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Potential for industrial use and in natura consumption of tangerine varieties in the Microregion of Garanhuns, Pernambuco State, Brazil

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SUMMARY

Brazilian citrus cultivation has been expanding, as in addition to sweet orange, mandarin cultivation has been growing and gaining market, however mandarin cultivation has a small variability regarding the varieties that are marketed to both the industry and the fruit market with Ponkan mandarin and Murcott tangor being the most notable, leaving producers with few alternatives when choosing the variety to be grown. Given the context, the objective of this work was the selection and classification of mandarin varieties in the climatic conditions of the Agreste Pernambucano, in view of the diversification of the Brazilian orchards regarding the agronomic aspects and physical, physicochemical and chemical characteristics, in order to classify their characteristics. Varieties with industrial and / or fresh consumption. Twelve varieties of mandarin were used, provided by EMBRAPA, applied at the Experimental Station of the Agronomic Institute of Pernambuco, Brejão-PE. The evaluated aspects were height, diameter and volume of the canopy, stem diameter above and below the grafting line, compatibility index, chemical and physical characteristics of the fruits. The experimental delimitation was performed in randomized blocks with three replications and one plant per plot. Results were subjected to analysis of variance and means compared by Scott-Knott test with a probability of 5%. The Nova Minneola, Ponkan and Piedmont varieties meet natural consumption requirements and the Mexerica, Robinson, Lee, Dancy, Murcott, Kinnow, Swatow and Fortune Iniasel varieties have industrial potential.

Index terms: *Citrus*, grafting, vitamin C, fruit farming, soluble solids, Brix.

Potencial de uso industrial e consumo *in natura* de variedades de tangerina na microrregião de Garanhuns, Pernambuco, Brasil

RESUMO

A citricultura brasileira vem apresentando uma expansão, pois além da laranja, o cultivo da tangerina vem crescendo e ganhando mercado, no entanto o cultivo da tangerina apresenta um menor número de variedades que são comercializadas tanto para a indústria ou para o mercado de frutas frescas como no caso da tangerina Ponkan e o Tangor Murcott, sendo essas as mais notáveis,

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ficando assim os produtores com poucas alternativas no momento de escolher a variedade a ser cultivada. Diante do contexto o objetivo deste trabalho foi a seleção e classificação de variedades de tangerina nas condições climáticas do Agreste Pernambucano, tendo em vista a diversificação dos pomares brasileiros quanto aos aspectos agronômicos e características físicas, físico-químicas e químicas, a fim de classificar as variedades com industrial e/ou consumo *in natura*. Foram utilizadas 12 variedades de tangerina, fornecidas pela Embrapa Mandioca e Fruticultura, plantadas na Estação Experimental do Instituto Agronômico de Pernambuco, Brejão-PE. Os aspectos avaliados foram altura, diâmetro e volume da copa da planta, diâmetro do tronco acima e abaixo da linha de enxertia, índice de compatibilidade, características das qualidades químicas e físicas dos frutos. O delineamento experimental foi realizado em blocos casualizados com três repetições e uma planta por parcela. Os resultados foram submetidos à análise de variância e as médias comparadas pelo teste de Scott-Knott com uma probabilidade de 5%. As variedades Nova, Minneola, Ponkan e Piemonte atendem aos requisitos de consumo *in natura* e as variedades Mexerica, Robinson, Lee, Dancy, Murcott, Kinnow, Swatow e Fortune Iniasel apresentam potencial industrial.

Termos de indexação: *Citrus*, enxerto, vitamina C, fruticultura, sólidos solúveis, Brix.

INTRODUCTION

Brazil stands out as the world's biggest producer of citric fruits, and the third biggest producer of mandarin, with approximately 50 thousand hectares of crops, and production of 996.872 tons per year, followed by China, Espanha and Turquia (FAO, 2017; IBGE, 2018). The main characteristics that contributes to the Brazilian productivity are its agronomical and climatic diversity, soil particularities, physiological aspects of the species, low incidence of diseases and pest, and local humidity (Cerqueira et al., 2004, Turra et al., 2014b).

