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Physico chemical parameters of tomatoes

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Abstract
An Investigation was undertaken to study physico-chemical parameters of tomatoes namely Pusa Ruby, Sadabahar, and Vaishali. The physico-chemical parameters included in the study were physical characteristics, PH, total soluble solids, moisture, reducing and total sugars, ascorbic acid, titrable acidity, lycopene and β-carotene content. The physical and chemical composition of three varieties of tomatoes were analysed by using suitable methods and techniques. The physical and chemical composition of three varieties differed significantly. It was observed that pusa ruby was deep red in colour, where as sadabahar was yellowish red in colour and vaishali was red in colour. Highest total soluble solids and sugar content was found in pusa ruby followed by vaishali where as least was observed in sadabahar. Among the varieties, the highest ascorbic acid and β-carotene content was observed in vaishali over other two varieties. The analysis of variance revealed a significant difference between the varieties at one percent level.

Keywords: Physical characteristics, parameters, chemical composition, total soluble solids, ascorbic acid, β-carotene

Introduction
Tomato (Lycopers icon esculentum Mill) is one of the most popular and important vegetable, not only in India but also in the world, because of its suitability for a variety of uses in fresh as well as processed form. Its food value has now fully been recognised and due importance has been attached to it. Its popularity is due to the pleasing acid taste and health properties at an inexpensive cost. It is a very good source of vitamin A, B and C and is a good appetizer. Quality and flavour of the tomato and its products depends on chemical components such as reducing sugars, acidity, lycopene, β-carotene, dry matter, total soluble solids, etc. It constitutes about 93 percent moisture and hence, perishable in nature and seasonal production its availability varies considerably leading most part of the year by a glut situation in the market. Post harvest losses and transportation losses are high in tomato as tomatoes start deteriorating immediately after harvest, due to enzymatic action leading to spoilage.
The chemical composition of tomato varies greatly with variety, soil and climatic condition in which they are grown. However, not all the varieties which are grown, are suitable for processing in to various products. There is a considerable variation for fruit yield and chemical composition of tomato in the world germ-plasm.

Materials and Methods
An investigation was undertaken to study physico-chemical parameters of tomato varieties. The fully matured fruits of the following three tomato varieties were procured from the local market in one lot and analysed for the following physico chemical paraemters.

1. Pusa Ruby is an improved variety which has been popularly called by local name as Jawari.
2. Sadabahar (S-28) - Hybrid which has been popularily called by local name as Mhycco.
3. Vaishali - Hybrid

The physico-chemical parameters included in the study were physical characteristics, pH, total soluble sugars, moisture, reducing and total sugars, Ascorbic acid, titrable acidity, lycopene, and β-carotene content. Visual observation viz., the colour, size and shape of tomatoes were observed and recorded. Randomly selected ten fruits was considered for weight and recorded in triplicate.
Fruits were weighed, washed in cold tap water, crushed with wooden laddle and juice was extracted and filtered the pass through double layered muslin cloth. Juice was weighed from first and second extractions. Juice yield was expressed as percent of fruit weight.

Pericarp thickness of fruit skin was determined by using vernier callipers, observations were recorded in triplicate. Ten randomly selected fruits were cut transversely and number of locules inside each cut fruit was counted and recorded. pH of fruit juice was determined by using digital pH meter. Total soluble solids of fruit juice was determined by using Erma refractometer. The fruits from each variety were divided into two lots, uniform size fruits from each lot were selected for analysis. Chemical analysis of each was carried out in triplicate.

Moisture content was determined by the difference between the accurately weighed samples before and after drying in an oven at 105 °C (Anon., 1990) [2]. Total soluble sugar and reducing sugars were estimated in alcohol extract with and without acid hydrolysis, by Nelson Somogyi's method (Hawk *et al.,* 1965) [6]. For estimation of total sugar, the alcohol free sample was hydrolysed with in HC1 at 100 °C for 30 minutes and made alkaline with IN NaOH using phenophthalein as an indicator. The sample was reneutralised with 0.01N HC1 and made up to a known volume. An aliquot of this was taken for the estimation of reducing sugar.

One milli litre with distilled water to which one ml of alkaline copper reagent was added and kept in a boiling water bath for 20 minutes. To each tube after cooling to room temperature, 1 ml of orsenomolydate reagent was added, thoroughly mixed immediately till effervescence ceased and made up to 10 ml. The absorbance was read in an colourimeter at 540 nm. The difference between total and reducing sugars was taken as non-reducing sugars.

