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Identification of causes of Thai pangas mortality in ponds and their control strategies

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Abstract
Mass mortality of Thai pangas (*Pangasius hypophthalmus*) is reported to be a big threat to monoculture of the species in Bangladesh. Twenty affected and twenty control Thai pangas ponds were investigated around Mymensingh district in order to identify the causes of pangas mortality. Sixty affected and sixty unaffected fish samples were examined and compared to find the fish-level variables associated with the disease. A range of haemorrhagic signs on snout, skin and fins were recorded during examination with naked eyes. *Aeromonas* spp. and *Edwardsiella* spp. were isolated from 87% and 80% of the affected fish, respectively. Even 4% of the seemingly healthy fish carried *Aeromonas* spp. on their skin. Among the four water quality parameters monitored, remarkably higher total ammonia (1.5 ppm) was found in water of the affected ponds compared to that of the unaffected ones (0.4 ppm). High ammonia in affected water caused by excessive organic decomposition and poor pond management might have reduced the immunity of fish, which predisposed them for bacterial invasion and consequent disease outbreak.

Key words: Disease identification, Thai pangas, Mortality

Research findings

- Remarkably higher ammonia (1.5 ppm) level was found in the disease affected ponds compared to the unaffected ones (0.4 ppm).
- Clinical signs and symptoms of the disease were recorded as haemorrhagic jaws and pectoral fin bases; haemorrhagic dorsal, anal and pelvic fins; red and pop eyes; sluggish movement, loss of appetite, sudden jumping and consequent death even up to 80% of the total mortality.
- Trichodinids, *Dactylogyrus* spp. and *Gyrodactylus* spp. were observed in microscopic examination of gill and skin slime of the affected and unaffected fish without distinct variation between case and control.

- *Aeromonas* spp. and *Edwardsiella* spp. were isolated from the skin of 87% and 80% affected fish. On the contrary, only 4% of the healthy fish carried *Aeromonas* spp. on their skin.
- High ammonia in affected pond water caused by excessive organic decomposition and poor pond management might have reduced the immunity of fish and predisposed them for bacterial invasion and consequent disease outbreak.

Policy implications

- Intensification of aquaculture demands formulation and adoption of a "National Aquatic Animal Health Management Policy" for sustainable production, environment protection and food safety.
- Epidemiology based investigations on fish disease should be done as it was found to be more reasonable rather than concentrating on pathogen and treatment.
- Understanding of current fish health management strategies by GO and NGO personnel is of great value. Therefore, GO and NGO personnel should be trained on the same.

Livelihood implications

Bacterial infection due to poor water quality and management causes up to 80% fish mortality. The fish loss due to the disease can be very frustrating to rural poor fish farmer. Fish farmers can reduce the risk of the disease by minimizing the hazards as mentioned, without using any expensive and toxic chemicals. Therefore, this has tremendous implications on the livelihoods of the fish producers and consumers.

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Study on regional differences in soil-water characteristics and their relevance to aquaculture productivity and fish disease

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Abstract
A total of 45 ponds used for fish polyculture were investigated in three zones of Bangladesh to identify the differences among the zones in respect to aqua-ecology, culture practices, fish productivity and health management. Four hundred and fifty fish from three zones were clinically examined by naked eye and histopathology. Out of total number of fish examined, 45 fish from Dhaka zones were examined for parasites and bacteria in addition to histopathology. Faded and haemorrhagic gill, skin, fin, scale loss and lesions were observed during fish examination. *Aeromonas* spp. *Pseudomonas* spp. and *Streptococcus* spp. were isolated respectively from 56%, 46% and 39% affected fish. Among the five water quality parameters analyzed, the highest average hardness and alkalinity respectively were recorded in Rajshahi (156 ppm and 142 ppm) followed by Dhaka (146 ppm and 132 ppm) and Chittagong (81 ppm and 90 ppm). The highest average pH was recorded in Mymensingh (7.52) followed by Rajshahi (7.13) and Chittagong (7.05). Water holding capacity of soil in Rajshahi zone was poor compared to other zones and farmers were found to be reluctant to fish farming.

