

Effect of Fish Poisoning on Human Health: A Review

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Abstract: - The purpose of this review was to highlight the human health risk associated with consuming fish contaminated by heavy metals and naturally occurring toxins and ways to reduce their effects on human. The presence of metals like mercury, cadmium and lead in human food are extremely dangerous to human health even at low levels of concentrations. Some of the health risk associated by consuming fish contaminated with metals include renal failure, liver and kidney damage, cardiovascular diseases, some produce neurogenic, carcinogenic effects and reduce immune system. Various species of fish and shell fish contain biotoxins that produce ciguatera fish poisoning, Scombroid fish poisoning, rudder fish poisoning, Tetrodotoxin or puffer fish poisoning when consumed by humans. To remedy fish poisoning, medical attention should be sought at the onset of symptoms, fish roes and organs as well as fish caught during algal bloom and global warming should not be eaten. Public enlightenment should be employed. Professional like Toxicologist, Doctors, Neurologists and other practitioners should all be involved; and finally advance technology generating less metal pollution to our environment and Aquacultural practices should be encouraged. This can give rise to hazard control upon fish habitats and making the food free from contamination.

Keywords: Algal bloom, Bioaccumulation, Biomagnification, Biotoxins, Fish, Health risk

I. INTRODUCTION

Fish are important resource for humans especially for food, commercial subsistence and plays a role in some cultures serving as deities, religious symbols and the subject of art, books and movies (Abubakar, *et al.*, 2015). The consumption of fish worldwide has increased in recent years especially with the awareness of its nutritional and therapeutic benefits (Bawuro *et al.*, 2018; Rabo *et al.*, 2014). Fish are also important sources of essential minerals, vitamins and unsaturated fatty acids (El-mosehly, 2000).

Fish make a vital contribution to survival and health of a significant portion of the world's population. In some Asia's poorest countries, people derive as much as 75% of their daily protein from fish (Ahmed and Krishen, 2007). In Nigeria, fish alone accounts for about 35% of animal protein (Market resources, 2009), while in rural and fishing communities, it plays a significant role in the diet providing up to 75% of the total animal intake. Due to the immense benefit humans derive from fish, the American Heart Association recommended consumption of fish at least twice per week in order to reach the daily intake per week of Omega – 3 – fatty acids (Kris-Etherton and Harris, 2012).

However, fish normally accumulate heavy metals and poison from food, water and sediments (Yilmaz and Ozdemir, 2007). Since fishes are major part of human diet, it is therefore not surprising that numerous studies have been carried out on metal pollution in different species of edible fish (Yilmaz and Ozdemir, 2007). Oguguah *et al.* (2017) opined that the health risk due to consumption of food from aquatic ecosystem contaminated with hazardous chemicals including metals has increased globally especially in developing countries like Nigeria. The increasing use of heavy metals in industries has led to their increased release into the aquatic system and they constitute the main group of pollutants due to their bioaccumulation and bio-magnification behaviours (Safahieh *et al.*, 2011). The presence of these toxic metals in fish is usually greater in summer than in autumn > winter > spring, which also depends on the sex and age of fish (Shah and Altindag, 2005). This is a good indicator of heavy metals contamination in water, as well as toxins gotten from food (Bawuro *et al.*, 2015). The bioaccumulation behaviours of metals forms the major route through which increased levels of pollutants are transferred through food chains, creating public health problems wherever humans are involved (Shah and Altindag, 2005).

The presence of toxic heavy metals and poisons in fish can invalidate their beneficial effects. When such contaminated fish are consumed by humans can cause a lot of health problems (Galeet *et al.*, 2017). The presence of metals like Cadmium, lead, mercury, barium, nickel, chromium, zinc and arsenic have been reported to be extremely dangerous to human health even at low levels of concentrations. Some of the health risk associated by consuming fish contaminated with heavy metals includes renal failure, liver damage, cardiovascular diseases. Some have neurotoxic, carcinogenic effects, and reduced immune systems (Oguguah *et al.*, 2017; Rahman, *et al.*, 2017; Sehar *et al.*, 2014).

