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Investigation on Yield and Fruit Quality of Some Cultivated Strawberry in Iran

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Abstract**—**fifteen cultivars of Strawberries (Queen Eliza, Sequia, Paros, Mcdonance, Selva, Chandler, Mrak, Ten beauty, Aliso, Pajero, Kordestan, Camarosa, Blackmore, Gaviota and Fresno) were investigated in 2011, under hydroponic system condition. Yield and fruit Firmness was determinate. Chemical analyses of soluble solids content (SSC), titratable acidity (TA), ascorbic acid (AA) and pH were done. 4 cultivars (Aliso, Selva, Paros and Gaviota) yielded more than 250 g/plant, while cultivar Black more, Fresno and Kordestan produced less than 100g/plant. The amounts of fruit firmness indicated that 'Camarosa' fruit was firmer than others cultivars. Cultivar 'Fresno' had the highest pH (3.27). Ttitratable acidity varied from 1.03g/l00g for cultivar 'Sequia' and 'Gaviota' to 1.48g/l00g for cultivar 'Chandler'. Fresno, Kordestan, Aliso and Chandler showed the highest soluble solid concentration. Ascorbic acid averaged for most cultivars between 30.26 and 79.73 mg/100gf.w. Present results showed that different cultivars of strawberry contain highly variable in fruit quality.

Keywords**—**Yield, Fruit quality, Ascorbic acid, Hydroponic system

I. Introduction

STRAWBERRY (*Fragaria ananassa* Duch.) are unique, with highly desirable taste, flavor, rich in vitamins, potassium, fiber and other secondary metabolites, also simple sugar source of energy, consumed as fresh table fruit or used in processing industry for jam and marmalades or frozen [16].Strawberry fruit component recognized health benefits which may help decrease the risk of blood clotting, reducing cardiovascular disease [14].

The components of quality can be sensory and nutritional [19]. Consumer prefers sweet strawberry and sweetness is positively correlated with soluble solid contents, total soluble sugars, and fructose [17]. Strawberries are a good source of ascorbic acid (vitamin C) which is a very important nutrient, being essential, e.g. for the synthesis of collagen [3]. Strawberry is a fruit that grows in a wide range of environments [9]. Strawberry was imported into Iran about 100 years ago from France. It can be grown successfully in different parts of Iran, from the northern part of Iran with a cold climate to the south with tropical and subtropical [13]. Recently, glasshouse production of strawberry in Iran is expanding and hydroponic systems are being increasingly used [8]. The main cultivar under cultivation in Iran is 'Kordestan'. This is a short day cultivar [20]. Demand for this cultivar is very big because of their aroma and flavor [13].

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For many years in Iran, conventional strawberry growers have routinely used to cultivate in open field. Today's demand for locally and off-season produce of fresh fruits and viable crop exhorts the production to spread greenhouses [2]. The increase of demand has caused the modern strawberry producing systems such as without soil cultivation or hydroponic system to replace the old and traditional systems [6]. There are many hundreds of strawberry cultivars in commercial production around the world with new varieties being continually bred. Greenhouse strawberry growers should trial a number of local and commercially grown varieties within their production system [14].The objective of our study was to determine the yield, physical and chemical characteristics of cultivated strawberries cultivars in Iran in hydroponic system condition.

II. Material and Methodes

The used strawberry varieties (Queen Elisa, Sequoia, Paros, Mc donnas, Selva, Chandler, Mrak, Ten beauty, Aliso, Pajero, Kordestan, Camarosa, Black more, Gaviota and Fresno) were obtained from the agricultural center of Sanandaj and cultivated in Greenhouse Research Center of Islamic Azad University Khorasgan Branch (Table 1). The experiment design was randomized complete block design one with three replication. Nutrient solution in vegetative and reproductive stages was according to Morgan [14]. The hydroponic system was used and the nutrition system was open. The greenhouse operated at 10- 15°C during night and 20-25°C daily temperature. The fruits of each cultivar were harvested at fully ripening stage and transported to the laboratory within 2h after harvested and whole fruit were stored of -20°C for further analysis.

