



International Journal of Fisheries and Aquatic Studies

E-ISSN: 2347-5129

P-ISSN: 2394-0506

(ICV-Poland) Impact Value: 5.62

(GIF) Impact Factor: 0.549

IJFAS 2018; 6(2): 110-116

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www.fisheriesjournal.com

Received: 16-01-2018

Accepted: 17-02-2018

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Puffer fish poisoning: An assessment of consumer awareness and availability in Sylhet region, Bangladesh

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Abstract

Puffer fish poisoning is periodically reported from different places of Bangladesh. On 6-7 December 2016, a total 7 people died and more than 30 people become sick due to consumption of fresh water puffer fish in Jaintapur upazila of Sylhet district. Following that outbreak, the present study was conducted to access a view of puffer fish consumption practice by local people, markets availability and finally general public awareness about toxicity of puffer fish. Freshwater puffer fish, *Tetraodon cutcutia* is commonly available in water bodies and locally known as 'Futka mach'. After proper investigation, it was found that 64.5% people regularly consume puffer fish that are mainly villagers; people of lower bracket income and ethnic community. There were 60.47% respondent eat puffer fish regularly or have an experience of eating puffer fish due to unique taste and lower market price. It was also revealed that 78% consumers collect puffer fish from the local fish market. During preparation of cooking puffer fish, 52.71% people remove outer skin and viscera, and 47.29% people remove only the viscera part but not the skin of the fish. In terms public awareness, 84.5% respondents from the study area were found unconscious about the toxicity of puffer fish.

Keywords: Puffer fish, poisoning, assessment, consumer, awareness

1. Introduction

Puffer fish poisoning is one of the well-known and recognized fish poisoning among all forms of fish poisoning in Asia^[1]. Death and illness due to ingestion of puffer fish is geographically widespread in many countries and has been reported in numerous places of the world, mostly in Japan^[2, 3], Taiwan^[4], Cambodia^[5], Thailand^[6, 7], Mexico^[8], Hong Kong^[9], Malaysia^[10], Brazil^[11], Australia^[12] and USA^[13]. In Bangladesh, a number of puffer fish poisoning incidents have also been recorded from several places of the country since last decades^[14-20]. Puffer fish intoxication is initiated by consumption of puffer fish, a fish from the *Tetraodontidae* family^[21, 22]. Globally puffer fishes are known as fugu, blow fish, patka fish, balloon fish, toad fish and globe fish^[1, 15, 23]. Both fresh and marine water puffer fishes are available in Bangladesh and of which only two are freshwater species^[24, 25]. However, puffer fish is popularly known as Tapa, Potka, Kutkuitta and Photka in Bangladesh^[26]. Almost all puffer fish are poisonous and contain a powerful neurotoxin, named tetrodotoxin (TTX) present in the liver, gall bladder, intestine, gonads, eggs and skin. On the other hand the body muscle part of this fish is relatively free of this poison^[1]. It is the causal agent responsible for puffer fish poisoning among individuals who consume the fish^[2, 9, 12, 17]. Tetrodotoxin (TTX) is also found in other marine species such as the blue-ringed octopus and some gastropods mollusks and worms and in several newts and frogs^[27, 28]. Tetrodotoxin is one of the recognized fatal elements, which is 275 times more lethal than cyanide and 50 times more intoxicating than strychnine or curare^[29] which is a heat-stable, water-soluble and a non-protein quinazoline derivative^[30]. The amount of TTX in puffer fish depend on type of species and the concentration is seasonal^[31].

