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EVALUATION OF THIRTEEN OPEN POLLINATED CULTIV ARS AND THREE HYBRIDS OF TOMATO *(LYCOPERSICON ESCULENTUM MILL):* 11. PHYSICAL PROPERTIES AND CHEMICAL COMPOSITION OF FRUITS

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Thirteen open pollinated tomato *(Lycopersicon esculentum* Mill) cultivars (Pello, Riogrande, Tz-lmproved, Rossol, Pakit, ACE 55 VF, Money Maker, Nagina, 88572*, Marmandi, DC 134, Ebein and Rohaba) and three hybrids (Miasara F_h 898 FJ, OS 12 F_1) were evaluated for their fruit physical properties, chemical composition and mineral contents. Data showed that hybrids and cultivars varied significantly ($p< 0.05$) in their fruit weight, dimensions, volume, % pulp and numbers of locules. Their juice and serum also varied significantly in their %, density, total soluble solids, total unsoluble solids, titratable acidity and vitamin C content.. The proximate analysis varied also significantly. Data showed significant variation in the total carbohydrates, reducing sugars and sucrose levels in whole fruit.. Minerals (Ca, Na, K, Zn, Mn, Mg, and P) varied significantly among cultivars and hybrids but thcy were comparable with values reported in recent literature except for Fe contents which were slightly higher but its variation was significant..

INTRODUCTION

Consumers preference for fresh tomatoes is influenced by its quality, quality in the market may be ambiguous. Some consumer groups may be influenced mostly by appearance and color as important source of variation, whereas the preference by others for fruit quality is influenced mainly by sensory quality and nutritional value.

Tomato is a leading crop in Jordan, the total annual production in 1991 was 275.6 thousand metric ton (Annonymous, 1992), several investigators have tested tomato cultivars and hybrid from different genetic resources which exhibited immense range of variation in fruit quality. The physical properties and chemical composition have been studied (Suwwan and Hamayel, 1982; Suwwan and Abubaker, 1986; Kasrawi, et al, 1981). Fruit size have been discussed (Kasrawi et ai, 1981; Dempsey and Boynton, 1965; Emery and Munger, 1970; Ibarbia and Lambeth, 1971). The shape and specific gravity of the tomato fruits varied in different cultivars as reported previously (Suwwan and Abubaker, 1986; Kasrawi et ai, 1981). Acidity, pH and total soluble solids have been reported to vary with cultivars (Suwwan and Abubaker, 1987; Shibli and Suwwan, 1987).

However, as new genetic resources are continuously produced, a new focus on open pollinated cultivars have been adopted in the Country to reduce the imported seeds cost.. The purpose of this study is to evaluate the physical and chemical properties of thirteen open pollinated cultivars and three hybrids of tomato (Table I) grown under drip irrigation and open field conditions and

to focus on quality parameters which other investigators did not include.

MATERIALS AND METHODS

Seeds of thirteen open pollinated tomato cultivars (pello, Riogrande, T_2- Improved, Rossol, pakit, ACE 55 VF, Money Maker, Nagina, 88572, Marmandi, UC 134, Ebein (Local]) and Rohaba (Local) and three hybrids (Miasara F I, 898 F I, and O.S. 12]) were germinated and grown to seedling (35 day old) were planted under field conditions through black plastic mulch on April 7, 1993, spaced at a distance of 0.5 m within rows. Irrigation was performed using a drip irrigation system with laterals spaced at 1.0 m provided with OR emitters (4 I/hr) at 0.5 m apart to fit the plants distribution within each treatment. The experiment was conducted In the Agricultural Experiment Station at Jordan University of Science and Technology, North of Jordan). The experimental site (clay loam soil) was amended (one month before planting) with sheep manure (10 tons/ha) broadcasted evenly, ploughed and rotovated to a finally pulverized seed bed. A compound fertilizer (Mikafoze, 18: 18:6 + 1.5: N, P, K + 0.15 ZnO, 0.15 B_2O_3, 0.15 CuO, 1.05 MgO) was side dressed at a rate of 25 gibed incorporated at 10-15 cm deep in the row before covering with black plastic mulch. Plants were fertilized once with urea at a rate of 50 kg/h with irrigation water one month after planting. Each cultivar was replicated for three times (25 plants per replicate) in a randornized complete block design (RCBD). Plants were sprayed with the insecticide Lanate (a.i: Mcthomyl: S-methyl-N- [(methylcarbomyl) oxy] thioacetirnidate) directly after the first harvest.

