

A possible upgrade of the Algarve Citrus protected geographical indication norm

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Abstract

Algarve Citrus comprise many species, hybrids and varieties, which are only harvested at their optimal edible ripening stage. As protected geographical indication (PGI) commodities, these fruits must observe several quantitative and qualitative requirements stipulated in a specific norm. In respect to oranges [*Citrus sinensis* (L.) Osbeck], the norm comprises a general approach for the whole group, without addressing specifically the various existing varieties. The main objectives of this study were: 1) to test if the consumer evaluation fully agreed with the Algarve Citrus norm and/or with other quality parameters measured; 2) if there were any differences among major orange varieties that should be accounted by the Algarve Citrus norm.

Then, we compared ‘Newhall’, ‘Lane late’ and ‘Valencia late’ from orchards located in Quarteira and Paderne, at the beginning of the respective marketing season, concerning both these parameters and their sensorial evaluation by a semi-trained panel. At harvest, all varieties had already attained the minimal values stipulated for juice percentage, soluble solids content (SSC) and maturation index (MI=SSC/titrable acidity). When comparing the sensorial evaluation results and the fruit quantitative analysis, a complex picture emerged. Indeed, the trend of some plain attributes such as sweetness or sourness hardly mismatched the respective quantitative parameters, namely SSC and pH juice. Furthermore, fruit with identical MI exhibited significant different firmness values (circa 30-50%) among the varieties. Yet, the current norm does not define a reference value for this attribute, despite the fact that it is a major factor determining the whole fruit postharvest life. Overall, our preliminary data suggest that, at least, firmness should be included in the Algarve Citrus norm in order to give producers a more complete assessment of the ripening stage and quality of the many orange varieties and a higher orchards management capacity.

Keywords: Oranges, organoleptic attributes, quality, maturation index, firmness.

Resumo

Sugestão de melhoramento da norma IGP dos Citrinos do Algarve. A IGP Citrinos do Algarve inclui diversas espécies, híbridos e variedades, que são colhidos apenas no estado de maturação adequado para consumo, respeitando requisitos quantitativos e qualitativos previstos na respetiva norma reguladora. Esta apresenta regras gerais para a laranja [*Citrus sinensis* (L.) Osbeck], sem abordar eventuais especificidades

das diferentes variedades. Este estudo teve como objetivos: 1) testar a concordância da avaliação sensorial com a norma estabelecida para a laranja e/ou com outros parâmetros de qualidade medidos; 2) avaliar a existência de especificidades das principais variedades de laranja que possam eventualmente vir a ser incluídas na norma da IGP. No início das campanhas de comercialização das variedades ‘Newhall’, ‘Lane Late’ e ‘Valência late’, provenientes de pomares situados em Quarteira e Paderne, compararam-se os parâmetros de qualidade estipulados na norma com a avaliação sensorial efectuada por um painel semi-treinado. À colheita, todas as variedades apresentavam os valores mínimos estipulados para a percentagem de sumo, teor de sólidos solúveis (TSS) e índice de maturação (IM). O enquadramento dos resultados obtidos demonstrou uma grande complexidade. Na verdade, a avaliação de alguns atributos mais “simples” como a acidez ou a doçura, de modo algum traduziam o padrão de variação dos respetivos parâmetros quantitativos, nomeadamente TSS e pH do sumo. Por outro lado, laranjas com IM idênticos apresentavam valores de firmeza significativamente diferentes (cerca de 30-50%) entre as variedades. No entanto, a norma atual não define o valor de referência para este parâmetro, apesar de ser um fator determinante da pós-colheita dos frutos. No geral, os nossos dados preliminares sugerem que, pelo menos, a firmeza deverá ser incluída na norma dos Citrinos do Algarve, a fim de proporcionar aos produtores uma avaliação mais completa da fase de maturação e da qualidade das diversas variedades de laranja, aumentando assim a capacidade de gestão dos pomares.

