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Phytochemical Variations in Different Tomato Genotypes Grown in Eastern Indian Indo-Gangetic Regions

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ABSTRACT

In this study, fifteen commercial varieties, nine exotic genotypes, and three wild species of tomato grown in Eastern India were analyzed for variations in different phytochemicals *viz*. ascorbic acid, lycopene, total carotenoids, total phenolics content and total antioxidant capacity. Selected genotypes showed significant differences with respect to phytochemical composition. Among antioxidant property parameter, ascorbic acid content ranged between 12.62 to 76.15 mg 100 g^{-1} of Fresh Weight (FW), whereas, the total phenolic content and total antioxidant capacity varied from 41.10 to 139.59 mg GAE 100 g^{-1} of FW and 1.16 to 4.52 µmol Trolex Equivalent (TE) g^{-1} of FW, respectively. Among carotenoid parameters, lycopene and total carotenoids content in whole tomato fruit ranged between 0.47 to 5.48 and 1.14 to 5.79 mg 100 g^{-1} of FW, respectively. Interestingly, it was found that, among the evaluated genotypes, Exotic Collection (EC lines) showed significant enriched amount of these phytochemicals. Results indicated that the maximum ascorbic acid (76.15 mg 100 g^{-1} FW), total phenolics content (139.59 mg GAE 100 g^{-1} of FW), and total antioxidant capacity (4.52 µmol TE g^{-1} of FW) was highest in exotic collection EC 528372, while, lycopene (5.48 mg 100 g^{-1} of FW) and total carotenoids content (5.79 mg 100 g^{-1} of FW) were recorded highest in cultivar Rio Grande. Thus, this group of screened genotypes consisting of phytochemical rich wild species and exotic collection can be further used for improvement of functional quality of tomato in future breeding programs of India and the Indo Gangetic region.

Keywords: Antioxidant, Ascorbic acid, Carotenoid parameters, Lycopene.

INTRODUCTION

Reactive Oxygen Species (ROS) or free radicals produced from internal as well as environmental sources cause damage to the cells and their functions. Scientific evidences confirmed that excessive accumulation of these ROS in the human body is associated with onset of several chronic degenerative diseases like cancer, cardiovascular disease, diabetes, rheumatoid arthritis, alzheimer's, etc. (Alfadda and Sallam, 2012; Halliwell, 1991). The adverse effect of these free radicals can be balanced by consumption of dietary antioxidants in our daily food (Alezandro *et al*., 2013). Horticultural crops and their varieties vary in their biochemical, morphological, and quality parameters (Neha *et al*., 2016a; Prasad and Sharma, 2016). The secondary metabolites not only affect internal quality, but also external quality, such as cosmetic appeal of fruit (Prasad *et al*., 2016a) and vegetable. Therefore, consumption of fruits and vegetables rich in natural antioxidants like ascorbic acid, carotenoids, phenolics, and flavonoids, etc. which have higher antioxidant capacity can minimize the effects of these harmful ROS on human health (Macedo *et al*., 2013). With respect to improving phytochemical composition of

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fruit and vegetables, there are two approaches among researchers: first is to increase the secondary metabolites in fruits and vegetables through postharvest treatment so that internal and external quality can be increased (Prasad *et al*., 2016b), and second is to increase the quality of produce by screening, identifying and developing the varieties rich in phytochemicals (Neha *et al.*, 2016). The second approach is more effective as there is scope of increasing the phytochemical composition to a higher level. This approach will help consumers in the consumption of fruits and vegetables varieties rich in phytochemicals.

