



## EFFECTIVENESS OF SOME AROMATIC OILS TREATMENTS ON QUALITY CONSERVATION OF PEPPERMINT FRESH CUT HERB UNDER COLD STORAGE

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### ABSTRACT

The effect of lavender, lemongrass and thyme volatile oils as a supplementary cold storage treatments on quality preservation of fresh cut herb of *Mentha piperita* L., during storage for 15 days at 5°C and 7°C followed by 5 days at 20°C, as a marketing condition simulation, was evaluated during 2018 and 2019 seasons. Physical properties, chemical constituents, respiration rate and volatile oil contents were recorded. The results illustrated that discarded herb %, weight loss %, and external appearance (scale) were greatly affected by both factors of the study. The great effect in this respect was obtained with storage at 5°C than 7°C and the effect was also continuous during marketing period at 20°C. An evident decrease in discarded herb % and weight loss % were obtained due to the applied treatments, whereas external appearance values were higher with applied treatments than control during cold storage durations and marketing period. Aromatic oils treatments with 0.50% of lavender, lemongrass and thyme oils were effective than 0.25% of the three aromatic oils. However, chemical constituents i.e total chlorophyll, L-ascorbic acid and total phenols of fresh cut herb were scored highly increases by storage at 5°C than at 7°C storage conditions. Furthermore, The richest chemical constituents mentioned above were obtained with 0.50% of the three aromatic oils treatments and with superior for marketing durations for 5 days at 20°C. On contrary, total acidity of fresh cut herb recorded the minimum values with applied treatments than control (except the treatment of 0.25% thyme oil) during all cold storage durations and marketing pe-

riod. On the reverse, electrolyte leakage and respiration rate values were controlled and minimized with the applied aromatic oils treatments under 5°C or 7°C cold storage conditions and followed by 5 days at 20°C as a marketing period. The decreases of both electrolyte leakage and respiration rate of fresh cut herb either with cold storage or due to the applied treatments are considered a good indicators to increase storage longevity and high quality. Meanwhile, volatile oil was greatly affected by both cold storage conditions and supplementary refrigeration treatments with lavender, lemongrass and thyme aromatic oils. Conclusively, it could be concluded that the peppermint fresh cut herb can be treated with lavender, lemongrass and thyme aromatic oils before storage at 5°C for 15 days, handling and marketing under 20°C to conserve the quality of the herb.

**Keywords:** Peppermint, fresh cut herb, aromatic oil, Lavender, Lemongrass and Thyme, cold storage, supplementary refrigeration, respiration rate

### INTRODUCTION

Peppermint (*Mentha piperita* L.) is an important species and one of the most well-known herb of the **Lamiaceae** family which having 25 species (**Karkanis et al 2018**). Additionally, spearmint (*Mentha spicata* L.) also is a perennial crop cultivated for its aromatic oils that are applied mostly in flavoring gum and dental hygiene products. Regarding to peppermint plant, it is a hybrid between watermint (*Mentha aquatic* L.) and spearmint (*Mentha spicata* L.) had many advantages such as health promoting and recuperating properties, the trademark reviving fragrance, makes mint one of the most attractive

herbs for use in different plates of mixed greens just as flower and trimming in foods. However the major contributor to world peppermint production is Asia with 92.23% of total production and is followed by Americas which contributes 7.61%. Different species of mentha had many health benefits, nutritional supplement in livestock feed (**Hosoda et al 2005**), food and peppermint freshener. So, since ancient times mint species are being consumed without any side effect and they are generally considered safe for human and animal consumption due to they are rich in polyphenols and flavones in different form. The main components are important in human health as a source for vitamins and as antioxidant (**Maisuthisakul et al 2007**).

Medicinal and aromatic plants essential oils represent an alternative to pesticide application in the production processes of agriculture food and commodities preservation during storage and handling (**Camele et al 2010 and Plaza et al 2004**). Since, various natural aromatic oils have been used to control plant diseases and prevent product losses due to microbial effect and consequently improved external appearance and reduced herb decay % (**Heidarpour et al 2013 and Ghanbari et al 2016**). It is well known that plant-based products such aromatic oil extracted from different aromatic plants are safe substances and good candidate for control of storage conditions as reported by **Isman, 2000 & Isman and Machial 2006**. The demand for food product free of pesticide and chemicals is growing. It has been demonstrated that postharvest deteriorations and preservation quality of stored commodities can be controlled by plant essential oils or plant extracts (**Plaza et al 2004**). Plant essential oils have antifungal and antibacterial effects depending on plant species and applied oil concentrations (**Arras & Usai 2001, Camele et al 2010, Combrinck et al 2011, Lalitha et al 2011 & Mari et al 2016**) causing evident decrease in weight loss %, decay % and an increase in external appearances.

However, many studies indicated the efficiency of essential oils and plant extract of many aromatic plants on fungal and bacterial diseases and consequently increase storability of different commodities (**Lee et al 2008, Lalitha et al 2011**). In this respect, lemongrass (*Cymbopogon citratus* L.) oil was reported by **Hyun et al 2015**, to decrease fungal activity of several plant pathogens and a reduction in disease incidence. However, weight loss, loss of fruit succulence and showed acceptable appearance during cold storage at market shelf conditions of avocado fruits were reported by **Mpho et al 2013**. In addition, thyme (*Thymus cupitates* L.) oil has

been used to control many plant diseases of several fruits (**Abd-alla et al 2011**). It was effective in preserving the losses of vitamin C and maintaining quality of the orange fruits (**Fatemi et al 2011**). Also, bergamot (*Citrus bergamia*) oil minimized fruit decay, weight loss % and delayed the change in fruit softening, total acidity, T.S.S%, vitamin C, anthocyanin pigment content and respiration rate of crimson seedless grapes (**Abd-Elwahab et al 2014**).

Similar trend of results on the great effect as aromatic oils as a supplementary refrigeration treatments were also found by peppermint oil on orange fruits (**Fatemi et al 2011**) and plum fruits (**Aminifard and Mohammadi, 2013**), rosemary oil on many commodities (**Almela et al 2006**), lavender oil, dill oil and coriander oil (**Serban et al 2011**). It could be discussed as a general view that, the role of essential oils act as antibiotic activity, allelopathy, attractants, feed in deterrents and phytoalexin (**Mahanta, 2007**).

The aim of this research was to evaluate the effect of aromatic oils of lavender, lemongrass and thyme plants as a supplementary refrigeration treatments on improving storability of peppermint fresh cut herb during storage at 5 or 7°C±1 and 95% RH for 15 days followed by 5 days at 20°C±2 as a marketing simulation conditions, during 2018 and 2019 seasons.

## MATERIALS AND METHODS

The present work was conducted during 2018 and 2019 seasons in Hort. Dept. Fac.of Agric., Ain Shams Univ., on the fresh cut herb of (*Mentha piperita* L.) Baladi cv. The aerial part of plant (main aerial stem, branches and leaves) were cut on the first of May in both seasons. The samples of herbs plants were obtained from a private farm located in Wadi El- Natrun region , Behira Governorate .After clean up and dipping in cold water for 5 minutes, the herb was rinsed in percidine bio-fungicide (25 mg/L) for 5 minutes (**Yousefzad et al 2015**), then subjected to air drying , the percidine – treated herb was dipped in distilled water and air dried .The cleaned herb of plant was adapted to 10 cm - branches length and bundled in 50 gm. for each bundle and subjected to pre – storage treatments as dipping for 5 minutes as follows :-

1. Control washed in distilled water
2. Lavender oil at 0.25%
3. Lavender oil at 0.50 %
4. Lemongrass oil at 0.25%
5. Lemongrass oil at 0.50 %
6. Thyme oil at 0.25%

7. Thyme oil at 0.50%

After the treatments, the bundles were air dried, packed in proliferated cellophane bags and held in foam dishes. A completely randomized block design with 4 replicates was used, each replicate contained from 10 herb foam dishes (7 treatments x 3 replicates x 30 dishes = 630 dishes for each temperature storage. All dishes were stored at 5 and 7 ± 1 °C for 15 days (relative humidity 95%), followed by 5 days at 20 ± 2 °C as a marketing condition simulation. Initial sample from each temperature storage was taken for different analysis .After that , samples were pull from cold storage at 5, 10 and 15 days and them subjected to different analysis whereas a part of sample (3 dishes) for each replicate was held at 20 ± 2 °C for 5 days as a marketing condition .

