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Fruit yield and quality traits of Pakistani cultivars of *Citrus sinensis* Osbeck in core area of Production

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Abstract

Citrus is an important table fruit having refreshing taste and rich source of vitamin C. *Citrus sinensis* is an important species of citrus which is being consumed by large masses due to its peculiar taste and high sugar content and early availability in the fruit market. A study was conducted to identify the potential varieties of this commercial species. Commercial varieties were evaluated for yield related and biochemical traits. It was identified that commercial variety "Salustiana" had the fruit of largest mass, least number of seed, juice mass, volume and peel mass. Disease free nursery may be developed to commercial this variety in core area of Punjab and may also be used in molecular studies.

Keywords: Juice mass; Fruit size; Peel thickness; pH

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Introduction

Citrus plant has great adaptability and being cultivated all around the tropical and sub-tropical world (Nair et al., 2018). Citrus stands second after grapes, having production of over 70 million tons per annum and ranked number 1 as commodity of fresh fruit trade (FAO, 2012).

It originated in Indo-Chinese and being document in Chinese literature as old as 2200 BC (Anonymous, 2006). China was the largest producer of citrus fruit followed by Brazil, India, USA and Mexico (FAO, 2018), while Pakistan was ranked at 10^{th} number for production of various citrus species and cultivars. It was cultivated on an area of 192832 ha which produced 2395550 tons of citrus fruit (Fruit, vegetables and condiments statistics of Pakistan 2014-15). It is grown all our the country but Punjab districts Sargodha, Sahiwal and Toba Tek Singh are core area of its production due to suitable climate and soil factors (Safdar et al., 2010).

Citrus genus contains diverse species or cultivars which differ in the fruit quality and special juice taste and maturity time but oranges and lemons prominent for taste and juice properties. Its fruits quality is dictated by specific genotypes and was also affected by various pre and post-harvest factors. Fruit flavor, texture and color as fruits develop, grow and ripen, as well as its maintenance are determined by the cultivars but may also affected by environmental factors such as temperature, humidity soil nutrition (Ogundiwin et al., 2009).

Citrus sinensis Osbeck occupy a unique position in Citriculture due to its refreshing taste. It contains extensive range of varieties, distribution and had high nutritive values. It comprises of more than 60 percent of world citrus. Apart from its edible value, its fruit peel is good source of essential oils and used to flavor large number of products including beverages, toothpastes, foods and cosmetics.

Trait which affects fruit desirability includes external fruit color, size and texture, while juice quality is affected by internal trait such as seediness, and its amount. Juice biochemical traits include TSS, TSS:TA ratio and titratable acidity (TA) and vitamin C contents (Ahmad et al., 2006). Maturity has a great effect on juice and fruit quality and was also affecting the storage potential (Siddiqui & Dhua, 2010). Poorly managed citrus orchards show lot of problems like fruit size, color, quality and premature fruit drop (Ibrahim et al., 2007). Soil salinity was also among major causes of citrus decline in many regions of the world (Sharma et al., 2011). The objective of the study was to evaluate the quality of different cultivars of orange fruit and to screen out the good quality cultivar.

Materials and Methods

Planting material

The research studies were carried out in University College of Agriculture, University of Sargodha, Sargodha. Eighteen uniform and healthy trees were selected in a fruit orchard. Different mature fruits of orange cultivars were harvested from Horticultural fruit nursery. The sweet orange cultivars included Jaffa, Pineapple, Musambi, Red blood, Tarocco-N and Salustiana. Trial had Randomized Complete Block Design (RCBD) with three replications. Data on following traits were collected.

Fruit yield related traits

Number of fruits plant^{-1} (yield) was calculated by counting total number of fruits tree^{-1} at the time of harvest. Mass of fresh fruit collected from all cultivars was individually determined on digital measuring balance (Sartoius, Japan) and then the average mass was calculated in grams. Fruit diameter was determined with digital vernier caliper (Mitutoyo 500-171-20, Japan) and values are given in mm. Peel thickness was determined by digital vernier caliper at different positions which was than averaged to obtain values in mm. Number of seeds fruit^{-1} were counted manually. Fruits were cut into two halves to obtain seed which were counted manually and averaged. Juice was extracted through selected fruits and volume was measured in beaker. Juice mass was determined on analytical balance.

