

# Chemical and Microbiological Safety of Vegetables Grown in the Upper Litani Basin

Bashayer Madi <sup>a</sup>, Rabih Kamleh <sup>b</sup>, Mey Jurdi <sup>b</sup>, Sami Ramia <sup>c</sup>, Samira Korfali <sup>d</sup>, Rola Ajib <sup>b</sup>, and Khalil Kreidieh <sup>c</sup>

<sup>a</sup> Department of Co-academics, Balamand University, [Bashayer.madi@balamand.edu.lb](mailto:Bashayer.madi@balamand.edu.lb)

<sup>b</sup> Department of Environmental Health, American University of Beirut, [rabih.kamleh@aub.edu.lb](mailto:rabih.kamleh@aub.edu.lb), [mey.jurdi@aub.edu.lb](mailto:mey.jurdi@aub.edu.lb), [rola.ajib@aub.edu.lb](mailto:rola.ajib@aub.edu.lb)

<sup>c</sup> Department of Medical Laboratory Sciences, American University of Beirut. [Sami.ramia@aub.edu.lb](mailto:Sami.ramia@aub.edu.lb), [Khalil.kreidieh@aub.edu.lb](mailto:Khalil.kreidieh@aub.edu.lb)

<sup>d</sup> Department of Natural Sciences, Lebanese American University, [skorfali@lau.edu.lb](mailto:skorfali@lau.edu.lb)

A potential health hazard is revealed due to the degradation in the Litani river water quality which is of major concern to the agricultural production in the Bekaa region. Hence, the study objectives are to (a) identify the microbiological and chemical hazards in soils and main vegetables grown and irrigated with the Litani river water, (b) compare the levels of chemical and microbiological contaminants in irrigation water, soils and vegetables to determine the levels of contaminants and identify factors impacting the translocation and accumulation of these contaminants in grown products, (c) evaluate the magnitude of the health hazards by comparing levels of chemical and microbiological contaminants to national and international standards, and (d) determine the antibiotic resistance patterns of detected pathogenic bacteria for proper foodborne disease management. A total of 48 composite samples of soils and vegetables (lettuce, parsley and potato) from three different experimental sites (Bar Elias, Dalhamieh and Zahle) and from control agricultural area from the same region irrigated with groundwater were analyzed. The microbiological and chemical quality of the vegetables and soil was determined and evaluated. Further, the antibiotic resistant pattern was determined for the four commonly prescribed antibiotics (Ciprofloxacin, Cefotaxime, Gentamicin, and Erythromycin).

Results indicate that the irrigation with Litani River water is leading to the accumulation of microbiological (*E. coli*, *E. cloacae*, *E. aerogenes*, *K. pneumonia*, *K. oxytoca*, *S. marcescens*, *C. freundii*, *Sh. sonnei*, *C. diversus*, *Listeria spp* and *P. aeruginosa*) and chemical contaminants (barium, arsenic, lead, cadmium, chromium, zinc, iron, nickel, copper, manganese and Molybdenum) in vegetables (lettuce, parsley and potato) and soils. And, the levels in leafy vegetable are higher than in tubular crops (potato). Moreover, the results of the study showed that the exposure to the polluted irrigation water through sprinkling irrigation is the main important factor impacting the safety of the grown crops. Furthermore, all isolated pathogens showed 100% resistance to Erythromycin, 98% resistance to Gentamicin and 93% resistant to both Ciprofloxacin and Cefotaxime.

As such, the consumption of vegetables irrigated with the Litani river water poses a major public health concern, and accordingly, it is recommended to operate the existing wastewater treatment plants and follow up on the construction of planned ones, substitute sprinkler irrigation by drip irrigation to reduce exposure to contaminants, disseminate awareness on appropriate household practices to reduce the levels of contaminants in the consumed crops, and implement integrated river basin management for proper risk assessment and risk management. Additional studies are also recommended to evaluate human exposure to the identified chemical and microbiological hazards.