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Review Article

Technological and Organizational Upgrading in the Bangladesh Shrimp Processing Industry

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Abstract

Facing with strict rules and regulations by the importing countries pertaining to food safety and quality assurance, the shrimp processing industry of Bangladesh has kept pace with the latest technological and organizational requirements and has implemented GMP, Standard Sanitation Operating Procedure (SSOP), Standard Operating Procedure (SOP) and Hazard Analysis and critical control point (HACCP) as part of the quality control, hygiene and management program. Most processing plants have added an extending space capacity to their existing facilities to host the latest technology upgrades. Plants use more than one process to produce a variety of products. This paper describes the changes in technology and organization that have been made in Bangladesh shrimp processing plants.

Key Words: Effect, EU ban, HACCP, Quality, Standard.

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Introduction

Shrimp is one of the most important and perishable traded seafood commodities, accounting over 20% of the value of international fisheries trade (FAO, 2001). The flow of trade is primarily from the developing to the developed world. Most of the farm-raised shrimp entering global markets comes from developing countries in Asia and Central and South America. In order to ensure market access, exporters are increasingly required to maintain internationally determined quality standards at every stage of the export chain.

Seafood is among the most perishable foodstuffs, seafood are harvested and processed in a wide variety of circumstances, often in remote, poorly equipped and unsanitary conditions. Shrimp, in particular is subjected to a wide

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range of hazards such as agrochemical residues, veterinary drugs and organic or inorganic heavy metals contamination. This has led importing countries to tight quality requirements, revise food sanitation laws and hygienic standards. Therefore, food control authorities in importing countries are moving away from inspection of the end products to a more vigorous and extensive process to control handling, processing and storage, in addition to the regulation of plant hygiene and sanitation during preparation and production. This means the establishment of a harmonized system of food inspection based on application of (HACCP) system to assure food safety in food processing plants.

Bangladesh Shrimp Sector:

The export of shrimp and prawn is an important contributor to economic growth in Bangladesh. Its yield is more than US$300 million annually. It represents the second largest source of export earnings in the country, the major imported markets are in USA, Japan and EU. In 2003-2004, export of shrimp was contributed 4.92% to Bangladesh's GDP and 5.71% of total national exports (BBS, 2004). About 10 million people are directly and indirectly worked in this sector (Some facts about Bangladesh's shrimp processing sector are shown in Table (1). Bangladesh is among the top 10 exporters of shrimp in the world and has share of less than three percent of its global production.

Table1: Fact sheet of Bangladesh shrimp processing sector:

- Total shrimp processing plants: 130
- Processing plants licensed by DOF: 68
- EU approved processing plants: 59
- Export revenue from shrimp: US$300 million
- Land area devoted to shrimp: 170,000 ha
- Annual production capacity: 270,000 mt
- Export of frozen shrimp: 46,533 mt
- Export of frozen fish: 15,763 mt
- Utilization of plant production capacity: 23%
- Export contribution in international market: <3.00%

Source: (DOF, 2003; BFFEA, 2004).

In the past, Bangladesh shrimp export trade has suffered heavy losses through the detention and rejection of its imported products due to the presence of pathogenic microorganisms, foreign matters and poor sanitary quality in it's consignments of shrimp exports. In 1997, EU bans imports from Bangladesh (EEC, 1997) that had a major impact on Bangladesh's export revenues and employment sector, affecting approximately one million people working at various stages of the domestic shrimp production supply chain. Cato and Santos (1998) estimated that the 1997 ban cost Bangladesh shrimp processing sector about US$ 14.66 million lost in revenues.

The government's support for many processing plants, has upgraded their operations to comply with HACCP quality standards and regulations imposed by international agencies and the specifications of the importing countries. The ban was withdrawn in February 1998 (EEC, 1998) and by 2005, 45 percent of the 130 shrimp processing plants were HACCP compliant.

Since 1997, these plants have gradually switched to semi-automation processes to speed up the production cycle and produce better quality and more diversified products. All functioning processing plants are privately owned and there are no joint ventures with foreign investors. EU-approved 59 plants but only 45 to 50 are producing. 35 of the producer plants are in Bangladesh which production and export represents 50% of the added products (Table 2). None of the plants is capable to operate at their full capacity due to shortage of raw materials and unfair competition among the processors.

