Department of Zoology

Dr.BRR Government College Jadcherla

Student Study Project

On

"Collection&Laboratory Preservation of Fish Specimen collected from the fresh water resources of erstwhile Mahabubnagar,TS"

Academic Year 2021-22

Dr. BRR GOVERNMENT DEGREE COLLEGE

JADCHERLA – 509 301

(Accredited with B++ by NAAC)

Dr. CH.Appiya Chinnamma, M.Sc., Ph.D.
Principal

The department of Zoology has conducted student study projects during the academic year 2021-22.

Title: "Collection and Laboratory Preservation of Fish Specimen collected from the fresh water resources of erstwhile Mahabubnagar,TS"

Place of Work: Erstwhile Mahabubnagar Dist.

1.	**Maheruba Begum,**	**B.Sc (BZCs), H.TNo. 20033006475005**	Maheruba	6309752628
2.	**Atufa Begum, B.Sc**	**(BZC), H.T No. 20033006445006**	Atuf Begum	7396266421
3.	**K.Shravani, B.Sc**	**(BZC), H.T No. 20033006445033**	Shravani	6305892896
4.	**K.Pravalika, B.Sc**	**(BZC), H.T No. 20033006445550**	K.Pravalika	9652645641
5.	**L.Arunasri, B.Sc**	**(BZC), H.T No. 20033006445562**	L.Arunasri	6281353483
6.	**M.Chandana, B.Sc**	**(BZC), H.T No. 20033006445570**	M.Chandana	9030178492

Dr. BRR GOVERNMENT DEGREE COLLEGE

JADCHERLA – 509 301

(Accredited with B++ by NAAC)

Dr. CH.Appiya Chinnamma, M.Sc., Ph.D.
Principal

Department of Zoology

Dr.BRR Government Degree College Jadcherla

Department of Zoology

A Student Study project

on

"Collection and Laboratory Preservation of Fish Specimen collected from the fresh water resources of erstwhile Mahabubnagar,TS"

By

1 Maheruba Begum, B.Sc (BZCs), H.TNo. 20033006475005 Maheruba 6309752628

2 Atufa Begum, B.Sc (BZC), H.T No. 20033006445006 Atufa Begum 7396266421

3 K.Shravani, B.Sc (BZC), H.T No. 20033006445033 Shravani 630589288

4 K.Pravalika, B.Sc (BZC), H.T No. 20033006445550 K.Pravalika 9652645641

5 L.Arunasri, B.Sc (BZC), H.T No. 20033006445562 L.Aruna Sri 6281353483

.6 Chandana, B.Sc (BZC), H.T No. 20033006445570 M.Chandana 9030178492

Supervised By

Bakshi Ravinder Rao,

Asst.Professor of Zoology

Department of Zoology

Dr.BRR Govt.Degree College Jadcherla

Supervisor HOD Principal

DEPT. OF ZOOLOGY
Dr. B.R.R. GOVT. COLLEGE
JADCHERLA

PRINCIPAL
Dr.B.R.R. Government Degree College
Jadcherla

Dr. BRR GOVERNMENT DEGREE COLLEGE

JADCHERLA – 509 301

(Accredited with B++ by NAAC)

Dr. CH.Appiya Chinnamma, M.Sc., Ph.D.
Principal

Student Study Project Completion Certificate:

•

<u>CERTIFICATE</u>

This is to certify that the project work entitled "Collection and Laboratory Preservation of Fish Specimen collected from the fresh water resources of erstwhile Mahabubnagar,TS" is a bonafide work done by Maheruba Begum Atufa Begum K.Shravani K.Pravalika L.Arunasri and Chandana the students of B.Sc. (BZC) IV semester students under my supervision in Zoology at the Department of Zollogy Dr.BRR Government College Jadcherla during 2021-22 and the work hasn't been submitted any other college or University either part or full for the award of any degree.

Place: Jadcherla

Date: 30/3/2022

B.Ravinder Rao

Asst.Prof.of Zoology

A Student Study project

on

"Collection and Laboratory Preservation of Fish Specimen collected from the fresh water resources of erstwhile Mahabubnagar,TS"

Acknowledgements:

The members of this project extend thanks to Dr.CH.Appiya Chinnamma, Principal for permitting to conduct this project.

