Impact of potassium nutrition on tomato fruit metabolite profile

F. E. Wenig[1], C. H. Weinert[2], B. Egert[2], E. Pawelzik[1], S. E. Kulling[2], I. Smit[1]

[1]Quality of Plant Products, Department of Crop Sciences, University of Göttingen, Carl-Sprengel-Weg 1, 37075 Göttingen
[2]Max Rubner-Institut, Department of Safety and Quality of Fruit and Vegetables, Haid-und-Neu-Str. 9, 76131 Karlsruhe

INTRODUCTION

Potassium (K) is involved in a variety of physiological functions in plants such as translocation of assimilates, activation of enzymes and stomata regulation[4]. Furthermore, it plays an essential role for tomato fruit composition and quality regarding sugar and acid accumulation[2,3]. Metabolic profiling of *Arabidopsis thaliana* plants revealed that under K deficient conditions neutral amino acids and amines were up-regulated, while acidic amino acids and organic acids were down-regulated, indicating an impact of K on C metabolism, i.e. TCA cycle and glycolysis, likely due to low enzyme activities[4,1]. The goal of this study was to evaluate the metabolite profile of tomato fruit under increasing K supply.

MATERIAL AND METHOD

Three cocktail tomato genotypes (Primavera, Resi and Yellow Submarine) were grown in an outdoor pot experiment (substrate peat) and fertilized with 5 increasing doses of K. Ripe fruits were sampled in the mid harvest season and by combining whole-fruit segments to pooled samples. After freeze-drying, grinding, methanol extraction and derivatisation, an untargeted metabolome analysis was conducted using GC×GC-MS[5].

RESULTS

Using the untargeted GC×GC-MS metabolomics platform, the three cultivars could be clearly discriminated based on a metabolite profile comprising more than 300 analytes. Predominantly, K supply influenced metabolite concentrations in a dose-dependent, but cultivar-specific manner. For example, increasing K fertilization resulted mostly in decreasing concentrations of putrescine, asparagine, *O*-phosphorylethanolamine, lysine and galactinol and an increasing content of citric acid, α-ketoglutaric acid, *cis*-aconitic acid, γ-aminobutyric acid and β-alanine. Additionally, some metabolites like succinic acid, phenylalanine, malic acid and quinic acid showed a highly cultivar-specific K effect. In summary, the results show that K has an impact on metabolite profile of tomato fruits depending on the K dose and on the cultivar.

REFERENCES

[1]Armengaud P., Sulpice R., Miller A. J., Stitt M., Amtmann A. and Gibon Y (2009). Multilevel Analysis of Primary Metabolism Provides New Insights into the Role of Potassium Nutrition for Glycolysis and Nitrogen Assimilation in Arabidopsis Roots. Plant Physiolgy, 150: 772–785.

[2]Fanasca S. Colla G., Maiani G., Venneria E., Rouphael Y., Azzini E., and Saccardo F. (2006). Changes in antioxidant content of tomato fruits in response to cultivar and nutrient solution composition. Journal of Agricultural and Food Chemistry, 54 (12): 4319-4325.

[3]Hartz T.K., Johnstone P.R., Francis D.M., and Miyao E.M. (2005). Processing Tomato Yield and Fruit Quality Improved with Potassium Fertigation. HortScience, Volume 40 (6):1862-1867.

[4]Maathuis F.J.M. (2009) Physiological functions of mineral macronutrients. Current Opinion in Plant Biology, 12 (3): 250–258.

[5]Wojciechowska, E., Weinert, C. H., Egert, B., Trierweiler, B., Schmidt-Heydt, M., Horneburg, B.; Graeff-Hönninger, S.; Kulling, S. E. and Geisen, R. (2014). Chlorogenic acid, a metabolite identified by untargeted metabolome analysis in resistant tomatoes, inhibits the colonization by Alternaria alternata by inhibiting alternariol biosynthesis. European journal of plant pathology, 139 (4): 735-747.