Tomato is one of the widely consumed vegetables in the world, both as fresh and processed form. Several processed products like tomato puree, paste, sauce, ketchup, soup, pickle, etc. are widely available in the market. Fresh tomatoes and tomato-processed products are the reservoir of several bioactive compounds such as carotenes (lycopene, β-carotene), ascorbic acid, phenolic compounds, etc. (Raiola *et al*., 2014; Kaur *et al*., 2004). For this, tomato is universally known as 'Protective Food' (Thamburaj and Singh, 2013). Lycopene present in tomato is a strong antioxidant and exhibits 2-10 times higher singlet oxygen quenching capacity than β-carotene and α-tocopherol (Di Mascio *et al*., 1989). Dietary intake of lycopene-rich foods is epidemiologically correlated with diminished risk of certain cancers, such as mouth, lung, prostate, colon cancers, coronary heart diseases and macular degeneration (Dillingham and Rao, 2009) and it has been found to be more effective than α and β-carotene in inhibiting cell proliferation in various human epithelial cancer cell lines (Giovannucci, 1999). Besides lycopene, tomato fruits also contain numerous phenolic compounds like chlorogenic acid, caffeic acid and rutin which exhibit several physiological properties like hepatoprotective, anti-inflammatory, hypoglycemic, cardio-protective, antimicrobial and antiviral effects (Navarro-González *et al*., 2011). Ascorbic acid is another potent antioxidant compound present in tomato. Thus, tomatoes have undoubtedly assumed the status of functional food considering the presence of several phytochemicals and overwhelming epidemiological evidence for its reducing risk of several chronic diseases (Abuajah *et al*., 2015; Nguyen and Schwartz, 1999). Although content of these phytochemicals in fruits and vegetables are strongly influenced by genotypic and environmental factors, information on functional properties of tomato genotypes grown in Eastern India is still lacking. Thus, the finding of this research will help tomato breeders in using superior genotypes for future breeding program to develop new varieties rich in phytochemicals. Generation of such information will also benefit the tomato processing industries to develop nutraceutical-rich tomato based products and also will benefit consumers, by meeting their need of dietary antioxidants. The present study, therefore, aimed at determining the phytochemical properties (ascorbic acid, lycopene, total carotenoids, total phenolics as well as total antioxidant capacity) of fifteen commercial varieties, nine exotic genotypes, and three wild species grown under Eastern Indian Indo-Gangetic conditions.

MATERIALS AND METHODS

Freshly harvested fully-ripe tomato fruits grown under field condition were used for the present study. The field experiment of this investigation was carried out in the Vegetable Research Farm, Bihar Agricultural University, Sabour, Bhagalpur, Bihar (India). Sabour is located at a longitude of 87º 2' 42" E, latitude of 25º 15' 40" N and an altitude of 45.57 m above mean sea level in the heart of the Indo-Gangetic plains of Eastern India. This location is under subtropical region and is slightly semi-arid, characterized by dry summer, moderate rainfall, and cold winter.

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During the plant growth and development period, the maximum temperature range and total rainfall recorded were 20–34.6°C and 108.4 mm, respectively. The experimental materials consisted of twenty seven lines of tomato genotypes, collected from different sources (Table 1). This experiment was designed in Randomized Complete Block Design (RCBD), replicated thrice and planted at 60×35 cm spacing. For further growth and development, standard cultural practices were used. Fully ripe-red tomatoes were harvested randomly from the plant and healthy fruits free from disease, pest or physical injury were selected for the study. Sampled fruits of each genotype were cut into small pieces, homogenized for 2 minutes and analyzed for different phytochemicals.

Ascorbic Acid Content

Ascorbic acid content in the sample was quantified by 2,6-dichlorophenol indophenols dye method of AOAC (2012). For this purpose, 2 g of sample was crushed and diluted to 100 mL with 3% metaphosphoric acid solution. The mixture was then filtered and after 10 minutes, the aliquot of filtrate was titrated with 2,6-dichlorophenol indophenols dye solution (0.025%). The end point was marked by the appearance of pink color persisting for 15 seconds. The content of ascorbic acid was expressed as mg 100 g^{-1} FW.

Lycopene Content

Lycopene content of tomato fruit was determined by the method of Lee (2001). To do this, 5 g of sample was crushed in acetone, till it became colorless. The extracted sample was then poured into a separating funnel and petroleum ether and sodium sulfate solution was added to it. The colored solution was then separated in a 50 mL volumetric flask and the volume was adjusted with petroleum ether. Finally, the absorbance of the sample was recorded at 503 nm in a spectrophotometer and the results were expressed as mg 100 g^{-1} FW.

Total Carotenoids Content

Total carotenoids content of tomato fruit was determined by the method of Roy (1973). Accordingly, 5 g of tomato pulp was crushed with a mixture of petroleum ether and acetone (3:1) till it became colorless, to extract the carotenoids. The mixture was assayed colorimetrically by spectrophotometer at 452 nm and the results were expressed as mg 100 g^{-1} FW.

Table 1. Tomato genotypes used in the experiment and its source.