Furthermore, there are toxins that occur naturally in fish. It has been observed that at certain times of the year, various species of fish and shell fish contain poisonous biotoxins even if well cooked (Hopkin, 2019). Fish containing these toxins do not look, smell or taste bad. Cooking, marinating, freezing or stewing does not destroy the toxins (Stommel, 2020; Zlateva *et al.*, 2017). These naturally occurring toxins are passed to fish through the food chain in the aquatic habitat especially during algal bloom and warming. Some of these toxins occurring in fish can produce various forms of poisoning in humans, when such fish are eaten and they

include ciguatera fish poisoning, scombroid fish poisoning, shell fish poisoning, rudder fish or escular fish poisoning and tetrodotoxin or puffer fish poisoning.

Therefore, this paper aimed at highlighting the effects of some metallic as well as naturally occurring fish poisons on human lives and ways to remedy fish poisons. This will in turn improve human health.

II. METALLIC FISH POISONS

The consumption of fish poisoned by metal are known to cause acute and chronic health effect on man, metals like mercury, cadmium, leadchromium and arsenic have been reported as extremely dangerous to human health even at low levels of concentration. While essential metals like coppers, selenium, selenium and magnesium required in race amounts are good for the proper functioning of enzymehaemoglobin and vitamins (Oguaguah *et al.*, 2017). Oguaguah *et al.* (2017) further opined that in the list of heavy metals such as lead, mercury and Cadmium are considered to cause public health hazards.

Mercury: Is a naturally occurring chemical but becomes harmful when it contaminates fresh and sea water areas. Human activities like coal burning gold mining and chloralkali manufacturing plants contributes to its release in our environment (Davis), especially the atmosphere which dissolve in fresh and sea water. Inorganic mercury and methylmercury are first consumed by phytoplankton then to zooplankton up the food chain to especially large predatory fish and to humans, showing clear evidence of biomagnification where its concentrations are higher in predator tissues than in the prey tissue (Rahman, *et al.*, 2017).

Negative health effect of mercury with time include neurological and chromosomal problems, uncontrollable shaking, numbness or pain in certain parts of the skin, blindness, double vision, inability to work well, memory problems, seizures and death with large exposure, miscarriages and birth defects in pregnant mothers (Brandford, 2016).

Cadmium: Is a non-essential, most toxic heavy metal commonly found in the aquatic system and the earth's crust (Seharet *et al.*, 2014). Cadmium released into the environment results from burning of fossil fuels like coal or oil and city wastes. Cadmium can be released into the aquatic system through disposal of industrial, household waste and fertilizer into the aquatic systems. The nutritive need of different tissues of fish depends on their bio-chemical configuration like mineral contents, amino acids, protein and vitamins etc. The sub lethal concentration of Cadmium has showed deviations on the electrophoretic arrangements of protein segments in gills and muscles of *Oreochromismossambiscus* (Seharet *et al.*, 2014).

The chemical contaminants of Cd are stored within the lipid component of the fish so they are well protected when entering the human body (OSTOW, 2003). When such

contaminated fish are eaten by man, Cd is then transported to the liver through the blood stream where it bond to proteins to form complexes that are transported to kidneys where it harms the purifying mechanisms thereby causing damage. Other health related problems include Diarrhea, vomiting, fractures in bones, damage to DNA, infertility, neurological and immunological problems and cancer.

Lead: Is a potent environmental pollutant and toxic to human health (Rossi and Jamet, 2008). Fish and humans are mostly exposed to lead by food ingestion and breathing. Lead can accumulate in the muscles, bones, blood and fats. Neonates and young children are mostly effect by low level of lead.

Lead causes severe damage to liver, kidney, brain, nervous and reproductive disorders; heart diseases like high blood pressure especially in men and anaemia. Extensive exposure to lead can cause memory problems, behavioural disorders and mental retardation. Lesser levels of Pb damage the nerve and brain in foetuses and young children resulting in lowered IQ and learning deficits (Sehar, *et al.*, 2014).

