Hazard index of heavy metals existent in industrial wastewaters in the body of south Karun farmed fish and its effect on human: from the view point of green ergonomics

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Abstract: Heavy metals produced from man- made, industrial and municipal effluents causes pollution of rivers and existing fish that are there, consequently create significant health risks and significant economic costs for the residents of the region. In order to investigate the effect of these human activities on water resources, fish as well as welfare and well-being of humans, this study has been carried out from the ergonomic perspective. For this purpose, in 2018, samples were taken from 4 pools of Shaheed Ahmadi Fish Farming Center of Khorramshahr. The purpose of present study was to investigate and to evaluate the risk indicator of heavy metals including Cadmium, Lead, Iron, Manganese, copper and zinc in muscle of *Cyprinus carpio* cultured fish in Southern Karun. Using wet digestion method and by helping of atomic absorption device, Perkin Elmer 4100, the concentration of heavy metals was measured which comparing achieved results with international standards indicated the pollution of the studied species in the Karun River to Cadmium, Lead, Iron, Manganese and copper in comparison with According to WHO, FAO, NHMRC standards. According to average concentrations of heavy metals in breading fish, daily pollutant adsorption rates (DI) are measured, which were higher than universal standard rates USEPA and except cadmium and copper, other elements has a significant differences with USEPA rates ((P <0/05). Measured risk indicator rates were equal to the total of risk factors of existing heavy metals investigated in breading fish. The results of present study showed that although the amount of risk factors for each of the studied metals was less than 1, but risk indicator rate resulted of total 6 risk factors in muscle of breading fish is significant amount and There is considerable potential for this to be increased by measuring the risk factor of other heavy metals in the muscle, which can be a warning to threaten the health those people who is consume these fish, especially in vulnerable groups of society (children, women and the elderly). Pervious researches have shown that the green ergonomic approach can provide a deeper and more profound understanding regarding the stable relationship between human beings and ecology and human well-being, considering the general functioning of the socio-ecological system.
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Introduction

Ergonomics that is human factors, deals with studying relations between human and other factors of a system interacting with each other in a work place and it uses theories, principles, data and relevant solutions to improve performance of the system as well as its welfare. Growth in population has lead to an increase in agricultural and industrial activities as well as amount of pollutants in the environment. As a result, it has made serious pollution problems in the aquatic ecosystem. Moreover, it has highly attracted attention of international institutions and organizations.

The most important conclusion of constancy of heavy metals is their expansion in the food chain. This means that, amount of heavy metals in the food chain can increase much more compared to water or air. The green ergonomics approach may help to set out the correlation among human, environment as well as human welfare regarding the performance of social – ecological system.

Human and nature ergonomics; green ergonomics

Morabi (1995) suggested that, ergonomics is limited to relations between human and equipment in the work place. Hilander (1997) focused on the necessity of dealing with world social and environmental problems including pollution in urban areas. Hanson (2010) used the term “ergonomics” to highlight why ergonomics collaboration to decrease

environmental effects through studying manufacturing solutions and using less energy.

1. Ergonomic interaction and sustainable development

The earth that is 5 billion years old appeared after a huge explosion like a flaming sphere. Over one billion years, existent gases in the hearth of the earthy sphere got cold and then life began. The life started when first amoebas created. Although human forms only a small percentage of biomass, but it is the dominant species in the world. The issue affects relations between human and its surrounding. So it changes human links from a balanced relation to an imperious one.

2. Stable and ergonomics framework of human factors

Indicators of the sustainable development could be studied in four social, economic, environmental and fundamental groups. Sustainable development is a process which aims to gain sustainable in each activity which needs resources and integrated displacement. In a developed community or economy, sustainable development, economic growth as well as human development all attempt to gain a consistent development far beyond economic one.

natural origins of heavy metals

Heavy metals are naturally found in the earth crust. In spite of their small amount and low solubility, they are mainly separated from the earth crust through weathering and washout and then enter into aquatic ecosystem, with the result that they consider as natural pollution. However, the amount and detrimental effects of heavy metals are less than human made pollutions.

human origins of heavy metals

In some areas, it is seen a marked increase in the amount of heavy metals owing to human industrial activities. Industrial and agricultural wastewater, pollution of transportation sectors, substances made from burning fossil fuels, earth washout, excreta and wastewater from animal husbandry are constituents of heavy metals in the aquatic ecosystem. The human origin of heavy metal is industrial activities, mining, transportation as well as other human activities.

5.3 human origins of heavy metals in Karun River

Karun's aquatic ecosystem is at the risk because of irregular using of water and discharging raw sewage into the river. Khuzestan is one strategic province in Iran with great potential for agricultural and industrial development. However, river pollution can significantly jeopardize its development.

