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THE INFLUENCE OF VARIOUS POSTHARVEST AND DRYING TECHNIQUES ON *Mentha spicata* L. HERB QUALITY

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ABSTRACT

The goal of this study is to investigate the effects of various drying methods, packaging types and storage durations on the percentage of essential oils and their major constituents as well as total microbial count on peppermint plants. The investigation was carried out from 2019 to 2021. The results showed that the highest essential oil percentage (2.40%) in zero time was recorded in shade drying followed by direct sun or oven drying methods (1.98 and 1.17, respectively). Moreover, the shade drying procedures recorded the highest essential oil percentage as 2.22, 2.06 and 1.71%, respectively after 4, 8 and 12 months**.** Also, herbs packed in paper bags had a greater essential oil percentage than other packing methods, with 2.31, 2.08, and 1.06%, respectively after 4, 8, and 12 months. Additionally, the highest essential oil content after a year of storage observed on shade dried and packed in paper bags. On the other side, the lowest average of total microbile account (TMC, million/g) was found in the mentha dry herb that was sun-dried and packed in kraft bags 3.20, 3.58, and 3.60 respectively, after 4,8 and 12 months in the first season and 3.30, 3.55, and 3.73 in the second season.The highest mentha oil contained levels of α-pinene, 1,8-cineole, and carvone were increased on shade drying and kraft packaging after one year storage. when, sun drying and two layers of aluminum packaging, of mentha plant recorded the highest levels of myrcene and limonene. Morover, The greatest quantities from of ɣ-terpineol and dihydrocarvone were obtained in herbs that were shade-dried and put in aluminum + metallic layers bags.

INTRODUCTION

The promotion of medicinal and aromatic plant production is considered a major goal in Egypt because these plants have significant economic value (**Kamaly and Sallam, 2018; Abdullah *et al*., 2023)**. Consequently, there is an increasing demand for them due to their multiple uses in various fields. This leads to higher prices, increased importance, and a prominent position in the Egyptian economy (**Kamaly and Sallam, 2018**). Despite the growing global interest in cultivating medicinal and aromatic plants for their high economic significance in various fields, including pharmaceuticals, cosmetics, and perfumes (**Lisboa *et al*., 2022)**. Egypt possesses many factors that aid in thriving of cultivation of the Medicinal and aromatic plants, leading to increased productivity (**Kamaly and Sallam, 2018)**.

Despite the prestigious status of Egyptian exports of medicinal and aromatic plants in global markets, where the demand is increasing, the actual production and exports do not reach the level commensurate with the production and export capabilities (**Kamaly and Sallam 2018)**. The fluctuation in production of these plants, the low productivity of some of them, and the decrease in the quality of production,

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whether related to cultivation or post-harvest processes, reflect the instability in their cultivation **(Huwishel *et al.*, 2017)**. The average percentage of land used for growing aromatic and medicinal plants was about 0.46 percent in 2015. The total area of mint cultivation nationwide reached around 4.72 thousand faddan in 2014 (**Kamaly and Sallam, 2018; Abdullah *et al.,* 2023**).

Mentha spicata can be grown in various regions across the world, including temperate climates with adequate rainfall or irrigation (**Djamila *et al.*, 2021)**. It is cultivated in the Mediterranean countries, and many others. *Mentha spicata* is a popular herb known for its aromatic leaves, sweet flavor, and versatile uses in cooking, beverages, and traditional medicine. *Mentha spicata* holds both cultural and economic significance in Egypt, being valued for its culinary uses, medicinal properties, and cultural traditions associated with its consumption. Leaf and flowering tops provide about 0.6% of the total yield. About 56% of the oil is made up of L-carvone, the main ingredient, but the dihydrocuminyl acetate, dihydrocuminyl valerate, and dihydrocarveyl acetate are what give the oil its distinctive spearmint overtones **(El-Gohary *et al.*, 2018 ; El Menyiy *et al.,* 2021)**.

