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Quality Analysis of Orange Varieties in the Mekong Delta and Kontum, Vietnam

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Abstract**—** *In the present study results, Orange were successfully produced and analysed for physical, chemical and sensory properties. It was observed that the resultant orange juice samples had a pH range of between 3.50 – 4.81 for samples for samples. A reversed case occurred on these samples for titratable acidity with a range of 1.47 – 3.18%. Cam Sanh (7) showed the highest concentrations of citric acid (3.18), The Total soluble sugar (TSS), Titratable acids (TA), TSS were also important parameters, related to orange quality, where Cam Canh(9) had the highest TSS value (17.8), and Cam Sanh (7) had the lowest TSS value (6.70). According to the above results, noticeable differences were observed among orange varieties.Oranges reduced the sugar content and increases the vitamin C content of the juice,and also has very high nutritional value. It is a very good source of vitamins, minerals and amino acids. Products were formulated and sensory evaluation was done by selected panel members. The results showed that there were significant differences in quality attributes, nutrients, and functional components among different orange varieties, which might be affected by the species, origin place, growing season, environmental factors, ripening, and changes in the storage process. The results of this study will provide valuable guidance for the identification and utilization of growing orange.*

Keywords**— Orange, sensory properties, titratable acidity(TA), Total soluble sugar(TSS), valuable**

I. INTRODUCTION

Citrus belongs to the *Rutaceae* family and is one of the most important fruit trees in the world. (FAO.2020) ,Oranges provide a source of macro- and micronutrients and fiber (Marín et al., 2007). They are also rich in antioxidant compounds (Liu et al., 2012), report anti-cancer and anti-inflammatory properties (Ma et al., 2020), and are effective in reducing the risk of cardiovascular disease, osteoporosis, and type 2 diabetes (Sugiura et al., 2016). Orange is a distinct fresh fruit, widely consumed and especially appreciated for its aromatic taste. Orange powder is an excellent source of vitamin C, providing 64% of an individual's daily needs [USA.2014]. In addition to the vitamin C content in orange juice, it is also rich in folic acid, potassium, and an excellent source of bioactive antioxidant phytochemicals, and they are important commercial commodities in most countries (Vasavada .2003). Its juice has a composition of nearly 81.2 – 86.2% moisture, 13 – 19% of total solids of which sucrose, glucose... Collagen synthesis in the body. Significant differences among different citrus varieties were found. In particular, the total soluble sugar content of Mingrijian was higher than that of other citrus, suggesting its potential for fresh consumption and food processing(Huan et al.,2023).Recently, more and more research has focused on the domestication of Citrus of Mekong delta and KonTum province , helping us to shed light on the origins of cultivated species. This provides a comprehensive resource on how wild resources can contribute to improving existing varieties (Ahmed et al., 2019). Traditional variety selection is one of the main strategies used to improve agronomic characteristics. In many citrus species, some varieties have evolved through conventional methods, such as mutagenesis, mid-and-in-specific hybridization, and asexual selection (Caruso et al.

2020). Therefore, to compare the quality of oranges is the goal of this study and to compare the physical, chemical and sensory properties of the product in order to select the orange variety in the direction of the best quantity.

II. MATERIALS AND METHODS

Site selection

The study on the effect of altitude and fruit bearing positions on fruit quality attributes was conducted at three villages *viz.*, KonTum , Hau Giang (Vị Thuy) , Ben Tre (Giong Trom)and Can Tho(Phong Dien, O Mon) Vinh Long(Binh Minh)

Sample collection

30 orange fruits representing the single tree were collected and a replica containing 4 organces of each bearing positions were packed in sealed plastic bags and collected for physiochemical analysis. Fruits were harvested in first week of May 2023.

