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# Study of Heavy Metal Contamination on Soil and Water in Major Vegetable Tracks of Pathanamthitta District, Kerala, India

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***ABSTRACT :*** *Heavy metal contamination on soil and water causes a serious environmental problem because it does not biodegrade. It accumulates in different levels of the food chain. The aim of the present study is to assess the heavy metal contamination on soil and water in the major vegetable tracks of Pathanamthitta district, Kerala, India. The concentrations of heavy metals namely Zinc, Iron, Lead,Chromium, Copper and Cadmium were determined by Atomic Absorption Spectroscopy. The concentration of heavy metals in soil from the study sites ranged from Zn (0.07-0.2mg/kg), Fe(0.2-1.4 mg/kg), Pb(0-0.5mg/kg), and Cu (0.1-1.0 mg/kg) respectively. Iron was detected in water samples (0.35-0.41 mg/kg). Water sample showed low values of BOD , COD and slightly acidic pH.*

***KEY WORDS****: AAS, Heavy metals, Pesticide, pH, Pesticides impact assessment.*

## I. INTRODUCTION

The term heavy metal refers to any metallic chemical element that is toxic. Examples of heavy metals include Iron, Mercury, Cadmium, Arsenic, Copper, Chromium, Thallium, Lead etc. Of these Iron, Cobalt, Copper, Manganese, Molybdenum, and Zinc are essential elements. Other heavy metals such as Mercury, Plutonium, and Lead are toxic and their accumulation over time in the bodies of animals can cause serious health problems. Heavy metals like Vanadium, Tungsten and Cadmium though toxic may become beneficial for certain organisms under certain favourable conditions. Heavy metals are easily accumulated in human vital organs and affect human health. Long-term exposure may result in slowly progressing physical, muscular and neurological degenerative problems like Alzheimer's disease, Parkinson's disease, muscular dystrophy and multiple sclerosis .

Heavy metals affect the natural vegetation also. Plants take up heavy metals by absorbing it from contaminated soil . The safety of vegetables is very important because vegetables can take up a lot of nutrients and heavy metals in a short period(1). In some studies it was mentioned that soil contained heavy metals through pollution (2,3). It was also reported that bioavailability of contaminants in soil and vegetables were controlled by soil properties, soil metal speciation and plant species (4,5). Works by researchers (6,7,8) and (9) had shown that some common vegetables were capable of accumulating high levels of metals from soils. In addition it had also been identified that an important pathway of heavy metal contamination of vegetable crops was foliar uptake of atmospheric heavy emissions.(10,11). The present work was focused on the study of contamination of heavy metals such as Zinc, Iron, Lead, Copper and Cadmium on soil and water in major vegetable tracks of Pathanamthitta district,Kerala, India.

## II. STUDY AREA

Pathanamthitta is a town and a municipality situated in central Travancore region in the state of Kerala, South India, spreading over an area of 23.50 sqkm. The town has a population of 1,197,412 (Census 2011). Pathanamthitta is landlocked district bordered by Kottayam and Idukki districts in the north, Alappuzha district in the west, Kollam district in the south and Tamil Nadu state in the east. Average annual temperature of the area ranges from 20°C to 39°C as per Indian Meteorological Department. The district experiences distinct weather conditions such as winter (December to February), summer (March to May) and the monsoon. The monsoons include south-west (June to September) and north-east (October to November). About 75 percent of the annual rainfall is received during south-west monsoon. Agriculture is the main occupation of the people. About 75% people are dependent on this sector. Rubber is the most important crop followed by vegetables such as snake gourd, brinjal, tomato, cucumber, bitter gourd, pea and plantain. The Pamba river (176 km long), the third longest river in Kerala, flowing through the study area, forms a major source of irrigation. Though farmers use farm chemicals, quite a good majority still depend on synthetic pesticides for pest management in the soil.The areas such as Naranamuzhy,Vechoochira and Ranni Panchayaths in Pathanamthitta district were considered for the present study.

## III. MATERIALS AND METHODS

The aim of the present study was to assess the heavy metal contamination in soil and water in the major vegetable tracks of Pathanamthitta district.

