Traditional jute (*Corchorus* spp.) retting process: A significant threat to fish health and fish biodiversity in Chandpur District, Bangladesh

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Abstract

The study was conducted to assess the impact of traditional jute retting process on the fish health and fish biodiversity in the six upazilas of Chandpur district, Bangladesh. Data were collected from respondents through face to face interviews and focus group discussions. All of the jute farmers in the study area used traditional water retting methods to extract fibres and these methods were entirely dependent on natural water bodies such as pond, canal and beel. Most of the jute farmers (72%) used canal's water for jute retting and farmers (76%) revealed that the highest intensity of fish mortality occurred in those canal water. Almost 30% of people mentioned water condition has deteriorated due to jute retting which is indicated by the presence of surface scum, bad odour etc. in the jute retting water bodies and 50% partially believed that jute retting causes the water quality deterioration but only in the case of closed water bodies. About 62% of people stated the availability of SIS (Small Indigenous Species) such as *Channa punctatus*, *Anabas testudineus*, *Channa striatus*, *Heteropneustes fossilis*, *Clarias batrachus*, *Mystus* spp., *Puntius* spp. gradually decreased in the jute retting water bodies after the jute retting. Nowadays fish farmers (78%) didn't practice aquaculture in the jute retting water bodies because they found it unprofitable due to the deteriorated water condition. After the jute retting season, the fishes especially carps such as *Labeo rohita*, *Gibeleon catla*, *Cirrhinus cirrhosis*, *Hypophthalmichthys nobilis* and SIS cultured in jute retting water bodies were affected by diseases and different signs such as skin lesion, ulcers, gill hemorrhage etc. were observed in the affected fishes and most of the fish farmers used lime, potash etc. for treatment of the fish diseases. Jute and fish both are valuable crops in the perspective of Bangladesh due to the contribution of these crops in total national export earnings and in the employment sector. Therefore, an environmentally friendly jute retting process should be extended among the jute farmers of Bangladesh which will not be a threat for fish health and fish biodiversity.

Keywords: Aquaculture, Fish biodiversity, Fish health, Jute retting, Water quality, Environmental pollution, Traditional

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Introduction

Jute (*Corchorus olitorius* L. and *Corchorus capsularis* L.) is called the 'Golden Fibre' of Bangladesh (Mia *et al.*, 2017; Akter *et al.,* 2020) because a large amount of foreign currency is earned by exporting jute and jute products which not only help Bangladesh's economy but also the employment sector of Bangladesh (Hossain and Abdulla, 2015). In the 2018-2019 fiscal years, the jute sector of Bangladesh contributed 4.9% to the total national export earnings of Bangladesh and Bangladesh earned $721.826 million by exporting jute and jute products by cultivating jute in a total area of 7,49,658 hectares in that year. Nearly one-fourth of the whole population of Bangladesh is directly or indirectly associated on jute and jute industries for their income (MOF, 2019). Due to its light weight and long-lasting nature, jute has many versatile applications such as upholstery, carpet, apparels, furnishing, bags etc. (FAO, 1998; Gangwar *et al*., 2011; Ali *et al.*, 2015) and quality of fiber is necessary for diversifying use of jute fiber which is determined by the efficacy of the retting process of jute (Majumdar *et al.*, 1991; Ahmed and Akhter, 2001). Jute retting is a biological process of extraction of fibers from the woody stems of jute plants and different types of jute retting processes are practiced such as dew retting, water retting, ribbon retting etc. But traditional water-retting procedure is mostly selected by jute farmers because it is simple (Roy and Hassan, 2016) and conducted in waterlogged area and shallow water body such as small ditches, canals, and ponds etc. (Ali *et al.*, 2015). During the traditional water-retting process, a vast amount of biomass undergoes decomposition in the water (Banik *et al.*, 1993) and results in the generation of waste liquor, and scum which appears on the surface of water bodies (Banerjee and Dastidar, 2005). The jute retting in water body causes the pollution of the aquatic environment and has a detrimental effect on aquatic flora and fauna, especially fish (Mondal and Kaviraj, 2008; Roy and Hassan, 2016). The water body which is the breeding, spawning and nursery ground of many freshwater fishes, is used for jute retting during the monsoon season, this disrupts the aquatic ecosystem (Mondal and Kaviraj, 2008). The fisheries sector (especially freshwater fishes such as *Labeo rohita*, *Gibeleon catla*, *Anabas testudineus* etc.; marine fishes such as *Tenualosa ilisha*, *Chanos chanos*, *Lates calcarifer* etc. and others such as prawn, shrimp, crab etc.) is also an important sector of Bangladesh which contributes 2.06% to the total national export earnings of Bangladesh (Islam *et al*., 2017) and 60% of the total animal protein intake of the country (FRSS, 2016). Bangladesh earned $508.48 million from exporting fish and fisheries products in the 2018-2019 fiscal years (DOF, 2019). More than 17 million people (about 11% of the total population), including approximately 1.4 million women, is directly or indirectly depended on the fishery sector for their livelihoods (FRSS, 2016; Islam *et al.*, 2017; Momi *et al.*, 2020).

