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Orange Fruited Tomato Cultivars: Rich Source of Beta Carotene

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Abstract

The present research work was undertaken in the Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri to evaluate recently developed somatic hybrid derivatives of *Lycopersicon esculentum* and *Lycopersicon peruvianum* Mill tomato species for beta carotene content. The field experiment consisting of eight orange fruited and five traditional red fruited tomato cultivars during rabi season in randomized block design with three replications. The recommended package of practices was followed for better production of the crop. The data revealed that, among the orange fruited cultivars, the highest beta carotene content was noticed in cv. 34A-1-1(7.03 mg/100 g) followed by cv. 42B-1-1 (4.00 mg/100 g) and cv. 22-1-1 (3.85 mg/100 g). Among traditional red fruited cultivars, cv. Dhanshree recorded the highest beta carotene content i.e. 1.30 mg/100 g followed by cv. Pusa Ruby (0.90 mg/100 g) and lowest in cv. Bhagyashree (0.41 mg/100 g). The orange fruited cultivars recorded higher mean beta carotene content i.e. 3.80 mg/100 g than the traditional red fruited cultivars (0.80 mg/100 g).

Keywords: Orange and traditional red fruited tomato cultivars; HPLC; Beta carotene

Introduction

The cultivated tomato (*Lycopersicon esculentum* Mill.) is one of the versatile and widely consumed vegetables in fresh, cooked and processed forms throughout the world. In India, the total area under tomato cultivation was 8.65 lakh hectares and production was 168.30 lakh metric tons while in Maharashtra, it was grown on an area of 0.52 lakh hectares with annual production of 73.80 lakh metric tons [1]. The tomato fruit is also rich in vitamins like A, B and C, minerals (calcium, sodium, magnesium, manganese, potassium, iron, phosphorus, boron and zinc) and carotenoid pigments like lycopene and beta carotene- precursor of vitamin A [2]. From nutritional point of view, tomato is popularly known as "*The Poor Man's Apple*", which is one of the chief vegetable crops in India. The French people called it as *'The Apple of Love'* whereas the Germans as '*The Apple of Paradise*' [3].

Vitamin A deficiency is a public health problem in 118 countries where over 200 million pre-school children are suffering from 'hypo-vitaminosis' [4]. Adding vitamin A to the diet could reduce child mortality by 23 per cent in developing countries while helping to prevent blindness and general infectious diseases. But disseminating vitamin pills would be costly and not suitable. Therefore, efforts were made in developing countries to incorporate beta carotene into crops like tomato converting into cell factory for antioxidant carotenoids which are presently available only through chemical synthesis. The cultivation of high beta carotene tomatoes may be one of the significant and noticeable steps to overcome the widely prevalent vitamin A deficiency in India [5].

Evidence from epidemiological studies have suggested that higher intake of beta carotene may reduce the risk of cancer and beneficial effect in prevention of numerous chronic diseases including cancer, cardio and cerebro-vascular, ocular and neurological diseases [6-9]. The popularity of tomato is mainly due to dark red colour i.e. lycopene content. It is one of the carotenoids that cannot be converted into vitamin A, but it is a powerful antioxidant that reduces the risk of heart attack, cancer and chronic diseases [10,11]. Till the date, no commercial cultivars developed in India especially for enrichment of vitamin A content [12].

The extensive research work has been carried out in India regarding development of new tomato varieties with resistance to pests and diseases and high yield potential. However, not much systematic research work has been reported so far to improve the nutritional value of tomato. Therefore, the present research work was undertaken to evaluate somatic hybrid derivatives developed at the Department of Horticulture, MPKV, Rahuri for beta carotene content by HPLC method.

Materials and Methods

The present investigation was undertaken in the Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri located at $19^0 47'$ to $19^0 57'$ North latitude and between $73^0 39'$ to $74^0 19'$ East longitude. The annual minimum temperature ranges from 6.0 to 23.4^0C and maximum 27.8 to 40.9 ^{0}C. The field experiment was laid out in Randomized Block Design (RBD) with thirteen genotypes consisting of eight orange fruited such as , 34A-1-1, 33A-1-1, 6B-1-1, 6A-1-1, 22-1-1, 42B-1-1, New Beta carotene (NBC) and 46-1-1 and five traditional red fruited tomato cultivars viz. Dhanshree, Pusa Early Dwarf, Bhagyashree, Pusa Ruby and M-1-1 (Plate 1) in three replications during *rabi* season of 2010.The gross and net plot size for each cultivar was 3.60 x 4.50 m (16.20 m^2) and 1.80 x 3.60 m (6.48 m^2).