Ascorbic acid reduces the dye, 2,6-dichlorophenol indophenol to a colourless leucobase. During the process, ascorbic acid gets oxidised to dehydroascorbic acid. The dye, which was blue in colour becomes pink in acid medium which was end point of the titration. Extracted the sample in oxalic acid filtered through muslin cloth and made up to a known volume with oxalic acid. Added a known amount of filterate in the conical flask, added 5 ml of oxalic acid and titrated against the dye V_2 to the pink end point (Anon., 1983) [3].

The organic acids can be easily extracted in distilled water and filtrated against alkali weighed. Fruit cut in to pieces and ground in a pestle mortar to a paste with the help of distilled water. Filtered through muslin cloth and made up to a known volume suitable aliquot of the filterate into a 100 ml conical flask was taken and added few drops of phenophthalein indicator and titrated against 0.05N sodium hydroxide from a. burette (Ranganna, 1986) [8].

Lycopene is responsible for the red colour of tomato. The carotenoids in the sample were extracted in acetone and then taken up in petroleum ether. Lycopene has absorbtion maximum at 473 nm and 503 nm (Sadasivam and Manikam, 1992) [9]. Extracted the pulp repeatedly with acetone using pestle and mortar. The acetone extracts were pooled and transferred to a separating funnel containing about 20 ml petroleum ether and mixed gently. Added about 20 ml of five percent sodium sulphate solution and added petroleum ether to the separating funnel for clear separation of two layers. Most of the colour will be noticed in the upper petroleum ether layer. Poured the washed petroleum ether extract containing carotenoids in to a brown bottle containing about 10 g anhydrous sodium sulphate. Kept it aside for 30 minutes or longer. Decant the petroleum ether extract in to 100 ml volumetric flask through a funnel containing cotton wool. Washed sodium sulphate slurry with petroleum ether until it is colourless and transferred the washings to the volumetric flask. Made up the volume and measure the absorbance in a spectrophotometre at 503 nm.

The β-carotene content was estimated utilizing an acetane-hexane solvent for extraction. The β-carotene was separated on a column of Alluminium oxide and the absorbance of the eluates was measured spectrophometrically (at 450 nm) for calculating the concentration of β-carotene from a standard curve. The data collected on physico chemical parameters was statistically analysed. Completely randomised design (CRD) was applied to test the significant difference in quality parameters. Student 't' test was used to test the significant differences in quality parameters within the varieties.

Results

This chapter includes the results of physico-chemical parameters of tomato varieties namely, Pusa Ruby, Sadabahar and Vaishali. Physical parameters of tomato varieties under study are presented in Table 1. Visual observation of tomato varieties revealed a variation in colour, size and shape. It was observed that Pusa Ruby was deep red in colour, where as Sadabahar (Mhycoo) was yellowish red in colour and Vaishali was red in colour. Pusa Ruby was small in size compared to other two varieties and spherical shape whereas Sadabhar had medium size and oval shape and Vaishali while having medium size and had spherical shape.

The fruit weight *of* the varieties ranged from 60 to 130 grams. Among the varieties, Vaishali recorded highest fruit weight (130) followed by Sadabahar (90) where as lowest was observed in Pusa Ruby (60). Analysis of variance showed the significant difference between the varieties for fruit weight at one percent level. Further the student 't' test revealed that fruit weight of Vaishali was significantly different from Pusa Ruby and Sadabahar.

Juice yield of the varieties ranged from 60.8 to 68.5 percent. Among the varieties, Vaishali registered highest juice yield (68.5%) followed by Sadabahar (61.1%) where as lowest juice yield (60.8%) was observed in Pusa Ruby variety. Analysis of variance revealed a significant difference between the varieties for juice yield at one percent level. The *t' test indicated that Vaishali had significantly higher juice yield over other varieties. However, no significant difference was observed between Pusa Ruby and Sadabahar varieties.

