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Yield, Quality and Postharvest Studies on Some Parsley Cultivars

[1]Samia M. Abd El-Hameed, [1]Wessam, M. Serag El-Din and [2]M.A. Saleh

[1]Medicinal and Aromatic Plants Department,
Horticulture Research Institute, Agriculture Research Center, Giza, Egypt
[2]Vegetable Handling Department, Horticulture Research Institute,
Agriculture Research Center, Giza, Egypt

Abstract: Growth, yield, quality and storage were investigated in all studied parsley cultivars during 2016-2017 and 2017-2018 seasons at the Department of Medicinal and Aromatic Plants, Horticulture Research Institute, Agricultural Research Center, Dokki, Egypt. Four cultivars of parsley were grown under the same conditions, two Italian ones including flat-leaf (Gigante D' Italia and Peione cultivars) and french curly leaf parsley (Bravour) cultivar was used to vegetative growth fresh and dry yield kg/m^2, oil percentage, oil yield, essential oil components, leaves content of chlorophyll, ascorbic acid and fibers compared to the local flat leaf cultivar (Egyptian parsley, the fourth one). The plants were harvested three times per seasons. Also, the effect of modified atmosphere packages on the quality and storability of Peione and local cultivars of parsley was studied. Maximum vegetative growth represented in leaves fresh and dry yield, essential oil profitable compounds and chemical properties were obtained for Peione cultivar. Also their essential oil composition contains component, responsible for cancer curing (anticancer compounds) and other diseases. Curley leaf parsley had the highest value of Myristicin (34.29%) followed by Gigante D' Italia cultivar (34.11%), local parsley (12.81%), while Peione cultivar demonstrated the lowest Myristicin content (6.85 %). Italian cultivars (Gigante D' Italia and Peione cultivars), were dominated by Apiole (24.03% and 28.32%) and β-Phellandrene (23.24% and 36.34%). The second cut increased significantly in this respect than the other cuts. For storage experiment parsley plants of Peione cultivar stored at active modified atmosphere packages at 8% O_2 + 3% CO_2 improved storability of plants, maintained plant quality and gave plants with good appearance till 28 days of storage at 0°C.

Key words: Parsley · Essential oil · Modified atmosphere packages · Storage · Chemical properties

INTRODUCTION

Parsley plant (*Petroselinum crispum* Mill.), family Apiaceae, is a biennial crop, native to Europe and Western Asia and cultivated as an annual for its aromatic and attractive leaves [1]. There are three main types of parsley, the flat leaf type (ssp. neapolitanum, Danert) which is popular in Egypt and Arab countries and the curly leaf type (ssp. crispum) cultivated for their foliage and the turnip-rooted or 'Hamburg' type (ssp. tuberosum), cultivated for its enlarged edible root [2, 3]. The fresh parsley leaves are used as a garnish and for seasoning in food industry. The dried leaves known as parsley flakes are used in the instant food sector as an ingredient to flavor soups and sausages [4].Medicinally, Parsley was used as a carminative, diuretic, hypertensive, stomachic, nervine, emmenagogic, abortifacient and nutritive agent [5, 6]. Parsley like many other herbs is highly seasonal in nature. It is a good source of vitamin C (vit. C) and E, b-carotene, thiamin, riboflavin and organic minerals [7-10].

All parts of the plant contain an essential oil that is responsible for the pronounced odor and flavor. Leaf oil of the finest quality possess flavor that resembles the fresh herb is not generally extracted and used because of its low yield. Usually commercial essential oil is derived from fruits and has a distinctly different flavor.

Parsley oil can be used as a flavoring agent in food industry, or a fragrance in perfumes, soaps and creams. In addition, the oil has antimicrobial and antioxidant

Corresponding Author: Wessam, M. Serag El-Din, Medicinal and Aromatic Plants Department, Horticulture Research Institute, Agriculture Research Center, Giza, Egypt.

activities [11, 12]. Zhang *et al.* [13] found that, Myristicin is a major volatile aroma constituent of parsley essential oil and may be effective as cancer chemopreventive agent.

In general, the major constituents of parsley leaves oil are 1,3,8-p-Menthatriene, followed by β-Phellandrene, Myristicin and Myrcene [4, 14]. Parsley varieties are characterized by their oil content and composition [15]. Bernath, [16] found that, the composition of the oil is affected by genotype, environmental conditions and cultural systems. For example, β-Phellandrene, 1,3,8-*p*-Menthatriene, *p*-Cymenene and Terpinolene constituted the primary components of the flat leaf type whereas curly leaf oil is higher in Myristcin than that of flat leaf and turnip rooted parsley whereas the roots of all three types are richer in Apiole than the leaves [3].

All cultivars produce higher oil percent in the second or third cut, which may be due to the higher temperature prevailed at the second or third cuts. Significant variance was also observed between cultivars studied [17].

A major problem for parsley marketing is the extension of its shelf life without significant change in chlorophyll content and color parameters during storage, such as changes resulting in leaf yellowing [18]. Also, parsley plants have a relatively high respiration and transpiration rates and short shelf life. The recommended conditions for commercial storage of fresh parsley has been reported to have a storage life of 1–2 months at 0°C and 95–100% Relative Humidity (RH), which reduce metabolism of product and as a result shelf life as prolonged modified atmosphere packaging (MAP) combined with property refrigeration has been considered to be an effective method to maintain the quality and shelf life of parsley leaves [19].

Modified atmosphere packaging (MAP) is regarded as a gas mixture, which has an atmosphere different from that of air and which surrounds the product to bring about beneficial effects, for extending the shelf life of the commodity [20]. The mixture atmosphere is made up primarily of oxygen, carbon dioxide and nitrogen [21]. The term, commodity generated or passive modified atmosphere packaging to designate the matching of commodity respiratory characteristics with the gas permeability of package system so that a suitable equilibrium MAP can passively evolve through the consumption of oxygen and the evolution of carbon dioxide in the respiration process [22, 23]. On the other hand, an active modified atmosphere can be established by venting air from the package and by back flushing through a selected gas mixture. Products with natural defense structures can be preserved by MAP; the reduction of ripening of product by means of MAP is beneficial for retaining the integrity of epidermal tissue and thus maintaining resistance to spoilage [24]. Higher carbon dioxide concentrations can inhibit aerobic microorganisms in MAP. Reduction of vegetable respiration rate has been occurred as result of the inhibition of the activity of oxidizes such as a polyphenol oxidize, ascorbic acid oxidizes and glycol acid oxidizes [25]. Many researchers have dealt with the field of modified atmosphere packaging. For example, Zenoozian [26] found that, parsley leaves stored in active MAP at 7-10% O_2, 7-10% CO_2 and 80-85% N_2 improved storability of leaves, inhibiting microbial growth, reducing the decay % and maintained leaves quality (vit. C and chlorophyll contain) during cold storage at 5°C for 7 days.

