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First report on distribution of heavy metals and proximate analysis in marine edible puffer fishes collected from Gulf of Mannar Marine Biosphere Reserve, South India

Kaleshkumar Karunanidhi, Rajaram Rajendran*, Dhinesh Pandurangan, Ganeshkumar Arumugam

DNA Barcoding and Marine Genomics Laboratory, Department of Marine Science, School of Marine Sciences, Bharathidasan University, Tiruchirappalli, Tamil Nadu, 620 024, India

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ABSTRACT

In the present study, the heavy metal concentration in different organs (skin, tissue, liver, kidney, gill, intestine, and ovary) and muscle proximate composition were studied in marine edible puffer fishes *Takifugu oblongus, Lagocephalus guentheri, Arothron hispidus, Chelonodon patoca* and *Arothron immaculatus* collected from Mandapam fish landing centre, South east coast of India. Heavy metals (Cd, Cu, Pb & Zn) were analyzed in different organs for the above mentioned species. The heavy metals concentration ranges in fish organs of all the five species were Cu (0.42 –6.31 mg/kg), Cd (0.01–0.79 mg/kg), Pb (5.80–19.87 mg/kg), and Zn (6.75–65.08 mg/kg). Zn was detected higher in all the samples followed by Pb, Cu and Cd. The proximate composition was determined in edible muscle tissues of all the five species. The highest and lowest protein contents were observed in *T. oblongus* (20.6 ± 0.6%) and *C. patoca* (17.9 ± 0.3%). In the present study, heavy metal concentrations were found very high in all the internal organs when compared to muscle tissues. Further, this is the first report on distribution of heavy metals and proximate compositions of commercialized important edible puffer fishes from Mandapam coast of Gulf of Mannar, Southeast coast of India.

1. Introduction

Heavy metals are natural components in the earth's crust that cannot be degraded or destroyed. They are dangerous substances because of their bioaccumulation and toxicity can threaten aquatic living organisms [33]. The Industrial wastes and mining of metals are the potential sources of heavy metals accumulation in the aquatic environment [32]. Permatasari [51] stated that the metal could not be ignored from daily life as it is actively used in agriculture, medicine, and industry. Recent increase of industries and power plants in the Tuticorin and Mandapam coast of Gulf of Mannar region discharges the heavy metal contaminants [47]. The research must be focused on heavy metals because of their environmental promise, toxicity at low concentration and capability to incorporate into food chain of marine organism [25]. The extensive persistence of heavy metals infectivity in bioaccumulation and biomagnifications are a serious threat of the food chain [9] and these heavy metals will automatically transfer into the body while consumed these seafood by humans [19].

Fishes are widely used to monitor the variations in marine environment of anthropogenic pollutants [4]. Fishes, crabs and shrimps form an important link in transferring the media to humans. Information on the level of heavy metal pollution in coastal origin is important because they cause serious environmental health hazards [62]. The estimation of heavy metals in the food-chain will be used to know the heavy metal transfer to the human body through sea-food [6]. The possible ways of heavy metal accumulation in fishes are through the direct uptake of water and food on the heavy metal polluted environment [50]. The heavy metals entering to the fish through gills and other organs have a chance to get accumulated in different parts of the body tissues and the excessive amount can build up to a toxic level [6]. Puffer fishes (Family: Tetraodontidae, order: Tetraodontiformes), which are carnivorous, slow swimming fish and they can live in different ecosystem such as open sea, estuaries and freshwater areas [66]. Totally 19 genera including 130 species of puffer fishes were recorded in Indian waters [43] and 28 genera with 189 species in all over the world water were recorded within the Tetraodontidae family [45]. Around 50 species were reported as poisonous to humans for certain reasons [57]. Yedukondala and Rukminisirisha [68] stated that consumption of

* Corresponding author at: DNA Barcoding and Marine Genomics Laboratory, Department of Marine Science, School of Marine Sciences, Bharathidasan University, Tiruchirappalli – 620 024, Tamil Nadu, India.
E-mail addresses: drrajaram69@rediffmail.com, dnabarcodingram@gmail.com (R. Rajendran).

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puffer fishes as an alternative food to meet the increasing food demand due to growing population and day-by-day collapse of natural resources. Hence, it is the time to study the proximate composition and to calculate the nutritional significance of the puffer fishes or else it can be exploited rationally.

Puffer fishes are non-target species and it is caught by incidentally or accidentally by trawl net and it is considered as trash fishes. Although these species are known to cause potential risk to humans, they contain potent and multifaceted neurotoxin called tetrodotoxin (TTX) that has been rarely detected in the muscles of fishes and it is also considered as a delicious food in few countries, particularly in China, Korea, Japan and Taiwan [38]. Chunfai & Hoifu [10] stated that puffer fishes contained rich amount of nutritional values in muscle. Recently, some of the Puffer fishes have been cultured due to high demand has been increased for human consumption [31]. In this present study, the bioaccumulations of heavy metals (Cd, Cu, Pb & Zn) in different organs of commercially important puffer fishes namely *Takifugu oblongus, Lagocephalus guentheri, Arothron hispidus, Chelodan patoca* and *Arothron immaculatus* and proximate composition of muscle tissues were analyzed and the permissible limit of these heavy metals via fish consumption were also discussed.

