Int. Journal of Universal Science and Technology
ISSN: 2454-7263, Volume: 05 No: 04 Published: Jan., 2019
Paper ID: IJUP3134, Web: www.universalprint.org
Title Key: Sensory and Chemical Studies in …

Sensory and Chemical Studies in Pummelo Genotypes

K. A. Gaikwad[1], P.C. Haldavanekar[2] and Y. S. Jadhav[3]
[1] Registry Assistant, PPV&FRA, Min. of Agriculture and Farmers Welfare, Govt. of India Branch Office Pune- 411 005, Maharashtra
[2] Associate Dean, College of Horticulture, Mulde, Dist. Sindhudurg- 416 520, Maharashtra
[3]Head of Department, Department of Horticulture, BV'S College of Horticulture, Kadegaon Dist. Sangli, Pin- 415 305, Maharashtra.
Email- kgaikwad52@gmail.com.

Abstract

Thirty pummelo genotypes fruits were analysed for six chemical characters *viz*., moisture (%), total soluble solids (^{0}Brix), acidity (%), pH, ascorbic acid (mg/100g) and sugars (%) whereas sensory evaluation was accessed for colour, flavor and texture.
Fruit chemical characterization disclosed that CG-9 had the highest vitamin C(40mg/100g). The greatest pH was determined in CG-14 (4.15). The best total soluble solids were determined in CG-29 (10.8 ºB). CG-29 recorded the highest titratable acidity of 3.7 % in contrast to 1.08 % for CG-23. The highest average sensory score (8.08) was recorded by CG-10 followed by CG-6 (7.67). Thus, the present study highlights the nutritional importance of this underutilized fruit crop.

Key words: *Citrus grandis* L., pummelo, genotypes, chemical analysis, sensory evaluation.

Introduction

Botanically pummelo is known as *Citrus maxima*Merr. (*C. grandis*Osbeck; *C. decumana* L.). In the western world, it is identified mainly as the principal ancestor of grapefruit. Taxonomically pummelo belongs to subgenus *Eucitrus* (commonly cultivated species of citrus) of the family Rutaceae, (2n=18). It has the biggest fruit among the citrus species (Ben, 2010). The areas in southern Thailand and northern Malaysia, which have the highest diversity of pummelos, are most likely the centre of origin of pummelos (Narong *et al*., 2005).

The top ten world producers of grapefruit (including pummelos) are USA, China, Mexico, South Africa, India, Argentina, Turkey, Cuba, Brazil and Tunisia (FAOSTAT, 2010). During 2010-11, the total area harvested, production and productivity of grapefruit including pummelo across the world was about 2,68,702 ha., 2,58,753 Hg i.e. 69,52,737 tones and 25.88 tones/ha., respectively. In India it is cultivated in U.P., Punjab, Maharashtra, Tamil Nadu and Karnataka for edible fruits. In India the area under grapefruit including pummelo is about 10,000 ha., with production and productivity about 2,60,300 tones and 26.03 tones/ha., respectively (Anonymous, 2012).

Food value per 100 g of edible portion*

Pummelo contains about 25-58 calories, 84.82-94.1 g moisture, 0.5-0.74 g protein, 0.2- 0.56 g fat, 6.3-12.4 g carbohydrates, 0.3-0.82 g fiber, 0.5-0.86 g ash, 21-30 mg calcium, 20-27 mg phosphorus, 0.3-0.5 mg iron, 20 I.U. vitamin A, 0.04-0.07 mg thiamine, 0.02 mg riboflavin, 0.3 mg niacin, 30-43 mg ascorbic acid and 1.2 g dietary fiber.
*Analysis made in China and the United States (Morton, 1987).

The objectives of the current work were to study the chemical and sensory characters of 30 pummelo genotypes.

Material and methods

Thirty pummelo genotypes were collectedfrom different locations *viz*., Harihareshwar, Shriwardhan, Diveagar, Murud, Sarve and Revdanda of Raigad district of Maharashtra

Chemical composition of fruits

Generally, seedling types of trees differ in fruit quality due to chemical composition of fruit. Therefore, determination of chemical composition is of immense importance to evaluate fruit quality.

