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Seasonal Variation Of Heavy Metal Accumulation In Water And Fish *Tilapia mossambicus* Collected From Puliyanthangal And Maniyambattu Lake Of Ranipet District, Tamilnadu.

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Abstract: The purpose of the study to evaluate the seasonal variation of heavy metal accumulation of lead (Pb) and chromium (Cr) in water and selected tissues such as gill, liver, muscle and ovary of the *Tilapia mossambicus* collected during the year between 2015 and 2016 at Puliyanthangal (PS1) and Maniyambattu Lakes (MS1) of Ranipet during the pre-monsoon, monsoon and post-monsoon seasons. Accumulation of heavy metals in water and fish samples was determined using atomic absorption spectrophotometry (AAS). Among the lead (Pb) and chromium(Cr) analyzed during a different season, the level of Pb and Cr concentration in S_1 and S_2 at Puliyanthangal lake (PS1) and Maniyambattu Lake water (MS1) were above the permissible limit of 0.05 and 0.01 prescribed by drinking purpose (WHO). The heavy metal concentration of lead (Pb) and chromium (Cr) in the Mouth region (S_1) seemed to be higher than the middle region (S_2) at PS1 and MS1. Results showed that the seasonal mean value of lead (Pb) in PS1 and MS1 were within the acceptable limit by international standards complied by FAO. The level of chromium (Cr) concentration in PS1 and MS1 higher than the permissible limit except for Cr content in muscle at PS1, which was within the acceptable limit. In Puliyanthangal lake (PS1), the lead (Pb) and chromium (Cr) content during different seasons showed the order gill>liver>ovary>muscle and liver>gill>ovary>muscle. In Maniyambattu Lake (MS1), the lead (Pb) content showed the order: liver>gill>ovary>muscle in monsoon and post-monsoon season and gill>liver>ovary>muscle in pre-monsoon season and chromium (Cr) concentration showed the order :liver>gill>muscle>ovary in the pre-monsoon season, gill>liver>ovary>muscle in monsoon and post-monsoon.Statistical analysis of Pb and Cr concentration in water and fish tissues among the seasons and between the sites significantly differed at $p>0.05$. Bioaccumulation of Pb and Cr was found more in gill and liver tissues than other organs because gill remains close contact with the environment. The liver plays a vital role in metal sequestration. The study concluded that Pb and Cr were found predominant in the tissues gill and liver with fluctuation of their level among the seasons.

Keywords: heavy metal, pollution, fish organs, bioaccumulation drinking and irrigational purpose.

Introduction

Environmental pollution is a significant worldwide issue that is escalating daily as a result of urbanization and industrialization. Heavy metals are defined as having a high atomic weight and a density more than five times that of water. The most often identified heavy metals in wastewater include arsenic, cadmium, chromium, copper, lead, nickel, and zinc, all of which are toxic to humans and the environment. Industrial effluents from leather tanneries included more significant levels of metal, particularly chromium. These effluents are discharged into a river or canal and a dump into groundwater, resulting in chromium buildup pollution. To a report, only 20% of chemicals used in tanning absorbed by the leather, with the rest leased as waste. The tannery sector significantly negatively influences the environment, particularly on water (because of its high oxygen consumption, discoloration, and hazardous chemical contents), terrestrial, and atmospheric systems. They are necessary for small amounts for health but may be harmful or harmful in large concentrations.

Groundwater is essential for potable water supply and acts as a water source for agricultural, irrigation, and industrial activity. Groundwater resources are increasingly at risk of contamination as a result of development and industrial expansion. The discharge of effluents into receiving water is the primary source of water contamination. These toxins are carried into aquatic environments such as rivers, lakes, and ponds, posing a threat to human health and the environment. There are approximately 230 and 240 tanneries in and around Ranipet district in Tamilnadu, India. The area is highly polluted due to tannery industries and chrome chemicals, refractories, ceramics, and other chemical businesses, which leak heavy metals into the environment. Mohiuddin (2011) studied heavy metals contamination in water and sediments of an urban river in a developing country and reported that the extent of heavy metals pollution in the Buriganga River system implies that the condition is much more frightening severely affect the aquatic ecology of the river. Igbinosa (2012) studied the assessment of physicochemical qualities, heavy metal concentrations and bacterial pathogens in Shanomi Creek in the Niger Delta, Nigeria and reported that the understudy of water has been highly contaminated and poses significant threats to water biota and public health. Srinivas (2013) studied heavy metals contamination in surface and groundwater of rural and urban areas of Kakinada, East Godavari district, A.P. observed that the situation is not too worst. Still, the higher concentrations of heavy metals in some sampling stations indicate that water is not suitable for domestic applications without proper water treatment. Rajeev Kumar (2014) studied the seasonal variation of heavy metal concentration in water of the River Yamuna, Allahabad, Uttar Pradesh, India and reported that the Pb and Cu concentrations in water were found to be greater than WHO permissible levels, indicating a potentially harmful risk to human health. Arsenic, on the other hand, was identified at quantities below the permissible limit. Sekar and Suriyakala (2016) Seasonal variation of heavy metal contamination of groundwater in and around Udaiyarpalyam taluk, Ariyalur district, Tamil Nadu reported some heavy metals in a few groundwater samples and hence refers to heavy metal accumulation of water sources. The result shows that most of the groundwater deteriorated less than the permissible limit of WHO.