A. Morphlogical traites

Fruit color and fruit shape of cultivars, was determinate based on Strawberry Descriptors [5].

B. Flesh firmness

The firmness of ten ripe berries of each cultivar was measured with a penetrometer using an 11 mm diameter probe and expressed as $kgcm^{-2}$. On each fruit, two measurements were taken at two diametrically opposite sites

C. pH

The pH of strawberry puree of each cultivar was measured with a pH meter.

D. Titriatable acidity

The acidity was measured by titrating 10g of pulp, homogenized with 124 ml distilled water. The initial pH of the sample was recorded before titration with 0.1N NaOH to a

final pH 8.2. The acidity was expressed as a percentage of citric acid equivalents to the quantity of NaOH used for the titration [12].

E. Soluble solids content (SSC)

An aliquot of the ground fruit tissue was left to trickle through filter and SSC was determined by portable refractometer (Atago Co. Ltd., Tokyo), using 3-4 drops of the subsequent extract.

F. Ascorbic acid

Ascorbic acid (AA) was determined using 2.6-Dichloroindophenol titrimetic method according to AOAC method 967.21[1] and expressed as mg $100g^{-1}$ fresh weight.

G. Statistical analysis

Data was analyzed by software SPSS. The analysis of variance and Duncan multiple range test were used to find significant differences in the means. Each value is the mean ± SD of three determinations (replicates). Mean values were considered significantly different when $p \leq 0.05$.

III. Result and Discussion

Results of total yield per plant of experimental cultivars are given in table 1. According to the obtained data the highest yield was obtained from Aliso (322.90g/plant), whereas the lowest yield was obtained from cultivar Blackmore (45.83g/plant). The average of all varieties was 163.64 g/plant.

The amounts of force required indicated that 'Camarosa' fruit was firmer than others cultivar. Difference in fruit firmness, influenced by the growing environment and plant genetic [14].The firmness of strawberries decreased ripening in the field and after harvest [15].

TABLE I
The Chemical Content and Some Plant Characteristics of 15 Strawberry Cultivars Grown in Soilless Culture System

Cultivars	Type of bearing	Fruit shape	Fruit color	Yield (g $plant^{-1}$)	Firmness (kg/cm^2)
Queen Eliza	Short day	Conical	Medium red	210.07e±7.92	0.63bc±0.02
Sequia	Short day	Ovoid	Dark red	106.91h±6.72	0.55de±0.02
Paros	Short day	Cylindrical	Orange red	252.76c±9.19	0.63bc±0.01
Mcdonance	Short day	Oblate	Orange red	133.48g±3.46	0.48f±0.03
Selva	day-neutral	Reiniform	Medium red	265.55b±8.56	0.52ef±0.02
Chandler	Short day	Biconical	Medium red	130.91g±5.42	0.48f±0.02
Mrak	day-neutral	Conical	Orange red	110.50h±0.89	0.49f±0.01
Ten Beauty	Short day	Reiniform	Medium red	125.11g±3.92	0.57de±0.02
Aliso	Short day	Biconical	Orange red	322.90a±4.93	0.58cd±0.02
Pajero	Short day	Reiniform	Medium red	220.28d±2.18	0.66ab±0.02
Kordestan	Short day	Conical	Orange red	69.86i±0.92	0.37g±0.03
Camarosa	Short day	Oblate	Medium red	152.97f±9.16	0.70a±0.02
Black more	Short day	Oblate	Orange red	45.83k±1.39	0.57de±0.01
Gaviota	Short day	Ovoid	Dark red	251.13c±3.11	0.60cd±0.03
Fresno	Short day	Oblate	Medium red	56.35j±4.41	0.56de±0.04
Mean value	----	----	----	163.64	0.52

Means ± standard derivation in the same column with the same letter are not significantly at *p≤0.05* using Duncan multiple range test.

pH of cultivars showed significant different ($p<0.05$) and cultivar 'Fresno' had the highest pH (3.27). Mean pH of cultivars (3.4) was agreed reported by Morgan [14] (3.27-3.86) (Table 2).

