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Processing characteristics of tomato (*Solanum lycopersicum*) cultivars*

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Tomato (*Solanum lycopersicum* L.) is one of the major vegetable crops, grown and processed in almost every country in the world. They are consumed fresh or as processed products. The economic service of USDA estimates that 35% of raw tomatoes are processed into sauces, 18% into tomato paste, 17% for canned tomatoes, 15% in juices and 15% in ketchup (Canene- Adams *et al.* 2005). They are a good source of potassium, folate, and vitamin E, soluble and insoluble dietary fibers. They have high levels of lycopene (71.6%) and ascorbic acid (12%) (Kaur and Kapoor 2008). There is a diverse germplasm available in India. Therefore, it is important to know the chemical composition of different cultivars to achieve the cultivar with best processing traits. Breeding programmes for improved cultivars should be designed for multinational giants so that better quality tomato products can be produced. Tomato has achieved a spectacular status of functional food because of its rich composition and widespread consumption. Tomato and tomato-based products are used as a preventive strategy against major lifestyle diseases, such as cancer and cardiovascular diseases (Canene-Adams *et al*. 2005).

It is valuable to exploit the antioxidant properties present in tomatoes as the first frontier of scientific investigation has moved from the primary role of food as the source of energy and body-substances to more subtle action of biological active food components on human health. In the view of the diverse use of tomatoes in human health, the present paper discusses the compositional differences between the various cultivars in terms of ascorbic acid, phenols, lycopene, total soluble solids and acidity.

Fourteen cultivars of Indian tomatoes were chosen for the study. Ten fruits of each cultivar were selected randomly in triplicates. The homogeneous macerate was used to study the contents of lycopene, phenolics, ascorbic acid, acidity and total soluble solids (TSS) in tomato fractions: peel and pulp respectively.

Lycopene was extracted with hexane: methanol: acetone (2: 1: 1), containing 2.5% butylated hydroxy toluene and was measured spectrophotometrically at 502 nm against a hexane blank (Rao *et al*. 1998). Results were expressed as mg/100 g fresh weight. Ascorbic acid content was determined by titrating a known weight of sample with 2, 6–dichlorophenol indophenol dye using metaphosphoric acid as a stabilizing agent (Albrecht 1993). Results were expressed as ascorbic acid content in mg/100 g. Total phenolic content was estimated using Folin ciocealteau reagent (FCR) as described by Singleton *et al*. (1999), using gallic acid as a standard. Results were expressed as mg Gallic Acid Equivalent (GAE)/100 g. TSS in °Brix was measured using an Abbe refractometer calibrated against sucrose. Acidity was measured according to AOAC Method 942.15 (1995) and expressed as per cent citric acid.

The experiments were set up in a completely randomized design. All data were analyzed by analysis of variance (ANOVA) and mean values were compared with Duncan's Multiple Range Tests using SPSS version 13.0 software (SPSS, New Delhi, India). All the experiments were repeated thrice as means ± standard error of mean.

Red colour is the index of the total quality in tomato products. It is due to principal carotenoid lycopene comprising about 83% of the total pigment present. ß-carotene is about 3–7% of the total carotenoid in tomatoes. The lycopene levels also showed significant difference among peel and pulp as well as among different cultivars. In the pulp of red cultivars the lycopene content ranged from 2.73 to 4.55 mg/100 g (Table 1). The lycopene content in the pulp of yellow cultivars ranged from 0.769 to 1.239 mg/100 g. Red cultivars had nearly 3–6 folds more lycopene content than the yellow ones. 'Cherry red' and 'Tawayan' seems to be the promising cultivars for lycopene content. The present data for lycopene are in agreement with those reported by Clinton (1998) and of Nguyen and Schwartz (1999). When tomatoes are crushed for processing, lycopene from peel also gets incorporated into it so it, is important to analyze the

*Short note

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Table 1 Phenolic, lycopene and total soluble solids in different tomato cultivars (mean of two years)