The following parameters were evaluated:-

### 1. Physical properties

- **Discarded Herb %:** The grams of decayed herbs was periodically recorded and expressed as a percentage from the total number.
- **Weight loss %:** Herbs were weighed at the beginning of the experiment just after treatments application and every 5-day interval during the storage period. Weight loss was expressed as the percentage loss of the initial total weight.
- **External appearance (scale):** was rated subjectively into one of five categories: 5 (excellent), 4 ( very good ) , 3 (good), 2 (fair), and 1 (poor), by an informal panel of five people (**Erkan et al 2005**)

### 2. Chemical analysis

- **Total chlorophyll (as mg/g fresh herb):** was determined according to **Nagata and Yamashita 1992**
- **Total acidity (as g Citric acid/100 g fresh herb)** was determined according to **A.O.A.C. 2005**.
- **L-ascorbic acid content (mg/g fresh herb)** was determined following the methods by **A.O.A.C. 2005**

- **Electrolyte leakage (% EC leakage):** Ten grams disks of the herb tissues were placed in a 100-ml glass beaker containing 30 ml of deionized water and magnetic stirred for 15 min. Electrical conductivity (EC) of the stirred solution was measured using electrical conductivity meter. Stirred solution of each beaker was then replaced by equal volume (30 ml) of deionized water for homogenizing the disks in a blender, and the aliquot was then used for measuring EC level as previously described. Percentage of solute leakage was then calculated as EC leakage using the method described by **Mirdehghan et al 2007**
- **Total phenoles (as mg/100 g dry herb):** was measured according to **Singleton and Rossi, 1965**.
- **Total flavones (as mg/100 g dry herb):** was determined according to **Dewanto et al 2002**.

### 3. Respiration rate (mg CO<sub>2</sub>/kg fresh herb /hr.):

Carbon dioxide produced by herb was determined after 10 hrs finished from treatments and then every 5 days during storage until experiment termination. The air-flow was passed through concentrated NaOH, to insure that air-flow is CO<sub>2</sub> free, before passing into 1-liter jar container (herb ambient) 50 g/jar ( one dish ) was considered as one replicate. The out-coming air-flow was then passed into 100 ml NaOH of 0.1 N for 1 h. Such solution was then titrated against 0.1 N HCl and CO<sub>2</sub> levels produced by the fresh herb was then calculated as (mg CO<sub>2</sub>/kg fresh herb/hr), according to **A.O.A.C. 2005**

### 4. Volatile oil content (%)

In both seasons, the essential oil was extracted by water distillation method according to **Novak et al (2002)**. The amount of obtained volatile oil was measured and oil percentages (%) were measured according to **Charles and Simon (1990)**.

### Statistical analysis

Data obtained were subjected to analysis of variance (ANOVA) using MSTAT-C software (MSTAT, Michigan University East Lansing). Duncan multiple rang test (LSR) was performed to determine any significant difference among various treatments. p<0.05 was selected as decision for significant differences, according to **Steel et al (1997)**.

## RESULTS AND DISCUSSION

### I. Physical properties

#### 1-1. Discarded herb %

A great effect of applied treatments and cold storage process on discarded herb % of mentha (**Table 1**) was recorded in both studied seasons. However, untreated fresh herb recorded the highest values of discarded herb % followed by the thyme oil treatment at 0.25% after 15 days of cold storage at 5°C. The lowest values of discarded herb% were recorded by lavender and lemongrass oils both at 0.50% in the two seasons. Moreover, during mar-

keting duration condition (20°C) all applied treatments of aromatic oils were effective in reducing discarded herb % than control, with the exception of 0.25% of thyme oil treatment. Generally, storage at 7°C exhibited higher values of discarded herb % than those at 5°C, in both studied seasons. Lavender and lemongrass oils treatments both at 0.50% recorded during storage on 5°C the least discarded herb %. Marketing duration for 5 days at 20°C after cold storage process at 7°C exhibited higher values of discarded herb than that recorded at 5°C. The obtained data showed, in general, that the effect of aromatic oils treatments was more pronounced on mentha fresh cut herb with storage at 5°C than at 7°C.

**Table 1.** Effect of some aromatic oils treatments on discarded herb % of mentha fresh cut herb stored at 5° and 7°C ± 1 and 95%RH, followed by 5 days at 20± 2 °C, during 2018 and 2019 seasons

Treatments	Temperatures storage							
	(5 ± 1°C)			5 days at (20 ±1°C)	(7 ± 1°C)			5 days at (20 ±1°C)
	Storage durations (days)				Storage durations (days)			
	5	10	15	5	10	15		
<b>2018 Season</b>								
Control	3.91 a	7.27 a	12.65 a	20.66 a	5.26 a	17.67 a	--	--
Lavender oil 0.25%	0.0 c	4.13 b	6.76 b	11.33 b	2.71 c	6.21 c	12.43 b	23.37 a
Lavender oil 0.50 %	0.0 c	0.0 d	0.0 d	4.11 de	0.0 d	0.0 e	5.22 d	7.40 c
Lemongrass oil 0.25%	0.0 c	2.55 c	3.83 c	9.52 bc	0.0 d	3.98 d	6.56 c	13.82 b
Lemongrass oil 0.50 %	0.0 c	0.0 d	1.74 d	3.13 e	0.0 d	0.0 e	4.91 d	7.57 c
Thyme oil 0.25%	2.72 b	6.23 a	11.79 a	17.87 a	3.95 b	10.88 b	22.57 a	--
Thyme oil 0.50%	0.0 c	0.0 d	2.87 cd	6.64 cd	0.0 d	3.17 d	6.45 c	15.45 b
<b>2019 Season</b>								
Control	3.64 a	9.46 a	15.55 a	27.75 a	2.74 bc	12.98 a	23.02 a	--
Lavender oil 0.25%	1.88 bc	3.61 b	9.39 b	14.79 c	2.78 ab	5.83 b	15.24 b	19.71 a
Lavender oil 0.50 %	0.0 c	0.0 c	2.61 de	6.32 ef	0.0 d	0.0 d	5.56 de	8.68 c
Lemongrass oil 0.25%	0.0 c	3.46 bc	6.22 c	11.87 cd	0.0 d	3.97 bc	9.97 c	13.98 b
Lemongrass oil 0.50 %	0.0 c	0.0 c	0.0 e	5.51 f	0.0 d	0.0 d	5.11 e	6.74 d
Thyme oil 0.25%	2.35 b	8.14 a	15.24 a	21.38 b	3.35 a	11.74 a	24.09 a	--
Thyme oil 0.50%	0.0 c	1.85 c	4.95 cd	9.17 de	2.21 c	3.22 cd	7.86 cd	13.57 b

Values followed by the same letter (s) are not significantly different at 5% level

The treatment was terminated due to discarded herb % reached about 20 %.