Table 1. The sites selected orange

Number	Lines	collected in Province	Sites: Latitude and longitude
1	Cam Xoan	Phong Dien Can Tho	Can Tho, latitude 9.9968° N, 105.6687° E, and the longitude is 105.6687
2	Cam Đuong	Phong Dien Can Tho	Can Tho, latitude 9.9968° N, 105.6687° E, and the longitude is 105.6687.
3	Cam Mat CT	Omon, Can Tho	Can Tho, latitude 10.1165° N,, and the longitude is 105.6326° E.
4	Cam MatBT	Giong Trom , Ben Tre	Latitude and longitude — 10.1719° N, 106.4641° E
5	Cam SanhBT	Giong Trom , Ben Tre	Latitude and longitude — 10.1719° N, 106.4641° E
6	Cam Sanh HG	Long My,HauGiang	Latitude 9.6696° N, longitud105.5650° E
7	Cam Sanh VL	Binh Minh Vinh Long	Latitude10.0705° N, longitude 105.8229° E
8	Cam Sanh KT	KonTum	Latitude14.3497° N, longitude 108.0005° E
9	Cam Canh	KonTum	Latitude14.3497° N, longitude 108.0005° E

Quality attributes assessment

Determination of quality attributes, total soluble sugar, and titratable acids in citrus fruits

Ingredients Fully ripe, ripe and fresh oranges are available at Kontum. They were transferred to the laboratory at the Mekong Delta High-Tech Agricultural Research Institute for further research. The chemicals and reagents used in this study belong to the analytical category.

Preparation of orange juice :Quality characteristics such as uniformity in size, color, shape have been considered in the selection of oranges. The selected ones are sorted and thoroughly washed under running water, after which they are washed with a 5% hypochlorite solution to remove surface bacteria and contamination.

- The fruit shape index (d/h) was calculated by dividing the transverse diameter by the vertical length of the fruit. After being peeled and deseeded, the fruit samples were weighed and then the edible proportion (%) was calculated as the percentage of the fresh weight of the edible tissues to the weight of the whole fruit.

Different chemical parameters i.e. Total soluble sugar (TSS), Titratable acids (TA), pH and ascorbic acid content were scored. TSS was measured by hand held refractometer, pH was measured by digital pH meter at 27°C and TA and ascorbic acid were measured as per the methods outlined in AOAC (2016) and (Li et al.2021)

-Total soluble sugar (TSS) was measured with a hand-held digital refractometer (precision of ±0.01, PAL-BX/ACID F5, ATAGO Co., Ltd., Tokyo, Japan) at 25°C, and the data was expressed as "°Brix." The refractometer was cleaned with distilled water after each measurement.

- Titratable acids (TTA) were measured using the Phenolphthalein indicator method according to (Li et al.2021).

Ten (10ml) of the juice was pipetted into a conical flask and 25ml of distilled water added as described by AOAC [2016]. Two hundred metres (200ml) of 0.1M NaOH was powered into a burette and was titrated against the sample in the flask using three drops of phenolphthalein as indicator. It was titrated until a pink colouration was observed and the corresponding burette reading taken using the following formula.

Titratable acidity % = Titreblanknormality of base xml equivalent of citric acid / Weight of sample

ML equivalent of citric acid(meq) = 0.06404

Total Sugar Content (o Brix) The hand held sugar refractometer was used. The prism of the refractometer was

cleaned and a drop of the juice was placed on the prism and closed. The total sugar content (o Brix) was read off the scale of the refractometer when held close to the eye according to the method of AOAC [2016].

-pH The pH of the juice was determined using a digital pH meter (pHs-2F, Harris, England) according to AOAC (2016) method. Fifty (50ml) of the juice was transferred into a beaker and the pH was determined after the meter was calibrated using standard buffer solutions of pH 4.0 and 7.0. Sufficient time was allowed for equilibration before readings were taken.

Determination of the contents of main nutritional compositions in citrus fruits

After the fruit was washed, the flesh and peel portions were separated by hand. The flesh portion was chopped, and homogenized using a Polytron blender for 1 min. Afterward, a weighed portion (100 g) was oven-dried and finely ground for further nutritional analysis. The content of moisture was determined using the hot-air drying method. Ash, protein, fat, and crude fiber were determined according to previously reported methods (Janati et al .,2012). Briefly, the fruit sample (1.0 g) was placed in a muffle furnace. The furnace temperature was gradually raised to 550°C and maintained for 30 min. After cooling the sample for 30 min, the furnace temperature was slowly raised to 550°C again and maintained for 30 min until the ash sample was obtained with a constant weight.

