Journal of Mines, Metals and Fuels, *71(11): 2126-2131; 2023. DOI: 10.18311/jmmf/2023/36036*

Print ISSN : 0022-2755

Journal of Mines, Metals and Fuels

Contents available at: *www.informaticsjournals.com/index.php/jmmf*

Study of Correlation of Arsenic in Fish Flesh and Occurrence of Oral Carcinoma in Effected Areas of West Bengal

Tanmoy Basak[1], Pritha Pal[2]* and Subhasis Sarkar[2]

[1]Research Scholar, Department of Microbiology, Swami Vivekananda University, Kolkata, West Bengal, 700121, India
[2]Assistant Professor, Department of Microbiology, Swami Vivekananda University, Kolkata, West Bengal, 700121, India; prithap@svu.ac.in

Abstract

Arsenic has been associated with the occurrence of various carcinoma like skin, lung, bladder, kidney, liver, oral cavity. Its toxicity is reported to have been contributed through the intake of drinking water from various contaminated sources. However, its possible relationship with the intake of the metal contaminated fish flesh with the occurrence of carcinoma has not yet been well established. 83 oral malignant and 80 control individuals were selected for the study and on their proper consent, the hair samples were processed for arsenic estimation by the method of flow injection hydride generation atomic absorption spectrometry. The data related to the determination of arsenic level in fish flesh obtained from the affected districts of West Bengal was collected from the literature. The statistical analysis of all the data was performed by using SPSS Version 10.1, which suggested a highly significant large positive correlation between the intake of arsenic contaminated fish and the occurrence of oral malignancy in the affected individuals (p value = 0.023). The study concludes that the intake of the metal contaminated fish can be a possible factor leading to the malignancy of the selected population.

Keywords: *Arsenic, Correlation, Fish Flesh, Metal, Occurrence, Oral Cancer, West Bengal*

1.0 Introduction

As a strong paradoxical human carcinogen, arsenic is a significant environmental hazard. While reports of its impact on many malignancies, particularly skin, lung, kidney, and bladder carcinomas, are available, its relationship with OSCC is currently also a subject of extensive research[1-3]. Millions of people are affected by arsenic toxicity worldwide, which has negative effects on their health including cancer and death. Drinking arsenic-contaminated ground water currently affects residents of more than 35 different nations[4]. Through oral consumption of carious dietary items like rice, fish, etc., the metal can also enter the humanbody through natural sources. One of the main ways that people are exposed to arsenic, cadmium, mercury, and lead is through fish intake[5]. Total exposure to arsenic is largely caused by fish; however, most of the arsenic foundin fish is in the form of organic arsenic, notably arsenobetaine, which is essentially benign[6].

The attempt of the present study is to study the possible correlation between the incidence of arsenic contamination in fishes and the occurrence of Oral Squamous Cell Carcinoma (OSCC) in the selected population of West Bengal, since the state is the most arsenic effected area in the country.

*Author for correspondence

2.0 Methodology

After obtaining the ethical clearance from the institutional committee, 83 oral malignant individuals and 80 control (healthy age and sex matched individuals from same geographic locations) individuals were selected for the study, among all the patients attending the Out Patient Departments of ENT Head & Neck Surgery and Oral Maxillofacial Surgery Departments of Ramakrishna Mission Seva Pratishthan, Kolkata. The patients were all screened by the respective clinician for the presence of oral squamous cell carcinoma in different oral sites. A detailed questionnaire regarding the dietary habits and other epidemiological data of the concerned individuals was administered with the respective individuals for collecting the related data. Upon their consent, the hair samples were collected from both the effected and control individuals and were processed for arsenic level estimation by the method of flow injection hydride generation atomic absorption spectrometry. The data related to the arsenic count in fish flesh of the respective districts of West Bengal (from where the effected and control individuals came) was collected from the literature. The final data of arsenic count estimated in oral malignant, control and fish flesh were statistically analyzed using software based on SPSS version 10.1 (spss.exe) Statistical Product and Service Solutions.