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Chandpur district is not only famous for its freshwater fisheries resources but also for the production of jute. In the 2018-2019 fiscal years, 35017 bales jute was produced from Chandpur district which was 0.4% of the total jute production of Bangladesh (BBS, 2019).

There is a lack of knowledge regarding the effects of jute retting on the vast floodplain area and other inland water bodies of Chandpur district. Therefore, the main objectives of the study were to investigate the effects of jute retting on the fish biodiversity and aquaculture in the water bodies of Chandpur district.

Materials and methods

Study area

Chandpur (23° 16' 11" N, 90° 42' 35" E) is one of the coastal districts which situated in the east-central part of Bangladesh (Fig. 1). It is surrounded by the largest estuarine system the Padma River and the Meghna River as well as Bay of Bengal to the south. The Padma River as well as the Meghna River estuary is the rich source of various fishes. The presence of rivers in Chandpur district has made district a rich source of freshwater resources of Bangladesh. The tidal floodplain of this estuarine river delta consists of a coastal and fertile delta land which lies 12 meters above the mean sea level and is bounded by an alluvial plain on three sides (BMD, 2016). The coastal regions are influenced by the semi-diurnal tidal cycles and the tidal fluctuations vary on the seasons. During the monsoon, most of the low lying areas of Chandpur are flooded with water and farmers use these water bodies like ponds, canals, rivers and beels etc. for jute retting purposes. About 22,10,162 people are lived in Chandpur where 3.03% people are directly engaged with fishing followed by 35.13% in agriculture, 20.04% in agricultural labor, 3.15% in wage laborer, 12% in commerce, 2.24% in transport etc., respectively (BBS, 2019). The present study was conducted at six upazilas of Chandpur district, Bangladesh namely the Chandpur Sadar, Faridganj, Haziganj, Matlab Dakshin, Matlab Uttar and Kachua.

Study period and target group

The present study was conducted during December, 2018- May, 2019 in six upazilas (Chandpur Sadar, Faridganj, Haziganj, Matlab Dakshin, Matlab Uttar and Kachua) of Chandpur district, Bangladesh. The main selected target groups were the local fishermen, fish farmers and jute farmers, fish wholesalers and fish retailers in the present study. For these, jute farmers, fish farmers, fisheries dependent people communities (fishers, traders, transporters etc.), BFRI (Bangladesh Fisheries Research Institute) officers, Extension officers, upazila fisheries officers, officers from the Department of Jute were interviewed. All the participants were randomly selected (Table 1). The farmers who were involved in jute cultivation, fish culture and both jute cultivation and fish culture were selected for this study. In the study area, many farmers involved in both jute cultivation and

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aquaculture and practiced in the same water bodies. Moreover, the fish farmers who live adjacent to the jute retting water bodies were also selected.

