Quality of Fishery Products with Special Emphasis on Battered and Breaded Products

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Food safety is a very challenging issue as it touches upon the lives of all consumers. Quality that encompasses safety has been and would continue to be the prime yard stick applied by, both importing countries and national food safety agencies, for accepting food products including fishery products for human consumption. The quality of a product may be defined as its measurement against a standard regarded as excellent at a particular price which is satisfactory both to the producer and the consumer. Quality can be measured in terms of the senses, chemical composition, physical properties and microbial flora. Strict quality guidelines have been put in place for sale of fish and fishery products in the domestic (Food Safety Standards Authority of India; Bureau of Indian Standards) and international markets (Export Inspection Council of India, European Union Directives, specific requirements of each importing country). The quality requirements set are either the complete absence of the particular bacteria or a maximum allowed number per gram.

a) EU directives pertaining to Food and Feed

1	Food Law	(EC) 178/2002
2	General Hygiene Criteria Reg.	(EC) 852/2004
3	Specific Hygiene Criteria Reg.	(EC) 853/2004
4	Official control of Feed and Food General Reg.	(EC) 882/2004
5	Official Control of Feed and Food of Animal origin Reg.	(EC) 854/2004
6	Water Quality Directive	98/83/EC
7	Microbial and Chemical criteria Reg.	2073/2006, (EC) 1881/2006, (EC) 2074/2005
8	Food Additives Reg.	(EC) 1333/2008
9	Labelling Reg.	(EC) 1169/2011
10	Requirements to sampling and testing Reg.	(EC) 333/2007 and (EC) 589/2014
11	Minimum required performance limits (MRPLs) for certain residues in food of animal origin (**Antibiotics**)	2003/181/EC
12	sampling methods and the methods of analysis for the official control of the levels of **benzo(a)pyrene** in foodstuffs	2005/10/EC
13	Amending Regulation (EC) No 466/2001 as regards **heavy metals**	(EC) No 78/2005
14	setting of minimum required performance limits	2004/25/EC

	(MRPLs) for certain residues in food of animal origin (**malachite green and leucomalachite green)**	
15	Fixing the total volatile basic nitrogen (TVB-N) limit values for certain categories of fishery products	95/149/EC
16	Food additives other than colours and sweeteners	**95/2/EC**
17	Feed hygiene Reg.	(EC) 183/2005
18	Veterinary Medicines Dir.	82/2001/EC
19	Aquatic Animal Health and disease control Dir.	88/2006/EC
20	Animal by-product rules Reg.	(EC) 1069/2009 and Reg. (EC) 142/2011

b) Government of India notifications related to fish and fishery products

1	Notifications of Fresh, Frozen and Processed Fish & Fishery Products Export Inspection Council (Ministry of Commerce and Industry, Govt. of India) • S.O. 730 (E) dated 21st August 1995 Subsequently amended vide No. Notifications • S.O. 415 (E) dated 11th April 2002, • S.O. 1029 (E) dated 24th September 2002, • S.O. 1034 (E) dated 9th September 2003, • S.O. 717 dated 25th February 2005, • S.O. 612 dated 15th February 2007, • S.O. 1519 dated 16th June 2008, • S.O. 2714 (E) dated 28th October 2009 & • S.O. 143 (E) dated 21.1.2011 • S.O. 497(E) dated 10.3.2011
2	Orders of Fresh, Frozen and Processed Fish & Fishery Products, Products Export Inspection Council (Ministry of Commerce and Industry, Govt. of India) • S.O. 729 (E) dated 21st August 1995 Subsequently amended vide No. Orders ▪ S.O. 792 (E) dated 17th August 2001, ▪ S.O. 722 (E) dated 10th July 2002, ▪ S.O. 464 (E) dated 24th April 2003, ▪ S.O. 1227 (E) dated 23rd October 2003 & ▪ S.O. 1227 (E) dated 31st July 2006.
3	Food safety and standards (contaminants, toxins and residues) regulations, 2011 Ministry of Health and Family Welfare, (Food Safety and Standards Authority of India) notification, New Delhi, dated the 1st August, 2011
4	Food safety and standards (food product standards and food additives) Third amendment regulation, 2017: Ministry of Health and Family Welfare, (Food Safety and Standards Authority of India) Notification, New Delhi, the 13th February, 2017. This regulation prescribes revised microbiological requirements for sea foods and covers new varieties of fish and fisheries products, maximum permissible limits of hygiene indicator organisms and safety indicator organisms in vide range of fish and fishery products.