Key words: Polyculture, Fish ponds, Soil-water characteristics, Fish diseases

Research findings

- A total of 45 ponds under fish polyculture were investigated in Dhaka, Chittagong and Rajshahi zones to identify the differences among the zones in respect to aqua-ecology, water quality parameters, culture practices, productivity and fish health management.
- Among the five water quality parameters analyzed, the highest average hardness and alkalinity respectively were recorded in Rajshahi (156 ppm and 142 ppm) followed by Dhaka (146 ppm and 132 ppm) and Chittagong (81 ppm and 90 ppm). The highest average pH was recorded in Mymensingh (7.52) followed byRajshahi (7.13) and Chittagong (7.05).
- Water holding capacity of soil in Rajshahi zone was poor compared to other zones and farmers were found to be reluctant for fish farming.

- Farmers in Dhaka zone were found to stock higher number of fish compared to Chittagong and Rajshahi.
- Out of total number of fish examined, forty five fish from Dhaka zones were immediately carried to BFRI fish disease laboratory, Mymensingh and investigated for parasites and bacteria in addition to histopathology.
- Clinical signs and symptoms of the disease were faded skin and gills, haemorrhagic skins and fins, scale loss, lesions of variable sizes, sluggish movement, loss of appetite, etc.
- *Aeromonas* spp. were isolated from 56%, *Pseudomonas* spp. from 46% and *Streptococcus* spp. from 39% affected fishes. Even a few unaffected fish carried *Aeromonas* spp. and *Pseudomonas* spp. on their skin.
- Trichodinids, *Chilodonella, Costia, Dactylogyrus* spp., *Gyrodactylus* spp. and *Argulus* spp. were as well isolated from skin and gills during microscopic examination of both diseased and healthy fishes.
- Higher infestation of parasites was observed in fishes of Dhaka zone and was followed by Chittagong and Rajshahi zones.

Policy implications

- A National Aquatic Animal Health Management Policy needs to be formulated for sustainable production, environment protection and food safety.
- Adoption of epidemiology based investigations on fish disease was found to be more reasonable rather than concentrating on pathogen and treatment.
- Understanding of current fish health management strategies by the concerned GO and NGO personnel is of great value. Therefore, GO and NGO personnel should be trained on Aquatic Animal Health Management.

Livelihood implications

Bacterial infection due to poor water quality and management causes up to 80% fish mortality. The fish loss due to the disease can be very frustrating to rural poor fish farmer. Fish farmers can reduce the risk of the disease by minimizing the hazards as mentioned, without using any expensive and toxic chemicals.

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Suitable sites for sustainable aquaculture development in Mymensingh, Bangladesh: A GIS methodological perspective

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Abstract
A GIS study was carried out to find out the sites suitable for aquaculture in Mymensingh region. A number of criteria were selected for GIS modeling followed by the approach of Kapetsky (1994). The criteria were developed from a range of existing data sources such as, surface and underground water level, availability of feed ingredients and animal wastes, sources of fish fry, market facilities, extension support and communication facilities for aquaculture development. The data were located, collected and compiled from different GOs and NGOs located in the region along with primary data from the field survey wherever necessary and then prepared for computer analyses. Using the database, a series of GIS models were developed in order to ascertain and prioritize the most suitable areas for aquaculture development in the region. Out of total 407,528 ha available lands in the region, the study identified 99,415 ha very suitable and 302,754 ha moderately suitable for aquaculture promotion. Result of the study is indicative to the modeling power of GIS for aquaculture application and could be used to refine the models in future, particularly if it is supported with further detail field data. To get a more concrete and complete model, detailed study should be made available on the availability of mustard oil cake, rice bran, wheat bran, and usable animal and urban wastes that could be used as low-cost feed for sustainable aquaculture.