Palavras-chave: laranja, avaliação sensorial, qualidade, índice de maturação, firmeza.

Introduction

Citrus fruit are the highest value fruit crop in international trade (Ladaniya, 2008). Algarve Citrus comprise many species, hybrids and varieties produced in Portugal, which are only harvested at their optimal edible ripening stage (<http://www.gpp.pt/pbl/diagnosticos/SubFileiras/Citrinos.pdf>).

As protected geographical indication (PGI) commodities, these fruits must observe several quantitative and qualitative requirements stipulated in a specific norm established about a decade ago (Uniprofrutal, 2003). Overall, in addition to the mandatory sanitary conditions and external aspect of the fruit, the decision on Algarve Citrus optimal harvest date (OHD) is based on minimal values of maturation index (MI), which is the ratio solid soluble content (SSC)/titratable acidity (TA), the values of SSC and fruit juice percentage. Regarding oranges [*Citrus sinensis* (L.) Osbeck], this norm comprises a general approach for the whole group, without addressing specifically the various existing cultivars.

Sensorial evaluation by a trained and/or consumers panel is an essential procedure if one wants to guarantee the best acceptance of a commodity on the market. This scientific approach allows the matching of the quantitative analysis of quality attributes determined by producers/packinghouses with the very subjective, but nonetheless very demanding consumer’s preferences (Joshi & Bhushan, 2000, Hui, 2010).

The main objectives of this study were: 1) to test if the panel evaluation fully agreed with the Algarve Citrus norm and/or with other quality parameters measured; 2) if there were any differences among major orange cultivars that should be accounted for in the Algarve Citrus norm.

Materials and methods

Fruit. The oranges [*Citrus sinensis* (L.) Osbeck] of three different cultivars were picked randomly from 75 geo-referenced trees chosen across two commercial orchards

(Figure 1), located in Quarteira (37°04'50.93"N 8°04'05.66"O; elevation 26 m) and in Paderne (37°11'07.73"N 8°10'44.74"O; elevation 65 m), Algarve, Portugal. With a similar climate, typed as Csa according to Köppen climate classification, the two orchards differed from sandy (Quarteira) to calcareous soil (Paderne). Sampling was performed at the beginning of each variety harvest season and after harvest for marketing by CACIAL, namely at November 2015, February and May 2016 (Table 1), for 'Newhall', 'Lane late' and 'Valencia late', respectively. For the sensorial evaluation, fruit were harvested as described above and in the morning of the evaluation day.

Quality attributes. The maximal equatorial diameter of each orange was determined with a digital caliper and the respective surface colour determined at three different positions around the fruit equator with a colorimeter (Minolta CR-200 Chroma meter, Japan) in the CIE $L^*a^*b^*$ colour space. Citrus Colour Index (CCI) was calculated according to the following expression: $CCI=(1000xa^*)/(L^* \times b^*)$. Firmness was determined by compression of the fruit with a Chatillon Force TCD200, Digital Force Gauge Dfis50 texturemeter (Chatillon, USA) fitted with a 65 mm diameter flat plate at 1 mm/s speed to compress fruit for 10 mm from contact point. Each fruit was then squeezed individually in an orange automatic squeezer and the total juice percentage (w/w) determined. A fraction of the juice was then used to measure the soluble solids content (SSC) with a digital refractometer (Atago Co. Ltd., Tokyo, Japan). Total titrable acidity (TA) was determined through titration of 5mL orange juice diluted with 5mL distilled water with 0.1 M NaOH to a pH of 8.2 using an automatic titrator (TitroLine® 6000, SI Analytics GmbH, Germany). Maturation Index (MI) was calculated from the ratio SSC/TA.

