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EFFECT OF PRE-COOLING PROCESS ON THE COLD STORAGE AND QUALITY OF SOME AROMATIC PLANTS

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ABSTRACT

The aim of this investigation was to study the effect of pre-cooling process on safe storage period, fresh weight loss, chlorophyll a and b, respiration rate and volatile oil percentage and its components for Rosemary (*Rosmarinus officinalis* L.) and Marjoram (*Origanum majorana* L.) herbs stored in refrigeration units at cooling temperatures of 0, 3 and 6 °C and 98 % relative humidity. The experimental work was conducted at Processing and Handling Research Department, Agricultural Engineering Research Institute and Medicinal and Aromatic plants Research Department, Horticulture Research Institute. The pre-cooling process was conducted by hydro-cooling at 5 °C, and then the plants were stored under three levels of storing temperatures of (0, 3 and 6 °C).

The results indicated that both herbs under study should be pre-cooled at 5 °C and stored at zero °C and 98 % RH to increase safe storage period for fresh consumption or marketing. Pre-cooling process increased the storage period and decreased the fresh weight loss for both Rosemary and Marjoram herbs. The storage period decreased and the fresh weight loss increased by increasing the storage temperatures from 0 to 6 °C. The average 7/8 cooling time of 25 min considered as proper cooling time for both herbs.

INTRODUCTION

Herbs have been used by mankind since the beginning of time as human searched for ways of preserving foods, alternating their taste and treating ailments through observing the effect of particular herbs on body's condition. Storage in low temperature for different periods as well as packaging methods are considered the most important factors, which affect the plant properties and they differ with the different plants. Pre-cooling by removing field heat from freshly harvested herbs and or fruits reduces microbial activity and gave the best longest storage period, fresh consumption or marketing after harvesting and good marketing quality. Furthermore, this also decreases the ripening rate, diminishes water loss and decay, and thus, helps preserving quality and prolongs shelf life of the herbs Ferreira *et al.* (1994) and Reina *et al.* (1995). Also pre-cooling is the first step in good temperature management. The field heat of a freshly harvested crop-heat the product holds from the sun and ambient temperature-is usually high, and should be removed as quickly as possible before shipping, processing and storage. Pre-cooling is generally a separate operation requiring special equipment and or rooms to maximize the shelf life of the fresh agricultural products including the medicinal and aromatic herbs to be on demand whenever required for a logic period. Traditionally many culinary herbs were produced in Europe, but many European countries are now unable to meet the increasingly demand for local supply and forced to import fresh herbs. As a result of fast transportation and improvements in handling and storage of agricultural commodities with a limited shelf life, fresh herbs can now be supplied to almost any location.

In Egypt, aromatic plants production must be extend because of our suitable environmental conditions including mild climate and abundance in soil types and especially the reclaimed ones.

Rosemary (Rosmarinus officinalis L.) is one of the most important medicinal and aromatic perennial plants. It is used externally as parasiticide, cicatrisant, for muscular pains and rheumatism, dandruff and exzema. It promotes hair growth and stimulates scalp. Internally it is used for asthma, bronchitis. Whooping cough, to stimulate poor circulation, it is employed for palpitation, debility, headache, neuralgia, rental fatigue, nervous exhaustion and stress-related disorders, dyspepsia, flatulence, hepatic disorders, hyper cholesterolaemia and jaundice (Lawless, 1992). Its oil is extensively used in soap, detergents, cosmetics, house-hold sprays and perfumes especially colognes. Also extensively used in most major food categories, especially meat products and drinks. Serves as a natural antioxidant (Lawless, 1992).

Marjoram (Origanum majorana L.) is a hardy perennial and herbaceous plant which grows in many areas as Egypt and eastern Mediterranean countries. Oil or sweet marjoram is used as a spice and condiment. The volatile aromatic compounds are employed in the food industry as flavouring and especially in canned meats. In additions it is cultivated as culinary herbs and as garden plants (Sivropoulou *et al.*, 1996). Volatile oil produced by this plant is anti spasmodic, digestive, better tonic, expectorant, diuretic, antidiabitic, antimimcrobial, antioxidant, regulates menstruation and carminative astringent, antihysterical, antiasthmatic, antiparslytic drugs (Yadava and khare 1995).

