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**POST-HARVEST HANDLING PRACTICES IMPACTED ON MICROBIOLOGICAL AND SENSORY QUALITY ATTRIBUTES OF GIANT FRESHWATER PRAWN *Macrobrachium rosenbergii* IN THE DISTRIBUTION CHAIN IN BANGLADESH**

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**ABSTRACT**

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To understand the effect of post-harvest good handling practices on prawn (*Macrobrachium rosenbergii*) quality, data were collected from stakeholders involved in distribution chain by semi-structured questionnaire, focus group discussion and transect walking at Kishoreganj and Mymensingh. Most used containers were split bamboo basket (39%), split bamboo basket with polythene lining (18%), plastic crate (12%), styrofoam crate (8%) and rectangular metal container (12%). 15%, 25%, 10%, 100% and 7% large prawns were water washed and 9%, 35%, 22%, 100%, 60% large prawns were iced immediately after harvest, later in fishing trip, immediately after landing, at wholesale house before transportation and during retail sale, respectively. Bacterial counts of water used for ice preparation, ice crushed mechanically and on soil floor collected from Bhairab Bazar and Karimganj were  $6.58 \pm 1.87 \times 10^3$ ,  $4.77 \pm 0.19 \times 10^2$ ,  $4.12 \pm 2.06 \times 10^3$  cfu/ml and  $4.82 \pm 1.56 \times 10^2$ ,  $6.01 \pm 1.61 \times 10^1$ ,  $6.90 \pm 1.61 \times 10^2$  cfu/ml, respectively. Ice melted water collected after unpacking prawn containers at Mymensingh, transported from Bhairab Bazar and Karimganj, had  $5.90 \pm 1.95 \times 10^7$  and  $6.32 \pm 2.06 \times 10^8$  cfu/ml bacterial counts, respectively; indicated unhygienic handling environments. However, existing post-harvest handling practices produce prawns acceptable for consumers as sensory assessment for prawns showed the quality defect points of 1.0 (Excellent), 2.1 (Good), 2.3 (Good) and 2.9 (Good) at harvesting, landing, wholesale and retail shop, respectively.

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## INTRODUCTION

Global fisheries and aquaculture production peaked at about 171 million tons worth of USD 362 billion in 2016 (FAO, 2018). Between 1961 and 2016, the average annual increase in global food fish consumption (3.2%) outpaced population growth (1.6%) and exceeded that of meat from all terrestrial animals combined (2.8%) (FAO, 2018). As an integral part of life and culture in Bangladesh, fish provide 60% of animal protein intake. Annual fish production of the country is increasing steadily. Total fish production in 2018 was 4.2 million metric ton, which contributed 3.50% of total GDP, 25.71% of agricultural GDP and earned USD 5.07 billion foreign currency, thus establish 'Fisheries' as the second largest export sector of Bangladesh (DoF 2019). More than 11% of total population of Bangladesh including approximately 0.5 million prawn and shrimp farmer are involved in fisheries sector and every year this sector creates about 0.6 million new employment (DoF 2010; DoF 2019). In 2018, 0.25 million metric ton prawn and shrimp was produced in Bangladesh from inland capture and culture sector (DoF 2019). Giant freshwater prawn (*Macrobrachium rosenbergii*) is now widely cultured in Patuakhali, Noakhali, Bagerhat, Satkhira, Khulna and Mymensingh. But actual potentiality of prawn production in inland and offshore waters of Bangladesh still has to be explored (DoF, 2014). Mymensingh and Kishoreganj are among the major prawn culture and production areas of the country. Kuliarchar of Kishoregonj district is one of the major freshwater fish landing centers of the country. Fishes and prawns of haor fisheries of Kishoregonj, Sunamgonj, Sylhet and Moulvibazar districts are landed in Kuliarchar from where a significant portion is exported to Europe, USA, Japan and Middle-East (Nowsad et al., 2010).