Fruit juice% was was calculated as follows:

$$\text{Juice \%age} = \frac{\text{Average Juice mass}}{\text{Average fruit mass}} \times 100$$

Peel mass and rag weight was also measured with help of analytical balance and data was averaged and given in grams.

Biochemical parameters

ºBrix value was determined by extracting 2-3 drops of juice from selected fruit of each cultivar which were placed on the prism of digital refractrometer and the reading was noted. The pH was determined with the help of digital pH meter (HANA 8520, Japan).

Statistical Analysis

All data was analyzed on computed based software and least significant differences (LSD) values were determined at $P \leq 0.05$.

Results and Discussion

Fruit weight: Data regarding fruit mass shows significant ($P \leq 0.05$) difference among all the sweet orange varieties (Fig. 1a). The highest fruit mass was observed in Salustiana (234.78 g) followed by Red blood (201.11 g) and Tarocco-N (192.22 g), while the lowest fruit weight was observed in Jaffa (145.56 g) statistically ($P \geq 0.05$) similar with Pineapple (157.78 g). Fruit mass was considered an important with respect to fruit quality, as it showed positive relationship with juice contents (Alva et al., 2006). Large sized fruit also had high market value and generally bring higher price within market while small sized fruits were considered inferior quality (Nawaz et al. 2012). Presence of variability among the sweet orange cultivars has also been documented earlier which showed that fruit mass in sweet orange ranged between 143-253 g (Mohar et al., 2011)

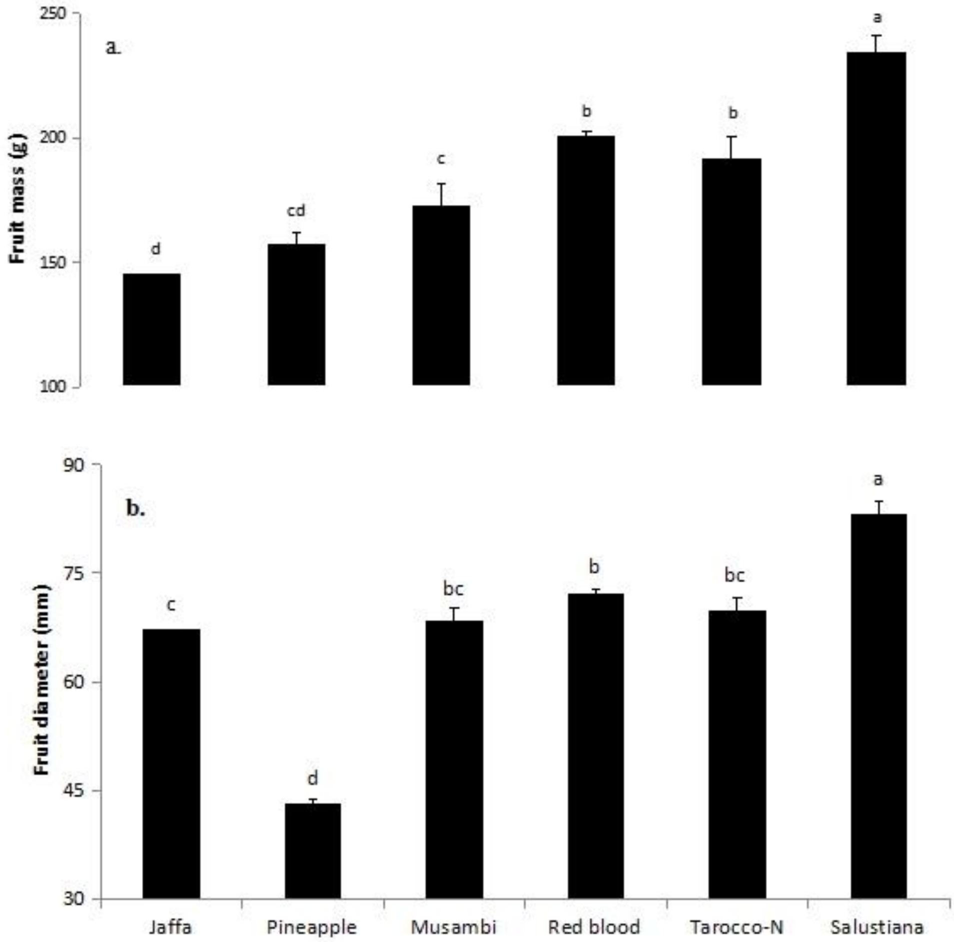

Figure 1. Comparison of means for (a) fruit fresh weight (b) fruit diameter of different sweet orange **cultivars**