The aim of this study was to evaluate four cultivars of parsley grown under the Egyptian conditions on the basis of vegetative growth, yield and chemical quality (essential oil content and its composition, total chlorophyll, ascorbic acid (Vitamin C) and fiber content) also, determines the effect of MAP on quality and storability of parsley leaves during storage.

MATERIALS AND METHODS

Field Experiment: A field experiment was conducted during the two successive seasons of 2016-2017 and 2017-2018 at the Agricultural Experiment Station Department of Medicinal and Aromatic plants, Horticulture Research Institute, Agricultural Research Center, Dokki, Egypt. Four cultivars of parsley were cultivated under uniform conditions, two Italian ones were flat-leaf (Gigante D' Italia and Peione) and the french curly leaf (cv, Bravour) which were obtained from Enza Zaden company, while the fourth one was the local variety (Egyptian flat leaf parsley) which obtained from Horticulture Research Institute.

The seeds of four parsley cultivars were sown directly (at the rate of 6 kg/Fed.) in the field in experimental units; of 2.5 x 3 m^2 including four rows (60 cm of its wide) on 25th and 27th October in the first and second seasons, respectively. The seeds were sown as broadcasting on the row surface. Cultivars were arranged in a randomized complete block design with three replications.

The horticultural recommended practices for parsley were applied. The parsley plants were hand harvested at the stage of marketable foliage size, by cutting at a height of 5 cm above soil surface, So three harvests were taken

per seasons on 6th and 10th January, 7 thand 9 thFebruary and 6th and 8th March in 2017 and 2018 seasons respectively. Data were recorded as follow:

Vegetative Growth: A random sample of twenty plants from each plot was taken at harvest time to investigate growth parameters for the four cultivars i.e. plant height (cm) and number of leaves per plant and plant fresh weight (g).

Yield: Fresh yield of herb kg/m^2 and dry yield of herb kg/$m^2$are determined.

Quality Characters

Essential Oil Percentage and Yield: Essential oil percentage was determined in fresh herb according to the method described in the British Pharmacopoeia [27]. Oil yield per m^2 was calculated by multiplying oil percentage by herb yield/ m^2 and expressed as ml/m^2.

Essential Oil Components: The volatile oil obtained from the fresh leaves was analyzed in Laboratory of Medicinal and Aromatic Plants Research Department, Horticulture Research Institute, (ARC) using Ds Chrom 6200 Gas Chromatograph apparatus, fitted with capillary column BPX-5, 5 phenyl (equiv.) polysillphenylene-siloxane 30 x 0.25 mm ID x 0.25µ film. Temperature program ramp increase rate of10°C/min from 70°C to 200°C. Flow rates of gases were nitrogen at 1 ml/min, hydrogen at 30 ml/min and 330 ml/min for air Detector and injector temperatures were 300°C and 250°C respectively [28].

Total Chlorophyll Content: Total chlorophyll was calorimetrically determined in leaf samples (mg/g. fresh weight) according to Saric *et al.* [29].

Ascorbic Acid Content: Ascorbic acid was determined by the method described by Klein and Perry [30]. The vitamin C content was expressed as mg/100g.

Fibers: Random sample of (100 g) herbs from each replicate were used and fibers were determined according to AOAC method [31].

Postharvest Experiment: Parsley plants of the best cut and the best cultivar and the Egyptian parsley were taken and then transported to the laboratory of Postharvest and Handling of Vegetable Crops Research Department, at Giza. Plants with uniform in size, color and healthy without any injures of leaves and stems were selected for postharvest experiment. 100 grams of leaves were bunched as one replicate, bunches of plants were divided into four groups; each group contained fifteen bunches for each of the following treatments.

- The first group, The bunches inserted into the polypropylene bags (20 × 25 cm) 30 µm in thickness and heat sealed, then flushed with a gas mixture at 8% O_2 and 3% CO_2, active Modified Atmosphere Packaging (active MAP1).
- The second group, The bunch inserted into the polypropylene bags (20 × 25 cm) 30 µm in thickness and heat sealed, then flushed with a gas mixture at 5% O_2 and 3% CO_2 active Modified Atmosphere Packaging (active MAP2).
- The third group, The bunch inserted into the polypropylene bags (20 × 25 cm) 30 µm in thickness and heat sealed, Passive Modified Atmosphere Packaging (Passive MAP).
- The fourth group, Unpacked bunches were served as control.

The treatments were arranged in complete randomized design and stored at 0° C and 90-95% relative humidity for 28 days. The sample for each treatment was taken at random in three replicates and evaluated after harvest and then after 7, 14, 21 and 28 days of storage for the following properties.

Weight Loss Percentage: Was Estimated According to the Following Equation:

Weight loss % = [(Initial weight - weight of herbs at sampling date)/Initial weight of herbs] x 100.

General Appearance (Score): As evaluated using a scale from 9 to 1, when 9=excellent, 7=good, 5=fair, 3=poor and 1=unsalable; planets rating (5) or below were considered as unmarketable, as described by Kader *et al.* [32]. It was recorded for both of the shriveling, wilting and color.

Chlorophyll Content: Leaves were taken using a portable chlorophyll meter (SPAD-502, Minolta, Tokyo, Japan) and was expressed in arbitrary absorbance (or SPAD values) as mention in Netto *et al.* [33].

Gas Composition Inside the Packages: The concentrations of O_2 and CO_2 inside the packages were monitored using Dual Trak model 902 D gas analyzer. By inserting the test probe through a rubber seal attached to the outside of the packaging.

GLC: Essential oil components were examined after 14 and 28 days of storage at 0°C.

Statistical Analysis: Data of the experiment were designed according to the Randomized Complete Block Design (R.C.B.D.) in a factorial experiment with two factors, the first one was cuts at three times during seasons 2016-2017 and 2017-2018 and the second one was four cultivars (Peione, Gigante D' Italia, Bravour or the local Egyptian parsley) of parsley, which grown under the Egyptian conditions during the same time. Each experimental unit (treatment) was of three replicates.

For storage experiment combined analysis for each trait was calculated over two years before calculating the combined analysis, a test for homogeneity of error squares for the two years was done as outlined by Snedecor and Cochran [34].

Data was subjected to statistical analysis according to ANOVA table by using MSTAT software. Means were compared by Duncan's test at $P<0.05$ was considered statistically according to Snedecor and Cochran [34].

RESULTS AND DISCUSSION

Vegetative Growth: Data in Table (1) showed that, there was a significant difference between the four cultivars on vegetative growth of parsley plants. For instances, Peione cultivar had significantly increment in plant height, number of leaves/plant, plant fresh weight (F.W) and dry weight (D.W) followed by Gigante cultivar with significant differences between them in the two seasons while Bravour cultivar had the lowest values.

