Effect of Peppermint Oil Extract on the Quality Characteristics of Cold-Preserved Camel Meat

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Abstract

The current study aimed to evaluate the qualitative, chemical of processed meat products (camel meat burgers) preserved through refrigeration at 4°C for 12 days. It was treated with three concentrations of peppermint oil extract. The volatile oils from peppermint leaves were extracted using steam distillation with a Clevenger apparatus. The peppermint oil extract was analyzed using a Gas Chromatograph-Mass Spectrometer (GC-MS) to isolate the active compounds., and conducting chemical, qualitative tests over 1, 4, 8, and 12 days of refrigerated storage. The results clearly showed the superiority of the 1% peppermint oil treatment (B2) over the other treatments in maintaining the chemical and qualitative characteristics within acceptable limits in the samples after a 12-day storage period at 4°C, with significant differences between the treatments at a probability level of ($P \leq 0.05$).

Keywords: Peppermint Oil, Camel Meat Burgers.

Introduction

A medicinal plant contains one or more chemical substances in one or more of its various organs, at either low or high concentrations, with the physiological capacity to treat a specific disease or at least to reduce the symptoms of an ailment if administered to a patient. This can be in the pure form after extraction from the plant material or when used in its original form as fresh or dried herbal vegetation or as a partial extract. [21] noted that scientists have used most medicinal substances and pharmaceutical preparations to extract active compounds from various medicinal plants known by our ancestors and used them to combat different diseases or prepare medications from natural sources.

Conversely, an aromatic plant contains essential volatile oils in one or more of its botanical organs or modifications, whether in their free form or another form that hydrolyzes or decomposes into volatile oils with an acceptable fragrance in the aromatic fields [29]. [28] indicated that some aromatic plants have been used in food preservation, such as meats and others, which consumers accept as natural and part of human food. It was found that both aqueous extracts and essential oils have varying antimicrobial effects (with inhibition zones ranging from 7-14 mm), and the essential oils were more effective than the aqueous extract. Variability was also observed in the minimum inhibitory concentration values for essential oils and aqueous extracts, ranging from 12.5 - 75 mg/ml for each. The results also showed high resistance of bacterial isolates from wound infections towards essential oils and aqueous extracts, with the minimum inhibitory concentration values ranging up to 7550 mg/ml for each. The above results indicate the potential use of aqueous extracts and essential oils of eucalyptus leaves for treating infections caused by Staphylococcus aureus bacteria.

Peppermint, belonging to the Lamiaceae family, stands as a significant aromatic medicinal plant with widespread prevalence across the globe. It is utilized in traditional medicine due to its broad biological and pharmacological efficacy spectrum.

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Peppermint can be added to tea and various foods to enhance flavour and taste, as it is rich in nutrients and dietary elements and is a source of antioxidants [32]

Peppermint is the most significant genus within the Lamiaceae family, comprising 18 species and 11 hybrids that are challenging to classify due to significant variations in morphological characteristics, with hybridization being widely used and of paramount importance. The most notable species include Peppermint (Mentha x piperita), Pennyroyal (Mentha pulegium), Spearmint (Mentha spicata), and Watermint (Mentha aquatica), all of which are characterized by their rapid growth. Since ancient times, these plants have been used as flavouring agents in food, medicine, and cosmetics, primarily due to their aromatic properties. The essential oil of peppermint showcases a variety of components influenced by various factors related to the plant type and environmental conditions, as well as other factors such as the time of harvest and the method of extraction. The most important components include menthol, carvone, pulegone, geraniol, menthone, and alpha-pinene, which are the principal components of the essential oils of these plant species [16]

Meat is a fundamental component of the human diet and is recognized as an excellent source of high-biological value protein and many other nutrients [26]Consumers have preferred meat consumption as part of their dietary habits. Despite its benefits, excessive meat consumption can lead to various health issues, such as heart disease, arteriosclerosis, elevated blood cholesterol, and triglycerides, in addition to kidney problems. Consequently, food manufacturers have focused on creating blends of plant-based and animal-based protein sources to mitigate the adverse effects of meat consumption.