The post-harvest handling of aromatic and medicinal plants plays a significant role in the production chain since it directly affects the quantity and quality of the active ingredients in the final product **(Huwishel *et al.*, 2017; Thamkaew *et al.,* 2020; Dgnd Gamage *et al.*, 2021)**. In the pre-procsessing of plants, drying has been one of the most crucial steps **(Lisboa *et al.,* 2018; Hazrati *et al.*, 2021; Lisboa *et al.*, 2022).**

Selecting appropriate drying methods and implementing them effectively during the preharvest stage of medicinal plants is crucial for maintaining their quality, potency, and shelf life (**Muller and Heindl, 2006; Hazrati *et al.,* 2021; Djamila *et al.*, 2021; Al-Hamdani *et al.,* 2022; Yue *et al.,* 2023)**. Proper drying helps preserve active constituents, prevent microbial growth, reduce enzymatic activity, prevent oxidation, control moisture content, and enhance the overall stability of medicinal plant materials **(Muller and Heindl, 2006; Thamkaew *et al.*, 2020; Djamila *et al.*, 2021; Al- Hamdani *et al.*, 2022; Amiri *et al.*, 2023)**.

Implementing appropriate packing methods during the preharvest stage of medicinal plants is crucial for protecting the plant material from physical damage, moisture absorption, light exposure, and contamination (**Lisboa *et al.*, 2022)**. Proper packing not only preserves the quality and integrity of the plant material but also extends its shelf life and facilitates organization and traceability (**Chaliha *et al.*, 2013; Ebadi *et al.*, 2017; Dgnd Gamage *et al.*, 2021, Lisboa *et al.*, 2022 ;Hamdane *et al.*, 2023)**.

The oil content of *Mentha spicata* can gradually decrease over time, especially if the plant material is not stored properly (**Djamila *et al.*, 2021**). Factors such as exposure to air, light, heat, and moisture can contribute to the degradation of essential oil. Implementing appropriate storage methods can help minimize oil loss and preserve the overall oil content of the plant material **(Djamila *et al.*, 2021)**.

The important goal of our research is to conduct studies on how mentha essential oil proportion and composition, as well as its total microbe counts are impacted by drying techniques, packaging, and storage times.

MATERIALS AND METHODS

This work was done over the course of during seasons in 2019–2020 and 2020–2021 at the Faculty of Environmental Agricultural Sciences, Arish University. The main goal of this investigation was to determine the influence of drying technique and packing pattern on microbial load, essential oil content, and percentage of active ingredients in the volatile oil of peppermint (*Mentha spicata* L.).

Plant Sources

A private farm in Manshyat Abo Meleah, Bani Sewif, was the source of the peppermint plant. Early in the morning plants were harvested by cutting it off 5 cm above the soil surface. Then 50 g of herb was placed in each packet.

Treatments for Drying

The following three drying techniques were investigated:

1- Shade drying involves placing the herb on craft paper under sun light for 24 hours then transferring it into the shade until it reached to constant weight

2- Oven drying: Placing the herb on stanless steal trays at 40 ºC for 48 hours until it reached to constant weight

3- Sun drying: The herb was placed on platforms with a wire roof under sun light until its weight was constant.

Treatments for Packaging

Mentha fresh herb samples were sorted into four different types of packages as follows:

1- Packaging in bag of aluminum + metallic layers (AM)

2- Packaging in kraft bags (KB).

3- Packaging in bag of two layers of aluminum (2LA).

4- Packaging in bag of three layers of aluminum (3LA).

The bags dimensions were 18×20×8cm. It was perforated, white in color and containing adhesive for closing g. While, the foam dish dimensions were 27×20×8 cm, for control treatments.

Plant was packaged as one sample (50 g herb) per each package, and then packages were well sealed according the above mentioned treatments. Control treatment was bare without any cover. Ten packages were represented as one replicate.

Storage Conditions

Four packaging type (aluminum + metallic layers, kraft bags, two layers of aluminum and three layers of aluminum) were used for each drying method. Samples of dried Mentha herb was packed and stored for twelve month in a standard storage room in the same farm, on room temperature (25±1), relative humidity was 25 to 40%.

Each treatment included ten replicates and each replicate was 50 g of Mentha dry herb. The stored samples of the dry herb in the different packages were studied for the tested characters in zero time and after 4, 8 and 12 months of storage period.

Data Recorded

Microbial Total Count (TMC) Using nutrient-rich agar media, it was evaluated in all samples using the technique outlined by **Freitas and Bauab (2012)**. The percentage of volatile oils were calculated for each sample. making use of a method outlined in the **British Pharmacopoeia (1963)**. Examination of GLC This method was performed to ascertain the chemical make-up of the Mentha essential oils used in each treatment at the National Research Center in Cairo's central herb lab for chemical analysis according to **Harris (2003)**.

