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EFFECT OF PEPPERMINT OIL ON THE QUALITATIVE PROPERTIES OF SOME PROCESSED MEAT PRODUCTS

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ABSTRACT

The current study aimed to evaluate the qualitative, chemical, and sensory aspects of processed meat products (camel meat burgers) preserved through refrigeration at 4°C ±2 for 12 d. 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 study involved adding three concentrations of peppermint oil (0.6%, 0.8%, and 1%) to the camel meat burgers manufactured according to the Iraqi Standard Specifications for the year 2019, No. 5110, and conducting chemical, qualitative Protein, Lipid, Ash, Moisture, CHO, PH, PV (m.equ/kg), T.B.A (mg MDA/kg), T.V.N (mg/100gm), FFA, and sensory tests over 1, 4, 8, and 12 d of refrigerated storage. 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 d 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 flavors, tastes and textures.

Keywords: Camel Meat, Peppermint Oil. Quality Properties.

تأثير زيت النعناع على الخصائص النوعية لبعض منتجات اللحوم المصنعة

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الخلاصة

هدفت الدراسة الحالية إلى تقييم الجوانب النوعية والكيميائية والحسية لمنتجات اللحوم المصنعة (همبرغر لحم الإبل) المحفوظة بالتبريد عند درجة حرارة 4 درجات منوية ±2 لمدة 12 يوماً. تم استخلاص الزيوت الطيارة من أوراق النعناع باستخدام التقطير بالبخار بجهاز كليفنجر. تضمنت الدراسة إضافة ثلاثة تراكيز من زيت النعناع (0.6%، 0.8% و1%) إلى برجر لحم الإبل المصنعة حسب المواصفات القياسية العراقية لسنة 2019 رقم 5110، وإجراء الاختبارات الكيميائية والنوعية (البروتين ، الدهن ، نسبة الرماد ،تقدير الكربوهيدرات، تقدير قيمة البيروكسيد ، تقدير قيمة الثيوباربتيوريك ، تقديرالنتروجين الكلي المتطاير،تقدير الرطوبة ،تقدير الرقم الهيدروجيني ، تركيز الأحماض الدهنية الحرة) والحسية على مدار 1 و 4 و 8 و12 يومًا من التخزين المبرد. نستنتج من هذه الدراسة أنه يمكن استخدام زيت النعناع لإطالة العمر الافتراضي لبرجر لحم الإبل بالتبريد لمدة تصل إلى 12 يوما وللمحافظة على الخصائص الكيميائية والنوعية لبرجر لحم الإبل ضمن الحدود المقبولة من بداية المعالجة دون ظهور النكهات والأذواق والقوام غير المقبول.

الكلمات المفتاحية: زيت النعناع، لحم الابل، الخصائص النوعية.

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. (**Hamdia, 2023)** 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 **(Sarey Al-Din, 2021)**. **(Salman & Yahya, 2017)** 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. as it is rich in nutrients and dietary elements and is a source of antioxidants **(Alib & Boukhta , 2021)**.

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) . 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 **(Darky, 2020).**

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 **(Nfor *et al.*, 2014)**. 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 **(Al-Jumaili, 2015).** 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 **(Abd El-Aali *et al*., 2011).**

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 **(Zulfa & Rukayadi, 2016).**

MATERIALS AND METHODS

Collection and Extraction of Peppermint (*Mentha spicata L.*) Essential Oil

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. 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 vapor 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-color oil with a pleasant smell was obtained, measuring 1 ml after 3 h, yielding 1% per 100 g.

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 o'clock and was minced twice for homogenization. The meat was

placed in sterile, refrigerated containers, with the animal aged 2.5 to 3 years. (The age of the animal was determined by the number of the animal's teeth).

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 h until grilling and conducting tests over 1, 4, 8, and 12 d of storage. The evaluation was done by the professors of the Home Economics Department after grilling the burger in the oven.

Chemical Tests For Burger Samples During The Cooling Storage Period

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 h **(AOAC, 2008).** The moisture content was calculated according to the following equation:

$$\text{Percentage of moisture} = \frac{\text{weight of the sample before drying} - \text{the weight of the sample after drying} \times 100}{\text{weight of the sample before drying}}$$

Protein Percentage Estimation

The Kjeldahl method was used to estimate the protein content in the samples, based on the method mentioned by **(Van Dijk & Houba, 2000)**. A standard solution (blank) was prepared using the same chemicals except for the sample, and the protein percentage was calculated according to the following equation.

$$\text{Protein } \% = \frac{\text{volume of HCL consumed} \times \text{standard} \times 0.014 \times 6.25}{\text{sample weight} \times 100}$$