Puffer fishes are common in the water bodies of Bangladesh^[24, 25, 26]. The puffer fish poisoning has also been reported to occur sporadically throughout the country. Over the last few years puffer fish poisoning attributed to ingestion of puffers as a rising health problem^[16]^[18-20]. Although mass people do not eat puffer fish but many food poisoning cases due to

ingestion of puffer fish have occurred. Most of these cases were caused by ingestion of contaminated puffer fish species. Though some of had the previous experience of eating puffer fish since long time but they were unaware about the toxic potential of puffer fish [18, 19]. On the other hand, lower price and delicious taste of puffer fish has also made it popular mostly among the people in the poor rural populations [14, 18, 19]. Meanwhile there is little published information on consumer awareness, marketing and consumption pattern regarding to puffer fish toxicity. In 6-7 December, 2016 six people were died and 33 people become sick after the ingestion of fresh water puffer fish in Jaintapur upazila of Sylhet district. Following that the present study was conducted to assess the availability and trade of puffer fish, to understand the extent of the local people's awareness about its toxicity and to know about consumption pattern of puffer fish in Sylhet region of Bangladesh.

2. Materials and Methods

2.1 Study areas

The study was carried out from 20 December 2016 to June 2017. Selected study areas were two upazilas of Sylhet district namely, Sylhet sadar and Jaintapur.

2.2 Use of puffer fish sample

Before starting of each step of this work, a photograph and/or a raw collected fresh water puffer fish were presented to all participants for collecting data about this fish. This method was so helpful to easily collect relevant information regarding availability, market value and main consumer of puffer fish etc.

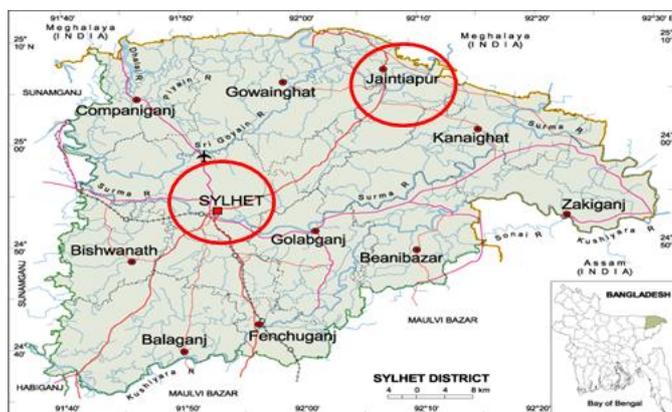


Fig 1: Study area.

2.3 Methods of data collection

Data were mainly collected by direct questionnaire base interview and group discussion with the rural people and visiting of local fish market of study area. A total 90 people from the rural area including family member of recent episode place were interrogated. People who consumed puffer fish and aware of any other people in their locality who had consumed the fish were also interviewed. In addition, 30 people of ethnic community which are mainly dweller of the tea state and tribal community were also put under questions with same questionnaire method.

In city fish market, a total 60 local resident were also talked to the questionnaire used in this study. Several interviews were conducted with 20 fishermen and fish sellers to explore availability and trade of puffer fish in the local fish markets. During the study a set of questions were discussed with all

participants related to puffer fish poisoning which were about local availability, their knowledge about its toxicity, any previous experience of eating puffer fish, process of preparation and cooking, history of consumption, preference of this fish. Ten (10) fish markets [Kazir Bazar, Lal Bazar, Tilagarh, Mejortiah and Baluchar Noya Bazar of Sylhet sadar upazila and Chiknagul, Dorbost, Sarighat, Haripur and Jaintapurfish market of Jaintapur upazila] were visited for the collection of data related to the market availability, price and to get an overview of main consumers of puffer fish.

2.4 Secondary data collection

Secondary data related to puffer fish poisoning in Bangladesh and worldwide were collected from documents of recent and past different newspaper reports and available papers from different related research publications.

2.5 Statistical analysis

Collected data were analyzed through using of Microsoft Excel and SPSS ver. 22.