Statistical Analysis

The experiment, which was created using a Complete Randomized Design, underwent statistical analyses of variance and mean comparison using **SAS (2004)**.

RESULTS AND DISCUSSION

Effect of Draying Types, Packing Methods and Storage Period and Their Interaction On

Total microbial count (TMC, million/g)

According to the results presented in Table 1, the draying types, packing types and storage periods had significantly (P< 0.05) affected on TMC in both seasons.

Results from Table 1 show a significant (P< 0.05) drop in TMC average for direct sun drying, followed by drying in an oven and then drying in shade (2.43, 3.35, and 3.22 million/g, respectively) in the first season and (2.65, 3.57 and 3.47 million/g, respectively) in the second season during the zero time.

In compared to other drying methods, the TMC average in mentha herb recorded the lowest values over a one-year storage period when dried utilizing a direct sun method. The TMC values after zero, 4, 8 and 12 month storge were 2.43, 3.81, 4.00, and 4.11 million/g in the first season and 2.65, 3.88, 3.92 and 3.91 million/g, respectively) in the second season (Table 1). Whereas, the greatest TMC recorded was 3.35, 4.10, 4.40, and 4.69 million/g in the first season and 3.57, 4.70, 4.54, and 4.43 million/g in the second season when herbs were dried using ovens.

Results in Table 1 observe a significant (P< 0.05) effects for packaging in both seasons. The materials that worked best for storing dry herbs for long periods of time with little contamination was kraft bag. So that, the lowest TMC values were recorded with kraft packing in both seasons compared with AM, 2LA and 3LA after 4.8 and 12 months storge which 3.72, 3.94 and 4.08 million/g in the first season and 3.30, 3.55 and 3.73 million/g. in the second seasons. Where the highest TMC values were recorded in herb packed in AM bags during the same storage periods which 4.34, 4.41 and 4.57 million/g in the first season and 4.97, 4.96 and 5.07 million/g in the second season.

Results in Table 1 clearly demonstrate that there was a significant (P< 0.05) decrease in TMC in dry mentha herb as a result of the interaction between the drying process and the package types. It was discovered that the sun drying method and storing the dried herb in kraft bags during the storage period in both seasons, produced the lowest average TMC in mentha dry herb. The values at 4, 8 and 12 months were 3.20, 3.58 and 3.60 in first season and 3.30, 3.55 and 3.73 in the second season. While the menthe herb dried using sun and packed in 2LA bags had the highest TMC which 4.14, 4.31, and 4.12 in the first season and 43.75, 4.15 and 73 in the second season. On the other site from our finding **Mehasen *et al.* (2009)** found that the lowest average of TMC in pepper mint dry herb was recorded in cases of solar drying and storing the dried herb in carton boxes or plastic cases during the storage period. However, direct sun and shade drying methods gave the highest TMC average. However, **Huwishel *et al.* (2017)** concluded that using the oven drying procedure and keeping the dried herb in carton boxes or plastic bags throughout the storage period resulted in the lowest average TMC in rosemary dry herb.

Essential oil Percentage

Results from Table 2 reveal significant (P< 0.05) variations in the proportion of volatile oils from zero time up to one year due to the effects of draying methods and packing types and their interaction in the second season.

Results showed that drying techniques had an significantly (P< 0.05) impact on the percentage of volatile oil of the mentha herb. The amount of volatile oil was significantly highest ($P< 0.05$) value when using shade draying methods (2.40%) followed with the direct sun drying method

Table 1. Effect of drying methods, storage packaging and storage period on TMC (million/g.) of *Mentha spicata* L.