Key words: GIS, Modeling, Sustainable aquaculture development

Research findings

- Out of total 407,528 ha lands in Mymensingh district, 99,415 ha was found to be very suitable and 302,754 ha moderately suitable for aquaculture promotion (Fig. 1).
- The land parcel under marginally suitable category is only 1% (5,359 ha) and the study could not identify any area as unsuitable for aquaculture within the surveyed area.
- All the suitable lands are situated around the upazila sadar where market facilities, extension support services and transportation system are well established.
- Agricultural by-products such as rice bran, wheat bran and animal wastes are in short supply in the studied area.

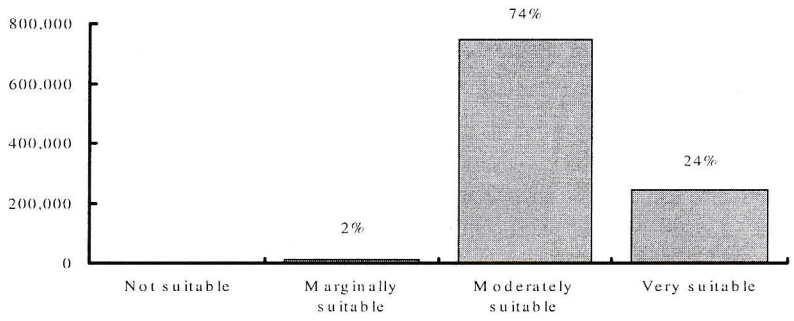

Fig. 1. Suitable areas for aquaculture development in Mymensingh region.

- The available agricultural by-products have competitive users like agriculture, poultry and cattle farmers.

Policy implications

- Although Mymensingh district is producing a huge quantity of fish compared to the neighboring districts, many of the potential water areas are yet to be brought under aquaculture and many households with suitable water bodies are still not getting desired economic benefit from the aquaculture development in the area.
- GOs and NGOs should come forward with appropriate policy decision to bring and motivate the farmers to culture different fish species according to the soil types and other essential parameters of the available water bodies.
- Supplementary feed items need to be produced in the area such as mustard, wheat and cattle wastes. Mass media should take appropriate measures to make the people aware about the necessity of proper use of supplementary feed to ensure maximum profit in fish culture.
- Enough infrastructure facilities should be built to connect the remote places with the highways for transportation of the farm products to the neighboring and distant markets quickly.
- Financial incentives might be offered as credit to the producer, processors and marketing personnel to boost up the fish culture activities in the region.

Livelihood implications

Mymensingh is producing a huge quantity of fish in comparison to the other districts but a lot of water bodies are still remaining fallow. If the farmers select their farm sites considering soil types, soil pH, avoiding flood risk, infrastructure, support services and marketing facilities, they can be substantially benefited from the production systems. That would eventually help the region to get more profit from aquaculture in a sustainable way and that would boost up the socioeconomic condition with nutritional upliftment, employment generation, foreign exchange earning and overall poverty alleviation in the region.

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Improved handling and preservation of freshwater giant prawn, *Macrobrachium rosenbergii* for producing safe and wholesome products