The importing countries expect quality of imported product. Therefore, shrimp and prawn intended to sell in international market requires cautious care to keep the original physical appearance, odor and other organoleptic properties unaltered as much as possible. The products must be free from dirt, pathogenic microbes or harmful preservatives. In many ways, these shrimps and prawns are not adequately taken care of during harvesting, post-harvest handling, preservation and processing in Bangladesh (Nowsad, 2013). As a result, chance of contamination by spoilage bacteria is very high, quality deterioration is enormous, keeping quality and nutritional status is very poor, whereby profit margin is minimum (Nowsad et al., 2010). About 20% of the landed marine fish become deteriorated 50-70% of its original quality before it reached the consumers (Nowsad, 2004). In case of freshwater fish, the actual qualitative loss might be very high. Because of comparative small size and vulnerability of constituent proteins and lipids, freshwater fish are most susceptible to spoilage (Nowsad, 2004). Since the quality loss of fish is not understood at least up to 50% of deterioration by organoleptic means (Sakaguchi, 1990), consumers generally take it without any complain on quality. This brings about serious catastrophe in the nutrition status of the half-starved and nutrition-deprived people as well as the health conscious one (Nowsad, 2005). The prawn exporters have been reported to suffer from great economic loss in the form of rejection of part or full consignments (DoF, 2010). Export of low quality prawn hampers the business, reduces the profit at low level stakes like farmers or fishermen and ultimately destroys the good will of country. Post-harvest good handling practice in the total production cycle is a crucial and critical part where it is possible to solve such problems. It is thus important to bring improvement in post-harvest handling practices. But information regarding this issue is so far scarce. Therefore, the objectives of this study were to comprehensively present the existing post-harvest handling practice in Mymensingh region for prawn intended to sell in domestic or export market, to study the sanitary condition of handling premise and to analyze the sensory quality of prawns at different stages from harvesting to retailing.

## METHODOLOGY

### Survey area and target group

Randomly selected 30 fishermen, foria/piker/commission agent, aratder/ wholesaler and retailer from Kuliarchar, Karimganj, Bhairab Bazar of Kishoreganj and Boro Bazar of Mymensingh were interviewed by semi-structured questionnaire and focus group discussion. Transect walking was also conducted at those survey areas.

### Microbiological quality and sanitary condition assessment of prawn handling

At every two months interval during 6 months study period, water used to prepare ice, ice crushed by mechanical ice crusher and by hammer on soil floor from Karimganj and Bhairab Bazar and ice melted water from Boro Bazar after unpacking of prawn container transported from Karimganj and Bhairab Bazar were sampled from two different sources with three replications. Bacterial load of samples was determined by consecutive decimal dilution method according to Ben-David and Davidson, 2014.

### Sensory quality assessment of prawn

Prawns at harvesting, landing, wholesale and retail shops were collected and transported to Fish Processing Laboratory, Bangladesh Agricultural University in chilled condition. Organoleptic quality and average defect points (DP) were assessed according to Howgate et al., 1992.

### Data processing and analysis

The analysis was done using descriptive statistics like percentage, frequency distribution, mean, and rank where appropriate.

## RESULTS AND DISCUSSION

### Containers used

Split bamboo basket, split bamboo basket with polythene lining, plastic crate, styrofoam crate and rectangular metal container are the major types of containers in use and contribute 39%, 18%, 12%, 8% and 12% of market share, respectively. Type of containers used for prawn handling has been shown in Table 1.

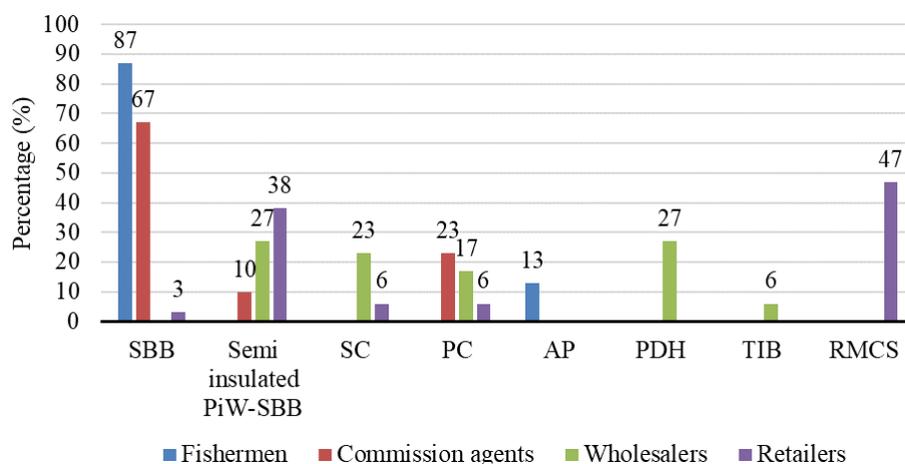
**Table 1.** Containers used at different stages of prawn handling