Concerning the effect of different cuttings, date revealed that, the growth of second cut measured in terms of plant height, number of leaves/plant, plant fresh weight and plant dry weight of parsley plants varied significantly for the different cuts (Table, 1). The second cut recorded the highest values of plant height, number of leaves/plant, plant fresh and dry weight in comparison with the rest cuts. These results were true in the two seasons.

The interaction between cultivars and different cuts on vegetative growth, data revealed that, four cultivars showed significant variation in the vegetative growth trails of both growing seasons, Peione cultivar gave the tallest plants, higher no of leaves/plant and highest values of plant fresh and dry weight at all cuts in both seasons, however, the highest values of plant height and number of leaves/plant were obtained from the second cut. Concerning the number of leaves/plant, data showed that the second and first cuts from Peione cultivar gave the highest values with no significant differences between them in the second season.

Table 1: Vegetative growth characters of parsley cultivars for the three cuts in both seasons

	First season 2016/2017				Second season 2017/2018			
Cultivars	First cut	Second cut	Third cut	Mean	First cut	Second cut	Third cut	Mean
				Plant height (cm)				
Local	31.67 EF	38.33 CD	29.35 FG	33.12 C	23.00 G	35.00 DE	31.33 EF	29.78 C
Peione	47.33 AB	50.67 A	38.00 CD	45.33 A	42.67 B	71.00 A	36.33 CD	50.00 A
Gigante	37.00 CDE	42.67 BC	34.35 D-F	38.01 B	31.52 EF	39.87 BC	30.36 F	33.92 B
Bravour	22.67 HI	25.63 GH	19.25 I	22.52 D	20.65 GH	24.35 G	18.82 H	21.27 D
Mean	34.67 B	39.32 A	30.24 C	----	29.46 B	42.56 A	29.21 B	----
				Number of leaf/plant				
Local	15.00 DE	15.10 DE	13.25 EF	14.45 C	15.36 E	16.22 E	14.68 EF	15.42 C
Peione	22.00 B	25.36 A	19.00 C	22.12 A	27.00 A	29.00 A	26.00 AB	27.33 A
Gigante	18.67 C	19.17 C	17.00 CD	18.28 B	21.69 CD	22.69 BC	17.93 DE	20.77 B
Bravour	10.33 GH	12.00 FG	9.39 H	10.57 D	10.66 FG	11.12 FG	8.24 G	10.01 D
Mean	16.50 B	17.91 A	14.66 C	----	18.68 AB	19.76 A	16.71 B	----
				Plant fresh weight (g.)				
Local	3.30 GH	12.56 D	5.20 FGH	7.02 C	2.71 F	10.16 C	4.20 E	5.69 C
Peione	9.43 DEF	39.31 A	24.15 B	24.30 A	8.11 D	23.58 A	11.54 C	14.41 A
Gigante	7.74 EFG	22.07 BC	18.91 C	16.24 B	6.81 D	16.17 B	8.20 D	10.39 B
Bravour	1.87 H	10.47 DE	2.28 H	4.87 C	1.90 F	7.86 D	2.44 F	4.07 D
Mean	5.59 C	21.10 A	12.64 B	----	4.88 C	14.44 A	6.59 B	----
				Plant dry weight/plant (g.)				
Local	0.480 EF	2.416 C	0.818 DEF	1.238 C	0.390 F	2.082 B	0.830 E	1.101 C
Peione	1.361 D	5.630 A	3.473 B	3.488 A	1.174 DE	3.406 A	1.665 C	2.082 A
Gigante	1.066 DE	3.043 BC	2.715 C	2.275 B	0.932 DE	2.229 B	1.128 DE	1.430 B
Bravour	0.254 F	1.460 D	0.448 EF	0.721 D	0.315 F	1.247 D	0.385 F	0.649 D
Mean	0.790 C	3.137 A	1.863 B	----	0.703 C	2.241 A	1.002 B	----

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test.

Total Yield (Kg/m^2): Data in Table (2) clearly indicated that, the fresh yield (kg/m^2) and dry yield (kg/m^2) of parsley cultivars significantly varied for the three cuts in both seasons. Peione cultivar was superior in producing higher fresh and dry yield compared with the other cultivars, while, the lowest values of these characters were obtained from Bravour cultivar. These results were in harmony with those reported by Pasikowska *et al*., [35] and Dris and Jain [36], who stated that the differences in nutrients uptake and metabolism in plants is influenced by genetic variability between plant crops and even between cultivars within the same species. There were significant differences between different cuts of fresh and dry yield; however, the second cut gave the highest values of these characters as compared with the other cuts followed by the third cut with significant difference between them in the two seasons.

Regarding the interaction between cultivars and different cuts, data in Table (2) showed that, the maximum values of fresh and dry yield were recorded in case of Peione cultivar in the 2ndcut. These results were true in the two seasons and in agreement with Sabry *et al.* [37].

Essential Oil Percentage: Data in Table (3) showed that, distinct variation between cultivars on oil percent, Peione cultivar contain the significant highest oil percent based on dry weight (0.058 and 0.051) in the first and second seasons, respectively followed by Gigante and Local cultivars. In addition the lowest production of oil was attained by Local, Bravour.

Concerning the different cuts, data revealed that, the second and third cuts gave the highest values of oil percent. These results were true in the two seasons and in agreement with Sabry *et al.* [37] who found that, some cultivars produced high oil percent in the second or third cut, which may be due to the higher temperature prevailed at the second or third cut.

Concerning the effect of the interaction between cultivars and different cuts, data revealed that the Peione cultivar gave the highest value of oil percent in the second followed by third cuts, the essential oil percent was similar to previous studies [17].

Table 2: Fresh and dry herb yields (kg/m^2) of parsley cultivars for the different three cuts in both seasons

	First season 2016/2017				Second season 2017/2018			
Cultivars	First cut	Second cut	Third cut	Mean	First cut	Second cut	Third cut	Mean
			Fresh herb yield (kg/m^2)					
Local	2.40 G	3.33 F	2.87 FG	2.87 C	2.03 G	3.07 E	2.55 F	2.55 C
Peione	5.83 BC	6.40 A	6.12 AB	6.12 A	4.85 C	6.01 A	5.43 B	5.43 A
Gigante	4.73 E	5.43 CD	5.11 DE	5.09 B	3.84 D	4.32 D	4.08 D	4.08 B
Bravour	0.85 H	1.34 H	1.07 H	1.09 D	1.21 H	1.60 GH	1.40 H	1.40 D
Mean	3.45 C	4.13 A	3.79 B	---	2.98 C	3.75 A	3.37 B	----
			Dry herb yield (kg/m^2)					
Local	0.349 F	0.630 D	0.446 E	0.475 C	0.292 E	0.627 CD	0.508 D	0.475 C
Peione	0.841 B	0.923 A	0.882 AB	0.882 A	0.699 BC	0.867 A	0.783 AB	0.783 A
Gigante	0.650 D	0.844 B	0.747 C	0.747 B	0.528 D	0.594 CD	0.561 D	0.561 B
Bravour	0.116 H	0.186 G	0.146 GH	0.149 D	0.198 E	0.251 E	0.227 E	0.225 D
Mean	0.489 C	0.646 A	0.555 B	---	0.429 C	0.585 A	0.520 B	---

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test.