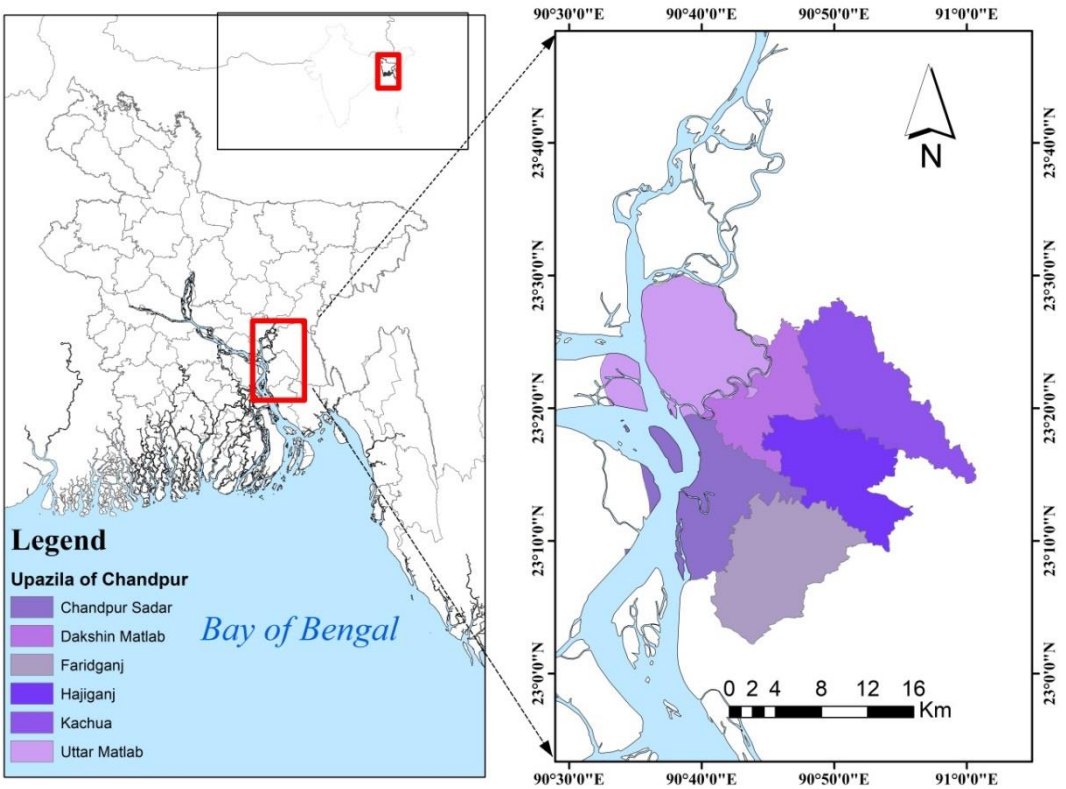

Figure 1: Map showing the study area in Chandpur District, Bangladesh.

Table 1: Data collection method and sample size of target groups.

Data collection method	Target group	Sample size (n)
Questionnaire interviews	Jute farmer and fish farmer	100
Focus group discussions	local fisheries related people (fish farmer, fishers, fish traders, transporters etc.) and others local people	60
Cross-check interviews	Key informants	18

Development and validation of questionnaire

A systematic questionnaire was prepared by the help of a vast literature review, personal and technical proficiencies as well as a group of vernal research minded enumerator and multidisciplinary researchers. A pre-test (piloting) study was done in Chandpur district among the fish farmers, fish landing centers and fish markets with similar patterns to cross-check the design and validation of questionnaires. About 20 fish farmers and 20 jute farmers were interviewed during pre-testing. After that, the

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feedback from pre-test study was summarized and the key information was picked up to redevelop the questionnaire for collecting data in a consistent way. Most integral part of a survey study is the direct observation which assists to arrange the collected data in a specific manner (da Cunha *et al.*, 2019). Meanwhile, the final survey questionnaire was developed in a logical sequence so that selected participants could answer the question systematically and confidently without any hesitation.

At the beginning of the interview, objectives of the study were illustrated clearly among the farmers and assured them that all information intended to be kept secret. Additionally, each question was asked systematically and explained clearly for their sound understanding. Through visiting the survey areas, some factors were considered with importance and included into the questionnaire. A scoring system as well as level of agreement to the statements and uncertain rating scale was used to record the answer of participants.

Data collection

The data were collected from participants through questionnaire interview, personal contact (face to face and via telephone) and Participatory Rural Appraisal (PRA) tool like Focus Group Discussion (FGD) as well as Crosscheck interview in the study area (Table 1). Random data collection method was followed during the interview. About 6 groups were formed among the study area each having 9-11 members including different ages of people for FGD. Moreover, other information was collected from various commune annual reports and documents such as scientific journal, workshop proceedings, technical report, books, annual publication of government, and non-government organizations and different national as well as regional newspapers and publications. After collecting the data, a crosscheck interviews were conducted with key informants such as BFRI (Bangladesh Fisheries Research Institute) officers, upazila fisheries officers, assistant fisheries officers, fisheries extension workers and officers of the Department of Jute for confirmation of the data.