The harvest season was commenced on June, 1993 and terminated Aug. I, 1993. At the peak of the harvest season (in the mid harvest), representative composite samples of red-ripe fruits were collected and kept in nylon bags either in a refrigerator or a freezer until the time of analysis.

Physical properties. Tomato fruits were washed thoroughly and dried at room temperature, the average weight of individual (25 fruit) was recorded per each replicate, fruits were cut, opened and the average diameter in cm was calculated. The fruit shape was determined by measuring the ratio of minor and major axis, the fruit size was determined by water displacement method, the specific gravity was determined on representative samples of ten fruits per replicate using the platform scale method outlined by Mohsenin (1970). Fruits were cut opened and the number of locules were counted. The tomato fruits were blanched at 100 QC to remove the peels which were weighed and percent peel was calculated, the average pulp weight was also recorded after seeds and peels being removed.

Juice was prepared by blending tomato on Waring blender for 3 min, the macerate was passed trough a double layer cheese cloth, the resulting juice was weighed and juice % was recorded. The juice was filtered through whatrnan paper 541, the pH of the filtrate was measured using a Jenway pH meter (model 3020) with a glass and calomel electrode at room temperature. The titratable acidity (% TA) was determined by titrating an aliquot of the serum with 0.1 N NaOH to pH 8.3, ABBE stage refractometer was used to determine total soluble solids *(TSS£}'rd)* at room temperature. The specific gravity (Sp. O) of the juice was determined using a 50 ml pycnometer at room temperature.

Chemical analysis. Moisture, protein (N x 6.25), crude fiber, crude fat and ash were determined according to AOAC (1984) procedures. Total carbohydrates were

calculated by difference, reducing sugars were determined by Lane-Eynon method (AOAC, 1984), sucrose was determined as in reducing sugars after hydrolysing as aliquot of the serum with 6 N HCl for ten minutes at 60°C, the hydrolysate was neutralized with NaOH, and % sucrose was calculated by difference. Total vitamin C content in fruit and tomato juice were determined by titration with 2.6 dichlorophenolindophenol method averages were computed at *90(Yr* moisture content..

Mineral analysis. Mineral matter analysis for Ca, Na, K, Zn, Cu, Fe, Mn, and Mg contents were determined using an atomic absorption spectrophotometer (pye Unicam model Sp9). Each sample (3g) was digested in a Kjeldahl flask with a mixture of nitric, sulfuric and perchloric acids (10: 1:4) until all the organic matter were oxidized, the resulting clear liquid was filtered through Whatman paper #42, brought to volume with distilled deionized water and introduced to the atomie absorption spectrophotometer, the final volume of Ca, and Mg contained 1% lanthanum oxide to overcome interferences mainly by phosphates. Phosphorous was determined according to Watanabe and Olsen (1965) procedure using a CECIL CE 1020 spectrophotometer. .

Statistical analysis. The collected data were analyzed according to Steel and Torrie (1980), means were separated according to Least Significant Difference (LSD) using MSTATC program (Michigan State University).

RESULTS AND DISCUSSION

The measurements of physical traits for tomato fruits obtained from the investigated eultivars are given in Table. 1, where fruit weight varied significantly and ranged between 59.0 (Rossol) and 286.4 g (Ebein). Fruit length and width and volume varied significantly, their ranges were from 3.8 (Marmandi) to 6.0 cm (Riogrande and Rohaba); 4.2 (Rossol) to 9.3 cm (Ebein) and 58.8 (88572) to 257.7 cm' (Ebein), respectively. Consequently the fruit density varied significantly among these cultivars and ranged between 0.954 (pello) and 1.960 g/ml (UC 134). peel'X; and number of locules also varied significantly. their ranges were from 5.2 (Miasara F_1) to 11.5% (Marmandi) and 2.3 (Riograndc, Rossol, Pakit, Nagina) to 14.8 (Rohaba), respectively, Trlmproved, Rossol, Nagina, and UC 134), sphere (898 F_1 Pakit, Money Maker, 88572, OS 12 F_1 and Marrnandi and Irregular (Ebein, ACE 55 VF and Rohaba).