-The protein content (nitrogen × 6.25) was estimated by the Kjeldahl method, and a nitrogen analyzer was applied. Total dietary fiber content was measured by enzymatic digestion with thermostable 50 μL amylase (300 U), 100 μL protease (30 U), and 100 μL amyloglucosidase (400 U) in 40 mL 4-Morpholineethanesulfonic acid-Tris buffer (MES-Tris, pH 8.2).

-The lipit content was measured using petroleum ether as the extractant in a Soxhlet apparatus, and the carbohydrate content was measured by the difference method (Ani et al .,2018). The carbohydrate content was estimated according to the formula: carbohydrate (%) = 100 − ash−moisture−fat−protein−dietary fiber. Moreover, the content of ascorbic acid was determined according to a previous report (Sigmann et al.,2004). Briefly, citrus samples (100 g) were weighed and mixed with 100 mL of the extractant solution (8% acetic acid and 3% metaphosphoric acid). Thymol blue was selected as the indicator, and the fluorescence intensity was measured at an emission wavelength of 350 nm and an excitation wavelength of 430 nm. All nutritional compositions were presented in wet weight.

-Vitamin C was determined by a dye solution of 2, 6 – dichloroindophenol (DCIP) titration method described by (Mazumdar and Majumder 2003).

-Macro elements, such as phosphorus (P), potassium (K), magnesium (Mg), calcium (Ca), and sodium (Na), as well as trace elements such as iron (Fe) and zinc (Zn), were analyzed using an inductively coupled plasma-optical emission spectrometry (ICP-OES; Varian ICP 720-ES, Varian Inc., Palo Alto, CA, United States) according to a previous study with appropriate modifications (Altundag et la.,2011). The sample (1.0 g) was added with 1 mL of $HClO_4$ and 5 mL of HNO_3 and treated on a hot plate. Where necessary, more acid was added to facilitate the dissolution of the residue, and a colorless and transparent digestion solution was prepared. Finally, the digested samples were cooled, fixed to volume, and filtered. Blanks were prepared in the same way as samples. The ICP-OES was calibrated using standard solutions of various elements prior to the analysis of citrus samples.

Sensory Evaluation

Sensory evaluation was carried out by nine trained panelists aged 24–45 years, following approval by HATRI .All the panelists had been trained for more than 6 months in citrus sensory evaluation, and they discussed a series of taste reference solutions, including sucrose (8%) for sweetness, citric acid (0.3%) for sourness, quinine (0.0025%) for bitterness, and tannins (0.2%) for astringency. Purified water was provided between evaluations to eliminate any residual taste from the tongue. Each taste intensity was marked on a 15 cm line scale with 0.5 cm anchors, labeled “very weak” on the left and “very strong” on the right (Kim et la.,2023).

Statistical Analysis Results were expressed as mean values and standard deviation of three (3) determinations. Data were analysed using a one-way analyses of variance (ANOVA) using Statistical Package for Social Science (SPSS) version 20.0 software 2011 to test the level of significance at 5% probability (p)

III. RESULT AND DISCUSSION

3.1. Analysis of citrus fruit quality attributes, total soluble sugar, titratable acids and pH

The quality attributes (fruit weight, and edible proportion) and juice properties (TSS, TA, and TSS/TA) and pH of citrus fruits are shown in table2. The appearance and cross-section photographs of different citrus varieties were displayed in figure 1. The mean fruit weight, was a significant difference among different citrus varieties. Cam Canh , a relatively small variety, had the lowest mean fruit weight (152.1 g). Marked differences were found in organic

