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Uptake of Tetracycline Antibiotics into Cereals

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Antibiotics may reach plants in the following way: by contaminated organic fertilizer (e.g. liquid manure) or water for irrigation and contaminated soil. Conditions for the uptake of different antibiotics into plants were studied for soybeans, alfalfa roots, rice and other cereals (Boonsaner and Hawker 2010 and 2012, Eggen et al. 2011, Kong et al. 2007, Lillenberg et al. 2010). Some of the studies indicate an accumulation in the roots without translocation, whereas others report detection of antibiotics in further plant tissues beside roots. Our initial investigations revealed an uptake of chlortetracycline (CTC) - a widely used veterinary antibiotic substance - from nutrient solution into wheat roots and leaves (Grote et al. 2007). Not much is documented about the potential for uptake of tetracyclines into cereal seeds although considerable amounts of tetracycline residues (~100 µg kg^{-1}) were detected in a screening study of cereal seeds grown under usual agricultural practice (Freitag et al. 2008).
In the present work we investigated the uptake of CTC into wheat plants and the translocation of CTC up to the seeds. Wheat plants were cultivated in hydroponic nutrient solution using vermiculite as solid support for roots under controlled conditions in a growth chamber. CTC was added in two different concentrations to the nutrient solution at a certain point of plant growth. Ripe kernels were harvested, weighted and immediately frozen. After milling, homogenised whole meal wheat flour was extracted and extracts where analysed for occurrence of CTC and related substances using an established chromatographic method in combination with tandem mass spectrometry.
The finding of appreciable CTC concentrations in wheat kernels, originating from our controlled growth culture experiment, strongly supports the hypothesis that wheat plants took up CTC via the roots and also transferred CTC into the seeds. A higher CTC concentration in the nutrient solution led to higher amounts of tetracycline residues in roots, leaves and the kernels. CTC was metabolised during uptake to more highly polar substances, which might have a different risk associated with than the original chemical agent CTC.
The second aim of the study was to investigate the contamination rate with tetracycline residues of German wheat and rye samples obtained from usual agricultural practice. TC-residues were detected in 31 (48%) wheat and rye samples (n=64) from North Rhine-Westphalia and Lower Saxony of harvest 2009 and 2010 at a concentration range between 0.1 to 5 µg kg^{-1}. After fifteen months storage time the concentrations of residues were reduced to 95 % of their original level.
Further research has to be done to confirm the occurrence and quantity of antibiotics in cereal grains. The question arises if small amounts of antibiotic residues in food and feed influence the initiation of resistant bacteria in animals or humans or have other effects e.g. on the metabolic system in plants, animals or humans.

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