

Water Filterable and Particulate Metals and Their Bioaccumulation in Prawns along Veifa Village, Central Province, Papua New Guinea

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Abstract: Toxic metals are released into the river systems from both anthropogenic activities and natural sources. These metals are present in water as filterable and particulate metals. These metals were found to bioaccumulate in prawn samples along Veifa stretch of the Angabanga River. The analytical results showed that As as particulate metal was high in concentration at $86 \mu\text{g}\cdot\text{g}^{-1}$ and Pb as filterable metal was high in concentration at $12 \mu\text{g}\cdot\text{g}^{-1}$. The metals Pb and As also accumulated in prawns along the Veifa stretch but were within recommended toxic metal standards.

Key words: Bioaccumulation, metal concentration, Veifa stretch, prawns.

1. Introduction

The fate of toxic metals in the environment must be established as these metals are known cumulative toxins. These metals are found to be carcinogenic and cause cancer when exposed in large amounts [1-3]. A study by Jarup [3] showed that As, Pb and Hg are highly toxic and have severe health implications when they bioaccumulate in water and aquatic organisms. The increased level of metals causes negative impacts on prawns and other food resources [4].

Therefore, the primary aim of this study is to investigate concentration of filterable metals and particulate metals. Thus, establish their concentrations and compare recommended environmental standards with the intention to reduce metals pollution in the river systems.

2. Materials and Methods

2.1 Sampling

2.1.1 Water Samples

Water samples were collected at two locations

along the Veifa stretch of the Angabanga River. Water samples were collected at a depth of about 0.5 m. The polyethylene sample bottle was immersed 20 cm below the surface before turning it towards the stream flow and treated with 10% HNO_3 for those samples to be analysed for metals. This treatment prevents adsorption of dissolved metals, colligation and possible complexing of metals. The samples were sealed, labelled and stored in an esky and transported to University of Goroka research laboratory.

2.1.2 Prawns Samples

Three fresh water prawns samples of the thumbnail species of the crustaceae sub-phylum were also collected from the same locations where water samples were collected. The samples were stored in plastic bag on ice, sealed and transported back to University of Goroka research laboratory in an esky.

2.2 Sample Preparation and Digestion

2.2.1 Water Samples

Raw water samples were filtered to remove undissolved solid particles before digestion.

Fifty milliliter of the filtered water sample was

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digested with 30 mL aqua regia on a hot plate. A clear solution was noticed with no fumes for the completion of digestion process. Twenty five milliliter of the digested sample was topped up in a 100 mL volumetric flask with 15% HCL to keep the target analytes in solution before instrumental analysis. The digested samples were tightly sealed and labelled.

2.2.2 Prawns Sample

About 3 g dried fresh water prawns sample from each site was digested using 25 mL nitric/perchloric acid. After the completion of the digestion process, 5 mL of the digested sample was topped up in a 25 mL volumetric flask with 15% HCL. The digested samples were tightly sealed and labelled for instrumental analysis.

2.3 Analytical Methods

The prepared samples were analysed for the targeted analytes (Hg, As and Pb) at the NAL (National Analysis Laboratory). The metals were analysed using AAS (atomic absorption spectrophotometer) while Hg was analysed using mercury analyzer.

3. Results and Discussion

3.1 Potential Metal Sources

The Veifa stretch is located approximately 50 km downstream of Tolukuma Gold Mine. The metals (As, Pb and Hg) may be introduced into the environment from their primary ores (arsenopyrite, galena or

Table 1 Filterable metals ($\text{mg}\cdot\text{L}^{-1}$) and particulate metals ($\mu\text{g}\cdot\text{g}^{-1}$) in water.