Abida Begum *et al.* (2009) analyzed the heavy metal level in the water, sediment and ten fish species (Catla, Silver Carp, Common Carp, Tilapia, Mrigala, Etroplus, Murrels, Nandus, A-Mola and Catfish) of Madivala Lakes of Bangalore, Karnataka. The Madivala Lake receives sewage stormwater from surrounding localities. Rouf *et al.* (2009) studied heavy metal levels in three significant carps *Catla catla*, *Labeo rohita* and *Cirrhina mrigala*, from the River Ravi, Pakistan. They reported that heavy metal concentration was highest in Baloki's head, probably due to more industrial and sewage water effluents. Velkova-Jordanoska and Kostoski (2005) studied histopathological analysis of liver in fish *Barbus meridionalis* (*Petenyi heckel*) in reservoir Trebenista. They observed pathological changes in the liver tissue, including parenchyma cell necrosis consociated with hemorrhagic. Nwabueze (2011) found that the Levels of Some Heavy Metals in Tissues of Bonga Fish, Ethmallosa Fimbriata (Bowdich, 1825) from Forcados River.

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The results reveal that zinc and cadmium levels in this study above the WHO maximum acceptable limit, whereas copper, lead, and nickel levels were within the WHO's defined limits. Heavy metal-contaminated E Fimbriata from the Forcados River may be hazardous to other aquatic wildlife and dangerous to humans.

Kayalvizhi et al.(2013) studied on distribution and accumulation of heavy metals in water and *Chanos chanos* in Gadilum River Cuddalore, South East Coast of India. They observed that the rates of heavy metal accumulation in the selected tissues are the following order Cu > Zn > Pb > Cd > Hg. The higher level heavy metal recorded in stations II and III are near to SIPCOT industrial complex. Samson Eneojo Abalaka (2015) reported from their study on heavy metals bioaccumulation and histopathological changes in *Auchenoglanis occidentalis* fish from Tiga dam, Nigeria. He observed substantial differences ($p < 0.05$) in the metal content between the dam's water and the fish liver. In the Zn > Fe > Cd > Pb sequence, accumulations of the metals in the liver were observed. However, changes in the gills indicated normal function despite modifications seen in the liver and kidney. It, therefore, showed that Zn, Cd, Pb, and Fe were contaminating the dam. Elbeshti et al.(2018) studied the effects of heavy metals on fish and observed that heavy metals cause severe damage to fish, thus endanger fish health and ecosystem and constitute respectable risks for human health via heavy metal contaminated fish consumption. Sehar Afshan et al. (2014) analyzed the Effect of Different Heavy Metal Pollution on Fish and they observed that Heavy metals accumulate in fresh water and elevate through the food chain. Fishes are badly affected because they are the top consumer in aquatic systems. Humans are also affected by the intake of fishes for primary people of those areas where the leading food is fish. Sabry Mohamed El-Bahr and Ahmed Abdelghany (2015) studied heavy metal and trace element contents in the muscle of three commercial fish species and reported that the fish muscles contain substantially less heavy metals and trace elements, according to an assessment of potential dangers linked with their human ingestion in Saudi Arabia. Human ingestion of the commercial fishes studied at the Al-Ahsa market in Saudi Arabia poses no health risk. Chaitanya et al. (2016) studied bioaccumulation of heavy metals in marine fish samples at Visakhapatnam and Bheemili region, northeast coast of Andhra Pradesh, India, and observed heavy metal concentrations in various organs varied dramatically depending on location. The Bheemili region has a high percentage of copper cadmium, but the Visakhapatnam region had a higher concentration of zinc, lead, and arsenic.

MATERIALS AND METHODS

AREA OF STUDY

Ranipet district of Tamilnadu, India, formed by trifurcation of the Vellore district. River Palar running through the area, which is bordered by Ranipet and Arcot cities. Arakkonam is the district's major taluk and town. The town is sometimes referred to as Ranipettai and is located around 60 miles west of Chennai.. Ranipet has a population of around 50,000 people. 12.932063, 79.333466 are the latitude and longitude coordinates. Ranipet is home to the SIDCO and

SIPCOT industrial areas, both of which are significant to the Ranipet economy. Ranipet was formerly lauded as a rapidly growing industrial zone. Several large- and medium-scale leather industries make finished leather and leather articles such as shoes and garments for export. Other small-scale businesses in Ranipet include chemical, leather, and tool manufacturing. These industries are the town's main source of income. Ranipet also has about 500 small and large-scale engineering units catering mainly to BHEL. The Ranipet region is a chronically polluted area, with 240 tannery industrial units located in and around the town and other businesses such as ceramics, refractory, boiler auxiliaries, and chromium compounds. This settlement on the Palar river's northern bank.

Analytical Methods

Collection of water samples

The water samples were collected from the mouth(S_1) and middle (S_2) region of Puliyanthagal Lake (PS1) and mouth(S_1) and middle (S_2) region of Maniyambattu Lake (MS1) of Ranipet district, Tamilnadu. The study was carried out from 2015 – 2016. At each sampling site, the polythene sampling bottles were rinsed with distilled water at least three times before sampling was done. All samples were correctly labeled—the collection of water samples done during morning times (9 am to 10.30 am). Suspended particulate matter was separated by filtering water samples through Whatman filters. Samples bottles were immediately transferred to the laboratory to estimate various heavy metals content in lake waters, the procedure given by APHA (2000) using Atomic Absorption Spectrophotometer. The research period was divided into three seasons that Pre-monsoon, Monsoon and Post-monsoon.

