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A Review on the Techniques for Quality Assurance of Fish and Fish Products

Kazi Naziba Tahsin, Asifur Rahman Soad, Amira Mohammed Ali,Israt Jahan Moury

Lecturer, School of Life Sciences, Independent University- Bangladesh, Dhaka, Bangladesh
Student, School of Life Sciences, Independent University- Bangladesh, Dhaka, Bangladesh
Student, School of Life Sciences, Independent University- Bangladesh, Dhaka, Bangladesh
Student, School of Life Sciences, Independent University- Bangladesh, Dhaka, Bangladesh

ABSTRACT: The safety of fish and fishery products has been looked at great importance as it can affect the consumer's wellbeing and FAO standards. Due to high demand of fresh fishes and fishery products, fish industries have been working more extensively on developing methods to evaluate the quality of fish. It is also critical to understand the changes occur in the fish, that causes them to lose its quality. Methods to evaluate freshness and microbial quality of fish have been carried out since ancient times and is still under research globally. This review article summarizes the current methods that are used most to assure fish quality and the parameters they measure. The paper also contrasts the ancient methods, with respect to a developing nations like Bangladesh, and the challenges they face in implementing new techniques available.

KEYWORDS: Fish quality, fish freshness, quality assuring technology

I. INTRODUCTION

Fish is low in fat but high quality protein filled with omega-3 fatty acids and vitamins such as D and B diet. Fish is an important source of minerals such as calcium and phosphorus, iron, zinc, iodine, magnesium, and potassium. Thus the demand for fish and its products are consumed in large numbers worldwide. As many countries, do not have the conditions to cultivate the desired fishes so are imported from coastal countries. Other than its nutritive value, fish is also an item of international trade and foreign exchange earner.

Bangladesh is located at South Asia, gifted with a large coastal line and a rich delta, is home to a vast capture fisheries and aquaculture sector. Bangladesh produced $ 1010.8 million fish and fish products in the year 2010 – 2011, of which 98 % was exported to the EU, Japan and North America[1].Bangladesh has been ranked as the 5th aquaculture producing country in the world[2].According to a report of Food and Agriculture Organization of United States it has been estimated that 45% of fish catch are being exported internationally[3].This makes fish to play an important role for a country like Bangladesh to earn revenue from exports. It is also critical that fish or fish products should be of good quality as poor quality fish are instantly rejected by the consumers.

Fish being a highly perishable product, the quality of the fish starts to deteriorate after the fish is brought to the landing sites. The deterioration of the fish occurs due to:

(1) Bacterial invasion and putrification,
(2) enzymatic autolysis,
(3) chemical oxidation and
(4) Mechanical damage and environmental optimization aggregating growth of microbes.

Deterioration of fish may cause adverse effect on consumers and as well deviate from the standard trading value. Major attributes to measure the quality of fish by evaluating its freshness are summarized in Figure 1. For this reason, food industries in Bangladesh and internationally, are working on developing techniques to assure the freshness of fish. The techniques being developed are based on the chemical and physical changes that occur on the fish following its captivation

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II. EXISTING TECCHNIQUES FOR QUALITY CONTROL

Methods of evaluation in Bangladesh involve assessing its organoleptic, chemical and microbial characteristics, have been appreciated for many years[4]. Recent advances in technology are needed to replace the older techniques. Even though new methods are developed that are rapid and some of them are portable, still has serious drawbacks which also need to be considered.Therefore, this paper discusses the methods available for fish quality assessment are presented and future researched technology will be discussed.

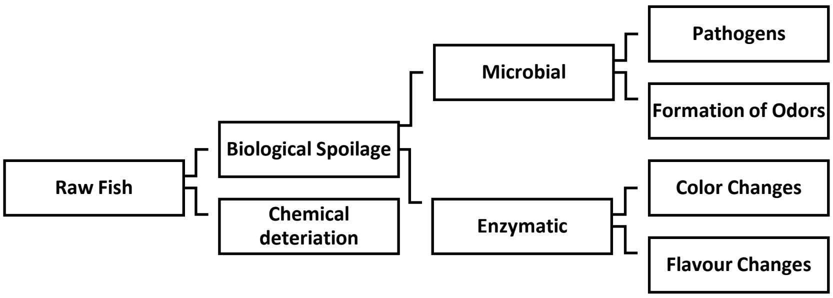

Figure 1: Attributes for assuring the quality of fish

A. SENSORY EVALUATION

Sensory evaluation measures the freshness of fish and fish products with respect to the five distinct senses including taste, smell, feel and appearance[5]. Sensory evaluation of freshness are widely used attributes for ensuring quality of fish. Sensory assessment can either be objective or subjective but for successful marketing, both are considered. In case of objective sensory assessment, trained personnel are used to classify freshness, whereas, in subjective sensing, one is based upon consumer satisfaction and market analysis of fish markets[6]. Figure 2 shows the supply chain of fish and fish products found typically in Bangladesh [7] as well as the routes of sensory evaluation.