Table 1: Physical characteristics of Tomato varieties

Physical characteristics	Varieties			
	Pusa Ruby	Sadabahar	Vaishali	C.D. + S.Em.
Tomato colour	Deep red	Yellowish red	Red	-
Tomato shape	Spherical	Oval	Spherical	-
Tomato size	Small	Medium	Medium	-
Locule number	5	3	5	1.63 + 0.471
Pericarpthickness (cm)	0.018	0.024	0.022	0.0052 ± 0.001
Tomato weight (gm)	60	90	130	30.26 ± 5.77
Juice yield (%)	60,83	61.16	68.58	1.90 ± 0.363

Locule number of the varieties ranged from three to five. Among the varieties, Spherical shaped varieties, Pusa Ruby, Vaishali had highest locule number (5) whereas oval shaped variety, Sadabahar had lowest locule number (3). Analysis of variance showed the significant difference between the oval shaped variety and spherical shaped varieties for locule number at five percent level. Further, the student 't' test revealed that the spherical shaped varieties had significantly higher locule number than oval shaped variety.

The pericarp thickness of the varieties ranged from 0.018 to 0.024 cm. Among the varieties, Sadabhar evidenced highest pericarp thickness (0.024 cm) followed by Vaishali (0.022 cm), whereas lowest was observed in Pusa Ruby (0.018 cm). Analysis of variance showed a significant difference between the varieties for pericarp thickness at one percent level. Further, the student *t' test revealed that Sadabahar had significantly higher pericarp thickness over other two varieties. There was a significant difference between Pusa Ruby and Sadabahar varieties.

Chemical composition

The data regarding the chemical analysis are presented in Table 2.

The moisture content of the tomato varieties varied from 92.25 to 94.47 percent with the mean value of 93.1 percent. Among the varieties, Pusa Ruby had the highest moisture content (94.47%) followed by Vaishali (92.52%), whereas lowest was seen in Sadabahar variety (92.25%).

From the analysis of variance, it was found that there was significant difference between the varieties for moisture content at one percent level. From the 't' test, it was observed that the moisture content significantly varied between Pusa Ruby and Sadabahar Vaishali varieties. However, there was no significant difference between Vaishali and Sadabahar varieties.

pH of the varieties ranged from 4.26 to 4.67. Among the varieties, Pusa Ruby had lowest pH (4.26) followed by Vaishali (4.56), whereas highest pH was observed in Sadabhar variety (4.67). Analysis of variance showed significant difference between the varieties for pH at one percent level. Further, the student 't' test revealed that significantly lower pH was observed in Pusa Ruby variety. There was significant difference between Pusa Ruby and Sadabhar varieties. However/ no such significant difference were evident between Pusa Ruby and Vaishali varieties.

The total soluble solids (TSS) of tomato varieties varied from 4.26° Brix to 4.96° Brix. Pusa Ruby variety had the highest total soluble solids (4.96°B) followed by Vaishali (4.45° Brix) where as least was observed in Sadabahar (4.26° Brix).

The analysis of variance revealed a significant difference between the varieties at one percent level. The 't' test revealed that Pusa Ruby significantly had higher total soluble solids over other varieties. But, there was no apparant difference between Sadabahar and Vaishali varieties. The results of the sugar content of different tomato varieties are given in Table 2. The mean value of the total sugars of tomato varieties ranged from 2.01 to 2.92 percent with the total mean value of 2.45 percent. Total sugar content in Pusa Ruby variety was 2.92 percent and 2.42 percent in Vaishali, where as Sadabahar variety had 2.01 percent. Highest sugar content was found in Pusa Ruby (2.92%) followed by Vaishali (2.42%). Whereas lowest was found in Sadabahar (2.01 %).

Analysis of variance revealed that the total sugar content of tomato varieties differed significantly at one percent level. From the 't' test it was observed that Pasa Ruby had significantly higher total sugar content over other two varieties.

The mean reducing sugars of tomato varieties varied from 1.81 to 2.13 percent. The highest amount of reducing sugar was observed in Pusa Ruby variety (2.13%) and the lowest amount was found in Sadabahar variety. Analysis of variance showed significant difference between the varieties at one percent level. Further student 't' test revealed a significant difference between Pusa Ruby and Vaishali varieties and Pusa Ruby and Sadabahar varieties.

The data furnished in Table 2 indicated the range of non reducing sugars from 0.20 to 0.78 percent. The mean highest non reducing sugar content was found in Pusa Ruby (0.79%) followed by Vaishali' (0.55%) and Sadabahar (0.203%). The non reducing sugar value for all the varieties were lower than the reducing sugar value.

