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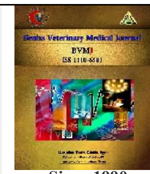

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Original Paper

Effect of Marjoram Oil on the Quality and Shelf life of Meat

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ABSTRACT

Essential oils can improve shelf life of meat due to its antimicrobial and antioxidant action. This study aimed to clarify the effect of marjoram essential oil (MEO) at different concentrations (0.5%, 1% and 1.5%) on meat fillet (250 gm each) which divided into four groups one untreated group (control) and three treated groups with MEO. All samples are examined for sensory properties and keeping quality criteria (pH, TVN and TBA) during cold storage at 4^0C for 15 days. The obtained results significantly showed lowering values ($P<0.05$) for sensory and chemical assessment than untreated (control) one. In addition MEO treated samples with 1.5% concentration had the greatest impact which revealed that mean values of PH, TVN (mg%) and TBA (mg /kg) at the end of the trial where 6.19,18.64 and 0.81 and 6.43,19.9 and 0.89 for samples treated with 1% marjoram oil concentration and 6.48, 20.68 and 0.93 for samples treated with 0.5% marjoram oil concentration. Therefore, marjoram oil with special reference to 1.5% concentration could be used as an alternative option to synthetic chemical substances to improve sensory and chemical properties as well as extending shelf life of meat fillet during cold storage.

1. INTRODUCTION

Meat and meat products are susceptible to biochemical and microbial deterioration, especially during storage, due to their complex composition which consists of several types of saturated and unsaturated lipids, proteins, carbohydrates, vitamins, and pigments (Lorenzo et al., 2014). Oxidation reactions are among the main important issues associated with meat quality deterioration (Lorenzo et al., 2017), being decline in nutritional quality, discoloration, texture deterioration (Gómez and Lorenzo, 2012), off-odors and off-flavors (Shahidi, 2002), and toxic compounds production are among the undesirable changes (Min and Ahn, 2005).

Moreover, meat is relatively low in antioxidant in nature (Ansorena and Astiasaran, 2004). Therefore, in meat industry, using of antioxidant is one of the major strategies for preventing lipid oxidation during storage (Shirahigue et al., 2011). However, the consumer awareness increased over the toxicity, potential health hazards and carcinogencity of synthetic antioxidant so, the natural antioxidant increased their demand in food industry (Bjelakovic et al., 2007).

In this regard, the application of herbal extracts and essential oils is dramatically important as natural preservative strategies to protect and extend the shelf-life of raw and processed meat. Essential oils are isolated from several aromatic plants (Fernandes et al., 2017). Their application is growing in the food, cosmetic and pharmaceutical industries due to their antioxidant and antibacterial activities (Bakhtiary et al., 2018).

Marjoram (*Origanum majorana L.*), a member of the Lamiaceae family is one of the most familiar kitchen herbs, which contains up to 3% of volatile oil, other compounds like flavonoid, caffeic acid, arbutin, tannins, rosmarinic acid, ursolic acid , carnosic acid, labiatic acid, and carnosol can be found in the herb (Shan et al.,2005). Marjoram essential oil is a natural product classified as generally recognized as safe (GRAS) and known to possess antimicrobial and antioxidant activities (Burt, 2004; Chan et al., 2012).

Ginger, oregano, rosemary, sage, marjoram, thyme, mint, and many other aromatic plants are the main sources of well-known essential oils. Several techniques, including the conventional and innovative methods, can be used for essential oil isolation from their resources. The traditional methods of essential oil distillation are steam and hydrodistillation while microwave-assisted hydro-distillation, or and supercritical fluid extractions, ohmic assisted hydro distillation are among the recently proposed methods of essential oil extraction (Hashemi et al., 2018).

Essential oils, as natural antioxidants, have several mechanisms of action to slow down the oxidation reactions. Prevention of chain initiation and continued hydrogen abstraction, free radical scavengers and terminators, quenchers of singlet oxygen formation and binding of transition metal ion catalysts are between their modes of actions (Tongnuanchan and Bejakul, 2014).

Therefore, the aim of the present work is to evaluate the effect of marjoram oil (MEO) on sensory properties and keeping quality criteria for extending shelf life of meat under cold condition.

