ISSN 0100-2945 http://dx.doi.org/10.1590/0100-29452017436

SCIENTIFIC COMMUNICATION

FREMONT - IAC 543: TANGERINE WITH POTENTIAL FOR THE BRAZILIAN MARKET[1]

CAMILLA DE ANDRADE PACHECO[2], FERNANDO ALVES DE AZEVEDO[3], VERA NISHIJIMA PAES DE BARROS[5], MARIÂNGELA CRISTOFANI-YALY[3], MARTA REGINA VERRUMA-BERNARDI[4]

ABSTRACT - Planting new types of tangerines is an interesting alternative for Brazilian citrus growers due to the increasing domestic market. Thus, the aim of this study was to evaluate a less exploited variety of tangerine, the Fremont. The physics and chemical quality of the fruit and juice (mass, peel color, juice yield, acidity, soluble solids and maturation index) was evaluated, followed by sensory testing for ranking of difference and preference to Nules clementine and Ponkan tangerine varieties. The Fremont tangerine produces fruits that meet the standards required by the Brazilian consumer market, with an appropriate mass for sale of the fresh fruit, a suitable juice yield, and early to mid-season maturation. Furthermore, et the preference, together with the Nules clementine, when compared to the Ponkan tangerine, wich is the main commercial variety in Brazil.

Index terms: *Citrus clementina* x *C. reticulata,* fresh fruit, preference, physicochemical quality, ordering test.

FREMONT - IAC 543 : TANGERINA COM POTENCIAL PARA O MERCADO BRASILEIRO

RESUMO - Plantar novos tipos de tangerinas é uma alternativa interessante para os citricultores brasileiros, devido ao crescente mercado interno. Assim, o objetivo deste estudo foi avaliar uma nova variedade de tangerina, a Fremont. A qualidade física e química da fruta e do suco (massa, cor da casca, rendimento de suco, acidez, teor de sólidos solúveis e ratio) foi avaliada, seguido por testes sensoriais para ordenar a diferença e preferência em relação às variedades clementina Nules e tangerina Ponkan. A tangerina Fremont produz frutos que atendem aos padrões exigidos pelo mercado consumidor brasileiro, com massa apropriada para a venda como fruta fresca, rendimento de suco adequado, maturação precoce a meia-estação. Além disso, teve a preferência, junto com a clementina Nules, quando comparado com a tangerina Ponkan, a principal variedade comercial no Brasil.

Termos de indexação: *Citrus clementina* x *C. reticulata,* fruta fesca, preferência , qualidade físico-química, teste de ordenção.

The release of new fruit varieties with good functional and nutritional properties contributes to diversify market opportunities, especially if the fruits are attractive, practical for consumption throughout the day, and have a longer shelf life (MARTÍN-ESPARZA et al., 2011). The diversity of fruits in Brazil that have characteristics appropriate for fresh consumption indicates that this is a potential market (LAGO-VANZELA et al., 2011).

There are currently few tangerine varieties available in Brazil, with the Ponkan tangerine and Murcott tangor being the most notable. The Fremont tangerine, which is a hybrid resulting from crossing the Clementine mandarin and the Ponkan, could be a new alternative for Brazilian citrus growers, especially for those who intend to extend the harvest period because the fruit of this new hybrid remains on the plant for a longer period than the Ponkan

[1](Paper 056-16). Received April 19, 2016. Accepted July 05, 2016.
[2]PhD, State University of Londrina, Londrina-PR, Brazil. E-mail: camillaap06@gmail.com
[3]PhD, Agronomic Institute, Sylvio Moreira APTA Citrus Center, Cordeirópolis-SP, Brazil. E-mails: fernando@centrodecitricultura.br; mariangela@centrodecitricultura.br
[4]PhD, Federal University of São Carlos, Araras-SP. Brazil. E-mail: verruma@cca.ufscar.br
[5]MSc, APTA, Polo Regional do Sudoeste Paulista, Capão Bonito-SP, Brazil. E-mail: vpaes@aptaregional.sp.gov.br

(NÚÑEZ et al., 2007). Additionally, the Fremont tangerine is resistant to the *Alternaria alternata* fungus, which causes the main fungal disease affecting tangerines, named alternaria brown spot (PACHECO et al., 2012).

