

Evaluation of Spearmint (*Mentha Spicata* L.) Productivity Grown in Different Locations under Upper Egypt Conditions.

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Abstract: The productivity of *Mentha spicata* of fresh, dry herb and its volatile oil were determined in four locations in upper Egypt (Beni-Suef, Sohag, Qena and Aswan Governorates). The productivity of fresh herb at Beni-Suef was the highest (6.35 kg/m²) followed by Sohag, Qena and Aswan (4.98, 4.71, 4.35 kg/m², respectively), this was equal to 26.67, 20.93, 19.79 and 18.25 ton/fed. (4200m²) for the four locations, respectively. The dry herb weight was 0.65, 0.51, 0.49 and 0.45 kg/m² equal to 2.75, 2.16, 2.08 and 1.89 ton/fed. The oil percentage in the dry herb was that determined to show the least in Beni-Suef (1.67%) and the highest value (2.68%) in Aswan where the same values in Sohag and Qena were 2.51 & 2.47%. The highest content of carvon was obtained from Qena and Aswan (53.09&53.32%) and the least from Beni-Suef (46.45%). On the other side, the highest content of limonene was obtained from Beni-Suef (30.87%) and the least from Qena (22.7%) while Sohag and Aswan came in between (28.25&27.84%). Menthon and pulegon contents were less in Beni-Suef than other locations.

Key words: Spearmint · Essential oil · Chemical composition · location

INTRODUCTION

Mint is the common name of approximately 25 perennial species of the genus *Mentha* belonging to the Lamiaceae family. Mints are used either in the herb form or in the essential oil from for flavoring, perfume production, and medicinal purposes. The global mint market exceeds billions of dollars. In the US alone, import Mint leaf, 3000 ton and 798.2 ton essential oil. Spearmint the farm-gate price of the commercialized mint reached 16 million U.S. Dollars in 2005, which is converted to in finished products^[1].

Mint is one of the most important herbs traditionally produced in Egypt. The area cultivated with mint in 2007 exceeded 3000 feddan (4200 m²) and produced about 6000 tons of mint herb. Mint exports in year 2008 were about 5000 tons, equal to 10 million\$. The Egyptian mint has a good reputation in the USA, Australia, and Europe which are the major markets.^[2, 3] Mint is preferred for flavoring tea and for culinary purposes. This work was conducted aiming to evaluate the productivity of *Mentha spicata* L. in four locations in Egypt; the four locations were Beni-Suef, Sohag, Qena and Aswan Governorates.

MATERIALS AND METHODS

This work was carried out during two successive seasons 2005/2006 and 2006/2007 at Beni-Suef Governorate (Mazora- Semsta center), Sohag

Governorate (West Tahta Project Tahta center), Qena Governorate (West El-Waqf Project - El-Waqf center) and Aswan Governorate (Wady EL-Nokra - Kom-ombo center), to investigate the effect of location on yield and oil production of Spearmint (*Mentha spicata* L.) and oil constituents.

The experiment was arranged in a complete randomized block design (four location) with 4 replicates. The transplants of Spearmint were sown on 15th February/2005 in experimental units; each was 2.5×3 meter.

Location:

- 1- Beni-Suef Governorate (Mazora -Semsta center).
- 2- Sohag Governorate (West Tahta Project Tahta center).
- 3- Qena Governorate (West El-Waqf Project - El-Waqf center).
- 4- Aswan Governorate (Wady EL-Nokra kom-ombo center).

The fertilization included the following:

- Nitrogen: at the rates of 900 kg / fed. Ammonium nitrate (33 % N)
- Phosphorus at the rate of 300 kg /fed. Calcium super phosphate (16 % P₂O₅).
- Potassium at the rate of 50 kg per feddan potassium sulfate (48 % K₂O).

Fertilization with calcium super phosphate and poultry manure at 20 m³/fed. was conducted

immediately before planting in each season in only one dose. As for nitrogen and potassium fertilizers were applied in five equal doses in both seasons. The plants were harvested every 30-40 days

Data Recorded as Follows:

A-Vegetative Growth Characters: Fresh and dry weight of herb kg / m².

