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Antibiotic Residues in Vegetables

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Are raw vegetables healthy and safe? The question is legitimate, as studies reveal a path of human exposure to veterinary antibiotics through plant-derived food [1]. A potentially large source of antibiotics and resistant bacteria is livestock waste, which is distributed on fields as fertilizer. The role of vegetables - cultivated by conventional or organic methods - as reservoir and carrier of antibiotic contaminants as well as antibiotic (multi-resistant) pathogenic bacteria [2], requires further investigations, to assess the risk to human health and possible consequences with regard to food safety.
At first, the incorporation of antibiotics into lettuce was estimated by growing the plants under hydroponic conditions, where no sequestration by the soil can occur [1]. The plants were exposed to non-labelled and ^{3}H-labelled sulphonamide and tetracycline. Data obtained by LC/MS-analyses and liquid scintillation counting corroborate the assumption that intact plants can take up substantial amounts of antibiotics by the roots. Subsequently these antibiotics are translocated and distributed in our plant organs. As a consequence, the potential of frequently consumed vegetables such as leek, green and red cabbage and carrots for uptake of highly prescribed veterinary drugs was also tested [3]. For this purpose sulfadiazine, enrofloxacine (ENR), tetracycline (TC), chlortetracycline (CTC), monensine or amoxicillin were added separately to nutrient solutions (2.5 – 5.0 µmol/L of each). The active compounds and conversion products were quantified in various organs of leek and cabbage (e.g. roots, young and old leaves). Depending on the type of antibiotic, vegetable species and plant organ, the visible effects of the drugs on plants were greatly different (bleaching of leaf sections, yellowing, lesions). The most severe plant damaging effects were caused by ENR. The concentrations of antibiotic residues determined in the plant organs comprised several orders of magnitude ranging from µg/kg to mg/kg of fresh weight (fw). For example, in the edible parts of carrots 6.0 mg/kg fw CTC and 4.1 mg/kg fw ENR were found. The roots contained up to 70.5 mg/kg fw CTC and 72.8 mg/kg fw ENR, respectively. Leek as well as green and red cabbage showed a high potential for uptake of chlortetracycline and, in particular, for enrofloxacine, which was partially metabolised in the plants to ciprofloxacine. The leaves of red cabbage contained 0.21 mg/kg fw CTC and 14.6 mg/kg fw ENR.
In addition, a field experiment was conducted to obtain further information on factors influencing the bioavailability of soil-bound antibiotics. Red cabbage was grown on experimental plots that were fertilized with manure, to which different amounts of CTC and ENR had been added. At harvest time the edible parts of the cabbage showed levels of 9.2 to 16.9 µg/kg fw ENR. However, no evidence was found for the uptake of CTC, which might be partly an effect of its strong sorption to soil matrix. Furthermore, samples were taken at various stages of the production of canned red cabbage and assayed for antibiotics. In fact, traces of tetracycline (16.4 - 19.2 µg/kg fw) were found in deliveries of freshly harvested red cabbage, grown conventionally, but not in the marketable canned vegetable [4].
It cannot be excluded to date that low (subinhibitory) levels of antibiotics in vegetables can contribute to the risk of developing bacterial antibiotic resistance. Therefore defined field experiments are carried out at the present, to take into account both, the uptake of drugs used in animal husbandry by vegetable from manured soil and possible influences on the frequency of resistance transfer. The spreading resistance of extended-spectrum-ß-lactamase (ESBL)-producing bacteria (e.g. *Escherichia coli*) from animal reservoirs , such as pigs and poultry production, via food is a matter of concern in the BMBF-research project RESET („Resistance in Enterobacteriaceae“, www.reset-verbund.de). In particular, the resistance of foodborne pathogenic *Enterobacteriaceae* against ß-lactams (e.g. amoxicillin, ceftiofur) and fluoroquinolones (e.g., enrofloxacine and ciprofloxacine) are taken into account.

[1] M. Grote, C. Schwake-Anduschus, R. Michel, H. Stevens, W. Heyser, G. Langenkämper, T. Betsche, M. Freitag, Incorporation of veterinary antibiotics into crops from manured soil. Landbauforschung Völkenrode - FAL Agricultural Research, 57 (1) 25-32 (2007).

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[2] C. Smith-Spangler, M. L. Brandeau, G. E. Hunter, J. C. Bavinger et al., Are organic foods safer or healthier than conventional alternatives?, Ann Intern Med., 157(5):348-366 (2012).
[3] M. Grote, D. H. Meriç, G. Langenkämper, H. Hayen, T. Betsche, M. Freitag, Untersuchungen zum Transfer pharmakologisch wirksamer Substanzen aus der Nutztierhaltung in Porree und Weißkohl, Journal für Verbraucherschutz und Lebensmittelsicherheit, 4, 287-304 (2009).
[4] F. Chowdhury, Untersuchungen zur Aufnahme von Antibiotika in Rotkohl und Möhren – Verbreitungspfade und mögliche Verbraucherrisiken, Dissertation Universität Paderborn 07-2012.