**Questionnaire Survey :** A detailed questionnaire survey was conducted in the vegetable tracks of Pathanamthitta district.to identify type, frequency of application and amount of pesticides used among farmers. Fifty selected farmers were interviewed and their responses were used to create a data base on pesticide use pattern in the vegetable tracks. Table (1).

**TABLE.** 1. Pesticide Use Pattern

| Types of pesticides used | Frequency of application | Dosage | Dose (ha) | Dose(L) |
|---|---|---|---|---|
| Thimet | At the time of planting | | 8.3 kg $ha^{-1}$ | |
| Curacron | 15-20 days interval | 150ml -300 ml $100L^{-1}$ | 750 ml $ha^{-1}$- 1.5L $ha^{-1}$ | 1.5-3ml $L^{-1}$ |
| Hilban | 20 - 25 days interval | 150ml-300 ml $100L^{-1}$ | 750 ml ha- 1.5L $ha^{-1}$ | 1.5ml -3ml $L^{-1}$ |
| Ekalux, Hilquin | 25 days interval | 200 ml $100L^{-1}$ | 1L $ha^{-1}$ | 2ml $L^{-1}$ |
| Hostathion, Josh | 25 days interval | 200 ml $100L^{-1}$ | 1L $ha^{-1}$ | 2ml $L^{-1}$ |
| Monocil, Nuvacron | 25 days interval | 200-250 ml $100L^{-1}$ | 1L -1.25L $ha^{-1}$ | 2ml $L^{-1}$- 2.5 ml $L^{-1}$ |
| Metacid | 15-20 days interval | 200 ml $100L^{-1}$ | 1L $ha^{-1}$ | 2ml $L^{-1}$ |
| Viraat | 20 days interval | 300 ml $100L^{-1}$ | 1.5L $ha^{-1}$ | 3ml $L^{-1}$ |
| Avaunt | 30 days interval | 30 ml $100L^{-1}$ | 150 ml $ha^{-1}$ | 0.03 ml $L^{-1}$ |
| Spark | 22 days interval | 75-100 ml $100L^{-1}$ | 0.37L $ha^{-1}$ | 0.75-1ml $L^{-1}$ |
| Karate | 15 - 20 days interval | 300 ml $100L^{-1}$ | 1.5L $ha^{-1}$ | 3 ml $L^{-1}$ |
| Shakti | 22 days interval | 300 ml $100L^{-1}$ | 1.5L $ha^{-1}$ | 3 ml $L^{-1}$ |
| Koragen | Monthly | 10 ml $100L^{-1}$ | 50 ml $ha^{-1}$ | 0.01ml $L^{-1}$ |
| Hilmida | 22 days interval | 200-300ml $100L^{-1}$ | 1-1.5L $ha^{-1}$ | 2-3 ml $L^{-1}$ |
| Titan | 22 days interval | 300 ml$100L^{-1}$ | 1.5L/ha | 3 ml $L^{-1}$ |
| Spark | 22 days interval | 100-300 ml$100L^{-1}$ | 500ml- 1.5L$ha^{-1}$ | 1-3 ml $L^{-1}$ |
| Josh | 22 days interval | 300 ml$100L^{-1}$ | 1.5L $ha^{-1}$ | 3 ml $L^{-1}$ |

**Sample collection**

- Soil samples were collected from five locations of Naranamuzhy, Vechoochira and Ranni Panchayaths during the month of May 2011 from each site.
- 250 gram of soil was taken for heavy metal analysis
- Water samples[1L] were collected from selected water resources for heavy metal analysis
- The extraction and clean up procedures were performed as per AAS method (18).

**Soil analysis :** Soil samples were analyzed for physico-chemical properties such as pH, electrical conductivity, cation exchange capacity, texture, water holding capacity and soil nutrients. All the chemicals and reagents used were of AR grade. The soil pH was determined by pH meter with glass electrode (12), electrical conductivity by Conductivity meter (12), texture by International pipette method (13), water holding capacity by Undisturbed core sample(14) and cation exchange capacity by Ammonium acetate method (12). The soil nutrients analyzed for the study included organic carbon (12), available nitrogen by alkaline permanganate method (15), available phosphorus and potassium by spectrophotometry (12), calcium and magnesium by EDTA method (16), sulphur by turbidimetry method (17).

