Effect of genotype and geographical origins on carotenoid content from *Citrus* sweet orange juices

C. Dhuique-Mayer[1*], A.L Fanciullino[2] C. Dubois[3], P. Ollitrault[4]

[1]CIRAD-Dept persyst-UMR Qualisud, TA B95/16, [3,4]Dept BIOS UPR 75, 34398 Montpellier cedex 5, France (claudie.dhuique-mayer@cirad.fr).
[2] INRA UR Geqa, site de San Guliano, F-20230, San Guliano, France

* corresponding author claudie.dhuique-mayer@cirad.fr

Introduction

Citrus juices, such as orange represent significant sources of carotenoids that could contribute with vitamins and polyphenols to the beneficial health effects of this fruit product. Genetic factor and particularly environmental factor influenced the carotenoid composition of citrus juices. In order to assess the effect of genotype and geographical origins, on carotenoid content from citrus juices, a selection of three orange varieties cultivated in Mediterranean, subtropical and tropical areas were analysed.

Materials and methods

Juices from three sweet orange cultivars, i.e. Pera, Sanguinelli and Valencia (*Citrus sinensis* (L.) Osbeck belonging to the same *Citrus* accessions and cultivated in Mediterranean (Corsica), subtropical (New Caledonia) and tropical areas principally Tahiti (citrus from Brazil, Cuba and Costa-Rica were added from local markets).All juices were analysed by HPLC using a C_{30} column according previous method (1,2). Representative samples harvested during 2004/2005/2006 seasons were collected from different countries at commercial and maturity index. Statistic analysis was used to evaluate significance of variety and year effect (SAS 9.1 Windows USA). Dissimilarity and Principal Component Analysis (PCA) analysis was performed to classify juices in function of their origins (@DARwin 5.0 cirad France; XLSTAT 7.0 France).

Results and discussion

- Annual carotenoid content variations in Corsican fruits were found to be limited compared to variations due to varietal influences (F-test probability for years no significant at 5 % level). The genetic variability among sweet orange cultivars was associated with significant variations in the contents of four carotenoids (*cis*-violaxanthin, β-cryptoxanthin, phytoene and phytofluene). Sanguinelli and Pera cultivar revealed significantly higher provitamin A carotenoid than valencia variety (table 1).

- Variations in valencia oranges from five geographical origins was illustrated by a dissimilarity tree (figure 1) which was drawn up with the content of seven carotenoids mentioned in table1, underlined that the quantitative compositions were more geographical origin dependent than annual variation-dependent.

- Influence of environmental conditions on carotenoid contents was particularly high for sweet oranges. Principal component analysis (PCA) showed that Mediterranean sweet orange with high carotenoid content are clearly differentiated from those of all other origins (figure 2). Strong correlations were observed between β-cryptoxanthin and phytofluene phytoene (r = 0.931) and β-carotene and phytoene (0.918). To complete this PCA, the graph (figure 3) highlighted that carotenoid profiles varied as a function of the two principal carotenoids (β-cryptoxanthin and *cis*-violaxanthin) with respect to origins (New-Caledonia, Corsica).

Conclusion

Our results underlined the importance of environmental factors in carotenoid synthesis and accumulation in citrus fruits. Interactions between *Citrus* accessions and environmental conditions may occur with respect to carotenoid biosynthesis in juice sacs. Environmental conditions also had a major role of nutritional interest, such as the main provitamin A carotenoid in orange citrus juice (β-cryptoxanthin) (figure 4).

References

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Table 1. Carotenoid contents (mg/L) and vitamin A values in three varieties of Corsican orange juices, mean over 3 years

Figure 1. Classification of Valencia orange juices from five different origins. The tree was constructed according to the Neighbour-joining method using Euclidean distances (V.NCal: Valencia New Caledonia; V.CostaR: Valencia Costa Rica).

Figure 2. Orange juice origin differentiation according to PCA of carotenoid content. A Differentiation of geographical origins. Per: Pera oranges; San: Sanguinelli oranges; Val: Valencia oranges. BR: Brazil; C3: Corsica year 1; C4: Corsica year 2; C5: Corsica year 3; CR: Costa Rica; CU: Cuba; NC: New Caledonia; TA: Tahiti.

Figure 3: "Radar" chart showing variations incarotenoid profiles of orange with respect to origins (New Caledonia, Corsica 2005).

Figure 4: Differentiation of sweet orange origins according two provitamin A carotenoid and vitamin A value (RAE: Retinol activity equivalent L^{-1})