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EVOLUTION OF SOME PHYSICAL AND CHEMICAL CHARACTERISTICS DURING GROWTH AND DEVELOPMENT OF MUSKMELON (*Cucumis melo L.*)

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Fruits of six muskmelon (*Cucumis melo* L.) cultivars were collected at four stages of development and ripening: young, pre-mature, mature and ripened from Dabuleni, Dolj County, Romania and analyzed in terms of physical properties and chemical compounds. Several analyses were performed as dry matter, soluble solids, titratable acidity, vitamin C content, content of pigments (chlorophyll a, chlorophyll b, ß-carotene and lycopene), the content of polyphenols and antioxidant activity. The accumulation of various compounds in muskmelon fruits varied during the stage of growth and maturation, following different pattern for each compound. Significant differences were found concerning the content in β-carotene among the six cultivars. Vitamin C was high in young fruits than in ripened fruits. There were differences among cultivars in vitamin C content that varied between 106.82 mg/kg fw (Kemer cultivar) and 297.21 mg/kg fw (Raymond cultivar). Total polyphenols content varied between 184.33 mg of gallic acid equivalents (GAE) kg^{-1}fw (Hybrid F1 cultivar) and 117.66 mg of gallic acid equivalents (GAE) kg^{-1}fw (Kemer cultivar). Significant diferences were found among cultivars concerning all determined compounds and physical properties.
Keywords: Muskmelon, pigments, phenols, antioxidant activity, carotene, growth

INTRODUCTION

Muskmelon (*Cucumis melo L.*) is one of the most important vegetable crops worldwide. Muskmelon is the fourth important fruit in the world fresh fruit market and serves as major bioactive compounds sources (Mabalaha *et al*., 2007). Concerning the chemical content, muskmelon is relatively low in calories, fat, sodium and a good source of vitamin C and an excellent source of beta-carotene (Lester, 1997). Fruits also have more than 90% of water (Rashid and Mahmood, 2004). It is also rich in folic acid, and potassium as well as other bioactive compounds (Lester and Hodges, 2008). The aroma of melons consists of many volatile compounds, derived from fatty acids, carotenoids, amino acids and terpenes (Milind and Kulwant, 2011).

Muskmelon is a nutritionally balanced source of dietary antioxidants and also essential in revealing the biosynthetic pathways of these compounds in these fruits (Menon and Rao, 2012). The protective action of fruits and vegetables is owing to the presence of antioxidants, mainly anti-oxidant vitamins, a-tocopherol and b-carotene (Kalt and Kushad, 2000; Prior and Cao, 2000).

However, numerous studies have shown that the anti-oxidant activity may be from compounds such as flavonoids, isoflavone, flavones, anthocyanin, catechin and isocatechin rather than from vitamin C, E and b-carotene (Kahkonen *et al.,* 1999). Several studies have shown that consumption of food and beverages rich in phenolic content can reduce the risk of heart disease by acting as anti-oxidants towards low-density lipoprotein (LDL) (Landbo and Meyer, 2001). Therefore, mostly, the current focus of the researchers is on the anti-oxidant action of phenols.

Fruit quality assessment and characterization is an important objective in many melon improvement programs (Paris *et al*., 2003). Several researchers (Hubbard *et al.,* 1989; Wang *et al.*, 1996; Gao *et al.,* 1999; Lester, 2008) studied the development and ripening of the muskmelon fruit. During development, the fruits of muskmelon undergo a metabolic transition marked by both physical and compositional changes such netting of the exocarp, mesocarp softening, and the onset of sucrose accumulation (Hubbard *et al*,1989). They are marked differences in growth patterns and ripening physiology of different muskmelon cultivars. There are differences in color, flavours and shape (Augustin *et al,* 1988).

The purpose of this work was the study of the variation of some physical properties and chemical constituents of six muskmelon cultivars during four stages of growth and ripening.

We also determined the variation of muskmelons antioxidant activity during the same development stages.