Collection of the fish tissues (gill, liver, muscle and ovary)

The live freshwater fish *Tilapia mossambicus* (Fig. 3) collected from the Puliyanthagal Lake (PS1) and Maniyambattu Lake (MS1) of Ranipet district, Tamilnadu and cut open and removed for the tissues of gill, liver, muscle and ovary. The study was carried out from 2015 – 2016. For heavy metal accumulation, the fish tissues such as gill, liver, muscle and ovary collected and preserved in the thermocol icebox were brought to the laboratory for further analysis. Standard methodology was followed to extract heavy metals (Jackson, 1973) from water and fish tissues such as gill, liver, muscle and ovary. The research period was divided into three seasons that Pre-monsoon, Monsoon and Post-monsoon.

Laboratory Analysis

Estimation of heavy metals in the water and tissue samples

For the estimation of heavy metals, the tissue samples like gill, liver, ovary and muscle were dried and made into powdered form. The processed samples of tissues and water for the analysis of Zinc, Cadmium, Chromium, Lead, Manganese and Copper by using the triple acid extraction method (wet digestion technique) as proposed by Jackson (1973). In this method, the tissue and water samples' known weight is digested with a triple acid mixture to destroy the organic fractions and bring the mineral constituents into the solution. Triple acid mixture prepared as 9:2:1 ratio of concentrated nitric, sulphuric and perchloric acids. Preweighed samples were taken into a 100ml conical flask with a small funnel and digested the flask contents over a sand bath till a clear solution was obtained. Afterward, it was diluted with distilled water and transferred to a 100ml volumetric flask. In final, the volume of the solution made up to 100ml with distilled water was taken for further analysis by employing the techniques of Atomic Absorption Spectrophotometry.Atomic absorption spectrophotometer (Perkin Elmer / model – 320, USA) was used to estimate heavy metals such as Lead and chromium present in the test samples of water and fish tissues. The accuracy of the equipment was high, being less than one part per million. The prepared ash solution was aspirated directly into the flame unit of the AAS.

Statistical Analysis

Two-way ANOVA and t-test were employed to evaluate the variability of the heavy metal concentration for different seasons and sites. All the statistical calculations were used carried out using the software Minitab. The analyzed data were expressed as mean ± standard deviation (SD), standard error (SE). A $p < 0.05$ was considered significant.

Selection Of Sampling Points

The sampling locations were chosen based on population density, industrial operations such as the production of sodium chromate, chromium salt, and essential chromium sulphate tanning powder for the leather industry, and groundwater utilized by inhabitants for drinking and irrigation. The present research areas of Puliyanthangal and Maniyambattu Lakes receive partly treated and untreated wastes from surrounding companies and untreated home wastes from adjacent villages, directly or indirectly. Organic and inorganic contaminants in conventional wastewater have the potential to cause serious problems. Water samples were collected from the mouth and middle regions of Puliyanthagal Lake (PS1) and Maniyambattu Lake (MS1) in Ranipet, Tamilnadu, during the pre-monsoon, monsoon, and post-monsoon seasons, respectively. The lakes (Fig.1) chosen for the present study are situated 1km away from the village. The untreated tannery effluents are discharged directly or indirectly into the lake. However, this industrial site contributes to the country's economic status by exporting processed, high-quality leather to various parts. The tannery effluents released into the watershed and surrounding land area are causing various diseases and problems to the humans and other animals that live in this area. Asthma, skin disease and ulcer are the common diseases prevailing among the people living in the surrounding area near the lake. The lake water consumed by the cattle is also at risk.

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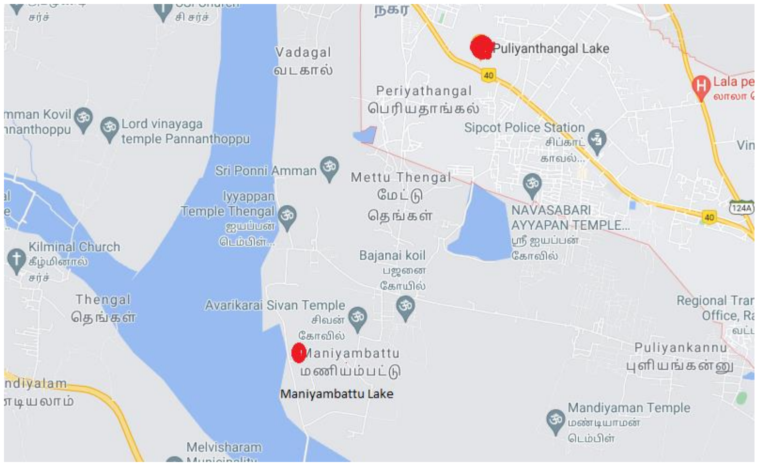

Fig.1.The map of the location is Ranipet district, Tamilnadu, India.

Result And Discussion

Heavy Metal Concentration In Puliyanthangal Lake.

Season wise, the level of lead (Pb) was ranged varied between 0.48±0.48 – 0.88±0.45 in S_1 and 0.06±0.06-0.3±0.48 in S_2 and chromium (Cr) was ranged from 0.07±0.02 – 0.11±0.02 in S_1 and 0.04±0.04 – 0.06±0.02 in S_2 at Puliyanthangal Lake water (PS1). The acceptable limit of lead (Pb) and chromium (Cr) is given by inland surface water (FAO) is reported to be 0.1 and 0.1 and for drinking purpose (WHO,1984) is reported to be 0.05 and 0.01, respectively.