Fruit diameter (mm): It is clear from the data that there was a significant ($P \leq 0.05$) difference among these sweet orange cultivars (Fig. 1b). Data showed that Salustiana has a higher fruit diameter (83.12 mm) followed by Red blood (72.23 mm), Tarocco-N (69.85 mm) and Musambi (68.30 mm). The lowest fruit diameter was measured in Pineapple (43.09 mm) followed by Jaffa (67.230 mm). Qureshi et al. (1993) noticed the variation in fruit diameter ranged from 6.2 cm to 7.5 cm in different sweet orange varieties. A fruit diameter of 65.5 mm was documented in Red blood sweet orange earlier (Saleem et al., 2008).

Peel thickness: Data concerning peel thickness showed a significant difference among these sweet orange cultivars (Fig. 2a). Highest peel thickness was measured in Pineapple (4.15 mm) statistically similar with Salustiana (3.83 mm), Red blood (3.68 mm) and

Tarocco-N (3.11 mm). On the other hand, Musambi showed a lowest peel thickness (2.72 mm) statistically similar ($P \geq 0.05$) to Tarocco-N (3.11 mm) and Jaffa (2.97 mm).

Rational peel thickness is compulsory to have a superior fruits. The fruits with high weight and size having thick peel remained fresh for longer time and gave more income than those fruits with thin peel, small size and low weight (Omaima and Metwally, 2007). Studies have shown that peel thickness ranged between 3.96 to 6.127 mm for various cultivars of sweet orange (Mohar et al., 2011).

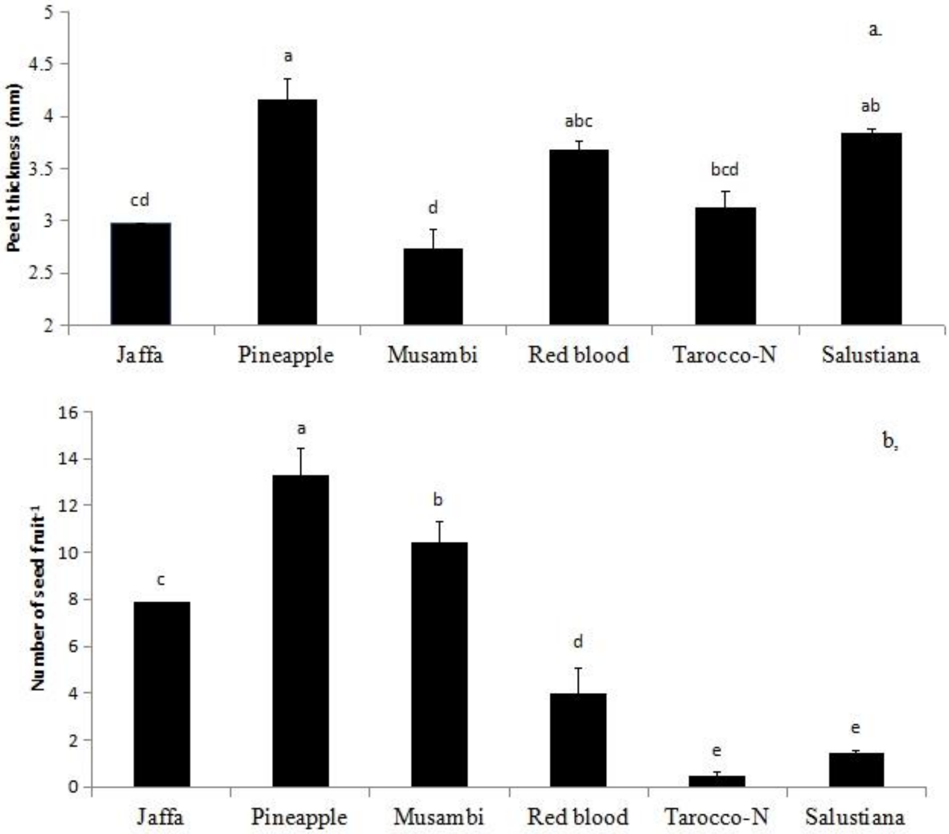

Figure 2. Comparison of means for (a) peel thickness (b) number of seeds of different sweet orange cultivars