III. NATURALLY OCCURRING FISH POISONS

Naturally occurring toxins are passed to fish through the food chain in the aquatic habitats. These toxins are associated with reef fish of the tropical and subtropical waters of the world (Hopkin 2019). Humans are poisoned when such contaminated fish are eaten. Among such are:

Ciguatera fish poisoning (CFP): isichthyosarcotoxicosis, a food borne illness that affects humans worldwide by eating reef fish or different kind of fishes containing the naturally occurring toxin called ciguatoxins (Zlatera *et al.*, 2017; Friedman *et al.*, 2008). Ciguatera fish poisoning is widely spread in the tropics and subtropical regions of the world. It has been reported that every year about 20,000 to 50,000 people fall sick after consumption of flesh of fishes caught in tropical and subtropical seas and oceans (Friedman *et al.*, 2008). However with increase in global travel and the increasing importation of exotic food fish species into many countries, ciguatera fish poisoning can be found everywhere in the world.

Ciguatoxins is derived from benthic dinoflagellates of the genus Gambierdiscus, others include Protocentrum, convacum, Protocentrum lima growing predominantly in association with microalgae (blue-green algae) in coral reefs in the tropical and subtropical climates (Zlateva, *etal.*, 2017). The toxin is passed through the food chain to herbivorous fish, then to carnivorous fish which are in turn consumed by man (Pean, 2001). The toxin does not affect the appearance, odour or taste of the fish and is not destroyed by cooking, refrigeration or freezing (This is because the poisons are thermostable (Zlateva, *et al.*, 2017)

Ciguatera toxin is one of the most potent naturally occurring substance and one of the Ciguatoxins in the Pacific Ocean possess health risk at concentrations as low as 0.08 to 0.01 ug/kg (Lehanand Levis, 2000). In humans Ciguatoxins

are known to activate the voltage-gated sodium channels in the cell membrane which increases sodium ion permeability and depolarizes the nerve cell which is believed to cause neurological signs associated with Ciguatera fish poisoning (Lehan and Levis, 2000). Ciguatera fish poisoning in man is usually sporadic and unpredictable marked with the following signs – Gastro intestinal disorders like diarrhoea, abdominal crabs could develop within 6-24 hours of eating a reportedly good – tasting reef fish but could be for a short time. Other symptoms include headache, fatigue, fainting, joint and muscle pains, tingling around the mouth, fingers and toes, burning sensation or skin pain on contact with cold water, extreme itching. Neuropsychiatric symptoms include anxiety, depression, hallucination, giddiness, incoordination and coma (Arena, *et al.*, 2004).

Chronic cases may last for weeks or months especially neuropsychiatric symptoms (Pearn, 2001). Reoccurrence of neurological symptoms could occur upon consumption of alcohol or other type of fish or food years after initial exposure. This is due to the fact that Ciguatoxins may be stored in a person's adipose tissue and that any activity involving increase lipid metabolism may result in ciguatoxins re-entering the blood stream, with subsequent re-emergence of ciguatera fish poisoning symptoms (Nicholson and Levis, 2006).

Puffer poisoning: This type of poisoning results from consuming the puffer fish or balloon fish/blow fish/swellfish. Puffer fish are also known as fugu in Japan (Tamoe *et al.*, 2001). Puffer fish are from the genus Tetradontidae. Puffer fish are the most poisoning fish in the world and second most poisonous vertebrates after the golden tart frog. Puffer fish can be found in the Indian Ocean, Pacific Ocean and in the North American waters. In Japan, 100 annual human fatalities due to ingestion of toxic puffer have been reported until 1960, the rate of death is said to reduce in recent years with improved legislation of fungus preparation and marketing (Tamoe *et al.*, 2001)

Puffer fish poisoning have been reported in Thailand, Malaysia, Bangladesh, Thailand and Japan. The poison also called tetradotoxin is located in the liver, reproductive organs, intestine, in the skin and sometimes on the muscles of the fish (Tamoe *et al.*, 2001). Tetradotoxins are not destroyed by the digestive system of animals that eat the fish. Tetradotoxins are known to block voltage sensitive sodium channels in nerve tissues leading to failure of depolarization and propagation of action potential in nerve tissue. Tetradotoxin can act on both the central and peripheral nervous system causing a lot of symptoms. Tetradotoxin is one of the most toxic substances known; it is 275 times more lethal than cyanide and 50 times more potent than strychnine or curare (Haque *et al.*, 2008). The colourless poison when touched paralysis the diaphragm muscles of human victims leading to rapid and violent death. When puffer fish are eaten symptoms like lip, tongue and facial paresthesia, numbness, salivation, nausea, vomiting and diarrhea with abdominal pains

may occur. Followed by motor dysfunction, hypoventilation and speechlessness. Extreme cases include cardiac dysfunction, paralysis, coma and death can occur within 4 to 6 hours. Predators like the nurse shark can die as a result of eating a trunkfish (Froese and Pauly, 2009).