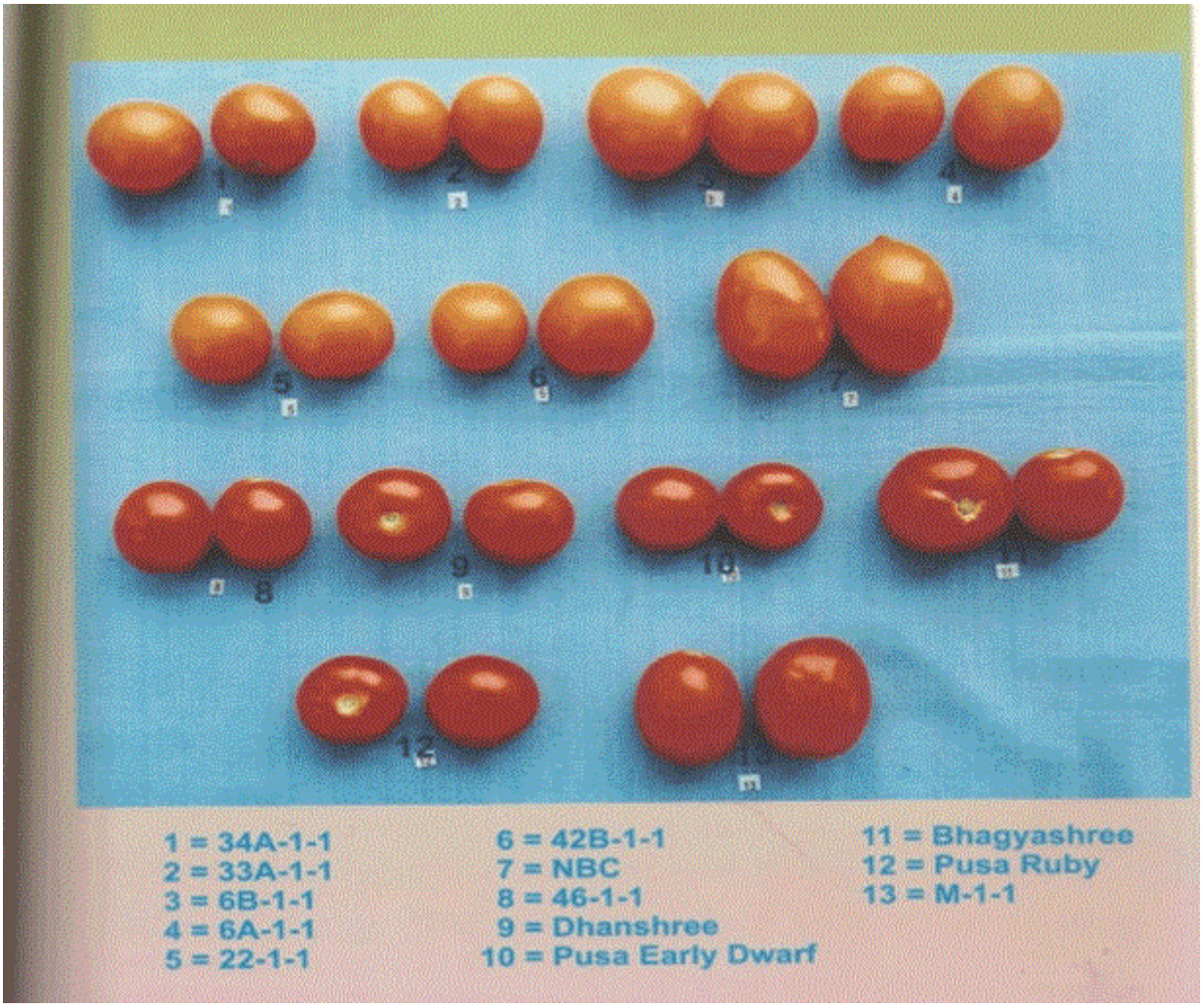

Plate 1: Tomato cultivars used for investigation

Fine raised beds of 3 x 3 m and 15 cm height were prepared and the beds were treated with fungicide and granular insecticide. The seeds were sown for rabi season during first week of November, 2010 at 5 cm apart in shallow lines parallel to width of beds. Immediately, after sowing beds were watered with water can and after seedling emergence, irrigation was given through water channels. Seedlings were protected against pests and diseases by adopting recommended plant protection measures. Seedlings were transplanted for *rabi* season during first week of December, 2010. A basal dose of 20 tons of FYM per hectare was applied. A dose of chemical fertilizers @ 200:100:100 kg per hectare $N:P_2O_5:K_2O$ was given at the time of transplanting and half of the N and whole P and K and remaining half of N was given in the split doses as top dressing at 20 days and 40 days after transplanting. Three hand weedings at fortnight interval were given. Insecticides and fungicides were applied as and when required for protecting the crop from pests and diseases. Plants were supported with bamboo, GI wires and sutali.

Fully plant ripe fruits of tomato cultivars under study were used for estimation of beta carotene content. The analytical work for beta carotene content was done at All India Network Project on Residual Analysis, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar with the help of high performance liquid chromatography (HPLC) method described by Bushway as explained under [13]. The generated data through this investigation was analyzed by the methods of Panase and Sukhatme [14].

Preparation of Standard for Estimation of Beta carotene

The standard beta carotene having the purity of 95% obtained from the M/S. Sigma Aldrich, Bombay and all the chemicals used for analysis were of HPLC grade. The stock solution of standard beta carotene was prepared by weighing 25 mg into 100 ml volumetric flask and brought to volume with THF (Tetrahydrofuron).

The separation was performed on C18 column (5 µm) with solvent system of Acetonitrile : Methanol : THF in 40:56:4 proportion. The flow rate of solvent was adjusted to 2 ml/minute and detection was done at 470 nm on Shimadzu LC-10 AT Japan make HPLC machine (Plate 2).