Tomato size as determined by fruit weight, volume, length and width are among the important quality characteristics, the US Department of Agriculture outlined six sizes for fresh tomato (45-90 mm) for large tomato eultivars. Table I shows that all the investigated eultivars fall within the standard range except for Money Maker and Marmandi cultivars, they were slightly lower than the lower value of the grade standard, but the fruit width values compare very well with the USDA standard. The variation in tomato size resulted in variation in fruit weight, volume and density. The physical properties of tomato were discussed by Suwwan and Harnaycl (1982); Emery and Munger (1970) ; Kasrawi et al, (1981); lbarbia and Lambeth (1971); Dempsey and Boy ton (1965) and Spliüstoesser (1990). The peel% varied significantly among tomatoes and ranged from 5.2 (Miasara) to 11.5% (Marmandi).

Tomato fruit weight varies among eultivars and decreases with seasons. lbarbia and Lambeth (1971) reported average fruit weight between 37.7 to 265.1 g, our data in Table I are comparable with values reported by previous investigators except for the local cultivars (Ebein and Rohaba) their average

Table No. I: **Physical Properties of whole fruits of thirteen open pollinated Tomato** cultivars **and three hybrids.**

Cultivar	Fruit Weight (g)	Fruit Length (cm)	Fruit Width (cm)	Fruit Volume (cm')	Fruit Density (g / ml)	Peel %	Locule Number
Pello	62.6	5.2	4.7	65.6	0.954	9.6	2.8
Riogrande	96.4	6.0	5.2	97.9	0.986	7.1	2.3
Tz-Improved	68.2	4.9	4.8	70.3	0.970	7.0	3.2
898 Ft	96.8	5.3	5.7	102.3	0.957	6.5	4.3
Ebein	286.4	5.2	9.3	257.7	1,300	8.1	13.8
Rossol	59.0	5.4	4.2	59.9	0.984	5.5	2.3
Pakit	76.1	4.9	5.2	79.2	0.960	7.6	2.3
ACE 55 VF	128.8	4.9	6.7	107.7	1,20	5.6	6.2
Money Maker	83.2	4.2	5.4	84.1	0.984	5.6	3.3
Nagina	77.5	5.9	4.6	81.1	0.958	7.9	2.3
Miasara F_1	95.0	5.3	6.9	75.5	1,488	5.2	3.5
88572	72.2	4.8	5.1	58.8	1.766	9.0	2.7
Rohaba	275.4	6.0	7.4	225.7	1.261	7.4	14.8
OS 12 F]	116.6	5.2	6.1	105.7	1.106	8.2	6.8
Marmandi	108.1	3.8	5.7	90.0	1,22	11,5	10.1
DC 134	92.9	5.3	5.3	82.6	1,960	7.5	2.8
LSD (0.05)	43.00	1,417	1,358	40,40	0.626	3.18	1.656

fruit weight were higher than the highest value of the average fruit weight reported by Ibarbia and Lambeth (1971), their weights were 286.4 and 275.4 g respectively. Fruit shape is most appropriately expressed based on the ratio for the largest equatorial diameter to the fruit depth, the shape is not thought to have a direct effect on the sensory quality of the tomatoes. However, the ratio of the internal loculzr material to the pericarp tissue, often reflected in the shape and may influence the relative contributions of each tissue type to the overall sensory quality, also shape irregularity is associated with multilocular structures in the fruit (kader and Mores, 1976). Our data were in agreement with these previous findings (Table I). Ebein and Rohaba cultivars have irregular shape, the highest width values (9.3, 7,4 cm) and the highest locule number/fruit being 13.8, 14.8, for the cultivars Ebein and Rohaba, respectively.

Different cultivars vary in their ability to develop seeds and locules, these are important characters because they are correlated to fruit maturity and weight (Dempsey and Boynton, 1965). Seeds presence or absence do not affect the shape or size of the fruit (Jonson and Hall, 1954). Our data on specific gravity are comparable with data reported by Stemvers and Stork (1976), who found that specific gravity varies with cultivar and stage of fruit ripening.

