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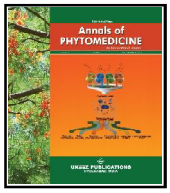

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Assessment of total soluble solids, ascorbic acid and acidity in cucumber (*Cucumis sativus* L.) varieties under open and protected conditions

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Abstract

Cucumber is one of the commercial cucurbitaceous vegetable crops grown in Tamil Nadu and other states of India. The present investigation involves the cultivation of 10 monoecious cucumber varieties such as Heera, K-75, Konkan Kakadi, Japanese Long Green, Pant Khira-1, Subhra, Phule Shubangi, Pusa Barkha, Swarna Sheetal, Solan Srijan under open and protected condition in two seasons having the maximum variation in quality characters. During the study, three quality parameters were investigated in each variety/hybrid. In varieties, maximum TSS (3.43 °Brix) in Japanese Long Green, maximum ascorbic acid (5.35 mg/100 g) in Heera hybrid and maximum acidity (0.44%) was recorded in K-75 variety. In growing conditions, protected condition obtained fruits had maximum TSS (3.16 °Brix), maximum ascorbic acid (4.20 mg/100 g) and maximum acidity content (0.34%). In treatment interactions, Japanese Long Green had the maximum amount of TSS content (3.53 °Brix) under protected grown environmental condition and the maximum ascorbic content was recorded in Heera hybrid (5.41 mg/100 g) under protected environmental grown condition and acidity content was highest in K-75 variety under open field condition (0.47%). The result concluded that the cultivation of cucumber varieties under protected condition significantly differ in quality attributes than cultivated in open field condition and are found to be superior quality of fruits. Thus, we might to say that growing environmental conditions is an important aspect that could be effective on the quality characters of cucumber varieties/hybrids.

1. Introduction

Cucumber (*Cucumis sativus* L.) is a cross-pollinated and popular monoecious climbing vegetable crop (Bailey, 1969). It is grown in the Southern states, whereas in North India, it is cultivated in summer and wet seasons; rarely in the kharif season, but only during the summer and winter seasons in Northern India and in the late Kharif season cultivation is rarely. Cucumber is a popular salad vegetable that contains a number of traditional nutrients and antioxidants. It is frequently used for a variety of skin disorders, especially swelling under the eyes and sunburn, since it provides skin inflammation with a refreshing, cooling, therapeutic, relaxing and anti-itching activity. Cucumber plant has been linked to a number of pharmacological actions, including antioxidant, antiwrinkle, antibacterial, antidiabetic and hypolipidemic properties. One of the antioxidants present in cucumber has been discovered as a key component in organisms oxidative stress defense systems. Cucumber had high silica content and cucurbitacin, which are triterpene phytonutrients. Cucumber is also an excellent source of iodine and includes 4-6% dry substances, 2% sugars, albuminous substances (1%), 0.7% cellular tissue and fat (0.1%). Cucumber flavour contains two compounds: 2,6-nonadenal and 2,6-nonadenol. Cucumber's pleasant scent is attributed mostly to 2, 6- nonadienal, with support from 2-hexenal.

Cucumber cultivation in India is mainly restricted to open-field farming, resulting in low yield and poor quality. While, polyhouse crops generate high-value, year-round fruit with low disease and insect incidence. Maximum tomato growth, production and quality were obtained under polyhouse conditions during the summer season (Ughade, 2016). The growing environment has a significant impact on the quality of the fruits. The micro environment presents in the polyhouse condition led to the creation of a favourable environment, particularly in terms of temperature, which allowed them to thrive well with increases in TSS content. Furthermore, in the current environment of growing demand for high-quality vegetables and significantly declining land holdings. Protected cultivation of vegetable crops appropriate for home consumption is thought to be the best solution for more efficiently using land and other resources. As a result, the current study was designed to assess the quality characteristics of 10 cucumber varieties/hybrids grown in Theni district of Tamil Nadu (India).

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2. Materials and Methods

2.1 Location of the experimental site

Periyakulam, the site of the present study is geographically situated at a latitude (10^0 13' North) and longitude (77^0 59' East) and it is located at an altitude of 90 meters above the mean sea level (MSL). The present research study was conducted out in a multi-span saw tooth type naturally ventilated polyhouse (40 × 20 m) and open field condition at Horticultural College and Research Institute, TNAU, Periyakulam.

2.2 Layout and design of experiment

The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications, it includes 2 factors, *i.e.*, ten varieties and two growing conditions and twenty interaction effects between varieties and growing conditions. The experiment included ten varieties and each variety were grown on a raised bed with intra-row and inter-row spacing of 60 cm and 110 cm, respectively in open as well as protected conditions in two seasons. Raised bed size of 1.0 m × 8.0 m with a path width of 40 cm with 14 plants in each raised bed under both open and protected conditions. The varieties have been randomly allotted in each replication.