Watada, (1986) mentioned that yellowing of leafy vegetables, such as spinach and parsley occurs with degradation of chlorophyll. Temperature is the most influential factor in rate of degradation, but the atmosphere could have effect.

Yamauchi and Watada (1991) found that degradation of chlorophyll appeared to be regulated through the peroxidase-hydrogen peroxide pathway, which opens the prophyrin ring, thus resulting in a colosless compound. This conclusion was arrived at from the analysis of chlorophylls and their metabolites by HPLC, chlorophyll decreased at 25 °C but not at 1 °C.

Cantwell and Reid (1993) found that quality characteristics of fresh coriander herbs include a fresh appearance, uniformity of leaf size, form and colour, characteristics of aroma and flavour; and a lack of defects, such as decay or yellowing which are best maintained by low-temperature and high-humidity storage.

Gillies and Tovionen (1995) studied the effect of cooling method and packaging with perforated film on broccoli (Brassica oleracea L.) quality during 2 °C storage. Hydro-cooling was the most rapid cooling method and resulted in the lowest vapour pressure deficits between the broccoli and the surrounding air. Broccoli that was hydro-cooled and then over wrapped with perforated film lost less weight, was firmest, and retained colour better.

Jeong *et al.* (1996) on carrot indicated that fast pre-cooling of agricultural produce after harvest (especially for those that have high respiration rates and or a gig surface to volume ratio), reduces the rate of quality loss and extends shelf life. Gomez *et al.* (1999) assessed weight loss and quality (appearance, aroma and colour) in fresh coriander (8 g packages) stored at 4, 10 and 25 °C for 2, 4, 6 and 8 days. They found that quality parameters decreased as storage temperature increased and storage at 4 °C is recommended for preserving quality for one week, although weight loss after 8 days at 4 °C was approximately 50 %.

Kuen Woo *et al.* (2000) investigated the MA response of fresh Cymbopogon citrates depending upon film packing and storage temperatures. Fresh weight loss was significantly lower at 5 and 0 °C than at higher temperatures. Rapid accumulation of Co2 was observed at high storage temperatures. The ethylene content during the whole storage period was higher at o °C than 5 °C, but concentration remained below 1 ppm and did not adversely affect quality.

Roura *et al.* (2000) stored fresh spinach beet leaves at 4 or 18 °C and 43, 86 and 98 % RH as leaf quality was unacceptable after 3 days of storage at 18 °C regardless of RH level, leaves held at 4 °C and 43 % RH were unacceptable after 4 days storage due to dehydration.

Guu and Jane (2004) on leafy sweet potato found tat the vegetables subjected to pre-cooling treatment prior to packing preserved greater amounts of water content, dry weight, vitamin C, soluble sugars, and chlorophyll and obtained less colour change than those of non-treatment counterparts.

Alvares *et al* (2007) on parsley indicated that, hydro-cooling procedure reduced the loss of fresh weight from the leaves in the first 12 hours of storage and maintained the relative water content (RWC) at a high level even after seven days of storage at 5 °C. Visual wilting of leaves was observed when approximately 10 % of the initial fresh weight was lost, which was achieved 30 hours after harvest for the control and 42 hours for the pre-cooled bunches.

This research aims to study and evaluate the effect of pre-cooling process of two different herbs (Rosmarinus officinalis L. and Origanum majorana L.) at 5 °C cooling temperature before storage into cold storage unit at different levels of storing temperature (0, 3 and 6 °C) and constant relative humidity of 98 %. The evaluation basis included fresh weight loss, chlorophyll a and b, volatile oil percentage and its components and the safe storage period of each herb.

MATERIALS AND METHODS

A) Materials:

This investigation was conducted at the department of Processing and Handling of Agricultural Crops, Agricultural Engineering Research Institute and the Medicinal and Aromatic plants Research Department, Horticulture Research Institute, during 2008. The samples of plants were obtained from the experimental farm of Horticulture Research Institute to investigate the effect of pre-cooling process on the storage period, fresh weight loss, respiration rate and volatile oil percentage and its components of Rosemary (Rosmarinus officinalis L.) and Marjoram (Origanum majorana L.) as non chilling sensitive herbs were stored under three levels of storing temperatures of (0, 3 and 6 °C) .The properties of plants were analyzed at the laboratory of the Medicinal and Aromatic plants Research Department, Horticulture Research Institute.