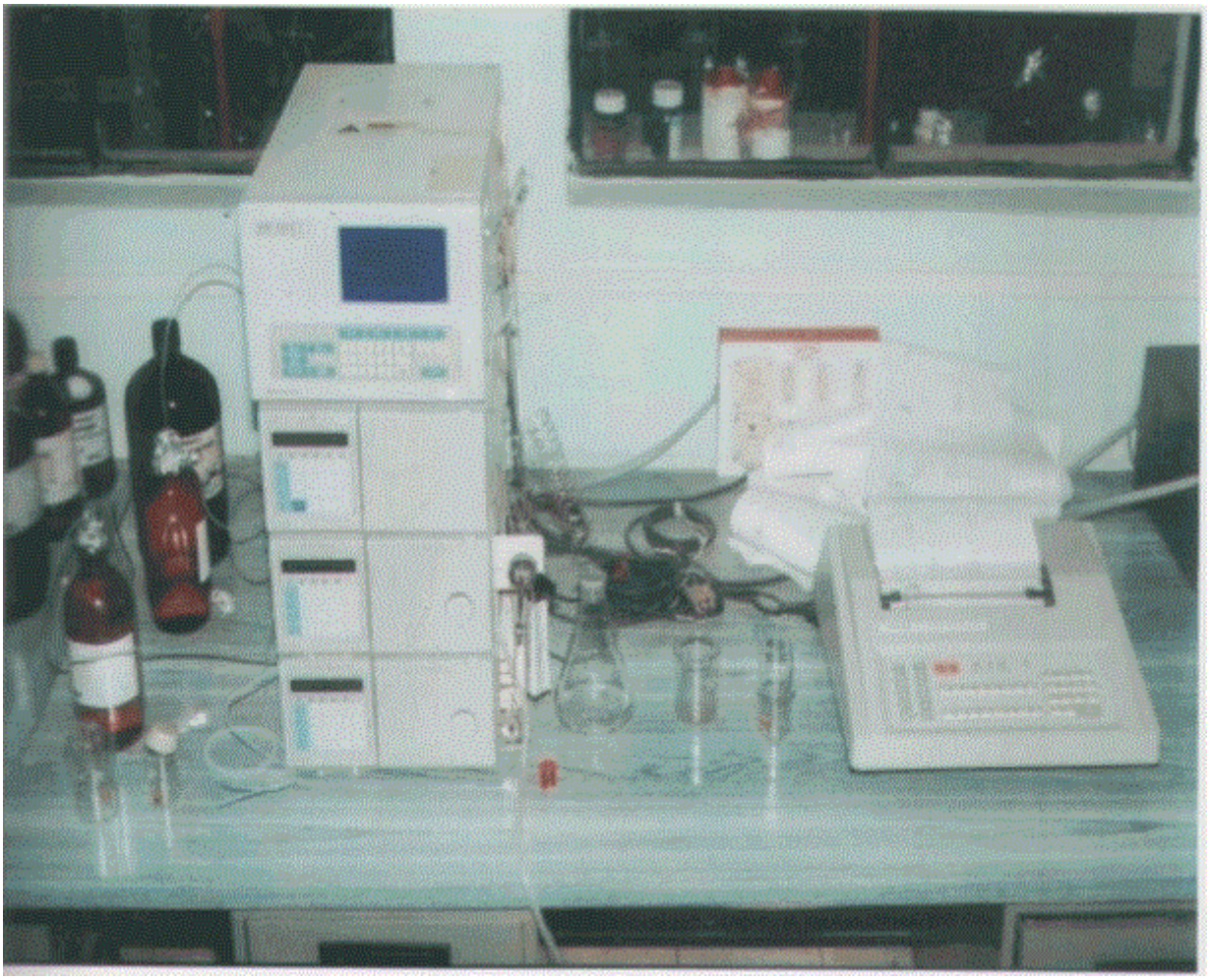

Plate 2: HPLC assembly used for estimation of beta carotene

Extraction and Determination of beta carotene

A 5 g sample of freshly homogenized pulp was weighed into a 125 ml flask followed by the addition of 70 ml of THF and extracted for one minute with a polytron at a speed of 6 and filtered through a Buchner funnel fitted with 7 cm Whatmen- 42 filter paper. The filter cake and paper were re-extracted with 70 ml of THF at a speed of 10 for 2 minutes making sure the filter paper was shredded. The combined filtrates were brought to a final volume of 200 ml and an 80 ml aliquot was evaporated to dryness under fan at room temperature. Once, dried sample was dissolved in 10 ml THF. A 20 µml of each sample and working standard was injected into the HPLC. Standard was injected first followed by four injections of an extracted sample and then standard. The HPLC chromatograms for standard beta carotene and samples were given in Figure 1. The peak height was used for quantification, since it was shown to be linear v/s concentration over the working range (Table 1).

Results and Discussion

The data presented in Table 1 clearly indicated that, among the orange fruited cultivars, the highest beta carotene content was noticed in cv. 34A-1-1(7.03 mg/100 g) among all the cultivars under study. Among the orange fruited tomato cultivars, the cv. 42B-1-1 recorded the beta