Essential Oil Yield (ml/m^2): Oil yield (ml/m^2) was calculated for the four cultivars in the present study. It was obviously shown that Peione and Gigante cultivars produced the highest oil yield as compared with the other cultivars with no significant differences between them in the first season. However, Local and Bravour cultivars produced the lowest oil yield with no significant differences between them in the two seasons (Table, 4)

Concerning the effect of different cuts, data revealed that, there were no significant differences between different cuts in the two seasons.

Table (3) showed the interaction between cultivars and cuts on oil yield (ml/m^2), data revealed that, no significant differences between cuts for the tested cultivars. However, Peione cultivar gave the highest oil yield in the 1$^{st.}$, 2$^{nd.}$ and 3$^{rd.}$ cuts for the two seasons respectively.

Essential Oil Composition (%): The results of GLC analysis of the volatile oils of the four cultivars of parsley in the second cut in second season in Table (4) showed that chemical composition of essential oil was different in response to the cultivar as follows: the essential oil of Peione cultivars, the main constituents were β-Phellandrene (36.34%), Apiol

Table 3: Essential oil percent (%) and oil yield (ml/ m^2) of parsley cultivars grown under Egyptian conditions at different cuts in both seasons.

	First season 2016-/2017				Second season 2017/2018			
Cultivars	First cut	Second cut	Third cut	Mean	First cut	Second cut	Third cut	Mean
	Essential oil percent (%)							
Local	0.020 A	0.039 A	0.027 A	0.029 AB	0.015 A	0.036 A	0.026 A	0.026 AB
Peione	0.054 A	0.061 A	0.059 A	0.058 A	0.043 A	0.058 A	0.052 A	0.051 A
Gigante	0.028 A	0.048 A	0.036 A	0.037 AB	0.026 A	0.039 A	0.034 A	0.033 AB
Bravour	0.014 A	0.031 A	0.022 A	0.022 B	0.011 A	0.027 A	0.023 A	0.020 B
Mean	0.029 B	0.045AB	0.036 A	----	0.024 A	0.040 A	0.034 A	----
	Oil yield (ml/m^2)							
Local	0.007 A	0.025 A	0.012 A	0.015 B	0.004 D	0.023 B-D	0.013 B-D	0.013 B
Peione	0.045 A	0.056 A	0.052 A	0.051 A	0.03 A-C	0.05 A	0.041 AB	0.040 A
Gigante	0.018 A	0.041 A	0.027 A	0.029 AB	0.014 CD	0.023 A-D	0.019 A-D	0.019 B
Bravour	0.002 A	0.006 A	0.003 A	0.003 B	0.002 D	0.007 D	0.005 D	0.005 B
Mean	0.018 A	0.032 A	0.024 A	----	0.013 A	0.026 A	0.020 A	----

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test

Table 4: GLC analysis of Essential oil components (%) of different parsley cultivars

Main components	Local	Peione	Giganta	Bravour
1- α-Pinene	12.59	0.37	1.32	5.58
2- β-Myrcene	12.17	4.07	4.92	7.13
3- β-Pinene	5.23	1.05	0.85	3.08
4- β-Phellandrene	22.79	36.34	23.24	27.75
5- p-Cymene	1.13	1.86	2.20	2.21
6- D-Limonene	0.20	7.21	2.19	1.87
7- γ-Terpinene	3.27	0.96	1.09	1.30
8- α-terpinolene	3.83	1.97	2.13	2.25
9- 1,3,8-p-Menthatriene	8.49	9.55	2.30	10.24
10- Germacrene	1.86	1.43	1.61	0.92
11- Myristcin	12.81	6.85	34.11	34.29
12- Apiol	15.63	28.32	24.03	3.38

(28.32%). Referring to the oil of curly parsley Bravour variety, its major constituents were Myristcin (34.29%), β-Phellandrene (27.75%), 1,3,8-*p*-Menthatriene (10.24%). Concerning the oil of Italy cultivar Gigante, its chief components were Myristcin (34.11%), Apiol (24.03%), β-Phellandrene (23.24%). Regarding the oil of Local cultivar, the major constituents were β-Phellandrene (22.79%), Apiol (15.63%), α-Pinene, Myristcin and β-Myrcene; 12.59%, 12.81% and 12.17%, respectively.

New cultivars and hybrids introduction to different environments and adaptation to new environmental conditions is very beneficial in crops breeding. The germplasm collection could serve as an important source of genetic material for plant breeding and selection based on different growth and yield characteristics and also upon known comparative relationships among essential oil constituents [38]. Toaima *et al.* [39] found that the composition of essential oil in different plant crops, particularly parsley is affected by genotype, environmental conditions and culture systems. Attokkaran [40] reported that the essential oil from the parsley herb contains Apiol, Myristcin, α-Pinene, β-Phellandrene, Myrcene and some oxygenated compounds, Sabry *et al*. [37] indicated that, parsley cultivars showed significant differences in their essential oil composition in response to different species.

Also, it could be noticed that the essential oil of curly parsley Bravour cultivar and two Italy cultivars Peione and Gigante were rich in Myristcin than the local variety. Furthermore, essential oil of Italy Peione variety contained highest percentage of Apiol, while the Local variety recorded lower value. Also, Bravour, Gigante and Peione varieties were rich in β-Phellandrene than the local variety. This analysis proved the importance of new introduced varieties for medical and food sectors as myristicin had an antioxidant and anticancer properties. Furthermore, Apiol (4, 7-dimethoxy-5-(2-propenyl)-1, 3-benzodioxole) has shown antioxidant, diuretic, anticancer and antimicrobial activities [13, 40-42].

The major constituents of the parsley accessions evaluated were in agreement with previous reports by Lopez *et al.* [43] indicated that, 1,3,8-*p*-Menthatriene, Apiol, Phellandrene, Myrcene and 4-Isopropyl-1-Methylbenzene were among the most prevalent constituents in parsley leaf oil.

Total Chlorophyll (mg/g F.W): Table (5) is presenting values of total chlorophyll content in fresh leaves of all evaluated parsley cultivars. Data presented that, Peione and Bravour cultivars had the significant highest value of chlorophyll (2.85, 2.75 and 2.64, 2.51 mg/g fresh weight) in the first and second season, respectively with no significant differences between them in the two seasons. The other two cultivars had lower values of chlorophyll content with significant difference between them (Local and Gigante cultivars). These results seem to match with that reported by Novac [44] and Osińska *et al.* [45] who found that, the content of chlorophyll in the leaves of parsley plants is depended on the variety. These results revealed the healthy benefits of new introduced foreign varieties as a rich source of chlorophyll pigment.