A considerable amount of water used in agriculture returns back to the river through drainage or other flows. Urban sewage increases pollutant content in the river in particular heavy metals including zinc.

Methodology

Muscle tissue of minnow farmed fish living in the south border of Karun River was used for sampling. In view of heavy metal importance as a source of pollution, their undesirable long-term effects on human health, easy entrance to the biological cycle, strategic importance of Karun River and its role for pisciculture, the present research was carried out in spring 2017 to measure amount of possible existent heavy metals in the understudied farmed fish as well as studying hazard index of human consumption particularly in surrounding villages.

1.6- Research site: Shahid Ahmadian fish farm, Khorramshar

Shahid Ahmadian fish farm is located in 15 kilometers of Khorramshahr and 25kilometers of Abadan, in the Khorramshar-Ahwaz road. It annually breeds 3600 ton fishes.

2.6 measuring hazard index (HI)

Hazard quotient (HQ) was calculated by the following equation:

$HQ = (Cm \times IR / BW) / R_fD$

Where:

HQ is the hazard quotient; C_m (measured consumption) is average concentration of pollutant in the fish tissue (microgram/ gr); IR (ingestion rate) is standard average of daily consumption of fish (30 gr daily); BW is body weight (70 Kg for an adult); R_fD is reference dose or the sum of authorized daily absorption of contaminant (mg/kg per day).

Daily zinc absorption, that is DI, is calculated by the following equation: $DI = (C_m \times IR) / BW$

To put it another way, the hazard factor is as follow: $HQ = DI / R_fD$

All in all, the sum of hazard indices (HI) of understudied heavy metals in the given sample would be calculated using the following equation: $HI=\sum HQ = HQ_a + HQ_b + HQ_c + HQ_d + \ldots + HQ_n$

Accordingly, the potential risk associated with consuming each kind of understudied species for human could be calculated using the hazard index (HI). Results suggest that consuming fish containing heavy metals have determinant effects on human health, when HI is less than 1.

Statistical hypothesis testing

Data were analyzed by SPSS and Excel softwares. Using t-statistic test average concentration was compared to international standards so as to determine if there is a significance level at 95% ($P<0.05$).

Results

1. Amount of heavy metals in the muscle tissue of the understudied farmed fish .

The following conclusion may be drawn from findings. The mount of heavy metals in the water is the most important factor for aggregation of metal in the muscle tissue of understudied species. According to most researchers, habitation of fish and amount of heavy metal are of the most importance. Shahid Ahmadian fish farm in Khorramshar, provided researcher with understudied farmed fishes. Karun River as the biggest river in Iran surrounded with several farms supplies its water. Annually, various physical, chemical and biological pollutants discharged into the river.

The roots of Karun's pollutant industries lie in agricultural runoff, industrial wastewaters and urban swages. Discharge of Industrial sewage from Khouzestan steel company, valve and pipes, pars-paper and Dezfoul sugar factories, agro-industries and other relevant industries, Abadan refinery, powerhouses as well as urban sewage into the river cause to increase amount of pollutants particularly heavy metals in the water.

2. comparing daily absorption of heavy metals in the muscle tissue of farmed fish with international standard .

Results suggest that, average daily absorption of all given heavy metals in the muscle tissue of minnow farmed fish is more than USEPA international standard which issues a warning about its danger for consumers in particular the poor. Except for cadmium and copper, average daily absorption of other understudied heavy metals suggest a significance difference with USEPA international standard ($P>0.05$).

3.Studying hazard index (HI) of understudied heavy metals in the muscle tissue of minnow farmed fish.

Findings suggest that, although hazard index rate for each understudied metal is less than 1, but hazard index obtained from sum of 6 hazard quotients in the muscle tissue of the farmed fish is significant, that is 0.545. Moreover, it probably increases if hazard index of other heavy metals in the sample are measured. So it suggests a warning about danger of consuming this type of farmed fish particularly for the poor.

In the present research, based on amount of existent heavy metals and the reference dose, HQ rate was compared in the muscle tissue of minnow farmed fish with USEPA international standards. According to obtained results, the highest and lowest amounts were calculated for Lead and Manganese, respectively.

Conclusion

Findings suggest that, the sum of 6 hazard quotients in the muscle tissue of the minnow farmed fish is significant and it probably increases if HQ is measured for other heavy metals in the sample. It sounds a warning about consuming this kind of fish particularly for the poor. Research suggest that the green ergonomic approach can provide a deep understand about stable relationship among human, ecology and welfare, by taking into account the whole performance of the socio-ecological system.

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