Sl No	Genotypes	Source
1	EC 625644	IIVR, Varanasi
2	EC 620421	IIVR, Varanasi
3	Azad -5	IIVR, Varanasi
4	CLN 1621 L	NBPGR, New Delhi
5	EC 521080	NBPGR, New Delhi
6	EC 528372	NBPGR, New Delhi
7	IIHR 2620	IIHR, Bengaluru
8	Sun Cherry	IIVR, Varanasi
9	Arka Vikash	IIHR, Bengaluru
10	*S. peruvianum*	NBPGR, New Delhi
11	*S. pimpinellifolium*	NBPGR, New Delhi
12	*S. chilense*	NBPGR, New Delhi
13	Selection-18	NBPGR, New Delhi
14	B-10-2	IIVR, Varanasi
15	EC 620377	NBPGR, New Delhi
16	Pusa Rohini	NBPGR, New Delhi
17	Arka Meghali	IIHR, Bengaluru
18	Kashi Vishesh (H–86)	IIVR, Varanasi
19	Azad T-2	IIVR, Varanasi
20	Azad T-6	IIVR, Varanasi
21	Rio Grande	IIVR, Varanasi
22	EC 620404	NBPGR, New Delhi
23	IIHR 2618	IIHR, Bengaluru
24	IIHR 2619	IIHR, Bengaluru
25	EC 538455	NBPGR, New Delhi
26	EC 677071	NBPGR, New Delhi
27	EC 620444	IIVR, Varanasi

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Total Phenolics Content

Total phenolics content in the tomato fruit was determined by the method of Singleton *et al.* (1999). To do this, 300 µL of sample extract (in 80% ethanol) was added to 2.7 mL of distilled water and 0.5 mL of 2N Folin-ciocalteu reagent in a test tube. After 3 minutes, 2 mL of sodium carbonate solution (20%) was added and the mixture was allowed to stand for 90 minutes. Finally, the absorbance was recorded at 760 nm in a UV-Vis spectrophotometer (HALODB-20S UV–Vis Double Beam Spectrophotometer, Australia) against a reagent blank. The results were expressed as gallic acid equivalent (mg GAE 100 g^{-1} FW).

Total Antioxidant Capacity

Total antioxidant capacity of tomato fruit was determined following CUPRAC method (Apak *et al*., 2008). For this purpose, 100 µL of sample extract (in 80% ethanol) was added to 1 mL each of copper(II) chloride solution, neocuproine solution, ammonium acetate buffer solution and distilled water in a test tube. After 30 minutes, absorbance of the sample was recorded at 450 nm in a spectrophotometer and the results were expressed as trolox equivalent (µmol TE g^{-1} FW).

Statistical Analysis

Collected data were analyzed using SAS statistical system 9.2 (SAS Institute, Cary, NC, USA). Data were significantly accepted at 1% and 5% level of significance. Phenotypic and Genotypic Coefficient of Variation (PCV and GCV) was calculated according to the formula suggested by Burton (1952). Heritability (h^2b) in broad sense was calculated as per formula suggested by Burton and Devane (1953). The expected genetic advance was computed with the help of the formula suggested by Lush (1949), Burton and Devane (1953) and Johnson *et al.* (1955). Genetic Advance as Percent of Mean (GAPM) was calculated by the following formula: Phenotypic and genotypic correlation coefficients were calculated as per formula suggested by Al-Jibouri *et al.* (1958).

Genetic advance as per cent of mean $= \left(\frac{GA}{\overline{X}}\right) \times 100$

GA= Genetics Advance, $\overline{X}$ = Mean of a character.

RESULTS AND DISCUSSION

Ascorbic Acid Content

In this study, among the genotypes, the highest Ascorbic Acid (AsA) content was recorded in EC 528372 (76.15 mg 100 g^{-1} FW) followed by EC 620444 (71.0 mg 100 g^{-1} FW) and *S. pimpenillifolium* (48.47 mg 100 g^{-1} FW) (Table 2). In light red tomato, Abebe *et al.* (2017) observed the average ascorbic acid content to be 21 mg 100 g^{-1}. Similarly, George *et al*. (2004) reported that AsA content in tomato pulp ranged from 8.4 to 32.4 mg 100 g^{-1}. The lowest AsA content was recorded in B-10-2 (12.62 mg 100 g^{-1} FW). The overall mean value of AsA content was 31.00 mg 100 g^{-1} FW. Similarly, Singh *et al*. (2010) described that AsA content of tomatoes vary according to color and it ranged from 23.21-40.44 and 24.38-33.87 mg 100 g^{-1} in red and yellow cultivars, respectively. In our study, Figure 1 represents the distribution of ascorbic acid in different tomato genotypes. The phenotypic and genotypic coefficient of variation was 47.78 and 47.59%, respectively. The heritability in broad sense (99.17%) as well as the genetic advance in per cent of mean (168.85) was high (Table 3). Our findings collaborates work of Dar and Sharma (2011) who obtained similar results for AsA in tomato.

Lycopene Content

Among all twenty seven tomato genotypes evaluated, the lycopene content ranged

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Table 2. Phytochemicals content in tomato genotypes.