3. Results and Discussion

3.1 Available puffer fish species

In Bangladesh, both freshwater and marine puffer fish are available and mainly freshwater puffer fish are available in the Sylhet region. According to the local people, fisherman, fish trader and experts, the *Tetraodon cutcutia* is much more available in the local waterbodies of this area. Puffer fishes are locally known as Tapa, Potka, Kutkuitta and Fotka [26]. In Sylhet, this fish is commonly known as 'futka mach' among the local people. Diener *et al.* [25] reported 13 species of puffer fish in Bangladesh. Both of the study listed two species of freshwater puffer fish (*Tetraodon patoca* and *Tetraodon cutcutia*). In a recent study of Shamsuzzaman *et al.* [32] acknowledged 3 species of freshwater puffer fish, including *Tetraodon fluviatilis* with previously identified two freshwater species. *Tetraodon patoca* is commonly found in the southern part and *Tetraodon cutcutia* is common in the northwest, northeast and northern part of Bangladesh [24]. During the market visit no marine puffer fish were found in any market of the study area. However, no one related to the wet fish business were reported about past experience of raw marine puffer fish availability in fish markets of Sylhet. But in some dry fish market few dried puffer fish were found during our study (Fig 4).



Fig 2: Fresh water puffer fish mixed with SIS in fish market.



Fig 3: Collected freshwater puffer fish.



Fig 4: Dried marine water puffer fish.

3.2 Species responsible for poisoning

Puffer fish poisoning is a well-known fish poisoning along the coasts of Asia ^[1]. Puffer fish consumed by the certain group of people and of which most of them are unaware about its toxicity. Therefore, puffer fish poisoning is quite common and sporadically reported in many places of the country (Table 1 ^[20] and Table 2). During this study, after visiting and discussed with local people, fishermen, affected family members and experts, it was confirmed that puffer fish poisoning case in Jaintapur upazila was due to ingestion of freshwater puffer fish *Tetraodon cutcutia*. Mahmud *et al.* ^[33] also documented ten occurrences of puffer fish poisoning due

to consumption of freshwater puffer fish (*Tetraodon patoca* and *Tetraodon cutcutia*) between the years 1988 and 1996. Hasan *et al.* ^[34] identified two tetrodotoxins (TTX) from the freshwater species *Tetraodon patoca*. In addition, intoxication due to intake of marine puffer fish is also known in Bangladesh. In many cases marine species, *Takifugu oblongus* is responsible for intoxication ^[14, 16]. Islam *et al.* ^[19] and Homaira *et al.* ^[18] also reported puffer fish poisoning due to intake of *Takifugu oblongus* in several places of the country. However, in a number of cases, it was not possible to identify responsible puffer fish species ^[20].

Table 1: Documented puffer fish poisoning outbreak in Bangladesh up to December 2010 (Chowdhury and Ahasan ^[20]).

Serial No.	Year and Month of occurrence	Species Identified	Place	Number of affected people	Death	Reference
1	1988–1996 (not specified)	<i>Tetraodon patoca</i> and <i>Tetraodon cutcutia</i> (freshwater)	Not specified	55	16	(Ahmed, 2006) ^[16] (Mahmud <i>et al.</i> 2000) ^[33]
2	1998 (November)	<i>Takifugu oblongus</i> (marine)	Cox's Bazar	8	5	Mahmud <i>et al.</i> 1999 ^[14]
3	2002 (April)	<i>Takifugu oblongus</i> (marine)	Khulna	37	8	(Ahasan <i>et al.</i> 2004) ^[15] (Chowdhury <i>et al.</i> 2007) ^[17] (Ahmed, 2006) ^[16] (Diener <i>et al.</i> 2007) ^[25]
4	2005 (July)	<i>Tetraodon patoca</i> (freshwater)	Khulna	6	0	(Chowdhury <i>et al.</i> 2007) ^[17] (Hasan <i>et al.</i> 2007) ^[34]
5	2008 (April)	<i>Takifugu stellatus</i> (marine)	Kishoreganj	3	2	(Islam <i>et al.</i> 2011) ^[19] (Homaira <i>et al.</i> 2008) ^[18]
6	2008 (April)	<i>Takifugu stellatus</i> (marine)	Narsingdi	45	5	
7	2008 (June)	Not identified	Dhaka	10	3	
8	2008 (June)	<i>Takifugu oblongus</i> (marine)	Natore	83	7	

Table 2: Newspaper reported puffer fish poisoning outbreak up to June 2017 (including present study).