2. MATERIAL AND METHODS

2.1 Samples:

A total of 5 kg of fresh meat (250 gm each meat fillet) were collected from different butcher's shops located at Tanta

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city, Ghrabia governorate, Egypt and immediately transferred in sterile bags to the laboratory without any delay and examined as quickly as possible.

2.2 Preparation of used oil:
Marjoram oil (*Origanum majorana L.*) was obtained from Benha University.

2.3 Experimental design:
The collected samples were divided into four groups including untreated group (control) and 3 treated groups with marjoram essential oil (MEO) at 0.5%, 1% and 1.5% concentration. All groups were aerobically packaged in sterile polyethylene bags, labeled, and stored at 4 °C for 15 days. Sensory analysis, pH, TVN and TBARs were determined in the examined groups at zeroday,3rd day ,6th day,9th day,12th day and 15th day during refrigerated storage. The experiment was applied in triplicate.

2.4 Determination of sensory evaluation:
Sensory properties of raw meat samples were evaluated by a 5-member panel appropriately trained and tested in sensory sensitivity according to (Fik and Fik, 2007). Briefly, the representative samples from the tested meat were randomly selected and served on porcelain plates in the laboratory (open area). Panel members were asked to evaluate the freshness grade using a 5-point scale-each attribute being scored from 1 to 5 points depending on specifications of sensory quality. The following properties were evaluated: color, odor, appearance and consistency. The overall sensory quality scores 5, 4, 3, 2, and 1 corresponded to the beef mince qualities evaluated as very good, good, acceptable, unacceptable and bad, respectively.

2.5 Physicochemical analyses:
The pH values were recorded by using a digital pH meter (HAANA, hI902 meter, Germany) as described by (Pearson, 2006). The total volatile nitrogen (TVN) was measured according to the procedure of (ES: 63-9/ 2006). Measurement of the thiobarbituric acid (TBA) value was performed according to (ES: 63-10/2006)

2.6 Statistical Analysis:
All the obtained data were statistically analyzed by One Way analysis of variance (ANOVA) using SPSS package (SPSS 19.0, Chicago, IL, USA). Significant (P<0.05) differences between treatments were determined using Duncan's post hoc test. Data were expressed as means ±standard error (SE). All experiments were performed in triplicate.

3. RESULTS

The sensory evaluation results of oil-treated and control meat samples during zero, 3rd, 6th, 9th, 12th and 15th day of refrigerated storage are represented in (Table 1)**.** The sensory attributes of meat samples during storage at 4 ºC were improved with the addition of marjoram essential oil. Generally, samples treated with marjoram oil 1.5% concentration revealed the highest sensory scores in comparison with the untreated ones. Data presented in (Table 2) shows the changes of pH values in the control and oil treated samples during cold storage at 4 ºC. The mean pH values in control samples at zero day, 3rd day, 6th day, 9th day, 12th day and 15th day were 5.66, 6.21, 6.57 and spoiled and 5.66 , 5.82 , 5.99 , 6.29, 6.48 and spoiled for samples treated with marjoram oil 0.5% concentration and 5.66 , 5.75,5.89,6.04 , 6.17 and 6.43 for sample treated with marjoram oil 1% concentration and 5.66 , 5.71 , 5.78 , 5.93, 6.02 and 6.19 for sample treated with marjoram oil 1.5%concentration, respectively. Results illustrated in(Table 3) showed that acceptability of samples based on their PH values were all examined samples which treated with marjoram oil 1.5% and 1% concentration were accepted while acceptability of samples treated with marjoram oil 0.5% was 80% where control samples acceptability 50% according to EOS 2008 Regarding the changes in chemical quality of control and oil treated samples in (Table 4) the mean TVN(mg%) values in control samples on zero day, 3rd day, 6th day, 9th day, 12th day and 15thdayat were 2.21, 12.94, 26.86 and spoiled and 2.21, 6.10, 11.79, 13.56, 20.68 for samples treated with marjoram oil 0.5% concentration and 2.21, 5.54, 9.38, 11.63, 14.71 and 19.90 for samples treated with marjoram oil 1% concentration and 2.21, 5.19, 8.52, 10.18, 13.01 and 18.64 for samples treated 1.5% concentration , respectively. In (Table 5) showed that acceptability of samples based on their TVN (mg%) values were all examined samples which treated with marjoram oil 1.5% and 1% concentrating were accepted while acceptability of samples treated with marjoram oil 0.5% was 80% where control samples acceptability 50% according to EOS 2008

Table 1. Sensory traits of control and Marjoram oil treated meat fillets samples stored at 4 ºC (n=5).