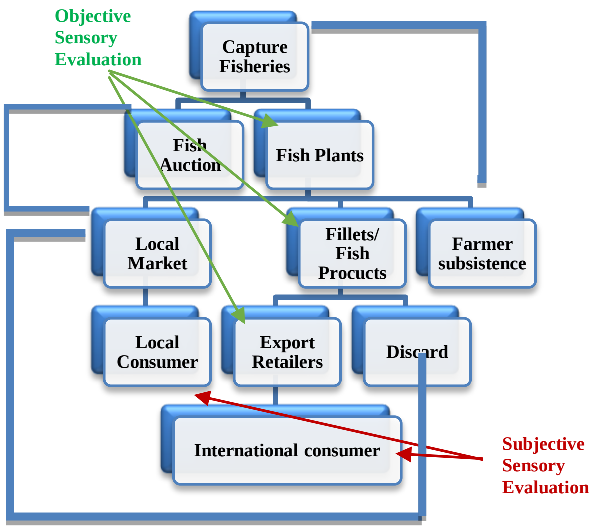

Figure 2 : Fish Supply Chain and Sensory evaluation in Bangladesh

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There are 3 major grading schemes that are followed by retailers to measure fish freshness. These include:
1. EU scheme,
2. Torry system
3. Quality indexing method

Fish exported to the EU is certified by the Department of Fisheries (DoF), is the Competent Authority (CA) for the EU, and is responsible for approving processing establishments for exports to the EU and for implementing EU regulations with regard to traceability and food safety control. The DoF implements EU schemes at the laboratory wing and the Fish Inspection Quality Control (FIQC) unit. Whole fish reviewed by EU scheme, is placed in one of four classes, the least being unfit for human consumption as summarized in Table 1. However the EU scheme had several flaws including, the grouping of different sensory terms into one quality grad and lack of species consideration. It is difficult to subdivide the quality grade characteristics within the same quality grade category making the grader confused and the system time slow.

The Quality Index Method was developed with descriptions of precise and independent grades. The QIM is based on the significant sensory parameters for raw fish and each new fish species**.**The inspector has to evaluate each attribute and the addition of each attribute gives an overall score. Minor differences in judgments of one characteristic does not influence the overall grade. Advantages of the QIM is that it does not require experienced assessors and can be used to calculate super fresh fish and has a linear relationship with shelf life.

Torry scheme is most commonly utilized scale for the assessment of cooked fish[8]. Processed, salted or dried fish exported by Bangladesh fish processing plants could use the Torry scheme as in Table 2for a particular fish species.

Table 1: EU Scheme for whole fish [9]

Criteria for Freshness				
	E	A	B	Unfit
Skin	Bright, iridescentpigment or opalescent;no discoloration	Pigmentation brightbut notlustrous	Pigmentation inthe process of discoloring anddull	Dullpigmentation
Eyes	Convex (bulging),black, bright pupil,transparent cornea	Convex andslightly sunken; black, dull pupil, slightly opalescentcornea	Flat, opalescentcornea, opaquepupil	Concave in thecentre, grey pupil, milky cornea
Gills	Bright color, nomucus	Lesscolored, transparentmucus	Brown / greendiscoloring, thick, opaquemucus	Yellowish, milkymucus
Flesh	Firm and elastic,smooth surface	Lesselastic	Flaccid, less elastic, waxy anddull surface	Soft , scales detached from skin, surface wrinkled

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Table 2: Tory Scheme[9]

Odour	Flavour	Score
Weak initial odours of sweetness, boiled milked, starchiness, with further intensification of these odours.	watery, metallic, starchy; initially no sweetness but meaty flavors with slight sweetness may develop	10
shellfish, seaweed, boiled meat, raw green plant	sweet, meaty, creamy, green plant, characteristic	**9**
Loss of odour, neutral odour	Sweet and characteristic flavors but reduced in intensity	**8**
wood shavings, wood sap, vanillin	neutral	**7**
condensed milk, caramel, toffee-like	insipid	**6**
milk jug odors, boiled potato, boiled clothes-like	slight sourness, trace of 'off' flavors	**5**
lactic acid, sour milk, 'byre-like'	slight bitterness, sour, 'off' flavors	**4**
lower fatty acids (eg acetic or butyric acids), composted grass, soapy, turnip, tallow	strong bitter, rubber, slight sulphide	**3**