Table 2: Chemical composition of tomato varieties

Parameters	Varieties			
	Pusa Ruby	**Sada-bahar**	**Vaishali**	**C.D. + S.Em.**
Moisture gram {%)	94.47	92.25	92.57	1.03 ± 0.199
PH	4.26	4.67	4.56	0.31 ± 0.060
Total soluble solids (° brix)	4.96	4.26	4.45	0.42 ± 0.081
Reducing sugars (%)	2.13	1.81	1.87	0.13 ± 0.024
Non-reducing sugars (%)	0.78	0.20	0.55	0.19+0.036
Total sugars (%)	2.92	2.01	2.42	0.09 ± 0.014
Ascorbic acid (mg/100 g)	22.01	20.06	27.38	2.20 ± 0.421
Titrable acidity (%) in terms of citric, oxalic, malic, tartaric acid, etc	0.65	0.53	0.58	0.03 ± 0.007
Lycopene (mg/100 g)	5.84	4.09	5.56	0.19 ± 0.035
fl-carotene (mg/100 g)	0.26	0.34	0.39	0.05 ± 0.011

The analysis of variance and 't' test showed significant difference between varieties at one percent level. The data furnished in Table 2 indicated the range of ascorbic acid content from 20.06 to 27.38 mg/100 g. The highest ascorbic acid content was visible in Vaishali (27.38 mg/100 *g)* followed by Pusa Ruby (22.01 mg/100 g) and least in Sadabahar (20.06 mg/100 mg). From the analysis of variance it was evident that significant difference at one percent level between the varieties.

From the 't' test, it was observed that the ascorbic content significantly varied between the Pusa Ruby and Vaishali varieties. However, Vaishali variety showed significantly high ascorbic acid content over Pusa Ruby and Sadabahar varieties. The data furnished in Table 2 indicated the range of titrable acidity content from 0.53 to 0.65 percent. The highest tirable acidity was found in Pusa Ruby variety (0.65%) followed by Vaishali (0.58%) and Sadabahar (0.53%).

The analysis of variance showed significant difference between the varieties at one percent level. The 't' test showed significant difference between Pusa Ruby and Sadabahar varieties. Similarly, significant difference was also observed between Pusa Ruby and Vaishali varieties. But, there was no such significant difference between Vaishali and Sadabahar varieties was apparent. The data furnished in Table 2 indicated the range of β-carotene content 0.26 to 0.39 mg/100 gm. The mean highest 0-carotene content was recorded in Vaishali (0.39 mg/100 g) followed by Sadabahar (0.34 mg/100 g) and Pusa Ruby (0.26 mg/100 g). The analysis of variance table revealed significant difference at one percent level between the varieties. The 't' test showed significant difference between the three varieties. Among the varieties β-carotene content was significantly higher in Vaishali followed by Sadabahar over Pusa Ruby.

The data furnished in Table 2 indicated the range of lycopene content from 4.09 to 5.84 mg/100 grams. The mean highest lycopene content was found in Pusa Ruby (3.84 mg/100 g) followed by Vaishali (5.56 mg/100 g) and Sadabahar (4.09 mg/100 g). Analysis of variance showed significant difference between the varieties at one percent level. Further 't' test showed there was significant difference between the three varieties.

Discussion and Conclusion

The physical characteristics and chemical composition of tomatoes are influenced by the variety, the age of the fruit and certain external and internal factors (Kalloo, 1985) [7]. Quality and flavour of the processed products depend upon the chemical composition of the tomatoes which has been reported to vary greatly with the variety (Winser, 1979) [11].

It is well documented that oval shaped varieties are yellowish red in colour where as spherical shaped varieties are reddish in colour (Aggarwal et *al.,* 1995) [1]. In the present study also Pusa Ruby, Sadabahar, Vaishali differed in colour and in shape in line with above studies. Gowda et *al.* (1994) [5] reported that weights of fruits varied significantly in different varieties. The varieties with higher fruit weight had bigger fruit size also (Thakur and Lal Kaushal, 1995) [10]. In the present study also the varieties differed significantly in fruit weight (60 to 130 grams). Sadabahar and Vaishali had higher fruit weight and had a bigger fruit size compared to Pusa Ruby. A wide variation in juice yield among the varieties was observed. Vaishali had a significantly higher juice yield. This may be due to the influence of genetic and agronomical factors.

Locule number was more (3-6) in round shaped varieties than oval to pear shaped varieties. Pericarp thickness of pear shaped varieties was much more than those of round shaped varieties and due to this character the keeping quality of pear shaped varieties is longer than those of round varieties (Thakur and Lal Kaushal, 1995) [10]. Similar results were observed in the present study also. Sadabahar had a less number of locules (3) as compared to Pusa Ruby and Vaishali (5). Pericarp thickness of Sadabahar variety was significantly higher than the other varieties. Because of this, the keeping quality of Sadabahar is longer than those of other two varieties.