Prawn item	On board handling container	Fishing vessel to market place	At market place	Transportation from wholesale house	Retail sale
Prawn (large)	SBB, AP	PiW-SBB, SBB	Plastic mat on earth	PiW-SBB, PDH, SC, PC, TIB	RMCS, PiW-SBB, SBB, SC, PC
Prawn (small)	SBB	PC	Plastic mat on earth	PiW-SBB, SC	RMCS

SBB= Split bamboo basket; AP= Aluminum pot; PiW-SBB= SBB with inner polythene lining; PC= Plastic crate; PDH= Plastic drums cut into half; SC= Styrofoam crate; TIB= Tank ice box, RMCS= Rectangular metal container on cement slab

Split bamboo baskets were limited only among fishermen and commission agents. Semi-insulated split-bamboo basket with polyethylene lining, plastic crate and styrofoam crates were found among commission agents, wholesalers and retailers (Figure 1).

In kuliarchar, split-bamboo basket or aluminum containers are used at harvesting, polythene inner-wrapped split bamboo baskets are used to transport prawn from boat to commission agents, plastic mat on earth is used at commission agents' shop and wholesalers use plastic crate, split bamboo baskets with polyethylene lining (Nowsad et al., 2010).



**Figure 1.** Container used by the stakeholders (SBB= Split bamboo basket; AP= Aluminum pot; PiW-SBB= SBB with inner polythene lining; PC= Plastic crate; PDH= Plastic drums cut into half; SC= Styrofoam crate; TIB= Tank ice box, RMCS= Rectangular metal container on cement slab)

#### Washing and cleaning of prawn after harvesting

Due to higher market value, more importance was given to wash large sized prawns than smaller ones. Commission agents and retailers seldom wash prawns. Almost all prawns were washed and cleaned at wholesale house (Table 2).

**Table 2.** Washing and cleaning of prawn after harvesting

Prawn item	Frequency of washing/cleaning (% of unit practice)				
	Immediate wash after harvesting	Wash later in fishing trip	Immediately after landing	At wholesale house before transportation	During retail sale
Prawn (large)	15	25	10	100	7
Prawn (small)	6	17	7	80	7

In Kuliarchar, 65%, 25%, 7% and 100% prawns were washed after harvest, on way to landing, immediately after landing and after wholesale, respectively (Nowsad et al., 2010).

#### Chilling of prawn

##### Ice quality

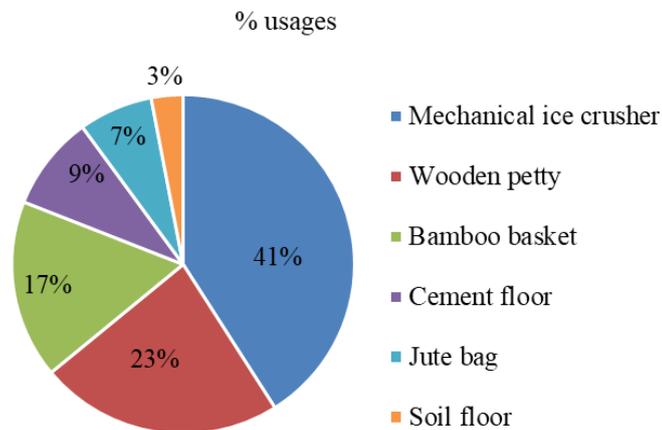
Most stakeholders used clear, transparent ice (Table 3) although some ice blocks were found to be contaminated with debris, algae and red-colored iron content. About 60% to 70% of the ice in use was half tempered, thus, irregular in shape. Nowsad, 2013 found, 16%- 32% ice was contaminated with iron or debris.