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Abstract

Studies were undertaken to evaluate the quality changes in freshwater giant prawn, *Macrobrachium rosenbergii* during various storage conditions of handling and preservation and producing safe and quality products. The samples kept in ice immediately after catch with head-on and head-less condition were found to be acceptable for 6 days and 7 days, respectively. Delaying of icing considerably shortened the shelf-life. The pH value increased from 6.36 to 8.0 after 10 days in ice. The initial average TVB-N value of sample increased from below 10 mg 100/g to 25 mg/100gwith the lapse of storage period. The Ca^{++} ATPase activity in presence of 0.1M KCl slightly decreased at the end of 10 days of ice storage. Immediately after harvest, initial aerobic plate count (APC) was 2.88 $\times 10^6$ CFU/g which gradually increased to 1.12 $\times 10^8$ CFU/g after 6 days in ice storage and showed early signs of spoilage. Initial bacterial genera in the prawn iced at 0 hours were comprised of Coryneform (22.21%), *Bacillus* (7.40%), *Micrococcus* (11.11%), *Achromobacter* (48.14%), *Flavobacterium/Cytophaga* (7.40%), *Pseudomonas* (3.70%) and *Aeromonas* (3.70%). During ice storage Coryneforms and *Bacillus* were always dominating along with less prominent ones - *Micrococcus*, *Achromobacter* and *Flavobacterium*. Studies were conducted on the stability of myofibrillar protein of *M. rosenbergii* under different storage and pH conditions. The influence of a wide range of pH on the remaining Ca^{++} ATPase activity of *M. rosenbergii* muscle myofibrils after storage at -20°C for 2 days, at 0°C for 2 days and at 35°C for 30 minutes demonstrated that ATPase activities were lower in acidic and alkaline pH regions and the activity remained relatively high. Mg^{++} ATPase activities both in presence and absence of Ca^{++} remained high at neutral pH compared to those of acidic and alkaline region. The solubility of myofibrillar protein decreased gradually both in acidic and alkaline pH regions. The study also examined the bacteriological quality of freshly harvested *M. rosenbergii*, pond sediment and pond water from four commercial freshwater prawn farms at Fulpur and Tarakanda upazilas in the district of Mymensingh. The study included aerobic plate count (APC), total coliform count, detection, isolation and identification of suspected public health hazard bacteria and their seasonal variation, salt tolerance test, antibiotic sensitivity test of the isolates and washing effect of chlorinated water on the bacterial load in the prawn samples. APC in sediment soil and water of the farm and gill and hepatopancreas of freshly harvested prawns varied considerably among the farms and between summer and winter season. The range of

coliform count in water, gill and hepatopancreas ranged between 6 - 2.8×10^2 CFU/ml, 1.2 $\times10^2$ - 3.32×10^2 CFU/g and 1.43 $\times10^2$ - 3.89 $\times10^3$ CFU/g, respectively. No coliform was detected in pond sediment sample. Suspected health hazard bacteria isolated and identified from pond sediment, water, gill and hepatopancreas included *Streptococcus, Bacillus, Escherichia coli, Klebsialla, Salmonella, Staphylococcus, Pseudomonas* and *Aeromonas. Bacillus, Salmonella* and *Staphyloccus*, and were found to be highly salt tolerant and capable of growing at 10% NaCl. The antibiotic discs with different concentration of antibiotics were used for the sensitivity test. The organisms were found to be most sensitive against Tetracyclin and Gentamycin.

Key words: Preservation, *Macrobrachium rosenbergii*, Shelf-life, ATPase activity

Research findings

- Four, 8 and 12 h delay in icing shortened the shelf-life of prawn to 3, 2 and 1 days, respectively.
- The pH and TVB-N values increased rapidly in samples kept at high ambient temperature for 4, 8 and 12 h prior to icing and in all the samples, the pH and TVB-N values exceeded the recommended values after 2 to 3 days of storage.
- ATP-ase activities declined considerably in all the samples kept at high ambient temperature of 4, 8 and 12 h prior to icing.
- Ca^{++}ATPase activity of *M. rosenbergii* muscle myofibrils during frozen storage at -20°C for 120-150 days decreased considerably which also indicates the denaraturation of muscle proteins during long term frozen storage.
- Ca^{++}ATPase activity declined drastically in acidic and alkaline pH range for both *M. rosenbergii* muscle myofibrils during storage at -20°C for 2 days, 0°C for 2 days and 35°C for 30 min. ATPase activities of myofibrils incubated at 0°C were quite high compared to that of myofibrils stored at -20°C and 35°C. Relatively poor activities in frozen storage at -20°C and at 35°C indicated the denaraturation of myofibrillar proteins during these storage conditions.
- Ca-sensitivity found very high in neutral pH region. It declined sharply both in acidic and alkaline pH region for *M. rosenbergii* muscle protein under various storage conditions. The poor Ca-sensitivity also indicates the effect of acidic and alkaline pH on the denaraturation of myofibrils.
- The solubility of *M. rosenbergii* myofibrils was found to be quite high at neutral pH region and poor solubility at acidic and alkaline pH region which indicate the influence of pH on the denaraturation of myofibrillar protein under various storage conditions.
- The inactivation rate was quite low in neutral pH while quite high in acidic and alkaline pH region both at 30 °C and 35°C for *M. rosenbergii* muscle myofibrils.
- Bacteriological studies indicated that aerobic plate counts increased considerably due to storage at high ambient temperature for 4, 8 and 12 h prior to icing.