The level of lead (Pb) and chromium (Cr) concentration at Puliyanthangal lake (PS1) in S_1 and S_2 exceeded the permissible limit for drinking purposes. Seasonal variation of lead (Pb) concentration in S_1 and S_2 at PS1were above the permissible limit except for S_2 in monsoon season and chromium (Cr) concentration in S_1 and S_2 were within the acceptable except S_1 in the pre-monsoon season of inland surface water standard. The heavy metal concentration of lead (Pb) and chromium (Cr) in the mouth region (S_1) seemed to be higher than the middle region (S_2) at PS1. Among the heavy metal analyzed in the mouth (S_1) and middle (S_2) region in the water sample, they showed the order of Pb > Cr and season wise the level of Lead (Pb) and chromium (Cr) concentration; they showed the order Premonsoon > post-monsoon> monsoon in S_1 and S_2. Statistical analysis revealed that the between the mouth and middle region of lead (Pb) concentration ($F=5.17$ and $p=0.035$) and Cr concentration ($F=12.68$, $p=0.002$) differed significantly at $p < 0.05$. Insignificant variation was observed between the season in lead (Pb) concentration ($F=0.09$ and $p=0.912$) and chromium (Cr) concentration) ($F=0.97$ and $p=0.399$) at $p > 0.05$.

Heavy Metal Concentration In Maniyambattu Lake.

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Season wise, the level of lead (Pb) was ranged from 0.31±0.49-0.56±0.56 in S_1 and 0.06±0.02-0.07±0.01 in S_2 and chromium (Cr) was ranged between 0.32±0.52 – 0.59±0.59 in S_1 and 0.05±0.02 – 0.09±0.10 in S_2 at Maniyambattu Lake water (MS1). The acceptable limit of lead (Pb) and chromium (Cr) is given by inland surface water (FAO) is reported to be 0.1 and 0.1. and for drinking purposes (WHO,1984) is reported to be 0.05 and 0.01, respectively. Among the lead (Pb) and chromium (Cr) analyzed during different seasons, the mouth (S_1) and Middle (S_2) regions at MS1 exceeded the permissible limit of 0.05 as prescribed drinking purpose (WHO).The level of lead (Pb) and chromium (Cr) in the mouth (S_1) were above the permissible limit and Middle (S_2) regions were within the limit of inland surface water standard. The heavy metal concentration of lead (Pb) and chromium (Cr) in the mouth region (S_1) seemed to be higher than the middle region (S_2) at MS1. Among the heavy metal analyzed in the mouth (S_1) and middle (S_2) region in the water sample, they showed the order of Pb > Cr. Among the season-wise the level of Lead (Pb) concentration, they showed the order Premonsoon> post-monsoon> monsoon in S_1 and Premonsoon=postmonsoon>monsoon in S_2 and the level of chromium (Cr) concentration seasonally, they showed the order Premonsoon> post-monsoon>monsoon in S_1 and S_2. Statistical analysis revealed that the between the mouth and middle region of lead (Pb) concentration ($F=6.78$, $p=0.018$) and chromium (Cr) concentration ($F=5.15$ and $p=0.036$) differed significantly at $p < 0.05$. Insignificant variation was observed between the season in lead (Pb) concentration ($F=0.30$ and $p=0.744$) and chromium (Cr) concentration ($F=0.28$ and $p=0.761$) at $p > 0.05$.

The increase of heavy metal concentrations in the lake water may be due to the intrusion of tannery effluent from tanning industries into the lake water. It is observed from the study the most of the tanning industries are letting the tannery effluent directly either into the land or into the canal without pre-treatment of tannery sludge. Finally, they are seemed to dilute into the lake water and thereby, the lake water has become unfit both for drinking and agriculture purposes. The common diseases of the people inhabiting this tannery industrial area are skin irritation, diarrhea, heart burning, respiratory tract infections, and severe cough.

The results indicated that tannery effluents mainly influence the Cr content. Therefore, the drinking water quality has deteriorated due to the escalation of Cr concentration more than permissible limits as prescribed by WHO (1984) and other pollution control Boards. It is predicted from this study that the water of Puliyanthangal Lake and Maniyambattu Lake of Ranipet is not suitable for drinking water purposes. Most of the investigators have consistently reported with the present work that the tannery effluents have elevated the Cr content and its related heavy metals, which would affect the water quality and thereby to human health and other living organisms. Srinivasa Gowd and Govil (2008) reported that some heavy/toxic metals like Zinc, Chromium, Copper, Lead, and cadmium are much above the permissible limits in surface water and are a health hazard, especially harmful to workers in the tanning industry. Mondall *et al.* (2005) observed that the untreated effluents from about 80 tanneries operating in and around Dindigul town in the Upper Palar basin Tamil Nadu, India, have considerably affected the quality groundwater this area.

Unpolluted lakes and rivers generally contain 0.036-0.075 mg/1 of chromium (Moore and Ramamoorthy, 1984). Higher values of 0.005-0.05 mg/1 were reported for several water bodies in the vicinity of industrial areas (Wilber and Hunter, 1977; Vandeerveen and Huizenga, 1980). In the present study, the overall values of chromium were ranged between 0.04±0.04 – 0.11±0.02at PS1 and 0.05±0.02 – 0.59±0.59 at MS1 in the water samples and thereby indicated that the values higher than the permissible limit both in water samples showed its harmful nature.