Ttitratable acidity (TA) varied from 1.03g/l00g for cultivar 'Sequia' and 'Gaviota' to 1.48g/l00g for cultivar 'Chandler'. There was no significant difference between TA of cultivars Mcdonance, Tenbeauity, Kordestan and Camarosa ($p<0.05$). Ttitratable acidity of cultivars Chandler, Mrak and Blackmore, higher than value reported by others researchers [14]. The highest SSC was characteristic of the fruits of Fresno (8.70%), followed by Kordestan (7.83%), Aliso and Chandler (7.77%). This amount was lower than value reported by Hancock [10] (10%). The least TSS was found with the fruit of Selva (5.98%), followed by Paros (6.17%).

Strawberries with higher soluble solids are generally preferred over lower soluble solids [4].

Ascorbic acid of fifteen strawberry cultivars showed significant difference and ranged from 30.26 to 79.73mg/100g.f.w. the highest ascorbic acid amount was belonged to cultivar 'Pajero'(79.73mg/100g.f.w) (Table 2). The least ascorbic acid content of 40mg/l00g.f.w was found in cultivars Tenbeauty, Kordestan and Fresno, whilst cultivars Paros, Chandler, Aliso and Pajero exceeded more than 60 mg/l00g.fw and its amount was higher than value reported by Westwood [22] (59mg) and Hancock [10] (56.7mg) and USDA [1] (58.8). The mean value amounted in this researched was 53.21mg per 100g of edible portions. Ascorbic acid is an essential nutrient for humans. For adults, dietary needs are met by a minimum intake of 60 mg/day [11]. An increase in intake of ascorbic acid is associated with health statues [18].

TABLE II
THE CHEMICAL CONTENT OF 15 STRAWBERRY CULTIVARS GROWN IN SOILLESS CULTURE SYSTEM

Cultivars	pH	TA(%)	SSC(%)	Ascorbic acid (mg/100g.f.w.)
Queen Eliza	3.34abcd±0.14	1.18cdef±0.05	6.58def±.19	57.82e±0.00
Sequia	3.19cd±0.05	1.03f±0.06	7.03cd±0.06	46.34i±0.00
Paros	3.36abcd±0.18	1.13def±0.13	6.17f±0.06	67.71c±0.39
Mcdonance	3.50abc±0.09	1.31abcd±0.17	7.37bc±0.23	45.34j±0.20
Selva	3.63ab±0.33	1.04ef±0.07	5.98f±019	58.01e±0.19
Chandler	3.51abc±0.06	1.48a±0.07	7.77b±0.69	69.90b±0.20
Mrak	3.36abcd±0.13	1.37abc±0.03	7.43bc±0.51	55.23g±0.18
Ten Beauty	3.42abcd±0.03	1.31abcd±0.05	7.30bc±0.26	38.6k±0.20
Aliso	3.30bcd±0.44	1.05ef±0.06	7.77b±0.25	60.83d±0.60
Pajero	3.04d±0.04	1.23bcde±0.08	6.87cde±070	79.73a±0.46
Kordestan	3.21bcd±0.07	1.30abcd±0.04	7.83b±021	30.26m±0.15
Camarosa	3.43abcd±0.15	1.31abcd±0.21	6.83cde±0.31	46.33i±0.01
Black more	3.45abcd±0.05	1.41ab±0.14	7.40bc±0.40	52.05h±0.16
Gaviota	3.54abc±0.53	1.03f±0.05	6.23ef±0.40	57.22f±0.20
Fresno	3.72a±0.20	1.23bcde±0.09	8.70a±0.35	32.86l±0.40
Mean value	3.4	1.22	7.15	53.21

Means ± standard derivation in the same column with the same letter are not significantly at $p \leq 0.05$ using Duncan multiple range test

IV. CONCLUSION

In this paper, Iranian local cultivar 'Kordestan', some European and American cultivars were compared. The examined cultivars differed clearly in their chemical properties. The results of this study showed that most of cultivars had good nutritional values.

The chemical composition of berry fruits can be highly variable depending on the cultivar, location, ripeness and harvest time .In addition, the environmental conditions of growth can be a major factor impacting overall fruit quality [23].

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