Moisture (%)

Moisture percentage was determined by drying the pummelo fruits (segments) in hot air oven at 55-60°C till the constant weight was obtained and it was calculated as the difference between initial and final weight of fruit and expressed in percentage (Ranganna, 1997).

Total soluble solids (^{0}Brix)

Total soluble solids were estimated by using Erma hand refractometer (0 to 32°B) and value was corrected at 20^{0}C with the help of temperature correction chart (Horwitz and Latimer 2005).

pH

The pH of pummelo fruit was determined by using pH meter at 28°C.

Sugars (%)

Reducing, non-reducing and total sugars were estimated on fresh weight basis by using Lane and Eynon method with modification suggested by Ranganna (1997).

Acidity (%)

Acidity was determined by titrating with standard sodium hydroxide solution and expressed as percentage (Horwitz and Latimer 2005).

Ascorbic acid (mg/100 g)

Ascorbic acid content of fruit was determined by using 2, 6 – dichlorophenol indophenol dye titration method (Ranganna, 1997)

Sensory evaluation

The sensory evaluation of the fruits was carried out by the panel of experts for assessing the colour, flavor and the texture. The panel evaluated the sample by 9-point Hedonic scale (Amerine*et al.*, 1965) as given below in Table 1.

The overall ratings were calculated by averaging the score of evaluation. The fruits with score 5.5 and above were rated as good and acceptable.

Int. Journal of Universal Science and Technology
ISSN: 2454-7263, Volume: 05 No: 04 Published: Jan., 2019
Paper ID: IJUP3134, Web: www.universalprint.org
Title Key: Sensory and Chemical Studies in …

Table 1: Hedonic scale

Organoleptic score	**Ratings**
9	Like extremely
8	Like very much
7	Like moderately
6	Like slightly
5	Neither like nor dislike
4	Dislike slightly
3	Dislike moderately
2	Dislike very much
1	Dislike extremely

Results and discussion

Chemical composition of fruits

Data regarding chemical composition of pummelo fruit are presented in Table 2.

Table 2: **Variation in chemical characters of pummelo genotypes**

Genotypes	**Moisture (%)**	**TSS (^{0}B)**	**Acidity (%)**	**pH**	**Ascorbic acid (mg/ 100g)**	**Reducing sugars (%)**	**Non reducing sugars (%)**	**Total sugars (%)**
CG-1	90.40	9.00	3.02	3.90	30.00	1.75	2.23	3.98
CG-2	86.40	7.40	2.15	3.75	27.50	2.37	4.48	6.85
CG-3	84.28	6.80	1.54	3.40	30.20	2.25	3.70	5.94
CG-4	87.54	6.50	1.35	3.80	23.75	2.49	2.56	5.05
CG-5	82.20	8.40	2.78	3.95	32.50	1.92	2.70	4.63
CG-6	84.00	7.90	2.50	3.80	28.75	1.84	2.57	4.41
CG-7	91.05	8.20	2.69	4.00	28.75	2.54	2.81	5.35
CG-8	83.51	8.00	3.02	3.50	29.00	1.61	1.94	3.55
CG-9	84.20	9.00	2.99	3.85	40.00	2.40	2.83	5.23
CG-10	84.56	8.10	2.60	4.00	37.50	1.78	1.94	3.72
CG-11	86.57	8.40	2.11	3.95	28.75	2.29	2.72	5.02
CG-12	89.24	8.90	2.45	4.00	33.75	2.30	3.27	5.57
CG-13	87.00	7.00	2.54	4.10	31.25	1.75	2.19	3.94
CG-14	86.30	8.40	2.01	4.15	32.50	2.49	2.80	5.29
CG-15	85.40	9.20	3.20	3.80	35.80	1.47	1.75	3.22
CG-16	89.10	7.00	2.47	3.90	30.90	1.78	2.21	4.00
CG-17	90.22	6.80	1.82	3.80	30.00	1.59	3.90	5.49
CG-18	82.10	8.00	2.11	3.80	36.25	1.86	3.07	4.93
CG-19	87.09	9.20	3.02	4.10	32.50	2.42	3.08	5.49
CG-20	89.94	9.00	2.57	3.70	31.25	2.31	2.40	4.72
CG-21	89.41	8.70	3.20	3.70	32.50	2.24	3.08	5.32
CG-22	86.00	8.90	1.71	3.80	31.25	2.24	2.99	5.24