Tangerine cultivation in Brazil has been expanding in the past few years. The main orchards are located in its Southeast region, which contributes with 64,5% and followed by the South region with 29,2% of the national production. The main producers are the states of São Paulo (40%) and Minas Gerais (20%). The Northeast reagion contributes only to 2,8% of the national production, and its main producers are the states of Bahia, Sergipe, and Ceará (IBGE, 2018). Tangerine production in Brazil is mostly aimed at in natura consumption, mostly due to its thinner, less adherent peel, subtle taste and scent, peel and pulp of orange colour (Detoni et al., 2009; Michielin et al., 2016).

There are few varieties of tangerine available for the producers of the Northeasterrn Region, leaving them with few alternatives for cultivation, with the Ponkan tangerine and the Murcott tangor being the most notable options. However, with the demand for the product, it has become necessary the evaluation of new commercial varieties suitable for the environmental characterisitcs of the Brazilian northeastern region (Santos, 2011; Michielin et al., 2016; Pacheco et al., 2017).

In face of this situation, the objective of this work was evaluate tangerine varieties in the climate conditions of the Agreste Pernambucano according to their potential for industrialization and in natura consumption.

MATERIAL E METHODS

The research was conducted with twelve-year-old citrus collection of the Experimental Station of Brejão - PE, provided by the Instituto Agronomico de Pernambuco (IPA). This Microregion exhibits an average altitude of 820m, latitude 8° 53' S, longitude 36° 31' W, dry subhumid climate, montly average of air temperature that varies between 17 and 22°C along the year, and average yearly precipitation of 782.4mm, accorning to the data of the Agencia Pernambucana de Aguas e Climas (APAC).

The varieties Lee, Robinson, and Murcott were grafted into the hybrid LVK-CLEO-264, the variety Nova was grafted into the hybrid LVK- 264-256, Minneola was grafted into the hybrid LVK-SKT-264, Ponkan was grafted into the hybrid LVK-264, Dancy was grafted into the hybrid LVK-CLEO -SKT, was Piemonte grafted into the hybrid CLEO-SKT-264, Kinnow was grafted into the hybrid LVK –SW-264, Swatow was grafted into the hybrid CLEO-SW-264 e Fortune Iniasel was grafted into the hybrid CLEO-264

The experiment was conducted from March 2016 to November 2016 with delimitation in randomized blocks with three repetitions and one plant per parcel, with a spacing of 6x4m. From the stabilization of the orchard, cleaning pruning was carried out annually to remove dry branches, thief branches and to facilitate aeration of the plant.

The physiological maturation of the fruits was indicative for harvest and later physical, physical-chemical, and chemical analysis, conducted in four fruits harvested randomly in the four quadrants of the plants per parcel, in the extension of the canopy. The harvest occurred between April and September 2016, in which was observed the consistency of the fruit's coloration. Immediately after the harvest the fruit samples properly identified and taken to the Laboratório de Biologia Vegetal of the UFRPE-UAG's in Garanhuns-PE for analysis. The chemical and physical-chemical characteristics of the fruits, the analysis comprehended: Solid Solubles (SS): obtained through direct reading of an aliquot of approximately 2mL in manual refractometer (RHB-32ATC), expressed in °Brix. Titratable acidity (TA): determined according to the methodology described by the AOAC Official Methods of Analysis (AOAC, 2005). Levels of vitamin C (ascorbic acid): determined by the titrimetric method, using 2.6 dichlorophenol indophenol, according to the methodology described by AOAC Official Methods of Analysis (AOAC, 2005) in triplicate, being expressed in mg of ascorbic acid per 100mL of juice. Ratio of soluble solids/titratable acidity: the arithmetic ratio between the total of the soluble solids and the acidity, calculating by the formula (SS/TA) and Potential Hydrogen (pH):

The data regarding the growth of the plants and the physical, physical-chemical, and chemical analysis of the fruits were submitted to variance analysis and Scott-Knott's mean comparison test at 5% probability, processed by the SISVAR software of the 5.6 version (Ferreira, 2011).

RESULTS AND DISCUSSION

The soluble solids values (SS) varied between 9.20 °Brix to 12.60 °Brix (Table 1), however, all varieties are within minimum standards for table *citrus*, which is 9°Brix (CEAGESP, 2011). The soluble solids represent an important factor in quality, due to being directly related to the taste of the product, being used as indirect measure for sugar levels in the fruits, as from the moment the sugar levels rise within the fruit, the soluble solids tend to increase as well (Silva et al., 2014).