Various natural aromatic oils have been used to control plant diseases and prevent product losses due to microbial effect and consequently improved external appearances and reduced herb decay % (Ghanbari et al 2016 Heidarpour et al 2013).

**1-2 Weight loss %**

It is clear from data in **Table (2)** that weight less % of peppermint fresh cut herb was greatly affected by aromatic oils treatments and cold storage conditions. However, the lowest values of weight loss % after 15 days at 5°C (5.80 and 5.12%) were recorded by lavender and lemongrass oils treatments both at 0.50% in first seasons of study. On the contrast, thyme and lavender oils treatments, both at 0.25% exhibited higher values of weight loss% than control. The same trend of results was also obtained during marketing at 20°C for 5 days. Data recorded

at 7°C storage declared that the weight loss values were higher than those at 5°C regardless of the applied treatments. After 15 days of cold storage at 7°C, the minimum values and favorable values of weight loss% were recorded by lavender and lemongrass aromatic oils treatments both at 0.50%, whereas the highest value was recorded with 0.25% thyme oil treatment.

The great effect to essential oils as a supplementary refrigeration treatments could be attributed to that they are made up of many different volatile components varied between species (Mishra and Dubey, 1994). They made edible films and coating upon the storage commodities helping in preservation because they provide a partial barrier to moisture and CO<sub>2</sub> (respiration rate) and avoiding chemical components from losses (Olivas and Barbosa-Canovas, 2005).

**Table 2.** Effect of some aromatic oils treatments on weight loss % of mentha fresh cut herb stored at 5° and 7 °C ± 1 and 95%RH, followed by 5 days at 20± 2°C, during 2018 and 2019 seasons .

Treatments	Temperatures storage							
	(5 ± 1°C)			5 days at (20 ±1°C)	(7 ± 1°C)			5 days at (20 ±1°C)
	Storage durations (days)				Storage durations (days)			
	5	10	15	5	10	15		
<b>2018 Season</b>								
Control	4.45 a	5.75 b	8.66 ab	15.27 a	4.65 a	8.96 a	--	--
Lavender oil 0.25%	3.36 b	6.72 a	8.77 ab	13.11 b	4.54 a	8.30 a	11.45 a	18.20 a
Lavender oil 0.50 %	1.88 d	4.13 d	5.80 d	10.22 d	3.07 c	5.31 c	7.71 c	12.20 c
Lemongrass oil 0.25%	3.28 b	5.38 bc	7.97 b	13.53 b	3.67 b	7.11 b	10.24 b	15.76 b
Lemongrass oil 0.50 %	2.26 cd	4.58 cd	5.12 d	9.11 d	3.11 c	5.12 c	7.30 c	13.97 c
Thyme oil 0.25%	3.47 b	6.83 a	9.24 a	16.20 a	4.71 a	9.20 a	12.74 a	--
Thyme oil 0.50%	2.73 c	5.89 ab	6.80 c	11.20 c	3.34 c	6.71 b	10.07 b	1.21 b
<b>2019 Season</b>								
Control	3.91 a	5.49 b	7.16 b	19.84 a	4.16 a	6.87 ab	9.43 a	--
Lavender oil 0.25%	3.27 ab	5.69 ab	6.88 b	12.72 c	3.69 ab	5.89 bc	8.33 ab	16.00 a
Lavender oil 0.50 %	1.72 c	3.16 de	3.16 d	8.85 e	2.19 d	4.30 de	4.85 d	10.89 d
Lemongrass oil 0.25%	3.04 bc	4.72 bc	5.36 c	11.93 c	3.49 b	5.01 cd	7.68 bc	13.66 b
Lemongrass oil 0.50 %	1.91 c	2.27 e	3.45 d	8.44 e	2.88 cd	3.49 e	5.32 d	10.24 d
Thyme oil 0.25%	3.42 ab	6.61 a	9.17 a	13.91 b	4.07 a	7.77 a	9.21 a	--
Thyme oil 0.50%	2.10 c	3.94 cd	4.09 d	10.81 d	2.55 c	4.24 de	6.90 c	12.77 c

Values followed by the same letter (s) are not significantly different at 5% level  
The treatment was terminated due to discarded herb % reached about 20 %.

It has been demonstrated that postharvest deterioration and preservation quality of stored commodities can be controlled by plant essential oils or plant extracts (Plaza et al 2004). Plant essential oils have antifungal and antibacterial effects depending on plant species and applied oil concentrations (Arras and Usai 2001 & Camele et al 2010 & Combrinck et al 2011 & Lalitha et al 2011 & Mari et al 2016) caused an evident decrease in weight loss %, decay % and an increase in external appearances.

### 1-3 External appearance (scale)

Table (3) data showed that, external appearance of mentha fresh cut herb was greatly improved due to aromatic oils treatments and cold storage ambient. It is clear that, external appearance was decreased with the long cold storage durations either at 5 or 7°C, regardless of the applied treatments. However, 5°C storage condition was more

effective than 7°C and the effect was continuous during marketing durations for 5°C at 20°C. Lavender oil, lemongrass oil and thyme oil all at 0.50% treatments recorded the highest values of external appearance of fresh cut herb under 5 or 7°C cold storage. Furthermore, it could be concluded from the obtained data that volatile aromatic oils could be used as a safe health and environmental treatments on edible commodity such as fresh cut herb without health problems. The effect of these aromatic oils was hastened with cold storage process during handling and marketing of commodities under the ideal conditions (20°C) for fresh cut herb.

It is well known that plant-based products such aromatic oil extracted from different aromatic plants are safe substances and good candidate for control of storage conditions as reported by Isman, 2000 & Isman and Machial 2006. The demand for food product free of pesticide and chemicals is growing.

**Table 3.** Effect of some aromatic oils treatments on external appearance herb (scale) of mentha fresh cut herb stored at 5 ° and 7 °C ± 1 and 95%RH, followed by 5 days at 20± 2 °C , during 2018 and 2019 seasons

Treatments	Temperatures storage							
	(5 ± 1°C)			5 days at (20±1°C)	(7 ± 1°C)			5 days at (20 ±1°C)
	Storage durations (days)				Storage durations (days)			
5	10	15	5	10	15			
<b>2018 Season</b>								
Control	4.00 b	3.45 c	2.82 c	2.11 c	4.00 b	3.65 c	--	--
Lavender oil 0.25%	5.00 a	4.20 b	3.31 c	2.29 c	5.00 a	3.22 b	2.45 d	1.74 d
Lavender oil 0.50 %	5.00 a	5.00 a	4.72 a	4.17 a	5.00 a	5.00 a	4.59 a	4.00 a
Lemongrass oil 0.25%	5.00 a	4.53 ab	3.86 bc	3.07 b	5.00 a	3.85 b	3.44 c	2.87 c
Lemongrass oil 0.50 %	5.00 a	5.00 a	4.46 a	4.06 a	5.00 a	5.00 a	4.44 ab	4.00 a
Thyme oil 0.25%	4.50 ab	4.11bc	3.05 c	1.78 d	4.30 b	2.74 c	1.98 d	--
Thyme oil 0.50%	5.00 a	5.00 a	4.31 ab	3.88 a	5.00 a	4.78 a	4.07 b	3.36 b
<b>2019 Season</b>								
Control	4.24 b	3.22 d	2.57 c	1.76 e	4.72 ab	3.36 d	2.27 d	--
Lavender oil 0.25%	5.00 a	4.11 bc	3.52 b	2.78 d	4.67 b	3.79 cd	2.57 cd	1.87 d
Lavender oil 0.50 %	5.00 a	5.00 a	4.46 a	4.12 a	5.00 a	5.00 a	4.65 a	4.11 a
Lemongrass oil 0.25%	5.00 a	4.34 b	3.86 b	3.14 c	5.00 a	4.21 bc	3.05 c	2.34 c
Lemongrass oil 0.50 %	5.00 a	5.00 a	4.63 a	4.31 a	5.00 a	5.00 a	4.33 ab	3.87 a
Thyme oil 0.25%	5.00 a	3.54 cd	2.76 c	1.91 e	4.53 b	3.48 d	2.00 d	--
Thyme oil 0.50%	5.00 a	4.78 ab	4.45 a	3.74 b	5.00 a	4.43 b	3.84 b	3.16 b