Estimation of fat

Fats were estimated based on the method (**AOAC, 1995),** 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 (Soxhlet). The weight of the device's beaker was then added to (250 ml) of hexane, and the process continued. The extraction takes about (5) h. 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:

$$\text{Fat percentage } \% = \frac{\text{weight of flask before extraction} - \text{weight of sample after extraction} \times 100}{\text{sample weight}}$$

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 h) **(AOAC, 1995).** Using the following equation:

$$\text{Ash percentage } \% = \frac{\text{weight of the lid with the sample after burning} - \text{weight of the empty lid} \times 100}{\text{weight of the sample}}$$

Carbohydrate Determination

The proportion of carbohydrates was estimated according to **(Capitani et al., 2015)** using the following equation:

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

Qualitative Assays During Cold Storage

Estimation Of Peroxide Value (Pv)

The peroxide value was estimated based on the method described by (**Egan *et al.*, 1981).** 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:

$$\text{Peroxide number (kg F)} = \frac{\text{number of millilitres of sodium thiosulfate x 0.01 x 1000}}{\text{weight of the sample}}$$

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 **(Witte *et al.*, 1970).** 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, sealed tightly, and stored in a dark place for 15-16 h 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 Absorbance at 530

Total Volatile Nitrogen (Tvn):

The total volatile nitrogen was estimated according to the method described by **(Egan *et al.*, 1981).** 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)

PH Estimation

The pH was measured according to the method provided by **(Sayre *et al.*, 1964),** 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 **(Egan *et al.*, 1981)**. 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 equalizer. 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.

$$\mathbf{FFA\ (kg\ F)} = \frac{\mathbf{number\ of\ millilitres\ of\ sodium\ \ hydroxide\ x\ 0.01\ x\ 5.61}}{\mathbf{weight\ of\ the\ sample}}$$

Sensory Evaluation

The sensory evaluation of burger treatments was conducted in the Home Economics Department of the College of Education for Women by professors specializing in nutrition, with 10 evaluators participating. The method followed for assessing the sensory evaluation scores of the product after grilling was mentioned by **(Tahir, 1979)**. It included various attributes such as colour, flavour, tenderness, juiciness, and overall acceptance, as detailed in Table (1), which represents a 7-point scale for evaluating the sensory characteristics of the burger.

Table (1): Sensory evaluation scores for Perker parameters.

Overall Acceptability	Tenderness	Juiciness	Flavor	Colour	degree
Very acceptable	Very tender	Very juicy	Strong flavour	Very acceptable	7
acceptable	tender	juicy	Medium flavour	acceptable	6
Slightly acceptable	Slightly tender	Little juicy	Little flavour	Slightly acceptable	5
medium	medium	Medium	No flavour	medium	4
Slightly unacceptable	Low hardness	Little dry	Slightly unacceptable flavour	Slightly unacceptable	3
unacceptable	hard	dry	Average unacceptable flavour	unacceptable	2
Very unacceptable	Very hard	Very dry	Very unacceptable flavour	Very unacceptable	1

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 ($P \leq 0.05$).

Chemical and Qualitative Examinations of Stored Burger Meat

Chemical and Qualitative Analysis of Burger Samples Treated Before Storage (0 D)

The results, as shown in Table (2), 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%, 0.8%, and 1% (1 d). The findings indicate no significant differences between the treatments and the control treatment (without treatment) for all the measured chemical components.

Table (2): Effect of peppermint oil on the chemical components of Parker camel meat samples before storage (1 d).

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 d:

The results presented in Table (3) 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 d 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 d) 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 ($P \leq 0.05$), 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 d) 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 d compared to (1 d) 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 oil 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 (3): Effect of peppermint oil on the chemical components of perker samples after a storage period of 4 d.

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-D Storage Period

The results demonstrate a continued decrease in the percentage of protein and fats after an 8-d 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-d 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 d 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 (4).

Table (4): Effect of peppermint oil on the chemical components of perker samples after a storage period of 8 d.

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-D 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-d 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 d 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. The current

study's findings also confirmed a continued increase in the value of thiobarbituric acid after a 12-d storage period, with no significant differences between the treatments used in the current study, as shown in Table (5).

Table (5): Effect of peppermint oil on the chemical components of perker samples after a 12-d 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 **(Abdel- Aziz *et al.*, 2014).** 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 d.