MATERIALS AND METHODS

Fruits of six muskmelon (*Cucumis melo* L.) cultivars: 'Jucar', 'Raymond', 'Hybrid F1', 'Kemer', 'Gediz' and 'Makdimon'

were collected at four stages of development and ripening i.e. young (F1-14 days after pollination), pre-mature (F2-21 days after pollination), mature (F3-28 days after pollination) and ripened (F4-commercial maturity, 36 days after pollination) from Dabuleni, Dolj county, Romania and analyzed in terms of physical and chemical characteristics. The selection of the fruits for these stages was based on size, weight, color and softening. Dabuleni is known for the sandy areas and also a Danube flooding area known as the "Melon Kingdom". From a climate perspective, it has a strong continental with mild Mediterranean influence. The region has severe drought in July to September and an average amount of rainfall in May and June. Average annual rainfall is 548 mm and varies year to year. The average annual temperature is 11.1°C.

Orchard management was consisted of cultural practices like thinning, manual weeding, reduction of number of fruits per plant up to 8, fertilization with 80-100-150 kg/ha NPK, pinching the stem and sprouts, pests and diseases control, and irrigation application in sandy soil. Planting was done on mulch soil with black plastic film.

The experiment was set up as a randomized block design in 3 replicates with 20 plants per cultivar. For evaluation of fruits of each cultivar from 20 plants 5 fruits in 3 replicates were collected. Several analyses were performed: dimensions, size index, average fruit weight, rind thickness, dry matter, soluble solids, titratable acidity, vitamin C content, content of pigments (chlorophyll a, chlorophyll b, beta-carotene and lycopene). We also determined the content of polyphenols and antioxidant activity. All the assays were made in fresh fruits.

***Analytical methods*:** Fruit linear dimensions (length, L; width, W; thickness, T) and rind thickness were determined with a Luthier digital caliper manufactured by Stewart-MacDonald (USA) and the results were expressed as mm. Average fruit weight (g) was determined by individual weighing on an analytical scale model ABT-320-4M manufactured by Kern (Balingen, Germany. Size index was calculated using the formula: (L+T+W)/3.

The total dry matter was determined by removing water from the sample in an oven at 105°C and expressed in percent. Soluble solids content of fruit juice was measured with a digital refractometer (Hanna Instruments, Woonsocket, USA). The titratable acidity was determined by titration of a known amount of water extract of fruits with 0.1N NaOH using phenolphthalein as indicator and is expressed as g malic acid kg^{-1} fresh matter.

Ascorbic acid (vitamin C) was extracted and analyzed by reversed phase HPLC. Fresh muskmelon homogenate (5 g) was mixed and diluted to 100 ml with 2% HCl. After 30 minutes the solution was centrifuged at 4200 rpm for 10 minutes. The supernatant was filtered through 0.2 mm pore size filter. HPLC-DAD analysis was performed on a Finnigan Surveyor Plus system (Thermo Electron Corporation, San Jose, CA, USA) coupled with a photodiode array detector (DAD) set at 245 nm. The separation was performed using a Hypersil Gold a Q column (25 cm x 4.6 mm) with a particle size of 5 mm. Water solution of KH_2PO_4 buffer adjusted to pH 2.8 with ortho-phosphoric acid was used as the mobile phase. The column temperature was kept at 10°C and the flow rate at 0.7 mL min^{-1}. All the data is expressed as $mgkg^{-1}$ fw. Acetonitrile was HPLC grade (Merck, Germany) while potassium dihydrogen orthophosphate and phosphoric acid were of analytical purity (Sigma-Aldrich, Germany). Ultrapure water was obtained from a Milli-Q water purification system (TGI Pure Water Systems, USA).

The content of pigments was based on a spectrophotometric analysis following the method developed by Nagata and Yamashita (1992) for the simultaneous determination of chlorophyll and carotenoids. The samples were thawed in the dark in a refrigerator at 4°C to avoid carotenoid oxidation. Sixteen milliliters of acetone-hexane (4:6) solvent were added to 1.0 g of muskmelon homogenate and mixed in a test-tube. Two phases separated, and an aliquot was taken from the upper solution for measurement of optical density at 663, 645, 505, and 453 nm in a spectrophotometer (Varian Cary 50 UV-Vis, Varian Co., USA). Lycopene and β-carotene contents were calculated according to the equations: Lycopene (mg 100 mL-1 of extract) = - 0.0458 × A663 + 0.204 × A645 + 0.372 × A505 - 0.0806 × A453; β-carotene (mg 100 mL-1 of extract) = 0.216 × A663 - 1.22 × A645 - 0.304 × A505 + 0.452 × A453. Chlorophyll a (mg/100 ml) = 0.999 × A663 - 0.0989 × A645; Chlorophyll b (mg/100 ml) 155 = - 0.328 × A663 + 1.77 × A645, and further expressed in mg kg-1 fw. Lycopene and β-carotene are expressed as mg kg^{-1} fw**.**