Values followed by the same letter (s) are not significantly different at 5% level

Many studies indicated the efficiency of essential oils and plant extracts of many aromatic plants on fungal and bacterial diseases and consequently increased storability of different commodities (Lalitha et al 2011 & Lee et al 2008). In this respect, lemongrass (*Cymbopogon citratus* L.) oil was reported by Hyun et al 2015, who found that an evident decrease in fungal activity against several plant pathogens and a reduction in disease incidence were obtained. However, weight loss, loss of fruit succulence and showed acceptable appearance during cold storage at market shelf conditions of avocado fruits were reported by Mpho et al 2013.

values with aromatic oils treatments than control. The loss of this important pigment which considered one of the main quality indicators was less in fresh cut herb-treated than untreated ones. However, storage at 5°C was better than storage at 7°C where the reduction of total chlorophyll was minimized after 15 days of storage at both temperature degrees. Data showed that after 15 days of cold storage at 5°C, the treatments of 0.50% from the three aromatic applied oils exhibited the higher values of total chlorophyll than other treatments or control. However, after 15 days of cold storage at 7°C the effective treatments in preservation of total chlorophyll content from losses were the treatments of lavender oil at 0.25 or 0.50%, and lemongrass at 0.25%. It is important depending on the obtained data, to explain that the marketing of perishable commodities such fresh cut herb must be handling at suitable conditions (20°C).

2- Chemical constituents

2-1 Total chlorophyll content (mg/g f.wt)

It is clear from data in Table (4) that total chlorophyll of mentha fresh cut herb recorded higher

Table 4. Effect of some aromatic oils treatments on total chlorophyll content (mg/g f.wt) herb of mentha fresh cut herb stored at 5° and 7°C ± 1 and 95%RH, followed by 5 days at 20± 2°C , during 2018 and 2019 seasons

Treatments	Storage temperatures							
	(5 ± 1°C)			5 days at (20±1°C)	(7 ± 1°C)			5 days at (20 ±1°C)
	Storage durations (days)				Storage durations (days)			
	5	10	15	5	10	15		
<b>2018 Season</b>								
Control	1.24 c	1.15 de	0.98 d	0.68 d	1.14 c	0.97 d	--	--
Lavender oil 0.25%	1.41 ab	1.27 c	1.03 c	0.83 c	1.29 ab	1.15 b	0.99 b	0.83 c
Lavender oil 0.50 %	1.42 ab	1.55 a	1.21 a	1.11 a	1.38 a	1.16 ab	1.10 ab	0.96 a
Lemongrass oil 0.25%	1.34 bc	1.25 cd	1.07 bc	0.91 bc	1.25 bc	1.07 bc	1.07 ab	0.87 bc
Lemongrass oil 0.50 %	1.38 b	1.51 ab	1.22 a	1.02 a	1.36 ab	1.19 a	1.17 a	1.01 a
Thyme oil 0.25%	1.30 bc	1.07 e	0.92 d	0.62 d	1.25 ab	0.99 cd	0.88 c	--
Thyme oil 0.50%	1.51 a	1.44 b	1.17 ab	0.97 ab	1.31 ab	1.06 bc	1.05 b	0.93 ab
<b>2019 Season</b>								
Control	1.41 bc	1.08 e	0.93 d	0.63 e	1.18 cd	0.97 cd	0.85 c	--
Lavender oil 0.25%	1.50 ab	1.35 bc	1.11 c	0.82 cd	1.27 bc	1.02 c	0.99 b	0.84 c
Lavender oil 0.50 %	1.51 ab	1.45 b	1.37 a	1.00 b	1.40 a	1.25 ab	1.19 a	1.07 a
Lemongrass oil 0.25%	1.48 ab	1.29 cd	1.19 bc	0.79 d	1.29 ab	1.15 b	1.12 a	0.91 bc
Lemongrass oil 0.50 %	1.56 a	1.63 a	1.46 a	1.17 a	1.42 a	1.29 a	1.24 a	1.11 a
Thyme oil 0.25%	1.32 c	1.19 d	0.97 d	0.75 de	1.11 d	0.91 d	0.78 c	--
Thyme oil 0.50%	1.49 ab	1.41 b	1.22 b	0.90 c	1.34 ab	1.17 b	1.16 a	0.95 b

Initial sample for total Chlorophyll recorded 1.48 and 1.65 (mg/100 g f.wt) for 2018 and 2019 seasons Values followed by the same letter (s) are not significantly different at 5% level

## 2-2 Total acidity (g citric acid / 100 g f.wt)

Fresh cut herb of mentha was loss its total acidity with advanced in cold storage durations either at 5°C or 7°C (**Table 5**). However, after 15 days of cold storage at 5°C, the maximum values of total acidity (1.03%) was recorded by thyme oil at 0.25 % whereas during storage at 7°C, the highest value of total acidity (1.16%) was exhibited by 0.25% of lavender oil treatment. Generally, it could be concluded that using aromatic oil as a pre-cold storage treatments to fresh cut herb of mentha could extend the marketing duration of the herb without high losses of total acidity. It is well known that, the reduction of total acidity with advanced in cold storage durations could be attributed to the consumption of these acids in respiration process pathway.

## 2-3 L-ascorbic acid (mg/ g f.wt.)

It is clear from data in **Table (6)** that L-ascorbic acid content in mentha fresh cut herb stored at 5 or 7°C for 15 days followed by 5 days at 20°C as a imitation marketing conditions was greatly affected by the different applied treatments. Generally, mentha fresh cut herb contained about 15 mg/100 g f.wt. Of L-ascorbic acid which considered as a medium

source of L-ascorbic acid. However, after 15 days of storage at 5°C the highest values of L-ascorbic acid were recorded by 0.50% treatments of lavender, lemongrass and thyme aromatic oils treatments, and this beneficial effect was continues during marketing period at 20°C. Regarding storage at 7°C, lavender and thyme oils both at 0.50% exhibited higher values of L-ascorbic acid after 15 days of cold storage than others.

It is difficult to associate the anti-fungal activity to aromatic oils to single components or groups of compounds, generally it could explain the antifungal and antimicrobial effects to the synergistic effect (**Bagamboula et al 2004**).

## 2-4 Electrolyte leakage (EC%)

The effect of aromatic oils treatments and cold storage temperatures on electrolyte leakage of mentha fresh cut herb are shown in **Table (7)**. It is well known that, electrolyte leakage is considered one of good quality indicators in leafy commodities and as it increased the quality of herb is minimized. So, as cold storage durations increased either at 5 or 7°C, electrolyte leakage values were increased regardless of the used treatments.