3.0 Results

The oral malignant individuals showed an elevated arsenic count ranging from 0.08-1.03 mg/kg while the control individuals showed the arsenic count ranging from 0.08-0.33 mg/kg. The literature indicated that the arsenic count observed in fish flesh dwelling in the water bodies of the concerned districts of West Bengal (Nadia, North 24 parganas, South 24 Parganas, Burdwan,

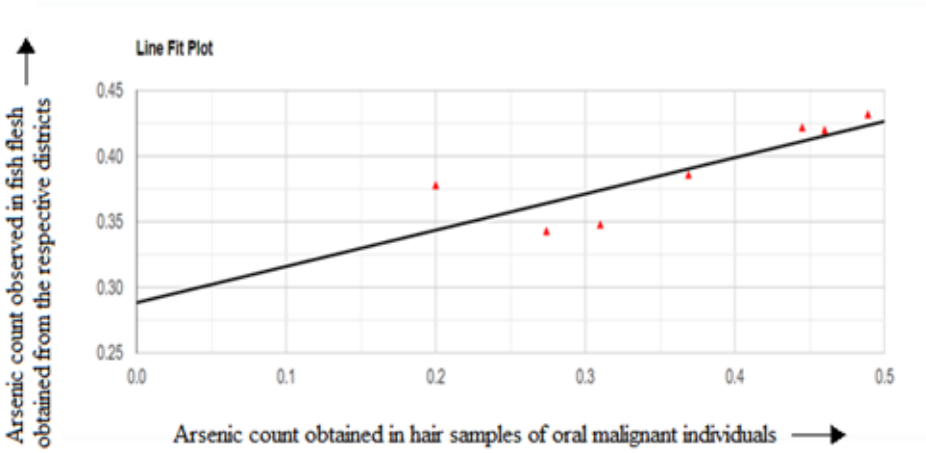

Figure 1. Graphical representation of correlation analysis of arsenic counts observed in hair samples of oral malignant individuals and fish flesh obtained from the respective districts of West Bengal.

Table 1. Tabular representation of mean values and standard deviation of arsenic levels obtained in hair samples of oral malignant & control individuals and fish flesh samples collected from the respective districts of West Bengal

	Arsenic count in malignant individuals	Arsenic count in control individuals	Arsenic count in fish flesh
Mean	0.3648193	0.145715	0.3578
Standard deviation	0.1735862	0.0471009	0.102209458

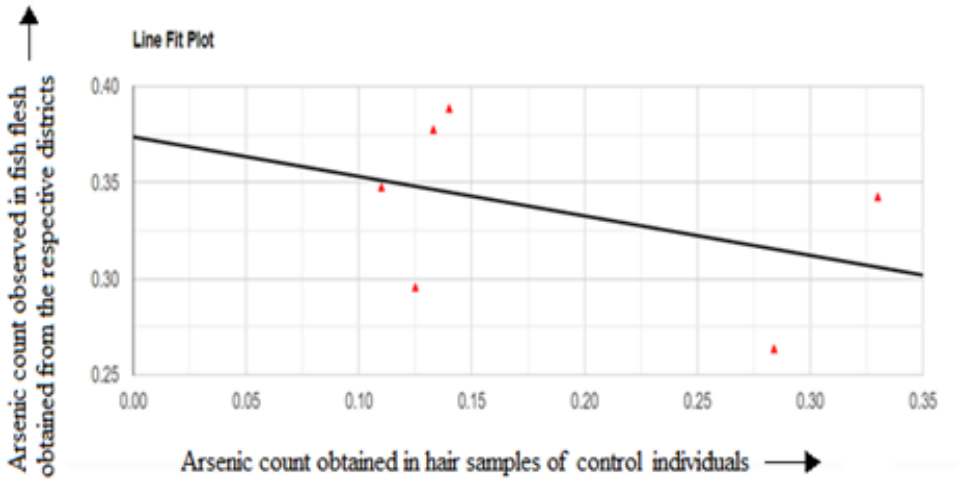

Figure 2. Graphical representation of correlation analysis of arsenic counts observed in hair samples of control individuals and fish flesh obtained from the respective districts of West Bengal.