Total phenol content was assessed by using the Folin-Ciocalteu phenol reagent method (Singleton and Rossi, 1965). Folin-Ciocalteu reagent (2N, Merck), Gallic acid (99% purity, Sigma), anhydrous sodium carbonate (99% purity, Sigma) were used. Muskmelon homogenate (2g) was extracted with 5 mL methanol in an ultrasonic bath for 45 min at ambient temperature. After extraction, the samples were centrifuged for 5 min at 4200 rpm. Supernatants were filtered through polyamide membranes with pore diameter of 0.45 μm and stored at a temperature of -20°C. 100 μL of each muskmelon methanolic extract were mixed with 5 mL of distilled water and 500 μL of Folin-Ciocalteau reagent. After 30 sec to 8 min, 1.5 mL of sodium carbonate (20% w/v) was added. The reaction mixture was diluted with distilled water to a final volume of 10 mL. The preparation of the standard solution of gallic acid followed the same procedure. The absorbance at 765 nm of each mixture was measured on a Varian Cary 50 UV spectrophotometer (Varian Co., USA) after incubation for 30 min at 40°C. The readings are expressed as mg of gallic acid equivalents (GAE) kg^{-1}fw.

Antioxidant activity was measured in methanol muskmelon extracts using the DPPH (2,2-diphenyl-1-picrylhydrazyl) assay. Methanol (Merck, Germany), 2,2-diphenyl-1-picrylhydrazyl (DPPH) (Sigma-Aldrich, Germany), and 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid (Trolox) (Merck, Germany) were employed. The extraction of samples was made according to the same protocol as described for total phenolic content. The free radical scavenging ability of the extracts against DPPH free radical was evaluated as described by Oliveira *et al*. (2008), with some modifications. Each methanol muskmelon extract (50 µL) was mixed with 3 mL of a 0.004% (v/v) DPPH methanolic solution. The mixture was incubated for 30 min at room temperature in the dark and the absorbance was measured at 517 nm on Varian Cary 50 UV-Vis spectrophotometer. The DPPH free radical scavenging ability was subsequently calculated with respect to the Trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid), which was used as a standard reference to convert the inhibition capability of each extract solution to the mmol Trolox equivalent antioxidant activity L^{-1}. The radical was freshly prepared and protected from the light. A blank control of methanol/water mixture was used in each assay. All assays were conducted in triplicate. The data is expressed in mmol Trolox kg^{-1} fw.

Data were evaluated by one-way analysis of variance (ANOVA) using Statgraphics Centurion XVI Software (StatPoint Technologies, Warrenton, VA, USA). Differences in physical features and content levels among the cultivars were estimated using the least significant difference test (LSD) at $P<0.05$.

RESULTS AND DISCUSSION

The results concerning the physical properties of muskmelon are presented in Tables 1 and 2. Muskmelon dimensions increased during the initial stages (young; pre-mature and mature). In the last stage - the ripening of the fruit - the growth rate (fruit dimensions) was significantly decreased with no instrumental differences between mature (F3) and ripened stage (F4) in all cultivars. In the same time the fruit weight registered a continue increase during fruit development with a major growth rate between mature and ripened stage in 'Hybrid F1' and 'Raymond' cultivars. This growth rate overlaps with increased synthesis of chemical compounds during the stages of maturation (mature to ripened).

Significant differences were found between the six cultivars in terms of fruit weight (F4). These differences remained visible during the development stages, with the fruit dimensions and weight following the same growth pattern in all cultivars. The data are accordance with the findings of Combrink *et al.* (2001) who showed that cell division and enlargement occurred during the first week after anthesis but only cell enlargement was liable for muskmelon fruit growth. The highest weight was found in 'Hybrid F1' (3.738 g) cultivar, which was followed by 'Raymond' (3.175 g) and 'Gediz' (2.820 g). As regards the rind thickness, no relevant differences were noted among cultivars during the stages of growth and maturation but with a downward trend until ripened stage (F4). During the first days of growth the rind thickness increased due the cell enlargement. In the latest stages (F3-F4) the rind thickness decreased due to cracks in the epidermal layer which preceded and probably initiated

Table 1. Variation in muskmelon cultivars for fruit dimension due to the established stages of growth and maturation.

