SAFETY OF RECYCLED WATER: Health Significance of Carbamazepine Detected in Fruits and Vegetables Irrigated with Recycled Water

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Introduction

A recent Israeli paper (Platiel *et al*., 2016) provided "proof of concept" that recycled water irrigated fruits and vegetables uptake Carbamazepine and its metabolites at detectable levels ranging from 0.1 ng/g (carrots and tomatoes) to near 100 ng/g (lettuce and parsley). Furthermore, the researchers reported finding detectable levels of the same compounds in the urine of test subjects who consumed such fruits and vegetables for a week. The urine of a control group of individuals consuming similar fruits and vegetables irrigated with potable water contained significantly lower concentrations of these compounds.

To provide an assessment of the risks of consumption of edible crops irrigated with recycled water containing carbamazepine (comparable to those in the Israeli study), the following calculations were performed.

Most Conservative Scenario

The more conservative set of circumstances assumed for this calculation involved the following:

- Consumer of vegetables and fruits is a vegan person,
- eating only vegetables and fruit irrigated with recycled water,
- eating 500 grams (~ one pound) of raw fruits and vegetables twice a day, and
- with average concentration of 10 ng/g of Carbamazepine in all of the fruits and vegetables[1] (not diluted within the market with other-irrigated fruits and vegetables).

Based on the above assumptions, the daiy intake of carbamazepine by the vegan person is calculated thus:

Daily Intake = 10 ng/g x 2/day x 500 grams = 10,000 ng/day

According to Shriks et al (2010), the Acceptable Daily Intake (ADI) for carbamazepine is 0.34 µg/kg body weight/day based on carcinogenicity as the health outcome. For an individual weighing 75 kg and a life expectancy of 80 years, acceptable lifetime intake of carbamazepine can be calculated:

0.34 ug/kg/day x 1000 ng/ug x 75 kg x 365 days/year x 80 years = 744,600,000 ng

[1] Based on Figure 2 of Paltiel *et al.* for a balanced mix of cucumber, carrot, coriander, lettuce, parsley, pepper, and tomato.

The number of years it would take for the vegan individual consuming 500 grams of vegetables and fruits irrigated only with recycled water to **accrue** one lifetime acceptable intake of carbamazepine would be:

744,600,000 ng / (10,000 ng/day x 365 days/year) = 204 Years[2]

More Common Scenario

The more common scenario involves the following assumptions:

- The consumer of fruits and vegetables is not vegan or strict vegetarian, and the amount of fruits and vegetables consumed would drop to half of that assumed for the above scenario, and
- the mix of vegetables and fruits purchased over a long period of time from various markets and sources would dilute the concentration of carbamazepine to 20 % of the above scenario

In that case, the calculation would be:

Daily Intake = 2 ng/g x 2/day x 250 grams = 1,000 ng/day

The number of years it would take for the non-vegan individual to **accrue** one lifetime acceptable intake of carbamazepine would be:

744,600,000 ng / (1,000 ng/day x 365 days/year) = 2,040 Years

Conclusions

It is important to note that "**accrual**" does not necessarily imply **accumulation** over the years calculated. In fact, Platiel *et al.* report a leveling off and a drop-off of carbamazepine levels in the urine of test individuals after the first week of consuming the fruits and vegetables irrigated with recycled water. This is in part due to elimination and in part breakdown of metabolites in the body. Use of one ADI for the above calculation is merely to illustrate the extremely low concentration of carbamazepine in the fruits and vegetables and not to imply that that dose level would actually ever be experienced by the consumers of fruits and vegetables irrigated with recycled water.

These conclusions are consistent with the Israeli paper's authors' conclusion, stated in this way:

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[2] These calculations can be repeated based on one therapeutic dose (400 mg, per Elmquist *et al.*, 1991) as the "safe" lifetime intake, yielding much longer periods of years to reach that dose. The more conservative approach, with Acceptable Daily Intake (ADI), was used in these calculations.

> "*From the public health standpoint two aspects of this study are reassuring. First, although participants reported eating more fresh produce during the study than they would normally consume, end-of-study carbamazepine levels returned to baseline values. Second, somewhat lower levels of the drug were detected in supermarket produce, presumably since it originates from a variety of farms and irrigation sources, thus "diluting" the effect of potential contaminants. Assessments of the potential for human risk versus benefit associated with reclaimed wastewater-irrigated produce should take into account the patterns demonstrated in this trial*."

Levels of carbamazepine detected in fruits and vegetables irrigated with recycled water in Israel provide one more dramatic manifestation of the rapidly increasing capability of analytic techniques in the laboratory. The fact that chemicals of emerging concern (CECs) can now be detected in recycled water, in produce grown with recycled water, and in the urine of people consuming those fruits and vegetables is quite interesting. However, the relevance of that information in terms of the health and safety of the consuming public is far more interesting and important. The calculations of years to reach one acceptable lifetime intake with conservative assumptions, show the extent to which the detected levels of carbamazepine are far from having any potential health impacts on consumers of food crops grown with recycled water.

REFERENCES

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