

Assessing potential risks from consuming fruits and vegetables irrigated with recycled water

Water recycling is the process of reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation, groundwater replenishment, and industrial processes. Water recycling offers financial savings as well as numerous environmental benefits, including reducing energy needs, serving as an additional source of water, decreasing the diversion of water from sensitive ecosystems, decreasing wastewater discharges, and the reduction of pollution. The use of recycled water has been successful in creating a reliable, diverse water supply without compromising public health. It has safely been used to irrigate school grounds, athletic fields, golf courses, parks, and other community grounds, as well as agricultural fields. Analytic techniques for detection of chemicals in water have improved so much that it is now possible to quantify with precision, the presence of extremely minute concentrations of compounds of emerging concern (CECs) in aqueous environments (Kay et al. 2017; Trussell 2015).

An in-depth analysis of the significance of low-level concentrations of selected pharmaceuticals and personal care products in recycled water for a representative set of nonpotable use cases was conducted in a research project sponsored by the WaterReuse Research Foundation (Kennedy et al. 2012). That study concluded that actual concentrations measured in recycled water were generally only a tiny fraction of acceptable concentrations for typical nonpotable recycled water uses such as irrigation of playgrounds and golf courses, irrigation of landscapes while gardeners are at work, and irrigation of agricultural lands where farm workers can come in contact with windblown spray and aerosols from recycled water sources.

The significance of these chemicals at these concentrations is put into perspective when the number of years of consumption needed to accrue one acceptable daily intake over a lifetime is calculated. As shown in Table 1, recent research on carbamazepine significance to human health by Dr. Bahman Sheikh indicated that the number of years required to reach the acceptable limit far exceeded the maximum human life expectancy. This assumed that an individual would consume a mix of fruits and vegetables irrigated with recycled water throughout an 80-year life span, excluding other food crops free from carbamazepine. Thus, it would take 204 years for an individual who maintains a strictly vegetarian/vegan-only diet to accrue one lifetime of acceptable carbamazepine intake.

Research indicates that the number of years required to accrue the acceptable daily intake* every day, over a lifetime for carbamazepine far exceeded the maximum human life expectancy.

The findings illustrate the extremely low concentration of carbamazepine in fruits and vegetables and does not imply that the safe dose level would actually ever be reached by consumers of fruits and vegetables irrigated with recycled water. More importantly, these calculations demonstrate that the detected levels of carbamazepine in food crops grown with recycled water are far from having any potential health impacts on consumers.

*According to Schriks et al. (2010), the acceptable daily intake (ADI) for carbamazepine is 0.34 µg per kg body weight based on carcinogenicity as the health outcome



Table I. Assessment of Potential Risks from Consuming Edible Crops Irrigated with Recycled Water Containing Carbamazepine

Diet	Assumptions	Daily Intake of Carbamazepine Calculation	No. Years Required to Accrue One Lifetime Acceptable Carbamazepine Intake
<p>Vegetarian/ Vegan-Only Diet</p> 	<ul style="list-style-type: none"> Individual consumes only vegetables and fruit irrigated with recycled water. Individual ingests 500 grams (~ one pound) of raw fruits and vegetables at each meal, twice a day. Mix of fruits and vegetables contains an average concentration of 10 ng/g of carbamazepine, not diluted within the market with fruits/vegetables irrigated with waters from non-recycled sources. Value above is based on Figure 2 of Paltiel et al. 2016 for a balanced mix of cucumber, carrot, coriander, lettuce, parsley, pepper, and tomato. Note: The highest concentration of carbamazepine was found in lettuce at near 100 ng/g. However, a scenario of a diet of only lettuce at the rate of 1 kg/day for a lifetime was not deemed fitting or realistic for fashioning the most conservative case. 	<p>Daily Intake = 10 ng/g x 2/day x 500 grams = 10,000 ng/day</p>	<p>204 years</p>
<p>Non-Vegetarian/ Non-Vegan Diet</p> 	<ul style="list-style-type: none"> Individual is not-vegan or strict vegetarian; thus the amount of fruits and vegetables consumed would drop to half of that assumed for the Vegetarian/Vegan-Only scenario. Mix of fruits and vegetables is purchased over an extended period of time from various sources – thus diluting the concentration of carbamazepine to a maximum of 0.5 ng/g, based on the concentration in produce from supermarkets, as reported in Paltiel et al. 2016). 	<p>Daily Intake = 0.5 ng/g x 2/day x 250 grams = 250 ng/day</p>	<p>8,160 years</p>

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