Trait / Storage time	Color (5)	Odor (5)	Appearance (5)	Consistency (5)	Overall (5)	Grade
Control:						
Zero time	5	5	5	5	5	Very good
3rd day	3.4	3.0	3.4	2.6	3.1	Acceptable
6th day	1.2	1.4	1.2	1.0	1.2	Bad
9th day	S	S	S	S	S	Spoiled
12th day	S	S	S	S	S	Spoiled
15th day	S	S	S	S	S	Spoiled
0.5% Marjoram oil: Zero time	5	5	5	5	5	Very good
3rd day	4.2	4.0	4.6	4.0	4.2	Good
6th day	3.8	3.4	4.4	4.2	4.0	Good
9th day	3.4	3.2	3.2	3.4	3.3	Acceptable
12th day	1.6	1.6	1.6	1.2	1.5	Bad
15th day	S	S	S	S	S	Spoiled
1% Marjoram oil: Zero time	5	5	5	5	5	Very good
3 days	4.6	4.4	4.6	4.2	4.4	Good
6 days	4.2	3.6	4.2	4.4	4.1	Good
9th day	3.6	3.2	3.4	3.6	3.5	Acceptable
12th day	3.0	2.8	3.4	3.2	3.1	Acceptable
15th day	2.4	1.8	2.6	2.0	2.2	Unacceptable
1% Marjoram oil: Zero time	5	5	5	5	5	Very good
3 days	4.8	4.2	4.4	4.6	4.5	Good
6 days	4.6	4.0	4.2	4.4	4.3	Good
9th day	4.2	3.6	4.0	4.2	4.0	Good
12th day	3.8	3.2	3.6	3.6	3.6	Acceptable
15th day	3.0	2.6	3.2	3.2	3.0	Acceptable

5: Very good 4: Good 3: Acceptable 2: Unacceptable 1: Bad S: Spoiled

On the other hand results in(Table 6) revealed that values of TBA(mg / kg) of control samples zero day, 3rd day, 6th day, 9th day, 12th day and 15th day at were 0.04 , 0.56 , 1.12 and spoiled and 0.04 , 0.18 , 0.47 , 0.69 , 0.93 and spoiled for samples treated with marjoram oil 0.5% concentration and 0.04 , 0.13 , 0.34 , 0.45 , 0.68 and 0.89 samples treated with marjoram oil 1% concentration and 0.04 , 0.11 , 0.24 , 0.33 , 0.59 and 0.81 for samples treated with marjoram oil 1.5% concentration, respectively . In (Table 7) showed that acceptability of samples based on their TBA (mg/kg) values were all examined samples which treated with marjoram oil 1.5% and 1% concentrating were accepted while acceptability of samples treated with marjoram oil 0.5% was 80% where control samples acceptability 50% according to EOS 2008.

Table 2. Influence of marjoram oil addition on pH of experimentally tested meat fillets samples for extending their shelf life (n=5).

Treatment / Storage time	Control	0.5% Marjoram oil	1% Marjoram oil	1.5% Marjoram oil
Zero time	5.66 ± 0.01	5.66 ± 0.01	5.66 ± 0.01	5.66 ± 0.01
3rd day	6.21 ± 0.01[a]	5.82 ± 0.01[b]	5.75 ± 0.01[bc]	5.71 ± 0.01[bcd]
6th day	6.57 ± 0.03[a]	5.99 ± 0.01[b]	5.89 ± 0.01[bc]	5.78 ± 0.01[cd]
9th day	Spoiled	6.20 ± 0.02[b]	6.04 ± 0.01[bc]	5.93 ± 0.01[cd]
12th day	Spoiled	6.48 ± 0.03[b]	6.17 ± 0.02[c]	6.02 ± 0.02[cd]
15th day	Spoiled	Spoiled	6.43 ± 0.03[c]	6.19 ± 0.01[cd]

*Means with different superscripts in the same rows were significantly differed (P<0.05).