Statistical analysis

The collected data were anatomized and sorted carefully to avoid any shortcomings. Microsoft office excels 2016 was used to analyze the data and represented in tabular and graphical form. The graphs, charts and associated tables were made in conformity to the study objectives.

Results

Jute retting process in Chandpur district

In the present study, all of the jute farmers in the study area used traditional water retting methods for jute decomposition which were based on natural water bodies (pond, beel, and canal). Farmers of the Chandpur district used different types of water bodies for jute retting. For jute retting, about 14%

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jute farmers used pond's water, 72% used canal's water and 14% used beel's. Most of the jute farmers depend on canal water for jute retting process.

Use of natural water bodies for jute retting

According to the present survey, majority of jute farmers of all upazilas (Chandpur Sadar, Hajiganj, Matlab Dakshin, Kachua, Matlab Uttar and Faridganj) in Chandpur district used canal for jute retting. The jute farmers of Chandpur Sadar and Faridganj upazila did not use beel water. In Matlab Uttar and Kachua upazila, the farmers did not practice the jute retting in pond water. Farmers of Hazigonj upazila were practicing jute retting in the three types of water bodies. In all the unions of Chandpur district, most of the jute retting was implemented by the farmers in canal water except 5th ward Pouroshova. The farmers performed the jute retting in the both pond (50%) and canal water (50%) equally in the 5th ward Pouroshova of Faridganj upazila (Table 2).

Table 2: Scenario of used water bodies for jute retting in different upazilas and unions of Chandpur district.

Study area	Selected unions	Percentage of jute farmers (%)		
		Pond water	Canal water	Beel water
Chandpur Sadar	Baliya	16%	82%	0
	Chanda	24%	74%	0
Hajiganj	Patanish bazar	14%	56%	28%
	West Hatila	32%	66%	0
Matlab Dakshin	6th south upadi	0	50%	50%
	5th North Upadi	16%	82%	0
Kachua	5th Sohodevpur	0	80%	20%
Matlab Uttar	Gojra	0	80%	20%
Faridganj	3th ward Pouroshova	40%	60%	0
	5th ward Pouroshova	50%	50%	0

Water quality deterioration in the jute retting area of Chandpur district

About 30% fish farmers in Chandpur district believed that this deterioration of water quality is occurred due to jute retting. About 20% farmers mentioned that jute retting is not as a responsible factor for deterioration of water quality in the study area. About 50% fish farmers in the study area mentioned that jute retting may be the responsible factor for deterioration of water quality in case of closed water bodies like pond but in case of running water bodies like canal it is not only responsible factor. Among all the upazilas in Chandpur district, majority of the farmers (60%) of Chandpur Sadar, Matlab Uttar and Faridgonj upazilas revealed that water quality deteriorated through jute retting when retting was occurred in closed water bodies but in case of running water bodies water quality remain unchanged. About 40% farmers of the three upazilas such as Hazigonj, Matlab Dakshin and Kachua directly declared that water

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quality deteriorated through jute retting. About 20% fish farmers of Chandpur Sadar, Kachua, Matlab Uttar and Faridganj upazilas stated that jute retting was not the responsible factor for water quality deterioration (Table 3).

Table 3: Different aspects related to the causes of water quality deterioration of Chandpur district.

Aspects related to the causes of water quality deterioration	Opinion of local people (%)					
	Chandpur Sadar	Hajiganj	Matlab Dakshin	Kachua	Matlab Uttar	Faridganj
Jute retting is the responsible factor	20%	40%	40%	40%	20%	20%
Jute retting is not the responsible factor	20%	10%	30%	20%	20%	20%
Jute retting is the responsible factor only in case of closed water bodies	60%	50%	30%	40%	60%	60%

Amid all the unions of Chandpur district, 26.67% farmers in 5th North Upadi, 20% in Patanish Bazar, 13.33% in three unions (Baliya, 5th Sohodevpur and Gojra) and 6.67% in two unions (West Hatila and 3rd ward Pouroshova) believed that the jute retting is the causes of water quality deterioration.