Numerous studies have confirmed that camel meat contains a low fat content, is high in energy, and is rich in protein and glycogen, which is converted into glucose, an essential component for the nervous system to generate cellular energy [8]. As a result, there has been a growing interest in camel meat in various countries worldwide, as it can contribute to meeting the demand for animal protein. This interest is due to the characteristics that qualify camels to become a good source of meat in those regions. Furthermore, camel meat and its products have become a fundamental pillar in meat markets not only in Arab countries but also in Australia, India, China, Iran, Indonesia, Thailand, and Pakistan. Many countries have established standard specifications for meat and its products due to the rapid spoilage of meat [5].

Meat, especially ground meat, is considered highly perishable due to the rapid growth of various microorganisms. Therefore, humans have sought to preserve meat for extended periods to make it suitable for human consumption, employing chemical preservatives to extend the shelf life of food in general and meats in particular. However, due to consumer concerns about the safety of foods containing synthetic chemical preservatives and the increasing resistance of pathogens transmitted through bacterial food to antibiotics, there is a growing interest in using natural antibacterial compounds such as extracts from herbs and spices for their flavour and properties, as well as their potential antimicrobial activity [34].

Materials and methods

Collection and Extraction of Peppermint Essential Oil

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Peppermint plants were obtained from local markets in Baghdad. The peppermint plant was classified in the herbarium of the College of Science, University of Baghdad, and immediately transported for extraction. The essential volatile oils from peppermint leaves were extracted using steam distillation with a Clevenger apparatus.

Initially, the peppermint plant was chopped into small pieces, approximately 1 cm in size. Then, 50 g of it were placed in a 1-litre flask, to which 500 ml of distilled water was added. The flask was connected to a Clevenger apparatus and then to a heat source at a temperature of 100°C. Upon boiling, the water vapour carried the volatile oil. Two phases were obtained through the condenser, which condenses the oil: an organic phase represented by the volatile oil and an aqueous phase represented by the aromatic water. Finally, a yellow-coloured oil with a pleasant smell was obtained, measuring 1 ml after 3 hours, yielding 1% per 100 g.

[6] mentioned in his study the effect of using the alcoholic extract of Boswellia sacra (frankincense) in extending the preservation period of ground mutton stored at refrigerator temperature. The meat was mixed with the alcoholic extract, and the treatments were stored over intervals, upon which some microbiological tests were conducted. The results demonstrated the effectiveness of the alcoholic extract in prolonging the meat's preservation, with a noted decrease in the number of microorganisms.

Collection and Preparation of Camel Meat Burgers

Camel meat (thigh region) was obtained from local markets in the Najaf governorate, 3 kg (Arabian camel), at 6 AM and was minced twice for homogenization. The meat was placed in sterile, refrigerated containers, with the animal aged 2.5 to 3 years.

The burgers were prepared according to the Iraqi Standard Specifications for 2019, No. 5110. The manufacturing process began with mincing the camel meat twice using an electric grinder. Salt was added at a 1% ratio and remixed. After that, peppermint oil concentrations (0.6%, 0.8%, and 1%) were added, and each sample was mixed manually and formed into patties weighing 100 g each. They were stored in a refrigerator at a temperature of 4°C for 4 hours until grilling and conducting tests over 1, 4, 8, and 12 days of storage.

Chemical Tests for Burger Samples During the Cooling Storage Period

Protein Percentage Estimation

The Kjeldahl method was used to estimate the protein content in the samples, based on the method mentioned by [31] A known weight of the sample (about 0.5 g) was placed in a flask, to which (5 ml) of concentrated sulfuric acid was added along with an appropriate amount of a mixture of potassium sulfate and copper sulfate. The digestion process was conducted by heating the contents until the mixture turned into a transparent liquid with a pale blue colour. This liquid was quantitatively transferred to the distillation flask of the Kjeldahl apparatus, which contains a concentrated solution (40%) of sodium hydroxide and is connected to a distillation flask condenser ending in a test tube immersed in a receiving flask containing a known volume of 20% boric acid solution, added with drops of methyl red indicator and bromocresol blue dye. The distillation flask was then heated until about 25 ml of the distilled liquid was collected in the flask, which was then titrated with 0.1N hydrochloric acid. A

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standard solution (blank) was prepared using the same chemicals except for the sample, and the protein percentage was calculated according to the following equation.