Drying method (D)	Zero time	Storage period														
		4 month					8 month					one year				
		Packing (P)														
		AM	KB	2LA	3LA	mean	AM	KB	2LA	3LA	mean	AM	KB	2LA	3LA	mean
								1st Season								
Shade	3.22	4.29	3.86	4.25	3.79	4.05	4.42	3.92	4.33	4.02	4.17	4.58	4.02	4.57	4.22	4.35
Oven	3.35	3.46	4.09	4.64	4.21	4.10	4.09	4.32	4.60	4.54	4.40	4.80	4.62	4.58	4.76	4.69
Sun	2.43	4.08	3.20	4.14	3.82	3.81	4.18	3.58	4.31	3.94	4.00	4.12	3.60	4.57	4.16	4.11
mean	3.00	3.94	3.72	4.34	3.94	3.99	4.23	3.94	4.41	4.17	4.19	4.50	4.08	4.57	4.38	4.38
LSD 0.05 (D)	0.81			0.30					0.20					0.21		
LSD 0.05 (P)			0.30						0.23					0.30		
LSD 0.05 (DXP)			0.05						0.01					0.03		
								2nd Season								
Shade	3.47	5.00	3.51	4.83	4.87	4.55	5.03	3.84	5.20	4.83	4.73	5.07	4.00	5.37	4.77	4.80
Oven	3.57	5.37	3.36	5.40	4.67	4.70	4.70	3.59	5.53	4.34	4.54	4.11	3.77	4.10	4.10	4.43
Sun	2.65	4.07	3.94	4.67	3.75	3.88	4.33	3.22	4.15	3.98	3.92	3.90	3.43	5.73	4.23	3.91
mean	3.23	4.81	3.30	4.97	4.43	4.38	4.69	3.55	4.96	4.38	4.40	4.36	3.73	5.07	4.37	4.38
LSD 0.05 (D)	0.57			0.62					0.50					0.50		
LSD 0.05 (P)			0.47						0.43					0,50		
LSD 0.05 (DXP)				0.44					0.33					0.31		

AM= Packaging in bag of aluminum + metallic layers, KB= Packaging in kraft bags, 2LA =Packaging in bag of two layers of aluminum and 3LA Packaging in bag of three layers of aluminum.

Table 2. Effect of drying methods, storage packaging and their interactions on essential oil percentage of *Mentha spicata* L.

Drying method (D)	Zero time	Storage period														
		After 4 month					After 8 month					After one year				
		Packing (P)														
		AM	KB	2LA	3LA	mean	AM	KB	2LA	3LA	mean	AM	KB	2LA	3LA	mean
Shade	2,40	2.08	2.77	2.16	1.90	**2.22**	1.91	2.57	2.03	1.77	**2.06**	1.83	2.47	1.89	1.71	**1.97**
Oven	1.17	0.41	1.67	0.67	0.70	**0.86**	0.35	1.43	0.63	0.62	**1.68**	0.26	1.33	0.57	0.48	**0.66**
Sun	1.98	1.68	2.50	1.60	1.78	**1.87**	1.53	2.23	1.33	1.63	**0.76**	1.30	2.02	1.22	1.30	**1.46**
mean	1.85	**1.39**	**2.31**	**1.47**	**1.43**	**1.71**	**1.26**	**2.08**	**1.33**	**1.34**	**1.62**	**1.13**	**1.93**	**1.23**	**1.16**	**1.49**
LSD 0.05 (D)	**0.28**			**0.35**					**0.32**					**0.32**		
LSD 0.05 (P)				**0.60**					**0.58**					**0.57**		
LSD 0.05 (DXP)				**0.18**					**0.23**					**0.28**		

AM= Packaging in bag of aluminum + metallic layers, KB= Packaging in kraft bags, 2LA =Packaging in bag of two layers of aluminum and 3LA Packaging in bag of three layers of aluminum.

(1.98%) where the oven draying methods (1.03%) achieved the lowest one at the zero time. These results are in the same line with those obtained by, **El-Gohary *et al.* (2018)** who indicated that the highest essential oil was in the fresh menthe plant followed by the shade draying and the lowest essential oil percentage was in plant dried by oven. Also**, Salim *et al.* (2015)** indicated that the most oil percentage was in the sun-dried samples followed by oven-dried samples at 70ºC, oven-dried samples at 80ºC, and dried herbs (at room temperature) and oven-dried herbs at 60ºC. Moreover, **Huwishel *et al.* (2017)** achieved the highest volume of oil percentage in rosemary herb at the zero time when employing the shade draying techniques compared with the direct sun and oven methods. On the other side **Mehasen *et al.*, (2009)** found that the solar drying method performed the best oil percentage of peppermint when compared to shade drying where the direct sun methods had the lowest oil percentage. Also, **Massoud *et al.* (2010)** indicated that the oven draying methods had the highest volatile oil percentage in basil herb compared with air drying and room drying which was the lowest one.