The team is indebted to all the fishers who helped in catching and donating the specimens to this college.

Special thanks are due to K.Neeraja, lecturer in Zoology and Smt.K.Subhashini Asst.Prof, of Zoology for their help and advice to complete this project.

Finally thanks are also due to Sri B.Ravinder Rao,HOD for guiding the team to during period the project.

Objectives:

To Promote interest in research aptitude among students

To indentify the Fish species in local area

To preserve the local fish species for studies

To document the Fish species

ABSTRACT

The fish diversity is a good indicator of the health of the aquatic ecosystem and represents the balanced ecosystem. Collection of the available Fish specimen in erstwhile Mahabubnagar district of Telangana, India was conducted from April 2021 to March 2022. For the study, 6 sampling stations were selected. From each station, collected fishes were identified with the help of standard keys. The fish specimens were collected monthly with help of local fishermen by using fishing Craft and Gear. The present investigation results revealed that the occurrence of 17 fish species belong to 8 orders, 10 families and 16 genera were identified. Order Cypriniformes were most dominant group represent by 5 species followed by Siluriformes 4, Cichliformes 2, Synbranchiformes 1, Anabantiformes 2, Osteoglossiformes 1, Gobiiformes1 and Mugiliformes 1, . Among the families recorded, Cyprinidae was the most dominant followed by the Bagridae. The study revealed that the areas are mostly stressed in nature due to anthropogenic activities and over exploitation of fishes throughout the year.

Keywords: Erstwhile Mahabubnagar, Telangana, Fish diversity, Craft and Gear.

INTRODUCTION

Fish is one of the protein foods that needs careful handling (Eyo, 2004). This is because fish spoils easily after capture due to the high tropical temperature which accelerates the activities of bacteria, enzymes and chemical oxidation of fat in the fish. Due to poor handling, about 30 – 50% of fish harvested are wasted in Nigeria. These losses could be minimized by the application of proper handling, processing and preservation techniques (Bate and Bendall, 2010).

The purpose of processing and preserving fish is to get fish to an ultimate consumer in good, usable condition. The steps necessary to accomplish this begin before the fishing expedition starts, and do not end until the fish in eaten or processed into oil, meal, or a feed (Karube *et al.*, 2001). Fish begins to spoil as soon as it is caught, perhaps even before it is taken out of the water. Therefore, the key to delivering a high quality product is close attention to small details throughout the entire process of preparation, catching, landing, handling, storage, and transport. Fish that becomes spoiled or putrid is obviously unusable (Gopakumar, 2000). Fish that is poorly cared for may not be so obviously bad, but it loses value because of off-flavors, mushy texture, or bad color that discourage (Burt, 2003), a potential purchaser from buying. If customers have bought one bad fish, they probably won't buy another. On the other hand, if you consistently deliver good quality at a fair price, people will become loyal customers (Nelson *et al.*, 2004).Spoilage proceeds as a series of complex enzymatic bacterial and chemical changes that begin when the fish is netted or hooked (Burt, 2003). This process begins as soon as the fish dies. The rate of spoilage is accelerated in warm climates. The fish's gut is a rich source of enzymes that allow the living fish to digest its food (Lima Dos Santos *et al.*, 2011). Once the fish is dead, these enzymes begin digesting the stomach itself. Eventually the enzymes migrate into the fish flesh and digest it too. This is why the fish becomes soft and the smell of the fish becomes more noticeable.

There are countless bacteria naturally present on the skin of the fish, in the gills, and in the intestines (Karube *et al.*, 2001). Normally, these bacteria are not harmful to a living fish. Shortly after death, however, they begin to multiply, and after two to four days they ingest the flesh of even a well-iced fish as enzymatic digestion begins to soften it. The bacterial load carried by a fish depends on its health, its environment, and on the way it was caught. Healthy fish, from clean water, will keep better than fish dragged along the bottom of a dirty pond in a trawl net. Both enzymatic digestion and bacterial decomposition involve chemical changes that cause the familiar odors of spoilage (Putro, 2005). Oxygen also reacts chemically with oil to cause rancid odors and taste. The aim of fish processing and preservation is to slow down or prevent this enzymatic, bacterial, and chemical deterioration, and to maintain the fish flesh in a condition as near as bacterial, and chemical deterioration, and to maintain the fish flesh in a condition as near as possible to that of fresh fish (Bate and Bendall, 2010).