Data on pulp, juice and serum contents of the investigated tomatoes and their quality aspects are given in Table 2. As expected, pulp% juice%, total soluble solids, titratable acidity (% citric acid monohydrate), pH of the juice, juice vitamin C content (mg/1 00 ml), serum total soluble solids, serum pH and total unsoluable solid percent varied significantly, but juice and

Table No. 2 **Juice and serum properties of thirteen open pollinated tomato cultivars and three hybrids.**

Cultivar	Pulp %	Juice %	Juice Density (g/ml)	Juice TSS %	Titratable Acidity %	Juice pH
Pello	86.3	70.31	0.963	4.15	0.1599	3.8
Riogrande	88.3	71.73	0.959	4.29	0.132	3.7
Trlmproved	89.0	71.66	0.967	6.67	0.169	3.7
898 F_1	90.1	75.31	0.973	5.78	0.261	4.0
Ebein	87.9	76.72	0.974	4.15	0.227	4.1
Rossol	90.8	72.90	0.970	4.97	0.188	3.8
Pakit	88.1	69.46	0.965	4.17	0.230	3.6
ACE 55 VF	90.2	73.14	0.963	4.86	0.230	3.7
Money Maker	90.7	72.89	0.968	4.16	0.114	3.8
Nagina	88.5	69.30	0.966	4.53	0.202	3.7
Miasara F_1	91.6	71.88	0.974	4.65	0.252	3.9
88572	87.0	72.88	0.966	4.53	0.202	3.7
Rohaba	88.0	73.10	0.963	4.35	0.190	3.9
OS 12 F_1	87.4	73.20	0.959	4.60	0.255	3.4
Marmandi	94.9	68.07	0.971	5.43	0.185	4.0
UC 134	89.5	73.88	0.979	4.60	0.231	3.7
LSD (0.05)	3.925	7.238	NS*	1.172	0.0913	0.52

	Juice Vit. C (mg)	Fruit Vit. C (mg)	Serum TSS %	Serum pH	Serum Density (mg/ml)	Total Unsolable Solids %
Pello	11.8	18.7	4.15	3.8	0.964	1.3
Riogrande	17.7	23.9	4.21	3.7	0.958	1.4
Trlmproved	20.9	22.1	4.43	3.9	0.967	1.4
898 F]	16.9	23.6	5.84	3.7	0.976	1.3
Ebein	17.3	15.9	4.55	4.2	0.970	0.9
Rosso1	14.7	15.4	4.81	3.7	0.971	0.7
Pakit	14.8	17.9	4.57	3.5	0.934	1.0
ACE 55 VF	20.6	19.3	4.86	3.5	0.967	1.0
Money Maker	12.7	14.8	4.33	3.9	969	1.1
Nagina	13.6	15.2	4.33	3.5	0.966	1.0
Miasara Ft	17.8	23.1	5.14	4.0	0.976	0.5
88572	11.2	16.3	4.94	3.6	0.964	0.8
Rohaba	12.7	13.9	4.35	4.0	0.959	0.7
OS 12 F_1	12.1	17.5	4.80	3.6	0.962	1.0
Marmandi	15.5	16.3	4.23	3.9	0.967	1.1
UC 134	16.0	21.0	4.64	3.6	0.975	0.7
LSD (0.05)	9.642	NS	0.860	0.533	NS	0.639