Sl. No.	Genotypes	Total antioxidant capacity (µmol TE g^{-1} FW)	Total carotenoids (mg 100 g^{-1} FW)	Lycopene content (mg 100 g^{-1} FW)	Total phenolics content (mg GAE g^{-1} FW)	Ascorbic acid content (mg 100 g^{-1} FW)
1	Arka Meghali	3.137^{de}	1.871^{k}	1.223^{jkl}	94.239^{c}	20.898^{o}
2	Arka Vikash	3.088^{e}	5.092^{c}	4.956^{b}	67.197^{i}	30.093^{hi}
3	Azad T-2	2.217^{hijk}	1.851^{k}	1.661^{hi}	57.693^{n}	16.380^{p}
4	Azad T-5	2.272^{hij}	1.251^{n}	1.095^{klm}	62.572^{k}	31.455^{gh}
5	Azad T-6	1.825^{lm}	2.310^{ij}	1.782^{h}	67.501^{i}	23.225^{lmh}
6	B-10-2	1.268^{n}	3.754^{e}	2.376^{g}	62.964^{k}	12.619^{q}
7	CLN-1621-L	1.897^{klm}	1.534^{ml}	0.705^{no}	72.392^{g}	27.771^{j}
8	EC-521080	2.970^{ef}	1.400^{mn}	1.228^{jkl}	59.316^{mn}	21.500^{mno}
9	EC-528372	4.524^{a}	1.930^{k}	1.786^{h}	139.592^{a}	76.150^{a}
10	EC-538455	3.210^{de}	1.413^{mn}	0.973^{lmn}	50.875^{p}	34.431^{f}
11	EC-620377	1.164^{n}	2.565^{hi}	1.102^{klm}	55.038^{o}	21.358^{no}
12	EC-620404	2.233^{hijk}	3.324^{f}	1.466^{ij}	54.602^{o}	23.116^{lmn}
13	EC-620421	2.519^{gh}	1.142^{n}	0.468^{o}	88.144^{d}	26.374^{jk}
14	EC-620444	3.468^{cd}	2.807^{gh}	2.684^{f}	84.195^{e}	71.033^{b}
15	EC-625644	1.870^{lm}	2.880^{g}	1.426^{ij}	86.357^{de}	23.609^{lm}
16	EC-677071	2.055^{jklm}	1.833^{k}	1.461^{ij}	64.557^{jk}	24.270^{lk}
17	H-86	2.665^{fg}	1.930^{k}	1.489^{ij}	69.924^{h}	34.380^{f}
18	IIHR-2618	2.662^{fg}	5.412^{b}	3.885^{e}	48.295^{q}	24.665^{lk}
19	IIHR-2619	4.507^{a}	2.239^{j}	1.495^{ij}	94.359^{c}	22.793^{lmno}
20	IIHR-2620	1.747^{m}	4.704^{d}	4.171^{d}	41.097^{r}	16.437^{p}
21	Pusa Rohini	2.722^{fg}	4.861^{cd}	4.636^{c}	66.610^{ij}	33.645^{fg}
22	Rio Grande	2.414^{ghi}	5.788^{a}	5.481^{a}	63.252^{k}	28.248^{ij}
23	Selection-18	2.927^{ef}	3.458^{f}	2.577^{fg}	88.234^{d}	32.257^{fgh}
24	*S. chilense*	4.068^{b}	1.782^{kl}	0.970^{lmn}	108.972^{b}	37.214^{e}
25	*S. peruvianum*	2.127^{ijkl}	2.845^{gh}	1.238^{jkl}	60.598^{lm}	46.182^{d}
26	*S. pimpenillifolium*	3.752^{bc}	1.829^{k}	0.824^{mn}	80.982^{f}	48.477^{c}
27	Suncherry	3.235^{de}	2.900^{g}	1.365^{jk}	64.238^{k}	28.416^{ij}
	LSD	0.3431	0.28	0.283	2.354	2.2066

