Agricultural Research & Technology
Open Access Journal
ISSN: 2471-6774

Juniper Publishers
key to the Researchers

Research Article
Volume 2 Issue 4 – September 2016
DOI: 10.19080/ARTOAJ.2016.02.555594

Agri Res & Tech: Open Access J


# Evaporation of Spearmint (*Mentha spicata* var. viridis L.) Herb Oil during One Year of Storage under Semi-Arid Condition

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**Submission:** October 06, 2016; **Published:** October 24, 2016

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**Abstract**

The experiment investigated evaporation of essential oil of stored spearmint herb under ambient temperature during one year of storage, in Sudan semi-arid conditions to study oil content per year months, seasons and evaporation rate. Spearmint herb samples were dried under shade for seven days and kept in polyethylene bags and stored at ambient room temperature. Spearmint oil was extracted by water distillation using the technique of British Pharmacopoeia; the oil determined initially after seven days of drying before storage and then every month for 12 months. Losses of oils under Sudan semi-arid seasons recorded and the rate of evaporation calculated with respect to changes per month. The results showed that the essential oil content progressively decreased during storage of spearmint herbs from 1.3 ml/100g initially and end by 0.1 ml/100 g after 12 months of storage. The oil content rate show a decreased by 0.1 ml/100 g every month during the first five months (January-May) of winter season; then decreased by 0.2 ml/100 g per month during hot summer (May-June); and negligible decease during rainy autumn season (July-August), after which the oil decreased by 0.1 at late hot dry summer (September – October) and the experiment end by a decreased of 0.05 ml/100g every month during the last storage period at beginning of winter (November -December).

**Keywords:** Spearmint; Storage; Evaporation rate; Essential oil

## Introduction

Spearmint (Mentha spicata) is considered as one of the most important and valuable source of essential oils. The highest growth and yield can be obtained from 20 cm spacing [1]. Early morning harvest yielded high oil content [2], from fresh leaves to yield good oil physic-chemicals [3]. And 40°C air-forced oven drying temperature is the best for high oil Carvone content [4]. The fresh and dried leaves are used as spice, flavoring agent and in folk medicine [5,6]. The oil is used in pharmaceutical, antiseptic, perfumery and food industries [5,7,8]. The major commercial form of spearmint is still the shelf-stable dried product, since it can be transported easily and stored well under proper conditions [9], Oil extracted during the first months of storage contain high Carvone content [10]. It can result in loss of essential oils, changes in color and texture and decrease in nutritive value [11,12]. Storage leads to gradual evaporation of essential oil from stored herbs, the major source of loss being due to oxidation and resinification of the essential oils [13] which can be recovered by not more than two redistillation process [14]. Therefore, investigating the effect of storage on oil content and composition under Sudan conditions is recommended. The objectives of this study were to evaluate the effect of storage period of spearmint herb on oil content per month during a year, oil content reduction during different seasons and evaporation rate of essential oil from stored herb.

## Materials and Methods

### Experimental site, soil and land preparation

Field experiment was conducted at 'Halfaya' area and storage at Shambat, Khartoum North, Sudan (15° 40/ N, 32° 22/E). The

climate was a semi – arid, tropical, with seasonal annual rainfall of 120 mm during the period mainly between July to September. The mean maximum and minimum temperatures are as high as 47.5 °C during summer (March – June) and as low as 7.5 °C during winter (Nov – Feb) [15]. The soil was an alluvial type with high content of silt; slightly alkaline. Land preparation and cultural practices were carried out as recommended. The land was divided into 48 plots of 4.5 X 6 mm each and 30 x 30 cm spacing. At harvested the whole plot was covered with spearmint aerial herb (stem and leaves) due to spread of underground runners, which gives good aerial shots at rhizome's nodes.

### Experimental material and husbandry

Spearmint (Mentha spicata var. Viridis) plants were raised from underground runners (rhizome-like rootstock). They were obtained from fully mature plants grown in spearmint growing area at 'Halfaya', Khartoum North, Sudan. The underground and surface runners were transplanted into new well prepared beds. Pre-transplanting irrigation was applied followed by the first irrigation immediately after transplanting. Irrigation was carried out every 7 during the experiment period.

### Experimental design

The samples were arranged in a completely randomized design of 12 treatments and four replicates. The treatments were namely: M0, M1, M2, M3, M4, M5 M6 M7 M8 M9 M10 M11 and M12; (where M: mean month, M0 at the beginnings, M1 for the end of January harvest till M12 that mean the end of December).