Howrah and Murshidabad) was considerably high, falling within the range of 0.04-0.4 mg/kg; safe limit being 0.08-0.25 mg/kg[7]. 96% of oral malignant individuals while only 4% control individuals showed arsenic level above safe limit. The mean and standard deviation of arsenic counts in malignant, control individuals as well as fish flesh is depicted in Table 1, which indicates a significant difference in the mean valuesof arsenic counts obtained in malignant group and control group.

Results of the Pearson correlation indicated that thereis a significant large positive relationship between X (arseniccount obtained in hair samples of oral malignant individuals) and Y (arsenic count observed in fish flesh obtained from the respective districts), (r(5) = .823, p = .023), presented in Figure 1 and there is a non-significant very small negative relationship between X (arsenic count obtained in hair samples of control individuals) and Y (arsenic count observed in fish flesh obtained from the respective districts), (r(4) = .404, p = .427), presented in Figure 2.

4.0 Discussion

Arsenic in drinking water has become a serious global issue, especially for developing nations. It is thought to bea significant risk factor for cancer in several nations, including Bangladesh, Taiwan, India, Mexico, China, Chile, Argentina, and the United States[8]. Arsenic has been linked to the development of skin, oral, liver, kidney, and bladder cancer in a number of nations, including India[9]. Ground water contamination with arsenic has been reported in West Bengal, Bihar, Uttar Pradesh, Jharkhand, Assam, and Chhattisgarh[10]. According to WHO recommendations, the safe level of arsenic in drinking water is 10 g/l, and the maximum amount that can be present is 50 g/l[11]. The maximum permissible limit for arsenic in drinking water is 0.05 mg/l according to Rajiv Gandhi National Drinking Water Mission and 0.01 mg/l according to Bureau of Indian Standard[12]. Aquaculture species, including fish, have been shown to be arsenic poisonous, which leads to the metal's bioaccumulation in fish flesh, liver, and gills. Finally, the deposited metal becomes biomagnified in the human body following fish consumption through food. The fish body absorbs arsenic through its gills, skin, digestive system, and absorption from arsenic-contaminated food. In gills, it enters theblood through a large amount of gill surface where the blood-metal barrier is quite thin[13]. Aquatic creatures exposed to arsenic develop bioaccumulative toxicity, which over time has harmful effects on the skin, gastrointestinal tract, circulatory

system, liver, gills, kidney, muscles, and, to a lesser extent, the heart and brain. They negatively alter the ion regulatory parameters,biochemical, and hematological parameters[14]. Biochemical diseases caused by arsenic bioaccumulation included poisoning, liver lesions, impaired fertility, cell damage, and cell death[15,16]. According to Min *et al*. (2014), physiochemical parameters including pH, temperature, salinity, turbidity, and water hardness of aquatic body also affect the toxicity level of arsenic[17]. At increasing temperatures, arsenic's toxic effects on growth and blood parameters both rise[18]. Fish are an attractive organism to research the toxicogenomic of toxicants since they are recognized biomarkers of exposure and are used as a surveillant for biomonitoring of pollution in aquatic medium[19]. Hematological levels that rise or fall outside of the usual range in response to harmful chemicals serve as a measure of physiological alterations and fish health[20]. One of the top 10 toxins for public health, according to the WHO, is arsenic. Due to their surroundings, fish contains a variety of contaminants. Fish have distinct mechanisms to bio-transform the persistent arsenic into less harmful forms for elimination[15]. Fish are the primary consumers of arsenic in the aquatic food chain, and they store this poison in their bones, liver, kidney, gills, fat, and other tissues[21]. In addition to epigenetic modifications (in utero) and genetic mutations that result in cancer, consuming contaminated fish caused a number of issues in bodily organ systems[22].