Water samples	Target metals	
W001 (filterable metals)	Pb	12
	As	< 0.0002
	Hg	< 0.0002
W002 (particulate metals)	Pb	14
	As	86
	Hg	< 0.2

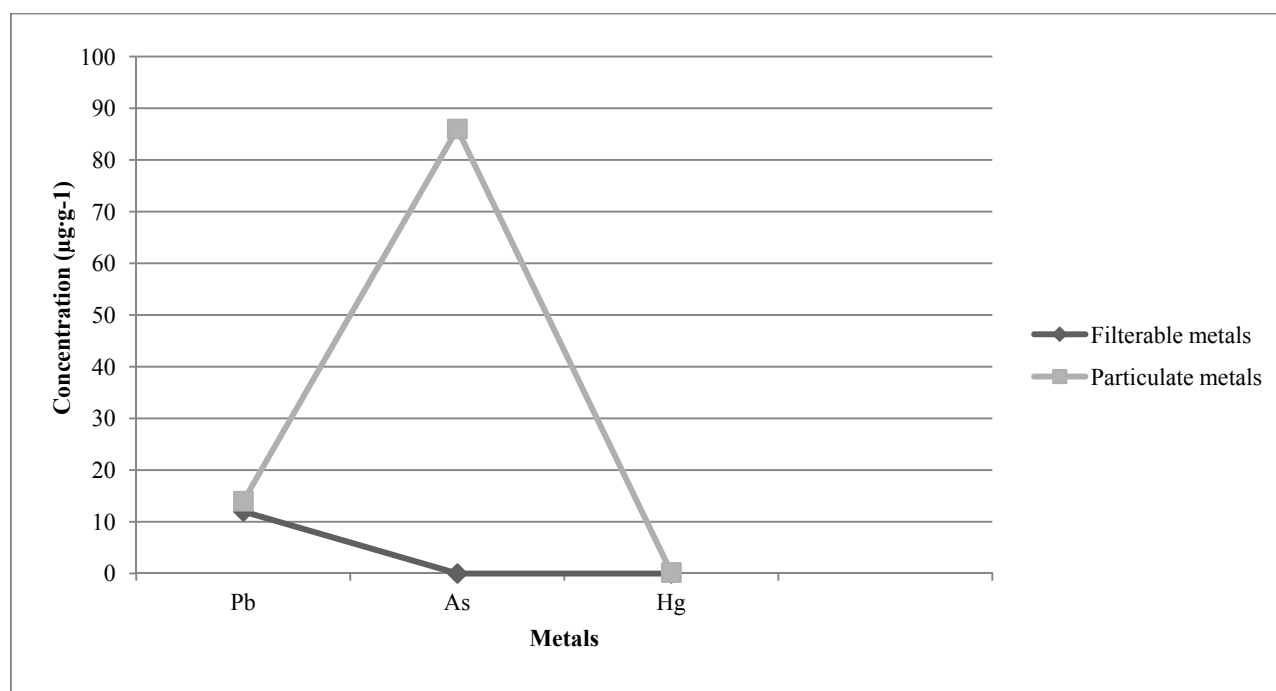


Fig. 1 Plot of metal concentration in water: filterable ($\text{mg}\cdot\text{L}^{-1}$) and particulate ($\mu\text{g}\cdot\text{g}^{-1}$).

Table 2 Metal concentration in prawn samples ($\mu\text{g}\cdot\text{g}^{-1}$).

Prawn samples	Target metals in prawns		
	As	Pb	Hg
1a	0.1	0.42	< 0.1
2b	0.254	0.27	< 0.1
3c	0.156	0.22	< 0.1

*1a, 2b and 3c are three different sites from which prawn samples are collected.