Serial No.	Year and Month of occurrence	Species Identified	Place	Number of affected people	Death	News paper link
1	2012 (August)	Not reported	Jessore	2	1	^[41]
2	2012 (September)	Not reported	Bandarban	6	1	^[42]
3	2013 (December)	Not reported	Sylhet	4	1	^[43]
4	2014 (June)	Marine (Species not identified)	Jhalokati	5	1	^[43, 44]
5	2014 (August)	Not reported	Dhaka	5	4	^[43, 45, 46]
6	2015 (March)	Not reported	Dhaka	4	1	^[43, 47, 48]
7	2016 (March)	Not reported	Potua khali	4	1	^[49]
8	2016 (December)	<i>Tetraodon cutcutia</i> (Freshwater)	Sylhet	33	7	^[50, 51]

Table 3: Grading of tetrodotoxin intoxication ^[40].

Symptoms and signs	
Grade 1	Perioral numbness and paraesthesia, with or without gastrointestinal symptoms (mainly nausea).
Grade 2	Numbness of tongue, face and other areas (distal); early motor paralysis and incoordination; slurred speech; normal reflexes.
Grade 3	Generalized flaccid paralysis, respiratory failure (dyspnea), aphonia and fixed/dilated pupils; patient still conscious.
Grade 4	Severe respiratory failure and hypoxia; hypotension, bradycardia and cardiac dysrhythmias; unconsciousness may occur.

3.3 Main consumers of puffer fish

In Sylhet region puffer fish is mainly consumed by lower bracket income people and villagers of rural area around the water body from where this fish is collected. This fish is one of the favorite items among rural community since long time. Lower price and its delicious taste made it more popular among villagers in rural areas and poor people ^[14, 15, 18, 35, 36]. Table 4 shows consumption habit of puffer fish from different area.

About 81.11% of villagers who are familiarize to consumption of puffer fish have a traditional family background history of eating of this fish. All rural respondent of our study said that they frequently eat puffer fish from their

earlier life. Puffer fish is also much more popular among the ethnic community of tea state. People of ethnic community (83.33%) of tea state also regularly eat raw and dry item of this fish.

At the urban area, 31.67% of people also informed about their experience of eating of puffer fish at least several time in their life. Rest of the respondents informed about no experience of eating this fish in their families. In town it is regularly eaten by lower income people mainly, fish seller, labor of fish market, cleaner and daily labor who are from village and have previous experience to eat puffer fish from their early life. 60% small scale fish seller (involve with business of native/Small Indigenous Species of fish) are also familiar with

puffer fish consumption.

Some respondents also informed about past experience about consumption of marine puffer fish, which are mainly from the southern part of the country like Noakhali, Khulna and Chittagong region. Only limited number of the respondent informed they have no idea about puffer fish consumption; instead they did not know that this fish may be consumable. However, no relevant published information were found related to from when this fish is entered the consumer table.

Table 4: Consumption habit of puffer fish.

Respondent people	Number of respondents	Consumption habit (number/percentage)	
		Yes	No
Villagers	90	73 (81.11%)	17 (18.89%)
Tea state's people	30	25 (83.33%)	5 (16.67%)
City dweller	60	19 (31.67%)	41 (68.33%)
Fish seller	20	12 (60%)	8 (40%)
Total	200	129 (64.5%)	71 (35.5%)

3.4 Reason of eating puffer fish

Most of the respondents (60.47%) who eat puffer fish regularly or have an experience of eating puffer fish informed that this fish is so tasty. Some stated that fried puffer fish is felt like as “soft rubbery” during consumption. This is one of the most important facts of choosing this fish. On the other hand, lower price of puffer fish than other available fish in market also made it popular to lower bracket income people (Fig 5). Interesting fact is that some people mentioned that this fish (dry) is used as a drug by many people.