carotene content of 4.00 mg/100 g closely followed by cv. 22-1-1 (3.85 mg/100 g) and cv. 6A-1-1 (3.83 mg/100 g) whereas, the lowest content of beta carotene content was noticed in cv. NBC (2.32 mg/100 g). The highest content of beta carotene was found in cv. Dhanshree (1.30 mg/100 g) followed by Pusa Ruby (0.90 mg/100 g) among the traditional red fruited tomato cultivars. In the present study, the mean beta carotene content of orange fruited cultivar was found about five times more (3.80 mg/100 g) than the traditional red fruited cultivar (0.80 mg/100 g). The present investigation confirmed the findings of Premachandra et al. [15] who reported that higher amount of beta carotene is the result of tomato interspecific hybridization with L. *peruvianum*. Similarly, the tomato cultivars namely 97L63, 97L66 and 97L97 developed by initial interspecific cross between L. *esculentum cv.* Floradade and the wild tomato relative L. *cheesmanii*, which produced fruits with high beta carotene content of 5.76, 5.51 and 5.55 mg/100 g, respectively on fresh weight basis [16] and Tomes [17] developed high beta carotene lines (6.60 mg/100 g) of orange fruited cultivars and intermediate lines (2.70 mg/100 g) of orange-red fruited tomato cultivars from donor paren L. *hirsutum*. The cv. 34A-1-1 was found to be the richest source of beta

carotene content among all the cultivars of tomato reported so far in India.

