

**Title** NMR-imaging studies on fungicide into citrus fruit rind following hot water immersion

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### Abstract

As a non destructive analysis method, Nuclear Magnetic Resonance Imaging (NMR Imaging) may provide helpful information on water movement and physiological effects of transpiration in senescing tissues. In the past decade, the use of NMR-Imaging has provided a better understanding of some physiological disorders in horticultural product (e.g., the internal break down) and on quality changes during storage. Here we report on NMR- Imaging techniques used to study the movement of water into the rind (flavedo and albedo) following fruit immersion in hot water containing imazalil (IMZ). Pummelo hybrid (Citrus paradisi x Citrus grandis cv Oroblanco) was used to study in a completely non-invasive mode the water-IMZ motion and permeation within unwounded or wounded rind following immersion at 25 or 50°C for 2 min. Fruit was harvested, graded, rinsed in distilled water and wounded (3x3mm; 0, depth) in the equatorial area. The 2 min treatment was performed 30 min after wounding by immersing fruit in the mixture at 25 or 50°C. Then, fruit was gently surface wiped with a paper towel, marked (position reference for analysis) and immediately subjected to NMR-Imaging. Twenty four h following immersion, measurements were repeated on the same fruit placed in the identical position. The NMR-Imaging was performed with a Philips Achieva MRI scanner operating at 1.5 Tesla, using a 8 channels (SENSE) Head Coil. Typical acquisition parameters were: T2 weighted images TR 3046 msec; TE 300 msec; matrix of 370x270 point producing a resolution of 0.04 mm; 15 slices of 0.5 mm. FLAIR images TR 11000 msec; TE 140 msec. Comparing resolved spatial information concerning the distribution of free-water a clear and fast motion of the IMZ-mixture into wounded rind occurred only when immersion was performed at 50°C and permeation in the neighbouring parenchyma cells took place within the subsequent 24 h. In wounded fruit immersed at 25°C changes of free-water inside the wounds were insignificant and, in unwounded fruit no differences were found between the two immersion temperatures. From the results of NMR-Imaging and the residue data it is likely that the fungicide in the albedo is acquired mainly at the time of treatment, while during storage permeation from the flavedo seems to be negligible independently from the immersion temperature.