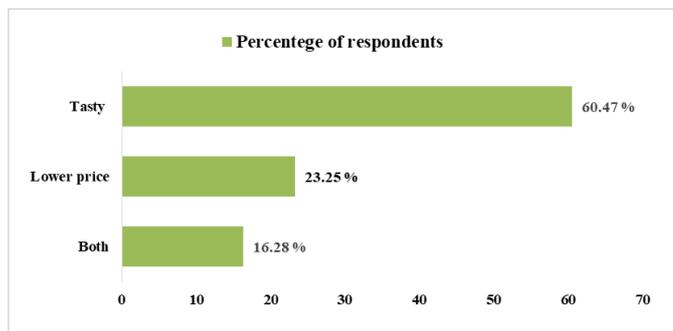


Fig 5: Preference factors of eating puffer fish.

3.5 Consumer source of puffer fish

Sylhet is one of the richest place bless with natural water bodies like haor, floodplain, beels etc. Puffer fish is mainly collected from this water bodies with other fish. Puffer fish is a non-target fish during harvesting. According to participant villagers, fisherman and fish traders informed that freshwater puffer fish is highly available in natural water bodies during the winter season. In this season water level become low and puffer fishes are floated (by take air in their air sac) in the surface level of the water body. When fishing operation is done this fish is caught as a trash with other fish. 78% of puffer fish consumer informed that they collected this fish from market (Fig 6).

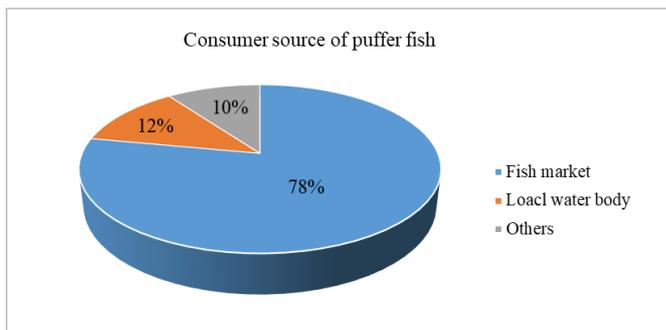


Fig 6: Purchase site puffer fish according to respondents.

3.6 Marketing channel of puffer fish

Puffer fish is come to consumer level mainly by three ways. Firstly, at fishing places this fish is collected by fishermen for their own consumption. Sometimes fishermen share collection of puffer fish to their neighbors or adjacent local people. Secondly, some fishermen sorted puffer fish from harvested mixed fishes after harvesting to sell in the local fish market near water body (Fig 2). Where, people can easily buy this fish. Thirdly, puffer fish mixed with other fishes come to big market then sell without separating from other fishes or after sorting sell separately (Fig 7). Clients (sometime fishermen himself) can collect/buy puffer fish from the water body or from local markets [15, 35]. Dried freshwater puffer fish is found in many dry fish market of Sylhet towns. Shamsuzzaman *et al.* [32] reported large dried marine puffer fishes to be sold in the local market of Sylhet. The present study was also deeply investigated the market availability of marine puffer fish. However, no marine species were found during our survey but dries form are found.