The results showed a decrease in protein content over the storage period, which lasted 12 d. 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 **(Zangana & Al-Jamili, 2010)**, as a lower moisture content leads to an increase in dry matter, which includes protein, fat, and ash **(Al-Janabi, 2021).** pointed out **(Hassan *et al.*, 2022)** Due to sausage types Ash values results in this study showed significant differences (P<0.05) among treatments where camel sausage sample showed the highest value while chicken sausage samples showed the lowest value.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 **(Adam & Abugroun, 2015)**. These results did not align with those found by **(Al-Tamimi, 2019),** who observed an increase in protein and fat content when treating fish balls with plant extracts during refrigerated storage, and **(Iheagwara, 2013)** 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 **(Abdel Fattah *et al.*, 2016),** which reported a decrease in protein content for beef birker samples prepared with increasing concentrations of pomegranate powder during different storage periods. The current study's results also agreed with **(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 & Conte-Junior, 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 **(Makki, 2021),** 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 **(Badawy & Ali , 2018)** in their study on the impact of plant extract on meat storage duration and by **(Das *et al.*, 2011)** 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 **(Hussein *et al.*, 2015)**. 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 enzymes **(Riernersman & Marí, 2016).** (**Al-Tamimi & Abu Al-Maali, 2011)** 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 **(Ibrahim & Salem, 2013)**, 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 d. 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-Zubaie, 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 **(Al-Qazzaz, 2014)**, who reported that plant extract leads to a decrease 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 **(El-Gharably & Ashoush, 2011). (Al-Hafud, A. S., 2017)** 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.

Sensory evaluation of Parker cold-preserved camel meat samples:

The results, as presented in Table 8, detail the sensory evaluation characteristics for camel meat burger treatments, revealing statistically significant differences among the treatments under study at a probability level of ($P \leq 0.05$) in sensory attributes (colour, flavour, juiciness, tenderness, and overall acceptance). The treatment with 1% peppermint oil (B2) scored the highest in all studied sensory evaluation attributes compared to the other treatments utilized in this study. Conversely, the control treatment received the lowest scores in sensory evaluation.

The statistical analysis results indicated significant differences between the treatments under study in attributes (colour, flavour, juiciness, tenderness, and overall acceptance). The treatment with 1% peppermint oil (B2) surpassed the rest of the treatments, with the highest scores being (6, 5.5, 6.6, 6.6, and 6.6) respectively, compared to the control treatment (A), which recorded the lowest scores in the studied attributes, reaching 1 for all attributes under study, as shown in Table (4-9). The gradual increase in scores obtained by the treatments indicates the effectiveness of compounds in plant extracts in protecting the burger from oxidation during refrigerated storage, thereby preserving the desired flavour **(Al-Tamimi & Abu Al-Maali, 2011)**. These results are consistent with the findings of **(Al-Tamimi, 2019)** and **(Awad, 2019)**, who pointed to the effectiveness of plant extracts in preserving foods during storage periods.

(Zaki *et al.*, 2018) found that burgers with added plant extract recorded the highest score in colour and juiciness compared to the control sample (without addition), which recorded the lowest evaluation score. The improvement in attributes for the burger treatments with added plant extracts can be attributed to the increased moisture content in the camel meat burger, which enhances the meat's water-holding capacity and reduces the loss of drip during thawing **(Al-Tamimi & Abu Al-Maali, 2011).**

Table (8): Results of the sensory evaluation of the sensory characteristics of Parker cold-stored camel meat treatments.

adjectives / Parameters	Color	Flavor	Juiciness	Tenderness	Overall Acceptability
A	1	1	1	1	1
B	1	1.2	1.2	1.3	1.3
B1	3	3.4	3.4	3.9	4
B2	6	5.6	6.6	6.6	6.6

This result also aligns with the findings of **(Al-Jamili, 2015)** and **(Al-Issawi & Nagi, 2016)**, who pointed out the effectiveness of plant extracts in preserving foods during storage periods. These outcomes are consistent with those obtained by **(Hussein *et al.*, 2015)**, who found that adding 2% of a plant extract to burger samples results in better acceptance**.** Similarly**, (Al-Tamimi, 2019)**, in his study on plant extracts and their effect on extending the shelf life of refrigerated fish balls, observed an increase in sensory values during the refrigeration storage period.

The increased overall acceptance scores for the refrigerated camel meat burger treatments could be attributed to the phenolic compounds present in the treatments used in this study, providing significant protection against oxidation, leading to the control of undesirable flavours compared with the control treatment. Consequently, this reflects on the overall acceptance attribute or may be due to the ability of plants to impart an additional flavour to the burger samples, as they belong to the spices used in flavouring meals **(Sallam *et al.*, 2010)**. The phenolic compounds found in plant extracts are highly effective as antioxidants, with the ability to quench free radicals, protect cell membranes, and prevent oxidation and rancidity, thereby preventing the emergence of undesirable flavours and odours in the meat **(Alwani, 2017; Ahmed, 2020; Al-Salmani, 2020).**

The decrease in the taste and flavour scores for the other treatments used and the control treatment can be attributed to the emergence of a mild acidic taste resulting from the decrease in pH after 12 d of storage **(Hakim, 2006)**. Alternatively, this decrease may also be due to the oxidation of unsaturated fatty acids, accompanied by the accumulation of oxidation products, which significantly affect the taste and flavour.

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 d 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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