The present study reveals a significant difference between the mean values of arsenic counts observed in oral malignant population and control population, also indicating a considerable high mean value of arsenic count observed in fish flesh obtained from the respective districts of West Bengal, the districts being arsenic effected areas of the state. The statistical analysis suggested a highly significant large positive correlation between the occurrence of oral malignancy in the effected individuals and the incidence of high arsenic level in fish flesh obtained from the corresponding locations. This can be explained by the fact that intake of contaminated fish flesh by the concerned individuals may have led to the development of malignancy, on taking the other factors like habit of various addictions, intake of rice, fruits, vegetables into consideration. So, intake of arsenic contaminated fish flesh can be one of the possible factors of the causation of this malignancy independently or along with the effect of other factors (if any), which can be explained with the evidence of elevated arsenic count (above the safe limit) in the hair samples collected from the effected individuals. The metal residing in fish flesh, when taken up by the concerned individuals may have accumulated in the keratin rich tissues, which upon biomagnification have gradually exerted its chronic toxicity leading to oral carcinoma. However, this explanation can be contradicted by the findings based on control group, which showed a very negligible percentage of individuals with high arsenic level and a non- significant small negative correlation between the incidence of elevated arsenic level in fish flesh and the occurrence of oral malignancy. Although both the effected and control individuals dwell in the same geographic location, indicating their equal extent and duration of exposure to the metal, yet the data of the two groups highly vary, suggesting the possible reason being retention capacity of the specific individual. The development of malignancy is reported to be not always linked to the duration and extent of metal exposure, rather it depends on mainly the retention capacity, ability of bioaccumulation and biomagnification of the concerned individuals, which gradually leads to a chronic outbreak, even in the form of cancer.

5.0 Conclusion

The study revealed a possible association between the intake of arsenic contaminated fish flesh and the occurrence of oral carcinoma in the concerned population, indicating the capacity of bioaccumulation and biomagnification along with the retention of the metal by the individuals for a chronic effect being the most important factor playing the role in the development of malignancy; which ultimately explains the fact of obtaining a highly significant difference in the occurrence of this malignancy between the two groups: control and effected. The other factors like various addictive habits, intake of various other food products like rice, wheat, fruits, vegetables, animal meat, which can also be considered as the potent risk factors of this metal contamination should also be taken into consideration, since the exposed individuals (both control and effected groups) showed a detailed history of intake of such food

products. Thus, the study reveals a possible contribution of arsenic contaminated fish flesh in the development of this malignancy in the selected population, independently or associatively with the other risk factors. However, a highly stringent population of participants with no history of intake of contaminated food products other than fish flesh for a considerable duration needs to be selected for drawing any strong conclusion indicating independent role of the metal contaminated fish flesh in this malignancy.

6.0 Acknowledgement

I would like to acknowledge all the higher authorities of Swami Vivekananda University for conducting the study. I am also indebted to the Secretary of Ramakrishna Mission Seva Pratishthan, Kolkata for allowing the smooth conduction of the preliminary data collection and analysis needed for the study.

7.0 Conflict of Interest

Authors declare no conflict of interest related to the study.