The fruits from the tangerine group are considered to be non-climacteric, which means they need to be harvested at an appropriate stage in terms of the maturation, sugar and acid content, and juice volume. Thus, in order to offer high quality fruit to the market, particular care is necessary during the harvest (CHITARRA and CHITARRA, 2005). The characterization of the soluble solid content, peel color, and juicy acidity help to determine the maturation index and, consequently, define the optimum harvest time for each variety (ROSSI & TORKOMIAN, 2015).

The market success of a product also depends on its performance with the consumer; thus, it is essential to conduct sensory tests to determine acceptance and preference and to determine approaches to increase acceptance. Maintaining the quality of a food encourages consumer loyalty to a specific product (STONE and SIDEL, 2004).

Thus, the aim of this work was to characterize the physics, chemical and sensory properties of the fruit of the Fremont tangerine (IAC 543) in comparison with the most consumed varieties in Brazil and worldwide, that are, the Ponkan tangerine (IAC 172) and the Nules clementine (IAC 1742), respectively.

Three samples containing six fruits of each variety were harvested in July 2015, in Mogi Mirim, Sao Paulo State, Brazil, in trees nine years-old, grafted on Rangpur lime and subjected to physics and chemical analyses. In the middle of the year is when the main tangerines are ripe in Brazil (AZEVEDO et al., 2013; NUÑEZ et al, 2007; PIO et al., 2006). The physical analyses included the mass (in grams); the longitudinal and transverse diameter in centimeters by direct reading with a digital caliper; the juice yield, which was determined after crushing the fruit in an extractor, calculated as the juice mass/fruit mass ratio and expressed as a percentage; and the average number of seeds in the fruit obtained through direct counting.

The chemical analyses of the juice included titratable acidity obtained by titration, with a standardized solution of 0.3125N NaOH, using phenolphthalein as an indicator, with the acidity concentration being expressed as a percentage; soluble solids (^{o}Brix) determined by direct reading in a refractometer; calculation the maturation index (soluble solids/acidity); and peel color, obtained with a Minolta CR-300 colorimeter, a D65 illuminant, an 8-mm aperture, to read the color space 'L', 'a' and 'b'.

Subsequently, a difference ranking test was performed (ABNT, 1994), using 30 untrained judges (Research Ethics Committee of UFSCar: protocol: 2305.0.000135-11). The three varieties were tested by placing them on coded disposable plates at room temperature, accompanied by cream cracker biscuits and water to cleanse the palate between samples.

The judges ranked the attributes of the samples in ascending order: color (less orange/more orange), size (smaller/larger), peel texture (less smooth/smoother), fruit firmness (less firm/firmer), ease of peeling (difficult/easy), aroma (weak/strong), flavor (less sweet/sweeter), fibrousness (less fibrous/more fibrous), number of seeds (fewer seeds/more seeds), and preference (liked less/liked more). This process enabled the determination of the preference of the consumer market and its position regarding the new variety (Fremont tangerine) in comparison with the varieties most consumed by the Brazilian and European markets, that are, the Ponkan tangerine and the Nules clementine, respectively.

For the physics and chemical quality of the fruits, the corresponding standard deviations from the mean were calculated, while the data from the tests for ranking difference and preference were analyzed using the Friedman's test ($p>0,05$), which indicates a critical difference between the ranking totals (NEWELL and MACFARLANE, 1987).