Protein % = volume of HCL consumed x standard x 0.014 x 6.25 / sample weight x 100

Estimation of fat

Fats were estimated based on the method [1] where a weight of (10) g was taken from the dried specimens, placed in a filter paper and placed in the thimble of the fat extraction device (Soxhole). The weight of the device's beaker was then added to (250 ml) of hexane, and the process continued. The extraction takes about (5) hours. The solvent is collected from the device, the beaker is taken out, and it is placed in an electric oven for half an hour at a temperature of (80°C) to ensure that the solvent residues evaporate from the beaker and that the fatty materials remain. Then, leave it out of the oven until it cools. Then, the beaker is weighed, and the fat percentage is extracted. According to the following equation:

Fat percentage (%) = weight of flask before extraction - weight of sample after extraction/weight of sample x 100

Estimation of ash content

The percentage of ash in the model was estimated by incineration of the model after placing it in a ceramic bowl of known weight in an incinerator oven at a temperature of about (252°C) for (16 hours) [1] Using the following equation:

Ash percentage (%) = weight of the lid with the sample after burning - weight of the empty lid/weight of the sample x 100

Carbohydrate Determination

The proportion of carbohydrates was estimated according to [15] using the following equation:

Carbohydrates % = (moisture + ash + protein + fat) -100%

Qualitative Assays during Cold Storage

Estimation of Peroxide Value (PV)

The peroxide value was estimated based on the method described by [18]. Two g of the extracted fat, obtained using the Soxhlet apparatus, were weighed and then mixed with 30 mL of a solution containing (3 parts glacial acetic acid + 2 parts chloroform). This mixture added 0.5 mL of saturated potassium iodide, 30 mL of distilled water, and 1 mL of starch indicator (1%). The mixture was then titrated with a 0.01 normality sodium thiosulfate solution until the blue colour disappeared. The peroxide value was calculated based on the following equation:

Peroxide number (mEq) = number of millilitres of sodium thiosulfate x 0.01 x 1000/weight of the sample

Estimation of Thiobarbituric Acid (TBA) Value

The lipid oxidation in the sample was measured by estimating the thiobarbituric acid according to the method described by [32] One gram of the sample was homogenized with 25 mL of a cold solution containing 20% trichloroacetic acid (TCA) dissolved in 2M phosphoric acid using a homogenizer for two minutes. The mixture was then transferred to a 50 mL volumetric flask, and the volume was made up to the mark with distilled water. The mixture was shaken, and 25 mL was centrifuged at 30,000 revolutions per minute (rpm) for 30 minutes. The mixture was then filtered through no. 1 filter paper, and 5 mL of the filtrate was transferred to a test tube. 5 mL of a 0.005M thiobarbituric acid reagent solution dissolved in distilled water was added. A blank was prepared by mixing all the contents except the sample to be measured. The contents were mixed, placed in test tubes,

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sealed tightly, and stored in a dark place for 15-16 hours at room temperature.

The absorbance was measured at a wavelength of 530 nm using a spectrophotometer, and the TBA value was calculated according to the following equation:

Value (TBA) mg MDA/kg = 5.2 x A 530

Total Volatile Nitrogen (TVN):

The total volatile nitrogen was estimated according to the method described by [18] A 100-gram sample of minced material was weighed and mixed with 300 mL of a 5% trichloroacetic acid (TCA) solution. The mixture was then filtered to obtain a clear extract. Subsequently, 5 mL of the clear extract was transferred to a Kjeldahl flask, and 5 mL of a 2-molar sodium hydroxide solution was added. The mixture was heated until distillation occurred into a receiving flask containing 4% boric acid. A few drops of methyl red and bromocresol green indicator were added to the distillate. The mixture was titrated with a 0.01 Molar hydrochloric acid solution to determine the amount of volatile nitrogen based on the following equation:

Amount of volatile nitrogen (mg nitrogen / 100 g) = 500 / XV (300 + MO)

Moisture Estimation

The percentage of moisture in the sample was estimated as the loss in weight of the sample before and after drying, based on the drying method. The approximate weight of the samples (3 g) was placed in a previously weighed crucible and then dried in an electric oven at a temperature of 105°C for 16 hours [2]The moisture content was calculated according to the following equation:

Percentage of moisture = weight of the sample before drying - the weight of the sample after drying/weight of the sample before drying x 100

PH Estimation

The pH was measured according to the method provided by [30] which involves taking 10 g of the sample and adding 100 mL of water to it, then homogenizing it for one minute. Subsequently, the sample was filtered, and the pH was measured using a pH meter.

Estimation of Free Fatty Acid Concentration

The concentration of free fatty acids (FFAs) was estimated according to the method described by [18] This method involves extracting the fat using a cold extraction process. Then, 10 g of the extracted fat were mixed with 25 mL of 95% ethanol. One millilitre of phenolphthalein indicator was added, followed by titration with 0.1N sodium hydroxide until the solution turned pink. The percentage of free fatty acids was calculated based on oleic acid.

Statistical Analysis

The statistical software SAS (2018) was utilized for data analysis to study the effect of different treatments on the studied traits according to a Completely Randomized Design (CRD). The significant differences between the means were compared using the Least Significant Difference (LSD) test at a significance level of ($P > 0.05$).

Chemical and Qualitative Analysis of Burger Samples Treated Before Storage (1 Day)

The results, as shown in Table (1), presented the percentage compositions of chemical components, including protein, fats, ash, moisture, carbohydrates, and free fatty acids, along with values for peroxide, thiobarbituric acid, and total volatile nitrogen, in addition to the pH level of burger samples treated with peppermint oil at concentrations of 0.6%,

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0.8%, and 1% (1 day). The findings indicate no significant differences between the treatments and the control treatment (without treatment) for all the measured chemical components.

Table (1): Effect of peppermint oil on the chemical components of Parker camel meat samples before storage (1 day)

Parameters	A	B	B1	B2	LSD value
Protein %	20.15	20.17	20.15	20.14	0.463 NS
Lipid %	2.78	2.78	2.78	2.79	0.194 NS
Ash %	6.08	6.07	6.08	6.08	0.177 NS
Moisture %	70.58	70.58	70.57	70.58	1.687 NS
CHO %	0.41	0.40	0.42	0.41	0.104 NS
PH	5.52	5.53	5.54	5.52	0.222 NS
PV (m.equ/kg)	3.25	3.21	3.21	3.24	0.287 NS
T.B.A (mg MDA/kg)	0.042	0.044	0.042	0.042	0.019 NS
T.V.N (mg/100gm)	3.05	3.04	3.02	3.02	0.056 NS
FFA %	0.35	0.35	0.34	0.35	0.064 NS
***(P≤0.05).**					

(CHO): Carbohrate **(PV):** Peroxide Value**, (TBA):** Thiobarbituric Acid**, (TVN):** Total Volatile Nitrogen, (FFA): Free fatty acid

Chemical and Qualitative Examinations of Burger Samples Treated After a Storage Period of 4 Days

The results presented in Table (2) relate to the percentage compositions of chemical components (protein, fats, ash, moisture, carbohydrates, free fatty acids) and the values (peroxide, thiobarbituric acid, total volatile nitrogen) in addition to the pH level for burger samples treated with peppermint oil at concentrations (0.6%, 0.8%, 1%) after a storage period of 4 days at a temperature of 4°C. The findings indicated a decrease in protein and ash percentages and a beginning decline in pH level, with an increase in moisture percentage, the value of thiobarbituric acid and the percentage of free fatty acids compared to the samples (1 day) for all treatments used in the current study, with no significant differences between these treatments. The results also showed a decrease in fat percentage with significant differences between treatments at a probability level (P≤0.05), where the treatment with 1% peppermint oil (B2) showed the highest fat percentage at 2.47% compared to the control treatment (A) which had the lowest fat percentage at 2.14%. Similarly, the carbohydrate percentage decreased compared to the examinations conducted on the samples (1 day) for all treatments, with significant differences between treatments. Nonetheless, there was an increase in the value of peroxide number and total nitrogen after a storage period of 4 days compared to (1 day) for all treatments, with significant differences between treatments. The treatment with 1% peppermint oil (B2) surpassed the rest by providing the lowest values for peroxide number and total nitrogen, which were 4.04