There are other forms of fish poisoning that occur by eating a variety of fish. Shell fish poisoning or paralytic/neurotoxic/amnestic shell fish poisoning is acquired when humans consume shell fish like bivalves, oysters, crabs, lobsters and clams. Paralytic fish poisoning could be deadly and may produce signs like tingling around the mouth, face and toes but could be wipe away in a few days; staggering, inability to talk, swallow and breathlessness may occur. Vomiting, abdominal cramps, diarrhea, confusion, loss of memory (amnesia), coma may occur in severe case. Rudder fish/escolar diarrhea is caused by eating fish belonging to escolar or oil fish groups. Due to their high wax content when eaten by humans, the wax cannot be digested and therefore cause oily diarrhea.

Scombroid fish poisoning also known as histamine fish poisoning especially in the United States of America results from improper processing and storage of fish. As a result bacteria like *Escherichia coli* and *Proteus morganii* act on the flesh of the poorly maintained fish to produce elevated histamine levels (as well as other bioactive amines) through the breakdown of the amino acid histidine (Froese and Pauly, 2009). Histamine is observed to be proportional to the histamine content of fish, bacterial histidine decarboxylase and environmental factors. Froese and Pauly, 2009) opined that histidine level vary from 1g/kg in herring to as much as 15g/kg in tuna; and unspoiled fresh fish do contain small amount of histidine (<0.1mg/100g) but do not cause histamine fish poisoning.

Fish of the families Scombroideae and Scomberesocidae like tuna, mackerels, seerfish, sardine, bonito and nonscombroid fish like herring, sardines and anchovies caught in warm areas are said to be linked to histamine fish poisoning (Stommel, 2020). Outbreaks of histamine fish poisoning are worldwide and are found in places where potentially spoiled, improperly handled scombroid-like fish species are eaten. In the United States, histamine fish poisoning results from improper handling of fish by recreational fishermen who have neither less knowledge nor the proper equipment to cool the fish properly. About 70 cases of histamine fish poisoning per year were reported per year by the board of health in the New York City with many more cases assumed to be a simple virus or food allergy (Stomme, 2020). Histamine fish poisoning results from high histamine levels (>50mg/100g) in spoiled fish that has high histamine content; and it has been confirmed that consuming spoiled fish with histamine is more poisonous than taking an equivalent amount of pure histamine. The histamine-potentiator hypothesis states that absorption, metabolism and / or potency of one biogenic amine might be altered in the presence of another amine (Stommel, 2020).

Fish affected by scombroid taste peppery indication of elevated histamine levels which could produce symptoms like tingling and hurting around the mouth, face, flushing of head, neck and sweating, nausea, vomiting, diarrhea, dizziness and rashes. Occasional arrhythmias, bronchospasm and cardiovascular collapse can also occur. The symptoms of histamine fish poisoning usually last for 8-12 hours and can come on within minutes of ingestion of atoxic meal. This can vary from person to person (Froese and Pauly, 2009).

IV. WAYS TO REMEDY FISH POISONING

Since fishes are a major part of human diet and normally accumulate heavy metals and naturally occurring toxins from food, water and sediments (Yilmaz and Ozdemir, 2007). There has to be solutions to reducing fish poisoning to the minimum so that human nutrition and health can be improved.

In the case of metallic poisons, it has been observed that most humans were born with a defense against exposure to metal like mercury initiated by specific sequence of genetic code that cause most people to expel the metal in 30-40 days. As a result scientists are focusing on environmental toxicology and genetics with the aim to provide clues to a person's sensitivity to environmental toxins and the potential for damage based on that person's genes; and then doctors might better understand how to prevent such harm and how to treat patients exposed to deleterious chemicals (Stommel, 2020). However people should be enlightened on the danger of dumping industrial and urban waste into open water bodies. Infact laws and guidelines should be clearly stated and prosecution penal enforced by Government at all levels.