Fig 1: Typical fish (source: www.wikipedia.com)

Taxonomy

Fish are a paraphyletic group: that is, any clade containing all fish also contains the tetrapods, which are not fish. For this reason, groups such as the "Class Pisces" seen in older reference works are no longer used in formal classifications.Traditional classification divide fish into three extant classes, and with extinct forms sometimes classified within the tree, sometimes as their own classes: (Romer and Parsons, 2011; Benton, 2005)

- Class Agnatha (jawless fish)

Subclass Cyclostomata (hagfish and lampreys) Subclass Ostracodermi (armoured jawless fish)

- Class Chondrichthyes (cartilaginous fish)

Subclass Elasmobranchii (sharks and rays)

Subclass Holocephali (chimaeras and extinct relatives)

- Class Placodermi (armoured fish)

Class Acanthodii ("spiny sharks", sometimes classified under bony fishes)

Freshness of fish

Freshness is usually judged in the trade entirely by appearance, odour and texture of the as sensory or organoleptic. The most important things to look for the freshness of fish are:

1. The general appearance of the fish including that of the eyes, gills, surface slime and scales and the firmness or softness of the flesh.
2. The odour of the gills and belly cavity;
3. The appearance, particularly the presence and absence of discoloration along the underside, of the backbone.
4. The presence or absence of rigor mortis or death stiffening;
5. The appearance of the belly walls (Bate and Bendall, 2010).

CAUSES OF SPOILAGE OF FISHES

Spoilage and freshness are the two qualities that have to be clearly defined (Gram and Huss, 2000). A fresh product is defined as the one whose original characters remain unchanged. Spoilage therefore is the indicative of post-harvest change (Hui, 2006). This change may be graded as the change from absolute freshness to limits of acceptability to unacceptability. Spoilage is usually accompanied by change in physical characteristics. Change in colour, odour, texture, colour of eyes, color of gills and softness of the muscle are some of the characteristics observed in spoiled fish (Baird-Parker, 2000). Spoilage is caused by the action of enzymes, bacteria and chemicals present in the fish. In addition, the following factors contribute to spoilage of fish (Abbas and Saleh, 2009).

- High moisture content
- High fat content
- High protein content
- Weak muscle tissue
- Ambient temperature
- Unhygienic handling

Process of spoilage

Fish is highly nutritive. It is tasty because of its constituents. The main components of fish are water, protein and fat (Adebowale *et al.*, 2008). The spoilage of fish is a complicated process brought about by actions of enzymes, bacteria and chemical constituents. The spoilage process starts immediately after the death of fish. The process involves three stages (Amos, 2007).

6. Rigor mortis
7. Autolysis
8. Bacterial invasion and putrefaction

Types fish spoilage

Enzymatic spoilage

Shortly after capture, chemical and biological changes take place in dead fish due to enzymatic breakdown of major fish molecules (FAO, 2005). Hansen *et al.* (2003) stated that autolytic enzymes reduced textural quality during early stages of deterioration but did not produce the characteristic spoilage off-odors and off- flavors. This indicates that autolytic degradation can limit shelf-life and product quality even with relatively low levels of spoilage organisms (FAO, 2005). Most of the impact is on textural quality along with the production of hypoxanthine and formaldehyde. The digestive enzymes cause extensive autolysis which results in meat softening, rupture of the belly wall and drain out of the blood water which contains both protein and oil (FAO, 2005).