Concerning the effect of different cuts, there was asignificant difference among three cuts on total chlorophyll content of parsley leaves in the two seasons. However, the first and the second cuts had the highest values of total chlorophyll with no significant difference between them in the first season.

The interaction between cultivars and cuts was a significant in the two seasons. Peione and Gigante cultivars had the highest value of total chlorophyll content in the first and second cuts with no significant differences between them in the two seasons.

Ascorbic acid (Vitamin C) content: Data in Table (5) showed that, there was significant difference between the four cultivars on Vitamin C (vit. C.) content of parsley leaves. For Peione cultivar had significantly increment in Vitamin C. compared with the other cultivars.

Vitamin C is one of the antioxidants that suppress the ROS (Reactive Oxygen Species) induced by stress and plays a key role in cell division and expansion [46, 47]. In our study the vitamin concentration value agreed with that reported in previous study for parsley (123 – 165 mg/100 g FW) [48].

Concerning the effect of different cuts, data revealed that, there was significant difference between different cuts of parsley leaves; however, the second cut had significantly highest values of vit. C. content compared with the other cuttings. In general, the interaction between cultivars and cuttings was significant in both seasons; however, Peione cultivar had significantly highest value of vit. C. in the second and first cuts with no significant differences between them in the first season, while the lowest one were recorded in Bravour cultivar in the three cuts with no significant difference between them in the second season.

In conclusion, the high quality was observed in plain-leafed parsley if compared to curly leafed parsley, which had higher vegetative growth parameter (plant height, number of branches/plant, fresh and dry weight/plant, fresh yield of herb/m^2 and dry yield of herb/m^2) and phytochemical contents (total chlorophyll and vit. C.) in the two seasons in the three cuts. Same studies attributed parsley popularity due to its high concentration of Vitamin C [49].

Table 5: Total chlorophylls, Ascorbic acid and Fiber content of parsley cultivars at the different cuts in both seasons

	First season 2016/2017				Second season 2017/2018			
Cultivars	First cut	Second cut	Third cut	Mean	First cut	Second cut	Third cut	Mean
			Total chlorophylls (mg/g F.W)					
Local	2.54 B-D	2.61 A-C	1.78 F	2.31 B	2.42 BCD	2.49 A-C	1.66 F	2.19 B
Peione	3.00 A	3.03 A	2.53 B-D	2.85 A	2.89 A	2.92 A	2.42 B-D	2.75 A
Gigante	1.85 F	2.11 D-F	1.93 EF	1.96 C	1.76 EF	2.02 D-F	1.84 EF	1.87 C
Bravour	2.68 A-C	2.92 AB	2.31 C-E	2.64 A	2.55 A-C	2.79 AB	2.18 C-E	2.51 A
Mean	2.52 A	2.67 A	2.14 B	---	2.41 A	2.56 A	2.03 B	----
			Ascorbic acid (mg/100g FW)					
Local	31.67 EF	38.33 CD	29.35 FG	33.12 C	23.00 G	35.00 DE	31.33 EF	29.78 C
Peione	47.33 AB	50.67 A	38.00 CD	45.33 A	42.67 B	71.00 A	36.33 CD	50.00 A
Gigante	37.00 CDE	42.67 BC	34.35 D-F	38.01 B	31.52 EF	39.87 BC	30.36 F	33.92 B
Bravour	22.67 HI	25.63 GH	19.25 I	22.52 D	20.65 GH	24.35 G	18.82 H	21.27 D
Mean	34.67 B	39.32 A	30.24 C	----	29.46 B	42.56 A	29.21 B	---
			Fiber (g/100g D.W)					
Local	0.750 D	0.780 CD	0.823 BC	0.784 B	0.700 C	0.730 BC	0.773 B	0.734 B
Peione	0.550 E	0.540 E	0.553 E	0.548 C	0.490 D	0.480 D	0.493 D	0.488 C
Gigante	0.550 E	0.560 E	0.580 E	0.563 C	0.480 D	0.490 D	0.510 D	0.493 C
Bravour	0.860 AB	0.890 A	0.900 A	0.883 A	0.830 A	0.860 A	0.870 A	0.853 A
Mean	0.678 B	0.693 AB	0.714 A	---	0.625 B	0.640 AB	0.662 A	---

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test.

Fibers (g/100g D.W): Data in Table (5) revealed that there was a significant difference between cultivars on fiber content of parsley leaves. However, Peione and Gigante cultivars had significantly lowest content in fiber content compared with the other cultivars with no significant differences between them in the two seasons. The highest once were recorded in Bravour cultivar.

Concerning the effect of different cuts, data showed that there was significant difference between cuttings on fiber content of parsley leaves. However, the first cut had significantly lowest value of fiber content followed by second cut with no significant difference between them in the two seasons. The highest once were recorded in the third cut.

In general, the interaction between cultivars and cuttings were significant in both seasons, however, Peione and Gigante cultivars had the lowest values of fiber content in the three cuts with no significant difference between them in both seasons.

These results may be due to increasing in different plant characters which were higher in Peione cultivar when compared with the other parsley cultivars or Local cultivar.

Postharvest Experiment

Weight Loss Percentage: Data in Table (6) showed that, weight loss percentage of parsley plants was increased considerable and consistently with the prolongation of storage period. These results are in agreement with those obtained by [50]. The loss in weight may be attributed to transpiration, respiration and other senescence related metabolic process during storage [8]. There were significant differences among MAP treatments, however active or passive MAP retained their weight during storage as compared with unpacked plants. Moreover, parsley plants hold in active MAP at 8% O_2 + 3% CO_2 followed by MAP at 5% O_2 + 3% CO_2 resulted prominent reduction in weight loss percentage during storage with significant difference between them. On the other hand, the highest values of weight loss percentage were recorded with unpacked plants (control). These results were true in the two seasons and in agreement with Ouzounidou [50] and Hammam [51].

Active MAP had at least loss in weight of parsley plants and this may be due to the respiration rates of parsley plants were restricted in active MAP, also carbohydrates resources were consumed slightly in active MAP [26].

The lowest weight loss percentage from active MAP treatment is due to the confinement of moisture around the produce by polypropylene bags. This increases the relative humidity and reduces vapor pressure deficit and transpiration. In addition, packaging creates a modified atmosphere with higher concentrations of CO_2 and reduced O_2 around the produce which slows down the metabolic processes and transpiration which diminished the weight loss during storage and shelf life [52-54].