serum densities *(g/ml)* and fruit content of vitamin C (mg/lOOg) did not vary significantly. The ranges of these quality parameter according to their sequence in Table 2 are from 86.3 (Pello) to 94.9 % (Marmandi); 68.07 (Marmandi) to 76.72 % (Rossol) : 0.959 (Riogrande and OS 12 F_1) to 0.979 *glml* (UC 134) ; 4.1 (88572) to 6.67% (TT Improved) ; 0.114 (Monkey Maker) to 0.287% (88572) to 3.4 (OS 12 F,) TO 4.1 (898 F_1) ; 11.2 (88572) to 20.9 mg Vitamin C per 100 ml (TT Improved) ; 68.07 (Marmandi) to 76.72% (Rossol) ;0.959 (Riogrande and OS 12 F_1) to 0.979 *glml* (IC 134) ; 4.1 (88572) to 6.67% (T2-Improved) ; 0.114 (Money Maker to 0.287% (88572) to 3,4 (OS 12 F_1) TO 4.1 (898 F,) ; 11.2 (88572) TO 20.9 mg Vitamin C per 100 ml (T_2 Improved) ; 13.9 (Rohaba) to 23.9 mg/lOOg (Riogrande) ; 4.15 (Pello) to 5.'85% (898 F_1) ; 3.5 (Pakit and ACE 55 VF) to 4.2 (Ebein) ; 0.934 (Pakit) to 0.976 *glml* (898 F] and Miasara F_1) and from 0.5 (Miasara F_1) to 1,4% (Riogrande and TTlmproved), respectively.

All the investigated tomato cultivars had high values of pulp and juice percentages, their total soluble solids also were slightly higher than values reported by Abubaker (1984) on twelve tomato cultivars grown under plastic housing conditions. High pulp, juice density and total soluble solid are of great importance to tomato industry.

The Titratable acidity and pH reflects the organic acid content mainly the citric acid. Our data on pH and % TA are in agreement with values reported by Orzolek and Anglles (1975) and Abubaker, 1984). The pH and TA % vary during maturation, small difference in fruit maturity result in highly significant differences in pH and TA% (Abubaker, 1984), but in this investigation all fruits were collected at the same stage of ripening, most likely the variation is due to cultivar effect.

Vitamin C content of raw tomatoes or juice is important from nutritional point of view, although vitamin C was higher in fruit than the juice, it seems all cultivars and hybrids have lower values than reported previously (21 mg/lOOg) (Annon 1971) except for five cultivars (T_2 -Improved, Riogrande, 898 F" Miasara F" and UC 134) had comparable amounts of vitamin C with values reported previously (Annon 1971). Vitamin C content of juice varied significantly, only two cultivar (TT Improved and ACE 55 VF) contained a slightly higher (20.9 and 20.6 mg/lOOml) amount of vitamin C than the normal (19.5 mg/lOO ml) amount reported previously (Annon, 1971). About Q\) g Dl 'Vitamin C \'s', n:\\\\\\:<;:dda\\'j b'j humans which is rather high for a vitamin (Nil son, 1978), in Jordan enough tomato are eaten to supply this vitamin. However, our values on vitamin C content of fruit and juice are in full agreement with values reported by Davies and Hobson (1981), who reported a range of 8.4 to 59.0 mg/lOO gripe tomato.

Serum soluble solids were slightly lower than juice total solid, factor influencing total soluble solids accumulation are apparently constrained during the plant growth had development such as fruit/leaf ratio according to Emery and Munger (1970) ; Wewitt et al (1982) and Young et al (1993). The pH of the serum is influenced by malic and citric acid accumulation which are genetically controlled according to young et al (1993). pH values for serum and juice are slightly lower than values reported by Saltveit and Sharaf (1992) but they are in agreement with pH values reported by Abubaker (1984) on tomato cultivars grown under pl~stic house conditions.

The total unsoluable solids are mostly the unsoluable pectines and Iycopen which are important for tomato product quality mainly consistency of tomato paste, the tomato cultivars varied in their unsoluable solids content significantly. Riogrande and T2-Improved were the highest (lA mg/1 OOg) and the hybrid Miasara F, was the lowest (0.5 mg/1 OOg), the ratio of total soluble solids to total unsoluable solids is very important from processing and quality stand point, also the ratio of total soluble solids to titratable acidity according to Goose (1964) and Saltveit and Sharaf (1992), respectively.

The chemical composition of the investigated tomato hybrids and cultivars significantly (Table 3) in their ash, protein, fat, fiber, carbohydrates, reducing sugars and sucrose content.. The 898 F) was the highest in ash (0.6%) and the local cultivar Rohaba was the local cultivar Rohaba was the lowest (0.3%). Most of these tomatoes have ash percent fall in the range (0.51 to 0.70) reported by Davies (1998) except the cultivars Riogrande, Pakit, 88572, Rohaba and Marmandi contained slightly lower ash values (0.3-004%), on the contrary all hybrids ash content arc in agreement with values reported previously (Frenkel and Jen, 1989).