A number of proteolytic enzymes are found in muscle and viscera of the fish after catch. These enzymes contribute to post mortem degradation in fish muscle and fish products during storage and processing. There is a sensorial or product associated alteration that can be contributed by proteolytic enzymes (Engvang and Nielsen, 2001). During improper storage of whole fish, proteolysis is responsible for degradation of proteins and is followed by a process of solubilization (Lin and Park, 2006). On the other hand, peptides and free amino acids can be produced as a result of autolysis of fish muscle proteins, which lead towards the spoilage of fish meat as an outcome of microbial growth and production of biogenic amines (Fraser and Sumar, 2008). Belly bursting is caused by leakage of proteolytic enzymes from pyloric caeca and intestine to the ventral muscle. The proteases have optimal pH in

Microbial spoilage

Composition of the microflora on newly caught fish depends on the microbial contents of the water in which the fish live. Fish microflora includes bacterial species such as Pseudomonas, Alcaligenes, Vibrio, Serratia and Micrococcus (Gram and Huss, 2000) Microbial growth and metabolism is a major cause of fish spoilage which produce amines, biogenic amines such as putrescine, histamine and cadaverine, organic acids, sulphides, alcohols, aldehydes and ketones with unpleasant and unacceptable off-flavors (Dalgaard *et al.*, 2006; Emborg *et al.*, 2005; Gram and Dalgaard, 2002). For unpreserved fish, spoilage is a result of Gram- negative, fermentative bacteria (such as *Vibrionaceae*), whereas psychrotolerant Gram-negative bacteria (such as Pseudomonas spp. and Shewanella spp.) tend to spoil chilled fish (Gram and Huss, 2000). It is, therefore, important to distinguish non spoilage microflora from spoilage bacteria as many of the bacteria present do not actually contribute to spoilage (Huss, 2005). Trimethylamine (TMA) levels are used universally to determine microbial deterioration leading to fish spoilage. Fish use Trimethylamine Oxide (TMAO) as an osmo-regulant to avoid dehydration in marine environments and tissue waterlogging in fresh water.

Bacteria such as *Shewanella putrifaciens*, Aeromonas spp., psychrotolerant Enterobacteriaceeae, P. *phosphoreum* and Vibrio spp. can obtain energy by reducing TMAO to TMA creating the ammonia-like off flavors (Gram and Dalgaard, 2002). *Pseudomonas putrifaciens*, *fluorescent pseudomonads* and other spoilage bacteria increase rapidly during the initial stages of spoilage, producing many proteolytic and hydrolytic enzymes (Shewan, 2001).

Chemical spoilage

Lipid oxidation is a major cause of deterioration and spoilage for the pelagic fish species such as mackerel and herring with high oil/fat content stored fat in their flesh (Fraser and Sumar, 2008). Lipid oxidation involves a three stage free radical mechanism: initiation, propagation and termination (Frankel, 2005; Khayat and Schwall, 2003). Initiation involves the formation of lipid free radicals through catalysts such as heat, metal ions and irradiation. These free radicals which react with oxygen to form peroxyl radicals.

During propagation, the peroxyl radicals reacting with other lipid molecules to form hydroperoxides and a new free radical (Fraser and Sumar, 2008; Hultin, 2004). Termination occurs when a build up of these free radicals interact to form non radical products. Oxidation typically involves the reaction of oxygen with the double bonds of fatty acids. Therefore, fish lipids which consist of polyunsaturated fatty acids are highly susceptible to oxidation. Molecular oxygen needs to be activated in order to allow oxidation to occur. Transition metals are primary activators of molecular oxygen (Hultin, 2004). In fish, lipid oxidation can occur enzymatically or non- enzymatically. The enzymatic hydrolysis of fats by lipases is termed lipolysis (fat deterioration). During this process, lipases split the glycerides forming free fatty acids which are responsible for: (a) common off flavour, frequently referred to as rancidity and (b) reducing the oil quality (Huis in't Veld, 2006; FAO, 2005). The lipolytic enzymes could either be endogenous of the food product (such as milk) or derived from psychrotrophic microorganisms (Huis in't Veld, 2006). The enzymes involved are the lipases present in the skin, blood and tissue. The main enzymes in fish lipid hydrolysis are triacyl lipase, phospholipase A2 and phospholipase B (Audley *et al.*, 2008; Yorkowski and Brockerhoft, 2005).