**Table 5.** Effect of some aromatic oils treatments on total acidity (g citric acid / 100 g f.wt.) herb % of mentha fresh cut herb stored at 5° and 7°C ± 1 and 95%RH, followed by 5 days at 20± 2°C , during 2018 and 2019 seasons

treatments	Storage temperatures							
	(5 ± 1°C)			5 days at (20±1°C)	(7 ± 1°C)			5 days at (20 ±1°C)
	Storage durations (days)				Storage durations (days)			
5	10	15	5	10	15	5	10	15
<b>2018 Season</b>								
Control	1.24 c	1.15 de	0.98 d	0.68 d	1.14 c	0.97 d	--	--
Lavender oil 0.25%	1.41 ab	1.27 c	1.03 c	0.83 c	1.29 ab	1.15 b	0.99 b	0.83 c
Lavender oil 0.50 %	1.42 ab	1.55 a	1.21 a	1.11 a	1.38 a	1.16 ab	1.10 ab	0.96 a
Lemongrass oil 0.25%	1.34 bc	1.25 cd	1.07 bc	0.91 bc	1.25 bc	1.07 bc	1.07 ab	0.87 bc
Lemongrass oil 0.50 %	1.38 b	1.51 ab	1.22 a	1.02 a	1.36 ab	1.19 a	1.17 a	1.01 a
Thyme oil 0.25%	1.30 bc	1.07 e	0.92 d	0.62 d	1.25 ab	0.99 cd	0.88 c	--
Thyme oil 0.50%	1.51 a	1.44 b	1.17 ab	0.97 ab	1.31 ab	1.06 bc	1.05 b	0.93 ab
<b>2019 Season</b>								
Control	1.41 bc	1.08 e	0.93 d	0.63 e	1.18 cd	0.97 cd	0.85 c	
Lavender oil 0.25%	1.50 ab	1.35 bc	1.11 c	0.82 cd	1.27 bc	1.02 c	0.99 b	0.84 c
Lavender oil 0.50 %	1.51 ab	1.45 b	1.37 a	1.00 b	1.40 a	1.25 ab	1.19 a	1.07 a
Lemongrass oil 0.25%	1.48 ab	1.29 cd	1.19 bc	0.79 d	1.29 ab	1.15 b	1.12 a	0.91 bc
Lemongrass oil 0.50 %	1.56 a	1.63 a	1.46 a	1.17 a	1.42 a	1.29 a	1.24 a	1.11 a
Thyme oil 0.25%	1.32 c	1.19 d	0.97 d	0.75 de	1.11 d	0.91 d	0.78 c	
Thyme oil 0.50%	1.49 ab	1.41 b	1.22 b	0.90 c	1.34 ab	1.17 b	1.16 a	0.95 b

Initial sample for total acidity recorded 1.51 and 1.64 (mg/100 g f.wt) for 2018 and 2019 seasons  
Values followed by the same letter (s) are not significantly different at 5% level

**Table 6.** Effect of some aromatic oils treatments on L- ascorbic acid (mg / g f.wt.) herb of mentha fresh cut herb stored at 5° and 7°C ± 1 and 95%RH, followed by 5 days at 20± 2°C , during 2018 and 2019 seasons

Treatments	Storage temperatures							
	(5 ± 1°C)			5 days at (20 ±1°C)	(7 ± 1°C)			5 days at (20 ±1°C)
	Storage durations (days)				Storage durations (days)			
	5	10	15	5	10	15		
<b>2018 season</b>								
Control	14.71cd	11.25 d	8.75 e	6.23 d	12.80 a	7.25 d		
Lavender oil 0.25%	14.85 bc	14.27 c	12.03 c	9.71 b	11.00 ab	9.75 ab	7.52 b	5.12 c
Lavender oil 0.50 %	16.43 a	15.72 a	15.11 a	12.22 a	11.51 ab	9.03 bc	7.57 ab	7.18 a
Lemongrass oil 0.25%	14.11 cd	11.55 d	10.30 d	7.74 c	10.62 b	9.73 ab	6.20 c	4.54 c
Lemongrass oil 0.50 %	15.74 ab	13.20 c	13.72 b	11.83 a	10.975 b	8.73 bc	6.25 c	7.54 a
Thyme oil 0.25%	13.82 d	12.27 cd	9.36 de	7.30 c	12.05 ab	8.07 cd	5.25 c	
Thyme oil 0.50%	15.01 bc	14.44 b	13.55 b	10.10 b	11.25 ab	10.05 a	8.53 a	6.11 b
<b>2019 Season</b>								
Control	13.31 d	11.10 d	7.83d	6.67 e	10.16 c	8.34 d	6.11 c	
Lavender oil 0.25%	14.18 cd	12.22 c	10.41 c	9.63 c	10.12 c	9.26 cd	8.56 b	6.73 c
Lavender oil 0.50 %	16.11 a	14.01 a	13.74 a	12.15 a	12.46 a	11.20 a	10.43 a	9.07 a
Lemongrass oil 0.25%	13.58 d	12.43 bc	10.54 c	7.73 d	10.74 c	10.54 ab	7.96 b	5.42 c
Lemongrass oil 0.50 %	15.32 ab	13.35 ab	12.20 b	10.77 b	12.01 ab	10.74 ab	9.95 a	8.13 ab
Thyme oil 0.25%	15.03 cd	12.10 c	8.24 d	7.10 de	9.07 d	7.54 d	5.32 c	
Thyme oil 0.50%	14.91 bc	12.92 bc	11.14 c	9.47 c	11.09 bc	9.75 bc	8.24 b	7.93 b

Initial sample for recorded 16.15 and 16.83 (mg / 100 g f.wt.) for 2018 and 2019 seasons  
Values followed by the same letter (s) are not significantly different at 5% level

**Table 7.** Effect of some aromatic oils treatments on electrolyte leakage (EC%) herb of mentha fresh cut herb stored at 5° and 7°C ± 1 and 95%RH, followed by 5 days at 20± 2°C , during 2018 and 2019 seasons

Treatments	Storage temperatures							
	(5 ± 1°C)			5 days at (20 ±1°C)	(7 ± 1°C)			5 days at (20 ±1°C)
	Storage durations (days)				Storage durations (days)			
	5	10	15	5	10	15		
<b>2018 season</b>								
Control	22.56 c	29.15 bc	43.57 a	71.11 a	28.75 a	42.29 a	---	--
Lavender oil 0.25%	20.27 d	26.26 e	32.17 d	37.13 e	26.20 b	28.74 e	35.20 d	61.12 d
Lavender oil 0.50 %	25.74 a	28.95 cd	39.74 b	56.11 d	29.42 a	35.11 c	42.79 b	71.11 a
Lemongrass oil 0.25%	20.16 d	28.02 d	35.54 c	40.27 e	24.27 c	29.19 e	40.27 bc	61.23 cd
Lemongrass oil 0.50 %	21.15 d	27.23 e	36.11 c	60.20 c	26.44 b	32.29 d	41.19 b	66.53 b
Thyme oil 0.25%	24.11 b	32.59 a	46.25 a	67.33 b	28.71 a	38.56 b	54.20 a	--
Thyme oil 0.50%	21.92 cd	30.00 b	38.32 bc	53.14 d	28.50 a	31.37 d	38.12 c	64.11 bc
<b>2019 Season</b>								
Control	23.19 a	34.41 a	49.30 a	70.16 a	24.71 a	33.75 a	49.66 a	
Lavender oil 0.25%	23.31 a	29.30 b	41.44 bc	60.21 cd	24.41 a	30.07 b	43.18 cd	70.40 a
Lavender oil 0.50 %	19.10 c	21.91 d	33.30 de	46.01 e	21.34 d	24.66 d	38.78 e	53.76 e
Lemongrass oil 0.25%	21.43 b	29.47 b	39.61 c	63.33 c	23.22 bc	29.28 b	43.63 bc	68.32 b
Lemongrass oil 0.50 %	17.08 d	22.63 d	30.63 e	48.05 e	21.56 d	25.19 d	37.36 e	56.10 d
Thyme oil 0.25%	23.76 a	29.92 b	43.38 b	64.79 b	24.06 ab	32.58 a	46.46 b	
Thyme oil 0.50%	20.39 c	24.73 c	35.81 d	56.87 d	22.52 cd	26.38 c	39.74 de	62.15 c