Considerable amount of work have been progressed in the recent days in various levels worldwide about the toxic amount of tannery effluent (Rao and Marriappan, 1972), inhibition of nitrification through tannin on soil and the activity of nitrogen-fixing organism (Basaraba, 1964; Pancholy, 1973), tannery waste in relation with irrigation of land soil microorganisms (Percuoco, *et al.,* 1973), discharge of tannery effluents into the water bodies affecting the Physico-chemical and biological character of water (Sastri and Madhavakrishnan, 1984), discharges of chromium-containing tannery effluents on land surface and then turns into unsuitable for irrigation purpose (Bera and Boraria, 1999) and the contamination of surface water and groundwater through tannery industries (Kamaludeen, *et al.,* 2003) etc with consistent support of the present work that tannery effluent discharged from the tanneries affect the water qualities in the palar water, Lake water, bore water and well water around the Puliyanthangal Lake and Maniyambattu Lake of Ranipet. Even though the government has taken a policy decision to release treated tannery effluents into the water, land and river, it is evidently found that there is no healthy environment ensured for the better survival of the human being having with the source of water, land and rivers and thereby an intensive steps have to be undertaken for the release of tannery effluent water into land and river and lake without affecting its nature.

Seasonal variation of heavy metal concentration of *Tilapia mossambicus* in Puliyanthangal Lake (PS1)

The content of lead (Pb) was more in the liver (4.59±4.68) followed by gill (2.84±3.55), ovary (0.50±0.079) and muscle (0.084±1.11) at pre-monsoon. In the monsoon season, lead (Pb) was more in the liver (1.50±3.20) followed by gill (1.17±2.76), ovary (0.16±0.05) and muscle (0.072±0.15). In post-monsoon season lead (Pb) was more in (2.45±3.75) liver followed by gill (1.44±2.97), ovary (0.28±0.07) and muscle (0.078±0.12). According to international standards in fish tissues, the lead (Pb) level could be permitted in the range between 0.5-10.0, respectively. The seasonal mean value of lead (Pb) within the acceptable limit by international standards complied by FAO. The seasonal mean value of lead (Pb) was analyzed in fish tissues like the gill, liver, muscle and ovary during pre-monsoon, monsoon and post-monsoon season at Puliyanthangal Lake (PS1) showed the order: liver>gill>ovary>muscle. The data indicated that the highest amount of lead (Pb) concentration in pre-monsoon and lowest concentrations in

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monsoon season. The pattern of lead (Pb) concentration seasonally was in decreasing order: pre-monsoon> post-monsoon>monsoon.

Chromium

The content of Cr was more in gill (8.17±3.72) followed by liver (3.26±2.24), ovary (2.86±2.53) and muscle (1.92±1.77) at pre-monsoon season. In the monsoon season, Cr was more in gill (3.12±2.55) followed by liver (1.88±1.60), ovary (1.07±0.91) and muscle (0.44±0.50) and post-monsoon season Cr was more in gill (5.12±3.28) followed by liver (2.35±2.39), ovary (1.45±1.22) and muscle (0.88±0.47). According to international standards in fish tissues, the Chromium (Cr) level could range between 1.0 respectively. Seasonal mean values of Chromium (Cr) were higher than the permissible limit of gill, liver, ovary and muscle by international standards complied by FAO except for the chromium (Cr) content in the muscle, which was within the acceptable limit in monsoon (0.44±0.50) and post-monsoon (0.88±0.47) season. The seasonal mean value of Chromium (Cr) was analyzed in fish tissues like gill, liver, muscle and ovary during pre-monsoon, monsoon and post-monsoon season at Puliyanthangal Lake (PS1) showed the order: gill>liver>ovary>muscle. The data indicated the highest Chromium (Cr) concentration in the pre-monsoon season and the lowest concentration in the monsoon season. The pattern of Chromium (Cr) concentration seasonally was in decreasing order: pre-monsoon> post-monsoon>monsoon. Seasonally mean value of heavy metals like lead (Pb) and Chromium(Cr) in the fish tissues like gill, liver, muscle and ovary at PS1 showed the order of Cr>Pb. Accumulation of chromium (Cr) was found more in the gill because the gill remains in close contact with the external environment. The concentration of lead (Pb) at various levels was found more in the liver because the liver plays an essential role in metal sequestration.

Seasonal variation of heavy metal concentration of *Tilapia mossambicus* in Maniyambattu Lake

The content of lead (Pb) was more in (2.21±4.24) gill followed by liver (1.45±3.29), ovary (0.95±0.80) and muscle (0.88±2.19). In the monsoon season, lead (Pb) was more in the liver (0.71±0.88) followed by gill (0.26±0.56), ovary (0.71±0.88) and muscle (0.06±0.09). In post-monsoon season, lead (Pb) was more in (1.4±3.73) gill followed by liver (1±2.34), ovary (0.06±0.09) and muscle (0.05±0.14) at Maniyambattu Lake (MS1). The seasonal mean value of lead (Pb) within the acceptable limit by international standards complied by FAO. The seasonal mean value of lead (Pb) analyzed in fish tissues like gill, liver, muscle and ovary during pre-monsoon, monsoon and post-monsoon season at Maniyambattu Lake (MS1) showed the order: liver>gill>ovary>muscle in monsoon and post monsoon season and gill>liver>ovary>muscle in pre-monsoon season. The data indicated the highest amount of lead (Pb) concentration in the pre-monsoon season (0.9±2.19 to 2.21±4.24) and lowest concentration in the monsoon season (0.063±0.09 to 0.6±0.14). The pattern of lead (Pb) concentration seasonally was in decreasing order: pre-monsoon> post-monsoon>monsoon.