Cultivar	Phenols (mg GAE/100 g)		Lycopene (mg/100 g)		Total soluble solids (°Brix)	
	Peel	Pulp	Peel	Pulp	Peel	Pulp
			Yellow cultivars			
'C-10-75-1-19-Y'	57.13±5.36[ef]	22.90±1.59[fg]	5.28±0.34[e]	1.04±0.09[d]	7.30±0.05[f]	4.90±0.11[h]
'Cherry orange'	135.0±3.51[a]	45.30±0.05[b]	1.64±0.19[f]	0.08±0.10[d]	10.53±0.17[b]	6.86±0.08[b]
'VS 618-2'	77.63±5.35[def]	22.50±4.02[fg]	4.57±0.08[e]	0.97±0.02[d]	7.46±0.06[f]	6.23±0.08[c]
'Avinash Y'	73.13±3.47[def]	26.23±1.52[defg]	3.38±0.07[ef]	1.23±0.17[cd]	8.76±0.03[d]	5.60±0.10[def]
'C-10-15-27-3'	76.13±2.87[def]	22.70±0.83[fg]	3.35±0.05[ef]	1.02±0.05[d]	7.36±0.14[f]	5.70±0.10[de]
'310269 Y'	71.53±0.48[def]	47.36±1.82[b]	1.47±0.22[f]	0.76±0.06[d]	7.30±0.15[f]	5.93±0.29[cd]
			Red cultivars			
'C-10-75-15-19 Red'	123.56±4.88[ab]	31.00±0.91[cd]	23.55±1.17[b]	4.18±0.04[ab]	10.60±0.00[b]	5.20±0.11[fgh]
'Pusa Gaurav'	78.40±33.74[cde]	29.63±0.26[cde]	19.51±2.66[c]	3.89±0.12[ab]	9.60±0.10[c]	5.86±0.14[cde]
'N-5'	83.30±9.24[cde]	34.33±2.72[c]	17.42±0.97[c]	4.50±0.11[a]	7.93±0.08[e]	5.50±0.05[def]
'Cherry red'	107.23±3.81[abc]	57.60±0.70[a]	26.75±0.08[a]	4.53±0.05[a]	13.56±0.23[a]	9.23±0.41[a]
'Tawayan'	96.79±1.63[bcd]	29.93±0.63[cde]	24.97±0.45[ab]	4.55±2.03[a]	9.66±0.08[c]	6.30±0.05[c]
'3900'	95.76±1.72[bcd]	27.56±0.58[def]	26.60±1.60[a]	3.53±0.16[ab]	8.06±0.08[e]	5.40±0.05[efg]
'1234'	82.13±2.42[cde]	25.00±2.30[efg]	24.35±1.21[ab]	3.14±0.27[ab]	9.53±0.18[c]	5.86±0.03[cde]
'Roma'	48.66±6.41[f]	21.46±2.27[g]	9.78±0.53[d]	2.73±0.01[bc]	6.50±0.05[g]	5.00±0.11[gh]

Values represent the mean of three replicates per cultivar. Mean followed by the same superscripts are not significantly different (P<0.05)

lycopene in peel as well. On an average, the peel contained about 3–5 times higher lycopene as compared to the pulp. Among the red and yellow cultivars, lycopene content in the peel ranged from 9.78 to 26.75 and 1.471 to 5.28 mg/100 g respectively. Hence processing of tomato has tremendous impact on the retention of nutrients and their availability in the body.

Ascorbic acid is taken as an index of quality of fresh produce. It is one of the most effective antioxidants in fruits and vegetables. Ascorbic acid content in tomato is usually moderate (84 to 590 mg/kg), but its contribution to diet is significant because of its high consumption. Ascorbic acid content ranged from 23.21 to 40.44 and 24.38 to 33.87 mg/100 g in red and yellow tomato cultivars respectively (Fig 1). There was a significant difference among the red and yellow cultivars in respect to the ascorbic acid content. Among the red and yellow cultivars, highest levels of ascorbic acid were present in '3900' and '310269 Y' respectively. Marcos *et al.* (2005) reported that the ascorbic acid content 13 to 15 mg/100 g in 'Spanish Tomato' cultivars. But in the present study ascorbic acid content is much higher, i e in the range of 23 to 40 mg/100 g. The variation in ascorbic acid content in tomatoes depends mainly on the agronomic conditions and the varietal differences.