End of Shelf Life

B. MICROBIAL ASSESSMENT

Fish decomposition starts after catch starts and changes occur in pH, atmosphere, nutrient composition have effects on micro flora. Raw fish consists of its own unique flora, determined by the microbial content of the surrounded water, which still remain despite food processing and subsequent cooling. Categorization of fish with similar microflora is considered when assuring the quality of Fish and its products. Microbes play a vital role in the shelf life of fish as gram-negative, fermentative bacteria (such as *Vibrionaceae*) spoil unpreserved fish, whereas psychrotolerant gram negative bacteria (*Pseudomonas* spp. and *Shewanella* spp)can continue growth in chillers[10,11]. Several standards are utilized to judge its freshness and adequacy.EU advised Bangladesh Government to implement the Hazard Analysis Critical Control Point (HACCP) in the processing of frozen fishes. Table 3 shows the microbial criteria set for exports for sea products from Bangladesh to the Gulf countries.

Total viable counts or TVC's are utilized widely as a part of microbiological allowing one to identify the active number of growing/dividingmicrobes. TVC ranges from 102 – 106 cfu/g in case of fish and the range determines its acceptability[8]. TVC limit varies greatly upon its conditions (temp, atmosphere, pH etc.). Among exports are the jew fish (bhola, bhetki), queen fish (talang), tongue sole fish , ribbon fish (baala), and cuttle fish (katla) marine fishes from Bangladesh. The maximum microbiological limit for the TVAC is 5×10^5 cfu/g and TVAC mostly ranged from 2.8×10^5 to 4.9×10^5 cfu/g for exported frozen fish which was below the maximum acceptable [12].

Research has co related, food spoilage is with changes in spoilage micro-organisms depending storage conditions[13]. Development of modelling of microbial spoilage dynamics in shelf-life prediction introduced the concept of **specific spoilage organisms (SSO)** allowing the formulation of microbial spoilage models. SSO has been defined as the part of the total microbe (*Pseudomonas spp, Photobacterium phosphoreum, Shewanella*) responsible for spoilage of fish and the spoilage domain as the range of product characteristics and storage conditions within which a given SSO causes product rejection [14][15]. Currently the detection of SSO is accurate using PCR method other than the Immono methods and rRNA probe based methods[15].

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C. BIOCHEMICAL ASSESSMENT

Sensory evaluations in assessing fish of high maxima or minima assessment values. Biochemical tests come into use when dealing with marginal quality of fish. Usually the chemical assessment either increases or decreases with respect to microbial spoilage or autolysis.

Total volatile basic amines (TVB) is one of has been used as measurements of fish quality[16]. The measurement of trimethylamine (produced by spoilage bacteria), dimethylamine (produced by autolytic enzymes during frozen storage), ammonia (produced by the deamination of amino-acids and nucleotide catabolites) or other volatile basic nitrogenous compounds in fish, increase in concentration [17]. The TVB-N value, especially for Bangladeshi fish species, was inverselyproportional with the sensory score of salted fishes[18]. The classic technique to measure volatile compound is the use of gas chromatography[19] but the emergence of 'electronic nose' has been adapted by many food industries.[20].

Fish lipids consists of highly unsaturated long-chain fatty acids. The lipid oxidation results in production of primary products like peroxides and secondary products like thiobarbituric acid reactive substances. This causes fish to degrade its quality during different storage conditions, reduced nutritional value and form harmful chemicals[21][22]. Traditionally chromatography techniques have been used in many food industries to measure lipid oxidation products. Analysis of quality can also be done by detection of **Primary (PV)** and secondary (TBARS**)** lipid oxidation products formed by oxidation[23]. PV counts increase in rate at the initial stage of growth curve, and this becomes reversed at later stages[24]. PV counts include the total amount of hydroperoxides by chromatographic techniques in details[25]. PV measurements could be done by iodometric titration, ferric ion complex measurement spectrophotometry, and infrared spectroscopy**. Malondialdehyde, MDA**, (MDA) a major product of lipid oxidation, has taken attention over years after it has been elucidated as carcinogenic and genotoxic[26]. MDA could be measured by **Thiobarbituric acid reactive substances**(T**BARS**) formed due to the degradation of fats by using the TBARS assay[27]. This involves the spectrometric quantization of resultant pink complex

D. BIOSENSOR DETECTION

Biosensors are developing as appealing instrumentation answers for quick discovery of food borne pathogens, toxins, pesticide and medication deposits, toxic metal particles. This propelled technique is useful in identifying fish freshness and quality, relying upon recording reactions that deliver physical, chemical and also immunological changes.