The fruits used in the tests were at the optimum ripeness (Table 1), with appropriate values for acidity, soluble solids, and, consequently, maturation index (>10), thus making them apt for commercialization and consumption (CEAGESP, 2011). Acidity values of approximately 1%, as observed for the juice of the Fremont tangerine, are important for processing use because they provide greater flexibility regarding the addition of sugar when preparing ready-to-drink beverages and hinder deterioration by microorganisms (FRANCO, 2005).

The fruit mass of the Ponkan tangerine fruit was greater, but there was no variation in the juice yield among the varieties. The fruit of the Fremont had a slightly lower diameter compared with the Ponkan, but what appears to be a disadvantage could be of interest because the consumption of portioned food or food in individual packages is increasing because families are becoming increasingly smaller, which enables better use of fruit. This consumer segment seeks convenience, greater shelf life for fruit, freshness, and a healthy appearance (TIBOLA and FACHINELLO, 2004).

One positive aspect of the Fremont tangerine,

with regard to the consumer, is the peel color of its fruit (Table 1 and Figure 1), It was evaluated as intense orange with a hue angle of 51.11, which is similar to the fruit of the Nules clementine (hue angle of 64.73, orange) but completely different from the fruit of the Ponkan tangerine (hue angle of 85.31), which is yellowy-orange in color (SILVA et. al., 2014). This is one of the parameters considered an extremely important quality attribute for the fresh fruit market because it is one of the determining factors in consumer purchase and may also be appealing to the juice processing industry (SANTOS et. al., 2010). Following this trend, CASTRO et al. (2013) observed that some hybrids between tangerine and sweet orange (TM x LP 222 and TC x LP 5) had aptitude for the juice industry and potential varieties for fresh fruit market. In another research PACHECO et al. (2014) describe that samples processed (juice) and fresh (fruit) of hybrid TMxLP 290 have found that the had 84% and 81% approval respectively, indicating good acceptance by the tasters, being options for citrus market in the future.

The Fremont tangerine stood out in the ranking and acceptance tests due to its low fibrousness and firm fruit with a more orange color and strong citrus aroma (Table 2). The intense orange color of the Fremont tangerine's peel is very attractive to the consumer market, both national and international. The search for fruit with an attractive color is becoming more common among consumers, who are increasingly demanding about the food quality (PIO et al, 2006).

The fact that the fruit of Fremont tangerine fruit was considered to be firmer is another positive aspect. There is a direct relationship between fruit firmness and the solubilization of pectic substances, which, when present in large amounts, give fruit a soft texture, thus reducing the shelf life (SILVA et. al., 2014). For the post-harvest quality of strawberry, firmness is very important because this attribute contributes to the maintenance of its quality during the storage period (PARASKEVOPOLOU-PAROUSSI et. al., 1995).

The accentuated smell of the Fremont tangerine is another favorable point highlighted by the ranking test, which indicated a high average score when compared to the other varieties studied, and this may allow exploitation of the essential oil of its fruit, which is a byproduct of the juice industry. The essential oils of tangerine, lemon, and orange are among the highest selling citrus compositions in the world for perfumes (BIZZO et al., 2009).

The Ponkan tangerine had the highest scores for ease of peeling and fruit size, while the fruit of the Nules clementine had higher values for the texture and flavor attributes. In resume, the ranking test showed that of the three varieties analyzed, the fruit of the Fremont tangerine, followed by the fruit of the Nules, was preferred by the judges. According to the statistical results, there was a significant difference between the three samples analyzed, with the fruit of the Fremont and the Nules being preferred to the fruit of the Ponkan (Table 2).

As for the number of seeds, the Fremont tangerine did not differ from the Ponkan tangerine, but both differed from the Nules (Table 2). The latter variety belongs to the group of seedless citrus varieties, which has a loyal foreign market (AZEVEDO et. al., 2013). It is worth mentioning that, in the present study, the Fremont, Ponkan, and Nules varieties met the ideal standards for commercialization of citrus fruits in Brazil (CEAGESP, 2011). However, with regard to the number of seeds, studies are being conducted by the Centro APTA Citros Sylvio Moreira to reduce the number of seeds in the Fremont variety through the irradiation method (GONZAGA et. al., 2011).