The content of chromium (Cr) was more in gill 1.88±1041, 4.65±3.79 in the liver, 0.68±0.88 in muscle and 0.79±1.08 in the ovary at pre-monsoon season, 1.59±0.85 in gill, 1.12±1.47 in the liver, 0.47±0.5 in muscle and 0.49±0.44 in the ovary at monsoon season and 1.81±1.18 in gill, 1.45±2.51 in the liver, 0.56±1.29 in muscle and 0.65±.87 in the ovary at the post-monsoon season. The seasonal mean value of chromium (Cr) above the permissible limit of 1. The seasonal mean value of chromium (Cr) analyzed in fish tissues like gill, liver, muscle and ovary during pre-monsoon, monsoon and post-monsoon season at MS1 showed the order: liver>gill>muscle>ovary in the pre-monsoon season, gill>liver>ovary>muscle in monsoon and post-monsoon. The data indicated the highest amount of chromium (Cr) concentration in the pre-monsoon season (0.79±1.08 to 4.65±3.79) and lowest concentration in the monsoon season (0.47±0.57 to 1.59±0.85). The pattern of chromium (Cr) concentration seasonally was in decreasing order: pre-monsoon> post-monsoon>monsoon. The lowest concentration of all the examined metals was consistently detected in the muscle tissue. Seasonal variation of lead (Pb) and chromium (Cr) levels within the tissues between the season and lakes were statistically significant at $p>.05$.

These observations seemed to agree with a broad literature review on heavy metals in fish by Jezierska and Witeska (2001). It is generally accepted that muscle is not an organ in which metals accumulate (Legorburu *et al*., 1988). Several species reported similar results showing that muscle is not an active tissue in accumulating heavy metals (Karadede and Unlo, 2000). This agrees with the present study that the metals analyzed were lower in the muscle than the liver, gill and ovary. It is concluded that the muscle tissue of fish is effectively protected by the other organs so that only trace level of the metals accumulate in it. This mechanism makes fish muscles safe for human consumption.

While Adefemi *et al.* (2008) reported the levels of the heavy metals in the *Tilapia mossambicus* from Ureje dam in South-Western Nigeria that the Zn, Cd, Pb and Mn were ranged between 0.73-1.02, 0.51-0.87, 0.08 and 0.49-1.02, respectively and these results were lower than that of same fish for the present study. It indicates that the variation between the metals in the Nigerian fish sample and the present study from Puliyanthangal Lake and Maniyambattu Lake of Ranipet of Tamilnadu may be due to the natural selection phenomenon or by anthropogenic pollutant or industrial pollution caused in the particular type of water body. In Nigerian water, the Cr content was not detected in the gill and muscle and Pb was also not detected in the muscle. Although the Cr and Pb contents were detected in the gill, liver and muscle, their level in tissues was lower than that of international standards for legal limits for hazardous substances for fish and fishery products compiled by FAO.

According to International standards in fish tissues, the levels of Cr and Pb could be permitted in the range between 1.0 and 0.5 – 10.0, respectively. The levels of heavy metals fluctuated with a lower quantity in the fish tissue of *Tilapia mossambicus* for the present study, indicating that the fish tissues were harmless and suitable for the eatable purpose since their

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values were within the international standard value for food consumption. When the accumulation of heavy metals occur continuously in Puliyanthangal Lake (PS1) and Maniyampattu (MS1) Lake either by tannery effluent discharge or by anthropogenic pollutants by direct and indirect means, the bio-concentration of metals in fish may pose a severe threat to the fish and thereby to the human population.

There are remarkably few studies on the dietary effects of Mn, Zn and Cr on predators or the adverse effects associated with particular tissue levels on the organisms themselves. Mn, Zn and Cr are essential trace elements, although all can cause toxicity at high doses. The reasons why many sources have explained the accumulation of heavy metals in the fish tissues at various levels. Entry of metal occurs either through the gill membrane or through ingestion. The difference in heavy metal accumulation in different fish organs was reported by Mathis and Cummings (1973) and Bury *et al.* (2003).

The level of bioconcentration of toxic metals among the fish organs, the liver was concerned to be an excellent bio-accumulator (Olsson, 1998). The fish actively controlled the accumulation of bioactive metals like Cu and Zn through metabolic processes of ambient concentrations (Pattee and Pain, 2003). Bioactive metals play an essential role in metabolism, thus in the physiology and pathology of fish. Metals like Zn and Cu functions as a cofactor in several enzyme systems (Bury *et al.*, 2003). However, these bioactive metals may pose severe threats to normal metabolic processes when in excessively high concentrations.

In fish, gills are considered the dominant site for contaminant uptake because of their anatomical and physiological properties that maximize absorption efficiency from water (Hayton and Barron, 1990). However, either bone or liver was the site of maximum accumulation for elements. At the same time, the muscle was the overall site of a minor metal accumulation in both *Oreochromis niloticus and O. mossambicus* (Chatterjee *et al.*, 2006).

Generally, heavy metal accumulation is more in the animal tissue than the water for drinking purposes. In the present study, the content of Cr was detected with high quantities in the fish tissues like gill, liver, muscle and ovary. In contrast, this metal contents were high in the liver and gill and compared to the level of these metals in water. The fluctuated high and low level of metals present in the tissues like gill, liver, muscle and ovary may be due to the absorption and its reabsorption for the metabolic activity of the fish tissues. It is generally suggested that more amount of micronutrients or otherwise called essential heavy metal are required for the maintenance of fish tissues compared to water for drinking purpose. It is predicted from this result that fluctuation of high and lower values detected in gill, liver, muscle and ovary were within the acceptable limit for food consumption as reported by FAO.