The results in Table 2 indicate that the menthe herb draying with shade methods significantly had the highest essential oil percentage across the whole experimental periods the values were 2.22, 2.06 and 1.97%, respectively after 4, 8 and 12 Months. These results are in same line with **Mehasen *et al.*, (2009) and Huwishel *et al.* (2017**). It could be inferred that the shade drying system, which evaporated the mentha herb's volatile oil less than the other drying techniques, was the optimal drying method. In terms of storage time, results are also denoted by storage time. It was discovered that the volatile oil concentration gradually dropped when the storage time was lengthened **(Huwishel *et al.*, 2017)**.

The average percentage of mentha volatile oil was therefore 1.85% at the beginning of experimental period, and regardless of the storage packaging, this figure decreased to 1.71, 1.62, and 1.49% after 4, 6, and 12 months these results are the same with those obtained by **Mehasen *et al.* (2009), Huwishel *et al.* (2017) and Salim *et al.* (2015)**.

These results led to the conclusion that employing the shada drying method for dried mentha herb in kraft bages for one year produced the best oil percentage. In this instance, the percentage of volatile oil was 1.49 % as opposed to 1.85 % at the zero time. After a whole storage period, the percentage of volatile oil was determined to have decreased by 24.16 percent.

The Lamiaceae family, which includes mentha, is notable for keeping its essential oils close to or on the surfaces of their leaves. This could explain why different drying techniques for mint result in a loss of the essential oil component **(El-Gohary *et al.,* 2018)**. So that, shade drying can lower plant moisture content, halt microbial and enzymatic activity, and preserve the product for a longer shelf life **(Salim, *et al.,* 2015; El-Gohary *et al.,* 2018)** Moreover**,** the shade drying helps preserve the volatile oils better than other drying methods, such as sun or oven drying, which can lead to the evaporation or degradation of the essential oils and evaporate more quickly lighter oil components may than heavy ones **(Salim, *et al.*, 2015; El-Gohary *et al.*, 2018)**. Also, The essential oils responsible for the characteristic flavor and aroma of mentha plants are delicate and can be volatile. Shade drying helps retain these aromatic compounds, resulting in a final product with a strong and pleasing scent (**Salim *et al.*, 2015)**.

Regarding the different packaging types and their impact on the volatile oil percentage of dried mentha, it was noted that the packaging types either preserved the volatile oil content or caused a significant decrease, and this pattern was evident throughout the storage period. The findings in Table 2 showed a substantial impact of (P< 0.05) packing types on the percentage of oil over the entire storage period. the highest volatile oil percentage was detected in case of kraft bag (2.31, 2.08 and 1.93 %) after 4, 8 and 12 months respectively, While the lowest one found in AM bag cases (1.39, 1.26 and 1.13) after 4, 8 and 12 months respectively. No proof was found to back up or demonstrate results on packing types. While **Mehasen *et al.* (2009) and Huwishel *et al.* (2017)** they discovered that rosemarry and peppermint plants preserved in carton boxes had higher essential oil content than those preserved in jute and plastic boxes.

Mentha herb, such as mint leaves, contain volatile compounds that give them their characteristic aroma and flavor. Kraft packaging helps to preserve these volatile compounds by allowing them to breathe. The porous nature of paper allows for some airflow, preventing the accumulation of moisture and reducing the chances of mold or bacterial growth. This helps to maintain the freshness and quality of the herb, ensuring that it retains its aroma and flavor for a longer period. It's important to note that while kraft packing is a suitable method for mentha plants, proper storage conditions such as cool and dry environments should also be maintained to ensure the longevity and quality of the dried leaves. Additionally, the specific packaging requirements may vary depending on factors such as the intended shelf life and end-use of the mentha plants.

Kraft packaging is generally more cost-effective compared to other packaging materials. It is widely available and relatively inexpensive, making it a practical choice for small-scale farmers or producers. Also, Paper packaging is considered more environmentally friendly compared to materials like plastic. It is biodegradable and can be easily recycled, reducing the impact on the environment.