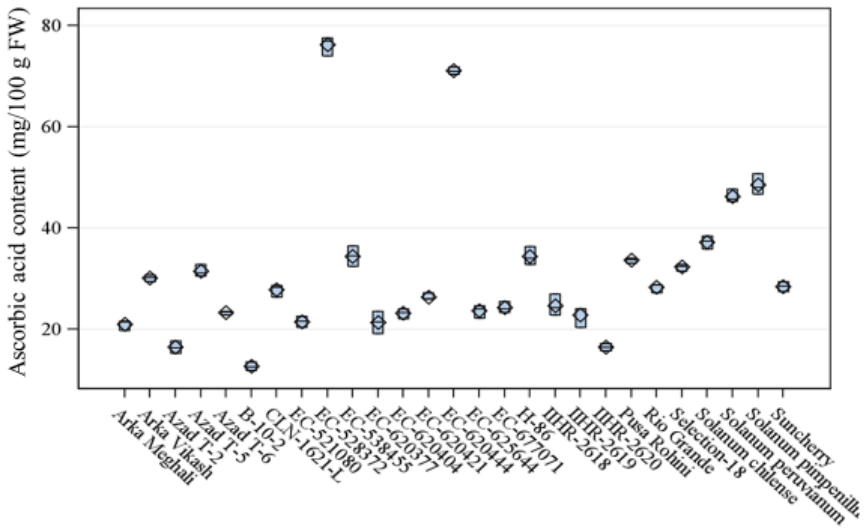

Figure 1. Ascorbic acid content among tomato genotypes.

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Table 3. Genetic performance of tomato genotypes.

Character	PCV [a] (%)	GCV [b] (%)	h^2b [c] (%)	GA [d]	GAPM [e] (%)
Ascorbic acid content	47.78	47.59	99.17	286.9468	168.8501
Total phenolics content	28.95	28.88	99.53	343.6368	102.7296
Total antioxidant capacity	33.32	32.40	94.53	12.56199	111.2831
Lycopene content	69.02	68.49	98.47	22.13508	241.8658
Total carotenoids content	54.03	53.68	98.72	13.24023	189.8951
Ascorbic acid content	47.78	47.59	99.17	286.9468	168.8501

[a] Phenotypic Coefficient of Variation; [b] Genotypic Coefficient of Variation; [c] Heritability in broad sense; [d] Genetic Advance, [e] Genetic Advance as Per cent of Mean.

between 0.47 to 5.48 mg 100 g^{-1} FW (Table 2). The highest lycopene content was recorded in Rio Grande (5.48 mg 100 g^{-1} FW) followed by Arka Vikas (4.95 mg 100 g^{-1} FW) and Pusa Rohini (4.63 mg 100 g^{-1} FW). Dar and Sharma (2011) also reported almost similar range of lycopene content in tomatoes (1.95 to 4.62 mg 100 g^{-1} FW). In another study, lycopene content in the pulp of tomatoes was reported in the range of 2.75–4.55 and 0.76–1.23 mg 100 g^{-1} FW in fruits belonging to red and yellow colored varieties, respectively (Singh *et al*., 2010). In tomato, lycopene is responsible for the red color of fruits, which varies due to different factors like influence of variety (generally genetic factors), maturity, agronomical and environmental conditions during growth and development (Kaur *et al*., 2013; Garcia and Barret, 2006; Favati *et al*., 2009). Figure 2 represents the range of lycopene in three replications and also the average mean. The colored cultivars had 3–6 times more lycopene content than yellow cultivars. It was also reported that peel contained about 3–5 folds higher lycopene in relation to pulp having a range of 9.78–26.75 and 1.47–5.28 mg 100 g^{-1} FW in red and yellow cultivars, respectively (Singh *et al*., 2010). Tomato extracts, especially the skin extracts, contained high amounts of lycopene (Singh *et al*., 2010). George *et al*. (2004) also reported significant variation in the pulp and peel fractions of examining genotypes. The phenotypic and genotypic coefficient of variation for lycopene content was 69.02 and 68.49%, respectively. The heritability in broad sense (98.47%) as well as the genetic advance in per cent of mean (241.86) was high (Table 3). Heritability observed by Dar and Sharma (2011) in lycopene content was 92%, which is high.

Total Carotenoids Content

Total carotenoid content in tomato fruits is affected by both the variety and ripening stage of the fruit (Martínez-Valverde *et al*., 2002). Among all characters, carotenoids content accounts for the major variability explained in the tomato genotypes (Frusciante *et al*., 2007). The carotenoids content of tomato depends on cultivars, stage of maturity, environmental factors, and growing conditions (Sahlin *et al*., 2004). In the present study, the total carotenoids content ranged between 1.14–5.79 mg 100 g^{-1} FW. The highest total carotenoids content was noted in Rio Grande (5.78 mg 100 g^{-1} FW) followed by Arka Vikas (5.07 mg 100 g^{-1} FW) and Pusa Rohini (4.86 mg 100 g^{-1} FW) (Table 2). The minimum total carotenoids content was found in EC 620421 (1.14 mg 100 g^{-1} FW). The overall mean value of total carotenoids content was 2.76 mg 100 g^{-1} FW (Figure 3). The phenotypic and genotypic coefficient of variation was 54.03 and 53.68%, respectively. The heritability in broad sense (98.72%) as well as the genetic advance in per cent of mean (189.89) was found to be more than 60% (Table 3).

