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Evaluation of physico-chemical characterization of tomato (*Lycopersicon esculentum* Mill.) germplasm

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Abstract

Eleven tomato germplasm (Cherry tomato, Rio Grande, Gala, Kalam, Red Star, Roma VF, Taj, Peshawar Local, Bambino, Roma and Roma King) of edible tomato (*Lycopersicon esculentum* Mill.) were investigated at The University of Agriculture Peshawar during 2017. The aim of this experiment was to evaluate and select tomato germplasm, which could be grown for raw material production and future breeding, taking into account their nutrition composition. The statistically analyzed data indicated that tomato germplasm were highly significant ($P \geq 0.01$) in physical and chemical contributing parameters. Physical and chemical data of different tomato fruits at harvesting stage indicated that maximum fruit weight (81.3g) and highest Ascorbic acid content (14.64 mg 100 g^{-1}) was found in tomato cv. Gala. Maximum fruit firmness (2.07) was observed in variety Roma. Maximum percent juice content (91.8 %) were taken by tomato germplasmKalam. Maximum Total Soluble Solid (TSS**)** (4.8) was measured in tomato germplasm Bambino, whereas maximum (0.37%) acidity was measured in cv. Rio Grande. Maximum (4.63) fruit pH was recorded in germplasm Roma King, which statistically at par with fruit pH (4.56) observed in tomato variety Bambino. It was established that according to above results the tomato cv. Gala and Rio Grande performed best in physical and chemical contributing parameters for quality attributes. These tomatoes cultivars can be grown for raw material production and may be used in future breeding.

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Introduction

Tomato (*Lycopersicon esculentum* Mill.) according to consumption capita, it is one of the most valuable vegetable crop of Solanaceae family. Peru- Ecuador is its origin. (Rick, 1969) Tomato is grown globally with production of 130 million tons lead by China with 41.87 million tons. It is widely grown throughout Pakistan with annual production of 599.59 thousand tons. It is grown for fresh consumption (salads), cooking and processing (puree, paste, ketchup). Tomato has enormous nutritional value. They contain ample amount of vitamins like A, C (ascorbic acid) and minerals like calcium, phosphorus and potassium (Dhaliwal*et al.,* 2003).

A lot of research has been carried out to improve tomato production in terms of quantity. But now the emphasis is shifting from quantity to the quality of produce. (Oko-Ibom and Asiegbu, 2007). It has been estimated that 25 to 42% of tomato produce is wasted globally due to post-harvest losses (Rehman *et al.*, 2007).Certain attributes of tomato like TSS, fruit firmness, juice contents and ascorbic acid levels are considered vital for extending its shelf life as well as making them more favorable for processing and value addition industry. Increased ascorbic acid levels makes plant more tolerant to biotic and abiotic stresses thus enhancing post-harvest fruit quality (Hail and Safawo, 2018). Besides this fruits that are more firm have relatively high shelf life, flavor and consumer demand (Abbasi *et al.*, 2011).

The current study is therefore, initiated to find out most promising cultivar of tomato with high qualitative attributes higher shelf life and less prone to post harvest losses.

Materials and methods

An experiment "Evaluation of physico-chemical characterization of tomato (*Lycopersicon esculentum* Mill.)germplasm" was conducted at The University of Agriculture, Peshawar Khyber Pakhtunkhwa, Pakistan. The quality of Eleven tomato germplasm (Cherry tomato, Rio Grande, Gala, Kalam, Red Star, Roma VF, Taj, Peshawar Local, Bambino, Roma and Roma King) of edible tomato (*Lycopersicon esculentum* Mill.) at harvesting stage were investigated at the Post harvest Laboratory of Horticulture Department, The University of Agriculture Peshawar during summer, 2017. These tomato germplasm were collected from different Districts of Pakistan.

For quality attributes both chemical and physical methods of investigations were applied. These tomatoes germplasm grow under the same conditions, same culture practices (hoeing, weeding, irrigation, pest, disease management and staking) were done throughout the experiment. The experimental plots where these tomatoes germplasm grow were ploughed, harrowed, leveled and equal amount of N: P: K was added to the soil.

Parameters studied

Fruit weight (g): Weight of randomly picked fruit of each treatment was determined through digital balance and mean was computed.

Fruit Firmness (kg cm^{-2}): Fruit firmness was measured with manual penetrometer for three randomly selected fruits and their average was calculated.

Percent Juice Content: A minimum three fruits of each treatment with similar size and color was randomly selected and percent juice content was calculated with the help of following formula.

$$\% \text{ Juice} = \frac{\text{Net juice weight (g)} \times 100}{\text{Fruit weight (g)}}$$

Total Soluble Solids (°Brix): The homogenized juice, extracted from pericarps of three randomly taken fruits for each germplasm, was scored for soluble solids, using a refractometer.