The results also demonstrated that there was significant interaction (P<0.05) between the factors considered in this investigation. After the 4, 6 and 12 months of storage, the results indicated that mentha herb with shade drying process and packaging in kraft bags significantly (P< 0.05) had the greatest volatile oil content, which were 2.77, 2.57 and 2.47%, respectively compared with the other methods. On the other hand, the lowest value of mentha oil percentage was obtained after a same period of storage using oven draying and AM bag which were 0.41, 0.35 and 0.26 %, respectively. The same results was founded by **Huwishel *et al.* (2017)**. They came to the conclusion that the rosemary plant with the highest essential oil percentage was shade-dried, packaged, and stored in a carton box.

Essential oil Components

The impacts of draying methods, packing types, and their interaction were presented in Table 3, which showed fluctuations in the component of volatile oils after one year of storage in the second season.

The α-pinene, 1,8-cineole, and carvone values of mentha oil content were found to be affected by the drying methods and the type of packing. When compared to the other parameters, the shade drying techniques with kraft bags yielded the highest levels of each of the three compounds (4.31, 3.56, and 47.89%, respectively) after the whole storage period on the second season. After one year of storage in the second season, the shade drying and kraft bag, sun drying and kraft bag, and shade drying and snacks bag had the lowest amounts of -pinene, 1,8-cineole, and carvone, at 1.22, 0.73, and 29.81%, respectively.

Table 3. Effect of drying methods, storage packaging and their interactions on essential oil component of *Mentha spicata* L.

Oil component	Drying methods											
	Shade				Oven				Sun			
	Packing											
	AM	KB	2LA	3LA	AM	KB	2LA	3LA	AM	KB	2LA	3LA
α-pinene	2.54	4.31	1.22	1.35	3.43	2.62	3.55	3.93	3.58	2.80	3.84	3.34
Myrcene	4.09	4.73	4.67	4.12	5.32	4.36	5.35	5.41	5.31	4.35	6.17	5.49
Limonene	8.15	9.95	10.04	9.01	10.36	9.56	11.78	10.30	11.39	10.54	12.88	11.19
1,8-cineole	0.82	3.56	1.58	1.02	2.45	1.88	2.56	1.27	0.80	0.73	2.63	1.59
ɣ- terpineol	3.69	2.73	1.44	2.23	3.31	2.40	-	2.78	3.34	3.51	-	2.82
Dihydrocarvone	7.46	3.36	3.81	3.72	2.03	-	-	1.39	-	-	-	1.75
Carvone	39.17	47.89	44.69	29.81	36.34	39.52	32.26	39.19	38.39	43.62	33.22	40.16
Dihydrocarveol acetate	3.26	2.04	1.86	1.41	1.98	2.99	-	2.23	2.38	3.00	-	2.75
B-caryophyllene	3.14	-	2.11	-	-	-	-	-	-	-	-	-

AM= Packaging in bag of aluminum + metallic layers, KB= Packaging in kraft bags, 2LA =Packaging in bag of two layers of aluminum and 3LA Packaging in bag of three layers of aluminum.

Results in Table 3 show that the highest levels of myrcene and limonene content were found in mentha herb after sun drying and 2LA packaging, with values of 6.17 and 12.88 %, respectively after one year in second season compared with the other factors. The herb that was shade-dried and AM bags packing had the lowest myrcene and limonene oil concentration at 4.09 and 8.15% ,respectively after a year of storage.

The amount of **ɣ**-terpineol and dihydrocarvone in the oil after a year of storage, as shown in Table 3, indicated that herbs that were dried in the shade and packaged in **AM** bags had the highest concentrations, which were 3.69 and 7.46%, respectively. The lowest levels of **ɣ**-terpineol and dihydrocarvone were found in herb dried in shad and 2LA packaging, oven dried, and 3LA packaging, with values of 1.44 and 1.39%, respectively.

The concentration of oil from Dihydrocarveol acetate had the maximum value (3.26%) in herb dried in shade and packed in 3LA bags, whereas the lowest value was in herb dried in shade and packed in snacks bags (1.41%) after one year of storage.

The GC mass instrument only picked up the concentration of B-caryophyllene oil only in two separate treatments which herb drying shade and AM packing (3.14%) and herb drying shade and 2LA packing (2.11%). The previous finding according the effect of drying methods are in the same tone with **Huwishel *et al.* (2017)**. They discovered that the rosemary herb dried in shade contained the highest concentration of 1,8-cineole, camphor, and pinene packed in carton box. However, **Mehasen *et al.* (2009)** discovered that the dried herb peppermint had the maximum menthol, menthone, and iso-menthone content after using a solar drying technique. Also, **El-Gohary *et al.* (2018)** discovered that the best mint oil component was highest in fresh mint plants, which were then dried in the shade, sun, and oven.

