



Towards a safe standard for heavy metals in reclaimed water used for fish aquaculture

M. Feldlite ^{a,*}, M. Juanicó ^b, I. Karplus ^c, A. Milstein ^d

^a Israel Water Works Association, Ramat-Hashron Water Plant, Morasha, Petah-Tikwa, 49001 Israel

^b Juanicó – Environmental Consultants Ltd., 2 Aliah St., Afula 18392, Israel

^c Aquaculture Research Unit, Agriculture Research Organization, P.O.B. 6, Beit-Dagan, 50520 Israel

^d Fish & Aquaculture Research Station, Dor. M.P. Hof HaCarmel, 30820, Israel

ARTICLE INFO

Article history:

Received 20 January 2008

Received in revised form 20 July 2008

Accepted 21 July 2008

Keywords:

Arsenic
Aquaculture
Cadmium
Fish
Lead
Mercury
Wastewater

ABSTRACT

The objective of the present study is to provide a basis for the development of a standard on the concentration of heavy metals in reclaimed water used for edible fish aquaculture, focusing on the four heavy metals addressed by the Israel standard for food quality (arsenic, cadmium, lead and mercury). A series of experiments were carried out on three commercial fish species of differing feeding habits and complementary measurements were made in fish growing in a reservoir with secondary treated effluent. In a field experiment the fish were raised on natural food and on pelleted feed, in reclaimed wastewater and in freshwater. In laboratory experiments, the fish were raised in aquaria while exposing them to heavy metals supplied in the pelleted feed or dissolved in the water. In the field experiment with fish growing in tertiary treated reclaimed water during five months, no detectable levels of the four tested heavy metals were found in fish flesh (no analyses in internal organs performed). In fish reared during two years in secondary treated reclaimed water, no detectable levels of heavy metals were found in fish flesh, but the concentrations of Cd and Pb in liver and bones of some fish were above the food standard. Laboratory experiments on rearing fish while exposing them to water and pelleted feed with increasing levels of heavy metals, revealed detectable levels of these heavy metals in fish flesh, bone and mainly in liver. The standards on reclaimed water for unrestricted irrigation are a good basis for the development of a water quality standard for growing fish in reclaimed water, because fish can be grown in the reservoirs used to storage the reclaimed water and/or this is the reclaimed water that can be used to fill fish ponds. Except for Hg, the proposed Israel requirements for heavy metals in reclaimed water used for unrestricted irrigation (As=0.1 mg/l, Cd=0.01 mg/l, Pb=0.1 mg/l, Hg=0.002 mg/l) are safe regarding the consumption of flesh from fish reared in reclaimed water, even if the growing season is long (up to two years). These requirements are not equally safe regarding the consumption of liver (and probably other viscera).