Fruit pH: Fruit pH was determined from ten grams of juice obtained from 3 fruits of each germplasm, using a pH meter.

Ascorbic Acid content (mg 100 g^{-1}): For ascorbic acid

content (vitamin C) determination in tomato standard method was used as reported in AOAC, (1998).

Acidity (%): Standard procedure given in AOAC (1998) was used for the determination of percent acidity. Acidity was determined from the juice extracted of selected fruits.

Statistical analysis

The data are presented as the averages of three measurements. The data were analyzed statistically with the help of STATISTIX 8.1 statistical software. In case the data was found significant, least significant differences (LSD) techniques were applied for mean comparison in order to see any differences between different tomato germplasm (Steel *et al.*, 1998).

Results

Physical characteristics (fruits)

The data regarding physical characteristics of tomato germplasm were given (Table 1) showed significant differences for quality attributes. The maximum fruit weight (81.3g) was recorded for cv. Gala, followed by variety Roma VF (73.0g). While minimum fruit weight was recorded for germplasm Cherry tomato (27.3g). In case of fruit firmness, mean data shows that variety Roma gave most firm fruits with firmness of 2.07 followed by Bambino as 1.47. Minimum fruit firmness (1.03) was found in germplasm Kalam. In case of Percent Juice content maximum juice content (91.8 %) were taken by tomato germplasm Kalam, followed by Red Star (87.1%) which statistically at par with Taj (87.4%) and Roma VF (87.7%). Minimum juice content (82%) was observed in variety Peshawar Local.

Table 1. Physical characteristics of tomato *(Lycopersicon esculentum* Mill.) germplasm fruits.

Germplasm	Fruit weight (g)	Fruit firmness (kg cm^{-2})	Juice content (%)
Rio Grande	71.0bc	1.17cde	83.6bc
Gala	81.3a	1.13de	87.7ab
Kalam	65.3cde	1.03e	91.8a
Red Star	59.7e	1.16de	87.1b
Roma VF	73.0b	1.30bcd	86.7b
Taj	68.7bcd	1.07e	87.4b
Roma	63.0de	2.07a	85.2bc
Cherry tomato	27.3g	1.07e	85.3bc
Bambino	46.7f	1.47b	85.0bc
Peshawar Local	42.7f	1.40bc	82.0c
Roma King	71.7bc	1.23cde	84.7bc
LSD at 1%	7.05	0.22	4.19

Chemical characteristics (fruits)

Significant differences were recorded throughout chemical components (Table 2). Mean data displays that maximum TSS (4.8) was measured in tomato germplasm Bambino, followed by variety Roma VF 4.43. Minimum (3.03) TSS value was found in Cherry Tomato. The mean values for fruit pH in different tomato germplasm showed that maximum (4.63) fruit pH was found in germplasm Roma King, which statistically at par with fruit pH (4.56) observed in tomato variety Bambino. Minimum fruit pH (4.16) was found in cv. Rio Grande, which statistically similar with fruit pH (4.17) observed in Roma VF. Similarly the highest Ascorbic acid content in mg 100 g^{-1} (14.64) was obtained from cv. Gala, followed by tomato cv. Rio Grande (13.90). While the lowest Ascorbic acid content in mg 100 g^{-1} was observed in tomato germplasm Peshawar Local that was 11.43. In the term of Acidity the result revealed that maximum (0.37%) acidity was found in tomato cv. Rio Grande followed by Gala (0.36%). Whereas minimum (0.31%) Acidity was perceived in tomato germplasm Bambino.

Discussion

Fruit weight (g)

From the data presented in Table 1, it is clear that the heaviest fruits were noticed in cv. Gala, whereas the lightest fruit was observed in germplasm Cherry tomato. These differences in fruit weight among germplasms may be attributed to variation in genetic makeup. Saglam and Onder (2016) reported that growing systems have no effect on average fruit weight (g), but varieties significantly affected it.

Our results are in accordance with the observation found by Khan *et al.* (2017) that fruit weight showed significant differences among all the lines. Shujaat *et al.,* (2017) also showed the decreasing trend in potato cultivars during the first month of storage period.

Table 2. Chemical characteristics of tomato *(Lycopersicon esculentum* Mill.) germplasm fruits.