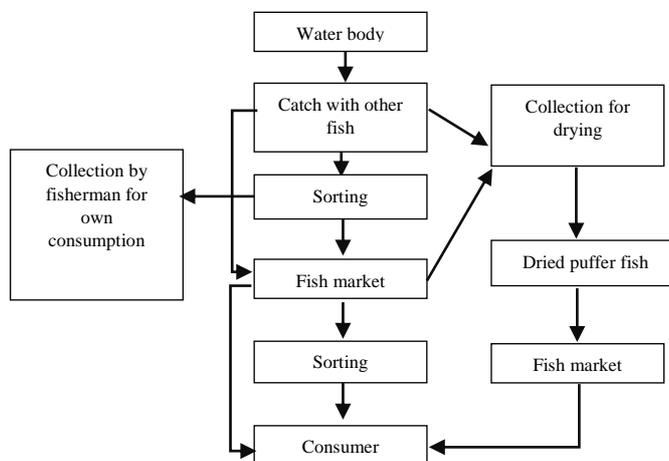


Fig 7: Marketing channel of puffer fish from water body to consumer.

3.7 Ways of processing before cooking

Both wet and dry form of this fish is consumed. Among the puffer fish consumer, it is popularly consumed with other vegetables items. Before cooking of this fish it is mainly prepared in two ways. Firstly, 52.71% people informed they used to remove the outer skin and viscera of the fish. Where, others (47.29%) remove only the digestive part but not the skin of the fish (Fig 8). Dry fish is consumed as “vorta”, a smashed item of dry puffer fish made with different spices and vegetables.

The puffer fish contains a neurotoxin named tetrodotoxin (TTX) and both freshwater and marine water puffer fish from

Bangladesh reported with analogues of tetrodotoxin [25, 34]. Though puffer fish shows wide individual, regional and seasonal variation in toxicity [37]. The highest concentration of the toxins (TTX) is found in the viscera (gonads, especially the ovaries; liver; intestine) and skin and body musculature is usually free of poison [1, 2]. In Bangladesh the mating and spawning seasons of puffer fish usually range from March to July [24]. During this time the fish remains very toxic as the TTX is principally concentrated in the gonads, intestine, and liver [20]. Chowdhury *et al.* [17] reported puffer fish intoxication due to only ingestion of 'liver' but not the fleshy portion of the marine puffer fish. Tetrodotoxin (TTX) is a heat stable, water-soluble and a non-protein quinazoline derivative [30]. Due to the toxic nature of the puffer fish and its known ill effects, in Japan and puffer fish is prepared by licensed cooks [23]. However, most people of our country are unaware about the special technique and precaution in cooking puffer fish [15]. In our study area, two types of preparation method are practiced before cooking of puffer fish. Some people remove of viscera while other removes both skin and viscera of fish. A limited number of people who consume puffer fish had a little or no idea about toxicity of skin and viscera of puffer fish.

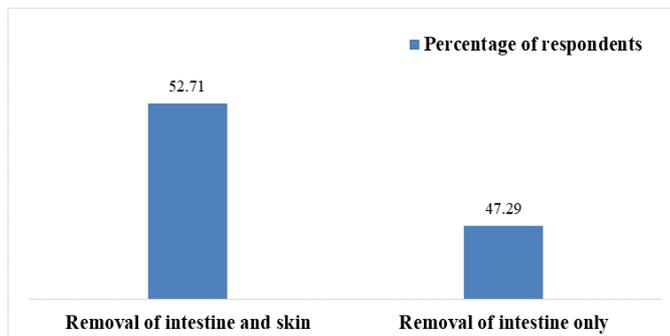


Fig 8: Locally used processing method of puffer fish before cooking.

3.8 Awareness about toxicity of puffer fish

About 84.5% people informed that they are totally unaware about the toxicity of puffer fish. Some also commented about puffer fish as inedible but not aware about its toxicity. However, few respondents (6.5%) mainly from the city area said that they slightly know about toxicity of puffer fish. Only 9% people reported that they have come to learn about puffer fish poisoning after Sylhet incident (Fig 9). Previous occurrences of puffer fish poisoning pointed out that, in some incident people were familiar to consumption of locally available fresh water puffer fish and poisoning occurred due to ingestion of marine puffer fish [18, 19]. In other cases consumers were totally unaware about cooking, preparation and eating of puffer fish [15, 36].