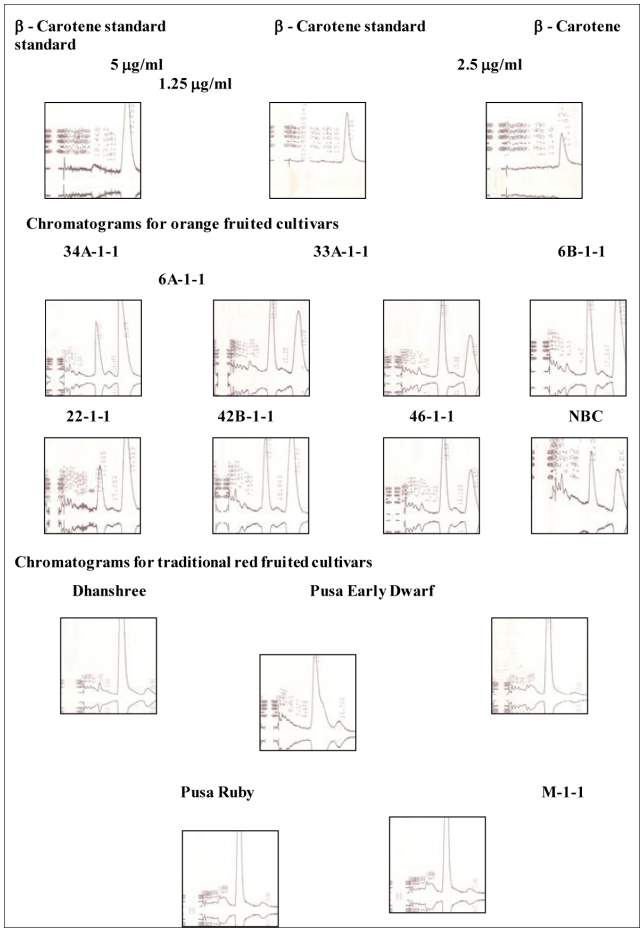

Figure 1: HPLC chromatograms for standard beta carotene and samples of tomato cultivars

Genotype/ Cultivar	Retention time (Min)	Peak height	µg/ml	Beta carotene (mg/100 g)
Standard beta carotene				
5.00 µg/ml	19.493	2260	5.00	--
2.50 µg/ml	19.26	1296	2.50	--
1.25 µg/ml	17.20	840	1.25	--
Orange fruited cultivars				
34A-1-1	20.875	5097	7029.18	7.03
33A-1-1	19.780	2678	3693.18	3.70
6B-1-1	20.57	2271	3131.89	3.13
6A-1-1	21.553	2774	3825.57	3.83
22-1-1	19.525	2793	3851.77	3.85
42B-1-1	20.797	2903	4003.47	4.00
New Beta carotene (NBC)	20.717	962	2319.63	2.32
46-1-1	20.657	1722	2374.78	2.40
Mean	--	--	--	3.80
Traditional red fruited cultivars				
Dhanshree	20.862	534	1287.60	1.30
Pusa Early Dwarf	19.975	293	706.50	0.71
Bhagyashree	19.930	168	405.09	0.41
Pusa Ruby	19.485	360	868.06	0.90
M-1-1	20.023	216	502.83	0.50
Mean	--	--	--	0.80
S.E. +	--	--	--	0.054
CD at 5 %	--	--	--	0.157

Table 1: Retention time, peak height and beta carotene content in the fruits of tomato cultivars on fresh weight basis

Conclusion

From the present study, it is concluded that the significantly highest beta carotene was recorded by cv. 34A-1-1 (7.03 mg/100 g) followed by cv. 42B-1-1 (4.00 mg/100 g) and thus they were identified as rich source for beta carotene content in tomato cultivars developed through somatic hybridization which was eight times more than traditional red fruited cultivars.

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