Table 2: Number of processing plants producing value added products:

Percentage	Khulna zone	Chittagong zone
> 80	5	4
60-79	2	1
40-59	6	1
20-39	6	6
< 20	2	2
Total	21	14

Source: Field survey.

The main upgrading of plants took place in the following areas:

- Quality control department.
- Laboratory facilities.
- Outer garments.
- High capacity modern equipments and machinery.
- Renovate the factory building.
- Flake ice producing unit.
- Sewerage system.
- Water treatment plant.
- Refrigerated/insulated van.
- Hygiene and sanitation facilities.
- Training for the staff.
- Health check up facilities.
- Packaging unit.

Technological and Organizational Changes in Bangladesh Shrimp Processing Plants

HACCP based quality assurance manual:

To comply with the new standards, each processing plant has developed its own check system which is described in the HACCP manual or quality manual book. The Deputy Director of the competent authority approves the manual. This manual is often regarded as the basis of the processing plant that details the following aspects:

- *Company information:* name, address, person responsible for HAACP plan management and top management commitment.
- Description of the plant and facilities.
- *Organization chart:* hierarchy of the persons in the processing plant.
- *Responsibility of the persons:* job description of the key personnel including HACCP team.
- *Standard Sanitation Operating Procedure (SSOP):* describing procedures taken to control critical areas in sanitation of the processing plant.
- *Standard Operating Procedure (SOP):* detailing of standard at each step of processing.
- *Product description:* characteristics of products necessary for analysis of hazards.
- *Process flow diagram:* listed important steps in production of products.
- *Recall:* product identity and traceability.
- Various forms of record keeping.

Processing of shrimp products:

In order to meet buyer and consumer expectations on quality, shrimp is processed to retain its color, texture, taste and freshness. Processing involves chilling, processing, packaging and storage of shrimp prior to export. The freezing is usually done in blocks, in Individually Quick Frozen (IQF) or semi-IQF forms using Blast freezer, Contact plate freezer, Tunnel freezer or Spiral freezer.

When raw shrimp reach the processing plant, it is sorted, deheaded, graded and washed with pressurized water. The washed shrimp is then soaked with salt for cooking and placed in the cooking plant or onto the inner cooler conveyor belt. It goes to the tunnel/spiral freezer through vibrating and on to the glazing chamber. It finally reaches the scale conveyor belt after hardening and is packed to buyer specifications. A typical process flow of IQF cooked shrimp product is shown in (Fig. 1).

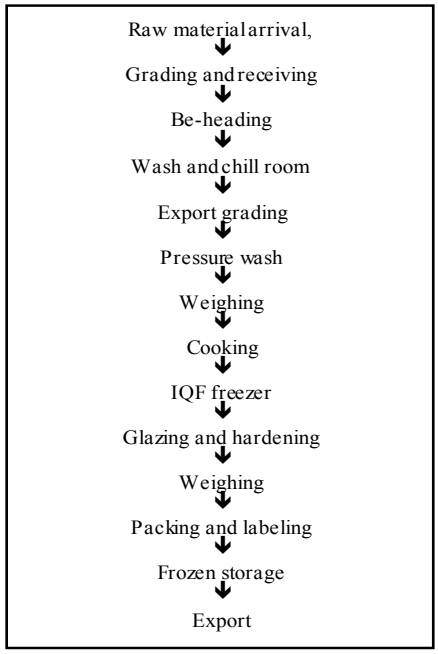

Fig. 1: Process flow chart of IQF Cooked shrimp product.

Structure and layout of the processing plant:
Almost all plants have two or more storeys building with the ground floor consisting of an entrance, dressing room, toilets, purchase room, chill room, processing and freezing room, machine room and flake ice room. On the first floor are the dry store, administrative office, laboratory, guest room, water treatment plant and overhead water tank.

Floors, walls and ceilings in all rooms are hard surfaced, water proofed, smooth and easy to clean and sanitize. The joints between wall and wall, wall and floor and wall and ceiling are rounded. The plant's different activities such as receiving, processing, packaging and storage are separated from each other according to specifications. Equipment is designed, constructed and installed to ensure that it can produce the required standard and is accessible to clean, sanitize, maintenance and inspection.