### Harvesting and impurity removals

About two kilograms of herb; during each harvest from well established 60 days plants; were harvested. The aerial parts of the plants (main aerial stem, branches and leaves) were cut about 5 cm above the ground level. Foreign materials and weeds were removed immediately from the harvested material.

### Herb preparation

The aerial parts of cut plants (main aerial stem, branches and leaves) were kept for further investigations. The herb was subjected to open shade air drying for seven days. Foreign materials and weeds were removed immediately from the harvested materials. The dried herb samples were kept in polyethylene bags and stored at ambient room temperature at Shambat area, Khartoum North, Sudan. Samples were taken every month for oil determination.

### Oil Extraction and determination

Essential oil of spearmint was extracted by water distillation using Clevenger apparatus and determined according to British Pharmacopoeia technique [16]. Oil content calculated on dry weight basis.

### Statistical analysis

Analyses of variance, followed by Duncan multiple range test with significance level $p \leq 0.05$ were performed on the data [17] using computer statistical method for data analysis.

## Results and Discussion

### Oil content in spearmint herb during one year of storage

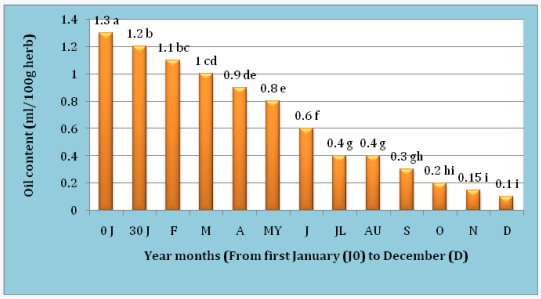
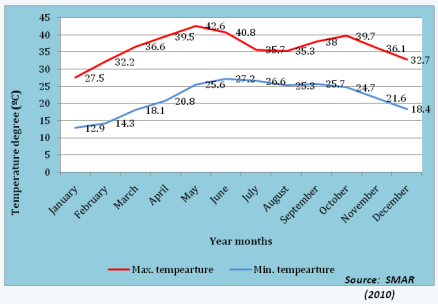



**Figure 1:** Oil content in spearmint herb during one year of storage.

Spearmint oil content was 1.3 ml/100g dry weight before storage (Figure 1); this agrees with reports that mentioned mint oil content is in the range of 0.75 - 2.00 ml/100g dry weight [18,19]. Oil content progressively decreased during storage of spearmint herbs at ambient conditions from 1.3 ml/100g initially, oil content decreased with successive significant decrease and end by 0.1 ml/100 g after 12 months of storage. Because drying decreases oil content on dry weight basis significantly in contrast to the highest oil in the fresh harvested herb [3]. Also agree with Ram et al. who reported that drying and storage of herbage of rose – scented geranium (Pelargonium sp.) for five days prior to distillation significantly reduced the essential oil recovery as well as oil quality [20].

The decrease in oil content during storage of plant material at ambient conditions was also well demonstrated in medicinal plants such as; mint [21], caraway (Carum carvi L.) [22], French tarragon (Artemisia dracunculus L.) leaves [23], black, green and white pepper (Piper nigrum L.) [24], lavender flower (Lavandula intermedia) and funnel fruits (Foeniculi fructus) [25].

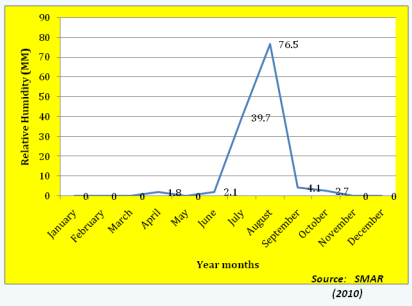
### Seasonal effect on evaporation of stored spearmint herb oil




**Appendix 1:** Maximum and min. temperature during a year (Shambat, Sudan).


**How to cite this article:** El Rasheed A S, Abu-Bakr A A-G, Hassan El-S K, Gaffar M El H. Evaporation of Spearmint (Mentha spicata var. viridis L.) Herb Oil during One Year of Storage under Semi-Arid Condition. Agri Res & Tech: Open Access J. 2016; 2(4): 555594. DOI: 10.19080/ARTOAJ.2016.02.555594