1- Herbs used in this investigation:

For rosemary plants the terminal steam cutting of (15 cm length) and the well rooted vegetative parts (runners) of equal size (8-10 cm length, with 5-8 leaves) were used. While the marjoram seedling (12-15 cm in height, with 10-12 leaves) were taken about one months after germination.

2- Data Recorded:

The following data were recorded:

2-1 Safe storage period (days):

The storage period in which the fresh herb of the pre-cooled and non-pre cooled remained in good quality till the beginning of deterioration was measured.

2-2 Fresh weight loss (g):

The difference between weights of sample before and after storage was determined by digital balance with accuracy of 0.2 g.

2- 3 photosynthetic pigments determination of the fresh leaves:

Chlorophyll a and b as well as carotenoids contents were determined in fresh leaves (mg/g) according to the procedure of Saric *et al.* (1967).

2-4 Volatile oil and its components:

The percentages of volatile oil were determined in the fresh herbs using 100 g samples for each plant. Distillation of the volatile oil was proceeded as described in the British Pharmcopoeia (1963).

2-5 Plants temperature:

The digital universal temperature meter with copper-constantan thermocouple was used for measuring the temperature change of plants during the pre-cooling process.

2-6 Respiration rate (Wt^{-1})

One hundred herbs were placed in a dessicator and connected to a tube contains 25 ml of 1.0 N KOH. Air free from Co2 was drown into the dessicator through, the KOH for one hour, then KOH was titrated with 1.0 N HC1 using thymol blue indicator and co2 production was calculated as mg co2 $Kg^{-1}h^{-1}$. Each value was converted into Wt^{-1} (1 co2 $Kg^{-1}h^{-1}$=3.0287 Wt^{-1})

B) Methods:

Experimental treatment and producer:

The freshly harvested herbs were divided into two parts one of them was kept without pre-cooling (C1) and the other one was subjected to Hydro-cooling (C2) at 5 ±1.0 °C before storing at storage temperature of zero, 3 and 6 °C and 98 % relative humidity (R.H.). The storage done in three refrigerators (Labconco, Model No. 77555, Labconco Corporation, Kansas City, US) at the Horticulture Research Institute, A R C, Dokki, Giza, Egypt.

Pre-cooling treatment (Hydro-cooling) was done by using ice box where the harvested herbs were filled in polyethylene bags (100 g/bag) and preciously tighted to avoid water leakage into the bags, then they were placed in the box immediately after harvesting to remove field heat before storage. The box was filled with ice cubs and tap water as a cooling medium. The temperature of the ice-water mixture was adjusted by using a digital temperature monitor as an indicator for adding ice cubes to the mixture to keep the required level of temperature all over the cooling period. Three copper constantan thermocouples were fixed at the centre of the tested samples to measure the temperature changes of the plants during the cooling process at 5 mints internal. The obtained data were used for plotting the cooling curves and calculating 1/2, and 7/8 cooling time for the two studied plants. The fresh herbs of the two treatments (C1 and C2) were cleared from damaged leaves for obtaining a uniform samples and packed in foam dishes (24 x 18 x 3 cm) covered with cured polyethylene shrink film (each sample weight was 100 g in the package). The samples were stored at storage temperature of zero, 3 and 6 °C and 98 % RH in the refrigerator at the Horticulture Research Institute, (A R C) Dokki, Giza, Egypt. The relative humidity was kept at the previously mentioned level using a humidistat and a water misting apparatus.

Analysis of cooling process

The rate of cooling depends upon the specific characteristics of a product such as: density, thermal capacity and conductivity the temperature difference between the product and its surrounding also influences the cooling rate. As the product cooling down, the temperature difference changes and therefore the cooling rate usually become time dependence. An object placed in surroundings at a constant lower temperature, with negligible temperature gradient within the object and constant thermal properties will follow the Neetons low for conduction cooling:

$$T = tr + (ti - tr)\, e^{-c\Theta} \text{ -----------(1)}$$

Where:

T = product temperature at any given time °C.

ti = initial product temperature °C.

tr = water temperature °C.

e = constant 2.718828

c = specific cooling coefficient (s^{-1}).