2. Materials and methods

2.1. Sample collection and preservation

Five species of marine puffer fishes from Tetraodontidae family namely *Takifugu oblongus, Lagocephalus guentheri, Arothron hispidus, Chelanodon patoca* and *Arothron immaculatus* (Fig. 2a-e) were collected from Mandapam (latitude 9°16′14”N; longitude 79°7′10”E) fish landing centre, Gulf of Mannar Biosphere Reserve, Southeast coast of India during the period of March to June 2015 (Fig. 1). In total, 10 specimens of each species were collected and the samples were transported to the laboratory within 5–6 h in ice packed condition in a storage box. The specimen was thawed to room temperature for morphometric study and weight was examined for all the collected specimens. All the specimens were measured to the nearest mm, whereas weights were recorded with the use of electronic balance to the nearest 0.01 g and stored in −20°C for further heavy metal and proximate analysis. The specimens were identified using the standard works [43,http://www.fishbase.org/]

2.2. Analysis of heavy metal concentration in edible marine puffer fishes

Throughout the study, all acids and chemicals used were analytical grade. For acid digestion, various parts namely, Skin, Tissue, Liver, Kidney, Gill, Intestine, and Ovary of fish samples were dissected using sterile stainless knife and scissor. One gram (wet weight) of the each sample were kept in a 100 ml glass beaker with 10 ml of mixed reagent (Con H_2SO_4: HNO_3: $HCLO_4$ ratio of 1:5:2) and heated on a hot plate at 60 °C until the tissue gets partial digestion, followed by 5 ml of 2N HCL was added to the samples and allowed few minutes for outright digest to reduce the volume at least 1 ml. Finally, digested suspension was filtered and made up to 25 ml with double distilled water and stored in acid cleaned fresh polypropylene containers at room temperature until analysis by slightly modified method of Olusola and Festus [46]. Blanks were also prepared using above procedure without adding fish samples. The samples were analyzed for Cd, Cu, Pb and Zn by Atomic Absorption Spectrophotometer (AA7000-Shimadzu, Japan) using air-acetylene lame with digital read out system, deuterium lamp background corrector, and automatic zero to compensate the blank. Settings were followed as recommended by the manufacturer. Calibrations using standard solutions were made by stepwise dilution of the stock solution. The absorption wavelength and detection limits were 228.8 nm for Cd, 324.7 nm for Cu, 217.0 nm for Pb and 213.9 nm for Zn. Quality assurance and Quality control testing was relied on the control of blanks and yield for chemical procedure. For precious quantification triplicates of the samples, blanks and standard reference were used throughout the analysis. The metal standards was obtained from Himedia laboratories,

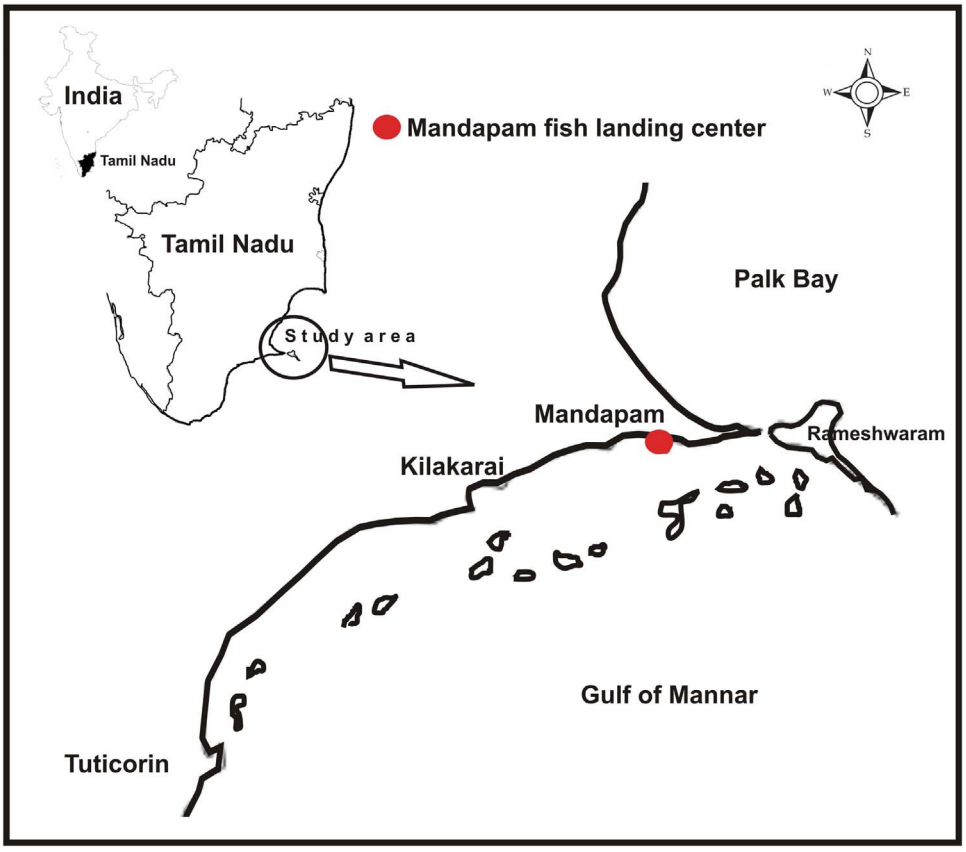

Fig. 1. Mandapam fish landing from Gulf of Mannar Marine Biosphere Reserve, South India.