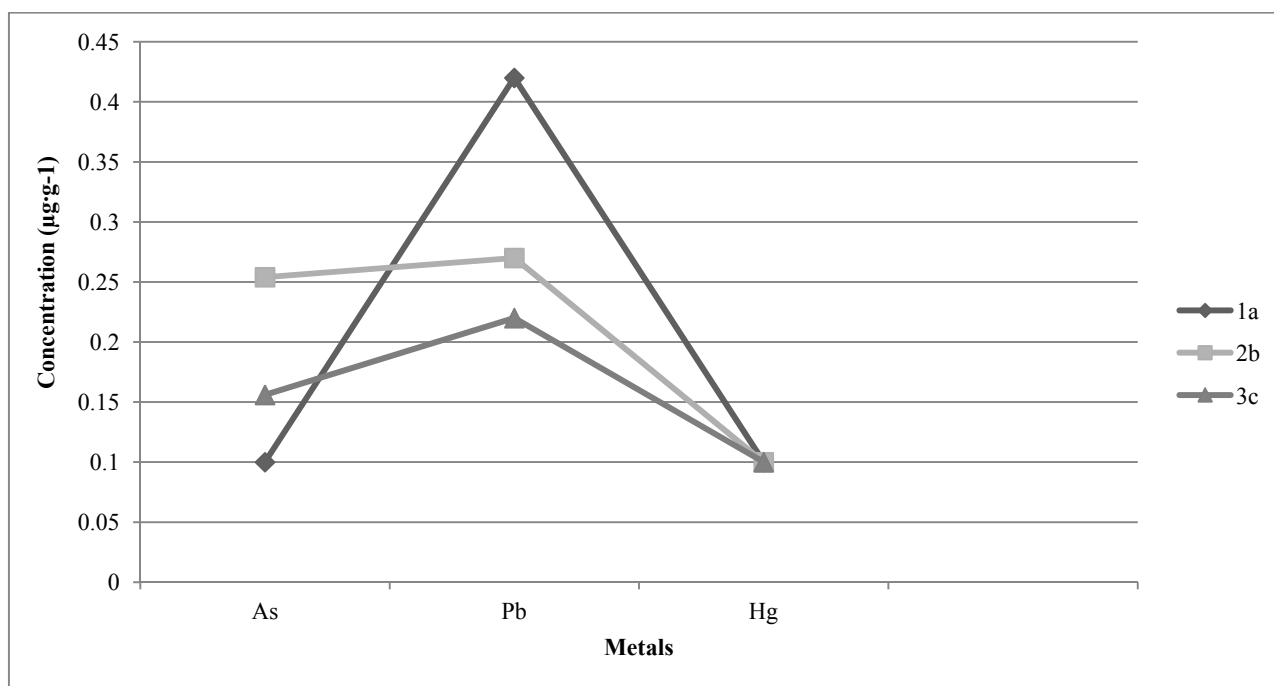


Fig. 2 Trends in metal bioaccumulation in prawn samples ($\mu\text{g}\cdot\text{g}^{-1}$), 1a, 2b and 3c are three different sites from which prawn samples are collected.

cinnabar) if those ores occur upstream. These metals can equally be introduced into the environment after sulphide containing ores undergo acid rock drainage [5, 6].

Increased levels of heavy metals (Pb, As and Hg) were found in water samples analysed for Auga-Angabanga River [7]. The most important sources for metals in the environment are mine tailings [8].

3.2 Filterable and Particulate Metal Concentrations in Water

The analytical results in Table 1 and Fig. 1 show that filterable Pb was high in concentration at $12 \mu\text{g}\cdot\text{g}^{-1}$ and particulate As was high at $86 \mu\text{g}\cdot\text{g}^{-1}$. The reason for high particulate As the sample was taken

from the water body that closer to a sedimentation area which acts as a reservoir of As. The concentration exceeded Papua New Guinea (PNG) drinking water standard of $50 \text{ mg}\cdot\text{L}^{-1}$ and Australian Drinking Water Guideline (ADWG) standard of $7 \text{ mg}\cdot\text{L}^{-1}$ and United States Environmental Protection Authority (USEPA) standard of $0.05 \text{ mg}\cdot\text{L}^{-1}$ [9, 10]. As is a health hazard in the study locality and is also the reason for the accumulation in prawns samples.

3.3 Bioaccumulation in Prawns

The metals (Pb and As) significantly bioaccumulate in prawns samples given in Table 2 and Fig. 2, but within recommended standards for heavy metal content in food and crustaceae [11]. These metals will bioaccumulate and reach toxic levels with time. The

variations in metal concentrations observed may be due to the different sizes of prawns sampled and the metals are not able to penetrate the exoskeleton as it is hard.

5. Conclusion

The metals in the environment come from their sources. Further study is required to critically comment on the natural sources of the metals in the water. Particulate As is high in concentration in water and is a health concern along Veifa stretch for the villagers.

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