Faecal contamination and hygiene aspect associated with the use of treated wastewater and canal water for irrigation of potatoes (*Solanum tuberosum*)

Abstract

Clean water has become one of the main limiting factors in agricultural food production in Europe, especially for countries around the Mediterranean, who now face more severe and frequent seasonal water shortages. In order to overcome water shortages the European Water Framework Directive encourages and promotes the use of treated urban wastewater in agriculture. However, the use of poor quality water in agriculture poses potential health risks. The application of wastewater through subsurface drip irrigation lines could possibly overcome public health concerns by minimizing contact with wastewater by farmers, farm workers but it is uncertain if the risk for consumers of wastewater irrigated produces would be acceptable. The objective of the current study was therefore to assess whether subsurface irrigation of potatoes with low quality water was associated with higher food safety and reduced human health risks as compared with surface irrigation. The microbial quality of soil and potatoes irrigated by sprinkler, furrow and subsurface drip irrigation, using treated urban wastewater, canal water and tap water were compared at experimental sites near Belgrade, Serbia and in Bologna, Italy. Water, soil and potato samples were collected from March 2007 to September 2008 and their faecal contamination estimated by enumeration of the faecal indicator *Escherichia coli*. In addition, water and potatoes in Italy were analysed for the presence of helminth eggs, another important indicator of faecal pollution. A quantitative microbial risk assessment (QMRA) model combined with Monte Carlo simulations was used to assess whether the different irrigation practices and associated health risks complied with guidelines set by the World Health Organization (WHO). The study found low levels of *E. coli* in irrigation water (Italy mean value: 1.7 colony forming units (cfu)/ml and Serbia 11 cfu/ml), as well as in soil (Italy mean: 1.0 cfu/g and Serbia 1.1 cfu/g). Similar low concentrations of *E. coli* were found on potatoes (Italy mean: 1.0 cfu/g and Serbia 0.0 cfu/g). The vast majority (442/516) of the collected different samples were free of *E. coli*. No helminth eggs were found in any types of irrigation water or on the surface of potatoes. The risk assessment models found the use of treated wastewater to exceed the levels of risks for gastro-intestinal disease ($1.0 \times 10^{-3}$ disease risk) as recommended by the World Health Organization (WHO) for the accidental ingestion of soil by farmers (Serbia: 0.22 and Italy: $5.7 \times 10^{-2}$). However, samples that exceeded disease risks set by the WHO were collected before initiation of wastewater irrigation and were limited to a few numbers of samples, which would indicate environmental contamination not linked to irrigation practice. Disease risk from consumption of potatoes in Italy and in Serbia was found to be within acceptable levels. No relationship was found between *E. coli* concentrations in irrigation water, soil and produce. Similar lack of association was found for *E. coli* findings in sprinkler, furrow or subsurface drip irrigated soils and produce. This indicates that subsurface drip irrigation can be practiced while ensuring food safety and protecting the health of consumers and farmers.

Keywords

Irrigation; Wastewater; Potato; Microbial contamination; Risk assessment