There was a preference by the judges for the Fremont and Nules over the Ponkan, which shows the potential for the first variety, given that it came out ahead of the most popular and valued variety for Brazilian and Asian consumers alike: the Ponkan tangerine. In conclusion, the Fremont tangerine meets the standard required by the Brazilian market and, together with the Nules, was the preferred fruit, suggesting a high potencial for its cultivation in Brazil.

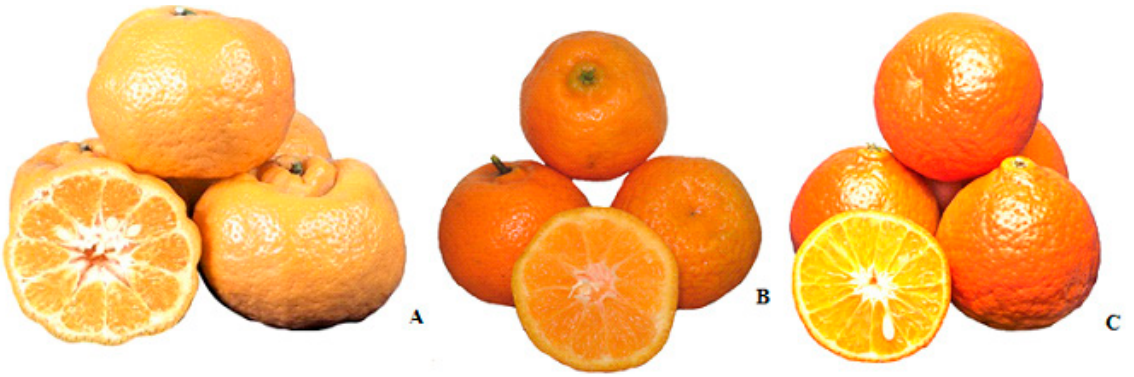

FIGURE 1- Fruits of the Ponkan tangerine - IAC 172 (A), Nules clementine - IAC 1742 (B) and Fremont tangerine – IAC 543 (C).

TABLE 1 - Mean values and corresponding standard desviation of mass and diameter of fruits, yield, acidity, soluble solids and maturation index of juice and peel color of three varieties of tangerine (Cordeiropolis, Sao Paulo State, Brazil, July 2015)

Varieties	Fruit mass (g)	Fruit diameter Longitudinal	Transverse	Juice yield	Acidity	Soluble solids	Maturation index	Peel color
		(cm)		(%)	(g 100 mL^{-1})	(^{o}Brix)		(^{o}h)
Fremont - IAC 543	125,5 ± 6,7*	6,7 ± 0,2	5,7 ± 0,3	44,8 ± 2,8	0,97 ± 0,2	11,2 ± 0,9	11,5 ± 1,1	51,1 ± 0,6
Nules - IAC 1742	106,4 ± 8,8	5,4 ± 0,1	6,2 ± 0,2	45,4 ± 3,6	0,80 ± 0,0	10,6 ± 0,7	13,3 ± 1,0	64,7± 0,7
Ponkan - IAC 172	157,0 ± 32,3	6,3 ± 0,3	7,2 ± 0,9	44,1 ± 1,8	0,63 ± 0,2	10,8 ± 1,2	17,2 ± 3,6	85,3 ± 2,1

*Average of 20 fruits, harvested in July/2015, followed by their respective standard deviations.

TABLE 2 - Ranking of peel color and texture, ease of peeling, flavor, number of seeds, size, fruit firmness, aroma, fibrousness and preference among three tangerine varieties (Cordeiropolis, Sao Paulo State, Brazil, July/2015).