Although tomato is not a good source for protein, all hybrids and cultivars contained protein levels higher than values reported by splittstoesser (1990), who reported a value of 1.0%. The hybrid 898 F] was the highest (2.0%) in protein while the cultivar 88572 was the lowest (1.1 %), all other cultivars and hybrids had intermediate values (Table 3). Tomatoes have traces of fat (Splittstoesser, 1990), our data in Table 3 shows that all hybrids and cultivars contained traces of fat except the miasara F] . which was the highest (0.13%) in fat content and the cultivar Nagina (0.11 %), other tomatoes have lower fat values ACE 55 VF was the lowest (0.03%).

Table No. 3 Chemical Composition of Whole Fruits of Thirteen Open Pollinated Tomato Cultivars and Three Hybrids. *

Cultivar	Ash %	Protein %	Fat %	Fiber %	Total	Carbohydrate %	
						Reducing Sugars	Sucrose
Pello	0.5	1.3	0.04	004	7.8	3.9	3.9
Riogrande	004	1.2	0.07	0.3	8.0	2.1	5.9
T2-Improved	0.5	1.5	0.05	0.5	7.5	3.5	3.9
898 F,	0.6	2.0	0.05	0.6	6.7	3.3	3.5
Ebein	0.6	IA	0.04	004	7.5	304	4.1
Rossol	0.5	1.3	0.05	0.5	7.6	2.6	5.1
Pakit	0.5	1.2	0.04	004	8.0	2.5	SA
ACE 55 VF	0.5	IA	0.03	0.3	7.0	1.7	6.1
Money Maker	0.5	1.2	0.09	0.7	7.6	2.7	4.9
Nagina	0.5	0.2	0.11	0.8	704	3.1	404
Miasara F]	0.5	1.0	0.13	0.9	7.1	1.1	5.7
88572	004	1.1	0.04	0.5	7.9	5.2	2.7
Rohaba	0.3	1.6	0.06	0.2	7.8	2.3	5.5
GS 12F)	0.5	1.2	0.6	004	7.8	3.2	4.7
Marmandi	004	lA	0.05	0.7	7.6	4.3	3.2
DC 134	0.6	1.9	0.07	0.5	7.0	3.5	3.5
LSD (0.05)	0.158	00458	0.075	0.34	0.599	2.322	2.356

* Average of three determinations, calculated at 90% moisture content..

Table No. 4 Mineral Matter analysis of thirteen open pollinated tomato cultivars and three hybrids.

Cultivar	Minerals (mg/lOO)								
	Ca	Na	K	Zn	Mn	Mg	Fe	Cll	p
Pello	17.0	18.6	129.8	0.18	0.10	13.0	1,12	0.10	15.5
Riogrande	15.1	21,1	145.8	0.14	0.09	12.0	0.94	0.07	25.2
Tz-Improved	13,5	18.2	140.0	0.21	0.10	13.1	0.85	0.09	29.5
898 F,	13,4	23.7	236.9	0.21	0.12	18.3	1,28	0.11	21,7
Ebein	11,7	23.9	206.7	0.19	0.08	14.1	1,40	0.10	16.9
Rossol	19.1	22.6	110.5	0.27	0.11	16,4	1,45	0.21	19.2
Pakit	10.5	18.3	200,4	0.22	0.11	18.7	2.26	0.12	27.7
ACE 55 VF	16.1	18.3	178.9	0.16	0.10	14.6	1,23	0.11	13,4
Money Maker	21,7	22.2	170.7	0.22	0.11	16,5	1,53	0.12	13,0
Nagina	16.1	24.5	173.1	0.24	0.10	16.3	0.99	0.10	17.8
MiasaraF]	17.3	29.2	171,1	0.20	0.09	20.8	1,31	0.08	24.2
88572	9.6	23.9	164.9	0.20	0.09	14.0	1,04	0.10	19.5
Rohaba	12.0	23,4	150.9	0.17	0.08	11,5	1,28	0.08	9.2
OS 12 F]	15.9	17.9	152.3	0.18	0.11	15.3	0.98	0.11	19,4
Marmandi	14.3	19.0	139.0	0.18	0.08	10.3	1,28	0.27	12.8
DC 134	19.1	23.3	194.3	0.25	0.15	18,4	1,47	0.15	23.2
LSD (0.05)	9.270	9.198	57.21	0.106	0.053	7.705	0.393	0.158	10,51

* Average of three determinations, calculated at 90% moisture content.