c) Quality requirements of fish and shrimp prescribed by Export Inspection Council of India (EIC), Ministry of Commerce and Industry, Govt. of India

i). Bacteriological parameters

Parameter	Fresh/ Chilled/ Frozen shrimp	Cooked shrimp
Total plate count at 37°C cfu per g (max)	5,00,000	1,00,000
E. coli count per g (max)	20	Nil
Coagulase positive Staphylococcus cfu/ per g. (max).	100	100
Salmonella & S. arizona per 25 gm	Nil	Nil.

ii). Antibiotics (farmed shrimp)

Antibiotic	MRPL/MRL (ppm)
Chloramphenicol	Nil
Furazolidone	Nil
Neomycin	Nil
Tetracycline	0.1
Oxytetracycline	0.1
Trimethoprim	0.05
Oxolinic acid	0.3
Nalidixic acid	Nil
Sulphamethoxazole	Nil

iii). Pesticides

Pesticide	Maximum residual level (ppm)
BHC	0.3
Aldrin	0.3
Dieldrin	0.3
Endrin	0.3
DDT	5.0

ppm: parts per million (mg/kg)

iv). Heavy metals

Heavy Metal	Maximum residual level (ppm)
Mercury	1.0
Cadmium	3.0
Arsenic	75
Lead	1.5
Tin	250
Nickel	80
Chromium	12

ppm: parts per million (mg/kg)

v). List of Antibiotics and other pharmacologically active substances banned for using in shrimp aquaculture

Sl. No.	Antibiotics and other Pharmacologically Active Substances
1	Chloramphenicol
2	Nitrofurans including: Furaltadone, Furazolidone, Furylfuramide, Nifuratel, Nifuroxime, Nifurprazine, Nitrofurantoin, Nitrofurazone
3	Neomycin
4	Nalidixic acid
5	Sulphamethoxazole
6	Aristolochia spp and preparations thereof
7	Chloroform
8	Chlorpromazine
9	Colchicine
10	Dapsone
11	Dimetridazole
12	Metronidazole
13	Ronidazole
14	Ipronidazole
15	Other nitroimidazoles
16	Clenbuterol
17	Diethylstilbestrol (DES)
18	Sulfonamide drugs (except approved Sulfadimethoxine, Sulfabromomethazine and Sulfaethoxypyridazine)
19	Fluroquinolones
20	Glycopeptides

Only those fish and fishery products that meet the quality requirements of the importing country are allowed to enter that particular country and those fish and fishery products that do not meet the quality criteria are rejected. Rejections have a negative effect on exports both in terms of monetary loss and tarnish the brand image of the fishery products of the exporting country.

d) Quality issues responsible for rejections of fish exported from India to the EU during the period 2000-2017.

	Hazard Category	Specific cause of rejection
1.	Adulteration Fraud	improper health certificate
2.	Biocontaminants	Histamine
3.	Biotoxins (other)	ciguatera poisoning
4.	Food additive & flavourings	Sodium carbonate, sulphite, allura red, sorbic acid, E160b annato/bixin/norbixin; E122 Azorubine; sulphite
5.	Foreign bodies	Faeces; defective packaging and infested with insects, foreign body (scraps of paper, cardboard, wire wool, hair and insects)

6.	Heavy metals	Cadmium, mercury
7.	Labeling	Insufficient/ incorrect labeling
8.	Non-pathogenic microorganisms	high aerobic plate count, thermotolerant Coliforms, Enterococci, *Enterobacteriaceae*
9.	Organoleptic aspects	Altered organoleptic characteristics and abnormal smell; spoilage and poor temperature control
10.	Packaging defects	Defective packaging and infested with insects; bulging
11.	Pathogenic microorganisms	Vibrios (*Vibrio cholerae*/ *Vibrio cholerae* NON O:1/NON O:139), *Vibrio parahaemolyticus*, *Vibrio vulnificus*, *V. alginolyticus*). Salmonella (*Salmonella paratyphi* B; *Salmonella Weltevreden*)
12.	Residues of Veterinary medicinal products (antibiotics)	Furazolidone (AOZ); Nitrofurazone (SEM), Oxytetracycline, Chloramphenicol.

e) Quality requirements for battered and breaded fishery products

Batter means liquid preparation from ground cereals, spices, salt, sugar and other ingredients and/or additives for coating. Breading means dry breadcrumbs or other dry preparations mainly from cereals with colourants and other ingredients used for the final coating of fishery products.