Stages	Jucar	Raymond	Hybrid F1	Kemer	Gediz	Makdimon
Length (L) (mm)						
F1	47.73±3.23c	42.81±2.75b	33.50±2.12a	40.36±1.89b	41.90±2.69b	34.55±2.15a
F2	135.90±4.20c	96.40±3.12a	98.82±2.58a	137.00±2.60cd	122.00±3.42b	146.00±2.91d
F3	147.50±2.56b	135.2±2.82a	164±30.34d	151.00±3.15bc	178.00±3.72e	155.00±3.08c
F4	162.80±2.33a	171±1.96b	185±20.78c	162.00±3.45a	191.00±4.31d	162.00±3.64a
Width (W) (mm)						
F1	44.98±2.81e	41.94±1.89de	33.20±2.34a	37.80±1.94bc	39.27±2.43cd	34.17±1.84ab
F2	126.53±2.98e	80.20±2.07a	97.00±2.65b	124.00±1.79e	108.70±2.33c	113.60±1.67d
F3	143.00±3.12b	129.00±2.79a	143.00±2.67b	143.00±2.08b	167.00±3.01d	149.00±2.33c
F4	144.00±3.30a	165.00±3.12c	1755.00±3.04d	154.00±196b	180.00±2.78d	156.00±2.19b
Thickness (T) (mm)						
F1	56.19±3.01a	57.00±1.95a	80.13±3.14d	64.67±2.76b	69.71±2.19c	54.50±1.73a
F2	124.23±2.56a	185.00±2.37d	210.00±2.87e	149.00±2.55c	134.00±2.57b	122.00±4.12a
F3	133.00±3.23a	225.00±2.07c	226.00±1.95c	165.00±3.19ab	165.00±1.69b	160.00±3.87b
F4	135.00±3.70a	235.00±3.12d	295.00±2.70e	176.00±2.94c	178.00±3.07c	167.00±2.43b

Different letters within the same row indicated significant differences ($P < 0.05$) among cultivars

Table 2. Variation in muskmelon cultivars for weight, size index and rind thickness.

Stages	Jucar	Raymond	Hybrid F1	Kemer	Gediz	Makdimon
Weight (g)						
F1	62.06±5.43a	55.05±4.76a	48.07±4.32a	45.80±4.46a	57.80±4.31a	33.70±3.19a
F2	1070.00±4.70d	855.00±5.12a	999.00±4.92c	118.20±4.95e	965.30±4.96b	1339.00±5.31f
F3	1490.00±5.96a	1945.00±5.78b	2105.00±5.64e	1980.00±5.93c	2560.00±5.71f	2019.00±5.72d
F4	1643.00±4.85a	3175.00±6.21e	3738.00±6.28f	2103.00±5.81b	2820.00±6.03d	2240.00±5.86c
Size index (L+W+T/3)						
F1	49.60±2.33b	47.27±1.94b	48.94±2.53b	47.61±2.07b	50.29±2.74b	41.04±2.55a
F2	128.88±2.74b	120.53±2.71a	135.27±3.03c	136.60±2.74c	121.50±2.93a	127.20±2.39b
F3	141.33±3.91a	163.00±3.43c	177.80±3.17e	153.00±2.82b	170.00±3.19d	154.00±3.17b
F4	147.26±3.85a	190.50±3.54d	218.50±2.96e	164.00±3.09b	183.00±3.42c	161.60±2.97b
Rind thickness (mm)						
F1	1.05±0.08a	1.69±0.41c	1.80±0.14c	1.12±0.10a	1.48±0.12bc	1.30±0.12ab
F2	1.00±0.06a	1.15±0.12abc	1.49±0.12d	1.10±0.09abc	1.33±0.99cd	1.28±0.09bc
F3	1.00±0.03a	1.00±0.07a	1.35±0.09b	1.00±0.06a	1.26±0.10b	1.25±0.10b
F4	85.00±0.07a	0.93±0.05ab	1.12±0.10bc	1.00±0.08abc	1.18±0.86c	1.20±0.11c

Different letters within the same row indicated significant differences ($P < 0.05$) among cultivars

Table 3. Variation in muskmelon cultivars for dry matter, total soluble matter and titratable acidity.