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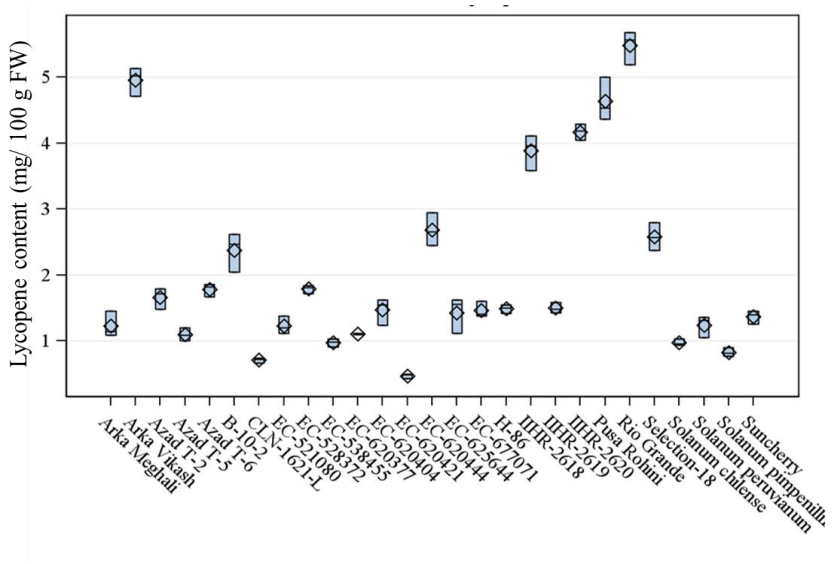

Figure 2. Lycopene content among tomato genotypes.

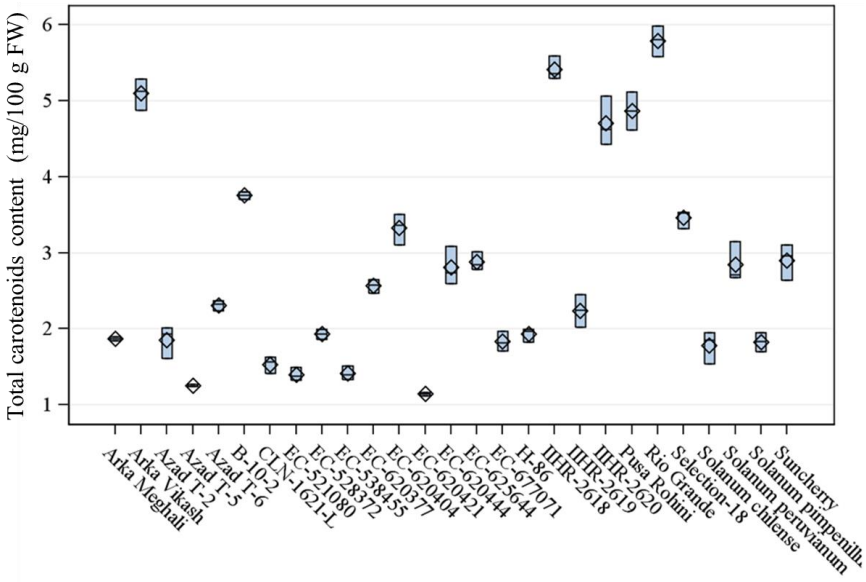

Figure 3. Total carotenoids content among tomato genotypes.

Total Phenolics Content

In this study, among the tomato genotypes evaluated, the highest total phenolic content was recorded in EC 528372 (139.59 mg GAE 100 g^{-1} FW) followed by *S. chilense* (108.97 mg GAE 100 g^{-1} FW), IIHR-2619 (94.36 mg GAE 100 g^{-1} FW) and Arka Meghali (94.23 mg GAE 100 g^{-1} FW) (Table 2). However, the lowest total phenolics content was noted in IIHR-2620 (41.09 mg GAE 100 g^{-1} FW). The overall mean value of total phenolics content was 72.36 mg GAE 100 g^{-1} FW and it ranged from 41.10 to 139.59 mg GAE 100 g^{-1} FW. Abebe *et al*. (2017) supported this result: he found 64.9% total phenolic content in controlled condition. According to the study of Singh *et al*. (2010), different tomato varieties of red and yellow colored have phenolic contents ranged from 21.46–57.60 and 22.5–

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47.36 mg GAE 100 g^{-1}, respectively. Moreover, in case of tomato fruit peel, the values ranged from 48.66–123.56 and 57.13–135.00 mg GAE 100 g^{-1}, respectively. These genotypes showed significant result as compared to the previous study. Figure 4 represents the distribution of total phenolic content among the different tomato genotypes. The phenotypic and genotypic coefficient of variation was 28.95 and 28.88%, respectively. The heritability in broad sense (99.53%) as well as the genetic advance in per cent of mean (102.72) was high (Table 3). The highest heritability was found in total phenolic content (99.53%).

