**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°C 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 TVN (mg%) and TBA (mg/kg) at the end of the trial were 6.19, 18.64 and 0.81 and 6.43, 19.9 and 0.89 for samples treated with 1.5% 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 carcinogenicity 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 (Bakhtiar 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, rosemery, 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 hydrodistillation, 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.
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 zero day, 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 consistence. 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 raw samples were evaluated by trained and tested sensory panel members 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 consistence. 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.

<table>
<thead>
<tr>
<th>Storage Time</th>
<th>Trait</th>
<th>Color</th>
<th>Odor</th>
<th>Appearance</th>
<th>Consistence</th>
<th>Overall</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero time</td>
<td>3rd day</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>Very good</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>6th day</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>Very good</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>9th day</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>Very good</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>12th day</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>Very good</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>15th day</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>Very good</td>
<td>3</td>
</tr>
</tbody>
</table>

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

On the other hand results in (Table 6) revealed that values of TBA (mg/ kg) of control samples were 0.04, 0.05, 0.06, 0.08 and 0.09 for samples treated with marjoram oil 0.5% concentration and 0.04, 0.05, 0.06, 0.08 and 0.09 for samples treated with marjoram oil 1% concentration, respectively. In (Table 7) showed that acceptability of samples based on their TVN (mg%) values were all examined samples which 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).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Storage time</th>
<th>Control</th>
<th>0.5% Marjoram oil</th>
<th>1% Marjoram oil</th>
<th>1.5% Marjoram oil</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Zero time</td>
<td>5.66 ± 0.01</td>
<td>5.66 ± 0.01</td>
<td>5.66 ± 0.01</td>
<td>5.66 ± 0.01</td>
</tr>
<tr>
<td></td>
<td>3rd day</td>
<td>6.21 ± 0.01</td>
<td>5.82 ± 0.01</td>
<td>5.75 ± 0.00a</td>
<td>5.71 ± 0.01ab</td>
</tr>
<tr>
<td></td>
<td>6th day</td>
<td>6.37 ± 0.03a</td>
<td>5.99 ± 0.01a</td>
<td>5.89 ± 0.01ab</td>
<td>5.78 ± 0.01ab</td>
</tr>
<tr>
<td></td>
<td>9th day</td>
<td>Spooled</td>
<td>6.20 ± 0.02b</td>
<td>6.04 ± 0.01b</td>
<td>5.93 ± 0.01abc</td>
</tr>
<tr>
<td></td>
<td>12th day</td>
<td>Spooled</td>
<td>6.48 ± 0.03c</td>
<td>6.17 ± 0.02c</td>
<td>6.02 ± 0.02c</td>
</tr>
<tr>
<td></td>
<td>15th day</td>
<td>Spooled</td>
<td>6.42 ± 0.03c</td>
<td>6.19 ± 0.01c</td>
<td></td>
</tr>
</tbody>
</table>

*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).

<table>
<thead>
<tr>
<th>Meat Samples</th>
<th>pH*</th>
<th>Accepted samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control samples</td>
<td>5.6 - 6.2</td>
<td>10 / 50</td>
</tr>
<tr>
<td>Samples treated with 0.5% MEO</td>
<td>5.6 - 6.2</td>
<td>16 / 80</td>
</tr>
<tr>
<td>Samples treated with 1% MEO</td>
<td>5.6 - 6.2</td>
<td>20 / 100</td>
</tr>
<tr>
<td>Samples treated with 1.5% MEO</td>
<td>5.6 - 6.2</td>
<td>20 / 100</td>
</tr>
</tbody>
</table>

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

4. DISCUSSION

The organoleptic examination is usually the main guide of the quality from the consumers’ point of view. It is advantageous to compare sensory evaluation for untreated and treated meat samples. The improvement of sensory attributes of the samples during refrigerated storage (4°C) 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 antioxidative 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 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).

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.
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. Inhibition of Marjoram oil addition on TBA of experimentally tested meat fillets samples for extending their shelf life (n=5).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Control</th>
<th>0.5% Marjoram oil</th>
<th>1% Marjoram oil</th>
<th>1.5% Marjoram oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero time</td>
<td>0.04 ± 0.01</td>
<td>0.04 ± 0.01</td>
<td>0.04 ± 0.01</td>
<td>0.04 ± 0.01</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; day</td>
<td>0.56 ± 0.05&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.18 ± 0.02&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.13 ± 0.03&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.11 ± 0.01&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>6&lt;sup&gt;th&lt;/sup&gt; day</td>
<td>1.12 ± 0.09&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.47 ± 0.05&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.34 ± 0.06&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.24 ± 0.02&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>9&lt;sup&gt;th&lt;/sup&gt; day</td>
<td>Spoiled</td>
<td>0.69 ± 0.07&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.45 ± 0.05&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.33 ± 0.04&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>12&lt;sup&gt;th&lt;/sup&gt; day</td>
<td>Spoiled</td>
<td>0.93 ± 0.08&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.68 ± 0.05&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.59 ± 0.06&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>15&lt;sup&gt;th&lt;/sup&gt; day</td>
<td>Spoiled</td>
<td>Spoiled</td>
<td>0.89 ± 0.09&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.81 ± 0.07&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

*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 malonaldehyde/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).

### 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.

### 6. ACKNOWLEDGMENTS

The author would like to express his appreciation to the department of food control stuff, Faculty of Veterinary Medicine, Benha University, Egypt and stuff of Health Research Institute Tanta, El-Gharbiam Egypt for their cooperation and their great effort.

### 7. REFERENCES