B- Essential Oil: Essential oil percentages. Oil yield per m² and per feddan Liter / m² Oil percentages of dried herb were conducted according to British Pharmacopoeia [4].

GC-MS Analysis: GC-MS analysis was conducted on a Hewlett-Packard 5985 coupled with a HP MS instrument system according to [5, 6].

Soil Analysis: At the beginning of the experimental season. Samples were collected from the soil surface layer (30 cm) for determine the physical and chemical soil characters; soil pH and available soil mineral (N, P, K, Na, Ca, Mg and SO₄⁻) as described by Cottenie *et al* [7] and the results are presented in Table (A)

3-Statistical Analysis: The complete randomized block design was used in the experiments (4 treatments) with 3 replicates. The statistical analysis was carried out according to [8]. L.S.D.test was used to compare the means.

4- Meteorological Data: the meteorological data of the different locations as average year of 2005, 2006 and 2007 were obtained from the Central Laboratory for Agriculture Climate, Ministry of Agriculture, and Cairo. The collected data are summarized and presented as a mean of the two seasons in

RESULTS AND DISCUSSION

1- Fresh and Dry Yield Herbs: Data in Table (1) show that Beni-Suef location resulted in the highest weight of fresh herb per square meter with average 6.35 kg/m², followed descendly by Sohag (4.98kg/m²), Qena (4.71kg/m²) and Aswan (4.35kg/m²) locations. The differences between the three later locations and Beni-Suef were significant, where the differences between the three later locations appeared only between Sohag and Aswan locations resulted in the least value.

As for the yield of fresh herb per feddan, Beni-Suef location resulted in the highest value with average of 26.67 ton/fed. Where Aswan locations resulted in the least value with average of 18.25 ton/fed. while Sohag and Qena resulted in 20.93 and 19.79 ton/fed., respectively.

The yield of dry herb per square meter or per feddan followed the same trend of fresh weight (Table, 2).

2- Oil Percentage and Oil Yield in the Dry Herb:

Data in Table (3) show that the highest oil percentage in the dry herb was obtained from Aswan location with average 2.68%.

Sohag and Qena locations followed Aswan location descendengly and were significantly less than Aswan and higher than Beni-Suef.

Oil yield in Table (4) show that, Sohag location produced the highest oil yield with average 54.21 Liter/fed. (0.0125 Liter/square meter) followed descendly by Qena (51.58 L. /fed, 0.012L./m²), Aswan (50.54 L. /fed., 0.0115 L. /m²) while the least yield was from Beni-Suef location (45.01 L. /fed., 0.0105L./m²).

3-Oil Constituents: Data in Table (5) show the constituents of oil as affected by cultivated of mint in different locations. The major constituents were found to be carvon followed by limonene. The carvone content in the essential oil of *Mentha spicata* cultivated in different locations ranged between 46.45and 53.32%, while the limonene content ranged between 22.7and 30.87%. Oil of spearmint available in the market is characterized by higher carvone content as the main constituent (73.18%), but lower limonene content (5.00%). 1,8-Cineole was almost comparable in the analyzed oils; its content ranged between 3.71and 6.78% in spearmint cultivated in different locations,. Almost all the other oil constituents were detected in all types of spearmint with variable proportions [9].

The highest percentage of carvon was obtained from Qena and Aswan locations (53.09&53.22) while in Sohag was (51.15%) and the least was belong to Beni-Suef (46.45%).

On the other side, the highest content of limonene belong to (30.87%) and the least belong to Qena (22.7%), while Sohag and Aswan came in between (28.25&27.84%). menthol and pulegone contents were less in Beni-Suef than the other locations.