2.3 Estimation of total soluble solids (°Brix)

A droplet of juice from mature fruit was placed over the prism of a Digital Pocket Refractometer Pal-1, Atago (range 0 to 32) and the Brix value was recorded and the process was repeated three times for each sample and the mean value was calculated.

2.4 Estimation of ascorbic acid (mg/100 g)

The dye solution was prepared by mixing 50 mg dye with 42 mg sodium hydrogen carbonate in 150 ml of hot distilled water. 20 g oxalic acid was added to 500 ml distilled water (A) and thoroughly mixed. After that, added 100 mg of ascorbic acid to 100 ml of solution A (B) and mixed well. After that, 90 ml of oxalic acid was added to 10 ml of solution B. Titrated with dye solution until light pink colour appeared after removing 5 ml and adding 10 ml oxalic acid (4 per cent).

Crushed the fruit and extracted a clear 15 ml juice, then 100 ml oxalic acid (4 per cent) was added to each and mixed thoroughly. Placed in tube to centrifuge for 10 min. Then, take 5 ml and add 10 ml oxalic acid (4 %) was added to it. Then titrate with dye solution until a bright pink colour appeared.

$$\text{Ascorbic acid} = \frac{0.5\,\text{mg}}{V_1} \times \frac{V_2(\text{ml})}{5\,\text{ml}} \times \frac{100}{\text{Weight of the sample}} \times 100$$

2.5 Estimation of acidity (%)

Acidity was calculated by titrating the fruit juice with 0.1 N sodium hydroxide (NaOH) using phenolphthalein as an indicator and expressed as per cent acidity.

$$\text{Acidity (\%)} = \frac{\text{Equivalent weight of acid} \times \text{Normality of NaOH} \times \text{Titre value}}{\text{Weight of sample}} \times 100$$

2.6 Statistical analysis

All the data recorded in laboratory were statistically analysed using analysis of variance technique and the treatment differences were evaluated by using WASP-Web Agri Stat Package 2.0 (ICAR, Goa). The critical difference was worked out for 5% level of significance.

3. Results

The data on the performance of cucumber varieties under two various environments with respect to biochemical characters such as total soluble solids, titratable acidity, ascorbic acid values given in Tables 1, 2 and Figure 1. These three chemical quality aspects showed significant variances among the varieties, growing environmental conditions and in between interactions.

3.1 Total soluble solids

Significant variation was observed among the varieties/hybrids of cucumber with respect to total soluble solids (TSS) under both protected and open conditions. The TSS content values for varieties/ hybrids ranged from 2.67 °Brix to 3.43 °Brix. The maximum TSS of 3.43 °Brix was recorded in the Japanese Long Green variety and the lowest TSS content was 2.67 °Brix in the Konkan Kakadi variety. The maximum value of TSS was obtained under the protected grown condition (3.16 °Brix) compared to open field condition (3.14 °Brix) (Figure 1b). In interactions, Heera hybrid had the maximum amount of TSS content (3.53 °Brix) under protected condition and the lowest TSS content (2.67 °Brix) was noted in Konkan Kakadi variety under open environmental condition (Figure 1a).

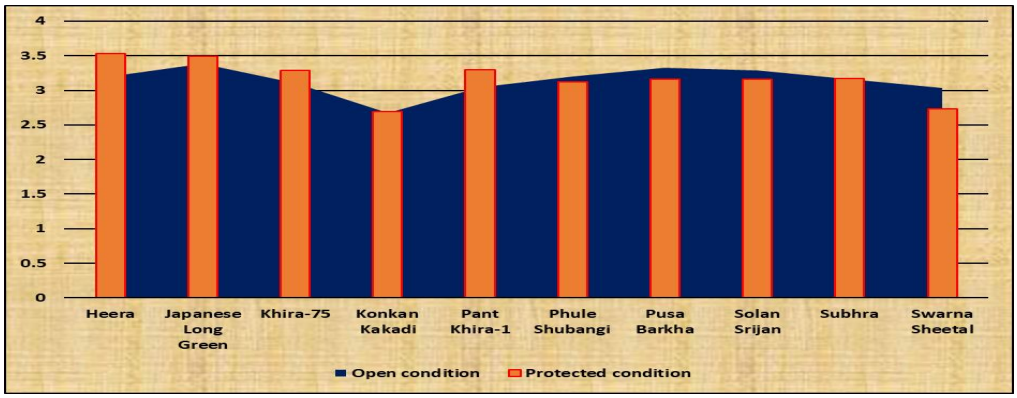

Figure 1 (a): TSS content (pooled data) in various interactions.