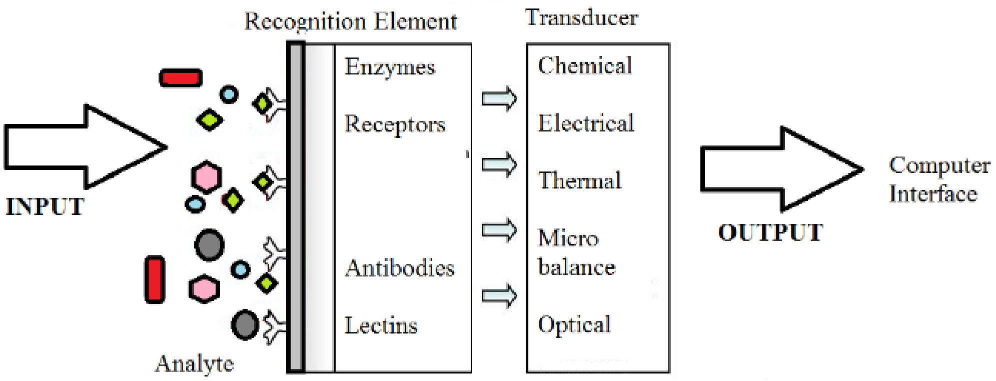

Figure 3: Biosensor Work flow

A biosensor is an quantitative analytical device consisting a biological sensing element (such as an enzyme, antibody, receptor, or microbe) coupled to a chemical or physical transducer[29]. The transducer surface is used to fix the biological sensing element. Transducers are responsible for converting the particular biological response

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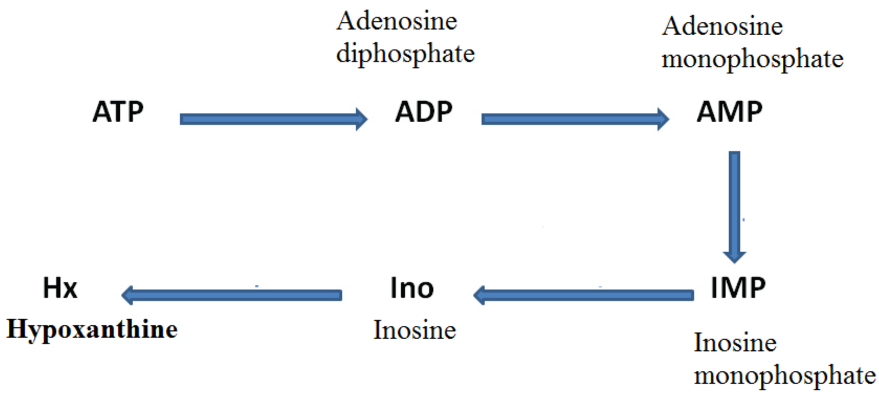
(electrochemical e.g electrodes), micro mass (quartz microbalances or surface acoustic wave devices), light (optical fibres), or thermal (thermistors) into an electrical impulse, which can be analysed by a software or an automated system as shown in Figure 3. After death, oxygen supply in fish meat ceases, metabolically activemuscles de hydrolyse ATP and initiates degradation forming compounds in the order :



Adenosine diphosphate (ADP), adenosine monophosphate (AMP), inosine monophosphate(IMP), inosine (Ino) and hypoxanthine (Hx) where X is xanthine which later converts to uric acid, U as shown above. The first to correlate autolysis, **K value**, and fish freshness was shown in[34]. Use of *K*-value in [35] was found applicable in one of Bangladesh's very common fish, Tilapia and the formula is given below:

$$\text{K value} = \frac{[\text{HxR}] + [\text{Hx}]}{[\text{ATP}] + [\text{ADP}] + [\text{AMP}] + [\text{IMP}] + [\text{HxR}] + [\text{Hx}]}$$