Table 3. Acceptability of the examined samples based on their pH values (n=20).

Meat Samples	pH*	Accepted samples No.	%
Control samples	5.6 - 6.2	10	50
Samples treated with 0.5% MEO		16	80
Samples treated with 1% MEO		20	100
Samples treated with 1.5% MEO		20	100

* Egyptian Organization for Standardization "EOS" (2008).

No 4334/2008 for fresh beef

4. DISCUSSION

The organoleptic examination is usually the main guide of the quality from the consumers' point of view. It is as advantageous to compare sensory evaluation for untreated and treated meat samples. The improvement of sensory attributes of the samples during refrigerated storage (4ºC) by using, marjoram oil concentration at 5%, 1% and 1.5% compared with the control samples over the storage period were in accordance with those recorded by Seydim and Sarikus, (2006) who found that the sensory properties of food could be modified by addition of EOs. Generally, samples treated with 1.5% marjoram oil improved of sensory characteristics followed by marjoram oil 1%, while the samples treated with 0.5% marjoram oil demonstrated lower enhancement. These results are comparable with those recorded by Skrovankova et al., (2012) and Mohamed and Mansour (2012) who reported that some plant EOs such as marjoram oils comprise antioxidant substances that improve meat color and flavor.

The pH measurement is very important in order to determine the shelf life and quality of meat. pH value was greater for the control sample at zero time. This rise in pH values may be due to the microbial spoilage that causes protein breakdown leading to the accumulation of alkaline compounds. The oil-treated samples had lowering in pH values than control samples, which may be explained by the antimicrobial activity of added oils. Generally, the pH values followed an increasing throughout the storage period in control and all treated samples. There was a significant effect ($p < 0.05$) of all treated in comparison with the control samples. The obtained results were corresponded with those reported by El-Desouky et al., (2006) who clarify that the addition of and marjoram oils to meat samples could decrease the pH values of treated samples during cold storage than the control group. As a result of antimicrobial activity of the active components of marjoram EOs (Özkan et al., 2003, Mandal and Mandal, 2016).

Table 4. Influence of marjoram oil addition on TVN (mg%) of experimentally tested meat beef fillets for extending their shelf life (n=5).

Treatment / Storage time	Control	0.5% Marjoram oil	1% Marjoram oil	1.5% Marjoram oil
Zero time	2.21 ± 0.07	2.21 ± 0.07	2.21 ± 0.07	2.21 ± 0.07
3rd day	12.94 ± 0.81[a]	6.10 ± 0.49[b]	5.54 ± 0.42[bc]	5.19 ± 0.38[cd]
6th day	26.86 ± 2.15[a]	11.79 ± 1.02[b]	9.38± 0.74[c]	8.52 ± 0.69[cd]
9th day	Spoiled	15.56 ± 1.34[b]	11.63 ± 0.99[c]	10.18 ± 0.92[cd]
12th day	Spoiled	20.68 ± 1.65[b]	14.71 ± 1.29[c]	13.01 ± 1.15[d]
15th day	Spoiled	Spoiled	19.90 ± 1.83[c]	18.64 ± 1.57[d]

*Means with different superscripts in the same rows were significantly differed (P<0.05)

Concerning the mean values of total volatile nitrogen (TVN), the control samples showed the highest results compared to other treated samples and had TVN about 26.86 mg% at 6th day of cold storage. However, the TVN value of about 20 mg% TVN in raw samples indicates minced meat spoilage according to the Egyptian Standards (Egyptian Standards, 2005). The samples treated with marjoram oils showed the lowest TVN values compared to other groups specially those treated with 1.5% concentration. This may be due to the effectiveness of these EOs on microorganisms. The progressive increase in TVN during cold storage is due to the breakdown of nitrogenous substances because of microbial activity and any autolytic enzymes found naturally in meat tissues. The results seemed comparable to the results of El-Desouky et al., (2006) and Shaltout et al., (2017) who clarify the antimicrobial and antioxidant properties of certain EOs.