m.equ/kg and 4.16 mg/100 gm, respectively, compared to the control treatment (A), which had the highest values at 5.02 m.equ/kg and 5.42 mg/100 gm respectively.

Table (2): Effect of peppermint oil on the chemical components of perker samples after a storage period of 4 days

Parameters	A	B	B1	B2	LSD value
Protein %	19.08	19.40	19.55	19.77	0.766 NS
Lipid %	2.14	2.33	2.40	2.47	0.019 *
Ash %	5.65	5.80	5.88	5.92	0.401 NS
Moisture %	72.88	72.26	71.93	71.4	1.97 NS
CHO %	0.25	0.21	0.24	0.44	0.089 *
PH	5.35	5.49	5.50	5.52	0.402 NS
PV (m.equ/ kg)	5.02	4.22	4.10	4.04	0.046 *
T.B.A (mg MDA/kg)	0.065	0.057	0.052	0.050	0.025 NS
T.V.N (mg/100gm)	5.42	4.32	4.22	4.16	0.037 *
FFA %	0.52	0.41	0.38	0.35	0.178 NS
***(P≤0.05).**					

(CHO): Carbohrate **(PV):** Peroxide Value**, (TBA):** Thiobarbituric Acid**, (TVN):** Total Volatile Nitrogen, (FFA): Free fatty acid

Chemical Examinations of Burger Samples Treated After an 8-Day Storage Period

The results demonstrate a continued decrease in the percentage of protein and fats after an 8-day storage period at a temperature of 4°C, with significant differences between treatments at a probability level (P≤0.05). The treatment with 1% peppermint oil (B2) showed superiority by providing the highest protein percentage (19.11%) and the highest fat percentage (2.23%) compared to the control treatment (A), which resulted in the lowest protein percentage (17.25%) and the lowest fat percentage (1.86%). The findings also indicated a decrease in ash percentage and a continued slight decrease in pH value, countered by an increase in moisture percentage after the 8-day storage period compared to the chemical examinations conducted at previous storage periods, with no significant differences between the treatments used in this study. Additionally, there was a decrease in carbohydrate percentage, matched by an increase in free fatty acids after the current storage period, with significant differences between the treatments used in the study. The results confirmed a continued increase in the value of peroxide number and total nitrogen after 8 days of storage, with significant differences, showing the treatment with 1% peppermint oil (B2) providing the lowest peroxide value (4.68 m.equ/kg) compared to the control treatment (A), which was (5.98 m.equ/kg), while the total nitrogen value was (4.72 mg/100 gm) compared to the control treatment which was (6.25 mg/100 gm). Additionally, there was a continued decrease in the value of thiobarbituric acid, with no significant differences between the treatments used in the current study, as shown in Table (3).

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Table (3): Effect of peppermint oil on the chemical components of perker samples after a storage period of 8 days

Parameters	A	B	B1	B2	LSD value
Protein %	17.25	18.58	18.90	19.11	1.104 *
Lipid %	1.86	2.05	2.11	2.23	0.167 *
Ash %	5.02	5.32	5.44	5.52	0.572 NS
Moisture %	75.58	73.55	73.25	73.00	3.25 NS
CHO %	0.29	0.50	0.30	0.14	0.067 *
PH	5.08	5.33	5.43	5.47	0.561 NS
PV (m.equ/kg)	5.98	4.97	4.75	4.68	0.063 *
T.B.A (mg MDA/kg)	0.078	0.063	0.060	0.057	0.029 NS
T.V.N (mg/100gm)	6.25	4.98	4.80	4.72	0.078 *
FFA %	0.70	0.55	0.51	0.49	0.011 *
***(P≤0.05).**					

(CHO): Carbohydrate **(PV):** Peroxide Value**, (TBA):** Thiobarbituric Acid**, (TVN):** Total Volatile Nitrogen, (FFA): Free fatty acid.