Θ = time which one wants to find t (s).

It is obvious from equation (1) that, the time needed to cool down the product to its surrounding temperature is going to be infinitely long. A term called the half-cooling time is used instead as it gives a practical meaning for the characterized cooling rate.

Half cooling time often denoted by the letter Z is defined as the time needed to reduce by half the temperature difference between the initial product temperature and the cooling medium temperature (Thompson *et al.*, 1998).

In the second half of the cooling time the temperature difference is reduced again by a half. After three half cooling times are elapsed the difference becomes only 1/8 of the initial difference and so on. At the 7/8 cooling time, the cooling rate become very slow and the cooling process can be stopped to save the cooling energy and the cost of the process.

RESULTS AND DISCUSSION

Hydro-cooling process

Figs. (1) and (2) illustrate the change in Rosemary and Origanum herbs temperature as related to cooling time respectively.

As shown in the Figures the cooling rate of both herbs increased during the early stage of pre-cooling process and starts to decline with time. Also, the cooling rate was depended upon the specific characteristics of each herb.

Cooling rate is usually described in term of half-cooling or 7/8 cooling time. These values remain constant for a given system. The 7/8 cooling time is the time needed to decrease temperature difference from initial product temperature to cooling air by 7/8. This value is an economical breakpoint for product cooling. Under this study, and as shown in Table (1) for the Rosemary the half-cooling time and the 7/8 cooling time were 9.15 and 26.9 min respectively. While, the corresponding values for the Organum herb were 8.7 and 24.3 min, respectively. This means that, at cooling temperature of 5 °C, the cooling rate and the corresponding cooling time of both herbs was very close. This means that, at the average 7/8 cooling time of (25 min), the pre-cooling process can be stopped to save the cooling energy and the cost of cooling process as mentioned by (Thompson *et al.*, 1998).

Table (1): Cooling time (min) for Rosmarinus officinalis L. and Origanum majorana L. during the hydro-cooling process.

Aromatic plants	Cooling time, min.	
	½ cooling time	7/8 cooling time
Rosmarinus officinalis L	9.15	26.9
Origanum majorana L	8.7	24.3

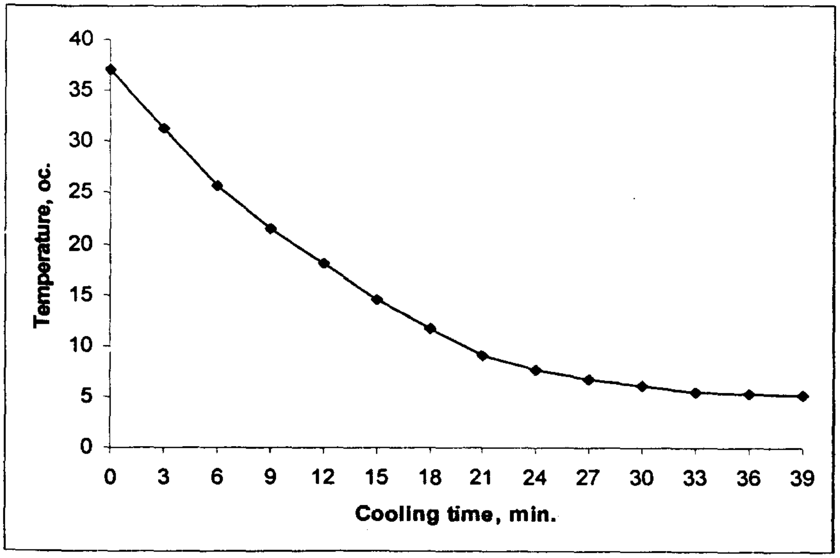

Fig. (1): Reduction of Rosemary temperature as related to cooling time.