Non-enzymatic oxidation is caused by hematin compounds (hemoglobin, myoglobin and cytochrome) catalysis producing hydroperoxides (Fraser and Sumar, 2008). The fatty acids formed during hydrolysis of fish lipids interact with sarcoplasmic and myofibrillar proteins causing denaturation (Anderson and Ravesi, 2009; King *et al.*, 1962). Undeland *et al.* (2005) reported that lipid oxidation can occur in fish muscle due to the highly pro-oxidative Hemoglobin (Hb), specifically if it is deoxygenated and/or oxidized.

Materials and Methods;

The study area was divided into three stretches for convenience i.e., Koilsagar reservoir and Sarala sagar reservoirs of Devarkadara mandal. Local streams, including Pedda vaagu, Meenambaram vagu and local tanks.The study area included 15 collection sites. The fish were collected in these reservoirs. Survey was conducted in the early morning or evening because those hours all the fishermen and fish landing zone is much more active than in other times of a day. Collections of fish were made with the help of local fishermen by using different mesh sized nets, such as gill nets, cast nets, shore-seine, hooklines etc.Alternatively, fish samples were also collected from the fishermen on the spot, fish landing centers and local fish markets of the studied area to ascertain the fish species composition as far as possible, the fish species were identified in the field itself. The samples were photographed, immediately prior to preservation as formalin decolourise the fish colour on long preservation. Unidentified collected specimens were preserved in 10% aqueous formaldehyde solution and were brought to the Science Laboratory, Department of Zoology, Dr.BRR Govt.Degree College Jadcherla, Mahabubnagar district, Telangana and identified with the help of standard keys mentioned in the taxonomic literature. The nomenclatures followed in this context were made according to Talwar and Jhingran (1991) and Jayaram (2010). Secondary data were also collected through observation and interview with fishermen through questionnaires at the studied area.

Labels and Labeling

Labels, giving all essential data, should be placed in the jar with the fishes when collected. Accurate information about the locality is as valuable as the specimens themselves; specimens without proper data are of little scientific value.

Labels should have at least the following information: exact locality, coordinates, nearest land mass, or reference to a town commonly appearing on maps, date collected, name of the collector, and any other information that seems pertinent, such as depth of water, method of capture any and all ecological data, etc.

Labels should be written with a soft lead pencil or permanent black ink (e.g., a Rapidograph pen) on 100% cotton or linen paper. Do not use ordinary paper because it will disintegrate in the liquid. Do not use a ball-point pen—the ink in most cases washes off in a matter of days.

Large fishes may be tagged, preferably through the lower jaw, with all essential data written on the tag, or a number may be used and the data recorded under the identical number in a notebook. Always keep a field notebook in which you record all the information about each collection made.

