and foodborne pathogens (Coliform and Yeast-Mold) in chicken meat treated with various oils and stored under refrigerated conditions. Significant differences were found across treatments, storage days, and their interactions for all parameters (TVC, TCC, and TYMC) (Table 5). The TVC ranged from 5.27–5.54 log10 CFU/g across treatments, with storage day values ranging from 5.14–5.59 log10 CFU/g. TVC increased gradually over time, with lower values being more favorable for consumer health. Previous research suggests that antimicrobial compounds in oils like cinnamon and clove can suppress spoilage microorganisms (Zhang et al., 2020; Matan et al., 2006). For the total coliform count (TCC), significant differences were observed across treatments and storage days, with values ranging from 2.71 to 3.27 log10 CFU/g. The control group (T_0) had the highest coliform counts, while the T_1 group showed the lowest, indicating better consumer health benefits. Similar results were seen by Singh and Immanuel (2014) in chicken meat emulsions and by Reddy et al. (2017) in chicken meat patties with natural antioxidants such as rosemary and green tea. For total yeast-mold count (TYMC), significant differences were again found across treatments and storage days, with values ranging from 2.50 to 3.33 log10 CFU/g. The control group had significantly higher yeast and mold counts, and the T_1 group had the lowest TYMC, which is preferable for consumer health. These results align with Fernandez et al. (2005), who found no yeast or mold growth in antimicrobial-treated beef meatballs. The lower TYMC in treated samples may be attributed to the antifungal properties of the oils used.

Table 5. Effect of different types of edible oil on microbial properties value (Mean ± SE) in marinated chicken meat at different day intervals

Parameters	**DI**	**Treatments**						**Level of significance**		
		T_0	**T_1**	**T_2**	**T_3**	**T_4**	**Mean**	**Treat**	**DI**	**T×DI**
	0	5.16±1.06	5.08±0.10	5.35±0.18	5.10±0.18	4.99±0.29	5.14^{b}			
	3	5.39±0.24	5.16±0.10	5.41±0.03	5.22±0.96	5.63±0.32	5.36^{ab}			
TVC (log10CFU/g)	**6**	5.53±0.16	5.28±0.15	5.59±0.10	5.38±0.05	5.61±0.12	5.47^{a}	NS	*	NS
	9	5.62±0.24	5.56±0.30	5.80±0.34	5.53±0.22	5.46±0.11	5.59^{a}			
	Mean	5.42^{a}	5.27^{a}	5.54^{a}	5.32^{a}	5.42^{a}				
	0	2.91±0.59	2.37±0.48	2.53±0.56	2.52±0.49	2.33±0.94	2.53^{c}			
	3	3.31±0.49	2.44±0.72	2.53±0.69	2.77±0.64	2.70±0.62	2.71^{bc}	*	*	NS
TCC (log10CFU/g)	**6**	3.48±0.46	2.96±0.53	2.78±0.57	2.78±0.52	2.94±0.63	2.99^{ab}			
	9	3.55±0.52	3.05±0.46	3.15±0.51	3.03±0.48	3.41±0.45	3.24^{a}			
	Mean	3.27^{a}	2.71^{b}	2.75^{ab}	2.77^{ab}	2.85^{ab}				
	0	3.08±0.40	2.35±1.02	2.28±0.07	2.24±0.99	2.74±0.56	2.54^{b}			
	3	3.17±0.52	2.39±0.10	2.75±0.62	2.79±0.60	2.95±0.56	2.81^{b}			
TYMC (log10CFU/g)	**6**	3.45±0.50	2.53±0.06	2.97±0.49	2.90±0.53	2.98±0.54	2.97^{ab}	**	*	NS
	9	3.63±0.58	2.70±0.06	3.32±0.64	3.34±0.58	3.34±0.58	3.27^{a}			
	Mean	3.33^{a}	2.50^{b}	2.83^{b}	2.82^{b}	3.04^{ab}				

The mean in each row having different superscripts varies significantly at values P < 0.05. Again, mean values with the same superscript in each row did not differ significantly at P>0.05. T_0 = (Control group), T_1 = (1% olive oil), T_2 = (1 % mustard oil), T_3 = (1% sesame seed oil) and T_4 = (1% soyabean oil), DI=Day Intervals, Treat= Treatment, T×DI=Interaction of Treatment and Day Intervals. *Means significant at 5% level of probability, ** means significant at 1% level of probability, NS means non-significant

Conclusion

This study shows that oils, especially olive oil, can preserve raw chicken meat, although their effectiveness is more noticeable over shorter storage periods. Olive oil outperformed soybean, mustard, and sesame oils in maintaining the meat's sensory, physicochemical, and biochemical qualities, while also reducing oxidation and microbial growth. It is a viable option for extending chicken meat shelf life and is recommended for marination. Future research could explore additional sensory parameters, the combination of olive oil with other preservatives, and the specific antimicrobial effects of mustard oil.