CG-23	85.60	9.80	1.08	3.70	31.40	2.23	2.92	5.15
CG-24	87.95	7.80	2.30	3.90	31.25	2.03	2.82	4.85
CG-25	84.23	7.90	2.11	4.00	25.00	2.15	2.87	5.02
CG-26	82.70	7.20	2.86	3.50	28.00	1.68	2.63	4.31
CG-27	87.00	10.20	3.16	3.40	29.80	2.31	3.01	5.32
CG-28	90.00	8.20	2.54	3.50	30.00	2.32	3.27	5.59
CG-29	86.54	10.80	3.70	3.40	34.00	1.63	2.20	3.83
CG-30	85.50	10.10	3.57	3.80	29.40	2.90	2.95	5.85
Range	82.1-91.05	6.5-10.8	1.08-3.7	3.4-4.15	23.75-40.0	1.47-2.9	1.75-4.48	3.22-6.85
Mean	86.53	8.36	2.51	3.80	31.12	2.10	2.80	4.89
S.D.	2.56	1.07	0.63	0.21	3.40	0.35	0.58	0.81
Variance	6.57	1.14	0.40	0.05	11.59	0.12	0.34	0.65
C.V.	2.96	12.80	25.16	5.62	10.94	16.78	20.92	16.50
S.E.	0.47	0.20	0.12	0.04	0.62	0.06	0.11	0.15

Moisture (%)

The chemical analysis of fruit revealed that the moisture content of fruit varied from 82.1 per cent in CG-18 to 91.05 per cent in CG-7. The moisture percentage was above mean (86.53 %) in genotypes viz., CG-1, CG-4, CG-11, CG-12, CG-13, CG-16, CG-17, CG-19, CG-20, CG-21, CG-24, CG-25, CG-28, CG-29 and CG-30. Similar findings were reported by Haque *et al.* (2009) in which he reported 90.23 g moisture in pummelo (*C. maxima*).

Total soluble solids i.e. T.S.S. (^{0}B)

The T.S.S of fruit varied from 6.5 to 10.8 0B in CG-4 and CG-29, respectively. Genotypes, CG-5, CG-9, CG-11, CG-12, CG-14, CG-15, CG-19, CG-20, CG-21, CG-22, CG-23, CG-27 and CG-30 exceeded T.S.S values above mean (8.360B). These results are in consonance with the work of Estellena and Odtojan (1992), Hua (1997), Samarasinghe (2005), Hien and Tung (2006), Singh and Singh (2006b), Ara *et al*. (2008), Patil and Reddy (2008), Paudyal and Haq (2008), Haque *et al*. (2009), Mitra *et al*. (2010), Srivastava *et al*. (2010) and Wu *et al*. (2011) who estimated the TSS of different pummelo cultivars in the range of 7.0 to 11.4^{0}B.

pH

It could be observed from the data presented in Table 2 that the average pH of pummelo fruit was 3.80. The highest pH (4.15) was noticed in CG-14, while the lowest (3.4) was in CG-3, CG-25 and CG-29. Nearer value of pH (3.5) was stated by Haque *et al*. (2009) in pummelo (*C. maxima*). Besides, the achievements of Radulovic*et al*. (2005) and Hassan *et al*. (2008) in different *Citrus* spp. are in correspondence with the current findings.