According to the affected family members (Jaintapur, Sylhet) and other participants of this study many of them have the previous experience of eating of fresh water puffer fish since long time and they have no idea about the toxicity of puffer fish. They regularly enjoyed consuming the small and locally available freshwater puffer fish without becoming ill [18]. However, in maximum places people were unaware of the fact that the puffer fish might be toxic [19, 36].

Since there is no specific treatment for puffer fish poisoning [38], that's why people should be made aware of the potential risk of eating puffer fish. Early recognition of the toxication condition and supportive care in a modern intensive care should ensure a safe outcome to this matter [12]. Clinical

features of this poisoning depend upon the amount of toxin ingested [20]. Salivation, nausea, vomiting, and diarrhoea with abdominal pain are developed at early stage with motor weakness and difficulty in speaking, which are most common clinical features [19].

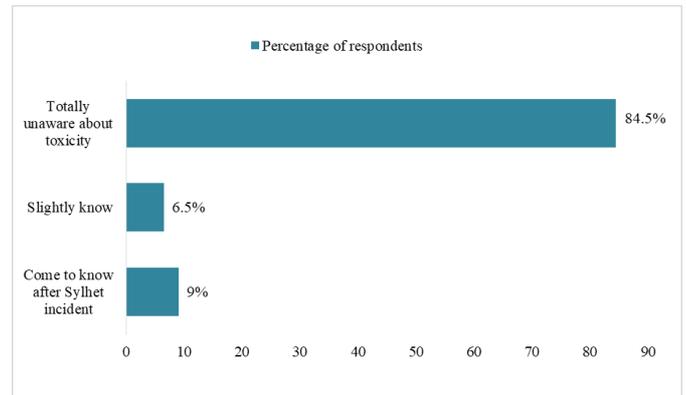


Fig 9: Public awareness about puffer fish toxicity.

A rapid ascending paralysis is the most common paralysis complication [15]. On the other hand, first symptoms include lip and tongue paraesthesia occurred less than 30 min to several hours after the ingestion of puffer fish and was followed by facial and limb paraesthesia and numbness [19]. Patients with severe poisoning may fall into a coma and death may occur within four to six hours of ingestion [39]. Meier and White [40] categorized the clinical effects of TTX poisoning according to the severity of neurological and cardiovascular involvement (Table 3) associated with puffer fish poisoning. Hence there is no specific effective antidote; prevention by increased population awareness should be the first priority [19, 36]. After certain outbreaks, Ministry of Fisheries and Live Stock launched extensive awareness program for the general public mainly in the coastline districts [20]. After Sylhet episode a number of awareness growing articles were published print media and some monitoring work were done by local governmental authority. Local authority concerned also banned the selling of fresh water puffer fish in the local fish market.

4. Conclusion and Recommendations

After proper investigation and collection of statement of local people and other respondent of the present study, it is clear that puffer fish poisoning in Sylhet region was due to consumption of freshwater puffer fish (*Tetraodon cutcutia*). It was also clear that lack of knowledge about toxicity of puffer fish and local's people consumption habit of puffer fish has triggered this incident. As puffer fish intoxication is sporadic in Bangladesh more public awareness rising activities against puffer fish consumption, regular monitoring by governmental authority and increase of more trained health personnel to face medical emergencies are utmost issue in this regard.

5. Acknowledgements

We are very grateful to Department of Fisheries Technology and Quality Control, and the Department of Fish Biology and Genetics, Faculty of Fisheries, Sylhet Agricultural University, Sylhet-3100, Bangladesh for providing support for successful implementation of this study. Gratitude also made to Md. Alamgir Hossain, former Veterinary Surgeon of Jaintapur upazila for his kind help throughout the study. We also express our appreciation to undergraduate student Debraj Ray,

Shuva Saha and Md. Golam Rabbani for their cooperation during this study.

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