The metabolism of monoterpenes of *Mentha* plants is strongly influenced by environmental factors, especially day length and photon flux density [10]. Burbott and Loomis [11] indicated that temperature is the main interacting factor influencing the essential oil composition. This is based on the fact that warm nights cause depletion of respiratory substrates, resulting in oxidizing conditions, while cool nights preserve high levels of respiratory substrates and thus maintaining reducing conditions. Cultivation of spearmint under

Table A: The physical and chemical analysis of the soil of at the experimental sites.

| Locations | E.CDs/m | pH | Chemical soil properties | | | | | | | |
|---------------------------------|---------|-----|---|------------------|-----------------|----------------|-------------------------------|-------------------------------|-----------------|-------------------------------|
| | | | Soluble cations and anions ml. Equiv./l | | | | | | | |
| | | | Ca ⁺⁺ | Mg ⁺⁺ | Na ⁺ | K ⁺ | CO ₃ ⁻⁻ | HCO ₃ ⁻ | Cl ⁻ | SO ₄ ⁻⁻ |
| Beni-Suef | 0.65 | 8.1 | 8.23 | 4.27 | 0.9 | 6.3 | -- | 99.1 | 0.93 | 0.47 |
| Sohag | 0.51 | 8.7 | 12.1 | 5.41 | 1.6 | 8.1 | --- | 133.4 | 1.34 | 0.89 |
| Qena | 1.35 | 9.1 | 32.4 | 0.54 | 2.6 | 0.2 | --- | 141.1 | 1.73 | 1.97 |
| Aswan | 1 | 7.5 | 9.6 | 4.59 | 0.9 | 5.7 | --- | 100.1 | 1.14 | 1.19 |
| Soil Texture and its fractions. | | | | | | | | | | |
| Locations | Sand % | | Clay % | | Silt % | | Texture Class | | | |
| Beni-Suef | 66 | | 22 | | 12 | | Sandy-clay | | | |
| Sohag | 70 | | 19 | | 10 | | Sandy | | | |
| Qena | 85 | | 5 | | 10 | | Sandy | | | |
| Aswan | 53 | | 33 | | 14 | | Sandy-clay | | | |

Table B: The meteorological data of four locations during Average years 2005, 2006 and 2007

| | Average Wind speed Km/h | Average Air temp.(C ⁵) | Average HumidityRH% | Average Solar radiation (MJ/m2/day) |
|-----------------------|-------------------------|------------------------------------|---------------------|-------------------------------------|
| Beni-Suef Governorate | | | | |
| 2005 | 22.12 | 21.33 | 51.67 | 23.66 |
| 2006 | 23.22 | 20.4 | 52 | 23.6 |
| 2007 | 21.5 | 21.85 | 52.5 | 23.6 |
| Sohag Governorate | | | | |
| 2005 | 13.3 | 22.42 | 43.2 | 24.2 |
| 2006 | 11.66 | 23.1 | 42.5 | 24 |
| 2007 | 12.2 | 23.85 | 40.11 | 24 |
| Qena Governorate | | | | |
| 2005 | 7.2 | 23.5 | 40.3 | 24 |
| 2006 | 6.58 | 24.24 | 40.66 | 24 |
| 2007 | 6.25 | 25.1 | 41.2 | 24 |
| Aswan Governorate | | | | |
| 2005 | 5.7 | 27.5 | 37.6 | 27 |
| 2006 | 6.2 | 26.67 | 38.25 | 27 |
| 2007 | 5.1 | 28.3 | 38.1 | 27.2 |

Table 1: The fresh herb yield (kg / m² and ton/fedd.) of *Mentha spicata* in different locations in the two seasons of 2005 and 2007 herb fresh weight kg / m²

| | Beni-Suef | Sohag | Qena | Aswan | L.S.D.5% |
|----------------------------|-----------|-------|-------|-------|----------|
| 1st Season | 6.29 | 4.96 | 4.73 | 4.33 | 0.54 |
| 2nd Season | 6.41 | 5 | 4.69 | 4.36 | 0.36 |
| Mean | 6.35 | 4.98 | 4.71 | 4.35 | |
| herb fresh weight ton/fedd | | | | | |
| | Beni-Suef | Sohag | Qena | Aswan | |
| 1st Season | 26.42 | 20.86 | 19.87 | 18.19 | |
| 2nd Season | 26.92 | 21 | 19.7 | 18.31 | |
| Mean | 26.67 | 20.93 | 19.79 | 18.25 | |

