

## Differences in soluble solids in Duncan and Parana grapefruit due to fruit section and position in the tree

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### SUMMARY

The objective of this study was to evaluate the variation in soluble solids, expressed as °Brix, in two grapefruit (*Citrus paradisi* Macf) varieties: Duncan and Paraná, both on citrumelo Swingle rootstock. Fifteen randomly selected fruits were sampled from two tree plots with four replications each. Sampling was performed in April; the trees were six to seven years old and located at Fram, Itapúa, Paraguay. Total soluble solids were determined in juice extracted from different fruit sections (peduncular, media and stilar) and compared to the juice extracted from the entire fruit. Fruits were sampled from the internal and the external part of the tree. Soluble solids were highest at the middle section, with 0.10 to 0.30 higher °Brix values in the juice from the middle section compared to the juice from the entire fruit. Soluble solids were highest in fruits sampled from the outside (8.76 °Brix) compared to the inside (7.85 °Brix) of the tree. No significant difference was found among the two varieties. However, Parana fruits had consistently highest soluble solids values than Duncan fruits.

**Index terms:** *Citrus paradisi*, soluble solids, fruit section, fruit sampling.

### Diferenças nos sólidos solúveis de pomelos Duncan e Parana devido à seção do fruto e posição na planta

### RESUMO

O objetivo deste estudo foi avaliar a variação nos sólidos solúveis, expressos em ° Brix, em duas variedades de pomelo (*Citrus paradisi* Macf): Duncan e Parana, ambos enxertados em citrumelo Swingle. Quinze frutos selecionados aleatoriamente foram amostrados de duas plantas por parcela, com quatro repetições cada. A amostragem foi realizada em abril e as plantas tinham seis a sete anos de idade e estavam localizadas em Fram, Itapúa, Paraguai. Os sólidos solúveis totais foram determinados do suco extraído de diferentes seções de frutas (peduncular, meio e estilar) e comparado ao suco extraído de toda a fruta. Os frutos foram amostrados da parte interna e externa da árvore. Os sólidos solúveis foram mais altos na seção do meio, com valores de sólidos solúveis de 0,10 a 0,30 °Brix superiores no suco da seção do meio em comparação com o suco de toda a

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fruta. Os sólidos solúveis foram mais elevados em frutos amostrados do exterior (8,76 °Brix) em relação ao interior (7,85 °Brix) da árvore. Não houve diferença significativa entre as duas variedades. No entanto, os frutos do Parana apresentaram valores de sólidos solúveis consistentemente mais elevados que os frutos de Duncan.

**Termos de indexação:** *Citrus paradisi*, sólidos solúveis, seção do fruto, amostragem de fruto.

## INTRODUCTION

Citrus cultivation in south-eastern Paraguay has increased over the last years. Fruit quality variations are common for different cultivars, and tree positions and even in the same fruit. Such differences should be taken into account when sampling fruits to determine harvest time.

The objectives of this study were to evaluate the variations in soluble solids, such as °Brix, in two grapefruit (*Citrus paradisi* Macf) varieties: Duncan and Paraná, on a citrumelo Swingle rootstock.

The internal quality index of citrus fruits expresses maturity and is used as a standard to determine the start of the harvest. The values of soluble solids (°Brix) are the main indicators of maturity. Soluble solids can vary according to the position of the fruit in the tree, fruit size and fruit colour (Wardowski et al., 1995).

Inadequate fruit sampling or the use of unsuitable methods to determine soluble solids negatively influences the decision making in terms of harvest time. The objective of this study was to evaluate sampling variations based on the determination of soluble solids in fruits of two grapefruit varieties. The varying factors were position of the fruits in the tree (external or internal) and juice from different parts of the fruit (peduncular section, middle section, stylar end and total fruit).

## MATERIAL AND METHODS

Determination of soluble solids (°Brix) was performed for the two grapefruit varieties Duncan and Parana, both on the citrumelo Swingle rootstock. Measurements were performed using a refractometer from ATAGO, Japan.

Soluble solids were determined in 15 fruits randomly taken from two trees in each of the four replications. Sampling was performed in April on trees six to seven years old.

The experimental area was located in the district of Fram, Itapúa, Paraguay, (27° 03' 38 79" S and 56° 03' 14 85" W), at an elevation of 150-300 m above sea level. The soil was red clay soil of basaltic origin. Mean annual temperature is 21 °C, with a minimum of -2 °C and a maximum of 39 °C. Mean annual rainfall is 1,700 mm.

Soluble solids were determined in juice obtained from different sections of each fruit (peduncular section, middle section, stylar end) and from the total fruit. Fruits were taken from the internal and from the external middle part of the tree, separately. Data were subjected to ANOVA using the INFostat Program.

The significance of differences between treatment means was determined using Tukey's MR test at  $p = 0.05$ .

## RESULTS AND DISCUSSION

Soluble solids were highest at the middle section. Differences were from 0.10 to 0.30 °Brix higher in the middle section when compared to the total fruit juice. When comparing the concentration of soluble solids from different parts of the tree the numbers were variable and different among varieties (Tables 1, 2).

Soluble solids were highest in fruits sampled from the outside (8.76 °Brix) compared to the inside (7.85 °Brix) of the tree; this result is in agreement with the findings of Sitesand & Reitz (1950a, 1950b, 1950c) and Wardowski et al. (1995) when comparing soluble solids from Valencia oranges. No significant difference was found among the two varieties. However, Parana fruits had consistently

**Table 1.** Soluble solids (°Brix) from Duncan grapefruit according to the position of the fruit in the tree

	Internal middle part of the tree	External middle part of the tree	Internal + external middle part of the tree
Peduncular section	7.51 bc	8.51 a	8.00 ab
Middle section	8.01 a	8.67 a	8.29 a
Stylar end	7.34 c	8.28 a	7.77 b
Fruit total	7.78 ab	8.47 a	8.19 ab

Numbers followed by the same letter (in each column) do not differ by Tukey's MR test at  $p = 0.05$  after ANOVA.

**Table 2.** Soluble solids (°Brix) from Paraná grapefruit according to the position of the fruit in the tree

	Internal middle part of the tree	External middle part of the tree	Internal + external middle part of the tree
Peduncular section	7.76 b	8.69 c	8.41 b
Middle section.	8.15 a	9.36 a	9.15 a
Stylar end	8.18 a	9.12 b	9.08 a
Fruit total	8.04 a	9.01 b	9.05 a

Numbers followed by the same letter (in each column) do not differ by Tukey's MR test at  $p = 0.05$  after ANOVA.

**Table 3.** Soluble solids (°Brix) in juice from different cultivars and positions in the tree

	Internal part of the tree.	External part of the tree.	Duncan	Paraná
Soluble solids	7.85 b	8.76 a	8.07 a	8.47 a

Numbers followed by the same letter (in each column) do not differ by Tukey's MR test at  $p = 0.05$  after ANOVA.

higher soluble solid values than 'Duncan' fruits (mean of 8.47 to 8.07 °Brix) (see Table 3).

### CONCLUSIONS

Based on our results, sampling to determine soluble solids should be performed in proportion to the numbers in both sites and independently for fruits from the internal and the external part of the tree. The juice extracted should be homogenised to avoid variations due to the differences in the different fruit sections.

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