Variety	*Peel color*	*Peel texture*	*Ease of peeling*	*Flavor*	*Number of seed*
Fremont (IAC 543)	86 a*	49 b	59 b	58 b	74 a
Nules (IAC 1742)	65 b	87 a	34 c	63 a	32 b
Ponkan (IAC 172)	29 c	44 b	87 a	59 b	74 a
	Size	*Fruit firmness*	*Aroma*	*Fibrousness*	*Preference*
Fremont (IAC 543)	30 c	83 a	78 a	44 c	67 a
Nules (IAC 1742)	60 b	75 b	61 b	61 b	65 a
Ponkan (IAC 172)	90 a	22 c	41 c	75 a	48 b

*numbers followed by the same letter in the column do not differ (Friedman's test, p>0,05).

ACKNOWLEDGMENTS

Research supported by Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) (2011/18605-0) and Instituto Nacional de Ciência e Tecnologia (INCT) de Genômica para Melhoramento de Citros (Process #573848/2008-4).

REFERENCES

ABNT - Associação Brasileira de Normas Técnicas**. NBR 13170**: Teste de ordenação em análise sensorial. Rio de Janeiro, 1994.

AZEVEDO, F.A.; BORGES, R.S.; FÁVERO, M.A.B.; GIORGI NETO, R.O.; SCHINOR, E.H.; BASTIANE, L.M. A polinização cruzada determina a formação de sementes em frutos de clementina Nules. **Pesquisa Agropecuária Tropical**, Goiânia, v.43, n.1, p. 88-92, 2013. doi: http://org/10.1590/S1983-40632013000100012.

BIZZO, H. R.; HOVELL, A. M. C; REZENDE, C. M. Óleos essenciais no Brasil: aspectos gerais, desenvolvimento e perspectivas. **Química Nova**, São Paulo, v.32, n.3, p.588-594, 2009. doi: http://dx.doi.org/10.1590/S0100-40422009000300005.

CASTRO, D.B.A; MAURÍCIO, F.N.; CRISFONI-YALY, M.; SCHINOR, E.H.; VERRUMA-BERNARDI, M.R. Sensory analysis of new varieties of citrus as a complementary strategy to the Brazilian citriculture. **Journal of Agricultural Science**, Cambridge, v. 5, n.4, p.161-170, 2013. doi: http://dx.doi:10.5539/jas.v5n4p161

CEAGESP - **Programa brasileiro para a melhoria dos padrões comerciais e embalagens de hortigranjeiros centro de qualidade em horticultura**. Campinas, 2011.

CHITARRA, M.I.F; CHITARRA, A. B. **Pós-colheita de frutos e hortaliças**: fisiologia e manuseio. 2. ed Lavras: UFLA, 2005. 785p.

FRANCO, B.D.G.M.; LANDGRAF, M.M.T.D. **Microbiologia dos alimentos**. São Paulo: Ed Atheneu, 2005. p.27-171.

GONZAGA, D.L.; LATADO, R.R.; TULMANN NETO, A.; PIO, R.M. Radiossensibilidade de dois tipos de propágulos de citros. **Bragantia**, Campinas, v.70, n.1, p.13-18, 2011. doi: http://dx.doi.org/10.1590/S0006-87052011000100003.

LAGO-VANZELA, E.S.; RAMIN, P.; GUEZ-UMSZA, M A.; SAMTPS, G.V.; GOMES, E.; DA SILVA, R. Chemical and sensory characteristics of pulp and peel cajá-manga (*Spondias cytherea* Sonn) jelly. **Ciência e Tecnologia de Alimentos**, Campinas, v.31, n.2, p.398-405, 2011.

MARTÍN-ESPARZA, M.E.; ESCRICHE, I.; PENAGOS, L.; MATÍNEZ-NAVARRETE, N. Quality stability assessment of a strawberry-gel product during storage. **Journal of Food Process Engineering**, Oxford, v.34, p.204-223, 2011. doi: http://dx.doi.org/10.1111/j.1745-4530.2008.00349.x.