Stages	Jucar	Raymond	Hybrid F1	Kemer	Gediz	Makdimon
Dry matter (%)						
F1	5.63±0.47c	5.62±0.44c	5.67±0.52c	3.37±0.29a	4.87±0.38b	3.845±0.27a
F2	6.16±0.54b	6.06±0.58b	5.91±0.57b	6.38±0.46b	4.93±0.42a	5.91±0.44b
F3	5.99±0.41a	6.84±0.49a	6.10±0.55a	8.65±0.73b	10.71±0.83c	12.02±1.04d
F4	10.29±0.97a	12. 87±0.93cd	12.22±0.85bcd	10.76±0.96ab	11.29±0.79abc	13.63±1.11d
Total soluble matter (%)						
F1	4.46±0.52cd	4.43±0.33d	4.53±0.59d	2..93±0.19ab	3.60±0.23bc	2.23±0.17a
F2	5.40±0.58ab	5.53±0.50ab	4.73±0.54a	6.90±0.55c	6.93±0.55c	5.80±0.52b
F3	4.76±0.39abc	5.13±0.39bc	4.40±0.40cd	4.16±0.37ab	5.26±0.52ab	4.70±0.50bc
F4	8.70±0.77a	12.1±1.05d	11.63±0.98cd	9.16±0.77ab	9.43±0.79ab	10.43±0.95bc
Titratable acidity (malic acid g kg^{-1} fw)						
F1	0.067±0.01a	1.0005±0.07c	0.670±0.04b	1.134±0.08c	0.670±0,01b	0.067±0.02a
F2	0.335±0.03a	1.0005±0.05c	0.670±0.02b	1.340±0.1d	0.350±0.01a	0.335±0.02a
F3	0.670±0.03b	1.0005±0.04c	0.670±0.05b	0.670±0.07b	0.335±0.03a	0.670±0.03b
F4	0.335±0.02a	0.6700±0.02b	0.335±0.02a	0.670±0.05b	0.335±0.02a	1.005±0.07c

Different letters within the same row indicated significant differences ($P < 0.05$) among cultivars

lenticel development which is consistent with recent findings (Combrink *et al*., 2001).

Table 3 shows the content of dry matter in muskmelon, as well as total soluble matter and titratable acidity. Data presented in this table shows that the content of dry matter and total soluble matter had an unexpected variation during the fruit development. The dry matter content had a constant increase in the first stages followed by a sudden increase during maturation stages (F3 - F4). On the other hand, the total soluble matter content followed a downtrend between the second (F2) and the third stage (F3). In the ripening stage (F4) the total soluble matter content had a sudden increase through synthesis of the compounds with high molecular mass. The highest content of dry matter and total soluble matter was found in 'Makdimon' cultivar followed by 'Raymond' and 'Hybrid F1'.

The titratable acidity did not record any significant differences during the growth and ripening stages or among cultivars. Still, the data showed the lowest values of titratable acidity in the ripened stage (F4), muskmelon being known as a fruit with low acidity. The highest titratable acidity was found in 'Makdimon' cultivar followed by 'Raymond' and 'Kemer'.

Table 4 shows the pigment content variation in muskmelon. The data showed the highest concentration of chlorophylls (a and b) in the earlier stages of fruit development. Additionally, during maturation, the chlorophylls amounts decreased until low values in the ripened stage F4 (0.13 mg kg^{-1} fw in Makdimon). However, there were significant

Table 4. Variation in muskmelon cultivars for pigments in fruits.