Table 6: Effect of cultivars and modified atmosphere packages on weight loss percentage of parsley plants during storage

	Storage period in weeks						
Cultivars	Treatments	0	1	2	3	4	Mean
Peione	MAP1	0.00 S	0.17 RS	0.33 Q-S	0.51 P-R	0.72 L-Q	0.35 F
	MAP2	0.00 S	0.34 Q-S	0.56 O-R	0.84 K-P	1.14 J-M	0.58 E
	Passive MAP	0.00 S	0.69 M-Q	0.95 J-P	1.25 I-K	1.36 IJ	0.85 CD
	Control	0.00 S	3.72 H	6.34 F	10.20 D	16.19 B	7.29 B
Mean		0.00 I	1.23 H	2.05 F	3.20 D	4.85 B	2.27 B
Local	MAP1	0.00 S	0.34 Q-S	0.63 N-R	0.85 K-P	1.12 J-N	0.59 E
	MAP2	0.00 S	0.54 O-R	0.83 K-Q	0.98 J-P	1.21 I-L	0.71 DE
	Passive MAP	0.00 S	0.82 K-Q	1.02 J-O	1.25 I-K	1.66 I	0.95 C
	Control	0.00 S	4.72 G	8.67 E	11.54 C	17.53 A	8.49 A
Mean		0.00 I	1.61 G	2.79 E	3.65 C	5.38 A	2.69 A
Mean	MAP1	0.00 J	0.26 IJ	0.48 HI	0.68 GH	0.92 FG	0.47 D
	MAP2	0.00 J	0.44 HI	0.69 GH	0.91 FG	1.17 EF	0.64 C
	Passive MAP	0.00 J	0.76 GH	0.98 FG	1.25 EF	1.51 E	0.90 B
	Control	0.00 J	4.22 D	7.50 C	10.87 B	16.86 A	7.89 A
Mean		0.00 E	1.42 D	2.42 C	3.43 B	5.12 A	

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test.

MAP1= Active MAP (8% O_2 + 3% CO_2) MAP2= Active MAP (5% O_2 + 3% CO_2)

The highest weight loss observed in unwrapped herbs throughout the storage period can be attributed to air movement, which tends to sweep away the unstirred layer of air (at aquibrium vapor pressure with the tissues) adjacent to the surface of the produce, thus increasing the vapor pressure deficit [55].

There was a significant difference between the two cultivars on weight loss percentage. However, Peione cultivar had significantly decreased in weight loss, percentage during storage compared with Local cultivar.

Concerning of the interaction among cultivars, MAP and storage period. Data in the same Table (6) revealed that, after 28 days of storage there were significant differences, however, parsley plants of Peione cultivar held inactive MAP at 8% O_2 + 3% CO_2 had the lowest weight loss percentage followed by active MAP at 5% O_2 + 3% CO_2 with no significant differences between them.

General Appearance (Score): Data in Table (7) revealed that, as expected General Appearance (GA) parsley plants, was decreased significantly with the prolongation of storage periods. Similar results were reported by Zenoozian [26] and Ouzounidou *et al*. [50] on parsley plants. The decrease in GA of parsley plants during storage period might be due to shriveling, wilting, color changes and decay [50].

There were significant differences between MAP treatments and unpacked plants (control) in GA during storage; moreover, active MAP was better than passive MAP or unpacked plants (control). The results proved that active MAP at 8% O_2 + 3% CO_2 was the most effective treatment for maintaining GA during storage of parsley plants. These results were in agreement with Zenoozian [26]. Previous studies showed that, MAP delayed senescence of parsley plants [51]. Water saturated atmosphere within the packages controlled water loss and delayed senescence in the absence of water stress and thereby extended postharvest longevity of parsley plants [50]. Beside, MAP can effectively inhibit the cell permeability increase [25].There for the shelf life of parsley plants was increased accordingly [22].

Higher carbon dioxide concentrations can inhibit aerobic microorganisms in MAP. Reduction of vegetable respiration rate has been occurred as result of the inhibition of the activity of oxidizes such as a polyphenol oxidase, ascorbic acid oxidase and glycol acid oxidizes [56].

There was a significant difference between the two cultivars on General Appearance of parsley plants during storage. However, the highest values of GA resulted from Peione cultivar, while the lowest ones were obtained from the Local cultivar.

Regarding the effects of cultivars, MAP and storage period on GA of parsley plant, data in Table (7) showed that, parsley plants of Peione cultivar stored in active MAP at 8% O_2 + 3% CO_2 showed the best appearance and they did not exhibited any changes in their appearance till 28 days of storage and give good appearance at the end of storage period (28 days). However, parsley plants of Peione cultivar stored at 5% O_2 and 3% CO_2 had good appearance until 28 days of storage and then dropped to fair level at the end of storage period. On the other hand, unpacked (control) plants of Local cultivar resulted in poor appearance after 14 days of storage.

Table 7: Effect of cultivar and modified atmosphere packages on general appearance (score) of parsley plants during storage.

	Storage period in weeks						
Cultivars	Treatments	0	1	2	3	4	Mean
Peione	MAP1	9.00 A	9.00 A	9.00 A	8.33 AB	7.00 CD	8.47 A
	MAP2	9.00 A	9.00 A	8.33 AB	7.00 CD	6.33 D	7.93 B
	Passive MAP	9.00 A	9.00 A	7.67 BC	6.33 D	5.00 E	7.40 C
	Control	9.00 A	7.67 BC	3.67 F	2.33 G	1.00 H	4.73 E
Mean		9.00 A	8.67 A	7.17 C	6.00 D	4.83 E	7.13 A
Local	MAP1	9.00 A	9.00 A	8.33 AB	7.00 CD	6.33 D	7.93 B
	MAP2	9.00 A	9.00 A	7.67 BC	5.00 E	5.00 E	7.13 C
	Passive MAP	9.00 A	8.33 AB	7.00 CD	3.00 FG	3.00 FG	6.07 D
	Control	9.00 A	5.00 E	3.00 FG	1.00 H	1.00 H	3.80 F
Mean		9.00 A	7.83 B	6.50 D	4.00 F	3.83 F	6.23 B
Mean	MAP1	9.00 A	9.00 A	8.67 AB	7.67 C	6.67 DE	8.20 A
	MAP2	9.00 A	9.00 A	8.00 BC	6.00 EF	5.67 F	7.53 B
	Passive MAP	9.00 A	8.67 AB	7.33 CD	4.67 G	4.00 GH	6.73 C
	Control	9.00 A	6.33 EF	3.33 H	1.67 I	1.00 I	4.27 D
Mean		9.00 A	8.25 B	6.83 C	5.00 D	4.33 E	

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test.
MAP1= Active MAP (8% O_2 + 3% CO_2) MAP2= Active MAP (5% O_2 + 3% CO_2)

Total Chlorophyll Content: Data in Table (8) there was significant reduction in total chlorophyll content of parsley plants during storage. This decrement in chlorophyll content could be attributed to gradual increase of chlorophyll destruction by chlorophyll degrading peroxides' activity and also transformation of chloroplasts to chromoplasts by chlorophylls activity [57]. These results were in agreement with those obtained by Hammam [51] on parsley plants.

