

## **CIRCADIAN VARIATION OF NON-VOLATILE ORGANIC ACIDS IN THE PRICKLY PEAR (*Opuntia ficus indica* L.)<sup>1</sup>**

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### **1. INTRODUCTION**

Some succulent plants exhibit a marked diurnal oscillation in their non-volatile acids content. Those plants are said to have a typical "crassulacean acid metabolism" (CAM). CAM is defined as a massive diurnal fluctuation of titrable acidity, accounted for by malic acid. Although citric and other acids may fluctuate, there are few detailed studies (14). According to OSMOND (7) CAM is a property of cells in photosynthetic leaf or stem tissues and is appropriately described in physiological rather than ecological terms. It refers strictly to the ability of chloroplast-containing cells to engage in significant CO<sub>2</sub> assimilation in the dark, leading to the eventual synthesis of malic acid. This acid, which is presumably stored in the cell vacuole is decarboxylated in the subsequent light period and the released CO<sub>2</sub> is refixed by photosynthesis. Although CAM, has been known since the XVII century (3), in fact, this special form of metabolism was first demonstrated in an *Opuntia* species (in

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#### 4. SUMMARY

Seven non-volatile organic acids of prickly pear (*Opuntia ficus indica* L) were analyzed by ion exchange and gas-liquid chromatography. The order of appearance in the chromatograms was: malonic, succinic, glutaric (as internal standard), malic, tartaric, citric, phorbic and piscidic acids.

The amount of malonic, malic, and citric acids in milligram per gram of fresh material were: 0.36, 9.85, and 1.78 at 6:00 a.m. and traces, 0.95 and 0.31 at 6:00 p.m., respectively. There was thus a great accumulation of those acids during the night. The same phenomenon was observed for piscidic acid, but an inversion of results was noted for phorbic acid, where the relative peak area dropped from 0.34 at 6:00 a.m. to 0.14 at 6:00 p.m.

Some involvement of those last substances in the crassulacean acid metabolism is suggested.

#### 5. RESUMO

##### (VARIAÇÃO CIRCADIANA DE ÁCIDOS ORGÂNICOS NÃO-VOLÁTEIS NA PALMA-DOCE (*Opuntia ficus indica* L.))

Sete ácidos orgânicos não-voláteis da palma-doce foram analisados por cromatografia de troca iônica e cromatografia de gás-líquido. O aparecimento dos picos dos ácidos nos cromatogramas seguiu a seguinte ordem: malônico, succínico, glutárico (como padrão interno), málico, tartárico, cítrico, fórbico e piscídico.

Os teores dos ácidos malônico, málico e cítrico expressos em miligramas por grama de matéria fresca foram: 0,36, 9,85 e 1,78, às 6 horas da manhã, e traços, 0,95 e 0,31, às 6 horas da tarde, respectivamente. Houve, portanto, um grande acúmulo desses ácidos durante a noite. O mesmo fenômeno foi observado na concentração de ácido fórbico, mas houve uma inversão de concentração do ácido fórbico, em que a área relativa dos picos caiu de 0,34, às 6 horas, para 0,14, às 18 horas.

Algum envolvimento destes dois últimos ácidos no metabolismo ácido-crassulaceano (CAM) foi sugerido.

#### 6. CITED LITERATURE

1. COCKBURN, W. & A. MCAULAY . Changes in metabolite levels in *Kalanchoe daigremontiana* and the regulation of malic acid accumulation in crassulacean acid metabolism, *Plant Physiology* 59: 455-458. 1977.