Stages	Jucar	Raymond	Hybrid F1	Kemer	Gediz	Makdimon
Chlorophyll a (mg kg^{-1} fw)						
F1	8.27±0.78c	2.92±0.18a	2.86±0.22a	3.43±0.30a	5.36±0.48b	8.80±0.73c
F2	3.54±0.29c	1.91±0.15a	2.78±0.19b	3.21±0.22bc	4.91±0.36d	7.45±0.69e
F3	3.57±0.31d	1.36±0.17b	1.31±0.09b	1.80±0.07c	1.22±0.10b	0.41±0.023a
F4	1.93±0.14c	0.26±0.012a	0.32±0.02a	0.28±0.02a	0.93±0.05b	0.26±0.01a
Chlorophyll b (mg kg^{-1} fw)						
F1	1.47±0.12a	1.93±0.09b	1.199±0.1a	2.21±0.18b	2.85±0.21b	4.42±0.31c
F2	8.93±0.62d	1.09±0.10a	1.197±0.09a	2.13±0.16b	2.08±0.14b	3.95±0.31c
F3	3.32±0.28e	0.80±0.05c	0.53±0.02b	2.04±0.11d	0.87±0.06c	0.30±0.01a
F4	1.33±0.09d	0.30±0.02b	0.28±0.01b	0.46±0.03c	0.47±0.02c	0.13±0.01a
β-Carotene (mg kg^{-1} fw)						
F1	2.34±0.21c	0.25±0.01a	2.97±0.25d	2.31±0.19c	1.63±0.13b	2.99±0.30d
F2	1.49±0.20c	0.39±0.02a	1.21±0.10bc	2.07±0.17d	1.17±0.10b	2.33±0.30d
F3	0.18±0.01a	0.23±0.01a	0.55±0.04b	0.49±0.03b	0.19±0.01a	1.64±0.11c
F4	0.63±0.03a	0.34±0.013a	10.96±0.92c	0.39±0.03a	1.35±0.10b	0.61±0.03a
Lycopene (mg kg^{-1} fw)						
F1	0.03±0.001a	0.40±0.04d	0.29±0.02c	0.31±0.02c	0.21±0.009b	0.4±0.03d
F2	2.95±0.22d	0.12±0.002ab	0.00±0.00a	0.31±0.01c	0.11±0.008ab	0.2±0.01bc
F3	1.04±0.09d	0.11±0.002b	0.00±0.00a	0.30±0.01c	0.08±0.004b	0.1±0.008b
F4	0.37±0.02c	0.11±0.003b	0.02±0.001a	0.48±0.03d	0.02±0.001a	0.02±0.009a

Different letters within the same row indicated significant differences ($P < 0.05$) among cultivars

differences among cultivars in the earlier stages (F1-F2), which were lower in the ripened stage (F4).

The β-carotene content recorded the same variation with chlorophylls, during the first three stages. The content of β-carotene decreased progressively in the subsequent stages of maturation with a minimum value in mature stage (F3), whereas the process differentiated an increase in the ripening stage especially at the orange colored pulp cultivar. Perkins-Veazie (2007) stated that the changes in pH, sugars, and lycopene with ripening indicate activity of several enzyme systems, and that may enhance carotenoid biosynthesis. However the yellow or orange color of muskmelon pulp was mostly due to the reduction of chlorophyll rather than the increase in β-carotene content in the ripened stage.

The increase rates vary from a cultivar to another, the higher amount being found in 'Hybrid F1' cultivar (10.96 mg kg^{-1} fw), which presented an orange colored pulp followed by 'Gediz' (1.35 mg kg^{-1} fw). Lycopene was found in small amounts in all cultivars during all stages of growth and maturation. Differences among cultivars were evidenced, the highest content being detected in F2 stage in 'Jucar'. In the ripened stage (F4) the highest content in lycopene was detected in 'Kemer' cultivar (0.48 mg kg^{-1} fw) followed by 'Jucar'.

Antioxidants are widely distributed in muskmelon in all stages of growth and ripening, the most important compounds being polyphenols and vitamin C. Their amount in muskmelon varied among stages and also from one cultivar to another.

