



Trophodynamics and health risk assessment of heavy metals in seafood from a tropical estuary in the gulf of Guinea

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ABSTRACT

Seafood is an essential protein source for coastal communities. However, they can accumulate heavy metals from human activities which could pose a potential health risk to consumers. In this study, we investigated the distribution, bioaccumulation, trophic transfer and potential human health risk of heavy metals in sediments, shell and fin fish collected from the Escravos Estuary in southern Nigeria. Heavy metals (Ni, Cd, V, Pb and Cu) in sediments, periwinkles and tongue soles from the two study sites were lower than the permissible limits for fishery products. The metal distribution in fish tissues was in the decreasing order of liver > gills > muscles > gonads > rest of the fish. Moderate to high BSAF (>1) was reported for Cd, Pb and Cu. All the studied metals, except Pb, showed evidence of biomagnification from periwinkle to tongue sole. The estimated daily intake (EDI) and hazard ratio (HR) for metals in periwinkles from both study sites were lower or within the USEPA reference doses (RfD) for the respective daily intake and HR value < 1, except for Cd, V and Pb for children. In contrast, EDI values in the muscle of tongue soles were higher than the RfD values for heavy metals except for Ni and Pb, whereas HR values > 1 except for Ni, Cd and V. In the whole fish, EDI and HR values were disproportionately high in both study sites with higher values reported for children. This study provides the first insights on the trophic transfer and risk assessment of heavy metals from petroleum and gas operations impacting the Escravos Estuary and the implications to public health.

1. Introduction

Pollution caused by heavy metals is a global issue due to their toxic effects on living organisms when concentrations surpass a certain threshold (Chakraborty et al., 2009). For decades, marine ecosystems worldwide have experienced significant contamination from domestic, agricultural and industrial discharges and ship emissions (Hossain, 2010). Among various pollutants, metal pollution in marine environments is emerging as a critical global concern, particularly in developing countries (Rumisha et al., 2012). Coastal and estuarine environments, often characterized by extensive industrial facilities and urban areas, face the consequences of wastewater discharge leading to the accumulation of pollutants like heavy metals, organometallic compounds, and persistent organic pollutants (Ridgway and Shimmield, 2002). When introduced into the environment, metals undergo chemical transformations that determine their transport and fate. In most cases, they infiltrate the food chain and bioaccumulate in aquatic organisms (Schweitzer and Noblet, 2018; Okogwu et al., 2019). Notably, heavy metals are recognized for their detrimental effects on humans, with food

products serving as the primary source of exposure for the general population (Gall et al., 2015). The toxicity of heavy metals depends on the exposure route, bioavailability, solubility and speciation (Reaves and Baker, 2000; Malandrino et al., 2011). Health effects of heavy metals include neurological, urinary, genetic, cardiovascular, immune and inflammatory disorders (Nestle et al., 2002; Joseph et al., 2005; Bandmann et al., 2015; Ala et al., 2019).

Seafood is a vital source of nutrition for millions worldwide (Mala-kootian et al., 2016). However, bioaccumulation of heavy metals in seafood varies from species to species and from tissue to tissue (Yousafzai et al., 2017). Periwinkle (*Tympanotonus fuscatus*, Linnaeus, 1758) is the most common and dominant gastropod in the mangrove sediments of West Africa. They are an important source of protein for coastal communities, contributing to food security and livelihoods. Its shell can be used as a source of calcium in animal feeds and for construction purposes (Jamabo and Chinda, 2010; Bob-Manuel, 2012). Due to their low mobility, periwinkles can be used to monitor the quality of coastal waters (Asuquo, 2020). Tongue sole (*Cynoglossus senegalensis*, Kaup, 1858), is a species of flatfish commonly consumed in Africa. They are

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