acid composition (Table 2), in which citric acid was the main organic acid, followed by malic and ascorbic acids. Cam Sanh (7)and Cam Sanh (8) showed the highest concentrations of citric acid (3.18 and 3.05 %,respectively), The TSS, TA, and TSS/TA were also important parameters, related to citrus quality, where Cam Canh(9) had the highest TSS value (17.8), and Cam Sanh (7) had the lowest TSS value (6.70). According to the above results, noticeable differences were observed among citrus varieties. The quality parameters of citrus samples varied with varieties and growing regions(Tounsi et al.,2011).Moreover, a citrus metabolomic pathway associated with the cultivation methods is proposed, and the correlations of the phytochemical profiles and sensory and soil characteristics are discussed by (Sung et al.,2024). Notably, among the selected citrus varieties, the Cam Xoan, Cam Canh , Cam Duong higher attention was given to it. This is confirmed by the TSS/TA ratio, an important indicator of commercial and sensory ripeness. This is used widely for citrus fruits because it helps define their characteristic flavour (Pilla et la.2022)The TSS/TA value of Cam Canh , Cam Xoan produced in KonTum , Cam Mat was higher than other varieties, even higher than Cam Xoan Can Tho (a variety famous for its high sweetness), indicating its potential for fresh consumption and food industrial processing. Maturity index was another important parameter related to the qualitative characteristics of citrus fruit and is linked to fruit ripeness. Cam Mat had the highest value as a result of its low citric acid content.

The physical properties' result showed that the pH of the juices ranged between 3.50 – 4.81 for samples , as presented in Table 2. This falls within the range of 3.50 – 3. for fruit as reported by (Ohwesiri et al .,2016). There were significant difference ($p<0.05$) in the pH values for samples 3(Cam Mat and 4 (Cam Mat)the reference sample (4.81, and 4.22), respectively. The pH value for sample 1: Cam Xoan (4.51) was significantly higher while samples 5,7,6 (3.50,3.51 and 3.63) respectively was significantly low compared to other samples.

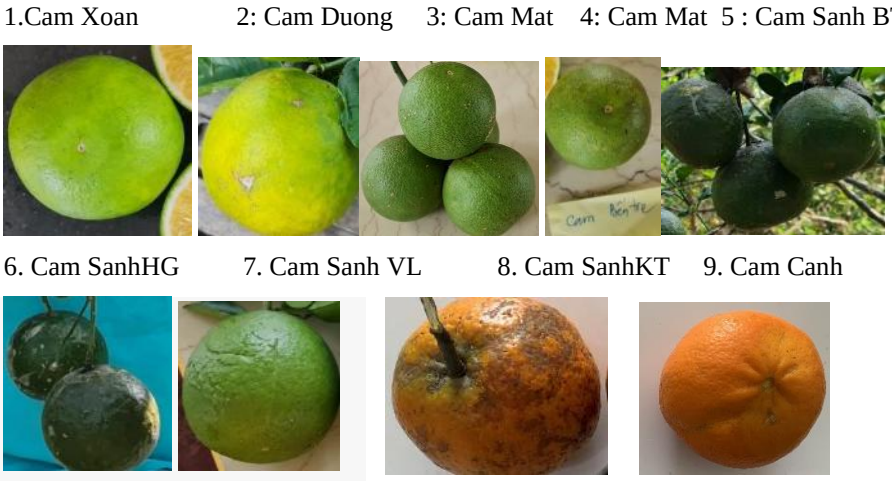

Fig.1. Appearance morphology of different citrus fruits. 1: Cam Xoan ;2: CamDuong PD;3: Cam Mat OM ;4: Cam Mat BT ;5 Cam Sanh BT; 6: Cam Sanh HG; 7: Cam Sanh VL;8: Cam SanhKT 9: Cam Canh

Table 2: Quality attributes, total soluble sugar, and titratable acids , pH of organe fruits.

No.	name	Weight(g)	Seed	TA(%)	TSS(Brix)	TSS / TA	pH
1	Cam Xoan	180.1d	1	1.56e	16.5b	10.58b	4.51a
2	Cam Đuong	253.5b	12	1.87d	15.6c	8.34c	4.32a
3	Cam Mat CT	156.7f	10	1.95c	14.6d	7.48d	4.81a
4	Cam MatBT	189.5d	12	1.75d	13.5e	7.71d	4.22a
5	Cam SanhBT	264.7a	14	2.89b	8.2f	2.83e	3.50b
6	Cam Sanh HG	256.3b	6	3.02a	7.6g	2.51e	3.63
7	Cam Sanh VL	212.7c	10	3.18a	6.7h	2.13e	3.51b
8	Cam Sanh KT	166.5e	13	3.05g	13.4e	10.72b	4.56a
9	Cam Canh	152.1f	15	1.47f	17.8a	12.10a	4.15a

Note: Numbers that follow the same character are not statistically significant at 5%.

