平成３０年度　環境科学院　修士論文内容の要旨

Assessment of some heavy metals in Tilapia fish from aquaculture ponds and Kafue River, Copperbelt, Zambia

（ザンビア、カッパーベルト内のカフエ川や養殖池で育ったティラピア魚中の重金属元素濃度評価）

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Copper mining plays an important role as one of the main driving forces in Zambia's economy, with the majority of mines located in Copperbelt Province. On the other hand, fish provides a cheaper source of animal protein for most Zambians, however, there is limited information on heavy metal levels in fish. Therefore, this study aims to address the deficiency in data on heavy metals in commonly available commercial fish. Secondly, to examine heavy metal accumulation in different fish tissues and compare the concentrations in the muscle with WHO standards for quality assessment. A total of 80 fish were collected in the dry season (August 2017 and May 2018). The samples were digested using microwave digestion and analysed for heavy metal concentrations by ICP-MS. Heavy metals (Cu, Zn, Mn, Cd, Pb, As) were examined in the muscle, gill, and liver of Tilapia fish collected from two aquaculture ponds near a mining area and one sampling site along the Kafue River in Copperbelt.

The results showed significant differences in trace metal concentration between different fish tissues of the same fish ($p < 0.05$). The muscle accumulated lower concentration of almost all the analysed elements while the liver accumulated higher concentrations of Cu, Zn, Cd and As. The concentrations of Mn and Pb were higher in the gills. The highest Cu concentration (8.85 mg/kg) in the muscle was detected among fish samples from the aquaculture pond that was relatively close to the mining area. This value was above the WHO (2003) limit of 3.5 mg/kg. The other elements in the muscle from the three sampling sites were below the WHO limits. The result of estimated daily Intake values showed that all the examined elements in the edible tissue (muscle) were below the WHO permissible tolerable daily intake values indicating that the analysed fish were safe for human consumption. However, measures should be taken to bring Cu concentration to much lower levels.

A strong positive correlation between Cu-Mn ($r = 0.82$) in muscle and ($r = 0.79$) in gills was observed. Other significant correlations detected in the two tissues were Mn-Zn, Mn-Pb, Cu-Pb, Cu-Zn, Pb-As and Cu-As. We also found a significant negative correlation between fish weight and heavy metals (Cu, Zn, Mn) concentration in most cases. This implies that smaller fish accumulated a higher concentration of these metals than bigger fish.

The study was extended to analyse the water chemistry and heavy metals (Cu, Zn, Mn) in sediments from the two aquaculture ponds. The results revealed significantly higher concentrations of Cu, Mn and SO_4^{2-} ($p < 0.05$) in the aquaculture pond that was relatively close to the mining area than in the one that was a little further. The higher SO_4^{2-} and Cu concentrations observed in this aquaculture pond may be an indication that the source of Cu in the two ponds is dust particles from mine tailings. This is because the most common copper ore in the area is $CuFeS_2$, therefore, the sulfide may have oxidised to form SO_4^{2-} hence increasing its concentration in the water while Cu accumulated in the sediments.