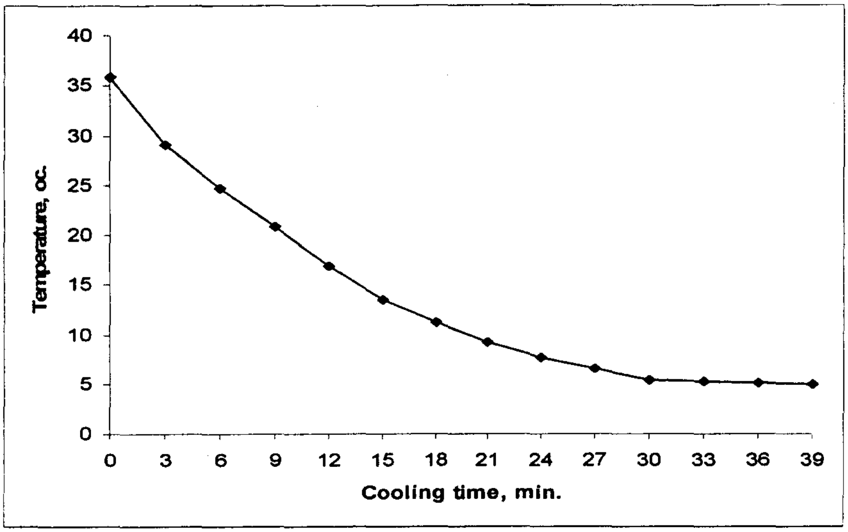

Fig. (2): Reduction of Origanum temperature as related to cooling time.

Weight loss as affected by pre-cooling process and storage temp.:

Data in Table (2) show the effect of pre-cooling process and storage temperatures on fresh weight loss (g) of Rosemary and Marjoram.

Data in Table (2) revealed that the fresh weight loss was affected by pre-cooling process and storage temperatures. It could be found that the non pre-cooled treatments gave the highest fresh weight loss when compared with the pre-cooled treatments in all cuts for Rosemary and Marjoram. Also the fresh weight loss increased by increasing the storage temperatures from 0 to 6 °C.

For Rosemary, the maximum fresh weight loss of 3.60 g/100g fresh herbs was obtained from the without pre-cooled samples and storage temperature of 4 °C, while the minimum fresh weight loss of 1.47 g/100 g fresh herbs was obtained from the pre-cooled herb produced from the storage temperature of 0 °C.

Table (2): Effect of pre-cooling and storage temperatures on fresh weight loss g/100 g fresh herbs.

Plants	Fresh weight loss (g)/ 100 g fresh herbs					
	C1			C2		
	Storage temperatures, °C			Storage temperatures, °C		
	0	3	6	0	3	6
Rosemary	2.41	3.25	3.60	1.47	1.53	1.60
Marjoram	3.11	3.55	3.71	1.55	1.90	2.35

Where: C1: without pre-cooling and C2: with pre-cooling.

For Marjoram, the maximum fresh weight loss of 3.71 g/100 g fresh herbs was obtained for the non pre-cooled samples and storage temperature of 6°C, while the minimum fresh weight loss of 1.55 g/100 g fresh herbs was obtained from the pre-cooled herb produced from the storage temperature of 0 °C. The weight loss of stored herb may be due to decreasing in degradable tissues and the higher respiration rate of the stored herbs.

Chlorophyll (a and b) as affected by pre-cooling process and storage temp.

Table (3) shows the effect of pre-cooling process and storage temperatures on chlorophyll a and b content of Rosemary and Marjoram.

Data in Table (3) showed that, there is no difference was found between C1 and C2 and between the three storage temperatures of 0, 3, and 6 °C on chlorophyll 'a' an b content for the plants under study.

These results may be return to, the herbs subjected to pre-cooling treatment prior to packing preserved grater amounts of chlorophyll with less colour change than those of non-treated herbs.

Table (3): Effect of pre-cooling and storage temperatures on chlorophyll (a and b) contents (mg/g).

Plants	Chloro-phyll, (mg/g)	Treatments					
		C1			C2		
		Storage temp., °C			Storage temp., °C		
		0	3	6	0	3	6
Rosemary	(a)	0.33	0.33	0.32	0.33	0.33	0.32
	(b)	0.22	0.22	0.21	0.22	0.22	0.21
Marjoram	(a)	0.35	0.35	0.34	0.35	0.35	0.34
	(b)	0.20	0.20	0.19	0.21	0.21	0.20

Where: C1: without pre-cooling and C2: with pre-cooling.