A major problem for parsley marketing is the extension of its shelf life without significant change in chlorophyll content and color parameters during storage, such as changes resulting in leaf yellowing [18]. There were significant differences between the two cultivars on total chlorophyll content during storage; however, parsley plants of Peione cultivar had the highest values of total chlorophyll content, while the local cultivars gave the lowest ones.

All MAP treatments significantly reduced the loss of total chlorophyll content as compared with unpacked plants control. However, parsley plants stored in active MAP at 8% O_2 + 3% CO_2 seems to be the most effective in reducing the total chlorophyll loss; followed by active MAP at 5% O_2 + 3% CO_2 with significant differences between them. The lowest value of total chlorophyll content was obtained from unpacked plants (control). These results were in agreement with Hammam [51] and Yamadchi and Watada [58].

The favorable effect of MAP reduction of chlorophyll loss of parsley leaves may be due to low oxygen concentration and low respiration, which inhibit certain ripening processes consequently reduce chlorophyll degradation in parsley plants [51].

During storage, the untreated parsley was more susceptible to chlorophylls and carotenoids loss and thus to yellowing. This could be attributed to differences in the balance of the antioxidant system in the tissues that resulted in higher accumulation of reactive oxygen species (ROS) [18].

Table 8: Effect of cultivar and modified atmosphere packages on total chlorophyll (SPAD) of parsley plants during storage

	Storage period in weeks						
Cultivars	Treatments	0	4	8	12	16	Mean
Peione	MAP1	42.61 A	42.26 AB	40.70 BC	38.87 D	36.92 EF	40.27 A
	MAP2	42.61 A	41.24 AB	39.22 CD	38.37 DE	34.62 G-I	39.21 B
	Passive MAP	42.61 A	40.82 A-C	38.73 D	36.36 FG	34.66 G-I	38.64 B
	Control	42.61 A	38.23 DE	34.67 G-I	29.55 KL	25.74 NO	34.16 C
Mean		42.61 A	40.64 B	38.33 C	35.79 D	32.98 F	38.07 A
Local	MAP1	36.62 EF	35.19 F-H	34.36 HI	31.21 JK	26.92 MN	32.86 D
	MAP2	36.62 EF	35.63 F-H	33.30 I	31.03 K	24.62 O	32.24 D
	Passive MAP	36.62 EF	34.33 HI	31.06 K	27.02 MN	24.00 O	30.61 E
	Control	36.62 EF	32.93 IJ	28.23 LM	19.92 P	15.74 Q	26.69 F
Mean		36.62 D	34.52 E	31.74 G	27.30 H	22.82 I	30.60 B
Mean	MAP1	39.62 A	38.73 AB	37.53 BC	35.04 DE	31.92 F	36.57 A
	MAP2	39.62 A	38.44 AB	36.26 CD	34.70 E	29.62 G	35.73 B
	Passive MAP	39.62 A	37.58 B	34.90 E	31.69 F	29.33 G	34.62 C
	Control	39.62 A	35.58 DE	31.45 F	24.73 H	20.74 I	30.42 D
Mean		39.62 A	37.58 B	35.03 C	31.54 D	27.90 E	

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test.
MAP1= Active MAP (8% O_2 + 3% CO_2) MAP2= Active MAP (5% O_2 + 3% CO_2)

Gas Composition Inside the Packages: Data in Tables (9 & 10) revealed that, there was a significant decrease in O_2 and increase in CO_2 during storage. These results agreed with Hammam [51] and may be due to O_2 composition and CO_2 production of parsley plants during respiration process [58].

There were significant differences between the two cultivars on O_2 and CO_2 inside the packages during all storage periods; however Peione cultivars gave the highest value of O_2 and lowest value of CO_2 during storage as compared with Local cultivars, indicating a reduction in the respiration rate in Peione cultivar then Local cultivar.

Concerning the effect of MAP, data indicated that, O_2 levels in active MAP were significantly lower than those of passive MAP or untreated MAP (control), while the values of CO_2 in package atmosphere were higher in active MAP. Similar pattern in the reduction of O_2 and the increase in CO_2 levels were observed in all packages at cold storage.

The respiration rate of parsley plants were suppressed under the conditions of decreasing O_2 and increasing CO_2 concentration and as results inhibited certain metabolic processing with maintaining the quality of parsley plant during storage [51].

Table 9: Effect of cultivar and modified atmosphere packages on O2 concentration inside the packages of parsley plants during storage

		Storage period in weeks					
Cultivars	Treatments	0	1	2	3	4	Mean
Peione	MAP1	8.00 I	7.80 IJ	7.40 KL	7.00 M	6.40 N	7.32 D
	MAP2	5.00 P	4.70 PQ	4.20 RS	3.60 T	3.20 U	4.14 F
	Passive MAP	20.80 A	20.20 B	19.50 C	17.92 E	14.30 G	18.54 B
	Control	20.80 A	20.80 A	20.80 A	20.80 A	20.80 A	20.80 A
Mean		13.65 A	13.38 B	12.97 D	12.33 F	11.18 H	12.70 A
Local	MAP1	8.00 I	7.60 JK	7.20 LM	6.60 N	6.00 O	7.08 E
	MAP2	5.00 P	4.47 QR	4.00 S	3.10 U	2.50 V	3.81 G
	Passive MAP	20.80 A	19.80 C	18.80 D	16.80 F	13.00 H	17.84 C
	Control	20.80 A	20.80 A	20.80 A	20.80 A	20.80 A	20.80 A
Mean		13.65 A	13.17 C	12.70 E	11.82 G	10.57 I	12.38 B
Mean	MAP1	8.00 F	7.70 G	7.30 H	6.80 I	6.20 J	7.20 C
	MAP2	5.00 K	4.58 L	4.10 M	3.35 N	2.85 O	3.98 D
	Passive MAP	20.80 A	20.00 B	19.15 C	17.36 D	13.65 E	18.19 B
	Control	20.80 A	20.80 A	20.80 A	20.80 A	20.80 A	20.80 A
Mean		13.65 A	13.27 B	12.84 C	12.08 D	10.88 E	

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test.
MAP1= Active MAP (8% O_2 + 3% CO_2) MAP2= Active MAP (5% O_2 + 3% CO_2)

Table 10: Effect of cultivar and modified atmosphere packages on CO2 concentration inside the packages of parsley plants during storage