The low value of heavy metals in the fish tissues suggests that the fish could reduce the concentration of these metals in their body from the aquatic environment. Fishes are notorious for their ability to concentrate heavy metals in their muscle (Varshney, 1991). In contrast to the non-essential trace metals such as Pb, Cd, Hg, Ar, the essential metals such as Cu, Zn, Fe and Co have essential biochemical functions in the organisms. They form either an electron donor system or function as ligands in complex enzymatic compounds. Since essential elements are only used by the organisms in trace amounts and generally as they exist in the environment in small concentration, their enrichment in the organisms does not exceed the level which allows the enzyme system to function without interference. This means that the concentration of essential trace elements is generally higher in the organisms than in water. If there is excess in the body, the metal content in the organism can be regulated by homeostasis (Bryan and Hummerstone, 1973)

Conclusion

This study shows that tannery effluent, whether treated or raw, has an impact on water quality. The maintenance of human existence and their dependant source of agriculture output are continually becoming difficult. Further, the animals like goats and cattle etc., are at risk of life. This analysis shows that heavy metals are present in fish tissues due to the influence of tannery effluent as one of the many other factors along with anthropogenic activities and other natural phenomena for the sedimentation process into the lake water. It is recommended that the release of the raw tannery effluent or processed tannery effluent by tanning companies into Puliyanthangal lake (PS1) and Maniyambattu Lake (MS1) may be halted. Other relevant precautions may be made to avoid infiltrating this water into lake water so that a healthy environment may be ensured around this place.

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Table 1. Results of Heavy metals concentration in water collected from the Lake Puliyanthangal, Ranipet.

Heavy metals	Season	Inland surface water standard (ppm)	Acceptable limit WHO (1984) (ppm)

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lead(Pb)	premonsoon	monsoon	postmonsoon	0.1	0.05
Mouth	0.88±0.45	0.48±0.48	0.63±0.79		
Middle	0.3±0.48	0.06±0.06	0.29±0.49		
chromium(Cr)	premonsoon	monsoon	postmonsoon	0.1	0.01
Mouth	0.11±0.02	0.07±0.02	0.08±0.02		
middle	0.06±0.02	0.04±0.04	0.05±0.02		

Table.2 The concentration of toxic metals (Pb and Cr) during a different season. Two-way analysis of variance (ANOVA) testing method and Values are statistically significant at p>.05.

PS1	source	DF	SS	MS	F	P
Lead	Between the place	1	1.28205	1.28205	5.17	0.035
	Between the season	2	0.04613	0.02307	0.09	0.912
	Interaction	2	0.42829	0.21414	0.86	0.439
	error	18	4.46479	0.24804		
	total	23	6.22126			

PS1	source	DF	SS	MS	F	P
chromium	Between the place	1	0.0078844	0.0078844	12.68	0.002
	Between the season	2	0.0012021	0.0006010	0.97	0.399
	Interaction	2	0.0031937	0.0015969	2.57	0.104
	error	18	0.111937	0.0006219		
	total	23	0.0234740			

Table 3. Results of Heavy metals concentration in water collected from the Lake Maniyampattu, Ranipet.

Heavy metals	Season			Inland surface	Acceptable limit WHO

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				water standard (ppm)	(1984) (ppm)
lead(Pb)	premonsoon	monsoon	postmonsoon	0.1	0.05
Mouth	0.56±0.56	0.31±0.49	0.55±0.58		
Middle	0.07±0.01	0.06±0.02	0.07±0.04		
chromium(Cr)	premonsoon	monsoon	postmonsoon	0.1	0.01
Mouth	0.59±0.59	0.32±0.52	0.35±0.51		
middle	0.09±0.10	0.05±0.02	0.06±0.04		

Table.4. The concentration of toxic metals (Pb and Cr) during a different season. Two-way analysis of variance (ANOVA) testing method and Values are statistically significant at $p>.05$.

MS1	source	DF	SS	MS	F	P
Lead	Between the place	1	1.008	1.00860	6.78	0.018
	Between the season	2	0.08957	0.04479	0.30	0.744
	Interaction	2	0.07442	0.03721	0.25	0.781
	error	18	2.67880	0.14882		
	total	23	3.85140			

Site2	source	DF	SS	MS	F	P
chromium	Between the place	1	0.76684	0.766838	5.15	0.036
	Between the season	2	0.08242	0.041212	0.28	0.761
	Interaction	2	0.09742	0.048712	0.33	0.725
	error	18	2.68108	0.148949		

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	total	23	3.62776			

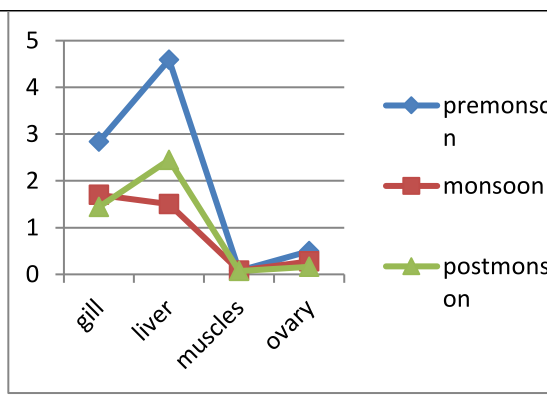
t-test Lead	Between the site	DF	T - value	P
		46	-1.31	0.045

T-test

chromium	Between the site	DF	T - value	p
		23	-1.05	0.03

Table 5. Heavy metals concentration in different fish organs of *Tilapia mossambicus* during different seasons in Lake Puliyanthangal lake, Ranipet.

lead(Pb) PS1	gill	liver	muscles	ovary
premonsoon	2.84±3.55	4.59±4.68	0.084±1.11	0.50±0.079
monsoon	1.7±2.76	1.50±3.20	0.072±0.15	0.16±0.05
postmonsoon	1.44±2.97	2.45±3.75	0.078±1.12	0.28±0.07



lead(Cr) PS1	gill	liver	muscles	ovary
premonsoon	8.17±3.72	3.26±2.24	1.92±1.77	2.86±2.53