Volatile oil (%) as affected by precooling process and storage temp.

Data in Table (4) show the effect of pre-cooling and storage temperatures on volatile oil percentage of Rosemary and Marjoram. As shown in the Table (4) oil percentage was slightly increased for the pre-cooled plants in comparison with the non-cooled samples.

For Rosemary, the volatile oil percentage increased by 0.12 to 0.179 % for the pre-cooled plants comparing with the non treated plants at storage temperature of zero and 6 °C respectively.

While, the volatile oil percentage for Marjoram was increased by 0.148 to 0.162 % for the treated plants comparing with the non treated samples at storage temperature of zero and 6 °C respectively.

Table (4): Effect of precooling and storage temp. on volatile oil percentage.

Plants	Volatile oil %					
	C1			C2		
	Storage temperatures, °C			Storage temperatures, °C		
	0	3	6	0	3	6
Rosemary	0.249	0.205	0.196	0.369	0.336	0.375
Marjoram	0.527	0.495	0.487	0.675	0.656	0.649

Where: C1: without pre-cooling and C2: with pre-cooling.

Effect of pre-cooling process on volatile oil components at storage temperature of 0 °C for rosemary and marjoram:

Data in Table (5) indicated that, for rosemary herbs 14 component were identified, the main components was 1.8 cineole followed by linalool. Regarding, the effect of pre-cooling on volatile oil component, it could be concluded that, the 1.8 cineol content was 14.50 % for the non pre-cooled herb while it was 20.63 % for the pre-cooled herb.

Table (5): Effect of precooling on volatile oil components (%) at storage temperature of 0 °C.

Components	Rosemary (*Rosmarinus officinalis* L.)	
	C1	C2
A – pinene	0.60	1.04
Camphene	0.62	0.83
B – pinene	0.91	0.91
Limonene	3.51	6.63
Γ-terpinene	8.31	10.60
1.8 cineole	14.50	20.63
Linalool	18.52	23.64
Camphor	7.14	6.86
P-cymene	7.27	13.00
Bornyl acetate	7.15	4.33
Borneol	2.46	3.49
B-carophyllene	0.93	0.71
Eugenol	1.28	1.44
Unidentified	7.28	9.55
Components	**Marjoram (*Origanum majorana* L.)**	
	C1	**C2**
A – pinene	1.49	2.02
B – pinene	6.38	8.14
Limonene	12.36	14.05
1.8 cineole	9.95	9.73
Γ-terpinene	3.91	6.21
Linalool	6.43	12.04
Terpinene-4-ol	41.74	47.59
A – terpineol	7.26	8.22
Linalyl acetate	1.43	2.89
Estragol	1.37	1.33
B – carophyllene	-	1.03
Eugenol	1.68	1.48
Unidentified	2.29	2.31

Where: C1: without pre-cooling and C2: with pre-cooling.

However, the maximum linalool content of 23.64 % was obtained for the pre-cooled herb, and the minimum linalool content of 18.52 % was obtained from the non pre-cooled herb. Meanwhile, for the samples of marjoram 13 components were identified; the main components were terpinene-4-ol, α-terpineol and limonene.

It could be seen that, the maximum terpinene-4-ol content was 47.59 % obtained from the pre-cooled herb, while the minimum terpinene-4-ol content of 41.74 % obtained from the non pre-cooled herb. Also α – terpineol was 7.26 and 8.22 % for non pre-cooling and pre-cooled samples respectively also the maximum limonene content of 14.05 % was obtained from the pre-cooled herb, while the minimum limonene content of 12.36 % was obtained from the non pre-cooled herbs.

6- Safe storage period as affected by pre-cooling and storage temp.

Based on the changes occurred on the stored herbs, the safe storage period of the pre-cooled and non-cooled samples were determined and tabulated in Table (6).

Table (6): Effect of pre-cooling and storage temperatures on the storage period (days).

Plants	Storage period (days)					
	C1			C2		
	Storage temperatures, °C			Storage temperatures, °C		
	0	3	6	0	3	6
Rosemary	14	11	9	25	21	14
Marjoram	18	15	12	30	25	19

Where: C1: without pre-cooling and C2: with pre-cooling.