Initial sample for Electrolyte Leakage recorded 18.79 and 16.11 (EC%) for 2018 and 2019 seasons  
Values followed by the same letter (s) are not significantly different at 5% level

However, after 15 days of cold storage at 5°C the least value of electrolyte leakage (32.17%) was recorded by lavender oil treatment at 0.25% and this effect was also found after 5 days at 20°C as a simulation to ideal marketing conditions. On the other hand, after 15 days of storage at 7°C the same treatment of lavender at 0.25% recorded the least value of electrolyte leakage (35.20%) and the reducing effect was continuous at 20°C for 5 days. Generally, electrolyte leakage values were higher during storage at 7°C than 5°C which means that 5°C storage temperature was suitable for mentha fresh cut herb than 7°C.

Due to large distances that the product generally must transport between the location of production and the shelf-life of the consumer, the demand for postharvest techniques to maintain the quality of the fresh product for longer of time has grown (Wills et al 2007).

## 2-5 Total phenols (mg/100g d.wt.)

As it shown in **Table (8)**, it is clear that total phenols content of mentha fresh cut herb was decreased with advanced in cold storage durations either at 5 or 7°C. The treatments of lemongrass oil at 0.25 % and thyme oil at 0.50% were effective than other treatments or control in reducing the rate of loss in total phenols and recorded the highest values after 15 days of cold storage at 5°C. However, lavender oil and lemongrass oil both at 0.50% were recorded the highest values of total phenols after 15 days of cold storage at 7°C.

In addition, during marketing durations at 20°C, the treatment of 0.50% lavender oil was effective in recording the highest values of total phenols after finished from cold storage process either at 5° or 7° storage temperatures.

**Table 8.** Effect of some aromatic oils treatments on total phenols (mg / 100 g d.wt.) herb of mentha fresh cut herb stored at 5° and 7°C ± 1 and 95%RH, followed by 5 days at 20± 2°C , during 2018 and 2019 season

Treatments	Storage temperatures							
	(5 ± 1°C)			5 days at (20 ±1°C)	(7 ± 1°C)			5 days at (20 ±1°C)
	Storage durations (days)				Storage durations (days)			
	5	10	15	5	10	15		
<b>2018 season</b>								
Control	35.49 d	32.85 c	28.70 bc	18.00 d	27.90 d	25.45 b	--	--
Lavender oil 0.25%	40.04 c	32.41 c	28.21 c	22.12 c	28.27 cd	24.39 c	19.67 d	14.05 e
Lavender oil 0.50 %	39.07 c	31.57 c	29.78 bc	28.06 a	28.69 cd	24.17 c	22.16 a	21.27 a
Lemongrass oil 0.25%	44.25 a	38.62 a	35.72 a	25.86 b	29.76 bc	25.45 b	19.45 d	16.17 d
Lemongrass oil 0.50 %	43.38 b	36.39 b	30.37 b	25.46 b	30.44 ab	25.44 b	22.10 ab	19.87 b
Thyme oil 0.25%	33.43 d	28.56 d	22.33 d	19.93 d	29.35 bc	25.59 b	21.11 bc	--
Thyme oil 0.50%	44.96 ab	32.88 c	34.02 a	24.80 b	31.77 a	28.65 a	20.61 cd	18.18 c
<b>2019 Season</b>								
Control	36.75 bc	28.41 cd	21.72 c	16.66 e	29.32 d	25.11 bc	21.57 a	--
Lavender oil 0.25%	37.15 bc	29.55 bc	22.34 c	20.11 d	30.15 cd	23.20 d	16.56 d	12.31 d
Lavender oil 0.50 %	42.38 a	34.45 a	30.11 a	29.74 a	32.95 a	28.56 a	21.08 a	19.91 a
Lemongrass oil 0.25%	38.25 b	31.10 b	24.40 b	21.83 cd	31.75 ab	25.11 bc	15.59 d	14.54 c
Lemongrass oil 0.50 %	35.56 c	27.21 de	21.47 c	24.26 b	30.16 cd	23.74 d	19.58 b	18.44 a
Thyme oil 0.25%	35.54 c	30.53 e	16.74 d	14.71 e	30.85 bc	25.26 b	18.45 c	--
Thyme oil 0.50%	36.26 bc	30.27 bc	26.70 b	23.20 bc	31.56 ab	24.25 cd	19.51 b	16.66 b

Initial sample for total phenols recorded 45.51 and 43.92 (mg /100 g d.wt.) for 2018 and 2019 seasons  
Values followed by the same letter (s) are not significantly different at 5% level

A great effect of phenolic compounds was observed by (Karthikesan et al 2010) through of hepatoprotective and hypolipidemic activities by inhibition lipid peroxidation and antioxidant properties. In addition, Brunerton 2005, reported that phenols compounds has a wide spectrum of biological activities including anti-inflamantory, anti-microbial, antioxidant and immunomodulatory properties.

**2-6 Total flavones (mg/100g d.wt)**

Table (9) data declared that total flavones of mentha fresh cut herb was greatly affected by both cold storage conditions and aromatic oil treatments. However, lavender, lemongrass and thyme aromatic oils treatments all at 0.50% recorded the highest values of total flavones after 15 days of cold storage either at 5°C or 7°C. However, during marketing durations at 20°C for 5 days after finished from cold storage at 5°C or 7°C, it is noticed that storage of

fresh cut herb at 5°C was better than those stored at 7°C, where it exhibited higher values of total flavones. It is well known that, total flavones considered as a pre cursor of many vitamins and consequently increased the nutritive value of herb. From the obtained data it could be concluded that the used of aromatic oils as a pre-storage treatments had many benefits mainly as environmental safe treatments.

The benefits of mentha different species had many health benefits, nutritional supplement in live-stock feed (Hosoda et al 2005), food and mouth freshener. So, since ancient times mint species are being consumed without any side effect and they are generally considered safe for human and animal consumption due to they are rich in polyphenols and flavones in different form. These main components are important in human health as a source for vitamins and as antioxidant for radical free (Maisuthisakul et al 2007).