Acidity (%)

The observations in Table 2 divulge that the average titratable acidity of pummelo fruits was 2.51 per cent, which was exceeded by genotypes viz., CG-1, CG-5, CG-7, CG-8, CG-9, CG-10, CG-12, CG-13, CG-15, CG-16, CG-19, CG-20, CG-21, CG-24, CG-26, CG-27, CG-28 and CG-30. The highest percentage of acidity (3.7 %) was noticed in CG-29,

while it was lowest (1.08 %) in CG-23. Singh and Singh (2006a), Singh and Singh (2006b), Ara *et al*. (2008), Patil and Reddy (2008), Paudyal and Haq (2008), Haque *et al.* (2009), Mitra *et al*. (2010), Srivastava *et al*. (2010), Wu *et al*. (2011) and Hazarika (2012) reported that the acidity in pummelo ranged from 0.11 to 6.80 per cent thus showing resemblance with present outcome.

Sugars (%)

The data (Table 2) pertaining to the reducing, non-reducing and total sugars indicated that an average reducing, non-reducing and total sugars in fruits of different pummelo genotypes were 2.10, 2.80 and 4.89 per cent, respectively. The reducing sugars ranged from 1.47 per cent (CG-15) to 2.9 per cent (CG-30). Comparable results were also recorded by Haque *et al.* (2009) for reducing and total sugar in pummelo (*C. maxima*) as 1.58 and 3.76 g, respectively.

The non-reducing sugars ranged from 1.75 (CG-15) to 4.48 per cent (CG-2), while total sugars ranged from 3.22 (CG-15) to 6.85 per cent (CG-2). Radulovic*et al*. (2005) and Mitra *et al.* (2010) estimated total sugars for tangerine and pummelo clones which ranged from 0.63 to 7.47 and 4.6 to 6.1 per cent showing resemblance with the current findings.

Ascorbic acid (mg/ 100 g)

The chemical analysis of pummelo showed that average ascorbic acid content was 31.12 mg/100 g fruit. The genotypes viz., CG-5, CG-10, CG-12, CG-13, CG-14, CG-15, CG-18, CG-19, CG-20, CG-21, CG-22, CG-23, CG-24 and CG-29 had ascorbic acid values above mean. The highest ascorbic acid (40 mg/100 g) was noticed in CG-9, whereas it was lowest (23.75 mg/100 g) in CG-4. Chen *et al*. (1993), Hua (1997), Haque *et al*. (2009) and Simona *et al*. (2011) also observed variable quantity of ascorbic acid in pummelo cultivars that is in agreement with the fore cited results, but Chen *et al*. (1993) estimated it at higher range of 20.4 to 100 mg/100.

Sensory evaluation

The data on the sensory evaluation of pummelo fruit in terms of colour, flavor and texture are presented in Table 3.

Table 3: Variation in sensory evaluation of pummelo genotypes

Genotypes	Sensory score			Total score	Average Score
	Colour	Flavour	Texture		
CG-1	7.65	7.43	7.00	22.08	7.36
CG-2	7.50	7.00	7.00	21.50	7.16
CG-3	7.26	7.60	7.15	22.01	7.33
CG-4	7.25	7.00	7.00	21.25	7.08
CG-5	6.50	7.50	7.50	21.50	7.16
CG-6	7.75	7.50	7.75	23.00	7.67
CG-7	7.75	7.50	7.50	22.75	7.58
CG-8	7.25	7.50	7.00	21.75	7.25
CG-9	8.00	7.50	7.25	22.75	7.58