Germplasm	TSS (°Brix)	Fruit pH	Ascorbic acid(mg 100 g^{-1})	Acidity (%)
Rio Grande	3.03f	4.16d	13.90b	0.37a
Gala	3.40e	4.21cd	14.64a	0.36ab
Kalam	3.33e	4.37abcd	12.13f	0.35bc
Red Star	3.23e	4.41abcd	13.10c	0.35bc
Roma VF	4.43b	4.17d	12.37d	0.32de
Taj	3.93c	4.46abc	11.03i	0.33cd
Roma	3.37e	4.53ab	12.23e	0.34bc
Cherry tomato	3.03f	4.28bcd	12.01g	0.35bc
Bambino	4.83a	4.56a	12.16f	0.31e
Peshawar Local	2.91f	4.38abcd	11.43h	0.35bc
Roma King	3.63d	4.63a	13.84b	0.33cd
LSD at 1%	0.18	0.27	0.062	0.017

Fruit firmness (kg cm^{-2})

Mean data (Table 1) shows that variety Roma gave most firm fruits while minimum fruit firmness was found in germplasm Kalam. Tomato fruit firmness tends to be influenced greatly by many post and preharvest factors, such as genetics, cultural practices, applications of fertilizers and maturity at harvest Diaz *et al.* (2008). Tomato that have firm fruit can be allowed to ripen more fully on the vine thus imparting great flavor and quality but, soft fruit are prone to injuries during harvesting, grading and marketing (Suarez *et al.*, 2008).

Percent Juice Content

In current study (Table 1), maximum juice content were taken by tomato germplasm Kalam, while minimum fruit juice content was observed in variety Peshawar Local. Juice content is an important measure of internal quality. Under or over-ripe fruit tend to be less juicy, which directly affects eating quality (Thakur *et al.*, 1996).

Total Soluble Solids (°Brix)

Total soluble solids or 'Degrees Brix' is measures percent of the total soluble solids in juice of ripen fruit. These soluble solids are primarily sugars; sucrose, fructose and glucose and indicates the sweetness of the fruit (Majidi *et al.*, 2011). Similar variation in TSS of different cultivars was reported earlier by Ali *et al.* (2016) who found the highest TSS (4.98) in Cv. Bambino and minimum TSS were found in Cv. Money Maker (3.70). Our results are in accordance with the observation found by Hossain *et al.* (2017) that fruit total soluble solid in different tomato varieties was significantly varied from 5.42 to 3.86.

Fruit pH

The mean values (Table 2) for fruit pH in different tomato germplasm showed that maximum fruit pH was found in germplasm Roma king, while minimum fruit pH was found in cv. Rio Grande, which statistically similar with fruit pH observed variety

Roma VF. Similar results were out lined by Au, (2011) whose findings evinced significant differences in pH of six tomato cultivars with mean value ranging from 4.12 to 4.35. This may be due to the genetic differences among accessions, environmental factors and soil nutritional status. Similar results were out lined by Gul (2011) whose findings evinced significant differences in pH of 59 accessions with mean value ranging from 4.125 to 4.664.

Ascorbic acid content (mg 100 g^{-1})

From the data presented in Table 2, it is clear that highest Ascorbic acid content in mg 100 $g^{-1}$was obtained from variety Gala, while the lowest Ascorbic acid content in mg 100 g^{-1} was observed in tomato germplasm Peshawar Local. Tomatoes are good source of ascorbic acid, however, ascorbic acid content vary greatly in different germplasm. Variation in ascorbic acid content of fruits may be attributed to the genetic diversity and environmental growing conditions of different tomato germplasm as reported by Peng *et al*., (2008). Similar variation in Ascorbic acid content of different cultivars was reported earlier by Ali *et al.* (2016) who found the highest Ascorbic acid content (16.53 mg/100g) in Cv. Roma and minimum Ascorbic acid were found in Cv. Bambino (14.54 mg/100g).

Acidity (%)

In the term of Acidity the result revealed that maximum acidity was found in tomato variety Rio Grande followed by Gala. Whereas minimum Acidity was perceived in tomato germplasm Bambino.

In canned vegetables if the acidity increased it reduced processing time and temperature, thus contributes to enhanced flavor, color, texture, and nutritive quality of products Swanson and Bonorden, (1989). Our results are in agreement with Ali *et al.* (2016) who found that tomato fruit acidity (%) in different tomato varieties was significantly varied from 0.40 to 0.35.

Conclusion

It was concluded that significant differences were shown by different tomato germplasm for all physical and chemical characteristics of tomato fruits. Among the eleven tomato genotypes, tomato cv. Gala and Rio Grande performed best in physical and chemical contributing parameters for quality attributes. These tomatoes cultivars can be grown for raw material production and may be used in future breeding. Whereas Cherry tomato and Peshawar Local showed lowest performance.

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