**Appendix 2:** Evaporation at shambat area, Sudan during a year.




**Appendix 3:** Rain fall during a year (Shambat area, Sudan).

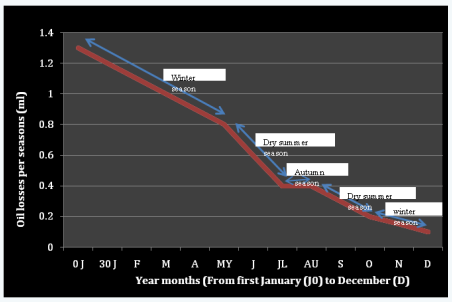



**Figure 2:** Seasonal effect on stored spearmint herb oil.

Seasonal effect of Sudan semi-arid climate Appendix 1-3 condition on spearmint herb was illustrated in Figure 2, the result showed that slight decreasing in the curve of losing during winter from 1st January to May, then the curve drastically decreased during hot summer season for high losses of essential oil due to high evaporation during hot weather. At autumn the curve stays horizontal due to negligible decrease or stoppage of essential losses due to high humidity and low temperature of Sudan semi-arid zone; and lastly slightly the curve decreased with decrease of humidity and increase of temperature after the rainy seasons; this period represent the send hot summer season in Sudan after the rainy one. At the last there is very slow decrease due to winter season. This gives an overall conclusion that the spearmint herb essential oil content was decreased by storage period under ambient room temperature except autumn season. These result due to that after drying; the essential oil stay in the oil secretary organ; oil glands; and evaporate without any replacement; since during the plant life there is compensation between the evaporated oil through stomata and the oil obtained by the biosynthesis process in the living cells. After the death of the living cells of spearmint herb the plant lost stomata and oil glands flexibility, and the oil content subjected to microclimate conditions; therefore oil losses is a factor that positively increase in temperature and negatively with decreasing of humidity in the surroundings, this finding agree with Salim who postulate that high temperature during the day results in reduction in essential oil content [2]. Lastly the climate condition; such as temperature, evaporation rate, humidity speed of wind and rainfall; of the area of study changed during the year in Appendix 1-3 are associated with the evaporation rates.

## Rate of essential oil evaporation during the year months

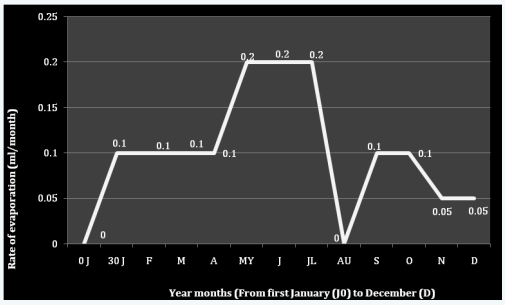



**Figure 3:** Rate of evaporation of essential per during 12 successive months.

The oil content of stored spearmint was decreased by 0.1 ml per 100g every month during the first five months (January – May) (Figure 3), and then it decreased by 0.2 ml per 100 g every month during the successive hot months (May-July), which characterized as a hot season in Sudan semiarid condition. The high rate of evaporation is due to high temperature during this period (Appendix 2) which leads to high rate of evaporation (Appendix 3). During autumn season (July- August), the decrease was stopped and oil content remained constant at 0.0 ml/100g; these decreases were due to that high rain during this period lead to saturation of the surrounding microclimates consequently increase humidity and temperature which resulted in oil evaporation; also during this period high cloud, rain (Appendix 3) and saturated air with humidity leads to reduce the temperature. The decreased after autumn is by 0.1 ml every month during the last storage period (September – December) (Figure 3); this is due to the slight increase of temperature. Essential oils possess high level of unsaturation and are unstable due to many factors, such as light, heat, oxidation and dehydration [26,27]. Choi and Sawamura reported that most essential oils are thermolabile or heat-sensitive and are subjected to oxidative changes in the presence of air and light, and during storage [28]. The degree of change is usually a function of both temperature and time. Other essential oil crops acts the same behavior; oil content declined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markedly during storage of black pepper in low density and high density polyethylene packages [29] and the major loss of essential oil in chamomile drug was reported to be due to high storage temperature [30].

## Conclusion

Oil content of spearmint herb progressively decreased during storage period at ambient conditions in Sudan semi-arid conditions and after 12 months of storage the essential oil will be near to zero percent. The highest decrease during hot summer season is due to high temperature, low rain and low humidity. Evaporation and stopped during autumn season are due to high rain fall, humidity and low temperature which they decreased the evaporation rate and then losses of stored herb essential oil.

## Acknowledgment

I wish to express my thanks to the staff in the Department of Horticulture (Faculty of Agriculture, U. of K., Sudan), Medicinal and Aromatic Plants Institute (NCR, Sudan), Institute of Food Research Industries at (IRCC, Sudan) and Mr. Mohammed Damona in Pharmaceutical Industries (IRCC) for their generous help in conducting extraction. My thanks are also due to IRCC for financing this research and contribution of everybody who directly or indirectly shared the help.

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