The **H value**, is used for INO-forming species having lost IMP quickly, a substantial accumulation of IN0 was observed during the ATP degradation[32]. For these species using the K value would soon give unity values quickly and is a wrong indicator of quality. The Hx ratio is calculated below:

$$\text{H ratio} = \frac{[\text{Hx}]}{[\text{IMP}] + [\text{INO}] + [\text{Hx}]}$$

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Table 3: Microbiological criteria under GCC Standardization Organization (GSO) consists of the National Standards Bodies of GCC member States approved by Gulf Standards/Technical[28]

Item	Microorganisms	Limit per gram or cm^2			
Raw fish and its products (chilled/frozen), segmented, minced, and sliced		N/ Number of sample units to be examined	C/ Maximum number of sample allowed to have a microbiological criterion value greater than "m" and not to exceed the value of "M"	m/ Acceptable microbial level in the sample unit	M/ Maximum criterion value that should not be exceeded in any of "n" units.
	Aerobic plate count	5	2	10^5	10^6
	Escherichia coli	5	3	10	$5x10^2$
	Vibrio parahaemolyticus	5	0	10^2	10^3
	Clostridium botulinum	5	0	0	–
Frozen/chilled breaded fish, (e.g. fish fingers, fish protein, and fish cakes	Aerobic plate count	5	2	$5x10^5$	10^7
	Escherichia coli	5	2	10	$5x10^2$
	*Salmonella**	5	0	0	–
	V. parahaemolyticus	5	1	10^2	10^3
	Staphylococcus aureus	5	1	10^3	10^4
Smoked fish including herring, cooked prior to eating and eaten uncooked	Aerobic plate count	5	3	10^5	10^6
	Escherichia coli	5	3	10	$5x10^2$
	V. parahaemolyticus	5	0	10^2	10^3
	Listeria monocytogenes	5	0	0	–
	Staphylococcus aureus	5	2	10^3	10^4
Dried and dehydrated fish and fish protein	Aerobic plate count	5	2	10^5	10^6
	Yeasts and moulds	5	2	10^2	10^4
	Salmonella	10	0	0	–
	Staphylococcus aureus	5	1	10^2	10^3
	Clostridium perfringens	5	1	10^2	10^3
Salted and/or fermented fish	Aerobic plate count	5	2	10^5	10^6
	Escherichia coli	5	1	10	4×10^2
	Escherichia coli O157	5	0	0	–
	Salmonella	10	0	0	–
	V. parahaemolyticus	10	0	0	–

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E. TOXIN DETECTION

Studies reveal that fishes are most susceptible to heavy metal contamination compared to other marine life. Toxic heavy metals enter the human body through food sources, particularly fish. Lead contaminates fish through water pipes, spilled paint and leaking gasoline in the sea.Low levels of Pb gradually affects the brain and high exposures causes poisoning. Methyl mercury (Hg) are commonly found in fish such as shark, swordfish and tuna[36]. Mercury poisoning may cause difficulties in movement in infants. Bangladesh has high levels of Arsenic (As), which is a carcinogenic, whereas cadmium has side effects in the male reproductive systems. Table 5 lists the maximum standards acceptable by the EU scheme of intoxins and heavy metals[37][38][39]. Histamin level detection during the HACCP implementation could be done by enzyme kits or elisa kits[40]. Tilapia fish underwent successful heavy metal screening was shown by using commercial Elisa kits and veterinary drug residual screening in [36].Benzo(a)pyrene (BaP) is one of Polycyclic Aromatic Hydrocarbons (PAHs) which cause health problems such as red blood cell damage (leading to anemia), DNA damage, genotoxicity, lung cancer, developmental and reproductive effects and the best known of the carcinogenic PAHs [41]. Maximum Contaminant Level (MCL) has been set by USEPA at 0.2 ppb in drinking water and 1 ppm in fish[41] . Rapid detection of benzo(a)pyrene by high performance liquid chromatography (HPLC) or Gas Chromatography with mass spectrometry[42].

