

Portuguese orange juice by-products: free and bound phenolic compounds profile and antioxidant activity

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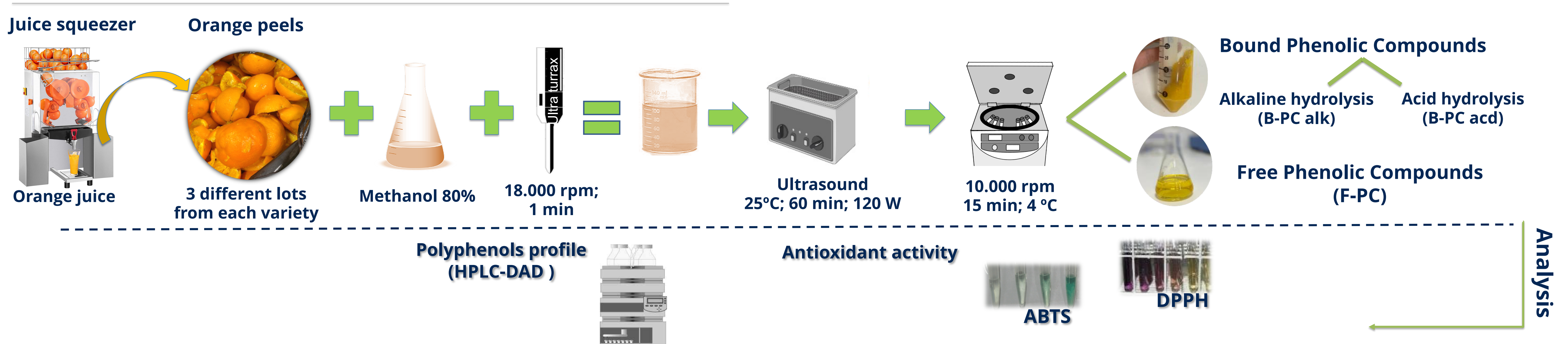
Introduction

Sweet orange is one of the most consumed fruit worldwide, with a production rate of 78 million tonnes in 2019. The European Union countries accounting up to 7% of the global production, where Portugal ranks the fifth place. "Algarve Citrus" are non-climacteric Protected Geographical Indication (PGI) fruit, grown mainly in the south of Portugal, and in the last year the production reached a total of 356 thousand tons. The orange juice represents one of the main orange uses, and during this process only about 50% of the fresh orange weight is transformed into juice. Therefore, large amounts of by-products, mainly orange peels (OP) are generated. OP are particularly rich in phenolic compounds (PC) which have been linked with diverse human health benefits associated with their antioxidant capacity (AOC). Recently hesperidin, the most representative PC in citrus fruits demonstrated the ability to hinder SARS-CoV-2 entry and replication.



The main objective of this work was to evaluate the free and bound PC present in OP by-products obtained from supermarket juice squeezer (ZUMEX®) from two different cultivars of PGI "Algarve Citrus" (Newhall and Valencia Late) and evaluate their antioxidant capacity (AOC).