NEWELL, G.J.; MacFARLANE, J.D. Expanded tables for multiple comparison procedures in the analysis of ranked data. **Journal of Food Science**, Chicago, v.52, p.1721-1725, 1987. doi: http://dx.doi.org/10.1111/j.1365-2621.1987.tb05913.x.

NÚÑEZ, E.E.; MOURÃO-FILHO, F.A.A.; STUCHI, E.S. Desenvolvimento vegetativo, produção e qualidade de frutos de tangerina 'Fremont' sobre quatro porta-enxertos. **Revista Brasileira de Fruticultura**, Jaboticabal, v.29, n.2, p.308-312, 2007. doi: http://dx.doi.org/10.1590/S0100-29452013000400016.

PACHECO, C.A.; MARTELLI, I.B.; POLYDORO, D.A.; SCHINOR, E.H.; PIO, R.M.; KUPPER, K.C.; AZEVEDO, F.A. Resistance and susceptibility of mandarins and their hybrids to *Alternaria alternata*. **Scientia Agricola**, Piracicaba, v.69, p.386-392, 2012. doi: http://dx.doi.org/10.1590/S0103-90162012000600007.

PACHECO, C.A.; SCHINOR, E.H.; AZEVEDO, F.A.; BASTIANEL, M.; CRISTOFANI-YALY, M. Caracterização de frutos do tangor TM x LP 290 para mercado de fruta fresca. **Revista Brasileira de Fruticultura**, Jaboticabal, v.36, n.4, p.805-812, 2014. doi: http://dx.doi.org/10.1590/0100-2945-219/13.

PARASKEVOPOLOU-PAROUSSI, G.; VASSILAKAKIS, M.; DOGRAS, C. Effects of temperature, duration of cold storage and packaging on postharvest quality of strawberry fruit. **Acta Horticulturae**, The Hague, v.379, p.337-344, 1995.

PIO, R.M.; AZEVEDO, F.A.; DE NEGRI, J.D.; FIGUEIREDO, J.O.; CASTRO, J.L. Características da variedade Fremont quando comparadas com as das tangerinas ´Ponkan` e ´Clementina Nules´. **Revista Brasileira de Fruticultura**, Jaboticabal, v.28, n.2, p.36-38, 2006. doi: http://dx.doi.org/10.1590/S0100-29452006000200015.

ROSSI, F.R.; TORKOMIAN, A.L.V. O processo inovativo das indústrias processadoras de suco de laranja brasileiras e norte-americanas: uma comparação utilizando a análise de patentes**. GEPROS Gestão da Produção, Operações e Sistemas**, Bauru, v.10, n.3, p.69-82, 2015.

SANTOS, D.; MATARAZZO, P.H.M.; SILVA, D.F.P.; SIQUEIRA, D.L.; SANTOS, D.C.M.; LUCENA, C.C. Caracterização físico-química de frutos cítricos apirênicos produzidos em Viçosa, Minas Gerais. **Revista Ceres**, Viçosa, MG, v.57, n.3, p.393-400, 2010. doi: http://dx.doi.org/10.1590/S0034-737X2010000300016.

SILVA, A.P.G.; SILVA, S.M.; SCHUNEMANN, A.P.P.; DANTAS, A.L.; DANTAS, R.L.D.; SILVA, J.A.; MENDONÇA, R.M.N. Índices de identidade e qualidade de tangerina 'Ponkan' produzida no estado da Paraíba. **AGROTEC**, Porto, v.35, n.1, p.143–149, 2014.

STONE, H.; SIDEL, J. L. **Sensory evaluation practices**. 3rd ed London: Academic Press, 2004. 408p.

TIBOLA, C.S.; FACHINELLO, J.C. Tendências e estratégias de mercado para a fruticultura. **Revista Brasileira de Agrociência**, Pelotas, v.10, n.2, p.145-150, 2004.