Water quality management after jute retting in Chandpur district

In the jute retting areas, jute retting is one of the causes of water quality deterioration that was indicated by the appearance of surface scum, bad odour etc. in the jute retting water bodies after the moonson. So before starting the fish culture in those water bodies, it is necessary to adopt some pre-stocking management practices to improve the water quality. From this study, it was observed that about 34% fish farmers in Chandpur district used lime, potash, zeolite, aerator to enhance the water quality. Majority of the fish farmers in Chandpur district (about 66%) did not practice pre-stocking management practices such as liming, fertilization etc. to improve water condition.

From the present study, it was observed that all the fish farmers of Faridgonj, Kachua and Matlab Uttar upazilas mentioned that they didn't practice management methods for improving the quality of jute retting water. On the other hand, 40%, 70% and 60% fish farmers of Chandpur Sadar, Hazigonj and Matlab Dakshin respectively practiced management methods including liming, fertilization etc. to improve jute retting water quality (Table 4).

Amid all the unions of Chandpur district, 41.18% farmers in Patanish Bazar, 35.29% in 6th North Upadi and 23.53% in Chanda union used lime, potash, zeolite for improving the water quality of those water bodies which

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were used for jute retting.

Table 4: Water quality management practice after jute retting of Chandpur district.

Study area	Percentage of farmers (%)	
	Adopted pre-stocking management practices	Didn't adopt pre-stocking management practices
Chandpur Sadar	40%	60%
Hajiganj	70%	30%
Matlab Dakshin	60%	40%
Kachua	0%	100%
Matlab Uttar	0%	100%
Faridganj	0%	100%

Aquaculture practice in Jute retting water bodies

The present study has shown that all the fish farmers had cultured the fish in semi-intensive method. It was found that about 22% farmers were used jute retting water bodies for aquaculture practice and among them, about 9.9% fish farmers practice monoculture system and 90.1% practice polyculture system for fish production. On the contrary, nearly 78% farmers of Chandpur district did not practice aquaculture in those water bodies which were used for jute retting because they have found it unprofitable due to the deteriorated water condition.

Amid all the upazilas of Chandpur district, the fish farmers of three upazilas (Kachua, Matlab Uttar and Faridgonj) did not use jute retting water bodies for aquaculture. On the other hand, almost 40% farmers of Chandpur Sadar and Matlab Dakshin upazilas and 30% of Hazigonj upazila didn't practice aquaculture in jute retting water bodies (Fig. 2).

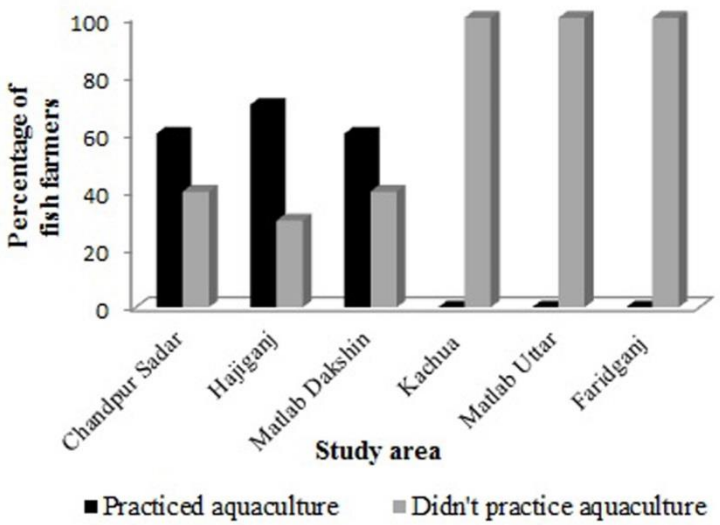

Figure 2: Aquaculture practice in the jute retting water bodies of Chandpur district.

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Among all the union of Chandpur district, around 36.36% fish farmers of Chanda, 27.27% of Patanish bazar, 36.36% of 6th South Upadi practiced aquaculture in jute retting water bodies. The fish farmers of Chanda union practiced both monoculture and polyculture but the farmers of Patanish bazar and 6th South Upadi adopted only polyculture system.

Generally the fish farmers of Chandpur district mentioned that tilapia (*Oreochromis niloticus*) was cultured in monoculture and the carp species such as Rohu (*Labeo rohita*), Catla (*Gibeleon catla)*, Mrigel (*Cirrhinus cirrhosis*), and Bighead carp (*Hypophthalmichthys nobilis*) were cultured through polyculture system in the jute retting water bodies.

