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Journal of Drug Metabolism & Toxicology

Short Communication

Implications and Significance of Methyl Mercury Toxicity and Exposure in Rice and Fish

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ABSTRACT

Rice and fish are staple food items in many cultures and are particularly vulnerable to the accumulation of heavy metals, specifically mercury, when exposed to agricultural contamination *via* agricultural soils and water sources. These contaminated foods are then consumed by higher organisms up in the food chain, leading to further accumulation of the mercury, a process known as bio-amplification. Mercury is considered to be the most toxic heavy metal due to the fact that it causes significant systemic toxic effects. This commentary discusses the implications and significance of mercury in rice and fish and illustrates the necessity for further research to demonstrate the importance for public awareness and education for prevention of exposure to mercury *via* fish and rice ingestion.

Keywords: Bio amplification; Methyl mercury; Toxicity; Neurotoxicity; Breast milk

DESCRIPTION

Mercury (Hg), exists in two forms, organic and inorganic, which when consumed in quantities more than our body can eliminate, the excess is mainly accumulated in the kidney, causing kidney damage and toxicity to surrounding organs and tissues [1]. Due to no established biological function, organic and inorganic forms of mercury are considered systemic toxins since they can cause multiple organ damage [2,3]. The inorganic form of mercury is already found readily within the environment, allowing it to directly enter the crop or organism when mixed with fresh or seawater [4]. When inorganic mercury combines with carbo *ia* microorganisms, methyl mercury (MeHG) is formed; this is then incorporated into the food source of rice and fish.

Once ingested MeHg gets absorbed by the gastrointestinal tract, where most of it binds to either hemoglobin within erythrocytes or to cysteine residues on various proteins to form covalent bonds [5,6]. Once MeHg is bound to cysteine residues, it forms a methylmercury-cysteinyl compound which can cross the blood brain barrier and enter the central nervous system. Within the central nervous system, the methyl mercury becomes de-methylated forming inorganic mercury, which accumulates and acts as a neurotoxin disrupting the production of neurotransmitters leading to paresthesia, ataxia, and dysarthria or even death. MeHg acts as a neurotoxin through the disruption of the oxidant/antioxidant balance via inhibition of thioredoxin reductase and glutathione peroxidase, leading to an increase in oxidative stress. The current mainstay of treatment for symptomatic mercury toxicity is chelating agents, plasma exchange, plasmapheresis, and hemodialysis [7].

The neurotoxic effects elicited by MeHG are especially important when concerning developing fetuses and infants, who are more vulnerable to smaller amounts of MeHg due to having underdeveloped metabolic pathways and decreased body weight [8-10]. Due to the widespread and increased use of rice in many commonly consumed items, such as baby food, infants are at an even greater risk for exposure [11].

Other at risk groups include, pregnant women, mothers who breastfeed their neonates and infants, low income populations and cultures which consume rice in large quantities [12-14]. Therefore, when a diet already composed largely of rice is combined with a diet rich in fish, risk for toxic methyl mercury levels is greatly increased, a process known as bio amplification.

When rice and fish are grown in an environment rich in mercury, it increases the exposure and risk of acquisition, furthering the bio amplification. The most prominent atmospheric source of industrial mercury (Hg) emissions is artisanal mining and smelting Hg emissions [15].The increased

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Received: July 02, 2021; **Accepted**: July 16, 2021; **Published**: July 23, 2021

Citation: Palmieri JR, Guthrie T, Kaur G, Collins E, Benjamin B (2021) Implications and Significance of Methyl mercury Toxicity and Exposure in Rice and Fish. J Drug Metab Toxicol. 12:258.

amounts of methyl mercury in rice come from sources such as mining that are done in nearby rice fields and from the farming practices that are implemented [16]. Inorganic mercury (IHg) released by industrial emissions is absorbed into the pore water of rice paddies. Anaerobic mercury-ethylating bacteria that reside in the soil of rice paddies methylate dissolved IHg into MeHg. MeHg is taken up and trapped by the roots of the rice plant [17]. The roots become a major bio accumulator for MeHg, not IHg [18]. When the farming fields or mining facility is near a water source runoff can occur leading to increased levels of inorganic mercury in the water, which is then transformed into methyl mercury by microorganisms [19].

The methyl mercury is then consumed by small aquatic organisms, such as fish [19].There is a lack of data on the recommended provisional tolerable weekly intake, PWTI, of mercury supplied by the FDA, thus it is difficult to educate and inform the at-risk populations on the tolerable mercury consumption levels [20].

CONCLUSION

More research is needed on Hg content in commercially available rice and rice-based foods, so that the FDA can monitor MeHg content and advise the aforementioned vulnerable populations accordingly, as is done with Hg content in fish. Additionally, there needs to be increased public education and regulations on mercury in rice and fish-based products in order to improve consumer knowledge regarding mercury presence in rice, breast milk, rice-based and fish-based products in order to mitigate the amount of exposure.

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