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monsoon	3.12±2.55	1.88±1.60	0.44±0.50	1.07±0.91
postmonsoon	5.12±3.28	2.35±2.39	0.88±0.47	1.45±1.22

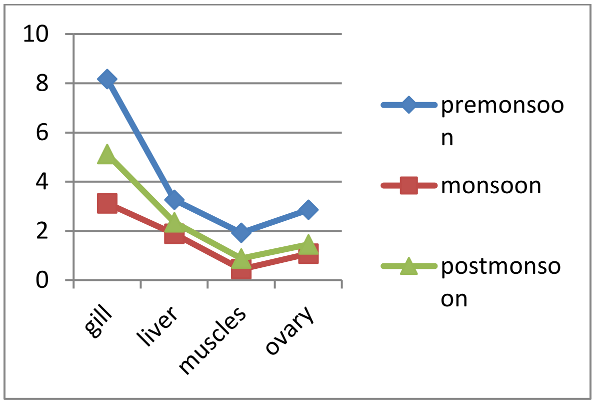

Table 6. Heavy metals concentration in different organs of Tilapia mossambicus during different seasons in Lake Maniyambattu lake, Ranipet.

lead(Pb) MS1	gill	liver	muscles	ovary
premonsoon	2.21±4.24	1.45±3.29	0.88±2.19	0.95±0.80
monsoon	0.26±0.56	0.71±0.88	0.05±0.14	0.06±0.09
postmonsoon	1±2.34	1.42±3.73	0.05±0.05	0.89±1.29

lead(Cr) MS1	gill	Liver	muscle	ovary
Premonsoon	1.88±1.41	4.65±3.79	0.68±0.88	0.79±1.08
Monsoon	1.59±0.85	1.12±1.47	0.47±0.57	0.49±0.44
Postmonsoon	1.81±1.18	1.45±2.51	0.56±1.29	0.65±0.87

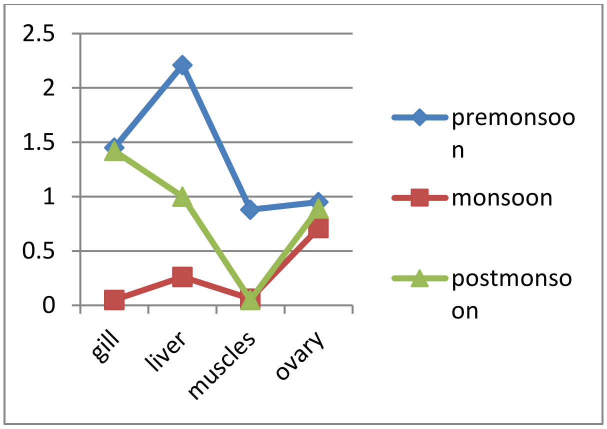

Table.7. The concentration of toxic metals (Pb and Cr) in different tissues of Tilapia mossambicus during a different season. Two-way analysis of varience (ANOVA) testing method. Values are statistically significant at p>.05.

Puliyanthangal Lake(PS1)	Source	DF	Adj SS	Adj MS	F-Value	P-Value
Lead (Pb)	Factor	3	0.7196	0.23987	11.01	0
Within The Tissues	Error	476	10.3687	0.02178		
	Total	479	11.0883			
Chromium(Cr)	Source	DF	Adj SS	Adj MS	F-Value	P-Value
Within The Tissues	Factor	3	186.9	62.306	14.36	0
	Error	476	2065.9	4.34		
	Total	479	2252.8			

Maniyambattu Lake(MS1)	Source	DF	Adj SS	Adj MS	F-Value	P-Value
Lead (Pb)	Factor	3	27.18	9.0591	47.02	0
Within The Tissues	Error	476	91.71	0.1927		
	Total	479	118.89			
Chromium(Cr)	Source	DF	Adj SS	Adj MS	F-Value	P-Value
Within The Tissues	Factor	3	130.5	43.4857	60.7	0
	Error	476	341	0.7164		
	Total	479	471.4			

Lead (Pb)	N	Mean	SE

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Puliyanthangal Lake (PS1)	480	0.272±0.498	0.023
Maniyambattu Lake (MS1)	480	0.133±0.152	0.0069
Between The Site	T-Value	DF	P-Value
	5.83	567	0

Chromium (Cr)	N	Mean	SE
Puliyanthangal Lake (PS1)	480	2.68±2.17	0.099
Maniyambattu Lake (MS1)	480	0.835±0.992	0.045
Between The Site	T-Value	DF	P-Value
	16.98	671	0

Puliyanthangal Lake(PS1)	Source	DF	Adj SS	Adj MS	F-Value	P-Value
Lead (Pb)	Season	2	0.5410	0.27049	12.23	0
Between The Season	Error	477	10.5473	0.02211		
	Total	479	11.0883			
Chromium(Cr)	Source	DF	Adj SS	Adj MS	F-Value	P-Value
Between The Season	Season	2	30.99	15.495	3.33	0.037
	Error	477	2221.82	4.658		
	Total	479	2252.81			

Maniyambattu Lake(MS1)	Source	DF	Adj SS	Adj MS	F-Value	P-Value
Lead (Pb)	Season	2	1.560	0.7801	3.17	0.043
Between The Season	Error	477	117.33	0.246		
	Total	479	118.89			
Chromium(Cr)	Source	DF	Adj SS	Adj MS	F-Value	P-Value
Between The Season	Season	2	4.942	2.471	2.53	0.081
	Error	477	466.504	0.978		
	Total	479	471.446			

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