Table 4 : Biosensors available for testing fish quality

Enzyme	**Remarks**	**Metabolite**	**Fish**	**Source**
Immobilized Xanthine Oxidase (XOD)	Xanthine is a major metabolite in the degradation of adenosine triphosphate the after the fish is caught.Measuring K value.	Conducting polyvinyl chloride (PVC) membrane	snake head murrel	[30][31]
Xanthine Oxidase Immobilized, Nucleoside Phosphorylase, & Nucleotidase Immobilized	*In this case, the Hx ratio or the H value, defined as [Hx]/[IMP + IN0 + Hx] index is considered as use of K value is irrelevant.*	Amperometric electrode	cod, tuna, flounder, skipjack,	**[32]**
Immobilized microbial sensor (Alteromonas putrefaciens)	Fish proteins or glycogen are decompose to smaller compounds, which are useful to microbes. These microbes consume oxygen causing a decrease in dissolved oxygen in the membrane.	Oxygen electrode,	Bluefin tuna, swordfish	**[33]**

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F. SPECTROSCOPY METHOD

Visible/Near Infra-Red Spectroscopy introduced a non invasive approach to gather information of fish produce based on the spectral parameters related to physio-chemical fish compose[43]. Ultraviolet Visible Near-Infra red (UV-Vis-NIR) spectroscopy has many modes of detection : transmission, and reflectance. Bangladesh determines and ensures the nutritional value of species before export or during farming[44]. Quality control and evaluation through VIS/NIR spectroscopy by fish content measurement of moisture , fat, and protein [45], and freshness evaluation in terms of absorption [46]. ***Moisture*** content used to analyses fish freshness quality, as it is responsible for giving it texture and muscle of fish. It has been 30 decades ago, NIR spectroscopy reflectance mode was used evaluate moisture contents in many fish species. Partial leastsquares (PLS) and multiple linear regression (MLR) were used to calibrate and relate reflectance data to water content having reliable results of standard errors 1 %, respectively[47]. Less errors during moisture detection using Principal component regression (PCR) models were found later on. ***Protein*** content of trouts, tuna, sea bass etc. were examined by NIR spectroscopy combined with PLS [45]and MLR calibrations[48]. Protein detection using NIR spectroscopy for whole salmon is not preferred[49]. Portable NIR spectroscopes was also used to analyse ***Fat*** in other fish species, such as trout, halibut [50],skipjack [51], and tuna, salmon fish[52].

Quality Inspection spectroscopesare designedto detect dark colorings in white fish. Dark colorings in the fish body relate to spoilage, insufficient bleeding and browning, bruising having negative impact in consumer preference. . As shown in table 1, grade E quality fish must not contain defects such as scars, bruises or clots and discoloration is allowed. For grade A, quality fish, no visible bruising is permitted. Evaluation of bruises in pacific pink salmon (Oncorhynchus gorbuscha) using visible spectroscopy by partial least-squares (PLS) modeling is a reliable technique used today[53]. QIM scores could be predicted by using visible spectroscopy in quantifying the freshness of cod[54]. Storage changes and frozen-thawed differences of salmon fillets using VIS spectrometry is shown in [55]. NIRS was used for real-time quantification of bacterial loads on fish [56].

Table 5: EU legislations on intoxins and chemicals allowed in fish imported from countries.

Toxin	Species	Maximum levels (mg/kg wet weight)
Lead	Whole fish	0.30
Histamine	Fresh fish Fishery products treated by enzyme maturation in brine	200 mg/kg 400 mg/kg
Cadmium	Whole except ones listed below; Anchovy (*Engraulis*, Bengali name: phasa), *bonito* (Sarda sarda), common two-banded seabream *(Diplodus vulgaris*), eel (*Anguilla anguilla*), grey mullet (*Mugil labrosus*), horse mackerel or scad (*Trachurus species*), louvar or luvar (*Luvarus imperialis*), sardine (*Sardina pilchardus*) sardinops, tuna (*Thunnus species*, *Euthynnus species*, *Katsuwonus pelamis*), wedge sole (*Dicologoglossa cuneata*); swordfish (*Xiphias gladius*)	0.050 0.10 0.30
Mercury	Fishery products and whole fish except ones below; Anglerfish (*Lophius*), atlantic catfish (*Anarhichas lupus*), bonito (*Sarda sarda*), eel (*Anguilla* species) emperor, orange roughy, rosy soldierfish (*Hoplostethus* species) grenadier (*Coryphaenoides rupestris*), halibut (*Hippoglossus hippoglossus*), marlin (*Makaira species*), megrim (*Lepidorhombus species*), mullet (*Mullus species*) pike (*Esox lucius*), plain	0.50 1.0