Number of seeds: Data pertaining to number of seeds depicted that there was significant ($P \leq 0.05$) difference among sweet orange cultivars (Fig. 2b). The highest number of seeds were observed in Pineapple (13.33) followed by Musambi (10.44) and minimum no of seeds were observed in Tarocco-N (0.44) statistically similar with Salustiana (1.44). Number of seeds determined the fruit quality as seediness was not preferred in different parts of the world and problematic for fruit export. These results are in line with the findings of (Khan et al., 2010) who calculated number of seeds from 0.75 to 22.87 during his work on assessment of eleven sweet orange varieties. Similarly, Simón-Grao et al. (2014) also counted number of seeds from 0 to 25 in eleven different mandarin cultivars.

Juice mass (g): The results for juice mass revealed significant difference among these sweet orange cultivars. The data presented in (Fig. 3a) that highest juice mass was measured in Red blood (73.33 g) statistically similar with Salustiana (68.147 g), Tarocco-N (64.110 g) and Musambi (62.217 g). While minimum juice mass was recorded in Jaffa (39.997 g) statistically similar with Pineapple (44.443 g).

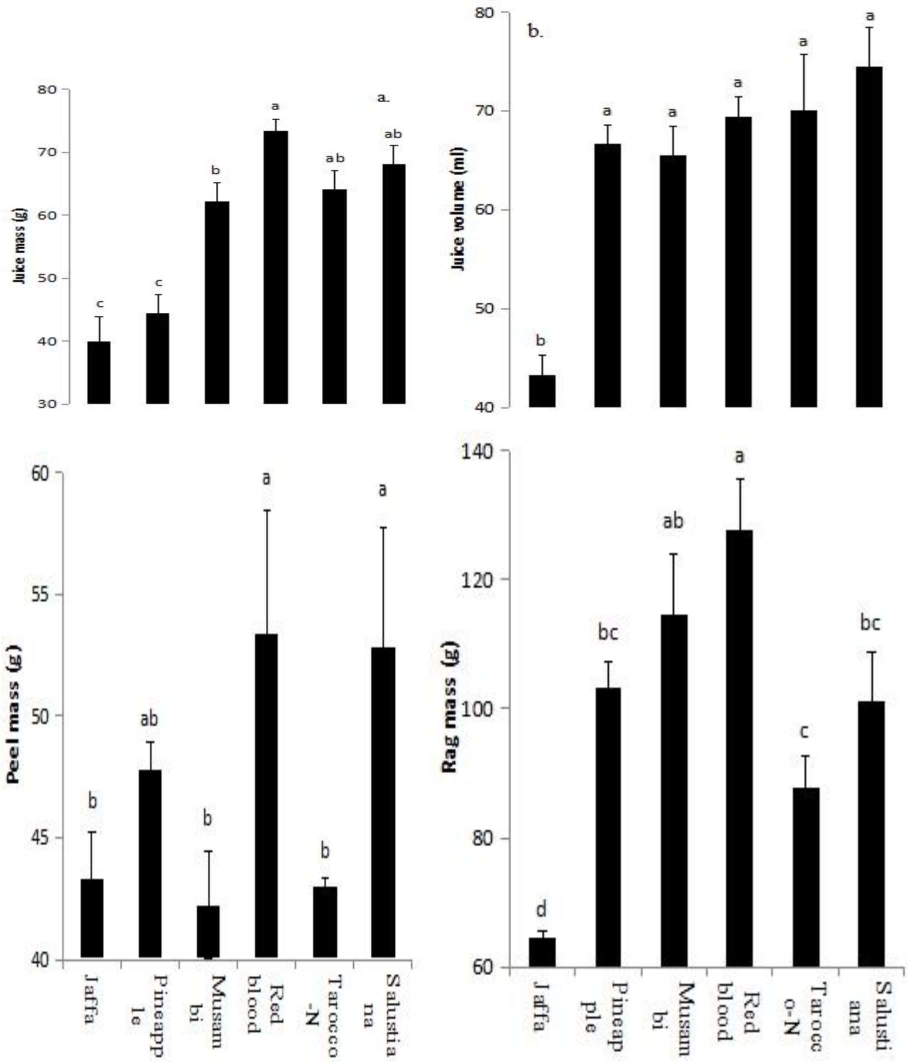

Figure 3. Comparison of means for (e) juice weight (f) juice volume of different sweet orange cultivars

Juice volume: Data regarding juice volume demonstrates significant difference among these sweet orange cultivars. Data revealed in (Fig.3b) that juice volume was higher in

Salustiana (74.447 mL) statistically at par with Tarocco-N (70.00 mL), Red blood (69.45 mL), Pineapple (66.66 mL) and Musambi (65.55 mL). While lower in Jaffa (43.33 mL). Similar results were also obtained by (Simón-Grao et al., 2014) who recorded a mean value of 80 ml of eleven mandarin cultivars. Similarly Chalal (2015) also observed the fruit juice of 81.67 ml while working on different sweet orange cultivars.