8.0 References

1. Pal P, Raychowdhury R, Halder A. Oral Carcinoma, HPV Infection, Arsenic Exposure- their Correlation in West Bengal, India. Otolaryngology: Open Access. 2016; 6(5):266. doi: 10.4172/2161-119X.1000266.
2. Pal P, Raychowdhury R, Dolai TK, Roy S, Dastidar R, Halder A. Study of arsenic exposure in oral/oropharyngeal carcinoma in West Bengal. International Journal of Occupational Medicine and Environmental Health. 2017; 30(2):271-279. doi: 10.13075/ijomeh.1896.00806.
3. Pal P, Halder A. Is there any Role of Arsenic Toxicity in HPV Related Oral Squamous Cell Carcinoma? Biol Trace Elem Res. 2018; 188(2):274-283. doi: 10.1007/s12011-018-1419-6.
4. Das N, Paul S, Chatterjee D, Banerjee N, Majumder NS, Sarma N, *et al*. Arsenic exposure through drinking water increases the risk of liver and cardiovascular diseases in the population of West Bengal, India. BMC Public Health. 2012; 12:639. doi: 10.1186/1471-2458-12-639.
5. Castro-Gonzalez MI, Mendez-Armenta M. Heavy metals: Implications associated with fish consumption. Environ Toxicol Pharmacol. 2008; 26:263-271. doi: 10.1016/j.etap.2008.06.001.
6. Francesconi KA. Arsenic species in seafood: Origin and human health implications. Pure Appl Chem. 2010; 82:373-381. doi: 10.1351/PAC-CON-09-07-01.
7. Arnold HL, Odam RB, James WD. In: Saunders, W.B. (Ed.), Disease of the skin. Clinical dermatology, Philadelphia. 1991. pp. 121–122.
8. Singh AP, Goel RK, Kaur T. Mechanisms pertaining to arsenic toxicity. Toxicol Int. 2011; 18(2):87-93. doi: 10.4103/0971-6580.84258.
9. Rahman MM, Chowdhury UK, Mukherjee SC, Mondal BK, Paul K, Lodh D, et al. Chronic arsenic toxicity in Bangladesh and West Bengal, India—a review and commentary. J Toxicol Clin Toxicol. 2001; 39:683–700.
10. Pal P, Raychowdhury R, Halder A. Correlation of Arsenic Toxicity with Oral/ Oropharyngeal Malignancy in West Bengal. Indian Journal of Human Genetics. 2014; Supplement 1/ Vol 20, Page S82.
11. Steinmaus C, Carrigan K, Kalman D, Atallah R, Yuan Y, Smith AH. Dietary intake and arsenic methylation in a U.S. population. Environ Health Perspect. 2005; 113:1153–9.
12. Nickson R, Sengupta C, Mitra P, Dave SN, Banerjee AK, Bhattacharya A, *et al*. Current knowledge on the distribution of arsenic in groundwater in five states of India. J Environ Sci Health. 2007; 42:1707-18.
13. Kumar R, Banerjee TK. Impact of sodium arsenite on certain biomolecules of nutritional importance of the edible components of the economically important catfish (*Clarias batrachus*). Ecol Nutr. 2012; 1:114-127.
14. Lavanya S, Mathan R, Chokkalingam K, Anamalai M. Hematological, biochemical and ionoregulatory responses of Indian major carp *Catla catla* during chronic sublethal exposure to inorganic arsenic. Chemosphere. 2011; 82:977-985.
15. Bears H, Richards JG, Schulte PM. Arsenic exposure alters hepatic arsenic species composition and stress-mediated gene expression in common killifish (*Fundulus heteroclitus*). Aquat Toxicol. 2006; 77:257-266.
16. Ribeiro CO, Vollaire Y, Sanchez-Chardi A, Roche H. Bioaccumulation and the effects of organochloride pesticides, PAH, and heavy metals in the eel (Anguilla Anguilla) at Camargue Nature Reserve, France. Aquat Toxicol. 2005; 74:53-69.

17. Min E, Jeong JW, Kang JC. Thermal effects on antioxidant enzymes response in Tilapia, *Oreochromis niloticus* exposed to arsenic. J Fish Pathol. 2014; 27:115-25.
18. Han JM, Park HJ, Kim JH, Jeong DS, Kang JC. Toxic effects of arsenic on growth, hematological parameters, and plasma components of starry flounder, *Platichthys stellatus*, at two water temperature conditions. Fisheries and Aquatic Sci. 2019; 22(1).
19. Das S, Unni B, Bhattacharjee M, Wann SB, Rao PG. Toxicological effects of arsenic exposure in a freshwater teleost fish, *Channa punctatus*. African J Biotech. 2012; 11(19):4447-4454.
20. Alwan SF, Hadi AA, Shokre AE. Alteration in hematological parameters of freshwater fish, Tilapia Zilli, exposed to aluminum. J Sci Applications. 2019; 3:12-9.
21. Dural M, Goksu MZL, Ozak AA. Investigation of heavy metal level in economically important fish species captured from the Tuzia Lagoon. Food Chem. 2007; 102:415-421.
22. Abdul KSM, Jayasinghe SS, Chandana PSE, Jayasumana C, De Silva PM. Arsenic and human health effects: A Review. Environ Toxicol Pharmacol. 2015; 40(3):828-46. doi: 10.1016/j.etap.2015.09.016.