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	bonito (*Orcynopsis unicolor*), poor cod (*Tricopterus minutes*), portuguese dogfish (*Centroscymnus coelolepis*), rays (Raja species), redfish (*Sebastes marinus, S. mentella, S. viviparus*), sail fish (*I. platypterus*), scabbard fish (*Lepidopus caudatus, Aphanopus carbo*), seabream, pandora (Pagellus species), shark (all species), snake mackerel or butterfish (*Lepidocybium flavobrunneum, Ruvettus pretiosus, Gempylus serpens*), sturgeon (*Acipenser species*) swordfish (*Xiphias gladius*), tuna (*Thunnus* species, *Euthynnus* species, *Katsuwonus pelamis*);	
Dioxins and PCB	whole fish and fishery products and products thereof, excluding eel whole eel (Anguilla anguilla) and its products	4.0 pg/g wet weight – 8.0 pg/g wet weight 4.0 pg/g wet weight 12.0 pg/g wet weight
Benzo(a)pyrene	Smoked fish and smoked fishery products Whole fish other than smoked	5.0 2.0
Inorganic Arsenic	Whole Fish	0.002 mg/kg bodyweight, or 0.12 mg/day for a 60kg adult

G. MACHINE VISION

In the last decade, Machine vision has introduced the automatic operations in fish quality inspection and assurance in terms of size, weight, numbers, grading, species recognition and monitoring[57][58]. Fish is mostly divided according to its size, weight and volume after catch. This is done by using computer systems[59] using size parameters in quantifying in line fish[60]. Fast weight determination by volume parameters of whole herring (Clupea harengus) with 2D and 3D machine-vision system shown in [61]. However size and volume sorting are related to its area of projection especially for tilapia [62]. Identification of fish species, size grading including residues of skin, bone and blood in fish products could be done with the aid of visual contrast results [63]. CV recognized different species of haddocks by distinguishing between their shape and color features with high accuracy[64]. Combining CV with artificial neural network system (ANN), measurements of width and height taken at different times in line conveyer system and comparing it with data stored about species types it was proved that ANN could classify more than 95% of any species of fish including sole, plaice, whiting, dab, cod, lemon sole correctly[63].

Quality grading of whole Atlantic salmon in different grading schemes was adapted by image segmentation and CV, classifying in terms of size and shape of fish[65]. Application of Fuzzy classification using inherent in grading-type data and specifications developed automated grading of fish products. Results showed that the generalized fuzzy classifier was accurate 89%[66].

Defects in fish cause quality degrading along with a more complex procedure for automated grading. Defects like wounds, bruises and dissections required multiple imaging modes in a single system could also enhance the visibility of superficial defects in Atlantic salmon fillets [67]. X-ray machine vision detected fish bones in salmon and trout fillets using X-ray images with accuracy of 99 % [68]. Although Machine Vision has been accepted in fishery industries in many countries, it is necessary for countries like Bangladesh, which are one of the most highest fish exporting nations, need to understand these advanced technological issues.

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III. DISCUSSION

Quality control measures in local fish markets in countries like Bangladesh is not necessary. However, fish production industries require export certificates of quality control under the Fish Inspection and Quality Control Services issued by Department of Fisheries (DOF).

Standards for quality control are maintained in laboratories under the DOF located at Chittagong, Dhaka and Khulna. These are the prime areas of marine production industries. Laboratories assurequality for fish and their products based

on microbiological, chemical tests and other sensing startegies. Quality control at landing, handling, distribution and marketing places are also periodically carried out. Table compares and contrasts each quality control strategy with respect to a developing country's prospective. Fish is also one of the main sources of protein for local people of Bangladesh. Strategies will soon be implemented to ensure quality of local business and industries.So new technologies need to be adapted for ensuring safety and quality of products in the local fish markets, as well as investing in capital required for achieving a greater production of fish and aquaculture for export.

Table 6 : Techniques for evaluating quality of fish/fish products according to economic, reliability and social issues with respect to developing nation's prospective.

Method	Advantages	Drawbacks	Types of fish used
Sensory evaluation	It is a non-destructive test Requires less capital. Labour intensive so increases employment for developing countries.	Perception can vary person to person and the investigators can be different from the consumer's. Investigator can become fatigue of investigating large number of fishes. The result can be biased.	All types of fish
Microbial inspection			
Total Viable Count	The technique is very sensitive. Species identification of organism appeared can be done.	Very time consuming. Contamination are likely to happen while transporting samples to the labs which can create inconclusive results. The number of sample can be examined are very limited. Method ineffective in predicting the remaining shelf life while being destructive and needs elaborative experimental steps and trained workers. TVC doesn't differentiate species.	Most of the sea fishes
Real Time PCR	This can detect the specific spoilage organisms and their quantity. Less time consuming and many samples can be run in one day.	It is huge capital required for instalment and less sensitive. Contaminations likely to be happen more in this technique	