- The overall bacteriological standard of the selected prawn farms are poor and highly contaminated with bacteria of public health concern.
- High total bacterial and coliform counts suggest that farm pond water is being contaminated with sewerage pollutant and unsafe for domestic use.
- Presence of suspected pathogens like *E. coli*, *Salmonella* sp., *Klebsiella* sp., *Staphylococcus* sp., *Streptococcus* sp., *Aeromonas* sp., *Bacillus* sp. and *Pseudomonas* sp. is objectionable in view of public health concern.
- Post-harvest quality of the prawns may be greatly influenced by the presence of public health hazard bacteria in farm water, gill and pancreas of prawn.
- High salt tolerance, resistance against some antibiotic and chlorine by the bacterial isolates may create great problem for the processors and exporters.

Policy implications

- Development of appropriate post-harvest handling, preservation, processing and transportation techniques is essential for maintaining the high quality of the product. Proper inspection and quality control by the GOs are also essential for maintaining and expanding market share in major export market.
- The overall bacteriological standard of the farms studied are found to be poor and highly contaminated with bacteria of public health concern. This suggests that high level of sanitation management is essential for the prawn farms in order to produce safe and wholesome raw material.
- The record of international market indicates that Bangladesh is experiencing heavy loses and runs the risk of black listing in major markets. It is, therefore, important to quantify post-harvest loses at different stages of handling and transportation to take development scheme for effective utilization of these high-valued commodity.

Livelihood implications

Production of high quality prawn in the farms of Bangladesh will bring great economic benefit to the prawn farmers. Since a large number of men and women are involved in the prawn farming all over the country it is expected that higher income of the farms would definitely benefit the poor farmers. Findings of the research may open the gateway of high quality prawn production in future through adoption of better management practices. That would obviously help in improving the livelihood of the poor communities living in and around the prawn farming areas.

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HACCP based management system for improving quality of freshwater giant prawn, *Macrobrachium rosenbergii*

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Abstract
The study was conducted on the present status of HACCP based quality management system of golda, *Macrobrachium rosenbergii* farms in Fulpur region of Mymensingh. Information was collected on general condition of farms, culture systems and post-harvest quality management. In almost all farms, there is no or inadequate infrastructure facilities such as, road access, electric supply, telecommunications, ice, feed storage facility, vehicle forgolda transportation, washing and toilet facilities. The problems associated with sanitation and hygiene was: widespread use of cow dung, poultry manure and construction of open toilet within the vicinity of prawn culture pond. Different grades of commercially available and locally prepared feeds were used forgolda culture in the pond. Golda post-larvae (PL) of 40-50 days old were stocked with carp species. The price ofgolda PL ranged from Tk. 1.00 to Tk. 1.25/piece. The pond size varied from 50 decimal (0.2 ha) to 2.5 acre (1.0 ha) with an average depth of 2-2.5 m. The culture period ofgolda varied from April-May to November-December and survival rate ranged between 75 and 80%. Production ofgolda varied from 250-500 kg/acre (625-1,250 kg/ha). Harvested golda were transported to city market within 4 h. Two size grading were generally followed during pricing, e.g.Tk. 500 to 550/kg for >100 g size and Tk. 300/kg for <100 g size. The cost-benefit ratio was found to remain around 1:1.25 depending on availability of PL. Water quality parameters such as, water temperature, pH, dissolved oxygen, total alkalinity and chlorophyll-*a* in five golda farms in Fulpur region were monitored. Water temperature ranged from 29°C to 33°C, dissolved oxygen from 2.28 to 4.13 mg/l, pH between 6.65 and 7.94, alkalinity from 44 to 70 mg/l and chlorophyll-*a* concentration from 61.88 to 102.34 µg/l in the five investigated ponds. The Aerobic Plate Count (APC) of the water sample was within the range of $2.0x10^6$-$2.96x10^7$ CFU/ml and of soil samples within the range of $6.9x10^6$-$7.73x10^6$ CFU/g. *Streptococcus* sp., *Bacillus* sp., *Escherichia coli*, *Staphylococcus* sp., *Pseudomonas* sp. and *Salmonella* sp. were isolated from pond water and sediment. Different feed samples used for golda was analyzed for proximate composition. Moisture content ranged around 14.14-21.22%, crude protein 20.55-44.1%, lipid 4.67-12.54% and ash 9.7-27.69%. The TVB-N values and peroxide values of feeds used as starter, grower and fish meal were found within the acceptable ranges and samples were free from pathogenic organisms. A training was organized for thegolda farmers on HACCP, water quality and post-harvest quality management of prawn.