3.2. Nutritional composition analysis

The health-promoting effects of organe fruits are largely attributed to their abundance of nutrients. Organe fruits are rich in a variety of other nutritional compositions, including protein, carbohydrates, fat, dietary fiber, and ascorbic acid. The nutritional compositions of different organe varieties were shown in Table 3. The protein content of the orange was low, ranging from 0.91 – 1.45 % for samples. Sample 5 (Cam Sanh) was observed to have significantly higher value compared to other 6 and 7 samples while sample 3 and 4 (Cam Mat) had no significant difference as compared to sample 2 (Cam Duong). The total lipid content of organe fruits was determined to be 0.20–1.15 g/100 g wet weight. The carbohydrate content of organe fruits was determined to be 7.21–11.08 g/100 g wet weight and The carbohydrate was the main component that gives organe its sweetness (Lu et al.2021). The dietary fiber of the organe fruits varied significantly among different varieties, ranging from 1.89 to 3.60 g/100 g wet weight. Cam Xoan was the variety with the highest dietary fiber content. Cam Duong (2) also had elevated dietary fiber content at about 3.03 g/100 g wet weight, while Cam Canh (9) (1.94 g/100 g wet weight) and Cam Mat (1.89 g/100 g wet weight) had the lowest dietary fiber content. These organe fruit quality parameters are under the influence of environmental factors (Chelong et al.,2013). The maturation of organe fruit is then impacted by climatic factors such as relative humidity, solar radiation and especially temperature. In fact, organe fruit maturation is closely related to thermal summation (Stenzel, et al.,2006). Depending on the plant investigated, degree days provide estimations of rates of activity of biochemical processes as well as plant growth. As shown in Table 3, Cam Sanh: sample 5,7, and 6 (36.3;35.75 and 30.2mg/mL) respectively and had the highest ascorbic acid content .Furthermore, the lowest ascorbic acid content was found in 8(20.6 mg/mL) and line 9 (21.49 mg/mL). Table 3

Table 3. Nutritional composition and elemental composition of orange fruit.

	1	2	3	4	5	6	7	8	9	
Protein(g/100g)	1.39b	0.91d	0.98d	0.95d	1.45a	1.36b	1.22c	0.86e	0.95d	
Lipit (g/100g)	1.15a	0.75c	0.85b	0.54d	0.52d	0.56d	0.54d	0.20e	0.78c	
Carbohydrade(g/100)	11.08a	10.32b	9.25c	7.89d	7.21d	7.23d	7.25d	9.86c	9.75c	
Acid ascorbic(mg/100g)	23.93f	25.61e	22.77f	32.18c	36.31a	30.2d	35.75b	20.62h	21.49g	
Vitamine C	61.2b	58.7c	63.7b	66.5b	72.8a	72.9a	73.0a	66.2b	60.4b	
Fiber(G/ 100g)	3.60	3.03	2.17	1.89	2.69	3.01	2.58	2.56	1.94	
Na(mg/100g)	3.2	3	3	3.1	3.1	2.95	2.95	2.74	3.0	
P(mg/100g)	188.5b	125.7b	189.6b	130.5c	114.7d	185.2	210.56a	200.45a	204.2a	
K(mg/100g)	2.06a	1.18d	2.04a	1.28c	1.25	1.47b	2.14a	2.25a	2.45a	
Mg(mg/100g)	119.8e	145.3b	120.5s	125.8s	118.5	155.7a	145.7b	114.5e	132.5c	
Canxi(mg/kg)	256.7c	321.4b	342.1b	415.2a	321.4b	241.2c	215.6c	224.1c	225.7c	
Fe(mg/Kg)	3.2	3.1	3.25	3.21	3.2	3.2	3.5	3.2	3.2	
Zn(mg/Kg)	2.12	2.15	2.13	2.14	2.01	2.03	2.14	2.10	2.25	

Note : 1: Cam Xoan ;2: CamDuong PD;3: Cam Mat OM ;4: Cam Mat BT ;5 Cam Sanh BT; 6: Cam Sanh HG; 7: Cam Sanh VL;8: Cam SanhKT 9: Cam Canh.