Mortality of fishes occurred in jute retting water bodies

In the present study, about 76% fish farmers in Chandpur district revealed that the highest mortality of fishes were occurred in canal water which was used mostly by jute farmers for jute retting and about 14% farmers mentioned that the fish mortality in pond water was more than beel water but lower than pond water. On the other hand, the fish mortality was lowest in beel water were said by only 10% farmers and beel was used by 13% jute farmers of Chandpur district (Fig. 3).

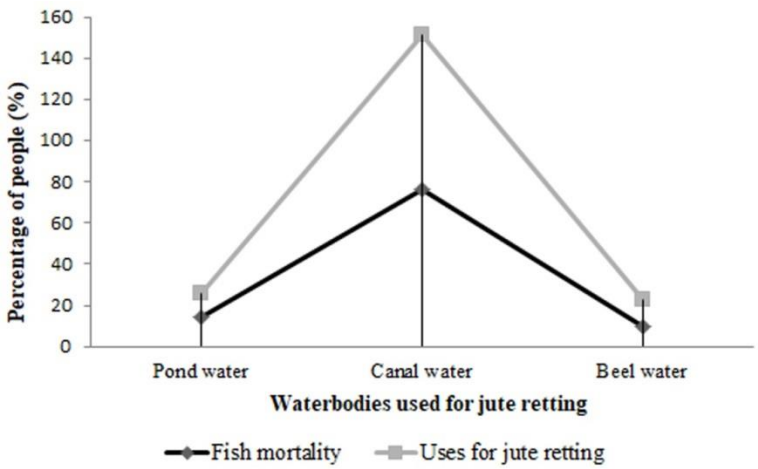

Figure 3: Intensity of fish mortality in different jute retting water bodies of Chandpur district.

Likewise, the majority of the fish farmers from different upazila of Chandpur district stated that the highest intensity of fish mortality occurred in canal. Similarly, Most of the fish farmers of all the unions of Chandpur district observed that the highest intensity of fish mortality was occurred in canal except 5th North Upadi. The fish farmer in 5th North Upadi reported that the fish mortality was occurred in both canal and beel water (Table 5).

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Table 5: Intensity of fish mortality in different jute retting water bodies of Chandpur district.

Study area	Belief of fish farmers (%) in study area		
	Pond water	Canal water	Beel water
Chandpur Sadar			
Baliya	17	83	0
Chanda	0	100	0
Hajiganj			
Patanish bazar	14	71	14
West Hatila	33	67	0
Matlab Dakshin			
6th south upadi	0	100	0
5th North Upadi	0	50	50
Kachua			
5th Sohodevpur	0	100	0
Matlab Uttar			
Gojra	0	90	10
Faridganj			
3th ward Pouroshova	33	67	0
5th ward Pouroshova	0	100	0

Availability of SIS in jute retting area

During the monsoon, Ponds, canals, floodplain areas which are locally known as beels are the most productive inland water bodies are used as breeding, spawning and nursery ground of many indigenous fish species and these inland water bodies are also used for jute retting in the Chandpur district. In the study area, the most abundant SIS (Small indigenous species) fishes observed during the study time were Taki (*Channa punctatus*), Koi (*Anabas testudineus)*, Shol (*Channa striatus)*, Shingi (*Heteropneustes fossilis)*, Magur (*Clarias batrachus*), Tengra (*Mystus* spp.), Punti (*Puntius* spp.) etc. In Chandpur district, About 32% fishers mentioned that SIS availability were higher whereas 62% stated the availability of SIS gradually decreased after the monsoon of jute retting in the jute retting water bodies. Furthermore, 6% fishers reported that there was no change occurred in SIS availability in the jute retting water bodies before and after the jute retting.

All the fishers of all the unions of Chandpur district revealed that SIS availability was decreased in the jute retting water bodies after the jute retting except Baliya, 3th ward Pouroshova and 6th south upadi. All the fishers of West Hatila reported that there was no change occur in SIS availability in the jute retting water bodies due to jute retting. On the contrary, all the fishers of Chanda, Patanish bazar, 5th North Upadi, 5th Sohodevpur and 5th ward Pouroshova stated that SIS availability was decreased due to jute retting (Table 6).