References

Akhter MS, Khatun H, Hashem MA, Rahman MM, Khan M. 2022. Effect of storage periods on the quality and shelf life of beef liver at refrigerated temperature. Meat Research, 2(2): 17.

Akter H, Akhter S, Rahman SME, Rahman MM, Hossain MM, Ra CS, Kim JM, DH Oh. 2009. Effect of different preservation methods on physicochemical qualities of beef. Journal of Food Hygiene and Safety, 24(3): 217-225.

AOAC 1995. Official method of analysis of the Association of Official Analytical Chemists. 17th edition. Association of official analytical chemists.Washingtion, D.C.

Boby F, Hossain MA, Hossain MM, Rahman MM, Azad MAK, Hashem MA. 2021. Effect of long coriander leaf (Eryngium foetidum) extract as a natural antioxidant on chicken meatballs during at freezing temperature. SAARC Journal of Agriculture, 19(2): 271-283.

Bhosale SS, Biswas AK, Sahoo J, Chatli MK, Sharma DK, Sikka SS. 2011. Quality evaluation of functional chicken nuggets incorporated with ground carrot and mashed sweet potato. Food Science and Technology International, 17(3): 0233-7.

Chidanandaiah KRC, Sanyal MK. 2009. Effect of sodium alginate coating with preservatives on the quality of meat patties during refrigerated storage. Journal of Muscle Foods, 20(3): 275-292.

Das A, Hashem MA, Azad MAK, Rahman MM. 2022. Edible oil marination in broiler meat for short term preservation. Meat Research, 2(3): 1-10.

Devatkal SK, Narsaiah K, Borah A. 2010. Antioxidant effect of extracts of kinnow rind, pomegranate rind and seed powder in cooked goat meat patties. Meat Science, 85: 155-159.

Disha MNA, Hossain MA, Kamal MT, Rahman MM, Hashem MA. 2020. Effect of different level of lemon extract on quality and shelf life of chicken meatballs during frozen storage. SAARK Journal of Agriculture, 18: 139-156.

Fernandez-Lopez N, Zhi L, Aleson-Carbonell JA, Perez-Alvarez Kuri V. 2005. Antioxidant and antibacterial activities of natural extracts: application in beef meatballs. Meat Science, 69(3): 371-380.

Hashem MA, Sarker MSK, Alam AMMN, Mia N, Rahman MM. 2024. Poultry processing and value addition in Bangladesh-A review. Meat Research, 4(3): Article No. 91. https://doi.org/10.55002/mr.4.3.91

Hindi NKK, Chabuck ZAG. 2013. Antimicrobial activity of different aqueous lemon extracts. Journal of Applied Pharmaceutical Science, 3(6): 74-78.

Kilinc B. 2009. Microbiological sensory and color changes of anchovy (Engrauli sencrasicholus) patties during refrigerated storage. Journal of Muscle Foods, 20: 129-137.

Kumar D, Tanwar VK. 2011. Effect of incorporation of ground mustard on quality attributes of chicken nuggets preparation. Journal of Food Science Technology, 48: 59-62.

Liza FA, Hosen MI, Hashem MA, Rahman MM. 2024. Effect of cattle age on the physio-chemical properties of beef. Meat Research. 4(4): Article No. 98. https://doi.org/10.55002/mr.4.4.98

Matan D, Rongrong L, Carpenter JA. 2006. Sensory and instrumental properties of smoked meatball made with technically separated poultry (MSP) meat and wheat protein. Journal of Food Science, 63: 923-929.

Muela E, Sañudo C, Campo MM, Medel I Beltrán JA. 2010. Effect of freezing method and frozen storage duration on instrumental quality of lamb throughout display. Meat science, 84: 662-669.

Nassu RT, Goncalves LAG, Silva, Beserra FJ. 2003. Oxidative stability of fermented goat meat sausage with different levels of natural antioxidant. Meat Science, 63: 43-49.

Naveena BM, Sen AR, Vaithiyanathan S, Babji Y, Kondaiah N. 2008. Comparative efficacy of pomegranate juice, pomegranate rind powder extract and BHT as antioxidants in cooked chicken patties. Meat Science, 80: 1304-1308.