Chemical Examinations of Camel Meat Burger Samples Treated After a 12-Day Storage Period

The results clearly demonstrated the superiority of the treatment with 1% peppermint oil (B2) over the other treatments in maintaining the chemical components within acceptable limits in the samples after a 12-day storage period at a temperature of 4°C, with significant differences between the treatments at a probability level (P≤0.05). There was a continued decrease in the percentages of protein, fats, ash, and pH in all treatments compared to previous storage periods, with significant differences between the treatments and a clear advantage for the treatment with 1% peppermint oil (B2), which provided the highest values for protein (18.86%), fats (2.10%), ash (5.13%), and a pH of (5.35) compared to the control treatment (A) with values of (17.00%, 1.41%, 4.77%) respectively and a pH of (4.77). Additionally, there was an increase in moisture percentage, with the 1% peppermint oil treatment (B2) having the lowest moisture content at 73.82% compared to the control treatment (A), which had the highest at 76.11%, and an increase in carbohydrate percentage after 12 days of storage, with significant differences between the treatments.

The results also indicated an increase in the value of peroxide number, total nitrogen, and the percentage of free fatty acids compared to previous storage periods, with the treatment with 1% peppermint oil (B2) providing the lowest values which were (4.04 m.equ/kg), (5.42 mg/100 gm), and (0.53%) respectively, compared to the control treatment (A) which had the highest values at (6.95 m.equ/kg), (6.85 mg/100 gm), and (0.77%) respectively.

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The current study's findings also confirmed a continued increase in the value of thiobarbituric acid after a 12-day storage period, with no significant differences between the treatments used in the current study, as shown in Table (4).

Table (4): Effect of peppermint oil on the chemical components of perker samples after a 12-day storage period

Parameters	A	B	B1	B2	LSD value
Protein %	17.00	18.00	18.66	18.86	0.093 *
Lipid %	1.41	1.80	2.00	2.10	0.014 *
Ash %	4.77	4.90	5.08	5.13	0.081 *
Moisture %	76.11	74.20	74.12	73.82	1.027 *
CHO %	0.71	0.10	0.14	0.18	0.019 *
PH	4.77	5.26	5.30	5.35	0.012 *
PV (m.equ/kg)	6.95	5.33	5.12	5.04	0.068 *
T.B.A (mg MDA/kg)	0.082	0.074	0.071	0.066	0.028 NS
T.V.N (mg/100gm)	6.85	6.00	5.80	5.42	0.174 *
FFA %	0.77	0.60	0.57	0.53	0.085 *
P≤0.05).					

(CHO): Carbohydrate **(PV):** Peroxide Value**, (TBA):** Thiobarbituric Acid**,**
(TVN): Total Volatile Nitrogen, (FFA): Free fatty acid

The superiority of the treatment with 1% peppermint oil (B2) may be attributed to the higher content of phenolic compounds in this treatment, which enhances its efficacy as antioxidants compared to other treatments [4] This is corroborated by the current study's GC-MS analysis results, which identified the presence of total phenolics and other compounds found in peppermint oil. The values and proportions of chemical components in the samples treated with 1% peppermint oil (B2) were within acceptable limits for the storage period covered in this study, which was 12 days.