**Table 9.** Effect of some aromatic oils treatments on total flavones (mg / 100 g d.wt.) herb of mentha fresh cut herb stored at 5 ° and 7 °C ± 1 and 95%RH, followed by 5 days at 20± 2 °C , during 2018 and 2019 seasons

Treatments	Storage temperatures							
	(5 ± 1°C)			5 days at (20 ±1°C)	(7 ± 1°C)			5 days at (20 ±1°C)
	Storage durations (days)				Storage durations (days)			
	5	10	15	5	10	15		
<b>2018 season</b>								
Control	23.11 e	18.23 cd	11.55 e	7.75 f	20.51 cd	17.21 d	--	--
Lavender oil 0.25%	25.23 de	19.32 c	19.17 c	17.17 d	21.49bcd	19.34 c	15.20 b	9.75 c
Lavender oil 0.50 %	29.7 ab	23.55 a	23.46 a	22.17 a	22.78 ab	21.56 a	18.17 a	12.74 a
Lemongrass oil 0.25%	26.30 cd	18.10 cd	18.56 c	19.19 c	21.93 bc	20.38 b	14.34 b	14.21 a
Lemongrass oil 0.50 %	30.58 a	21.36 b	22.10 ab	21.25 a	23.90 a	21.74 a	17.20 a	14.35 b
Thyme oil 0.25%	20.17 f	17.10 d	13.23 d	11.12 e	20.41 d	18.21 d	13.74 c	--
Thyme oil 0.50%	28.26 bc	22.71 ab	21.59 b	20.63 b	22.06 b	21.56 a	18.13 a	14.51 a
<b>2019 Season</b>								
Control	24.10 d	22.57 bc	10.40 e	8.57 e	23.51 d	17.20 e	11.57 e	--
Lavender oil 0.25%	24.25 cd	24.59 a	17.20 c	16.17 c	26.11 c	24.20 c	19.17 c	12.25 d
Lavender oil 0.50 %	28.75 a	25.10 a	22.20 a	20.46 a	30.07 a	27.58 a	23.46 a	16.13 a
Lemongrass oil 0.25%	25.07 cd	20.44 d	19.14 b	15.56 c	27.56 bc	23.59 c	18.56 c	14.36 c
Lemongrass oil 0.50 %	28.11 ab	24.73 a	21.33 a	19.10 ab	28.52 ab	26.43 ab	22.10 ab	15.28 ab
Thyme oil 0.25%	24.25 cd	21.57 cd	14.56 d	10.25 d	26.73 c	21.51 d	13.25 d	--
Thyme oil 0.50%	26.15 bc	24.32 ab	20.11 b	18.59 b	27.73 bc	24.95 bc	21.59 b	15.11 bc

Initial sample for total flavones recorded 32.27 and 29.81 (mg / 100 g d.wt.) for 2018 and 2019 seasons  
 Values followed by the same letter (s) are not significantly different at 5% level

### 3. Respiration rate (mg CO<sub>2</sub>/kg herb/hr.)

**Table (10)** data suggested that the supplementary refrigeration treatments including 3 aromatic oils at two rates were effective in minimizing the respiration rate of mentha fresh cut herb. After 15 days of cold storage at 5°C, the treatments of high concentrations (0.50%) from the three aromatic oils were recorded the least values of respiration rate followed by the low one (0.25%). Meanwhile, the same trend of the results was also obtained after 15 days of cold storage at 7°C, but with high values of respiration rate than those on 5°C. This finding led to more preservation quality of fresh cut herb during storage at 5°C than at 7°C. During marketing period at 20°C for 5 days, the effect of volatile oils

treatments were also reported, where all oils treatments recorded less respiration rate values than control either after cold storage at 5 or 7°C. The great effect of low temperature on reducing the respiration rate of fresh herbs was also mentioned by (Sandhya, 2010). In similar findings, thyme (*Thymus cupitates* L.) oil has been used to control many plant diseases of several fruits (Abd-alla et al 2011). It was effective in preserved the losses of vitamin C and maintaining quality of the orange fruits (Fatemi et al 2011). Also, bergamot (*Citrus bergamia*) oil minimized fruit decay, weight loss %, delayed the change in fruit softening, total acidity, T.S.S%, vitamin C, anthocyanin pigment content and respiration rate of Crimson seedless grapes (Abd-Elwahab et al 2014).

**Table 10.** Effect of some aromatic oils treatments on respiration rate (mg CO<sub>2</sub> / kg herb / hr.) herb of mentha fresh cut herb stored at 5 ° and 7 °C ± 1 and 95%RH, followed by 5 days at 20± 2 °C, during 2018 and 2019 seasons

Treatments	Storage temperatures							
	(5 ± 1°C)			5 days at (20 ± 1°C)	(7 ± 1°C)			5 days at (20 ± 1°C)
	Storage durations (days)				Storage durations (days)			
	5	10	15	5	10	15		
<b>2018 season</b>								
Control	32.69 c	39.25 d	37.82 e	71.87 e	47.73 a	56.73 b	--	--
Lavender oil 0.25%	35.21 bc	40.11 cd	45.94 c	96.35 d	26.18 d	38.84 d	58.54 d	104.43 d
Lavender oil 0.50 %	39.93 a	56.51 a	54.94 b	133.40 a	41.83 b	55.12 b	72.00 b	145.30 a
Lemongrass oil 0.25%	38.73 a	49.53 b	53.76 b	98.80cd	26.50 d	43.46 c	53.82 e	115.19 c
Lemongrass oil 0.50 %	38.11 ab	54.30 a	63.48 a	112.71 b	38.15 b	56.70 b	72.03 b	139.35 a
Thyme oil 0.25%	33.24 c	40.25 cd	41.08 d	75.61 e	46.26 a	60.78 a	80.22 a	--
Thyme oil 0.50%	36.65 ab	42.56 c	54.08 b	104.73 c	31.20 c	46.35 c	64.25 c	128.60 b
<b>2019 Season</b>								
Control	30.56 b	41.73 d	57.57 d	84.53 e	46.66 a	66.54 b	76.60 a	--
Lavender oil 0.25%	35.35 a	46.25 c	69.55 b	105.94 c	40.00 b	48.17 de	49.44 e	120.81 d
Lavender oil 0.50 %	37.22 a	59.20 a	78.72 a	135.19 a	46.10 a	57.22 c	70.07 b	156.81 a
Lemongrass oil 0.25%	36.30 a	51.43 b	70.18 b	111.00 bc	40.23 b	46.71 e	46.01 e	113.78 d
Lemongrass oil 0.50 %	34.98 a	61.10 a	76.71 a	131.57 a	45.11 a	51.19 d	60.56 d	148.56 b
Thyme oil 0.25%	31.27 b	38.00 e	52.48 e	92.12 d	44.62 a	71.64 a	64.86 c	--
Thyme oil 0.50%	31.95 b	52.50 b	62.34 c	115.28 b	41.57 b	49.96 d	66.64 bc	135.60 c

Initial sample for total flavones recorded 72.88 and 78.19 (mg CO<sub>2</sub> /kg /hr.) for 2018 and 2019 seasons  
Values followed by the same letter (s) are not significantly different at 5% level

### 4. Volatile oil %

A great effect of both supplementary refrigeration treatments in the present study, i.e. volatile oils treatments and cold storage conditions on volatile oil % of mentha fresh cut herb was illustrated in **Table (11)**.

Hence, volatile oil % in mentha fresh cut herb ranged from 0.26-0.27% F.wt. regardless of the

used treatments or storage conditions. However, after 15 days of cold storage at 5°C or 7°C, the highest value of volatile oil % (0.20%) were recorded by 0.50% of lavender oil treatment. In addition, during marketing durations for 5 days at 20°C after finished from cold storage process at 5° or 7°C, the great affect to 0.50% lavender oil treatment was also obtained. Volatile oil of mentha has used in many purpose like perfume industry, insecticidal treatments

and as a cumulative (Ghorbani and Esmailzadeh, 2017). Finally, it could be concluded that fresh cut herb and perishable commodities must handle and marketing under cold conditions (20°C) to reduce the loss of active ingredient and increase of shelf-life.

In this regard, Wang 2003 reported that treating raspberries with natural volatile compounds increased fruit acidity during cold storage. However, application of lemongrass aromatic oil significantly preserved potato quality i.e. minimize sprouting percentage, sprout number, length of sprout and weight

loss during cold storage (Kushal et al 2020). Similar trends of results on the great effect of aromatic oils on postharvest quality as a supplementary refrigeration treatments were also found with peppermint oil on orange fruits (Fatemi et al 2011) and plum fruits (Aminifard and Mohammadi, 2013), rosemary oil on many commodities (Almela et al 2006), oils of lavender, dill and coriander (Serban et al 2011). The role of essential oils as antibiotic activity, allelopathy, attractants, feed in deterrents and phytoalexin was reported by Mahanta et al 2007.