Generally, the battered and breaded fishery products are partially cooked by the processor for culinary purposes (e.g., setting the batter or breading, or stabilizing the product shape), and are customarily fully cooked by the consumer or end user. Although the exterior of these products may appear cooked, the interior fish protein is not coagulated, and the products are not ready-to-eat. Quality specifications have been laid by the Food Safety and Standards Authority of India (FSSAI, 2017) for battered and breaded fishery products which covers mainly the microbiological requirements vis-à-vis hygiene indicator organisms and safety indicator organisms.

i) FSSAI Microbiological Requirements for battered and breaded fishery products

a) Hygiene Indicator Organisms

Aerobic Plate Count				**Coagulase positive Staphylococci**				**Yeast &mold count**				**Stage where criterion applies**	**Action in case of Unsatisfactory results**
Sampling Plan		Limits (cfu/g)		Sampling Plan		Limits (cfu/g)		Sampling Plan		Limits (cfu/g)			
n	c	m	M	n	c	m	M	n	c	m	M		
5	2	**1 x 10^5**	1 x 10^7	5	1	**100**	1000	5	0	**100**		End of Manufacturing	Improvement in hygiene; Time-Temperature Control

b) Safety Indicator Organisms

Escherichia coli				***Salmonella***				***Vibrio cholerae* (O1 and O139)**				***Listeria monocytogenes***			
Sampling Plan		Limits (MPN/g)		Sampling Plan		Limits		Sampling Plan		Limits		Sampling Plan		Limits	
n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M
5	2	**11**	500	5	0	**Absent/25g**		5	0	**Absent/25g**		5	0	**Absent/25g**	

n = Number of units comprising a sample.
c = Maximum allowable number of units having microbiological counts above **m**.
m = Microbiological limit that may be exceeded number of units **c**.
M = Microbiological limit that no sample unit may exceed.

ii) ***CODEX Alimentarius Standard (166 – 1989) International Food Standard for quick frozen fish sticks (fish fingers), fish portions and fish fillets - breaded or in batter***

- A fish stick (fish finger) is the product including the coating weighing not less than 20 g and not more than 50 g shaped so that the length is not less than three times the greatest width. Each stick shall be not less than 10 mm thick.
- A fish portion including the coating may be of any shape, weight or size.
- Fillets are slices of fish of irregular size and shape which are removed from the carcass by cuts made parallel to the back bone and pieces of such fillets, with or without the skin.

The freezing process shall be carried out in appropriate equipment in such a way that the range of temperature of maximum crystallization is passed quickly. The quick freezing process shall not be regarded as complete unless and until the product temperature has reached -18°C or colder at the thermal centre after thermal stabilization. The product shall be kept deep frozen so as to maintain the quality during transportation, storage and distribution.

The final product shall be free from microorganisms or substances originating from microorganisms in amounts which may present a hazard to health in accordance with standards established by the Codex Alimentarius Commission; shall not contain histamine that exceeds 20 mg/100 g (applies only to species of *Clupeidae, Scombridae, Scombresocidae, Pomatomidae* and *Coryphaenedae* families); shall not contain any other substance in amounts which may present a hazard to health in accordance with standards established by the Codex Alimentarius Commission.

Factors influencing quality of breaded or battered fishery products

Raw Material	Fish/shrimp used for preparing the battered and breaded product shall be of a quality equal to that of fish/shrimp sold fresh for human consumption.
Coating material	All the ingredients used for coating shall be of food grade quality and conform to all applicable Codex standards
Frying fat (oil)	Oil used in the cooking operation shall be suitable for human consumption and for the desired final product characteristic.
Food additives	Antioxidants, humectants, acidity regulators, thickeners colours, emulsifiers, flavour enhancers, raising agents, and used in accordance the *General Standard for Food Additives* (CODEX STAN 192-1995)

iii) HACCP (Hazard Analysis and Critical Control Point)

HACCP is a system to prevent hazards so that the food processed will be safe for human consumption. HCCP is defined as a systematic approach to the identification, evaluation, and control of food safety hazards. Hazard is any biological, chemical or physical property that may be expected to cause an unacceptable health risk to consumers if present in the product.

HACCP is a proactive strategy where hazards are identified and assessed, and control measures are developed to prevent, reduce, or eliminate a hazard. Establishing HACCP system will be an ideal platform for seafood processing unit to comply with food safety regulations.