Key word: HACCP, *Macrobrachium rosenbergii*, Improved quality

Research findings

- The sizes of the farms were small to medium with no well-defined boundary. There were poor infrastructure and other facilities such as, road access, electric supply, telecommunication, ice and feed storage, vehicle for golda transportation, simple hygienic and sanitation.
- The major problems associated with sanitation and hygiene is widespread use of cow dung, poultry manure and construction of open, hanging toilet within the vicinity of prawn culture pond. Different grades of commercially available feed used as starter, grower and nursery feed manufactured by Saudi-Bangla fish feed Ltd., Modina fish feed Ltd., CP fish feed Ltd., Niribili fish feed Ltd. and locally prepared feed were used for golda.
- Golda PLs of 40-50 days old were stocked with carp species such as *Catla catla*, and *Labeo rohita*.
- The price of golda PL ranged from Tk. 1.00 to Tk. 1.25/piece. The pond size varied from 50 decimal (0.2 ha) to 2.5 acre (1.0 ha) with an average depth of 2-2.5 m. The culture period of golda varied from April-May to November-December and survival ranged between 75 and 80%.
- Production of golda varied from 250-500 kg/acre (625-1,250 kg/ha) depending on size. Harvested golda were transported to city market using bamboo basket and took 4 h to reach. Golda were sold in two size categories, e.g. Tk. 500 to 550/kg for >100 g size and Tk. 300/kg for <100 g size. The cost-benefit ratio was found to remain around 1:1.25 depending on availability of PL.
- Water quality parameters were within the acceptable ranges for aquaculture. APC of the water sample was within the range of $2.0x10^6$-$2.96x10^7$ CFU/ml and of soil samples within the range of $6.9x10^6$-$7.73x10^6$ CFU/g. *Streptococcus* sp., *Bacillus* sp., *Escherichia coli, Staphylococcus* sp., *Pseudomonas* sp. and *Salmonella* sp. were isolated from pond water and sediment.
- Different feed samples used for golda was analyzed for proximate composition. Moisture content ranged around 14.14-21.22%, crude protein 20.55-44.1%, lipid 4.67-12.54% and ash 9.7-27.69%. The chemical composition of the feeds were calculated on the dry weight basis.
- The TVB-N values of starter ranged around 23.38-24.5 mg/100 g, grower around 14.56-27.93 mg/100 g and fish meal around 25.34-33.7 mg/100 g. The peroxide values of starter ranged from 18.26 to 27.23 m eq./kg oil, grower from 16.37 to 25.63 m eq./kg oil and fish meal from 18.74 to 29.53 m eq./kg oil and samples were free from pathogenic organisms.
- The APC for starter varied from 4.58×10^4 to 8.13×10^4 CFU/g, grower from 9.25×10^4 to 2.7×10^5 CFU/g and fish meal from 5.4×10^4 to 1.34×10^5 CFU/g and some feed sample showed coliform contamination but *Salmonella* was not detected.
- Training was organized for the golda farmers on HACCP, water quality and post-harvest quality management of prawn in collaboration with the DoF.