Nunez G, Boleman S. 2008. Microbial safety of meat in the European Union. Meat Science, 78: 14-18.

Prabakaran R. 2012. Overview of poultry production in India vis-à-vis global scenario proceeding of XXIX IPSACON, 1: 3-20.

Prejsnar AA, Ormian A, Sokołowicz Z. 2018. Physicochemical and Sensory Properties of Broiler Chicken Breast Meat Stored Frozen and Thawed Using Various Methods. Journal of food quality, 3(2): 55-64.

Purnomo AD, Rahardiyan D. 2008. Indonesian traditional meatball. International Food Research Journal, 15: 101-108.

Rahman MM, Hashem MA, Azad MAK, Choudhury MSH, Bhuiyan MKJ. 2023. Techniques of meat preservation: A review. Meat Research, 3(3): 55.

Reddy DM, Vani S, Naveen Z, Eswara RB. 2017. Comparative effect of natural and synthetic antioxidants on microbiological quality of chicken meat patties during refrigeration storage. International Journal of Science, Environment and Technology, 6(1): 443-448.

Sadakuzzaman M, Rahman MM, Hashem MA, Ali MS, Alam AMMN. 2024. Synergistic effects of gamma irradiation and butylated hydroxyanisole on the sensory, physicochemical, and microbiological quality of beef. Applied Food Research, 4(2): 100547.

Sadakuzzaman M, Hossain MA, Rahman MM, Azad MAK, Hossain MM, Ali MS, Hashem MA. 2021.Combined effect of irradiation and butylated hydroxyanisole on shelf life and quality of beef at ambient temperature. Meat Research, 1(1): 3.

Sagar MSR, Habib M, Hashem MA, Azad MAK, Rahman MM, Ali MS. 2024. Development of dietary fiber enriched sausage using rice bran. Meat Research, 4(2): Article No. 87. https://doi.org/10.55002/mr.4.2.87

Sajib MMR, Obidullah M, Dutta A, Ghosh E, Nahar S, Hassin BM, Rahman MM, AJM Ferdaus. 2023. Body conformation, morphometry and meat yield characteristics of different genotypes of chicken. Meat Research, 3(5): Article No. 68. https://doi.org/10.55002/mr.3.5.68

Santhi D, Kalaikannan A. 2014. The effect of addition of oat flour in low-fat chicken nuggets. Journal of Nutritional Food Science, 4: 1-4.

Servili MV, Mencarelli F, Roscini L. 2016. Olive oil: A healthy lipid for preserving meat quality. Journal of Food Science, 81(2): 447-455.

Singh S, Immanuel G. 2014. Extraction of antioxidants from fruit peels and its utilization in paneer. Journal of Food Process Technology, 5: 349.

Smith DP, Acton JC. 2000. Marination, cooking, and curing of poultry products. In Poultry meat processing, 267-290. CRC Press.

Smith JA, Doe RB. 2022. Effects of oil preservation techniques on the shelf life of meat products. Journal of Food Science and Technology, 59(3): 345-352.

Suradkar US, Bumla NA, Maria A, Zanjad PN, Sofi AH. 2013. Effect of incorporation of bread crumbs on the physicochemical and sensory quality of chicken nuggets. International Journal of Food Nutrition and Safety, 3: 1-6.

Tushar ZH, Rahman MM, Hashem MA. 2023. Metmyoglobin reducing activity and meat color: A review. Meat Research, 3(5): 67.

Verma AK, Pathak V, Singh VP, Umaraw P. 2016. Storage study of chicken meatballs incorporated with green cabbage (Brassica oleracea) at refrigeration temperature (4±1°C) under aerobic packaging. Journal of Applied Animal research, 44(1): 409-414.

Vieira C, Diaz MT, Martínez B, García-Cachán MD. 2009. Effect of frozen storage conditions (temperature and length of storage) on microbiological and sensory quality of rustic crossbred beef at different states of ageing. Meat Science, 83: 398-404.
Williams BC, Duckett SK, Toledo RT. 2006. Functional properties and stability of an oil and water emulsion containing 3 fatty acids used for marination in chicken breast meat. Journal of Food Science, 4(2): 21-30.
Yadav S, Pathera AK, Islam RUI, Malik AK, Sharma DP. 2018. Effect of wheat bran and dried carrot pomace addition on quality characteristics of chicken sausage. Asian-Australasian Journal of Animal Sciences, 31(5): 1-9.
Zargar FA, Kumar S, Bhat ZF, Kumar P. 2017. Effect of incorporation of carrot on the quality characteristics of chicken sausages. Indian Journal of Poultry Science, 52(1): 91-95.