Data in Table (6) show the effect of pre-cooling process and storage temperatures on the storage period (days) of Rosemary and Marjoram.

As shown in the table, the storage period increased for the pre-cooled plants in comparison with non pre-cooled samples. Also the storage period decreased by increasing the storage temperatures from 0 to 6 °C.

For Rosemary, the maximum storage period was 25 days which obtained for the pre-cooled herbs stored at 0 °C, while the minimum storage period of 9 days was obtained for the non pre-cooled herb stored at 6 °C. This means that, pre-cooling process increased the storage period of rosemary herbs by 5 to 11 days in comparison with the non pre-cooled herbs.

For Marjoram, the maximum storage period was 30 days which obtained from the pre-cooled herbs stored at 0 °C, while the minimum storage period was 12 days which obtained from the non pre-cooled herb stored at 6 °C. It is also clear that the pre-cooling process increased the storage period by 7 to 12 days in comparison with the non pre-cooled herbs.

In general the of pre-cooling process is an efficient method to reduce the metabolic activity of a plant, as the rate of biochemical reactions such as respiration rate may decreased and lead to a longer storage period, as shown in Table (7).

Table (7): Effect of pre-cooling and storage temperatures on respiration rate of Rosemary and Marjoram.

Plants	Respiration rate					
	C1			C2		
	Storage temperatures, °C			Storage temperatures, °C		
	0	3	6	0	3	6
Rosemary	241.43	244.13	247.22	218.51	220.11	223.89
Marjoram	216.32	219.22	222.34	201.91	204.51	206.16

Where: C1: without pre-cooling and C2: with pre-cooling.

CONCLUSIONS

The obtained results could be summarized as follows:

- To obtain the longest safe storage period for fresh consumption or marketing after harvesting of Rosemary and Marjoram, fresh herbs should be pre-cooled at 5 °C and storing at zero °C and 98 % R.H.
- The average 7/8 cooling time of 25 min considered as proper cooling time for both herbs.
- The pre-cooling process increased the storage period for both Rosemary and Marjoram herbs. Also the storage period decreased by increasing the storage temperatures from 0 to 6 °C.
- The non pre-cooled samples gave higher fresh weight (g) loss when compared with the pre-cooled samples for both Rosemary and Marjoram herbs. Also the fresh weight loss increased by increasing the storage temperatures from 0 to 6 °C.
- There is no-significant effect of pre-cooling process at temperatures of 5 °C, on chlorophyll a, and b content (mg/g) for both Rosemary and Marjoram herbs.
- Volatile oil percentage and respiration rate were affected by pre-cooling process for both Rosemary and Marjoram herbs.
- The pre-cooling process showed the maximum cineole and linalool content in volatile oil compared with non pre-cooled samples of Rosemary. While it has gave the maximum terpinene-4-ol, α – terpineol and limonene for Marjoram.

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تأثير عملية التبريد المبدئى على التخزين المبرد وجودة بعض النباتات العطرية

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استعمل الانسان الاعشاب منذ قديم الزمن مابين الطعام وعلاج الامراض وذلك لما لها من تأثير على اتزان الجسم. وتعتبر عملية التخزين فى درجات الحرارة المنخفضة لفترات طويلة بالاضافة الى طرق التعبئة من أهم العوامل التى تؤثر على خصائص النباتات وجودتها. وتعتبر عملية التبريد المبدئى من العوامل الهامة والاولية والتى تتم بعد عملية الحصاد مباشرة وذلك بهدف ازالة حرارة الحقل من الاعشاب المحصودة وخفض النشاط الميكروبى، الامر الذي يترتب عليه زيادة فترة تخزين المحصول وتحسن مواصفاته التسوقية.

يتناول هذا البحث دراسة تاثير التبريد المبدئى، على طول مدة التخزين، والفقد فى الماء، ونسبة ومواصفات الجودة للزيوت الطيارة الناتجة لكل من الحصالبان والبردقوش وذلك باجراء التبريد المبدئى للعشب على درجات حرارة ٥ م ° قبل التخزين، ثم التخزين على درجات حرارة صفر، ٣، ٦ درجة مئوية ورطوبة نسبية ٩٨ % .