- A handbook entitled, "Post-harvest Handling for Preservation of Golda Quality" and "Hazard analysis work sheet and HACCP plan" was prepared in Bengali to implement at field level for fish farmers. A pre-training test on the quality management aspects, sanitation and hygiene was conducted through interviews and discussions. The effect of delayed icing on the quality changes in golda was highlighted during the training.

Policy implications

- Poor condition of culture system, post-harvest quality management and infrastructure in the golda farms suggested that more effort should be exerted by the extension agencies to improve those conditions by providing technical support and training to the farmers.
- Facilities for regular monitoring of water quality should be made available to the farmers to tackle the problem of any wide spread disease and pollution.
- Little or no knowledge of the farmers on good hygiene and sanitation, which is a prerequisite for the production, harvesting, handling and marketing of safe food, may seriously undermine the dimension of golda culture in Bangladesh.
- Irregular and inadequate supply of PL is a serious problem of golda culture in Fulpur, Mymensingh. Extension agencies and private entrepreneurs should come forward to establish more hatcheries in the region.

Livelihood implications

Among the freshwater prawns, golda (*M. rosenbergii*) is most valuable and considered to be one of the most important products of aquaculture in Bangladesh. The consumer at home and abroad prefers golda for its size and taste. However, with the increasing demand in the international market, golda farming has been expanding rapidly throughout the country. In the study area a substantial number of men and women are directly or indirectly earn their livelihood from golda farming, harvesting, handling, transportation and marketing. There exists enormous prospect of extension of golda farming at Fulpur area of Mymensingh. Better management in culture practices, harvesting, handling, and marketing of golda is expected to bring great economic benefit to the common people of that area and Bangladesh as well.

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Studies on the suitability of producing value-added products from silver carp, *Hypophthalmichthys molitrix*

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Abstract
Silver carp, *Hypophthalmichthys molitrix* is contributing significantly to the total production of fish through aquaculture in Bangladesh. However, its low market price has become a serious concern to the fish farmers. The suitability of silver carp mince for the production of various value-added products (VAPs) - surimi, fish sausage, fish burger and fish stick was studied during April-September 2000 to ensure more appropriate and profitable utilization of silver carp. Surimi/frozen mince block was produced by washing the silver carp mince with 0.1% NaCl for 7-8 min (4-5 min agitation and 3-4 min settling). A two-step heating schedule for incubation at 50°C for 2 h and cooking at 95°C for 30 min gave high textured good quality consumer product. With the addition of cryoprotectants, surimi could be kept frozen for 5 months without loosing much of its textural and sensory qualities. Mince-mix and a batter with different ingredients and spices were formulated to produce fish burger using potato smash as the binding agent. Fish flake-mix and a batter with different ingredients and spices were formulated to prepare fish stick using both potato starch and potato smash as filler ingredients. Unwashed and washed frozen mince block or fresh flesh of silver carp was used to prepare fish sausage by heating at 100°C for 1 h after incubating at 50°C for 2 h. A spice-mix formulated with various local spices at the rate of 1.0-1.2% gave good texture and flavor to the sausage. A good-appeared sausage-pink color was developed by combining three food-grade colors of asthaxanthin. Products prepared with potato starch, potato smash and rice smash had an acceptable bacterial load in refrigeration (5°C) for up to 8 days and in room temperature (28°C) for up to 3 days. No coliform bacteria were found in the products prepared.

Key words: Silver carp mince, Value added products, Cryoprotectant, Shelf life

Research findings

- Techniques were developed for the production of VAPs like surimi, fish sausage, fish burger and fish stick from low-valued silver carp flesh.
- Suitability of unwashed and washed mince and some cheaper ingredients were tested and optimized.