Team members collecting Fish specimen from the local markets

Team members preserving the Fish specimen in the Zoology museum

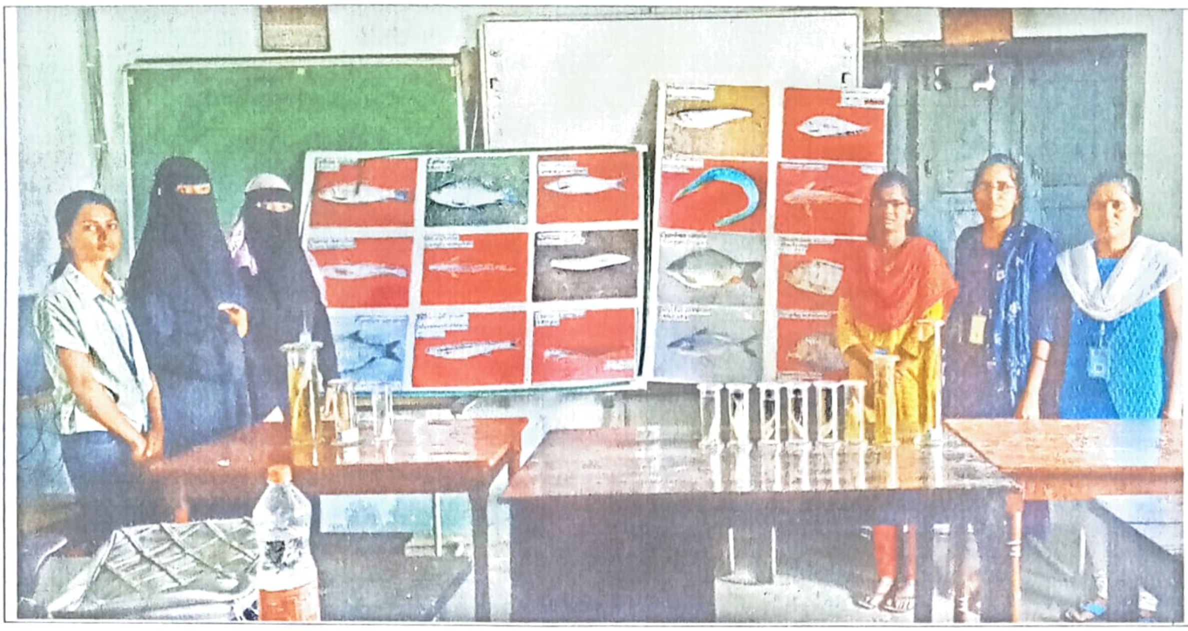

Table.1: List of collected Fish specimens

S.No.	Order	Family	Scientific Name	Local Name
1	Cypriniformes 5	Cyprinidae	Catla catla	Bocha
2			Cyprinus carpio	Bangaru teega
3			Cirrhinus mrigala	Mrigal Yerramosu
4			Puntius sarana	Perka
5			Labeo rohita	Rohu
6	Mugiliformes 1	Mugilidae	Rhinomugil corsula	Meedi kandla chepa
7	Siluriformes 4	Bagaridae	Mystus cavasius	Mooti jella
8			Sperata seenghala	Mooti jella
9		Siluridae	Ompac bimaculatus	Bugga damma
10		Claridae	Clarias batracus	Marpu
11	Anabatiformes 2	Channidae	Channa Striata	Korrameenu
12			Channa marulius	Poo meenu
13	Cichliformes 2	Cichlidae	Etropus suratensis	Duvvena chepa
14			Oreochromis niloticus	Dobocha
15	Gobiformes 1	Gobidae	Glossogobius giuris	Iska dondu
16	Osteoglossoformes 1	Notapteridae	Notapterus notapterus	Mangali katti
17	Synbranchiformes 1	Mastacembelidae	Mastacembelus armatus	Bommidai,

Results:

For the study, 6 sampling stations were selected. From each station, collected fishes were identified with the help of standard keys. The fish specimens were collected monthly with help of local fishermen by using fishing Craft and Gear. The present investigation results revealed that the occurrence of 17 fish species belong to 8 orders, 10 families and 16 genera were identified. Order Cypriniformes were most dominant group represent by 5 species followed by Siluriformes 4, Cichliformes 2, , Synbranchiformes 1, Anabantiformes 2, , Osteoglossiformes 1, Gobiiformes1 and Mugiliformes 1, . Among the families recorded, Cyprinidae was the most dominant followed by the Bagridae. The study revealed that the areas are mostly stressed in nature due to anthropogenic activities and over exploitation of fishes throughout the year.

CONCLUSION

Fish preservation and processing is a very important aspect of the fisheries. Normally the fish farms or other fish capturing sites are located far off from the market place and there is chance of fish decomposition and the uncertainties of their sale in market. When the fishes are caught in numbers, greater than the amount of consumption, their preservation becomes a necessity for their future use. Preservation and processing, therefore become a very important part of commercial fisheries. It is done in such a manner that the fishes remain fresh for a long time, with a minimum loss of flavour, taste, odour, nutritive value and the digestibility of their flesh.

RECOMMENDATION

The preservation and processing of fishes should be taken seriously by all as to avoid wasting of the fish products.

Government should invest more on the fish processing as a lots of Economic benefits could be derived from proper processing and preservation of the fishes.

It is recommended that more research should be carried out on the processing of the fishes as not much research work has been done on it.

References:

Abbas, K.A., Saleh, A.M., Mohamed, A., and Lasekan, O (2009). The relationship between water activity and fish spoilage during cold storage: A review. *Journal of Food and Agricultural Environment*, 7: 86-90.