The results showed a decrease in protein content over the storage period, which lasted 12 days. This reduction in protein content in the Birker samples during the cooling storage period could be explained by the loss of soluble protein or associated with the activity of bacterial enzymes that break down protein. The decrease in fat content may be due to the increased moisture content in the birker samples [33] as a lower moisture content leads to an increase in dry matter, which includes protein, fat, and ash [7] Generally, camel meat contains a high moisture level, a moderate amount of protein and ash, but a low fat content, which clearly supports the fact that camel meat is moister due to its lower content of muscular fats compared to sheep, cattle, and goats [5]. These results did not align with those found by [10] who observed an increase in protein and fat content when treating fish balls with plant extracts during refrigerated storage, and [24] noted an increase in protein content in smoked mackerel fish when a plant extract was used. However, these results were consistent with the findings of [3]which reported a decrease in protein content for beef birger samples prepared with increasing concentrations of pomegranate powder during

different storage periods. The current study's results also agreed with Al-Alwani (2017), who found that adding rosemary extract and carnosic acid to ground, refrigerated beef led to a decrease in fat content with increased storage duration.

The pH level was estimated to monitor the changes in acidity of the treated and studied samples during their refrigeration storage period. The decrease in pH values with increased storage duration results from increased acidity, possibly due to the conversion of lactose into lactic acid (Pereira Da Costa, 2015).

Peroxide value is an important indicator that provides insight into the extent of oxidation in oils and fats in foods. Peroxides are primary products formed by reacting to atmospheric oxygen and unsaturated fatty acids in fats. The peroxide value, typically expressed as millimoles of oxygen bound in peroxide form per kilogram of fat, reflects the degree of lipid peroxidation. The decrease in peroxide value observed in samples treated with 1% peppermint oil (B2) compared to the control treatment is attributed to the antioxidant effect of 1% peppermint oil, which can scavenge free radicals. This observation aligns with the findings of [25] who noted a reduction in peroxide value in camel meat patties treated with plant extract. These results encourage using plant extracts in meat storage due to their high antioxidant efficacy, which preserves meat samples during refrigerated storage within standard limits. This was corroborated by [14] in their study on the impact of plant extract on meat storage duration and by [17] in their research comparing the peroxide values in meat patties treated with plant extracts against a control sample.

The results of the current study indicate a direct relationship between the storage period and the levels of both thiobarbituric acid and total volatile nitrogen, showing that as the storage period increases, the values of thiobarbituric acid and total volatile nitrogen also increase. This increase is attributed to protein breakdown due to the activity of microbial strains and proteolytic enzymes [22]. It was also observed that thiobarbituric acid and total nitrogen values decreased when samples were treated with 1% peppermint oil (B2) compared to the control treatment. This suggests that the added substance led to a reduction in total nitrogen values due to its role as an antioxidant and antimicrobial agent, which is the result of the presence of active phenolic compounds that participate in protein stabilization and reduce the activity of microbial proteolytic [27]. [11] also noted a decrease in total volatile nitrogen values for samples treated with a plant extract compared to the control treatment. This result is consistent with a study by [23], which found that the total nitrogen value increased in untreated chicken meat patties during cold storage. They reported that using lemongrass oil as an antioxidant with chicken patties was effective, and the values of thiobarbituric acid and total nitrogen were lower than the control treatment during a storage period at 4°C for 9 days. These tests are among the standards used to estimate fat oxidation in meat products during ripening and storage, as rancid flavours appear when the value of thiobarbituric acid exceeds 9.00 mg MDA/Kg. This study agrees with the findings of Al-Zoubi (2010) in his study on fermented basturma, where he observed an increase in the value of thiobarbituric acid within permissible limits. These results were confirmed by [9] who reported that plant extract leads to a decrease

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in thiobarbituric acid values when meat is stored for weeks at -18°C. The presence of antioxidant compounds in peppermint oil acts to slow down fat oxidation and stop the formation of free radicals by preventing the transfer of a hydrogen atom to the free radical, thereby stabilizing these radicals and preventing rancidity from developing, such as ketones, aldehydes, and carboxylates. Thus, natural antioxidants prevent oxidation in products and fatty meals [19].

Conclusion

We conclude from this study that peppermint oil can be used to prolong the shelf life of camel meat burgers by refrigeration for up to 12 days and to maintain the chemical and qualitative characteristics of camel meat burgers within acceptable limits from the beginning of treatment without the appearance of unacceptable flavours, tastes and textures.

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