The levels of crude fiber contents of the investigated tomatoes were less than 1% for all hybrids and cultivar.. These values are slightly lower than the values reported by Hoff (1985). Miasara F] had the highest value (0.9%) and Rohaba was the lowest (0.2%), all other crude fiber values were intermediate.

"The total carbohydrates, reducing sugars and sucrose content are given in Table 3. The cultivars Riogrande and Pakit had the highest carbohydrate content (8.0%) and the hybrid 898 F] had the lowest value (6.7%), all other hybrids and clutivars had intermediate carbohydrate contents, our values compared very well with values reported by Keithly et al (1991), the reducing sugars which are excellent measure for glucose and fructose content varied significantly and ranged from 1.1 (Miasara Fl) to 5.2% (88572), all other hybrids and cultivars had intermediate values, these values are in agreement with values reported by young et al. (1993) on accumulation of the component of total solids in ripening of tomato fruits., also the sucrose content ranged from 2.7 (88572) to 5.9% (Riogrande), these values are comparable with values reported by Kcithly et al (1991). The importance of carbohydrates in tomatoes vary from attributing to taste and brown color of tomato products to increasing the yield of process tomato and the soluble solids.

Sugar content of tomato fruits and juice usually 9.0 and 10.0 mg/lOOg (Ann on 1971), the total solids average of tomatoes ranges between 5.0 to 6.0, mostly sugars, organic acids comprise 1/10 of the total solids, the sugar/acid content in a large part a function of cultivar genetic background which may account for the differences in the

metabolic propensity for the accumulation of the compounds according to Frenkel and Jen (1989).

Data on mineral matter analysis of tomatoes are given in Table 4. Money Maker cultivar was the highest in Ca content (21.7 mg/ 100g) while 88572 was the lowest (9.6 mg/100g), all hybrids and cultivars had intermediate Ca content, our data on Ca agree very well with values reported by Frenkeld and Jen (1989) who reported a range of 4-21 mg/l OOg tomato, Na content also compare very well with data presented by the previous investigator who reported a range of 1.2-32.7 mgil OOg for tomato fruits, our data showed that the hybrid Miasara F_1 had the highest Na content (29.2 mg/lOOg) whereas the OS 12 F_1 had the lowest Na content (17.9* mg/100 g). K content of tomato fruits varied significantly among cultivars, 898 F_1 was the highest (236.9 mg/lOOg) while the cultivar Rossol had the lowest value (110.0 mg/l OOg), all other cultivars ere intermediate, our data on K content compare very well with values reported by Frenkeld and Jen (1989) who reported K content range (92.0-376.0 mg/l OOg) on level of constitments in ripe tomato fruit. Zn, Mn, Mg, Cn and P..... were also significantly different. Highest concentrations were 0.27 (Rossol), 0.15 (UC 134), 20.0 (Miasara FI) 0.27 (Marmandi) and 29.5 (Tz- Improved) for Zn, Mn, Mg, Cn and P, respectively. Lowest concentrations were 0.14 (Riogrande), 0.04 (Riogrande), 10.3 (Marmandi), 0.07 (Riogrande) and 9.2 (Rohaba) for Zn, Mn, Mg, Cu and P, respectively. All mineral values fall within the corresponding ranges reported by Frenkeld and Jen, 1989 except for Fe contents, they were slightly higher than the reported range for Fe contents, they were slightly higher than the reported range (0.35-0.95 mg/100g fruit). Our data on Fe contents shown in Table 4 ranged horn 2.26 (Pakit) to 0.85 mg/lOOg (Tz-Improved).

The variation in mineral contents which is reported in this study from previous studies might be due to genotype or environmental effect. This variability will be utilized in addition to the yield in order to select the best genotypes to suit the Jordanian conditions and consumers quality preference.

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