**Extraction of heavy metals from soil :** 1g of air dried, ground and sieved soil sample was taken in an Erlenmeyer flask. Then 50 ml of extracting solution (0.05N HCl and 0.025N $H_2SO_4$) was added to it and placed in a mechanical shaker for 15 minutes. It was then filtered through Whatman filter paper into a 50ml volumetric flask and diluted to 50 ml with extracting solution. The solution was analyzed for Zinc, Lead, Chromium, Copper and Cadmium using AAS method(18).

**Water analysis :** Water samples were analyzed for physico-chemical properties such as pH, BOD and COD.

**Extraction of heavy metals from water :** Water samples were collected using a Van Dorn type sampler from which 200 ml was filtered through a 0.45-micron filter. . After acidification with concentrated HCl 100

ml was transferred into a 250 ml Erlenmeyer flask. The pH was adjusted to 3.6 by adding 2ml of phthalate buffer. After adding 7ml of Diethyldithiocarbamate and 15 ml Methylisobutylketone (MIBK), the solution was transfered to a 500 ml separating funnel .The resulting solution was shaken vigorously for 30 seconds and the phases were allowed to separate. The MIBK layer was drawn off into glass stoppered test tube. The organic layer was analysed for Zinc, Lead, Chromium, Copper and Cadmium (18).

## IV. RESULTS AND DISCUSSION

**Physico chemical properties of soil :** The physico chemical properties of soil samples from the three locations were analyzed and presented in Table 2. It was observed that the sanples were very rich in organic carbon content and organic matter.The pH (6.24 ~ 6.90) of the soil sample seemed to be slightly acidic. The electrical conductivity ranged from 0.145 to 0.298 $dSm^{-1}$,nitrogen content varied from 386.91 to 712.46 $kgha^{-1}$, phosphorus ranged from 62.70 to 113.98 $kgha^{-1}$, potassium varied from 702.06 to 801.20 $kg^{1}$,sulphur seemed to be 19.66 to 42.06 $kgha^{-1}$,organic carbon content ranged from 2.21 to 2.31 %, organic matter had a range of 3.67 to 3.89, exchangable calcium varied from 1.72 to 1.78 % and exchangable magnesium was observed as 1.12 to 1.33 . An average of 44% water holding capacity was detected in all soil samples.

**TABLE.2**. Physico-Chemical Properties of Soil

| **Parameter** | **Naranamuzhy** | **Vechoochira** | **Ranni** |
|---|---|---|---|
| pH | 6.24 | 6.72 | 6.90 |
| EC ($dSm^{-1}$) | 0.298 | 0.145 | 0.273 |
| Available N (kg $ha^{-1}$) | 386.91 | 684.56 | 712.46 |
| Available P (kg $ha^{-1}$) | 113.98 | 104.75 | 62.70 |
| Available K (kg $ha^{-1}$) | 759.80 | 702.06 | 801.20 |
| Available S (kg $ha^{-1}$) | 19.66 | 42.06 | 19.88 |
| Organic C (%) | 2.31 | 2.30 | 2.21 |
| Organic matter | 3.67 | 3.89 | 3.73 |
| Exchangeable Ca | 1.76 | 1.72 | 1.78 |
| Exchangeable Mg | 1.33 | 1.17 | 1.12 |
| Water holding capacity (%) | 45.74 | 46.40 | 42.06 |

**Physico Chemical properties of water. :** Water samples were analysed and results were presented in Table 3. It was found that the pH was slightly acidic

**TABLE.3**.Physico-Chemical Properties of Water

| **Parameter** | **Narnamuzhy** | **Vechoochira** | **Ranni** |
|---|---|---|---|
| pH | 6.85 | 6.7 | 6.28 |
| BOD | 2.0 | 2.1 | 2.13 |
| COD | 62.4 | 62.8 | 63 |

**Monitoring of Heavy Metals in Soil** : The soil samples collected from the three Panchayaths were analysed for heavy metals. Concentration of heavy metals in soil samples was given in TABLE.4.and presented in Fig 1.

