Trends in Fish Processing and Quality Assurance in Gujarat

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Gujarat is a leading state in marine fish production and export. Recent fish production of the state is over 0.65 million tonnes and export over Rs. 6000 million. The state is leading in export of fish such as squid, cuttlefish and *surimi*. Contrary to general perception, per capita fish consumption in the state is 7.77 kg.yr^{-1}, double that of national average. Dried fish and fishmeal accounts for over 55% of the fish production. The freshwater aquaculture holds good prospects in the state. Processing practices, important fish and fishery products, and major quality problems in the state, are discussed in this paper. Need for prawn culture, maketing of freshwater fishes, live fishes and shellfishes are highlighted. The paper stresses the need to realise the potential for internal marketing and export of dried fish and byproducts.

Key words : Fish processing, quality assurance, Gujarat

Fisheries sector is very important in socio-economic development of the country. It contributes nearly 1% of the Gross Domestic Product (GDP) and 3.1% of the foreign exchange earnings (2000-01) of India. It is an important source of livelihood and nutrition for a large section of the population. During 2000-01, the total fish production in Gujarat was 7,41,280 t. This comprised of 6,70,950 t marine and 70,330 t of inland fish. The important fish landing centres of the state are Veraval, Porbandar, Okha, Dwarka, Jakhau, Jaffrabad and Navabundar. The fish landings at Veraval and Porbandar are the highest in the state at 1,43,090 t and 1,03,238 t, respectively (Table 1). India exported 3,43,031 t of marine products valued at Rs. 51,166 million during 1999-2000. The total export of fish from the state was 0.124 million t, which formed 24.18% of total exports from India. The value realized was Rs. 6,155 million, forming 9.55% of the total export earnings (Anon, 2000). The prominent catch landed in the state includes sciaenids, ribbonfishes, perches, cephalopods, Bombay duck, pomfrets, seerfishes, tunas, sharks, catfishes, shrimps, lobsters and crabs. The frozen shrimps, lobsters, squids, cuttlefishes and finfishes are the main items of export. These products are exported to Japan, USA, European Union, China, Southeast Asian and Middle East countries. The low valued fish species like ribbonfishes and sciaenids are exported

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to China, Taiwan, Korea and Hong Kong. Landings of marine fish in Gujarat is given in Table 1 (Anon, 2001b). Per capita consumption of fish has progressively increased in the state and contrary to general perception it is 7.77 kg.yr^{-1}, double that of the national average (Table 2).

There are about 64 processing plants in Gujarat, with a processing capacity of 2588 t.day^{-1}. Of these units, 12 are approved for exports to the EU. 47 processing units are located in Veraval (Anon, 2000). The state has two *surimi* plants and one chitosan plant catering to export markets. The state also has more than 724 ice factories with a capacity of 9,384 t.day^{-1}. There are 235 cold storages with a capacity of 11,354 t; 60 freezing plants with a capacity of 2,631 t; and 54 fish pulverizing units manufacturing 885 t of pulverized fish (Anon, 2001a).

Table 1. Top ten fish landings centres of Gujarat (1999-2000)

Fish landing centre	Catch, t	Contribution, %
Veraval	233129	33.19
Porbandar	80776	11.50
Jakhau	47529	6.77
Mangrol	40428	5.76
Navabundar	36211	5.16
Okha	35151	5.00
Jaffrabad	29989	4.27
Rajpara	16288	2.32
Umarsadi	16117	2.29
Dwarka/Rupen	12421	1.77
Other centres	154316	21.97
Total	702355	100

Source: Anon (2001b)

Table 2. Fish landings and consumption in Gujarat

Year	Total fish production, t	Total fish consumption, t	Population, x10^6	Per capita consumption * kg.yr^{-1}
1990-91	516144	153995	34.0	4.52
1991-92	569887	153662	41.3	3.72
1992-93	660257	217314	42.5	5.11
1993-94	658855	339030	43.3	7.83
1994-95	713561	304898	44.0	6.93
1995-96	658509	250649	44.8	5.58
1996-97	725346	308002	45.6	6.75
1997-98	772805	360485	46.4	7.77*

*All India per capita consumption: 3.3 kg.yr^{-1}; Source: Anon (2001b)

Present status of fish processing in Gujarat

Fish drying, semi-drying, salting, icing, freezing and fishmeal production are the main methods of processing in Gujarat. Bombay duck (*Harpodon nehereus*), *jawala* (*Acetes indicus*) golden anchovy (*Coilia dussumeri*), other anchovies and white fish (*Lactarius lactarius*) are dried and marketed to different parts of India. Semi-dried and salted sharks, rays, tunas, catfishes, leather jackets, marlins, etc., have demand in southern states and some quantities are also being exported. Large varieties of fishes and shrimps are iced and marketed in Delhi, Punjab, Madhya Pradesh and Rajasthan.