Prevention of naturally occurring poisons requires educating people on the risk of eating coral reef fish such as barracuda, grouper, snapper, amberjack and sturgeonfish that are caught in areas known to be contaminated, such as waters off pacific, south Florida and the Caribbean (Zlateva *et al.*, 2017). Ciguatera toxins can be detected by liquid chromatography-mass spectrometer (Bradford, 2016). Before fish meals are made, organs like gills, intestines, head, gonads should be removed and the fish thoroughly washed (Friedman *et al.*, 2008). Avoid tile fish from the Gulf of Mexico, shark, sword fish and king mackerel. The Federal Department of Aquaculture recommends eating two to three serving (8 to 12 once or 227 to 340 grams) of fish each week. To obtain Omega 3 fatty acids, dietary supplements like fish oil or algal oil should be used (Bradford, 2016). The following fish are classified as mercury low, Anchovies, utterfish, catfish, clams, domestic crabs, crayfish, croaker, (Atlantic), Hake, Herring, Mackerel, Oysters, perch, Salmon, Sardines, Scallops, Shrimps, Squids, Tilapia and Freshwater trout therefore are save for food.

In the case of naturally occurring toxins like ciguatera poisoning it is recommended to avoid fish in excess of 3 kilograms or avoid fish in excess of 1.35kg, but eat small portions of less than 50 grams of different fish than eating large portions of any individual fish that might be associated

with ciguatera fish poison (Nicholson and Levis, 2006). In addition, it is recommended that one should avoid eating warm water ocean fish at least for 6 months and avoid alcohol for at least 3 months for people recovery from ciguatera fish poisoning (Bradford, 2016).

To avoid scombroid fish poisoning, fish should be chilled and properly refrigerated as soon as it is caught to prevent histamine formation; also many countries have set limits for the maximum-permitted levels of histamine in fish. Stommel (2020) observed that fish with less than 100ppm hitamine (1mg/100g of fish is save for consumption while illness usually occurs at levels of 1000ppm (100mg/100g of fish). HFP can be controlled by using corticosteroids, charcoal and histamine blockers. There is no effective antidote to tetradotoxin. Treatment is entirely supportive with early intubation and may involve mechanical ventilation or inotropic support (Haque *et al.*, 2008); Charcoal is also said to effectively bind the toxin. Tetradotoxins can be detected using research chromatography and flurescent spectrometry but neither is available in acute clinical situation. Rudder fish or escolar diarrhea can be avoided when seafood retailers are encourage to display signs advising that escolar or oily fish might cause symptoms; also mouse bioassays could be used to detect paralytic shell fish toxins (Haque, *et al.*, 2008). Human should also seek information from local fishermen on the types of fish that are poisonous. Furthermore, since it has been observed that levels of heavy metals in fish is greater in summer >autumn> winter>spring, it therefore follows that fish caught in summer or global warming and algal bloom should not be eaten. Finally, it is recommend that to eliminate and avoid aquatic life contamination with hazardous metals, there is need to use the advance technologist generating less metal pollution to our environment and also encourage aquaculture practices. Aquaculture practice can give rise to hazard control upon fish habitats, assessing and making the food free from contamination.

V. CONCLUSION

The presence of metals like mercury, cadmium and lead in human food are extremely dangerously to human health even at low levels of concentrations. Some of the health risk associated by consuming fish contaminated with metals include renal failure, liver and kidney damage, cardiovascular diseases, some produce neurogenic, carcinogenic effects and reduce immune system. Various species of fish and shell fish contain biotoxins that produce ciguatera fish poisoning, Scombroid fish poisoning, rudder fish poisoning, Tetradotoxin or puffer fish poisoning when consumed by humans. To remedy fish poisoning, medical attention should be sought at the onset of symptoms, fish roes and organs as well as fish caught during algal bloom and global warming should not be eaten. Public enlightenment should be employed. Professional like toxicologist, Doctors, Neurologists and other practitioners should all be involved; and finally advance technology generating less metal pollution to our environment and Aquacultural practices should be encouraged. This can give

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