Table 2: The dry herb yield (kg / m² and ton/fedd.) of *Mentha spicata* in different locations in the two seasons of 2005 and 2007
herb dry weight kg / m²

| | Beni-Suef | Sohag | Qena | Aswan | L.S.D.5% |
|---------------------------|-----------|-------|-------|-------|----------|
| 1st Season | 0.66 | 0.52 | 0.49 | 0.46 | 0.043 |
| 2nd Season | 0.65 | 0.51 | 0.5 | 0.44 | 0.051 |
| Mean | 0.655 | 0.515 | 0.495 | 0.45 | |
| Herb dry weight ton/fedd. | | | | | |
| | Beni-Suef | Sohag | Qena | Aswan | |
| 1st Season | 2.77 | 2.18 | 2.06 | 1.93 | |
| 2nd Season | 2.73 | 2.14 | 2.1 | 1.85 | |
| Mean | 2.75 | 2.16 | 2.08 | 1.89 | |

Table 3: Oil content (%) in air dried herb of *Mentha spicata* in cultivated different locations in the two seasons of 2005 and 2007
Oil content (%)

| | Beni-Suef | Sohag | Qena | Aswan | L.S.D. 5% |
|------------|-----------|-------|-------|-------|-----------|
| 1st Season | 1.68 | 2.52 | 2.48 | 2.66 | 0.1 |
| 2nd Season | 1.65 | 2.5 | 2.47 | 2.69 | 0.09 |
| Mean | 1.67 | 2.51 | 2.475 | 2.68 | |

Table 4: Oil yield (l/m² and l / fedd.) of mint cultivated in different locations in the two seasons of 2005 and 2007
Liter / m²

| | Beni-Suef | Sohag | Qena | Aswan |
|--------------|-----------|--------|-------|--------|
| 1st Season | 0.011 | 0.013 | 0.012 | 0.012 |
| 2nd Season | 0.01 | 0.012 | 0.012 | 0.011 |
| Mean | 0.0105 | 0.0125 | 0.012 | 0.0115 |
| Liter /fedd. | | | | |
| | Beni-Suef | Sohag | Qena | Aswan |
| 1st Season | 46.53 | 54.93 | 51.08 | 51.33 |
| 2nd Season | 45.04 | 53.5 | 52.08 | 49.76 |
| Mean | 45.07 | 54.21 | 51.58 | 50.54 |

Table 5: The constituents of *Mentha spicata* Oil as affected by culture in different locations.

| Component | Peak are Average a (%) | | | |
|------------------|------------------------|-------|-------|-------|
| | Beni-Suef | Sohag | Qena | Aswan |
| a-Pinene | 0.88 | 0.95 | 0.97 | 0.96 |
| Sabinen | 0.62 | 0.67 | 0.62 | 0.62 |
| b-Pinene | 1.22 | 1.24 | 1.21 | 1.2 |
| Myrcene | 0.61 | 0.81 | 0.82 | 0.88 |
| Menthon | 3.41 | 4.22 | 4.41 | 4.5 |
| Limonene | 30.87 | 28.25 | 22.7 | 27.84 |
| 1,8-Cineolea | 6.1 | 3.71 | 6.78 | 3.88 |
| Menthol | 0.61 | 1.22 | 1.11 | 1.19 |
| Polygon | 0.95 | 1.3 | 1.12 | 1.5 |
| Carvon | 46.45 | 51.15 | 53.09 | 53.32 |
| cis-Carvylacetat | 1.84 | 1.66 | 1.82 | 2.23 |
| unidentified | 6.44 | 4.82 | 5.35 | 1.88 |

other different geographical and weather conditions slightly affected it's the yield of dry herb, oil percentage and constituents of oil^[9,12,13].

Conclusion:

- The best location which gave the highest value of fresh an dry weight was Beni-Suef location.
- For oil content the data indicated that the highest value of oil content was recorded in Sohage and Aswan locations which could concluded that there will a promising areas for mint production.
- For Oil constituents the data concluded that the environmental conditions of Aswan, Qena and Sohage was effective to gave high percentage in Carvon as a mean components in spearmint which led to increase the exportations of Spearmint from these Governorates.

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