Thakur and Lal Kaushal (1995) [10] reported that oval shaped varieties had lower acidity and higher pH as compared to spherical or round varieties / hybrids. In the present investigation also, oval shaped variety Sadabahar had higher pH and lower acidity where as round shaped varieties (Pusa Ruby and Vaishali) had lower pH and higher acidity.

Higher the titrable acidity of the fruit higher the flavour and lower its pH has been the pattern (Balasubramanian (1984) [4]. In the present study also Pusa Ruby and Vaishali had lower pH and the flavour score of these varieties was higher. Pusa Ruby had higher amount of lycopene (5.84 mg/100 gram) than other two varieties. This may be the reason for deep red colour of the fruit, where as Sadabahar had a lower amount of lycopene (4.09 mg/100 g). The lower amount of lycopene might have resulted in yellowish red colour of the fruit. β-carotene content in the study ranged from 0.26 mg/100 gram to 0.39 mg/100 gram. Vaishali had higher amount of β-carotene followed by sadabahar and pusa Ruby.

The moisture/total soluble solids and sugars (reducing and total) were recorded higher in Pusa Ruby than other two varieties. The moisture content in the respective varieties/ hybrids could be the result of higher pulp to serum ratio in the fruit and differences among them with respect to total soluble solids of fruit might be due to their genetic makeup, Vaishali had higher ascorbic acid content (27.38 mg/100 gram) as compared to Pusa Ruby and Sodabahar. The significant difference between varieties for physical characteristics and chemical composition observed may be due to the diversity of genetic makeup that causes strain difference and varietal characteristics.

It is evident that Pusa Ruby had all characteristics viz., higher titrable acidity, lower pH, higher total soluble solids and lycopene content. Because of these characteristics, this variety can be used for processing purposes. Vaishali may be best suited for juice and concentrate making because of its high juice yield and it is nutritionally superior because of its high ascorbic acid and β-carotene contents. Sadabahar had higher pH, lower moisture and lower acidity because of these characteristics, it can be used for salad preparation. It also had noticeable amount of ascorbic acid and fl-carotene content, hence considered as nutritionally superior in quality.

References

1. Aggarwal P. Studies on the physiochemical and processing characteristics of some newly evolved tomato cultivars for making juice and concentrate. *Indian Food Packer,* 1995; 49(2):45-53.
2. Anonymous. Official methods of analysis of the Association of official analytical chemists. 20th Edn. AOAC, Washington, D.C, 1990.
3. Anonymous. Vitamin C estimation by dye method. A manual of laboratory techniques. National Institute of Nutrition, ICMR, Hyderabad, 1983, 121-122.
4. Balasubramanian T. Studies on quality and nutritional aspects of tomato. Journal of Food Science and Technology. 1984; 21:419-421.
5. Gowda IN, Ramanjaneya KH, Anand N, Sadashiva AT, Tikoo SK. Studies on physico-chemical characteristics and processing quality of two IIHR tomato varieties in relation to commercial cultivars. Journal of Food Science and Technology. 1994; 31(2):126-129.
6. Hawk Bp, Oser Bl, Sommerson Hw. Practical Physiological Chemistry, 12th Edn. Me Graw Hill Book Co. Inc. New York, 1965.
7. Kalloo. Chemical composition. In : Tomato published by R.N. Sachdev, Allid Publishers Pvt. Ltd., New Delhi, 1985, 25-42.
8. Ranganna S. Hand Book of Analysis of quality control for fruit and vegetable products, 2nd Edn. Tata Me Graw Hill Publishing Co. Ltd., New Delhi. 1986; 1:77.

9. Sadasivam S, Manickam A. Determination of peroxide value. IN ; Biochemical methods for Agricultural Sciences (Pb.) H.S. Poplai, Wiley Eastern Limited, 1992, 27-28.
10. Thakur Ivs, Lalkaushal Bb. Study Of quality characteristics of some commercial varieties and F^ hybrids of tomato grown in Himachal Pradesh in relation to processing. Indian Food Packer. 1995; 49(3):25-29.
11. Winser Gw. Some factors affecting the quality and composition of tomatoes. Acta Horticulture 1979; 93:335-341.