To reduce the risk of human contamination and to speed up the production cycle, processing technology has been semi-automated. Labor saving equipment such as washing tanks and shrimp graders have been installed and grading tables made from stainless steel and conveyor belts are now widely used.

Hygiene and sanitation facilities:
Ensuring high standards of sanitation is central to the HACCP process. Some of the measures introduced to meet such standards are foot operated, hand washing facilities with adequate supplies of hot and cold potable water, liquid soap dispensers, hygienic methods for drying hands, toilet rooms with walls and ceilings of a smooth, washable, light coloured surface and floors constructed of impervious and readily cleanable materials. Pet control traps are placed at different areas of the premises and inspected regularly. Staff amenities such as lunchrooms, changing rooms, washrooms and toilet rooms are required to be kept in a hygienic condition at all times.

External and internal drains are of sufficient depth with rounded bottoms, easily cleaned in both high and low risk areas and covered with removable and easily cleanable stainless steel plates. All outlets are protected by nets to prevent the entry of rodents and other vermin.

Water treatment and ice supply:
All water for processing and other operations comes from deep tube-wells or supplied by the public department. Water is pumped to the aerated plant and then to the overhead tank via the water treatment plant and subsequently distributed throughout the plant. Reverse osmosis is used to treat the water and ozonized water has also been introduced.

Each EU approved processing plant is required to install a flake ice machine with a production capacity of 12 mt/day. Water used in the final stage of production and for the production of ice is treated in the ultraviolet sterilization unit. Water is chilled mechanically and distributed to all stages of processing. Hot water is used for personal cleanliness and to disinfect utensils and processing areas.

Freezing:
The most common form of freezing is contact plate freezer. The processors have installed between one and three plate freezers, which do not require a door and shutter system and have a capacity of up to 1000kg/hr. The largest company installed IQF machines during 1990s. Since early 2000s the successful plant owners have installed state-of-the-art cooking and freezing systems completed with water coolers, air handling systems and other equipments (IQF hardening, hot water greezer, inter cooler counter flow belt, vibrator, glazing chamber). The IQF Tunnel freezer was used in the 1990s but has been replaced in most of the big processing plants by spiral freezers with a capacity to process 800kg/hr. Steam cooked machines have also been set up to produce cooked products. Some plants use blast freezing to process finfish.

Laboratory:
Each processing plant has set up a laboratory under its quality control department with qualified microbiologists and technicians equipped with

autoclave; incubator; distillation water unit; blender (Stomacher); circulating water bath; hot air sterilizer; microscope; electronic balance; refrigerator and other necessary instruments with reagents to conduct daily organoleptic and microbiological tests of every lot processed. The following tests are carried out in the laboratory:

- Standard plate counts (SPC)/gm.
- Total Coliform/gm.
- Escherichia coli/Faecal coliform/gm.
- Salmonella in 25gm.
- Vibrio cholera in 25gm.
- Water and ice tests.
- Swab test.

Labeling and Packaging:

Printed poly bags or header cards are used as inner cartons to pack the IQF and block frozen products. Each inner carton is marked with brand, product name, net contents, nutrition facts, packer's name, date of product, expiration date, count, type, storing temperature, US, FDA and EU code numbers. The inner cartons are placed into master cartons made of corrugated cardboard of sufficient thickness and quality to take the stress and strain of transit. The master carton bears the same information as the inner carton along with serial/batch and lot number. Both inner and master cartons show that the shrimp have been produced according to the approved HACCP plan.

In response to supermarket demands, new packaging systems have been introduced. For example, vacuum packing is used for supermarket products as well as being packed in auto sealing machines. A few processors have also introduced the shrink wrapping machine. Packing is done in the anteroom containing a de-humidifier to prevent condensation at temperatures below 10^{O}C. Each packed product passes through a metal detector to detect the presence of metal fragments. Two kilogram blocks are wrapped with polythene sheet and packed in both side wax coated laminated one flap duplex board non toxic painted inner carton and then six of these blocks (2kgx6= 12kg) are placed in a corrugated wax coated master carton.