Sensorial analysis. Fruit sampled from each orchard were washed, peeled and 3 sections from 3 different oranges were presented, in two plates marked A and B, to a semi-trained panel (15-20 individuals). An extra and representative fruit group from each orchard was kept intact on the bench for the external fruit assessment. Panelists were asked to evaluate different organoleptic attributes (fruit appearance, pulp appearance, aroma, texture, sweetness, sourness and fruit flavour) in isolated booths according to a score sheet with the following scoring scheme: 1-dislike very much; 2-dislike; 3-dislike slightly; 4-neither like or dislike; 5-like slightly; 6-like; 7-like very much. They were provided with a glass of water to use in between samples and asked to record their evaluations on a specific sheet that was decoded and analyzed by statistical procedures.

Data analysis. The effects of orchard and variety on each of the quality parameters were tested by a two-way ANOVA and further multi-comparisons among groups were performed by the Student–Newman–Keuls test for a significance level of $p<0.05$ [(SPSS 18.0 software (SPSS Inc., USA)].

Results and discussion

At harvest, all varieties had already attained the minimal values stipulated in the PGI norm for juice percentage ($\geq 35\%$), soluble solids content ($SSC \geq 10$ °Brix) and maturation index ($MI = SSC/\text{titrable acidity}$; $MI \geq 8$) (Table 1). The later, with the exception of 'Lane late', was significantly higher ($p>0.05$) in Quarteira, while the opposite trend was observed for fruit size, which was nonetheless, always higher than the 62 mm stipulated by the norm (Table 1) (Uniprofrutal, 2003). Overall, for most of the fruit attributes, the differences found among the varieties followed in this study were dependent on the orchard location (Table 1). This confirms not only the expected effect of the different edapho-climatic conditions of Quarteira and Paderne throughout the pre-harvest on the final quality of the fruit, but further suggests that this effect has a different impact depending on the variety (Antunes et al., 2005).

Interestingly, fruit with identical MI exhibited significantly different ($p < 0.05$) firmness values (circa 30-50%) among the citrus varieties followed and/or orchards, which suggests that at the same ripening stage, there are typical firmness values for the various orange varieties (Table 1). This seems quite clear for 'Lane late' in comparison to the other two varieties.

Yet, the current norm does not define a reference value for firmness, despite the fact that it is a major factor determining the whole fruit postharvest life (Ladnyia, 2008). As long as the market is capable to buy and sell all fruit, citrus producers choose to harvest oranges once they reach the minimal MI and SSC values established by the PGI norm (Uniprofrutal, 2003). This way, they assure fruit that can be packed and exported to distant places from the production areas. However, if the producer chooses and/or is forced to delay harvest, which is very common in Portugal, an effective and real-time orchard management is mandatory in order to follow all these fruit attributes and avoiding the harvest of too soft fruit, which will suffer faster spoilage and decay before reaching the final consumer.

As expected, the whole varieties were highly scored by the panelists in the sensorial evaluation, which confirms the value of the PGI norm as a reference to producers and consumers, thus guaranteeing the quality of Algarve Citrus when it reaches the final consumer (Figure 2). In general, Quarteira fruit tended to attain higher scores than those of Paderne by the panelists (Figure 2), although only for 'Newhall' and 'Valencia late' statistically significant differences ($p < 0.05$) were found with respect to fruit external appearance. These significant differences ($p < 0.05$) between orchards were also extended to pulp appearance, sweetness and fruit flavour in 'Newhall' (Figure 2).

When comparing the sensorial evaluation results (Figure 2) and the quantitative analysis made to the fruit of the three varieties (Table 1), a complex picture emerges. For instance, while the panel scored identically all varieties in respect to sweetness and sourness, SSC and juice pH varied differently and significantly among varieties and/or orchards. Furthermore, fruit texture of 'Valencia Late' from Quarteira was apparently less appreciated by the sensorial panel, than that of 'Lane late' and 'Newhall', although this was not statistically confirmed ($p < 0.05$). Indeed no significant differences were found among orchards or varieties in respect to this parameter (Figure 2). In contrast, firmness, a standard and quantitative indicator of fruit texture, did vary significantly ($p < 0.05$) among varieties and orchards (Table 1). This agrees with many reports on the description of the composition, tissue structure and biochemical processes determining fruit texture, without being able to fully explain the reasons why panelists perceive juiciness, crispness and dryness, the main components of texture, differently in fruit with the same firmness (see the review by Redgwell & Fisher, 2002).