Fish health management system in jute retting water body

In the study, it was found that fishes of jute retting water bodies were affected by various diseases/pathogens. Most signs were observed that were lesion, scales loss, gill hemorrhage, EUS, gas

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bubble diseases, skin hemorrhage, fin erosion, tail erosion etc. About 45.45% fish farmers of Chandpur district used chemicals to treat the diseases affected fishes of the jute retting water bodies and 54.55 % did not adopt any treatment methods. Most of the fish farmers used lime, potash, zeolite etc. for treatment the fish diseases (Table 7).

Table 6: SIS availability in the jute retting water bodies of Chandpur district after the monsoon of jute retting.

Study area	Opinion of fishers (%) in study area about the SIS availability		
	Increased in SIS availability	No changed in SIS availability	Decreased in SIS availability
Chandpur Sadar			
Baliya	100	0	0
Chanda	0	0	100
Hajiganj			
Patanish bazar	0	0	100
West Hatila	0	100	0
Matlab Dakshin			
6th south upadi	100	0	0
5th North Upadi	0	0	100
Kachua			
5th Sohodevpur	0	0	100
Matlab Uttar			
Gojra	30	0	70
Faridganj			
3th ward Pouroshova	100	0	0
5th ward Pouroshova	0	0	100

Table 7: Fish health management system in the jute retting water bodies.

Upazilas of Chandpur district	Sign of Fish Diseases	Treatment method
Chandpur Sadar	Skin lesion, ulcers, gill hemorrhage etc.	Lime and potash
	Tail erosion, ulcers, fin erosion	No
Hazigonj	Skin lesion, gill hemorrhage, fluid in body cavity.	Lime, Zeolite, Bio-x
	Skin lesion, ulcers, gill hemorrhage etc.	No
Kachua	Skin lesion, ulcers, gill hemorrhage etc.	No
Matlab Uttar	Skin lesion, ulcers, gill hemorrhage etc.	No
Faridgonj	Skin lesion, ulcers, gill hemorrhage etc.	No
	Skin lesion, ulcers, gill hemorrhage etc.	No
Matlab Dakshin	Tail erosion, ulcers, scales loss	Lime, Zeolite, Aerator
	Skin lesion, gill hemorrhage, fluid in body cavity.	Lime, Zeolite

Discussion

All the jute farmers of Chandpur district used traditional water-retting methods for jute retting which is consistent with the findings of Ali *et al.* (2015) who reported that the majority of jute farmers in Bangladesh practiced traditional retting methods. The traditional water-retting methods were mostly used in the study area due to the availability of

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water bodies or requirement of less labour or due to ignorance about the eco-friendly jute retting method such as ribbon retting. In the study area, different types of natural water bodies (pond, beel, and canal) were used for jute retting. Most of the jute farmers of Chandpur district (72%) used canal water for jute retting process followed by 14% jute farmers used pond's water and 14% used beel's water. Similar findings were reported by Ali *et al.* (2015) who stated that in Bangladesh jute retting is conducted on small ditches, canals, and ponds etc. where the water stands only for a short period. Among all the unions of Chandpur district, majority of jute farmers performed the jute retting in canal water except 5th ward Pouroshova, where jute retting was done in both pond and canal water equally (Table 2). From this survey, it was observed that jute farmers used different types of water bodies according to their facilities that may be transportation facility.

From the present survey, it was noticed that the water quality in the study area's water bodies is not so good, in most cases it can said to be polluted. Most of the people of Chandpur district reported that jute retting was the only cause of deterioration of water quality in pond but in the case of canal, jute retting was not only causative factor (Table 3). They mentioned that jute retting have various negative effects such as water color change mainly turn into blackish color, fluctuation of water temperature, produce gas bubble etc. in closed water bodies like pond. The finding of the present study is consistent with the findings of Haque *et al.* (2002) and Ali *et al.* (2015). Haque *et al.* (2002) reported that jute retting process increases the microbial load in water and the water loses its original color, odor, etc. and becomes darker. Similarly, Ali *et al.* (2015) stated that the jute retting in different water bodies such as pond, canal, river etc. generates the disgusting odor and pollutes the local environment.

Faunal diversity and availability depend on the water quality of the aquatic ecosystem (Sudta *et al.*, 2021). Good fish production depends on good water quality. So some pre-stocking management methods have to follow for improving water quality before stocking the fish in water bodies because it has direct impact on the growth and yield of fish (Malla *et al.*, 2020). Majority of the fish farmers in Chandpur district did not practice pre-stocking management practices to improve water condition (Table 4).