Total Antioxidant Capacity

Among the genotypes evaluated, the highest total antioxidant capacity was recorded in EC 528372 (4.52 µmol TE g^{-1} FW) followed by IIHR 2619 (4.51 µmol TE g^{-1} FW) and *S. chilense* (4.06 µmol TE g^{-1} FW) (Table 2). The lowest total antioxidant capacity was noted in IIHR 2620 (1.75 µmol TE g^{-1} FW). In general, total antioxidant capacity varies between 80 to 200 µmol TE 100 g^{-1} FW (Odriozola-serrano *et al*., 2008). The overall mean value of total antioxidant content was 2.69 µmol TE g^{-1} FW. Exotic collections and wild species have significant

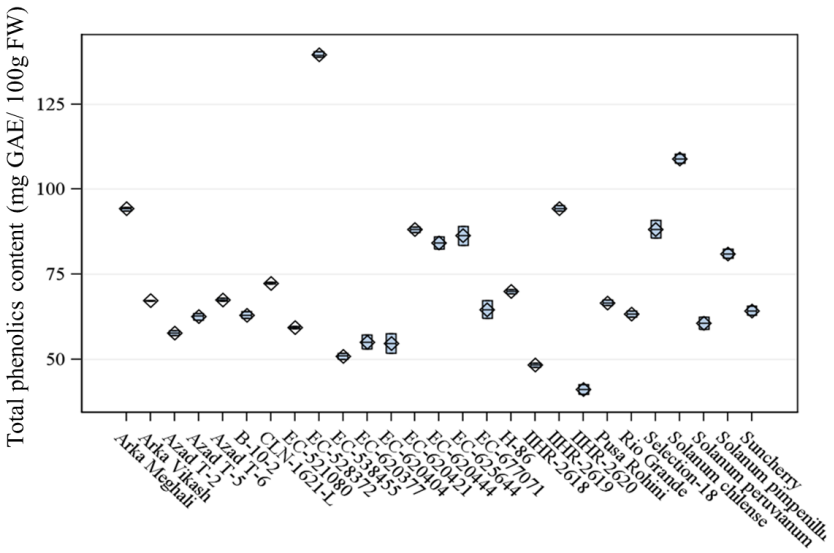

Figure 4. Total phenolics content among tomato genotypes.

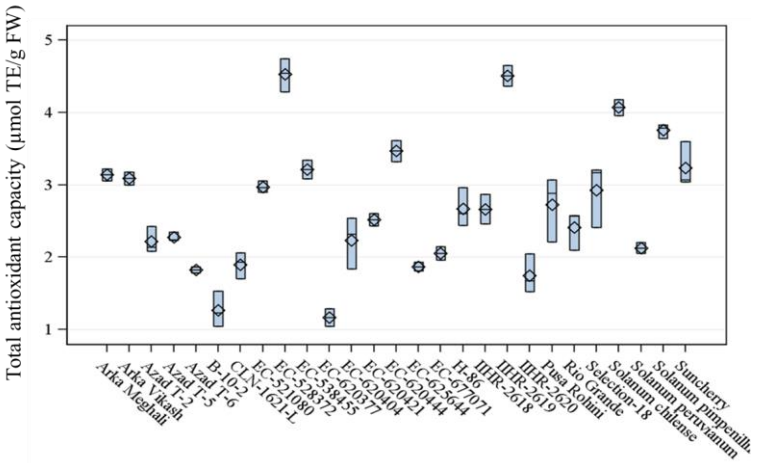

Figure 5. Total antioxidant capacity among tomato genotypes.

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amount of total antioxidant capacity, which is very helpful for curing various types of cancers and other diseases. In our study, total antioxidant capacity ranged between 1.16–4.52 µmol TE g^{-1} FW. Gonzalez-Cebrino *et al*. (2011) reported similar results of total antioxidant activity ranged from 22.65 to 43.58 mg TEAC 100 g^{-1} FW (Figure 5). The phenotypic and genotypic coefficient of variation was 33.32 and 32.40%, respectively. The heritability in broad sense (94.53%) as well as the genetic advance in per cent of mean (111.28) was high (Table 3).