3.3. Elements analysis

Orange juice is a good source of minerals, such as P, K, Mn, Ca, Mg, F, Cu, etc. The types and contents of elements in different varieties of orange were shown in Table 3. The contents of Na in the citrus samples were lower than 3 mg/100 g, and the contents of K were determined to be 1.18–2.45 mg/kg. The contents of Ca in the pulp of orange fruits were determined to be 194.2–446.9 mg/Kg. Ca, which plays an important role in building strong bones (Czech et la.2020). The contents of P in the pulp of orange fruits were determined to be approximately 114.7–210.56 mg/kg. The contents of Mg in organe samples were determined to be 114.5–155.7 mg/kg.These essential phytonutrients played important roles in various enzymatic reactions, but their contents were not shown in this study due to low levels. In conclusion, the orange fruit variety had a significant effect on the content of mineral elements in citrus pulp. This result might attribute to the mineral composition of the soil in

which they are grown, the types and amounts of fertilizers used, weather conditions, and the composition of irrigation water (Czech et la.,2020).

3.4. Sensory Properties of Orange

The statistical analysis revealed that there were significant difference (p>0.05) in the tasted of all the orange juice samples as shown in Figure 2. Some fruit orange that have been produced reported by researchers to obtain high sensory value are cashew juice with sensory score range of 1 .5(Cam Sanh VL – 5 (Cam Duong) on a 5 – point hedonic scale . Citrus flavor is a combination of various metabolites involved in the basic taste (sugars, acidic compounds, phenolic compounds, and limonoids) and volatile compounds (Lado et la., .2023). In particular, acidic compounds play a dominant role in orange taste by stimulating bitterness and suppressing or partially masking sweetness (Jiang et la.,2019).

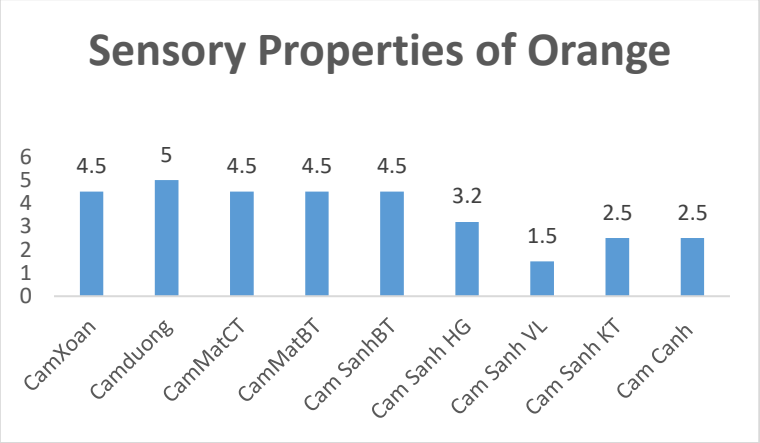

Fig.2: Sensory properties of orange

IV. CONCLUSION

The total soluble sugar content of Cam Xoan and Cam Canh produced in Can Tho and KonTum in this study was higher than those of other orange varieties, suggesting its potential for fresh consumption and food industrial processing. Orange were successfully produced and analysed for physical, chemical and sensory properties. It was observed that the resultant juice samples had a pH range of between 3.50 – 4.81 for samples for samples. A reversed case occurred on these samples for titratable acidity with a range of 1.47 – 3.18%. Oranges reduced the sugar content and increases the vitamin C content of the orange. Its moisture value falls within the acceptable range and presented no significant difference compared to the reference sample. The dietary fiber of the organe fruits varied significantly among different varieties, ranging from 1.89 to 3.60 g/100 g wet weight. Cam Xoan was the variety with the highest dietary fiber content. Cam Duong (2) also had elevated dietary fiber content at about 3.03 g/100 g wet weight, while Cam Canh (9) (1.94 g/100 g wet weight) and Cam Mat (1.89 g/100 g wet weight) had the lowest dietary fiber content. All the sensory attributes of the orange reference sample. The results showed that there were significant differences in quality attributes, nutrients, and functional components among different orange varieties, which might be affected by the species, origin place, growing season, environmental factors, ripening, and changes in the storage process. The results of this study will provide valuable guidance for the identification and utilization of growing orange.

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