وكانت النتائج المتحصل عليها كالتالى:

- يعتبر متوسط ٨/٧ فترة التبريد والذى يعادل ٢٥ دقيقة مناسبة لعملية التبريد المبدئى لكلا النباتين موضوع الدراسة.
- أدت المعاملة بالتبريد المبدئى الى زيادة مدة التخرين الامن عن المعاملة بدون تبريد مبدئى لكل من نباتات الحصالبان والبردقوش. حيث كانت اطول فترة تخزين ٢٥ ، ٣٠ يوم باستخدام التبريد المبدئى عند درجة حرارة تخزين صفر م ° لنبات الحصالبان والبردقوش على الترتيب، بينما كانت القيم المطابقة ١٤، ١٨ يوم لكل من نباتات الحصالبان والبردقوش على الترتيب فى حالة عدم التبريد المبدئى.
- أدت المعاملة بالتبريد المبدئى الى اقل فقد فى الوزن الطازج لكل من نباتات الحصالبان والبردقوش. وكاناعلى فقد فى الوزن الطازج فى حالة المعاملات الغير مبردة تبريدا مبدئيا حيث وصلت الى ٣,٦٠، ٣,٧١ جرام/١٠٠ جم وزن طازج عند درجة حرارة تخزين ٤ م ° لكل من نباتات الحصالبان والبردقوش على الترتيب، وكان اقل فقد فى الوزن الطازج للمعاملات المبردة مبدئيا عند درجة حرارة تخزين صفر م ° ١,٤٧، ١,٥٥ جرام/١٠٠ حم وزن طازج لكل من نباتات الحصالبان والبردقوش على الترتيب.
- لايوجد تأثير ملحوظ للتبريد المبدئى ودرجة حرارة التخزين على محتوى العشب من الكلورفيل أ،ب مجم/جرام لنباتات الحصالبان والبردقوش.
- أدت المعاملة بدون التبريد المبدئى الى انخفاض نسبة الزيت الطيار مقارنة بالمعاملات المبردة مبدئيا. وكانت اعلى نسبة مئوية للزيت الطيار ٠,٣٦٩، ٠,٦٧٥ % فى حالة المعاملات المبردة تبريدا مبدئيا عند درجة حرارة تخزين صفر م ° لكل من نباتات الحصالبان والبردقوش على الترتيب ، وكانت اقل نسبة مئوية للزيت الطيار ٠,١٩٦، ٠,٤٨٧ % لمعاملات الغير مبردة تبريدا مبدئيا عند درجة حرارة تخزين ٦ م ° لنباتات الحصالبان، والبردقوش على الترتيب .
- أدت المعاملة بالتبريد المبدئى عند درجة حرارة تخزين صفر م ° الى اعلى محتوى من السنيول ومن اللينالول من مكونات الزيت الطيار لنبات الحصالبان. حيث زاد المحتوى من السنيول من ١٤,٥٠ الى ٢٠,٦٣ % ومن اللينالول من ١٨,٥٢ الى ٢٣,٦٤ % بدون تبريد مبدئى والتبريد المبدئى على الترتيب لنبات الحصالبان.
- أدت المعاملة بالتبريد المبدئى عند درجة حرارة صفر م ° الى اعلى محتوى من تربينين-٤-اول ومن الليمونين من مكونات الزيت الطيار لنبات البردقوش. حيث زاد المحتوى من تربينين-٤-اول من٤١,٧٤ الى ٤٧,٥٩ % ومن الليمونين من ١٢,٣٦ الى ١٤,٠٥ %، ومن التربينول من ٧,٢٦ الى ٨,٢٢ % بدون تبريد مبدئى والتبريد المبدئى على الترتيب لنبات البردقوش.
- للحصول على اطول فترة تخزينية، اقل فقد فى الوزن الطازج، واعلى مواصفات جودة للزيوت الطيارة وعشب طازج ذو مواصفات تسويقية جيدة لنباتات الحصالبان والبردقوش يلزم اجراء عملية التبريد المبدئى للعشب على درجة حرارة ٥ م ° بعد الحصاد مباشرة وقبل التخزين على درجة حرارة صفر مئوية ورطوبة نسبية ٩٨ % .