Storage:

Plants have several frozen storage facilities with a capacity to store 200mt as well as chill storage rooms of 15-20mt capacities to store raw materials. Liquid ammonia is used as a refrigerant and dial thermometers for recording the temperature. The processed products are stored on raised wooden pallets away from walls and roofs to allow adequate air circulation and easy cleaning. The master cartons with frozen products are stored in the frozen store at–18^{0}C while raw materials in the chill room are stored in plastic tubs and trays at temperature below 5^{0}C. All packing materials are kept in well-ventilated rooms. Chemicals are also stored separately to avoid hazards.

Waste disposal:

Adequate drainage facilities have been provided inside and outside processing plants for solid wastes and discharge of effluent or processed water and the waste bins are placed at several locations and cleaned regularly. The waste products are then dropped into municipal dustbins. The head portion of freshwater prawns (*M. rosenbergii*) is taken by some traders for further processing and export. The effluent water from the plant is discharged into a reservoir, which is further treated with chlorine before being discharged into the nature. One plant owner has set up a system to carry the head part of the shrimp along two conveyor belts into a waste tank from where it is pumped with the processed water outside of the plant.

Production Technology:

Processing technology for the production of IQF, cooked, prepared, ready-to-cook and ready-to-eat products has been introduced and several new products have been developed for international markets. Automated production is used to reduce human contamination also cookers (Batch and continuous) are used to speed up the production cycle and improve yield. Today, only 20% of processing plants are capable to produce cooked, prepared, ready-to-cook and ready-to-eat frozen products. Examples of valuable added products include head on shell

on shrimp with claws (IQF, semi IQF and block frozen); headless shell on (Neck meat trimmed) IQF raw consumer pack; headless shell on easy peel (Raw, raw garlic and herb bases butterfly, blanched and cooked in the form of BF or IQF); peeled shrimp (Raw, cooked in the form of BF or IQF); peel De-veined (PD) and P & D tail on (Raw and cooked in the form of BF or IQF); P & D butterfly and P & D butterfly tail on (Raw and cooked in the form of BF or IQF); PD skewer, P & D butterfly tail on skewer (IQF shutter pack raw); Breaded Nobashi (IQF raw shutter pack) and Pull vein tail on (Ring cooked IQF).

Other technical and organizational changes: Each plant has two or more refrigerated vans of 10 tons capacity each and some have one insulated van to carry raw shrimp from the farms/ depot to the plants and to forward processed shrimp for shipment. Insect killing devices are now placed at all entrances and processing room to control the presence of insects. Some plants have set up closed circuit television cameras inside and outside the plant to monitor activities during production. A few of the newly constructed plants provide centrally controlled air conditioning throughout the plant. Each plant has one or two standby generators with a capacity 150-630 KVA for use when public power supply fails. Reciprocating compressors are also in place with computerized recording system. A registered MBBS doctor is employed by each processing plant to provide periodic medical services to staff and shop-floor workers. Each employee has a health card, which provides information on clinical examinations, diagnoses and treatments given.

SWOT Analysis of the Shrimp Processing Plants

Strength	Weakness
• Compliance with food safety standards	• Underutilization of full capacity
• Adequate processing capacity	• Inadequate scientific knowledge
• Adequate manpower and cheap labours	• Inadequate education and training facilities
• Well furnished equipment and machine	• Substantial nos of temporary workers
• Diversification of value added products	• Poor support to female workers
• On time performance in delivery service	• Lack of professionalism
• Effective industry association	• Bangladesh is price taker rather than setter
• Retain market access to major markets	• Communication gap between grower and processor
• Financial government incentives	
Opportunity	**Threat**
• More value added products	• More competitors in the world market
• Expansion of new market	• Tighter regulation by importing countries
• Interaction between exporters and importers	• Shortage of raw materials
• The increase on trade liberalization	• Economic downturn and market price fluctuation

Conclusion

With growing international and importer-country rules and regulations on food safety and quality, Bangladesh shrimp processing sector has been required to adopt new technologies and organization practices which have benefited processors since 1998. However, the rate of adoption of these practices has been uneven as some plants have been either unwilling or unable to make the required changes in order to compete against other local processors as well as their international competitors.

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