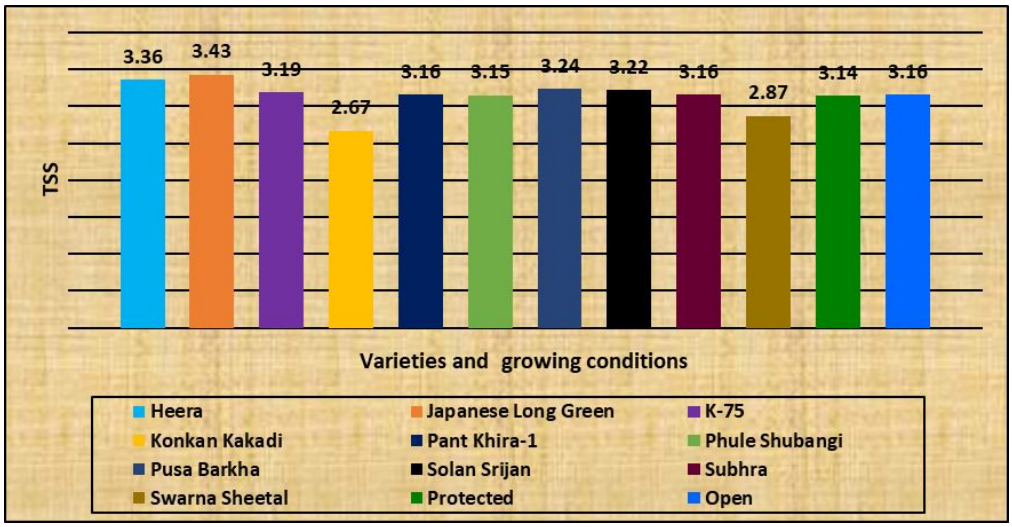

Figure 1 (b): TSS content in varieties and growing conditions (factors data).

3.2 Ascorbic acid

In varieties, ascorbic acid content ranged from 3.45 mg/100 g to 5.35 mg/100 g as mentioned in Table 1. Among all the varieties, the maximum ascorbic acid content was recorded in Heera hybrid (5.35 mg/100 g) and the minimum ascorbic acid content was recorded in K-75 variety (3.45 mg/100 g). Among the two growing conditions, protected condition had the maximum value of ascorbic acid (4.20 mg/100 g) as compared to open field condition (4.06 mg/100 g). In individual interactions, the maximum ascorbic acid (5.41 mg/100 g) was obtained in Heera hybrid under protected condition and the lowest ascorbic acid value was recorded in Phule Shubangi under open (3.19 mg/100 g) environmental condition.

Table 1: Ascorbic acid content (mg/100 g) of cucumber varieties under open and protected structure

S. No.	Ascorbic acid content (mg/100 g)							
	Treatments	Growing conditions (C)						Varieties pooled
	Varieties/ hybrids (V)	Open condition			Protected condition			
		Summer	Winter	Pooled	Summer	Winter	Pooled	
1	Heera	5.43	5.16	**5.30**	5.39	5.43	**5.41**	**5.35**
2	Japanese long green	4.96	4.71	**4.84**	4.34	4.23	**4.29**	**4.56**
3	K-75	3.4	3.13	**3.27**	3.61	3.69	**3.65**	**3.45**
4	Konkan kakadi	4.26	4.04	**4.15**	4.31	4.44	**4.38**	**4.26**
5	Pant khira-1	4.14	4.21	**4.18**	4.3	4.45	**4.38**	**4.27**
6	Phule shubangi	3.26	3.11	**3.19**	4.16	3.72	**3.94**	**3.56**
7	Pusa barkha	4.31	4.11	**4.21**	4.26	3.65	**3.96**	**4.08**
8	Solan srijan	4.36	4.21	**4.29**	4.39	4.1	**4.25**	**4.26**
9	Subhra	4.1	3.91	**4.01**	4.61	4.44	**4.53**	**4.26**
10	Swarna sheetal	3.33	3.13	**3.23**	3.43	3.06	**3.25**	**3.23**
Growing conditions pooled		4.15	3.97	**4.06**	4.28	4.12	**4.20**	**4.13**
Factors		**Growing conditions (C)**			**Varieties (V)**			**C × V**
C.D (0.05 %)		0.05			0.12			0.18
S.E (d)		0.02			0.06			0.09
S.E (m)		0.02			0.04			0.06

3.3 Acidity

The acidity content in varieties ranged from 0.26% to 0.44% as presented in Table 2. The maximum acidity content was recorded in K-75 variety (0.44%) and Swarna Sheetal (0.26%) was found with the minimum acidity content. Among the two growing conditions, under protected condition fruits obtained the maximum content of acidity (0.34%) which is on par to the open condition, (0.33%). In interactions, K-75 variety had the maximum amount of acidity content in fruits (0.47%) in open condition and the minimum acidity content (0.25%) recorded in Subhra hybrid under open environmental grown fruits.