Correlation Coefficient Among the Different Phytochemicals

Correlation coefficient was analyzed to determine the mutual relationship among the phytochemicals at 1 and 5% level of significance. This is to determine the component character on which selection of cultivar can be emphasized for quality improvement. In general, the magnitudes of genotypic correlation coefficients were higher than the respective phenotypic correlation coefficient (Table 4). Ascorbic acid content was found to have highly significant and positive correlation with lycopene (0.39) and total carotenoids content (0.58), whereas, total phenolics content exhibited highly significant and negative correlation with total antioxidant capacity (0.317) and total carotenoids content (0.37). Total antioxidant capacity showed highly significant and positive correlation with lycopene (0.57) and total carotenoids content (0.59). Lycopene content exhibited highly significant and positive correlation with total ascorbic acid (0.39) and total antioxidant capacity (0.57). Total carotenoids contents showed highly significant and positive correlation with ascorbic acid content (0.58), total antioxidant capacity (0.59), and lycopene content (0.67), while it had highly significant and negative correlation with total phenolic content. Our findings collaborate with the work of Ilahy *et al*. (2011) who reported similar correlations.

CONCLUSIONS

There was considerable variation among fifteen commercial varieties, nine exotic genotypes, and three wild species of tomato grown in Eastern India or selected tomato genotypes with respect to their phytochemical properties. Exotic collections were rich in phytochemicals especially ascorbic acid, total phenolics and total antioxidant capacity. Therefore, the existing variability offers an opportunity to improve the phytochemical properties of tomatoes. Moreover, these genotypes will be very useful for improvement of the quality traits in tomato.

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تغییرات مواد شیمیایی گیاهی در ژنوتیپ های گوجه فرنگی کاشته شده در شرق ناحیه Indo-Gangetic هندوستان

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چکیده

در این پژوهش، ۱۵ رقم تجارتی، ۹ ژنوتیپ غیر بومی، و سه گونه وحشی گوجه فرنگی کاشته شده در شرق ناحیه Indo-Gangetic برای تعیین تغییرات مواد شیمیایی گیاهی آن ها مورد بررسی قرار گرفت. این مواد عبارت بودند از اسکوربیک اسید، لیکوپن، کاروتنوئید کل، فنول کل، و کل ظرفیت آنتی اکسیدانی. ژنوتیپ های انتخاب شده تفاوت های چشمگیری را در رابطه با ترکیب مواد گیاهی نشان دادند. در میان پارامتر های خواص آنتی اکسیدانی، محدوده تغییرات اسکوربیک اسید بین ۱۲/۶۲ تا ۷۶/۱۵ میلی گرم در ۱۰۰ گرم وزن تازه(FW) قرار داشت، در حالی که فنول کل برحسب mg GAE/ 100 g FW بین ۴۱/۱۰ و۱۳۹/۵۹ و کل ظرفیت آنتی اکسیدانی در محدوده µmol Trolex equivalent (TE) ۱/۶۱ تا ۴/۵۲ تغییر می کرد. از نظر پارمتر های کاروتنوئید، لیکوپن، و کاروتنوئید کل در میوه گوجه فرنگی به ترتیب در محدوده ۵/۴۸ -۰/۴۷ و ۷۹/۵-۱۴/۱ بر حسب mg 100 g FW/ تغییر میکرد. از نتایج جالب توجه این بود که در میان ژنوتیپ های ارزیابی شده، دو رگ های غیر بومی مقادیر غنی شده چشمگیری از این مواد شیمیایی گیاهی داشتند. نتایج گواهی میداد که که مقدار بیشینه اسکوربیک اسید (۷۶/۱۵ mg/100 g FW)، کل فنول ها (mgGAE/100 g FW ۱۳۹/۵۹) و ظرفیت آنتی اکسیدانی کل (۴/۵۲ µmol TE/g FW) در کلکسیون غیر بومی EC 528372 بود در حالیکه مقدار بیشینه لیکوپن (5/48100 mg/ 100 g FW) و کاروتنوئید کل (۵/۷۹ mg/ 100 g FW) در کولتیوار Rio Grande به دست آمد. از این قرار، این گروه از ژنوتیپ های غربال شده شامل گونه های وحشی و کلکسیون غیر بومی، سرشار از مواد شیمیایی گیاهی بود که می توان از آن برای بهبود و اصلاح عملکرد کیفی گوجه فرنگی در برنامه های اصلاح نژاد در هندوستان و ناحیه Indo Gangetic بهره جست.

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