Overall, these results confirm the subjective and complex nature of the consumer perception of quality attributes, accounting for many compounds involved in the fruit overall flavour and leading to an altered evaluation of plain characteristics such as sweetness, sourness or texture. Once the sensorial evaluation is mandatory for the success of a commodity in the market, the introduction of other fruit quality parameters in the quantitative analysis should be a pressing matter to consider. Yet, current standard practices to assess fruit quality and ripening are unable to deal with this challenging demand (Magwaza et al., 2012).

Conclusions

Despite the need for a sensorial evaluation by a consumer's panel comprising a larger number of individuals belonging to different genders, age and socio-economical backgrounds, our preliminary data seem to suggest that consumers seem to prefer certain

varieties of Algarve Citrus oranges and that these preferences are not consistent to some of the quality attributes quantified currently. Most probably, others should be included in order to understand better these preferences.

Finally, our data seem to suggest that, at least, firmness should be included in the Algarve Citrus norm in order to give producers a more complete assessment of the ripening stage and quality of the many orange varieties and a higher orchards management capacity. This would require more effective and fast assessment methods and practices.

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Tables and Figures

Table 1. Fruit quality parameters of ‘Newhall’, ‘Lane late’ and ‘Valencia late’ of Quarteira and Paderne orchards at harvest for marketing by CACIAL (beginning of the harvest season). Values in the table are mean \pm SE of 25 independent replicates. Statistically different means ($p < 0.05$) are signaled with upper (orchard) and lowercase letters (variety) in the table.

Sampling date (sensorial evaluation date)	Cultivar/ Orchard	Fruit size (mm)	CCI	Firmness (N)	Juice % (W/W)	SSC (°Brix)	Juice pH	MI (SSC/TA)
17/11/2015 (24/11/2016)	‘Newhall’/ Quarteira	83.15 \pm 1.60 ^{Ac}	0.62 \pm 0.66 ^{Aa}	68 \pm 2.0 ^{Aa}	48.4 \pm 0.6 ^{Aa}	11.2 \pm 0.3 ^{Aa}	3.48 \pm 0.05 ^{Aa}	15.1 \pm 0.5 ^{Aa}
	‘Newhall’/ Paderne	88.55 \pm 1.40 ^{Bc}	3.1 \pm 0.26 ^{Ba}	91.4 \pm 2.4 ^{Bb}	41.2 \pm 1.0 ^{Ba}	11.7 \pm 0.2 ^{Aa}	3.25 \pm 0.03 ^{Ba}	11.1 \pm 0.5 ^{Ba}
02/02/2016 (17/02/2016)	‘Lane late’/ Quarteira	80.28 \pm 1.086 ^{Abc}	3.76 \pm 0.51 ^{Ab}	112.2 \pm 3.5 ^{Ac}	50.3 \pm 1.6 ^{Aa}	11.6 \pm 0.3 ^{Aa}	3.52 \pm 0.03 ^{Aa}	16.4 \pm 0.7 ^{Aa}
	‘Lane late’/ Paderne	86.88 \pm 1.43 ^{Bbc}	4.70 \pm 0.13 ^{Ab}	114.2 \pm 3.4 ^{Ac}	49.8 \pm 0.5 ^{Abc}	11.0 \pm 0.2 ^{Aa}	3.69 \pm 0.03 ^{Bb}	16.0 \pm 0.5 ^{Ac}
24/5/2016 (31/05/2016)	‘Valencia late’/ Quarteira	71.66 \pm 0.74 ^{Aa}	4.90 \pm 0.23 ^{Ac}	83.0 \pm 3.0 ^{Ab}	51.2 \pm 1.0 ^{Aa}	12.4 \pm 0.1 ^{Ab}	3.84 \pm 0.02 ^{Ab}	15.8 \pm 1.0 ^{Aa}
	‘Valencia late’/ Paderne	81.16 \pm 1.37 ^{Ba}	4.31 \pm 0.12 ^{Ab}	78.1 \pm 4.3 ^{Aa}	51.4 \pm 0.9 ^{Ac}	11.1 \pm 0.2 ^{Ba}	3.79 \pm 0.03 ^{Ab}	13.1 \pm 0.4 ^{Bb}