The products for export are frozen mainly in plate freezer. Bigger fishes like tunas and fillets from *ghol* (*Protonibea diacanthus*) and *koth* (*Otolithoides biauritus*) are frozen in blast freezers. Value added items like cuttlefishes and squids, and derived items such as fillets, tentacles and rings, etc., are individually quick-frozen (IQF). Other value added items like king fish steaks, cut crab, octopus and shrimp in retail pack are exported from Gujarat. With the wider acceptance and use of Individual Quick Freezing (IQF) technique, flake ice, insulated boxes and refrigerated containers, the quality and value of fish products has increased.

Mince based products like *surimi* in bulk pack and imitation crabsticks in consumer packs are being produced for the export market. The landings of Japanese threadfin bream (*Nemipterus japonicus*), the main raw material for *surimi*, have been very high in recent years. Gujarat is the leading state in India in fishmeal production. However, the quality of fishmeal is low as it is produced by reduction of dried bycatch of poor quality.

Fish utilization pattern in Gujarat

According to the data available, the exports account for 25% of the fish production, contributing over Rs. 6,000 million. Fresh fish marketing in iced form is mainly confined to internal markets of the state and different parts of the country. Fishes like tuna, seerfish, catfish, hilsa, *Pellona* sp., black pomfret and low priced shrimp like *Solenocera* spp., have demand in Punjab, Delhi, West Bengal, Madhya Pradesh and Rajasthan. These are transported in iced condition in tea chest boxes by road and rail. Fishes like shark, skates, rays, marlins, sailfish, leather jackets and tuna are cured as semi-dried fish for the markets in the states of Tamil Nadu and Kerala. Small quantities of dried and semi-dried fish are also exported to Sri Lanka and southeast Asian countries. The main species dried include Bombay duck, white fish, silver bellies, anchovies, lizardfishes and small sized shrimps. The bulk of the dried products come from Jaffrabad, Navabundar and Rajpara area of the state. The trawl bycatch comprising of squilla, small sized crabs, juveniles of fish species, etc., and processing waste comprising of shrimp

shell and filleting waste, etc., are dried and converted into powdered form to be used as poultry feed. Waste from processing of squid and cuttlefish is collected separately and made into meal, which has very high protein content.

Quality aspects

With the application of HACCP in seafood processing, the level of sanitation, hygiene and quality awareness have improved significantly. However, the condition of road, drainage, sanitation and hygiene, etc., particularly in harbour area, require substantial improvement. The presence of heavy metals, residual pesticides, antibiotics and hormones, etc., can pose problems and the maximum permissible limits are to be enforced. There are reports of heavy metal and other pollutants originating from the industrial units located along the Saurashtra coast (Sen *et al.*, 2003). Untreated sewage dumped in the fishing harbour and backwaters is a major bacterial problem.

Water and ice quality

Potable water is scarce in Gujarat. In fish processing units, water is supplied by tankers. The requirement of water in fish processing is very high. To process 1 kg of fish about 10 l of water is needed. The bacteriological quality of water is generally poor. The ice prepared from such water is also poor in quality. High Total Plate Count and faecal coliforms are observed regularly. Most of the processing plants are having water treatment systems but they are not put to regular use. By providing sufficient quantity of good quality water, the quality of processed products can be increased substantially.

Microbiological hazards

The fish and shellfish harvested from sea are generally free from pathogens and contain natural bacterial flora. However, handling and storage onboard, use of insufficient ice, poor sanitation and hygienic conditions at landing centres, increase the bacterial load. Most of the bacterial load in fish is in the skin, slime, gills and guts. Fish muscles are normally free form contamination. *Aeromonas* sp. and *Pseudomonas* sp. are normal bacterial flora associated with fish. *Proteus* sp. is also of common occurrence. *Escherichia coli*, fecal streptococci, coagulase positive staphylococci, etc., find their way into fish, due to faecal contamination and improper handling. Other pathogenic bacteria like *Salmonella* sp. and *Vibrio cholerae* non-O1 can be found in raw fishes. *Vibrio parahaemolyticus*, *Shigella* sp., *Listeria monocytogenes* and sulfite reducing clostridia are commonly detected organisms in marine products. In recent years, rejection of some containers on account of poor microbiological quality has been reported. High amount of Total Volatile Base Nitrogen (TVBN) is indicative of quality deterioration due to bacterial action and its amount is lower in freshwater fishes than in marine fishes.