CG-10	8.25	8.00	8.00	24.25	8.08
CG-11	7.00	7.50	7.00	21.50	7.17
CG-12	6.65	6.68	6.50	19.83	6.61
CG-13	7.00	7.50	7.68	22.18	7.39
CG-14	6.85	7.00	7.00	20.85	6.95
CG-15	6.66	5.74	6.33	18.73	6.24
CG-16	7.53	7.16	7.35	22.04	7.35
CG-17	7.00	7.00	6.90	20.90	6.97
CG-18	6.90	6.20	6.30	19.40	6.47
CG-19	7.00	6.30	6.90	20.20	6.73
CG-20	7.30	7.20	7.00	21.50	7.17
CG-21	7.20	7.00	7.00	21.20	7.07
CG-22	7.50	7.00	7.00	21.50	7.17
CG-23	6.45	6.50	7.00	19.95	6.65
CG-24	7.50	7.25	6.75	21.50	7.17
CG-25	7.45	7.50	7.29	22.24	7.41
CG-26	7.50	6.75	6.75	21.00	7.00
CG-27	7.00	7.50	7.24	21.74	7.25
CG-28	7.43	6.50	7.00	20.93	6.98
CG-29	6.70	7.13	6.75	20.58	6.86
CG-30	8.00	5.50	6.75	20.25	6.75

It is evident from the data that the highest average sensory score (8.08) was recorded by CG-10 followed by CG-6 (7.67), while lowest sensory score (6.24) was noticed in CG-15. Other genotypes like CG-1, CG-2, CG-3, CG-5, CG-7, CG-8, CG-9, CG-11, CG-13, CG-16, CG-20, CG-22, CG-24, CG-25 and CG-27 also recorded higher average sensory score than remaining genotypes.

Colour of pulp was found to be best in CG-10 followed by CG-9, CG-30, CG-6 and CG-7. Lowest score (6.45) for the colour was recorded in CG-23.

Pulp of CG-10 recorded the highest score (8.00) for flavour followed by CG-5, CG-6, CG-7, CG-8, CG-9, CG-13 and CG-25. The lowest score (5.50) for flavour was noticed in CG-30. Hua (1997), Jiang *et al*. (2002), Samarasinghe (2005) and Mitra *et al*. (2010) reported wide variation in pummeloflavour like rich acidic-sweet, sour, moderate good, sweet, very sweet, bitter and moderately bitter. Whereas, Khan *et al.* (2008) revealed that organoleptic values of 'Feutrell's Early' mandarin cultivar extended from 3.73 to 6.90 showing resemblance with present study.

References

1. Anonymous, 2012. FAOSTAT. FAO Statistics Division 2012, 22 January 2012. http://www.fao.org.
2. Amerine, M.A., R.M. Pangborn and E.B. Rocssler. 1965. Principles of sensory evaluation of food. Academic Press,London.
3. Ara, N., M. K. Bashar, M. K. Uddin and K. M. Khalequzzaman 2008. Evaluation of pummelo, *Citrus grandis* L cultivars in northern area of Bangladesh. *Journal of Agricultural Research (Lahore)*, 46(1): 65-75.
4. Ben, G. B. 2010. Crop Info and How-To Guide in Growing Pummelo. Crops Review.
5. Com: Towards an Informed Application of Science and Agriculture http://www.cropsreview.com/ pummelo.
6. Chen, X. S., Q. Y. Chen, C. L. Jiang, Y. L. Wu, T. C. Guo, H. T. Nie, Y. Ji and J. X. Gan (1993). Evaluation of 23 pummelo cultivars. China Citrus, 22 (2): 3-7.
7. Estellena, N. T. and R. C. Odtojan.1992. Pomological characterization of eight Pummelo cultivars, *Citrus maxima* (Burm.) Merr. *Philipp J. Crop Sci.*, 17(3): 137-142.
8. FAOSTAT. 2010. http://www.cropsreview.com/pummelo.
9. Hassan, N. A., A. A. El-Halwagi, R. M. Khalaf, H. A. Sayed, and A. A. El-Homosany. 2008. Morphological characterization, pollen grain fertility and some chemical characters of selected mandarin (*Citrus* Spp.) varieties. *Arab Univ. J. Agric. Sci., Ain. Shams Univ*., 16(1): 161-177.
10. Haque, M. N., K. Saha, M. R. Karim and M. N. H. Bhuiyan 2009. Evaluation of nutritional and physico-chemical properties of several selected fruits in Bangladesh. *Bangladesh J. Sci. Ind. Res.*, 44(3): 353-358.
11. Hazarika, T. K. 2012. Citrus genetic diversity of north-east India, their distribution, ecogeography and ecobiology. *Genet. Resour. Crop Evol.*, 59: 1267–1280.
12. Hien, D. M. and N. T. Tung (2006). Analysis of pomelo value chain in Ben Tre province. Ministry of trade of S. R. Vietnam. 25 p.
13. Horwitz, W. and G. W. Latimer (2005). Official Methods of Analysis of AOAC international. 18th Edition. AOAC international, USA.
14. Hua, Z. L. (1997). The pomello variety "LongduZaoxiangyou". South China Fruits, 26 (6): 8.
15. Jiang, Z. X., L. Z. Hao, L. Q. Wen, Y. C. Yong, Q. S. He and H. S. Zhou (2002). New pummelo variety with high quality and good tolerance to storage - Gongshui white pomelo. Acta HorticulturaeSinica, 29 (4): 396.
16. Khan, M. M., S. Mumtaz, S. Ahmad, M. Abbas and I. A. Khan (2008). Some studies on the morphology of Kinnow mandarin and Feutrell's early. Pak. J. Agri. Sci., 45 (4): 424-431.
17. Mitra, S. K., C. S. Maity, B. Ghosh and P. K. Pathak. 2010. Genetic resources of pummelo (*Citrus grandis*Osbeck) in West Bengal, India. *Acta Horticulturae*, 918:

XXVIII International Horticultural Congress on Science and Horticulture for People: III *International Symposium on Plant Genetic Resources*.

18. Morton, J. 1987.In: *Fruits of warm climates*. Florida Flair Books, Miami, Pummelo. p. 147–151.
19. Narong, C., K. Chapman and P. Griffee. 2005. Fruits of Vietnam in Food for all, FAO of United Nations at http://www.ecoport.org.
20. Patil, P. and B. M. C. Reddy. 2008. Ex situ characterisation and evaluation of pummelo germplasm. *National Symposium on Citriculture: emerging trends*. NRCC, Nagpur, 24-27.
21. Paudyal, K. P. and N. Haq (2008). Variation of pomelo (*Citrus grandis* (L.) Osbeck) in Nepal and participatory selection of strains for further improvement. Agroforestry Systems, 72 (3): 195-204.
22. Radulovic, M., S. Malidzan and T. Perovic (2005). Major pomological properties of tangerine unshiu (*Citrus unshiu*Marc.). Vocarstvo, 39 (4): 387-394.
23. Ranganna, S. (1997). Hand book of Analysis and Quality Control for Fruit and Vegetable products. Second Edition. Tata-Mc. Graw-Hill Publishing Company Ltd., New Delhi, India.
24. Samarasinghe, P. W. S. M. 2005. Selection and conservation of good quality pummelo (*Citrus grandis* L.) mother trees. *IPGRI Newsletter for Asia, The Pacific and Oceania*, 47: 21-22.
25. Simona, B., F. Alexandrina, T. D. Mirela and S. Ildiko (2011). Studies on citrus species fruits ascorbic acid content using kinetic, spectrophotometric and iodometric methods. AnaleleUniversitatii din Oradea, FasciculaProtectiaMediului, 16: 212- 217.
26. Singh, I. P. and S. Singh (2006a). Horticulture for sustainable income and environmental protection. Illustrated ed. Concept Publishing Company, 1: 718 p.
27. Singh, I. P. and S. Singh (2006b). Citrus Monograph. NRCC, Nagpur, MS 96 p. Srivastava, A. K., I. P. Singh and A. K. Das. 2010. Citrus production constraints in Meghalaya: Issues and Strategies. *ENVIS Bulletin*, 18: 18-28.
28. Wu, S., C. N. Chang, W. S. Tzeng, K. C. Ho and Y. T. Shyu (2011). Functional antioxidant and tyrosinase inhibitory properties of extracts of Taiwanese pummelo (*Citrus grandis*Osbeck). African Journal of Biotechnology, 10 (39): 7668-7674.