Adebowale, B.A., Dongo, L.N., Jayeola, C.O and Orisajo, S.B (2008). Comparative quality assessment of fish (*Clarias gariepnius*) smoked with cocoa pod husk and three other different smoking materials. *Journal of Food Technology*, 6: 5-8.

Alasalvar, C, Miyashita, K., Shahidi, F and Wanasundara, U (2011). Handbook of Seafood Quality, Safety and Health Applications, John Wiley and Sons, p. 349.

Amos, B (2007). Analysis of quality deterioration at critical steps/points in fish handling in Uganda and Iceland and suggestions for improvement. United Nations University, Uganda. P. 45.

Ananoui, S., Maqueda1, M., Martínez-Bueno, M and Valdivia, E (2007). "Biopreservation, an ecological approach to improve the safety and shelf-life of foods" In: A. Méndez-Vilas (Ed.) Communicating Current Research and Educational Topics and Trends in Applied Microbiology, Formatex, p. 456.

Anderson, M.L. and Ravesi, E.M (2009). Reactions of free fatty acids with protein in cod muscle frozen and stored at -26°C after aging in ice. *Journal of Fish* Res, 26: 2727-2736.

Audley, M.A., Shetty, K.J and Kinsella, J.E (2008). Isolation and properties of phosphilase A from Pollock muscle. *Journal of Food Science*, 43: 1771-1775.

Baird-Parker, T.C (2000). The Production of Microbiologically Safe and Stable Foods. In: The Microbiological Safety and Quality of Food, Lund, B.M. and
T.C. Baird-Parker (Eds.). Aspen Publishers Inc., Gaithersburg, MD., USA, Pp. 3-18.

Bate, E.C and Bendall, J.R. (2010). Changes in fish muscle after death. *British Medical Bulletin*, (12): 2305.

Bekker-Nielsen, T (2005). Ancient fishing and fish processing in the Black Sea region,Black Sea studies, Aarhus University Press, 2: 34-45.

Benton, M. J. (2005). The quality of the fossil record of vertebrates, Wiley, New York, Pp. 269–303.

Bremner, H.A. (2003). Safety and Quality Issues in Fish Processing, Woodhead Publishing Limited, 4(3): 34-43.

Burt, J.R. (2003) Hypoxanthine a biochemical index of fish quality. *Process Biochemistry*, 11(10): 23-25.

Carey, F.G and Lawson, K.D. (2004). "Temperature regulation in free-swimming bluefin tuna". *Comparative Biochemistry and Physiology*, 44 (2): 375–392.

Dalgaard, P., Madsen, H.L., Samieian, N and Emborg, J (2006). Biogenic amine formation and microbial spoilage in chilled garfish (*Belone belone*) effect of modified atmosphere packaging and previous frozen storage. *Journal of Applied Microbiology*, 101: 80-95.

Deepchill, (2010). Variable-State Ice in a Poultry Processing Plant in Korea".
Retrieved February 4, 2017.

Emborg, J., B.G. Laursen and P. Dalgaard, 2005. Significant histamine formation in tuna (*Thunnus albacares*) at 2°C: Effect of vacuum-and modifiedatmosphere- packaging on psychrotolerant bacteria. *International Journal of Food Microbiology*, 101: 263-279.

Engvang, K. and Nielsen, H.H (2001). Proteolysis in fresh and cold-smoked salmon during cold storage: Effects of storage time and smoking process. *Journal Food Biochemistry*, 25: 379-395.

Eyo, E. E (2002). Fish Processing and Utilisation. Paper Presented at the National Workshop on Fish Processing, Preservation, Marketing and Utilistion, New Bussa, pp.4-5

FAO Fisheries and Aquaculture, (2008). Globalisation and Fisheries: Proceedings of an OECD-FAO Workshop Organization for Economic Co-operation and Development, OECD Publishing, p.56.

FAO, (2005). Post-harvest changes in fish. In: FAO Fisheries and Aquaculture Department, Food and Agriculture Organization, Rome, Italy. http://www.fao.org/fishery/topic/12320/en

FAO, (2007). Survey Methods of Appraising Evaluation of traditional solar dry system in Nigeria Fisheries Resource. Fish Technical Paper, pp. 171

FAO, (2011). Handling of fish and fish products Fisheries and aquaculture department, Rome. Retrieved February 2017.