Heavy metals

The presence of chemical contaminants is another problem in seafoods. The levels of metals like cadmium, lead, arsenic, zinc and mercury are regularly monitored by CIFT. Occasionally, some samples of cuttlefish whole clean, cuttlefish whole, squid whole, tentacles and rings, etc., are found to contain higher concentration of cadmium and lead (Zynudheen *et al.*, 2003). Heavy metals accumulate more in body organs of fish like kidney and liver, which are not generally consumed. The fish muscle contains low level of heavy metals. The heavy metals find their way into fish tissue through food chain. Fishes grown in sewage may have higher amount of heavy metals. The quality requirements for fish and shellfish are given in Table 3. For fish from aquaculture also these limits are accepted.

Table 3. Quality requirements for fresh fish and shellfish

Parameters	Max. permissible limit	Source
Microbiological parameters		
Total Viable Count	1,00,000 – 5,00,000.g^{-1}	BIS
Escherichia coli	20.g^{-1}	BIS
Staphylococcus aureus	100.g^{-1}	BIS
Salmonella	Nil in 25 g	BIS
Vibrio cholerae	Nil in 25 g	BIS
Chemical parameters		
Histamine	100 ppm	EU
Total Volatile Base Nitrogen	30 mg.$100g^{-1}$	EU
Pesticides		
BHC	0.3 ppm	FDA
Aldrin	0.3 ppm	FDA
Dieldrin	0.3 ppm	FDA
Endrin	0.3 ppm	FDA
DDT	5.0 ppm	FDA
Heavy metals		
Mercury	1.0 ppm	FDA
Cadmium	3.0 ppm	FDA
Arsenic	76 ppm	FDA
Lead	1.5 ppm	FDA
Chromium	12 ppm	FDA

BIS : Bureau of Indian Standards; EU: European Union directives;
FDA: Food and Drug Administration

Residual antibiotics, pesticides, drugs, hormones and fertilizers

The residues of above chemicals are problems mainly related with aquaculture products. In intensive and semi-intensive culture of fish and shellfish, antibiotics, fertilizers, hormones and pesticides are used to control

disease and to increase production, which could find their way in to cultured organism. The recent food regulations in various countries list over 50 antibiotics and their maximum residual limits (MRL) in milk, meat and other products (WHO, 1999). MRL are specific to fish species and tissue type. Zero tolerance is prescribed for many parameters. Prescribed withdrawal period is to be enforced before harvest so that the fish does not contain excessive level of residual antibiotics. Administration of overdose of antibiotics by fish farmers is common in many areas. Prolonged use of antibiotics develops the strains of bacteria resistant to drugs and can be transferred to human being causing untreatable bacterial disease.

Most common drugs used in aquaculture are oxytetracycline, oxolinic acid and furazolidone and sulfa drugs. Oxytetracycline and terramycine are used for control of septicemia and furunculosis. Accumulation is more in body organs like liver and kidney. Pesticides, polychlorinated biphenyls (PCBs) and polyaromatic hydrocarbons are the other chemicals of concern in seafood. The tolerance for dichloro diphenyl trichloroethane (DDT) varies from 0 to 5 ppm. Polychlorinated biphenyl (PCB), dieldrin, dibenzofurans, etc., should be minimal. Chemicals like formalin are used for control of external protozoa, trematodes and fungi in fish and shrimp. Algicides containing chelated copper are not commonly used (WHO, 1999). As the importing countries are testing for these basic contaminants in farmed products, preventive steps for wild marine catch have become necessary.

Prospects for development of fish processing sector in Gujarat

Value added fish products

Exports of marine products from Gujarat are characterized by high volume and low value items like bulk packed ribbonfish, sciaenids and whole squid and cuttlefish. The per unit value realization is low compared to other centres in India. The catch of quality fishes has reduced considerably. Value added products in consumer packs for retail export market could ensure better returns. Value added items like king fish steaks, fillets from *ghol* (*Protonibea diacanthus*) and *koth* (*Otolithoides biauritus*), and squid rings had been exported for quite some time. Ready to eat products, retort pouch packed consumer packs and skewers, etc., as per consumer requirement must be promoted.