Phenolic compounds are rarely encountered in the normal compositional tables of fruits and vegetables and their quantification can give vital information relating to antioxidant functioning, food quality and potential health benefits. They are presently being viewed as star nutrients because of their antioxidant properties (Kaur and Kapoor 2008). Peels contained 3–4 times more phenols than the pulp. In the red cultivars the phenolic content in the pulp ranged from 21.46 to 57.60 mg GAE/100 g highest in 'Cherry Red' and 'N 5' (Table 1). In the yellow cultivars the phenolic

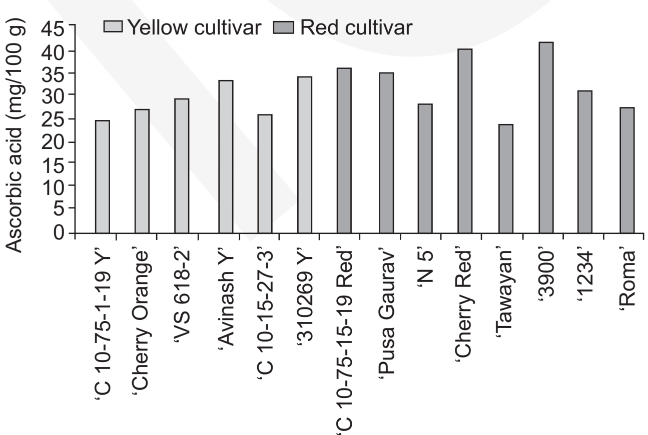

Fig 1 Mean ascorbic acid content among the Indian tomato cultivars

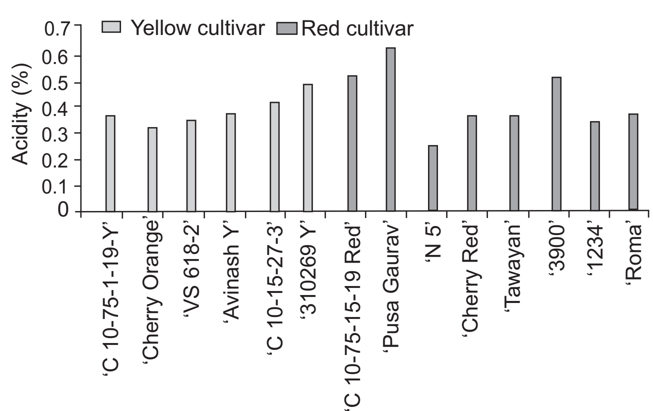

Fig 2 Mean acidity among the Indian tomato cultivars

content ranged from 22.5 to 47.36 mg GAE/100 g and highest in 'Cherry Orange' and '310269 Y'. The above data for total phenolic content are in agreement with the values given by Zhou and Yu (2006). As evident from the data, the total phenol content in the peels of red and yellow cultivars ranged from 48.66 to 123.56 and 57.13 to 135 mg GAE/100 g respectively.

Total solids have direct implications in tomato processing industry. They influence the final yield, consistency and overall quality of the finished product. Thus high solids are desirable because making concentrates to a desirable solid level with high tomato solids provides greater product yield and also requires less concentration, reducing the cost. As evident from the data (Table 1), TSS of the peel of all the cultivars is approximately 1.5 folds higher than the pulp. TSS content in the pulp of red and yellow cultivars ranged from 5.0 to 9.2 and 4.9 to 6.8 B respectively. Maximum TSS content was observed in 'cherry' varieties. Among the red and yellow cultivars, TSS content in tomato peel ranged from 6.5 to 13.5 and 7.3 to 10.5 B. Our results are in agreement with the results shown by George *et al* (2004). Acidity is an important quality factor governing the microbial stability of the processed products. In addition to flavour and consistency, it influences the processing time and temperature of the products. Acidity in different cultivars is shown in Fig 2. Among red and yellow cultivars, acidity was in the range of 0.25 to 0.63% and 0.32 to 0.50% respectively (Fig 2). Maximum acidity content was observed in 'Pusa Gaurav' and '310269Y' in red and yellow varieties. According to the guidelines of Gould (1992); tomato should have acidity in the range of 0.35 to 0.55% to qualify as a processing cultivar. In this context, all the examined cultivars in our study except 'Pusa Gaurav' and 'N 5' had acidity in the recommended range.

SUMMARY

A study was conducted during 2007–09 on 14 cultivars of tomatoes (*Solanum lycopersicum* L.) for their processing characteristics. All the cultivars had significant levels of ascorbic acid, phenolics and lycopene content. Maximum lycopene content was found in 'Tawayan' (4.55.mg/100 g), whereas highest level of ascorbic acid was present in cultivar '3900' (40.44 mg/100 g). Phenolic content (57.60 mg GAE/100 g) and TSS (9.23°B) was highest in 'Cherry Red' cultivar, on the other hand 'Pusa Gaurav' (0.63%) had maximum acidity level. Attractive bright red colour and high content of ascorbic acid, acidity and TSS favours cherry cultivars for processing purposes. A deep insight into the characteristics affecting the processing traits will help to define the quality of tomato products.

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