**Table 3.** Ice quality used by stakeholders (%) involved in prawn marketing

Quality of ice	Fishermen	Commission agents	Wholesalers	Retailers
Clear transparent	67	64	70	64
Dirt inside	33	36	30	36
Fully tempered (Homogenous shaped ice)	30	30	40	30
Half tempered (irregular shaped ice)	70	70	60	70

### Ice block crushing methods

Block ice kept in bamboo basket, jute sack, wooden petty box or ice block kept on soil or cement floor were crushed manually with hammer into small pieces. Mechanized ice crushers were mostly used while ice crushed on the soil floor using hammer was negligible (Figure 2).



**Figure 2.** Use (%) of crushing device among the stakeholders

Nowsad, 2013 identified that block ices were crushed by wooden pestle on bamboo basket (40%-55%), on soil floor, on cement floor (16%-18%), on wooden petty, on steel petty (2%-4%), by traditional out-fashioned ice crusher (2%-4%) etc. methods (Nowsad, 2013).

### Ratio of ice to prawn in practice

It was found that no prawn handler used standard 1:1 ice to prawn ratio (Table 4). The prevalent ice to prawn ratio practiced by the different stakeholders were 1:5. Ice to prawn ratio was also low in commission agents and retailers.

**Table 4.** Ratio of prawn and ice used by the stakeholders in prawn value chain

Ice: Prawn	Fishermen	Commission agents	Wholesalers	Retailers
1:1	0	0	0	0
1:2	0	18	28	18
1:3	19	28	36	20
1:4	35	23	21	36
1:5	46	31	15	26

In case of prawn and shrimp marketing in South-Western Region i.e., Khulna, Satkhira and Bagerhat, majority of the depot holders which is equivalent as wholesalers of this study, use shrimp to ice ratio of 1:1. Only a few, for example 10% of the depot holders use small quantity of ice (shrimp to ice ratio of 5:1) (Nowsad, 2013).

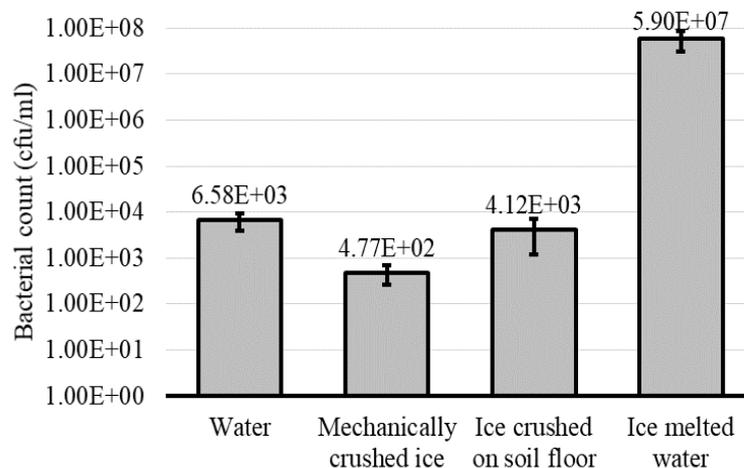
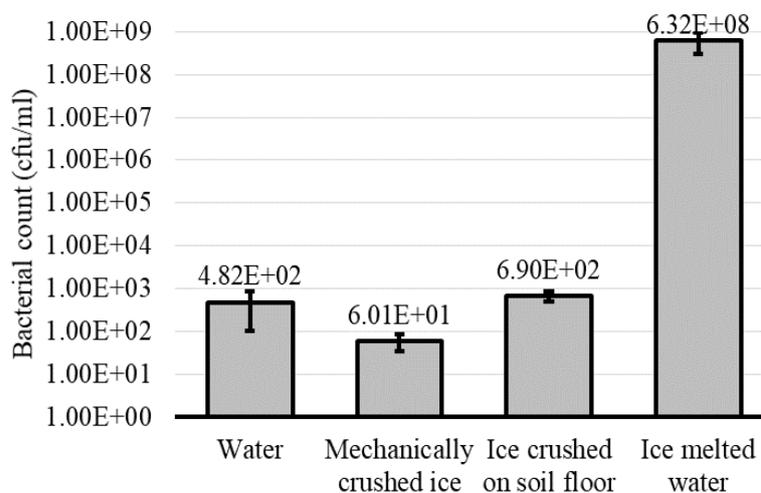
### Frequency of icing