Export of dried fish

Dried fish is having good demand in most parts of India, particularly, in southern and northeastern states. Dried, semi-dried and salted products from fishes like sharks, tuna and catfish, etc., have traditional domestic markets. Dried fish from India have been exported to many neighboring countries like Sri Lanka, Myanmar, Singapore, Malaysia, Mauritius and Nepal. Recently, dried

fish has entered high value market by exporting quality product under chilled temperature storage and transport. *Saurida tumbil* (greater lizardfish) is landed regularly in significant quantities as trawl catch in Gujarat. A catch of over 15,000-20,000 t of lizardfish is landed annually in the state (Anon, 1996). Till recently, the fish was considered of low value and demand. New avenues are opening up for export of dried lizardfish to unconventional markets like Taiwan and Korea. Recently, the lizardfishes have been processed under sanitary and hygienic conditions, stored in chilled condition and exported in refrigerated containers as high valued item. Similar products from many other fishes like *Coilia dussumieri* (golden anchovy), *Lactarius lactarius* (whitefish) and non-penaeid prawn (*Acetes indicus*) can be prepared. *Coilia dussumieri* locally called as *medali* is having average annual landing of 1500-2,000 t in Gujarat (Anon, 1996). The fish is mainly used for drying and have good market. Such product is having good demand in internal market and has export potential in many countries. The main spoilage in dried fish takes place due to poor packaging and storage conditions. The chilled storage of dried and cured fish is innovative. Packing is done in polypropylene woven sacks, which permits air transfer. Storage is done at -5 to -10°C in cold store and shipment under chilled conditions. The dried fish stored under such conditions remains in very good condition over a period of one year. There is need to give due emphasis on processing, quality control and marketing of dried product to realize full export potential.

Shrimp culture

Giant freshwater prawn, popularly known, as scampi has emerged recently as an important item of export trade, particularly to USA. This has promoted USA as the largest seafood importer from India replacing Japan. Andhra Pradesh, particularly Nellore district, is contributing most of exported aquaculture products. During 2001-02, the export of scampi from India was 11,000 t valued at Rs. 7,500 million (Anon, 2001a). Gujarat produced 1,200-1,500 t of shrimp during 2001-02 mainly constituted by black tiger (*Penaeus monodon*) and scampi (*Macrobrachium rosenbergii*) from culture in the districts of Bharuch, Navsari-Valsad, Vadodara, Kheda, Narmada and Surat. Annual catch of scampi of 2,000 t is estimated from capture fishery in Gujarat. The catch is transported to Mumbai for export and local consumption. Traditionally, this has been cultured from wild seed collection from Narmada, Tapti, Daman Ganga and Karjan rivers. During October-November, 20 million post-larvae (25-75 mm size) were collected. The farmers of Gujarat, Madhya Pradesh, Maharashtra and Rajasthan are culturing under polyculture system. The scampi seed hatchery established with French collaboration, in Umberwada in Bharuch district, is expected to produce 40 million post-larvae, annually. This will increase scampi production in the state significantly.

Export of freshwater fishes

There is stagnation in the marine fish catch, in recent times. However, catch from freshwater bodies, particularly from aquaculture, is increasing. During the last decade, the rate of growth in marine fish production is low at about 2.5% in comparison to the growth in inland fish sector to the tune of 6.5%. Asia is contributing to about 90% of the world's aquaculture production. China is the leading country in aquaculture production, followed by India. At present, in India, the contribution of marine fish and shellfish in export is more than 90% and freshwater resources less than 10% (Anon, 2001a). There is enough scope in future to increase the share of freshwater fish and shellfish in export. Some processing plants have started export of freshwater fishes. These include *Catla catla*, *Labeo rohita* and catfishes like *Mystus seenghala* and *Wallago attu*, in head-on and gutted condition. The main market is in the middle east countries. Of the total inland fish production in Gujarat, 42% comes from aquaculture in ponds, 17.44% from reservoirs, 10.46% from rivers and 29% from estuarine waters (Anon, 2000). The catch of freshwater fishery resources of Gujarat has been irregular. During years of sufficient rain, catches are good and during draught very low catches are reported. As many rivers and reservoirs dry completely during summer months, the auto-stocking and breeding of cultured fishes are adversely affected. However, with Narmada water being made available for irrigation in canals and rivers, there is possibility for enhancing freshwater fish culture. For competing in export market, the production and quality of cultured fish has to be maintained as per the requirement and standards of importing countries. There is difference in the quality and value of fish caught from wild and culture ponds. Salmon from wild is 3-4 times more expensive than farmed fish. There are incidences of Epizootic Ulcerative Syndrome (EUS) in some fish species, especially from polluted waters. Off-flavours and muddy flavour are also the problems in fishes like *Catla* sp., caught from certain water bodies. Presence of parasites and worms in fish are other quality problems.