Microorganisms are one of the most clearly identified acute risks to fish consumers. Infections due to pathogenic bacteria, enteroviruses, fungi and biogenic amine poisoning are the most significant microorganism associated illnesses. Fish consumers succumb to illness due to ingestion of preformed microbial toxins (*Clostridium botulinum*, *Bacillus cereus*, *Staphylococcus aureus*) or by ingestion of sufficient number of viable pathogenic bacteria (*Listeria*, *Salmonella*, *Vibrio cholerae*, *V. parahaemolyticus*, *V. vulnificus*, *Shigella*) or by microbial decarboxylation of histidine to the allergic histamine. Microbial hazards enter the fish either due to human/animal faecal pollution, from microorganisms autochthonous to the aquatic environment or as a result of growth of microorganisms due to improper post-harvest handling.

Strategies for controlling pathogenic bacteria in fish and fishery products include

- Killing pathogenic bacteria by cooking or pasteurizing or retorting
- Controlling the amount of moisture that is available for pathogenic bacteria growth (water activity) in the product by drying
- Controlling the amount of salt or preservatives, such as sodium nitrite, in the product
- Controlling the level of acidity (pH) in the product
- Managing the amount of time that food is exposed to temperatures that are favorable for pathogen growth and toxin production.

HACCP approach to control *Staphylococcus aureus* toxin formation in hydrated Batter mixes

S. aureus toxin formation in hydrated batter mixes can cause consumer illness. S. aureus is the bacterium responsible for Staphylococcal Food Poisoning (SFP). Symptoms of SFP include: vomiting, diarrhea, abdominal pain, nausea, and weakness. Symptoms usually start within 4 hours of consumption. *S. aureus* can enter the process on raw materials. It can also be introduced into foods during processing, from unclean hands of workers and improperly washed utensils and equipment. The hazard develops when a batter mix is exposed to temperatures favourable for the growth of *S. aureus* for sufficient time to permit toxin development. *S. aureus* toxin does not normally reach levels that will cause food poisoning until the numbers of the pathogen reach 500,000 to 1,000,000 per gram. S. aureus will grow at temperatures as low as 7°C and at a water activity as low as 0.83.

Toxin formation is not likely at temperatures lower than 10°C or at water activities below 0.85. The preventive measure that can be applied for S. aureus toxin formation in hydrated batter mixes is controlling the amount of time that hydrated batter mixes are exposed to temperatures above 10°C. Exposure times greater than 12 hours at temperatures between 10°C and 21.1°C could result in toxin formation. Exposure times greater than

3 hours at temperatures above 21.1°C could also result in toxin formation.

Staphylococcus aureus toxin in hydrated batter mixes is identified as a hazard. The critical control point (CCP) for this hazard is the hydrated batter mix storage or recirculation step. The critical control limit (CCL) is the temperature of the hydrated batter mix and the time of exposure at temperatures above 10°C and above 21.1°C. The processor needs to monitor

by destroying the battered product and remaining hydrated batter mix or hold the product and hydrated batter mix until the hydrated batter mix can be sampled and analyzed for the presence of staphylococcal enterotoxin. Regain control over the operation after a critical limit deviation by adding ice to the hydrated batter mix storage and recirculation tank and/or repair the hydrated batter mix refrigeration equipment. Maintain record of the temperature and time or data logger printouts.

that the hydrated batter mix should not be held for more than 12 hours, cumulatively, at temperatures between 10°C and 21.1°C; and hydrated batter mix should not be held for more than 3 hours, cumulatively, at temperatures above 21.1°C. Monitoring is done manually using a thermometer and noting the time or mechanically by using a continuous temperature-recording device (data logger). In case of critical limit deviation, the processor has to take the following corrective action

A concerted and coordinated approach by the processor is needed to develop safe and healthy battered and breaded fishery products that meet consumer expectations. This can be achieved by strict implementation of HACCP-based management practices, during primary production /harvest stage, processing stage in fish processing units, distribution to domestic and international markets and storage during retail sale.

Table: HACCP plan using "Control Strategy Example - Hydrated Batter Mix Control

CCP	Significant Hazard	Critical limits	Monitoring				Corrective action	Records	Verification
			What	How	Frequency	Who			
Batter mix recirculation tank	*S. aureus* growth and toxin formation	Hydrated batter mix temperature not to exceed 10°C for more than 12 hours, cumulatively, nor 21.1°C for more than 3 hours, cumulatively	Temperature of the hydrated batter mix & time of exposure at temperatures above 10°C and above 21.1°C	Data Logger / thermometer	Continuous, with visual check once per day	Production employee	Destroy hydrated batter mix and any product produced during the period of the deviation Adjust hydrated batter mix refrigeration equipment	Recorder thermometer chart	Check the recorder thermometer for accuracy and damage and to ensure that it is operational before putting into operation; Check it daily, at the beginning of operations; Calibrate it once per year