The variation in vitamin C and total polyphenol content in muskmelon as well as the antioxidant activity is shown in Table 5. The content of vitamin C was higher in the first stage (young), it decreased thereafter with a second increase to maximum in the ripened stage. The total polypenols content was high in first stage (F1), decreased thereafter but a second increase was shown in the ripening stage of the muskmelon, which is in accordance with recent findings of Menon and Rao (2012). However, the muskmelon shows a relatively low content of vitamin C (from 105.61 mg/kg fw to 297.21 mg/kg fw in 'Raymond' cultivar) and total polyphenols (from 101.45 mg of GAE kg^{-1}fw to 184.33 mg of GAE kg^{-1}fw in 'Hybrid F1' cultivar) in comparison with blueberries, blackberries and other wild fruit. Certain differences were found between cultivars regarding vitamin C content and total polyphenols content, even if they followed the same pattern of evolution during the stages of growth and maturation, with the lowest values in 'Kemer'. The varied pattern of polyphenol content in ripened stage may be due to the different extent by which the biosynthetic pathways of these compounds are affected by ripening (Menon and Rao, 2012). Also, Hodges and Lester (2006) showed that the vitamin C accumulate differently in various cultivars grown in different conditions.

The antioxidant activity reached its peak in the ripening stage. However high values of antioxidant activity were detected also in young stage of growth (F1) followed by a relatively decrease or stagnation in pre-mature stage. The range of antioxidant activity in muskmelon for all cultivars

Table 5. Variation in muskmelon cultivars for vitamin C, total polyphenols and the antioxidant activity.

Stages	Jucar	Raymond	Hybrid F1	Kemer	Gediz	Makdimon
Vitamin C (mgkg^{-1} fw)						
F1	199.17±8.6c	233.58±9.2d	260.31±7.2e	177.85±6.2b	108.95±6.2a	187.32±7.1bc
F2	148.25±6.3e	105.94±6.7bc	121.77±5.7d	96.34±4.7b	65.60±4.9a	106.79±5.3c
F3	181.86±6.7c	153.71±6.9b	197.91±5.3d	105.63±5.5	105.61±5.7a	171.47±6.1c
F4	251.52±8.8c	297.21±9.6e	281.26±8.4d	106.82±5.1a	115.22±5.9a	217.30±7.9b
Total polyphenols (mg of gallic acid equivalents (GAE) kg^{-1}fw)						
F1	149.62±7.3c	122.75±6.21b	173.19±7.9d	104.30±6.1a	128.21±7.4b	120.10±6.1b
F2	95.21±5.9a	128.04±7.1bc	130.78±5.8c	103.21±5.9a	123.521±6.9bc	118.43±5.7b
F3	104.32±6.4ab	113.46±6.2bc	114.36±5.3bc	101.45±5.7a	116.84±6.2c	111.67±5.2abc
F4	119.89±6.9a	180.97±7.2b	184.33±8.2b	117.66±6.4a	124.68±7.1a	174.34±6.7b
Antioxidant activity (mmol Trolox kg^{-1} fw)						
F1	0.207±0.02b	0.282±0.030c	0.532±0.049d	0.25±0.017bc	0.100±0.008a	0.250±0.018bc
F2	0.357±0.02d	0.282±0.027c	0.407±0.038e	0.214±0.014b	0.120±0.010a	0.201±0.014b
F3	0.282±0.01b	0.407±0.033c	0.457±0.041d	0.25±0.018b	0.175±0.014a	0.500±0.030d
F4	0.407±0.03a	0.615±0.053c	0.607±0.050c	0.75±0.05d	0.500±0.020b	0.500±0.020b

Different letters within the same row indicated significant differences ($P < 0.05$) among cultivars

was relatively low which is according with recent findings of Wang (2006). Significant differences were recorded among cultivars in what concerns the antioxidant activity, varying between 0.75 mmol Trolox kg^{-1} fw (Kemer) and 0.407 mmol Trolox kg^{-1} fw (Jucar) in ripened fruits. These differences may be due to the genetic factors that according with Wang (2006) play an important role in determining antioxidant capacity in muskmelon.

***Conclusions*:** The muskmelon stands out as a source of antioxidants, which maximizes their nutritional value. The compounds accumulations in muskmelon, during growth and ripening, is reflected by the evolution of their physical characteristics, with a strong increase rate in the first stages (growth) and a reduced one during ripening. The accumulations of various compounds in muskmelon varied from one stage to another, following different patterns for each compound. Although data for all parameters measured varied significantly among cultivars it can be noticed that the highest quantitative accumulation of chemical compounds during growth and ripening stages were found in 'Hybrid F1', 'Raymond' and 'Gediz' cultivars, which results in a higher quality of the mature fruit and better acceptability by consumers.

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