Fattening of lobsters and crabs

Lobsters and crabs are high value items in export market. The lobster resources have been overexploited. The size of lobster in commercial catch has reduced drastically. Lobsters of 50-100 g each are common. These can be grown to commercial size by culturing them for 6-8 months. Similarly, the fattening of crabs and harvesting as per the demand will result in better returns.

Marketing of live fishes

During 1999-2000, India exported 1,676 t of live fish valued at Rs. 380 million (Anon, 2000). Hong Kong, Malaysia, China and many other countries

in the region are big markets for live fish. Live reef fish like coral trout fetch 20-50 US$.kg^{-1}. *Epinephelus* spp. is much preferred in live condition. Prawns, mussels, crabs and some fish varieties are suitable for marketing and export in live condition. Marketing of fish in live form is prevalent in many parts of India, particularly in inland states, where short distance transport (up to 50 km) of fishes in containers is a common practice (Badonia, 2001)

Generally, 10 l of water is required for keeping one kg of live fish. During live marketing, it is observed that 1:1 ratio of water and fish is practiced in case of carps and still less quantity in case of other fishes like *Clarias* sp. and eel. Mussels are transported in moist gunny bags and in plastic containers with water. Prawns are kept alive in water in netting pouches and taken out at the time of sale. Crabs are kept in gunny bags, tubs, etc. In the case of carps, the fishes of medium size are kept because the survival of larger specimen is low. During summer months, ice is added in water to bring down the temperature. Generally the temperature range is 25-35°C and dissolved oxygen 4-7 mg.l^{-1}, in pool water. In practice, specimens of uniform size are kept together, particularly in species where cannibalism is common like crab and prawn. Just molted and soft-shelled specimens are also not put along with other specimen to avoid cannibalism. The claws of crabs are tied with rubber band to prevent damage to each other. Under commercial conditions, a weight loss of 8-10% is noticed during captivity. Use of antibiotics and anesthetic substances has not been observed. During holding, the mussels and clam survive well over 6 months in water tanks. Crab and *Clarias* sp. survive for 2 months. Eel and prawn survive for 15 days to one month. Carps and tilapia can remain alive for 10 days duration. The rate of mortality is high in carps, particularly with respect to bigger specimens (Badonia, 2001).

Marketing of fish in live condition offer several advantages. The consumer preference is more for live fish and the prices are higher by 30-50% than iced fish. Demand for fish is heavy during winter season, festivals and marriages and it is met by holding the fish in live condition. The size of fish and shellfish marketed are of uniform size making processing easy. Though the rate of spoilage is faster in prawns, crabs and mussels, freshness can be maintained in live fishes and shellfishes. In the remote areas, where transport and availability of ice is difficult, freshness and quality can be maintained by holding the fish in live condition. Most of the factors can be monitored and the application of HACCP is easy in marketing the live fish. The depuration of mussels and clams in holding tanks as required depending on the initial quality, is useful. Sometimes, muddy flavor, residual pesticides and antibiotics can pose problems in cultured fishes. By holding them in clean water these problems can be minimised. Taking into account the vast resources of exportable varieties, the development of marketing of live fish and shellfish hold very good prospects.

Fish skin and isinglass

Gujarat is having good landing of fishes like *ghol*, *koth*, sciaenids, perches, etc. Skins of these fishes are available as bycatch of processing industry. Good export potential exists for fish skin to countries like Spain and Italy for making ornamental items like watch strap, purse, hand bags, etc., as substitute for reptile skin. The natural scale pattern of fish skin is attractive and good products are obtained after tanning. State has been producing significant quantities of air bladders from fishes like *ghol* (*Protonibea diacanthus*) *koth* (*Otolithoides biauritus*), eel and catfish. Production of finished product in the form of powdered isinglass can give better returns. There have been some queries on supply of large quantities of clean cuttlefish bone.

Thus, in the light of trends in marine fish production, serious thought is to be given for the development of aquaculture in the state. Streamlining the marketing of inland fishes and promoting the possible live transportation of fishes besides other types of value addition are some of the activities that need to be considered for the future development of fisheries in the state.

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