Table 5. Acceptability of the examined samples based on their TVN (mg%) values (n=20).

Meat Samples	TVN* (mg%)	Accepted samples No.	%
Control samples		10	50
Samples treated with 0.5% MEO	20	16	80
Samples treated with 1% MEO		20	100
Samples treated with 1.5% MEO		20	100

* Egyptian Organization for Standardization "EOS" (2008).
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With regard to the values of thiobarbituric acid (TBA) as a lipid oxidation indicator. The thiobarbituric acid values of all examined samples increased significantly ($P < 0.05$) as the storage period progressed. However, the lowest TBA value (spoiled) was recorded for 1.5% marjoram oil-treated samples, meanwhile the largest increase in TBA value was reported for control samples (1.75 mg malonaldhyde/kg) at the end of experiment (day 15). The results obtained were similar with that obtained by Shaltout et al., (2017) who found that TBA values of minced meat treated with EOs were significantly lower than control samples ($P < 0.05$), declared that spice extracts were extremely safe and highly protective against lipid oxidation in raw meat under refrigerated conditions. In general, the increase of TBA levels reported in oil-treated samples were less than that found in the control samples that might be explained by the antioxidant activity of EOs (Yashin et al., 2017). Essential oils, as natural antioxidants, have several mechanisms of action to slow down the oxidation reactions. Prevention of chain initiation and continued hydrogen abstraction, free radical scavengers and terminators, quenchers of singlet oxygen formation and binding of transition metal ion catalysts are between their modes of actions (Tongnuanchan and Bejakul, 2014).

Table 6. Influence of marjoram oil addition on TBA of experimentally tested meat fillets samples for extending their shelf life (n=5).

Treatment / Storage time	Control	0.5% Marjoram oil	1% Marjoram oil	1.5% Marjoram oil
Zero time	0.04 ± 0.01	0.04 ± 0.01	0.04 ± 0.01	0.04 ± 0.01
3rd day	0.56 ± 0.05^{a}	0.18 ± 0.02^{b}	0.13 ± 0.01^{bc}	0.11 ± 0.01^{bcd}
6th day	1.12 ± 0.09^{a}	0.47 ± 0.05^{b}	0.34± 0.04^{bc}	0.24 ± 0.02^{cd}
9th day	Spoiled	0.69 ± 0.07^{b}	0.45 ± 0.05^{c}	0.33 ± 0.04^{cd}
12th day	Spoiled	0.93 ± 0.08^{b}	0.68 ± 0.05^{c}	0.59 ± 0.06^{cd}
15th day	Spoiled	Spoiled	0.89 ± 0.09^{c}	0.81 ± 0.07^{cd}

*Means with different superscripts in the same rows were significantly differed (P<0.05)

TBA results for oil-treated samples after 15 days of storage were below the permissible threshold (< 0.9 mg malonaldhyde/kg for minced meat) set by the Egyptian standards (Egyptian Standards, 2005). However, the chemical composition of the essential oils determines their characteristics and therefore their mode of action. However, due to a great variety of compounds, their antioxidant activity cannot be only attributed to a single mechanism of action (Burt, 2004). However, to facilitate exploring the antioxidant effects of essential oils, some researchers linked the antioxidant activity of the main components to the total activity of the essential oil (Wei and Shibamoto, 2010).

Meat Samples	TBA* (mg/kg)	Accepted samples	
		No.	%
Control samples	0.9	10	50
Samples treated with 0.5% MEO		16	80
Samples treated with 1% MEO		20	100
Samples treated with 1.5% MEO		20	100

* Egyptian Organization for Standardization "EOS" (2008). No 4334/2008 for fresh beef

5. CONCLUSION

Marjoram oil (1.5%) treated meat samples showed significantly lower values of pH, TVN and TBARS than those of control samples during refrigerated storage with satisfactory effect on sensory attributes. Therefore, Marjoram oil could be used as a natural antioxidant alternative to the synthetic antioxidant without altering the sensory attributes.

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