Table 2: Acidity content (%) of cucumber varieties under open and protected structure

S. No.	Acidity (%)							
	Treatments	Growing conditions (C)						Varieties pooled
	Varieties/ hybrids (V)	Open condition			Protected condition			
		Summer	Winter	Pooled	Summer	Winter	Pooled	
1	Heera	0.31	0.29	**0.30**	0.35	0.39	**0.37**	**0.33**
2	Japanese long green	0.41	0.31	**0.36**	0.42	0.45	**0.44**	**0.39**
3	K-75	0.49	0.44	**0.47**	0.44	0.39	**0.42**	**0.44**
4	Konkan kakadi	0.36	0.29	**0.33**	0.31	0.38	**0.35**	**0.33**
5	Pant khira-1	0.31	0.28	**0.30**	0.38	0.37	**0.38**	**0.33**
6	Phule shubangi	0.36	0.31	**0.34**	0.31	0.27	**0.29**	**0.31**
7	Pusa barkha	0.33	0.29	**0.31**	0.29	0.24	**0.27**	**0.28**
8	Solan srijan	0.39	0.33	**0.36**	0.33	0.36	**0.35**	**0.35**
9	Subhra	0.26	0.24	**0.25**	0.29	0.31	**0.30**	**0.27**
10	Swarna sheetal	0.29	0.26	**0.28**	0.21	0.3	**0.26**	**0.27**
Growing conditions pooled		0.35	0.30	**0.33**	0.33	0.34	**0.34**	**0.33**
Factors		**Growing conditions (C)**			**Varieties (V)**			**C × V**
C.D (0.05 %)		0.007			0.016			0.02
S.E (d)		0.004			0.008			0.01
S.E (m)		0.003			0.006			0.08

4. Discussion

The present investigation results had significant differences among the varieties, growing conditions and interactions in cucumber. These similar findings are also reported by Pragathi (2014) who showed that there were significant differences in total soluble solids between the varieties. The maximum value of TSS was obtained under the protected grown condition compared to open field condition. Das *et al.* (2018) reported that the maximum amount of total soluble solids content was found in cucumber cultivar Malini (4.06 °Brix) compared to open field condition (3.98 °Brix). The increase in total soluble solids content could be due to water evaporation, dehydration and pectin substances of pulp are degraded in soluble solids, which caused hydrolysis of polysaccharides such as starch converted into monosaccharides (sugars). These results are in similar with the findings of Arora *et al.* (2006) in NP-5002 variety and Chandra *et al.* (2003) under protected condition, while Cantore *et al.* (2008) and Ahmet and Vedat (2009) reported under open field condition.

A significant difference was observed with respect to the ascorbic acid (mg/100 g) content of cucumbers for both open and protected conditions. Phookan and Barua (2016) reported that the maximum amount of ascorbic acid content was recorded in hybrid Alisha (9.80 mg/100 g). Generally, the high ascorbic acid content might be increasing the nutritive content of cucumber, which would help better retention of flavour and colour. Similar findings were reported by Rahman *et al.* (2008) in cucurbits. Therefore, cucumber varieties/ hybrids possessing maximum ascorbic acid are highly preferred. Protected grown cucumber varieties/hybrids were found to have more ascorbic acid value than grown in open condition and it increase in quality. The reduction in ascorbic acid is due to the formation of dehydro ascorbic acid by the ascorbinase enzyme. It might also be due to the maximum vitamin C content of fresh fruits and minimum losses during the processing. The above research results are in full agreement with the earlier work of Thangam and Thamburaj (2008) and Caliman *et al.* (2010) under greenhouse condition and Kumar *et al.* (2007) reported similar observations under open-grown condition.

Titratable acidity showed significant difference among all the varieties and growing conditions. Similar findings were reported by Soujanya *et al*. (2021) in mango varieties with respect to crude fibre content. The pooled data of acidity showed that the maximum acidity content was slightly highest under the polyhouse which might be the increased metabolic activity of the plants as well as in fruits to support the reproductive growth and quality (biochemicals activity) of the fruits. The reduction in acidity might be attributed to the chemical interactions between the organic constituents of the pulp induced by temperature and the action of different enzymes. Similar findings were also reported by Munshi and Kumar (2005).