According to the pH criteria, the varieties are classified as low acidity (pH>4.5), acidic (pH from 4.0 to 4.5) and very acidic (pH<4.0). That way, all varieties have been classified as acidic or very acidic (Table 1) promoting microbiological stability of the juice (Dionisio et al., 2016). According the data in Table 1, it can be verified that the pH varied between 2.94 for the Fortune Iniasel variety and 4.05 for the Lee variety.

The titratable acidity varied between 1.99% and 0.60% of citric acid (Table 1). As the fruit market for in natura consumption favours fruits with TA lower than 1% (Montenegro, 1958) the varieties that fit these parameters are: Lee, Nova, Robinson, Minneola, Ponkan, Mexerica, Piemonte, and Swatow, and since the industry favours a titratable acidity higher than one, the varieties that are fit for the industry are: (Dancy, Murcott, Kinnow, and Fortune Iniasel (Table 1).

Table 1. Physical-chemical characteristics of tangerine varieties from the citrus collection in Brejão-PE

Varieties	SS (°Brix)	pH	AT (%)	SS/AT	VIT. C (mg/100g)
Lee	9.20b*	4.01 a	0.60 c	17.00 a	18.28 c
Nova	10.53 b	3.94 a	0.69 c	16.71 a	39.34 a
Robinson	11.26 a	3.65 b	0.78 c	14.79 a	37.11 a
Minneola	10.06 b	3.82 a	0.79 c	13.49 a	21.78 b
Ponkan	11.46 a	3.70 b	0.74 c	15.56 a	24.69 b
Mexerica	9.40 b	3.50 b	0.96 c	9.93 b	13.04 c
Dancy	11.20 a	3.00 c	1.18 c	9.63 b	38.31 a
Murcott	10.26 b	3.37 b	1.13 c	9.03 b	19.51 c
Piemonte	11.00 a	3.48 b	0.98 c	11.22 b	34.30 a
Kinnow	11.66 a	2.99 c	1.99 a	6.14 b	29.91 b
Swatow	12.60 a	3.62 b	0.85 c	16.14 a	29.01 b
Fortune Iniasel	12.06 a	2.94 c	1.47 b	8.59 b	27.11 b
C V (%)	6.54	5.58	27.48	24.17	7.71

SS: soluble solids, pH: hydrogenionic potential, AT: titratable acidity, SS/AT: ratio soluble solids/titratable acidity and vitamin C levels. *Means followed by the same letter do not differ significantly from the comparison test by Scott-Knott at 5% probability.

The ratio is the relationship between the soluble solids rate (°Brix) and the titratable acidity rate, being an indicator used to determine the maturation stage (Teixeira et al., 2017). Literature establishes values above 8.5 for in natura consumption, however all the varieties are within the minimum standards set for table citrus (CEAGESP, 2011). The industry requires values between 12 and 15 according to Steger (1990), however the varieties Robinson and Minneola are within the established limits.

The levels of vitamin C varied between 13.04 mg/100mL and 39.34 mg/1100 mg of juice (Table 1). According to Detoni (2009) tangerines exhibits in average 20 to 50 mg of ascorbic acid per $100mL^{-1}$ of juice. Based on the data on Table 1, we can observe that the varieties Nova, Robinson, Minneola, Ponkan, Dancy, Piemonte, Kinnow Swatow, and Fortune Iniasel are within the established limit.

CONCLUSIONS

In the climatic conditions of the Garanhuns Microregion, the Nova, Minneola, Ponkan and Piemonte varieties met the minimum standards required for fresh consumption, with an important attribute that differentiates them and allows them to compete in the market, adequate soluble solids content.

The varieties Mexerica, Robinson, Lee, Dancy, Murcott, Kinnow, Swatow showed as a main characteristic a titratable acidity within the minimum standards for industrial processing.

The varieties Lee, Robinson, Murcott, Nova, Minneola, Ponkan, Dancy, Piemonte, Kinnow, Swatow and Fortune Iniasel exhibited many agronomic characteristics within what was expected of this group of citrus in the aforementioned region.

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