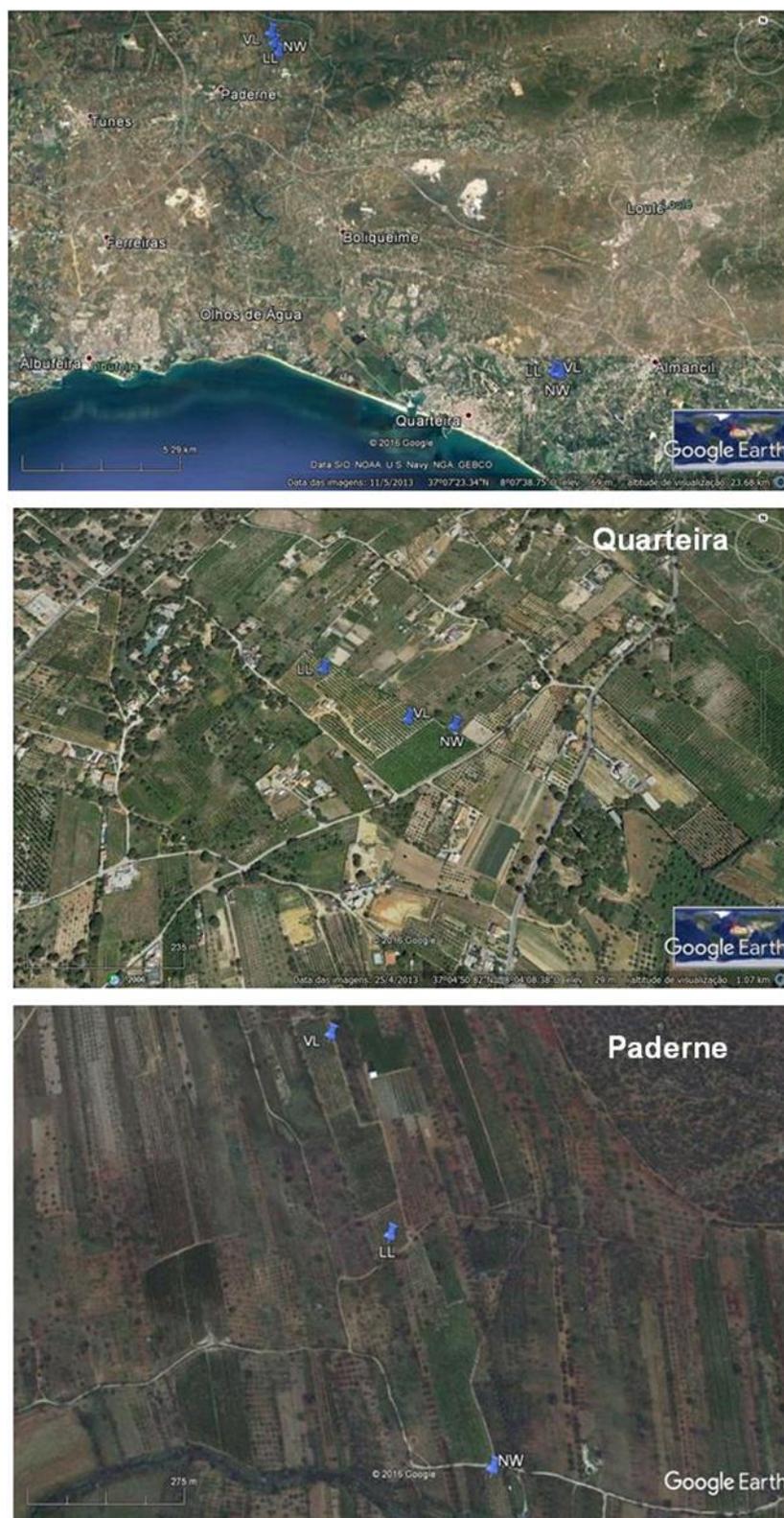


Figure 1. Location of the orchards of ‘Newhall’ (NW), ‘Lane late’ (LL) and ‘Valencia late’ (VL) in Quarteira ($37^{\circ}04'50.93''\text{N}$ $8^{\circ}04'05.66''\text{O}$; elevation 26 m) and Paderne ($37^{\circ}11'07.73''\text{N}$ $8^{\circ}10'44.74''\text{O}$; elevation 65 m), Algarve, Portugal.

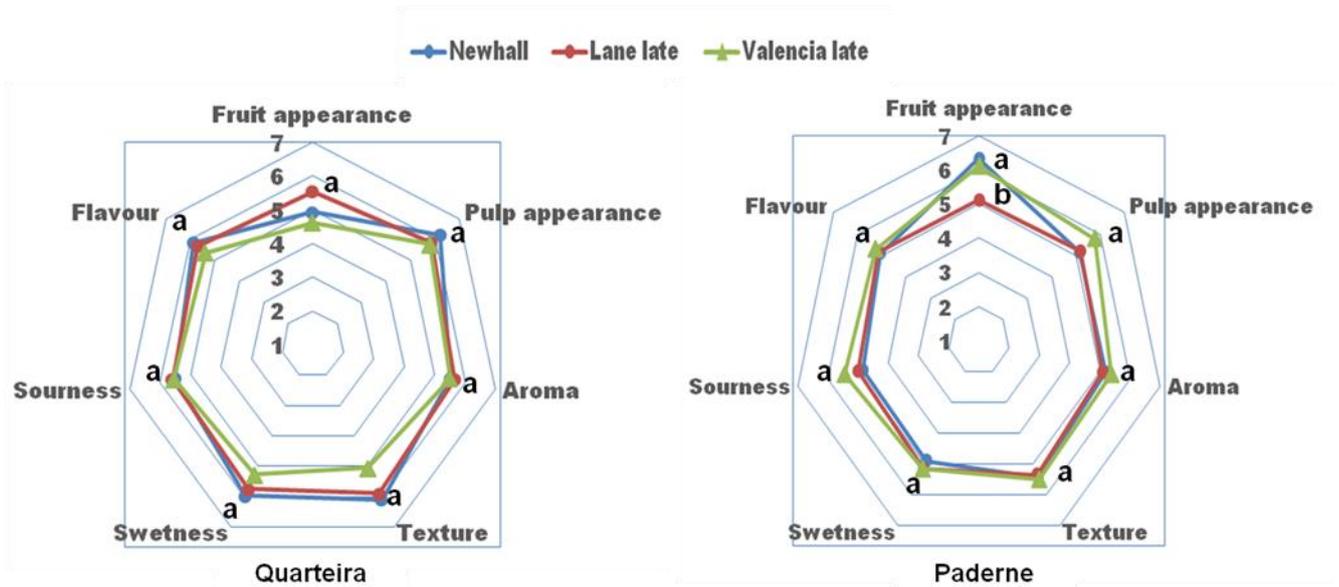


Figure 2. Sensorial evaluation of fruit at harvest for marketing by CACIAL from 'Newhall', 'Lane late' and 'Valencia late' of Quarteira and Paderne orchards. For each variety, at least 15 independent replicates were tested by a semi-trained panel. Scoring sheet: 1-dislike very much; 2-dislike; 3-dislike slightly; 4-neither like or dislike; 5-like slightly; 6-like; 7-like very much. Statistically different means among varieties ($p < 0.05$) are signaled with different lowercase letters on the figure.