5. Conclusion

Based on the above results, it could be concluded that all ten open-pollinated varieties of cucumber are commercially available all over India in ICAR institutions and these varieties had an adequate source of ascorbic acid, total soluble solids and titratable acidity. From the results, the highest total soluble solids content was recorded in the Japanese Long Green variety, maximum ascorbic acid content was recorded in Heera hybrid and K-75 variety had the maximum titratable acidity. According to two seasons pooled data, protected condition grown plants are given high-quality fruits compared to open field condition. Finally, the quality status of the popular ten cucumber varieties in ICAR institutions in India was estimated for the TSS, ascorbic acid and acidity content, which will help the consumers, dietitians and processing policy makers.

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Conflict of interest

The authors declare no conflicts of interest relevant to this article.

References

Ahmet, Turhan. and Vedat, zeniz (2009). Estimation of certain chemical constituents of fruits of selected tomato genotypes grown in Turkey. African Journal of Agricultural Research, **4**(10):1086-1092.

Arora, S.K.; Bhatia, A.K.; Singh, V.P.; Yadav, S.P.S. and Kumar, P. (2006). Fruit quality of greenhouse grown tomato under north Indian plains. Haryana Journal of Horticultural Sciences, **35**(3/4):295-296.

Bailey, L.H. (1969). Manual of Cultivated Plants. 11 Printing.

Caliman, Fabiano Ricardo Brunele, Derly José Henriques da Silva, Paulo César Stringheta, Paulo Cezar Rezende Fontes, Gisele Rodrigues Moreira, and Everardo Chartuni Mantovani. (2010). Quality of tomatoes grown under a protected environment and field conditions. Idesia, **28** (2):213-227.

Cantore, V.; Boari, F.; Vanadia, S.; Pace, B.; De Palma, E.; Leo, L. and Zacheo, G. (2008). Evaluation of yield and qualitative parameters of high lycopene tomato cultivars. Acta Horticulturae, **14**:173-179.

Chandra, P.; Awani K singh, Behera, T.K. and Srivastava, R. (2003). Influence of graded levels of nitrogen, phosphorus and potassium on yield and quality of polyhouse grown tomato (*Lycopersicon esculentum*) hybrids. Indian Journal of Agricultural Sciences, **73**(9):497-499.

Das, Twarita.; Saikia, Luchon. and Vikash Kumar. (2018). Comparative quality analysis of cucumber grown under polyhouse and in open condition. International Journal of Biochemistry Research and Review, **22**(1): 1-11.

Kumar, Mukesh.; Singh, P.; Singh, N.; Singh, L. and Prasad, R.N. (2007). Studies on quality traits of open pollinated varieties and hybrids of tomato responsible for their shelf life at ambient conditions. Indian Journal of Agriculture Biochemistry, **20**(1):17-22.

Munshi, A.D. and Kumar, R. (2005). Off season cultivation of tomato and capsicum. Indian Horticulture, **4**:12-13.

Phookan, D.B. and Barua, S. (2016). Performance of hybrid cucumber varieties during off season under naturally ventilated polyhouse conditions. Journal of Eco. Friendly Agriculture, **12**(1):95-96.

Pragathi, K. (2014). Evaluation of cucumber (*Cucumis sativus* L.) hybrids for production potential and qualitative traits under net house conditions (Doctoral dissertation, Thesis, M. Sc., Dep of vegetable Sci. Horit. Coll., Hout. Univ.

Rahman, A.H.MM.; Anisuzzaman, M.; Ahmed, F.; Islam, A.K.M.R. and Naderuzzaman, A.T.M. (2008) Study of nutritive value and medicinal uses of cultivated cucurbits. Journal of Applied Sciences Research, **4**(5):555-558.

Soujanya, B.; Kiran Kumar, A.; Bhagwan, A.; Sreedhar, M.; Vanisri, S.; and Saidaiah, P. (2021). Estimation of crude fiber content in different cultivars of mango (*Mangifera indica* L.) grown in Telangana State, India. Ann. Phytomed, **10**(1):319- 324.

Thangam, M. and Thamburaj, S. (2008). Comparative performance of tomato varieties and hybrids under shade and open conditions. Indian Journal of Horticulture, **65**(4):429-433.

Ughade, S.R.; Tumbare, A.D. and Surve, U.S. (2016). Fertigation scheduling to summer tomato (*Solanum lycopersicum* L.) under protected cultivation. The Bioscan, **11**(1):321-325.

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