Methods



Results

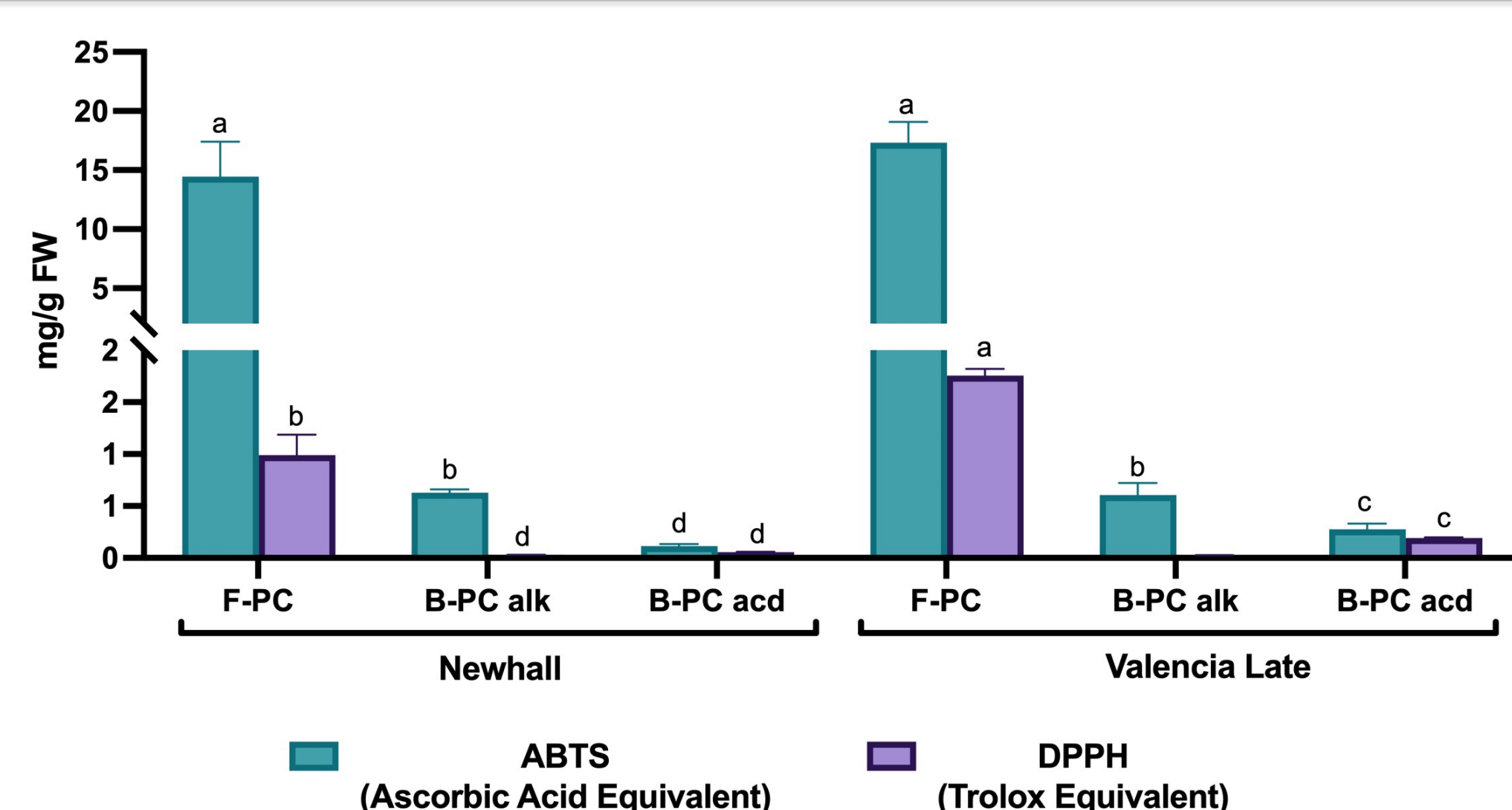


Figure 1: Antioxidant activity (ABTS and DPPH assay). Results are the means of three determinations \pm standard deviation. Different letters in the column with same color are significantly different, as determined by ANOVA and the posthoc Tukey test ($p < 0.05$).