Aquaculture is an important fisheries subsector in Bangladesh that fulfills the demand of nutrition for people in Bangladesh (Dey *et al.*, 2010). Most of the farmers of Chandpur district did not use jute retting water bodies for aquaculture purpose because they stated the practice of aquaculture in those water bodies was unprofitable due to the deteriorated water condition (Fig. 2). That was due to the fishes of jute retting water bodies were affected by various diseases in the study area. Most signs that were observed in the fishes of jute

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retting water bodies were lesion, scales loss, gill hemorrhage, EUS, gas bubble diseases, skin hemorrhage, fin erosion, tail erosion etc. And that may be occurred due to the change of physico-chemical parameters of water due to the jute retting (Ghosh and Biswas, 2018). Due to the jute retting, a huge amount of biomass undergoes decomposition in the water and this leads to the growth of different microorganisms which are harmful for fish species (Banik *et al.*, 1993; Mondal and Kaviraj 2008; Ali *et al.*, 2015). Post-retting water contain higher microbial load than the pre-retting water (Das *et al.*, 2011). Different fungi such as *Aspergillus niger, Macrophomina phaseolina, Mucor, Chaetomium* sp. and several *Penicillium* sp. and several aerobic bacteria of the genus *Bacillus* viz., *B. subtilis, B. polymyxa, B. mesentericus, B. macerans* (Bhatacharyya, 1974) and anaerobic bacteria of the genus *Clostridium viz., C. tertium, C. aurantibutyricium, C. felsineum* etc. (Alam, 1970) have been isolated from retting water which can cause serious problems in fish health. Though the main concerns related to the fin erosion are reducing swimming ability which limited the survivability of fish and the aesthetics value to the angler and consumers, but it also causes high fish mortality (Latremouille, 2003). Virulent strains of *Aeromonas salmonicida* and *Flexibacter* have been found as responsible of fin erosion or fin rot for which high mortality was observed in afflicted fish (Bullock, 1968; Latremouille, 2003).

Mortality in fish populations is occurred due to a variety of biotic and abiotic causes and among the abiotic causes environmental or physicochemical stress is one of the important issues (Ellis *et al.*, 2012). Most of the fish farmers in Chandpur district mentioned that the highest mortality of fishes was observed in canal water compared to the pond and beel water and that may be due to the lentic water condition of canal (Fig. 3). This result is in accordance with the study by Mondal and Kaviraj (2008) who reported that two species of freshwater fish species (*Labeo rohita* and *Hypophthalmicthys molitrix*) were highly susceptible to the jute retting water and the minimum percentage of jute retting water caused significant mortality which was 50% for *L. rohita* and 70% for *H. molitrix.* In the present study, it was observed that jute retting have no effect on some fishes such as shing (*Heteropneustes fossilis*), koi (*Anabas testudineus*), taki (*Channa punctata*), shol (*Channa striata*) etc. in the jute retting water bodies. Similar findings were stated by Haque *et al.* (2002) who observed that due to the transitory effects of jute retting on water, the O_2 depletion occur in water and this causes the death of gill-breathing fishes but air-breathing fishes can survive. Majority of fishers in Chandpur district stated the availability of SIS gradually decreased after the monsoon of jute retting in the jute retting water bodies (Table 6). Similarly, jute retting is the causes of large scale fish mortality through reduction of DO, high BOD

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load and and moderately high TAN (Total Ammonia Nitrogen) and this becomes a factor leading to decline of indigenous fish population (Dasgupta *et al.*, 2006; Mondal and Kaviraj 2008; Ghosh and Biswas, 2015).

Jute sector and fishery sector both are the most important sectors in Bangladesh for its contribution in GDP or in total national export earnings or in the employment sector. Different types of problems like environment pollution, loss of fish biodiversity, fish diseases etc. appear in the traditional jute retting process. Therefore the traditional retting process of jute is not suitable for our environment as well as aquatic organisms. However, most of these problems of jute retting can be minimized if the jute retting is done through ribbon retting. The appropriate technology such as ribbon retting with artificial polythene tanks is needed to extend in Bangladesh for the environment as well as fishes.

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