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Chemical Inspection			
Electronic nose	E-nose are portable. It provides rapid results with good sensitivity and specificity. It is also a non-destructive test.	High efficiency e-nose is still not present. It can detect limited analytes. The instrument itself is expensive and also requires high costs in maintenance. Detects later stages of advanced spoilage. Unreliable for the measurement of several species initially during initial spoilage.	haddock, cod and redfish
Chroma-tography	Has high sensitivity. It requires less equipment. The cost is affordable. It requires minimal sample preparation.	TVB Values do not measure the mode of spoilage (bacterial or chemical). Hard to trace the source. Results depend to a great extent on the method of analysis. Poor agreement among six published TVB procedures makes it difficult form of assessment.	Salmon, sea scallops

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Spectroscopy	It is a non-destructive and non-invasive technique. It can measure different parameters of fish freshness evaluation and involves online monitoring of fish. It is very rapid.	Very expensive and requires high monitoring costs. Inputs large number of chemical measurements leaving the accuracy of the analysis dependent on external factors. It requires skilled person to operate the technique. It can be harmful to workers as continuous exposure to electromagnetic waves used in the technique are carcinogenic Research needed in HSI technique, in improving the precision of the prediction model, reducing hyper spectral data redundancy, increasing speed and determining wavelengths for multispectral imaging systems before systems become commercially stable.	Salmon, Sardine, Cod, Sea bass, Abalone, Trout, Halibut
Biosensor	They give quick response. Have high specificity and sensitivity. They show minimum cross reactivity. Future may replace automated biosensors for online detection and cost of labour reduced.	The electrical signal from the transducer is often weak with heavy noise. The biological agents are often less stable and degrade within a short time. They are not re-usable.	Cod fillets

Machine Vision	Rapid identification and sizing of selected parameters, along with and faster classification of samples into shape, size, color and other grading attributes. Workmen would otherwise take longer times being less efficient. Fish industry needs inspection of diverse raw and processed aquatic foods delicate and non-destructive manner as it provides non touchable concepts of analysis. Machine vision will provide commercial applications based on new techniques in image processing, in order to provide reusable and cheap alternatives to evaluate large numbers of fish parameters to assess freshness and storage life.	Constraints of MV involve image capturing in fast speed requirements, variations in species, accounting for size and shape of each species, differences in optical morphology of each species, and the harsh background for MV systems in industries. Challenges involving interpretation and use of large amounts of data. Advances in identification and sorting algorithms in machine learning is required for a successful application of computed technologies related to classification properties related to fish quality. Developing nations need high capital and trained craftsman to start automated technologies, making fishery workers lose plenty of jobs which now automated robots/ machines will otherwise do.	Mainly salmon and rainbow Trout; guppy fish (Poecilia reticulata); whole herring (Clupea harengus)
Physical inspection			
Texture analyzer	A texture profile analysis test replicates the effect of two bites on a sample which is similar to humans.	It is a destructive, costly and it is unable to use for large number of samples. Less reproducibility and requires lengthy sample preparation	Salmon

IV. CONCLUSION

The nature of fish and fishery items is a noteworthy worry in fish industry around the world. As fish is extremely perishable thing without proper quality and freshness it will lose its affirmation to the purchaser. A number of techniques/methods are utilized worldwide to assess its freshness and to anticipate the rest of the time span of usability. Here we have reviewed particular techniques/methods for quality evaluation of fish and fish products. Replacing automated machinery or skilled trainee will assist Bangladesh and developing nations to think about their confinements, invest in new techniques and overcome slower strategies by utilizing the most progressive and powerful one in future.

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AUTHOR'S BIOGRAPHY

[1]. **Ms Kazi Naziba Tahsin** has been a lecturer in the Independent University of Bangladesh (IUB)since 2016. She obtained her Masters of Engineering from University of Guelph, Ontario, Canada with a specialisation in Wireless Biosensor Technology. Her areas of Research interests are Bio Energy systems, Biomedical Engineering and Sensory detection Systems.

[2]. **Asifur Rahman Soad** is pursuing his final year in Microbiology at IUB, Bangladesh.His current research project is on the detection ESBL producing enterobacteria in Shrimps.

[3]. **Amira Mohammed Ali,** is an IUBStudent, pursuing her final year in the department of Microbiology. She is currently researching on isolation and identification of bacteria in different food samples.

[4]. **Israt Jahan Moury**is an IUB Student who is pursuing her final year with a major in Microbiology.