Icing immediately harvesting were very poor, ranging from 5-9% only. In 35% cases, large sized prawns were iced during later part of fishing trip while for small prawns that was 17% (Table 5). After landing, the rate of icing was low. But after washing at wholesale houses, all the prawns were iced, as those had to transport to distant destinations. Retailers had considerable attention in using ice.

**Table 5.** Icing of prawn during post-harvest handling

Prawn item	Frequency of icing (% of unit practice)				
	Immediate icing after harvesting	Icing later in fishing trip	Immediately after landing	At wholesale house before transportation	At retail sale
Prawn (large)	9	35	22	100	60
Prawn (small)	5	17	19	100	50

In prawn and shrimp marketing in South-Western Bangladesh, many farmers do not use ice since duration between harvesting and marketing take 1-4 hour (Hassan et al., 2012). In this study it was found that prawns required 1.5-10 hours to reach landing station after harvesting. Thus it seems that icing frequency may significantly compromise prawn quality.

**Figure 3.** Bacterial counts of water and ice samples of Bhairab Bazar and ice melted water collected at Mymensingh**Figure 4.** Bacterial counts of water and ice samples of Karimganj, and ice melted water collected at Mymensingh

### Microbiological quality and sanitary condition of prawn handling

In Bhairab Bazar, water used for ice preparation contained more bacteria than ice crushed mechanically or on soil floor with hammer (Figure 3). In Karimganj, water used for ice preparation contained less bacteria than ice crushed on soil floor with hammer but contained more bacteria than ice crushed mechanically (Figure 4). In both cases, ice crushed on soil had more bacterial load than mechanically crushed ice and highest bacterial load was found in ice melted water.

Temperature variation of analyzed water and ice varied bacterial load in them (Frazier and Westhoff, 2008). Soil floor acts as a good source of bacterial contamination. Bacterial load of samples analyzed is far beyond the standard microbial limit, thus, indicates unhygienic handling environments (WHO, 1997).

### Prawn quality for post-harvest handling

Prawn quality was excellent after harvest (Table 6). Large prawns at retail had although acceptable organoleptic quality but DP value was close to 'Poor' condition (Table 6).

**Table 6.** Quality of prawn at different stages of handling

Prawn item	Quality at harvest		Quality at landing		Quality at wholesale house		Quality at retail shop	
	DP	Condition	DP	Condition	DP	Condition	DP	Condition
Prawn (large)	1	Excellent	2.1	Good	2.3	Good	2.9	Good
Prawn (small)	1	Excellent	2.3	Good	2.9	Good	3.4	Poor

Nowsad et al. (2010) found DP 1.0 (Excellent), 2.0 (Good), 2.2 (Good) and 2.3 (Good) for prawns handled at harvesting, landing, wholesale house and at fish processing plant window, respectively.

## CONCLUSION

Containers used were stakeholder specific. Most stakeholders used quality ice and mechanically ice crushed or ice crushed by hammering in wood, bamboo baskets. There is scope to improve post-harvest handling practice by providing training to fishermen, commission agents and retailers on ideal washing and icing procedure, icing frequency, sanitary condition etc. Future research should be focused on fish box, dimension of ice (plate ice, tube ice etc.), type of ice (bactericidal ice, dry ice etc.), method of washing and type of water used, biochemical changes and microbiology of prawns as a function for various handling practices, consumer behavior etc. Existing handling practice brings out acceptable quality prawn at retail sale.

## CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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