Peel mass: Response of these sweet orange cultivars in case of peel weight shows that they are significantly different among themselves. The data revealed in (Fig. 3c) that peel weight was higher in Red blood (53.33 g) statistically similar to Salustiana (52.77 g) and Pineapple (47.78 g). While lower peel weight was recorded in Musambi (42.22 g) statistically similar to Jaffa (43.33 g) and Tarocco-N (42.96 g).

Khan et al. (2010) evaluated some exotic cultivars of sweet orange and resulted that Lane Navel (98.66 g) produced maximum peel weight per fruit while musambi (55.47 g) showed minimum peel weight per fruit. Our results are in line with Chalal (2015) who said that Peel weight of the different sweet orange fruits was found to be 37.93 g.

Rag mass (g): It is clear from the (Fig. 3d) that in case of rag weight these cultivars are significantly different from each other. High rag weight was observed in Red blood (127.78 g) which is statistically similar to Musambi (114.44 g) and lower was obtained from Jaffa (64.44 g) followed by Tarocco-N (87.78 g). Similarly Chalal (2015) also reported that the highest rag weight was found in sweet orange variety Ruby Nucellar (40.08). Hussain et al. (2017) observed that maximum rag weight was found in grapefruit variety Duncan (21.20).

pH: The results regarding pH (Fig. 4a) depicted significant ($P \leq 0.05$) difference among sweet orange cultivars under study. The highest pH was noted in Tarocco-N (1.78) statistically similar to Musambi (1.64), Salustiana (1.53) and Red blood (1.48). Lower pH was calculated in Jaffa (1.05) statistically similar to Pineapple (1.24). The pH of citrus juices provides the information about the state of acidity and basicity. The increase in pH might be due to decrease in acidity with the maturity and decrease in pH indicates the increased acidity of the fruit and this might be due to the formation of acidic compounds due to degradation of reducing sugars (Anwar et al., 1999). Simón-Grao et al. (2014) reported that maximum pH was found in mandarin cultivar Clemenules (4.73). Similar results were also found by (Din et al., 2012).

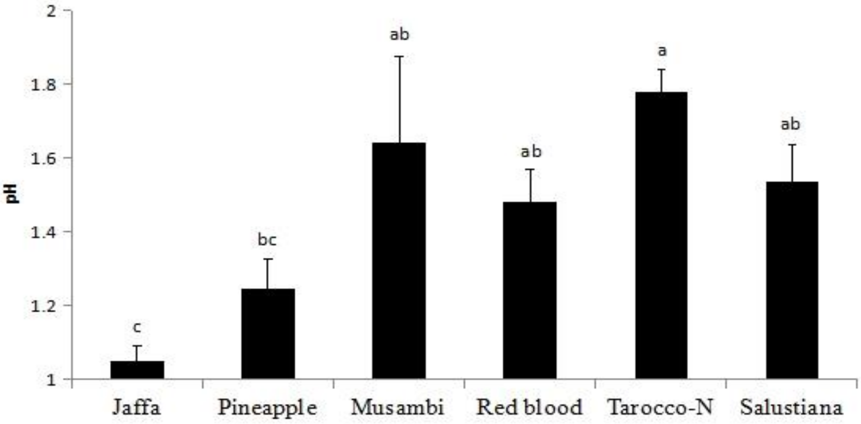

Figure 4. Comparison of means for pH of different sweet orange cultivars

Conclusion

It is concluded from the studies that "Salustiana" performed better with respect to physio-chemical characteristics regarding fruit weight, fruit diameter, juice volume, peel mass. This cultivar can be recommended for the commercial cultivation to enhance yield and quality traits of *Citrus sinensis*. Characterization of sweet orange cultivars may help to meet international quality standards of citrus which may help to improve citrus export.

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