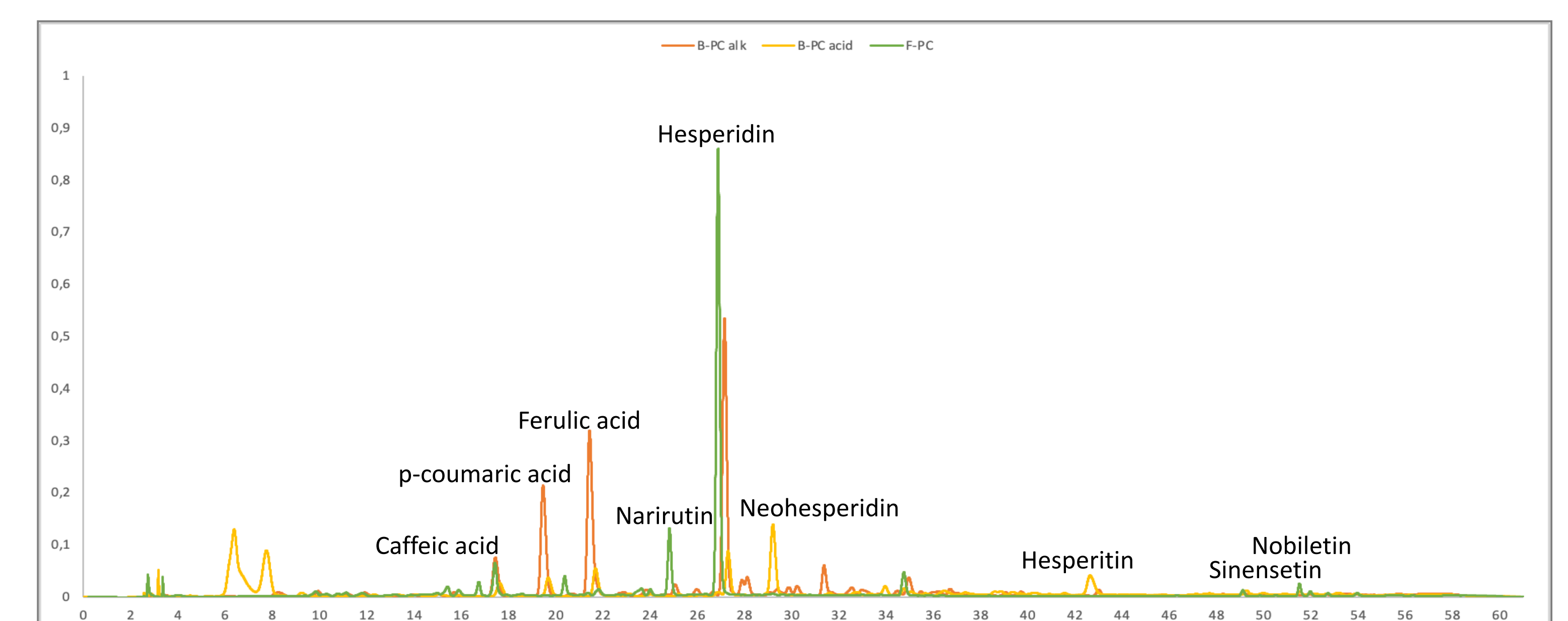


Figure 2: Phenolic compounds profile by HPLC-DAD at 280 nm from a representative replica of newhall variety.

Table 1: Concentration of phenolic compounds (mg/g FW) in Newhall and Valencia Late varieties. Results are the means of three determinations \pm standard deviation. Different letters in the same column are significantly different, as determined by ANOVA and the posthoc Tukey test ($P < 0.05$).

Variety	Extract	Hesperidin	Narirutin	Hesperitin	Neohesperidin	Ferulic acid	Caffeic acid	p-coumaric acid	Sinensetin	Nobiletin
Newhall	F-PC	3.07 \pm 0.05 ^a	0.86 \pm 0.08 ^a	N.D	N.D	N.D	0.01 \pm 0.00 ^b	N.D	0.08 \pm 0.01 ^a	0.74 \pm 0.05 ^a
	B-PC alk	0.37 \pm 0.03 ^d	0.02 \pm 0.00 ^d	N.D	N.D	0.14 \pm 0.01 ^b	0.06 \pm 0.00 ^a	0.06 \pm 0.01 ^a	B.Q.L	0.01 \pm 0.00 ^c
	B-PC acid	B.Q.L	N.D	0.03 \pm 0.00 ^b	0.05 \pm 0.01 ^b	0.01 \pm 0.00 ^c	B.Q.L	0.01 \pm 0.00 ^b	N.D	0.01 \pm 0.00 ^c
Valencia Late	F-PC	2.86 \pm 0.10 ^b	0.48 \pm 0.02 ^b	N.D	N.D	N.D	N.D	N.D	0.04 \pm 0.01 ^b	0.37 \pm 0.02 ^b
	B-PC alk	0.75 \pm 0.11 ^c	0.05 \pm 0.01 ^c	N.D	N.D	0.28 \pm 0.09 ^a	0.04 \pm 0.01 ^a	0.03 \pm 0.00 ^b	0.01 \pm 0.00 ^b	0.02 \pm 0.00 ^c
	B-PC acid	0.02 \pm 0.00 ^d	B.Q.L	0.26 \pm 0.08 ^a	0.25 \pm 0.11 ^a	0.02 \pm 0.00 ^c	B.Q.L	0.02 \pm 0.00 ^b	B.Q.L	0.02 \pm 0.00 ^c

Abbreviation: B.Q.L, below quantification limit; N.D, non detected

Conclusions

- ✓ The HPLC-DAD results revealed that Newhall and Valencia Late have similar free and bound PC profile. Hesperidin was the most representative PC in F-PC and B-PC either in the Newhall or in the Valencia Late variety. Furthermore, narirutin and nobiletin were in high concentrations in the free form of OP. High concentrations of ferulic acid was detected in B-PC. Phenolic acids (ferulic, caffeic and p-coumaric acids), neohesperidin and hesperitin were detected only in B-PC, since after the hydrolysis these compounds are release from the cell wall.
- ✓ F-PC extracts showed an excellent AOC either in the Newhall and Valencia Late variety. Moreover, B-PC extracts showed AOC but with less bioactivity due to its lower concentration of PC.



The results demonstrated that OP from "Algarve Citrus" PGI cultivars are an excellent source of PC with great AOC and may be valorized with value-added towards applications as natural additive for food industry or as a nutraceutical for human health enhancement.

Acknowledgements

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