Conclusion

Extract from the foregoing that drying the mint plant in the shade and then packing it in packages of kraft give its best ratio of oil and preserve the important oil ingredients in the mint plant for a whole year.

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الملخص العربي

تأثير معاملات ما بعد الحصاد وطرق التجفيف المختلفة على جودة عشب النعناع

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أجريت هذه الدراسة بالمزرعة البحثيه لكلية العلوم الزراعية البيئة – جامعة العريش خلال موسمين متتاليين (٢٠١٩/٢٠٢٠، ٢٠٢١/٢٠٢٢م) بهدف دراسة تاثير التجفيف في الظل وأشعة الشمس المباشرة وفرن التجفيف والتعبئة في اربع عبوات الاولي تتكون من طبقه من الألومنيوم والميتاليك اللامع و الثانيه من الكرافت و الثالثه تتكون من طبقتين من الألومنيوم و الرابعه تتكون من ثلاث طبقات من الألومنيوم خلال التخزين لمدة ٤ و ٨ و ١٢ شهراً وتأثير ذلك على الحمل الميكروبي والمحتوى من الزيت الطيار ونسبة المكونات الفعالة. أظهرت النتائج ان معامله التجفيف في الظل اعطت اعلي نسبه من الزيت تقدر ب ٢,٤٠ % يليها التجفيف المباشر من الشمس ثم التجفيف في الفرن بمعدل ١,٩٨ و ١,١٧ % خلال مرحله بدايه التجربة. خلال فترات التجربه المختلفه ٤ و٨ وعام أوضحت النتائج تفوق التجفيف في الظل في زيادة تحقيق اعلي نسبه للزيت في عشبه نبات النعناع بمعدل ٢,٢٢ و ٢,٠٦ و١,٧١ % مقارنه بالتجفيف المباشر في الشمس والفرن. كما كانت التعبئه في عبوات الكرافت خلال فترات التخزين المختلفه الافضل في نسبه الزيت بمعدل ٢,٣١ و ٢,٠٨ و ١,٠٦ عن المعاملات الاخري. اوضح التداخل بين طرق التجفيف و انواع التعبئه المختلفه تفوق الاعشاب المجففه في الظل والمعبئه في عبوات الكرافت في نسيه الزيت بمعدل ٢,٣١ و ٢,٠٨ و ١,٠٦ بعد ٤ و ٨ و ١٢ شهر من التخزين علي التوالي مقارنة بباقي المعاملات الاخري. قل الحمل الميكروبي (مليون / جرام) في الاعشاب المجففه باشعه الشمس المباشرة والمعبئه في عبوات الكرافت خلال فترات التخزين المختلفه بعد ٤ و ٨ و ١٢ شهر حيث كانت ٣,٢٠ و٣,٥٨ و٣,٦٠ خلال الموسم الاول و ٣,٣٠ و ٣,٥٥ و ٣,٧٣ في الموسم الثاني مقارنه بالمعاملات الاخري. اظهرت النتائج بالنسبه لمكونات الزيت الي تواجد مكونات الفا بنين و ١,٨ سينول و كارفين بنسبه عاليه في الاعشاب المجففه في الظل و المعبئه في عبوات الكرافت. احتوت اعشاب النعناع المجففه في الشمس المباشرة و المعبئه في عبوات مكونه من طبقتين من الألومنيوم علي اعلي نسبه من مكونات الليمونين و المرسين بينما احتوت الاعشاب المجففه في الظل و المعبئه في عبوات مكونه من طبقه من الألومنيوم والميتاليك اللامع علي أعلي نسبه من الفا تربينول و الداي هيدروكارفون. يستخلص مما سبق بان تجفيف نبات النعناع في الظل ثم تعبئته في عبوات من الكرافت اعطي افضل نسبه للزيت و حافظ علي مكونات الزيت الهامه في نبات النعناع لمدة عام كامل.

الكلمات الإسترشادية: النعناع، معاملات ما بعد الحصاد، التجفيف والتعبئة.

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