		Storage period in weeks					
Cultivars	treatments	0	1	2	3	4	Mean
Peione	MAP1	3.00 J	3.20 IJ	3.40 HI	3.90 EF	4.30 D	3.56 C
	MAP2	3.00 J	3.30 HIJ	3.60 FGH	4.20 DE	4.70 BC	3.76 B
	Passive MAP	0.03 P	0.30 OP	0.60 O	1.10 MN	1.40 LM	0.69 E
	Control	0.03 P	0.03 P	0.03 P	0.03 P	0.03 P	0.03 F
Mean		1.52 F	1.71 E	1.91 D	2.31 C	2.61 B	2.01 B
Local	MAP1	3.00 J	3.40 HI	3.80 FG	4.40 CD	5.00 B	3.92 AB
	MAP2	3.00 J	3.50 GHI	3.90 EF	4.50 CD	5.40 A	4.06 A
	Passive MAP	0.03 P	0.50 O	1.00 N	1.50 L	1.90 K	0.99 D
	Control	0.03 P	0.03 P	0.03 P	0.03 P	0.03 P	0.03 F
Mean		1.52 F	1.86 DE	2.18 C	2.61 B	3.08 A	2.25 A
Mean	MAP1	3.00 G	3.30 F	3.60 DE	4.15 C	4.65 B	3.74 B
	MAP2	3.00 G	3.40 EF	3.75 D	4.35 C	5.05 A	3.91 A
	Passive MAP	0.03 L	0.40 K	0.80 J	1.30 I	1.65 H	0.84 C
	Control	0.03 L	0.03 L	0.03 L	0.03 L	0.03 L	0.03 D
Mean		1.52 E	1.78 D	2.05 C	2.46 B	2.85 A	

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test.
MAP1= Active MAP (8% O_2 + 3% CO_2) MAP2= Active MAP (5% O_2 + 3% CO_2)

The interaction between cultivars, MAP and storage period on gas concentration was significant. After 28 days of storage, Peione cultivar stored at active MAP (8% O_2 + 3% CO_2) were (6.40 O_2 + 4.3 CO_2) while the gas composition inside the packages with passive MAP reached (3.0 O_2 + 1.4 CO_2).

Essential Oil Compounds: The parsley essential oil constituents a results of two cultivars and MAP treatments and their interactions during 28 days of storage period are presented in Tables (11 & 12) showed clearly that MAP treatments had appreciable quantitative effects on essential oil constituents of parsley after 14 days of storage in local cultivar the main components in MAP treatments (MAP1, MAP2, passive MAP and control) were β-Phellandrene 28.85, 33.12, 31.23 and 37.42% respectively, which decreased to 26.27, 25.97, 25.39 and 25.93% respectively after 28 days of storage, while Apiol content in MAP treatments after 14 days of storage were 18.62, 27.65, 21.43 and 31.39% respectively which increase to 25.59, 37.23, 30.47 and 37.68 respectively after 28 days of storage.

Table 11: GLC analysis essential oil of Local cultivar.

		Storage period in weeks							
		After 14 days				After 28 days			
Main components	Zero time	MAP1	MAP2	Passive	Control	MAP1	MAP2	Passive	Control
1- α--Pinene	12.59	11.82	4.09	7.69	0.97	16.17	14.59	14.80	15.07
2- β-Myrcene	12.17	9.59	6.32	8.84	6.39	11.56	8.49	10.87	8.25
3- β-Pinene	5.23	0.79	4.11	0.86	0.81	3.69	5.12	3.95	6.22
4- β-Phellandrene	22.79	28.85	33.12	31.23	37.42	26.27	25.97	25.39	25.93
5- p-Cymene	1.13	1.28	1.58	1.48	3.03	0.64	0.80	0.70	0.39
6- D-Limonene	0.20	0.48	0.86	0.94	1.04	0.98	1.66	1.87	1.99
7- γ-Terpinine	3.27	2.91	2.38	1.77	1.06	-	-	-	-
8- α-terpinolene	3.83	3.55	2.10	3.69	1.85	2.17	1.54	1.88	1.30
9- 1,3,8-p-Menthatriene	8.49	9.23	9.99	9.75	11.59	3.47	1.72	2.73	1.22
10- Germacrene	1.86	0.98	0.41	0.78	-	-	-	-	-
11- Myristcin	12.81	11.91	7.38	11.53	4.46	9.46	2.89	7.35	1.94
12- Apiol	15.63	18.62	27.65	21.43	31.39	25.59	37.23	30.47	37.68

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test.
MAP1= Active MAP (8% O_2 + 3% CO_2) MAP2= Active MAP (5% O_2 + 3% CO_2)

Table 12: GLC analysis essential oil of Peione cultivar.

		Storage period in weeks							
		After 14 days				After 28 days			
Main components	Zero time	MAP1	MAP2	Passive	Control	MAP1	MAP2	Passive	Control
1- α--Pinene	0.37	2.42	1.06	1.86	5.49	4.87	3.71	4.96	8.89
2- β-Myrcene	4.07	4.10	3.68	4.23	2.51	3.42	3.31	3.77	2.11
3- β-Pinene	1.05	0.95	0.41	0.71	4.77	3.44	1.82	3.07	7.95
4- β-Phellandrene	36.34	24.70	27.36	31.84	28.35	38.12	39.01	40.98	41.13
5- p-Cymene	1.86	1.81	1.83	1.80	1.17	1.21	1.20	1.42	0.76
6- D-Limonene	7.21	5.78	1.18	3.98	6.85	3.21	2.56	1.82	2.53
7- γ-Terpinine	0.96	0.87	0.44	0.81	0.22	0.47	-	0.36	-
8- α-terpinolene	1.97	1.81	0.90	1.76	0.76	1.62	-	1.47	-
9- 1,3,8-p-Menthatriene	9.55	12.74	15.73	12.45	12.62	7.52	4.33	11.54	7.75
10- Germacrene	1.43	0.85	-	-	-	-	-	-	-
11- Myristcin	6.85	6.56	6.13	6.37	3.84	7.08	5.68	5.74	6.62
12- Apiol	28.32	37.40	41.27	34.20	33.42	29.04	38.37	24.88	18.92

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test.
MAP1= Active MAP (8% O_2 + 3% CO_2) MAP2= Active MAP (5% O_2 + 3% CO_2)

For Peione cultivar, after 14 days of storage the main components in MAP treatment (MAP1, MAP2, passive MAP and control) were β-Phellandrene 24.70, 27.36, 31.84 and 28.35 respectively which increase to 38.12, 39.01, 40.98 and 41.13 respectively after 28 days of storage. While Apiol content in MAP1, MAP2, passive MAP and control (37.40, 41.27, 34.20 and 33.42) respectively decrease to 29.04, 38.37, 24.88 and 18.92 respectively after 28 days of storage.

CONCLUSION

Peione cultivar which imported from Italy and introduced to our area of Giza, Egypt and cultivated in the clay soil were adapted to these conditions, showed very acceptable vegetative growth high yield of fresh and dry weights and essential oil. Moreover, parsley plants of Peione cultivar stored at active modified atmosphere packaging (MAP) at 8% O_2 + 3% CO_2 improved the storability, maintained quality and gave plants with Good Appearance (GA) of parsley plant till 28 days of storage at 0°C.

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