**TABLE.4.** Concentration of Heavy Metals in Soil

| **Location** | **Zn** **mg/kg** | **Fe** **mg/kg** | **Pb** **mg/kg** | **Cr** **mg/kg** | **Cu** **mg/kg** | **Cd** **mg/kg** |
|---|---|---|---|---|---|---|
| Naranamuzhy | 0.07 | 0.2 | 0.5 | ND | ND | ND |
| Vechoochira | 0.1 | 1.4 | ND | ND | 1.0 | ND |
| Ranni | 0.2 | 0.9 | ND | ND | 0.1 | ND |

**Fig.1. Graphical representation of Table.4**

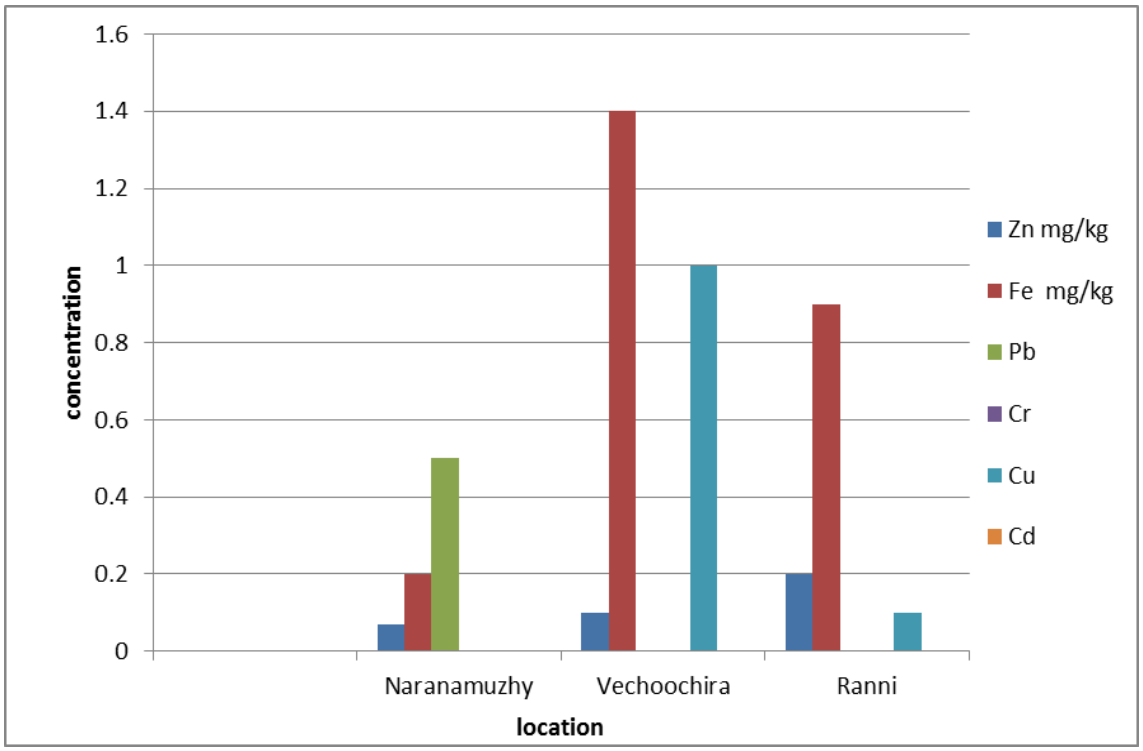


Fig 1: Heavy metal concentration in soil

The analysis revealed that soil samples were contaminated with heavy metals such as Zinc, Iron, Lead, and Copper . Of these zinc and Iron were present in all the three samples. (0.07, 0.1, 0.2).Iron (0.2, 1.4, 0.9), Lead in first sample (0.5), Copper in second and third sample.(1.0, 0.1).