**Table 11.** Effect of some aromatic oils treatments on volatile oil herb % of mentha fresh cut herb stored at 5° and 7 °C ± 1 and 95%RH, followed by 5 days at 20± 2°C, during 2018 and 2019 seasons

Treatments	Storage temperatures							
	(5 ± 1°C)			5 days at (20 ± 1°C)	(7 ± 1°C)			5 days at (20 ± 1°C)
	Storage durations (days)				Storage durations (days)			
5	10	15	5	10	15			
<b>2018 season</b>								
Control	0.20 d	0.19 c	0.12 d	0.10 d	0.19 d	0.16 c	--	--
Lavender oil 0.25%	0.24 c	0.20 bc	0.17 bc	0.12 cd	0.25 ab	0.23 a	0.20 a	0.10 d
Lavender oil 0.50 %	0.30 a	0.24 a	0.20 a	0.15 a	0.26 a	0.24 a	0.20 a	0.17 a
Lemongrass oil 0.25%	0.20 d	0.18 c	0.11 d	0.11 cd	0.23 bc	0.19 b	0.17 b	0.13 c
Lemongrass oil 0.50 %	0.27 b	0.24 a	0.19 ab	0.13 bc	0.26 a	0.23 a	0.19 ab	0.16 ab
Thyme oil 0.25%	0.24 c	0.23 a	0.16 c	0.12 cd	0.21 cd	0.18 bc	0.13 d	--
Thyme oil 0.50%	0.25 bc	0.22 ab	0.15 c	0.13 bc	0.20 d	0.18 bc	0.16 c	0.14 bc
<b>2019 Season</b>								
Control	0.24 c	0.19 d	0.15 d	0.10 c	0.22 cd	0.17 c	0.15 b	--
Lavender oil 0.25%	0.28 b	0.25 c	0.20 c	0.17 b	0.24 bc	0.15 c	0.12 c	0.9 d
Lavender oil 0.50 %	0.34 a	0.31 a	0.30 a	0.21 a	0.27 a	0.24 a	0.18 a	0.16 a
Lemongrass oil 0.25%	0.30 b	0.27 bc	0.25 b	0.15 b	0.22 cd	0.20 b	0.14 bc	0.11 cd
Lemongrass oil 0.50 %	0.31 b	0.29 b	0.23 b	0.15 b	0.26 ab	0.22 ab	0.16 ab	0.14 ab
Thyme oil 0.25%	0.28 b	0.25 c	0.17 d	0.10 c	0.21 d	0.15 c	0.12 c	--
Thyme oil 0.50%	0.27 c	0.21 d	0.16 d	0.15 b	0.24 bc	0.20 b	0.16ab	0.13 bc

Initial sample for recorded 0.31 and 0.36 % for 2018 and 2019 seasons  
Values followed by the same letter (s) are not significantly different at 5%

### RECOMMENDATION

From the obtained data it could be successfully storage of (*Mentha piperita* L.) fresh cut herb at 5°C for 15 days followed by 5 days at 20°C as imitation to marketing condition and the effect was more pronounced by treating the herb with lavender, lemongrass and thyme oils all at 0.50 % before cold storage.

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## تأثير المعاملات ببعض الزيوت العطرية على جودة الحفظ للعشب الطازج لنبات النعناع تحت ظروف التخزين المبرد

[36]

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### الموجز

اشتملت على الكلوروفيل الكلي - حمض الاسكوربيك - الفينولات الكلية والتي تحسنت كثيراً بالتخزين على 5° م عن التخزين على 7° م. كذلك سجلت أعلى القيم من الصفات الكيماوية المذكورة مع الزيوت العطرية الثلاثة بالتركيز 50%. واستمر التأثير الايجابي أثناء فترة التسويق على 20° م لمدة 5 أيام. وعلي العكس تناقص محتوى العشب من الحموضة الكلية مع المعاملات المختلفة مقارنة بالكنترول (ما عدا معاملة زيت الزعتر بتركيز 25%). خلال فترة التخزين المبرد التسويق. بالنسبة لصفة التسرب الالكتروليتي ومعدل التنفس فقد سجلت أقل القيم مع المعاملات المختلفة مقارنة بالكنترول و ذلك خلال فترة التخزين المبرد على (5° م و 7° م) والتسويق (20° م). ويعتبر تناقص قيم التسرب الالكتروليتي والتنفس نتيجة المعاملات المختلفة او التخزين المبرد مؤشر جيد لنجاح التخزين المبرد والحفاظ على الجودة. تأثر محتوى الزيت الطيار لعشب النعناع مع كلا من التبريد والمعاملات المختلفة المكملة للتبريد بالزيوت العطرية (اللافندر - حشيشة الليمون - الزعتر). ويمكن التوصل الي انه يمكن تخزين العشب الطازج المقطوف للنعناع جيداً على 5° م لمدة 15 يوم بعد المعاملة بالزيوت العطرية (اللافندر - حشيشة الليمون - الزعتر) ثم التسويق لمدة 5 أيام على 20° م مع جودة عالية للعشب.

**الكلمات المفتاحية:** النعناع، العشب الطازج المقطوف، الزيوت العطرية، اللافندر، حشيشة الليمون، الزعتر، التخزين المبرد، المعاملات الاضافية للتبريد، معدل التنفس.

زاد محتوى عناصر النيتروجين - الفوسفور - البوتاسيوم - الماغنسيوم في نباتات حشيشة الليمون التي رويت بالماء الممغنط مقارنة بالماء المالح وكانت المعاملة 100 جزء في المليون من النانو زنك هي الاعلى قيماً في عناصر النيتروجين والفوسفور والبوتاسيوم بينما معاملي الماغنسيوم 100، 200 جزء في المليون كانت متفوقة في تسجيل أعلى القيم من عنصر الماغنسيوم خلال موسمي الدراسة. درس تأثير زيوت اللافندر، حشيشة الليمون، الزعتر كمعاملات اضافية للتبريد على حفظ جودة العشب الطازج المقطوف للنعناع خلال التخزين المبرد لمدة 15 يوم على 5° م او 7° م متبوعة ب 5 أيام على 20° م كحاكاة لفترة التسويق المثالي للعشب الطازج خلال موسمي 2018 ، 2019. سجل تأثير ذلك على الصفات الطبيعية - المكونات الكيماوية - معدل التنفس - نسبة الزيت الطيار حيث أوضحت النتائج المتحصل عليها ان نسبة العشب الطازج التالف - الفقد في الوزن - المظهر الخارجي قد تأثرت كثيراً بالمعاملات المختلفة وكان التأثير عند التخزين على 5° م أكثر فعالية عن التخزين على 7° م واستمر التأثير ايضاً مع التسويق لمدة 5 أيام على 20° م. انخفض كثيراً نسبة الفقد في الوزن ونسبة التالف مع المعاملات المختلفة وتحسن المظهر الخارجي للعشب كثيراً عن عشب المقارنة مع المعاملات المختلفة أثناء التخزين المبرد على 5° م و 7° م ثم فترة التسويق 5 أيام على 20° م. استخدام الزيت العطري بتركيز 50. % من اللافندر، حشيشة الليمون، الزعتر كان أكثر فعالية عن التركيز 25. % من الزيوت الثلاثة. المكونات الكيماوية

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