Technical note

THE SUGAR-POTASSIUM NEXUS WITHIN THE GRAPE BERRY

Introduction

Sugar accumulation into the grape berry accelerates with the onset of ripening and many macronutrients also accrue more rapidly. This research characterises the potential functional link between berry sugar and potassium (K^+) accumulation. Potassium may have a role in the long distance transport of sugars along the vascular system and may thus facilitate the accumulation of sugar into the grape berry. Potassium also has an osmoregulatory function and may facilitate the ingress of water to drive berry growth. Berry K^+, sugar (glucose and fructose) and water content were assessed during ripening in the skin, pulp and seeds under different photosynthetic and K^+ fertilisation regimes. The expression of ten different transporters related to these three components was also characterised. While sugar transporters in relation to phloem unloading have received some attention in grapevines, the study of K^+ transporters is still in its infancy.

The key outcomes

This study was novel in that the sugar-K^+ relationship was, for the first time, illustrated in individual grape berries and in the grape berry tissues. Potassium and sugar accumulation were closely correlated in the berry pulp, skin and seeds, especially from véraison onwards. However, the sugar content increased more rapidly than K^+ with a ten-fold difference observed at harvest. There was also extensive plasticity from berry to berry in the ratio between the two components. A strong ternary relationship between berry K^+, sugar and water content was also evident. The closely correlated expression patterns of berry sugar, K^+ and water transport proteins further supports the functional link between these three parameters.

Recommendations

Given that K^+ is integral to normal berry development and because of its close links with water and sugar accumulation during ripening it is clear that K^+ deficiency should be avoided. While many Australian soils are naturally high in K^+, deficiency can occur through leaching or crop removal. The availability of K^+ can also be limited in sandy soils, heavy clays and acid soils. Potassium can be applied as potassium chloride (in low saline soils), potassium nitrate or potassium sulphate. Mulches and composts may provide an additional source of K^+ to the vineyard. Care is needed to satisfy the K^+ requirements of grapevines without excess, given that excess can lead to high pH in grape juice and wine and negative effects on wine quality. Soil and petiole testing will give a good indication of additional requirements to be rendered through fertilisation.

What's next?

Proposing a mechanism for sugar and potassium co-loading into the grape berry pericarp cells will be the first step towards revealing the underlying basis of the relationship.

Acknowledgements

This research was conducted by the Australian Research Council Training Centre for Innovative Wine Production (www.adelaide.edu.au/tc-iwp/), which is funded as a part of the ARC's Industrial Transformation Research Program (Project No IC130100005) with support from Wine Australia and industry partners.

References

1. Coetzee ZA, Walker RR, Deloire A, Barril C, Clarke SJ, Rogiers SY. 2017. Impact of reduced atmospheric CO_2 and varied potassium supply on carbohydrate and potassium distribution in grapevine and grape berries. Plant Physiology and Biochemistry 120:252-260.
2. Coetzee ZA, Walker RR, Deloire A, Clarke SJ, Barril C, Rogiers SY. 2017. Spatiotemporal changes in the accumulation of sugar and potassium within single Sauvignon Blanc (*Vitis vinifera* L.) berries. Vitis 56:189-195.
3. Rogiers SY, Coetzee ZA, Deloire A, Walker RR, Tyerman SD. 2017. Potassium in the grape berry: transport and function. Frontiers in Plant Science 8: 1629.

Contact

Zelmari Coetzee (zel.coetzee@ecodev.vic.gov.au) or
Suzy Rogiers (suzy.rogiers@dpi.nsw.gov.au)
ARC Training Centre for Innovative Wine Production
School of Agriculture, Food & Wine
Wine Innovation Central, Level 4
Corner of Hartley Grove and Paratoo Road,
The University of Adelaide, Waite Campus, Urrbrae SA 5064
Phone: +618 8313 2820
Fax: +618 8313 7116
http://www.adelaide.edu.au/tc-iwp/