**Monitoring of heavy metals in water :** The concentration of heavy metals in water was shown in Table 5. and Fig 2.

**TABLE.5.**Concentration of Heavy Metals in Water

| **Location** | **Zn** **mg/kg** | **Fe** **mg/kg** | **Pb** **mg/kg** | **Cr** **mg/kg** | **Cu** **mg/kg** | **Cd** **mg/kg** |
|---|---|---|---|---|---|---|
| **Naranamuzhy** | **ND** | **0.4** | **ND** | **ND** | **ND** | **ND** |
| **Vechoochira** | **ND** | **0.35** | **ND** | **ND** | **ND** | **ND** |
| **Ranni** | **ND** | **0.41** | **ND** | **ND** | **ND** | **ND** |

**Fig.2 Graphical representation of Table.5**

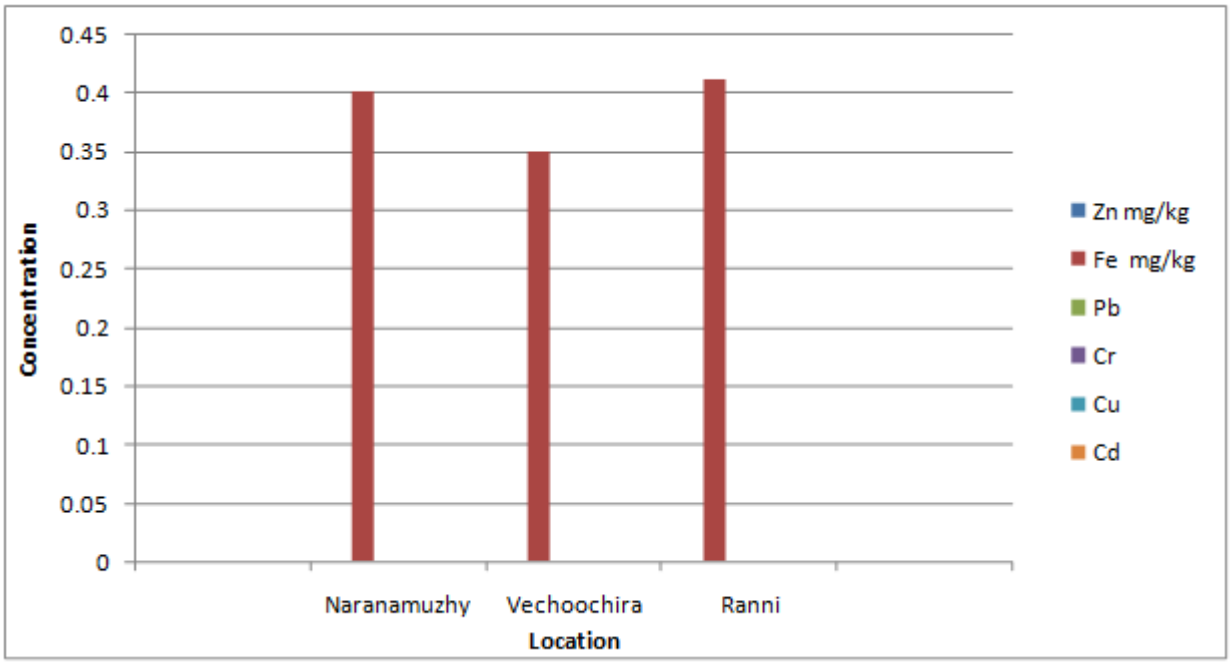


Fig 2. Concentration of heavy metals in water

When water samples were analysed for heavy metals only Iron (0.4, 0.35, 0.41)was detected and it indicated that the water bodies were not polluted due to heavy metals.

## V.CONCLUSION

In this study, a detailed analysis was carried out to study the contamination level of soil, and water with heavy metals at Naranamuzhy, Vechoochira and Ranni Panchayaths. The physico-chemical analysis of the soil samples showed that the area was highly suitable for agriculture.Though heavy metals were detected ,it was well below quantification level. The water sample analysis revealed that presently the water was not contaminated with heavy metals . The reason for this was due to leaching, runoff and microbial degradation. The study therefore showed that, if the use of pesticides continued the concentration of pesticide residues in soil and water may increase which in turn increased the concentration of heavy metals and could harm the flora and fauna of the area. It was found that plants like sunflower ,and corn could absorb heavy metals from soil..So if we plant them also along with crops, the heavy metal contamination could be controlled to some extent. This raised concern and needed immediate management policies to be adopted in the study area.

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