

Heavy metal effects on types and levels of Omega-3 polyunsaturated fatty acids (PUFAs) in Tilapia Fish (*Oreochromis niloticus*) in Winam gulf of Lake Victoria

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2012

Abstract:

Winam Gulf is facing major pollution threats from anthropogenic input of pollutants such as heavy metals and pesticide residues. This has deleterious effects on the flora and fauna in the lake and consequently may affect the quality of omega - 3 fatty acids which have numerous health benefits in humans. The major objective of the present study was to establish whether there is a correlation between the heavy metal pollutants and the levels of omega - 3 polyunsaturated fatty acids in fish and microalgae. Levels of heavy metals - lead (Pb), cadmium (Cd), Zinc (Zn) and chromium (Cr) in sediments, water, microalgae and Nile tilapia fish (*Oreochromis niloticus*) from four sites in Winam Gulf of Lake Victoria for three seasons were investigated. They were analyzed using Atomic Absorption Spectrophotometry. Nile tilapia muscles and microalgae were further analyzed for omega -3 polyunsaturated fatty acids (PUFAs) using gas chromatography. Heavy metal concentrations in sediment samples (mg/kg dry weight) ranged from 9.50 \pm 0.10 - 85.00 \pm 1.73 (Pb), 36.70 \pm 1.53 - 277 \pm 1.53 (Zn), bdl-3.30 \pm 0.50 (Cd), and bdl - 21.00 \pm 0.70 (Cr). There was a strong correlation between Pb and Zn ($r = 0.985$, $P < 0.05$); and Zn and Cr ($r = 0.967$, $p < 0.05$) in sediments. The trend of heavy metal abundance in sediments was: Zn > Pb > Cr > Cd. The heavy metal concentrations in the fish (mg/kg dry weight) ranged from 0.9 \pm 0.00 - 24.7 \pm 0.57 (Pb), 17.7 \pm 0.50 - 40.0 \pm 0.50 (Zn), bdl-1.93 \pm 0.10 (Cd) and bdl- 7.8 \pm 0.70 (Cr) where bdl stands for 'below detection limit'. The heavy metal concentrations in microalgae (mg/kg dry weight) ranged from bdl to 19.0 \pm 0.71 (Pb), 2.5 \pm 0.00 to 21.0 \pm 0.70 (Zn), bdl to 1.5 \pm 0.00 (Cd) and bdl to 5.25 \pm 0.05 (Cr). For water samples the concentrations of heavy metals (mg/L) were the lowest ranging from 0.02 \pm 0.00 - 0.1 \pm 0.01 (Pb), 0.015 \pm 0.00 - 0.14 \pm 0.00 (Zn), bdl- 0.02 \pm 0.00 (Cd) and bdl - 0.06 \pm 0.00 (Cr). Oil contents were in the range of (2.47 - 3.87) % of dry weight. Omega-3 polyunsaturated fatty acids, particularly alpha-linolenic (ALA), eicosapentaenoic (EPA), docosapentaenoic (DPA) and docosahexaenoic (DHA) acids were found to be in substantial amounts in fish. Ratios of polyunsaturated to saturated fatty acids (0.47 to 1.28) were in the range considered adequate by USFDA for normal health. Ratios of 0- 3 to 0- 6 were in the range of 1.59 - 2.70 which is within the recommended ratio by USFDA for fresh water fish. The results show that Nile tilapia fish is a good source of omega- 3 polyunsaturated fatty acids. Oil content for microalgae ranged from (1.76 \pm 0.35 to 5.65 \pm 1.02) %. For the fatty acids, the most prominent fatty acids were: palmitic (C16:0), palmitoleic (C16:1) and alpha linolenic acids (C18:3 n3). ANOVA two way showed that there was no variation ($p > 0.05$) between the oil contents and sampling sites or times. There were positive correlations ($r = 0.995$, $p < 0.05$) between omega-3 and omega-6 polyunsaturated fatty acids (PUF A); and also between total PUFA and omega- 3 ($r = 0.995$, $p < 0.01$) in microalgae. There was no clear link observed between the levels of heavy metals and omega - 3 fatty acids in fish ($p > 0.05$) although fish muscles showed presence of these metals. Therefore consumption of fish from Winam Gulf does not pose any danger with respect to levels and quality of omega -3 fatty acids to consumers at present. On the other hand, urgent intervention is required regarding presence of heavy metals above set guidelines in both water and fish which may cause health problems in future