Flajnik, M. F., and Kasahara, M. (2009). "Origin and evolution of the adaptive immune system: genetic events and selective pressures." *Nature Reviews Genetics*, 47-59.

Frankel, E.N (2005). Chemistry of free radical and singlet oxidation of lipids. Progress. *Lipid Res*, 23: 197-221.

Fraser, O. and Sumar, S (2008). Compositional changes and spoilage in fish. *Nutrition of Food Science*, 5: 275-279.

García, M.R., Vilas, C., Herrera, J.R., Bernárdez, M., Balsa-Canto, E and Alonso, A.A (2015). "Quality and shelf-life prediction for retail fresh hake (Merluccius merluccius)", *International journal of food microbiology*, 208: 65–74.

Goldman, K.J. (2011). "Regulation of body temperature in the white shark,Carcharodon carcharias". *Journal of Comparative Physiology,* 167(6): 423–429.

Gopakumar, K. (2000). Enzymes and Enzyme products as Quality Indices. Seafood Enzymes, pp 337-363. Harrd N.F and Simpspn, B.K., (Eds). Marcel Dekker, Inc.New York, Basel, U.S.A.

Gram, L and Dalgaard, P (2002). Fish spoilage bacteriaproblems and solutions, *Current Opinion Biotechnology*, 13: 262-266.

Gram, L. and Huss, H.H (2000). Fresh and Processed Fish and Shellfish. In: The Microbiological Safety and Quality of Foods, Lund, B.M., A.C. Baird- Parker and G.W. Gould (Eds.). Chapman and Hall, London, Pp. 472-506.

Grandin, E., Temple, R.T and Johnson, C. (2005). Animals in Translation. New York, New York, Scribner, pp. 183–184.

Hansen, T.L., Gill, T., Rontved, S.D and Huss, H.H (2003). Importance of autolysis and microbiological activity on quality of cold-smoked salmon. *Food Res International*, 29: 181-186.

Helfman, G., Collette, B and Facey, D. (2004). The Diversity of Fishes. Blackwell Publishing. p. 375.

Hui, Y.H (2006). Handbook of Food Science, Technology and Engineering. CRC Press, Boca Raton, FL, Pp. 32-36.

Huis, T and Veld, J.H.J (2006). Microbial and biochemical spoilage of foods: An overview. *International Journal of Food Microbiology*, 33:1-18.

Hultin, H.O (2004). Oxidation of Lipids in Seafoods. In: Seafoods Chemistry, Processing Technology and Quality, Shahidi, F. and J.R. Botta (Eds.)., 1st Edn., Blackie Academic and Professional, London, UK, pp. 49-74.

Huss, H.H (2005). Quality and quality changes in fresh fish. FAO Fisheries Technical Paper 348, FAO, Rome, Italy, p.34.

Huss, H.H. (2009). Quality and quality changes in fresh fish FAO Fisheries Technical Paper, Rome, p. 348.

Idachaba, F.S (2001). The Nigerian Food Problem. of processed fish and had varied sources of proteins. *Journal of Agriculture, Science and Technology*, 1(1): 5- 16.

Karube, I., Marouka, H., Suzuki, S., Watanabe, E and Toyana, K. (2001). *Journal of Agriculture and Food Chemistry*, 32: 314-319.

Khayat, A. and Schwall, D (2003). Lipid oxidation in seafood. *Food Technology*, 37: 130-140.

King, F.J., Anderson, M.L and Steinberg, M.A (2002). Reaction of cod actomyosin with linoleic and linolenic acids. *Journal of Food Science*, 27: 363-366.

Lecointre, G and Le-Guyader, H. (2007). The Tree of Life: A Phylogenetic Classification, Harvard University Press Reference Library, p.34.

Leistner, L and Gould, G.W (2002) Hurdle technologies: combination treatments for food stability, safety, and quality Springer, p.334.

Lima Dos Santos, C.A.M., James, D and Teutscher, F (2011). Guidelines for chilled fish storage experiments. FAO Fisheries Technical paper, No 210. FAO, Rome.

Lin, T.M. and Park, J.W (2006). Protein solubility in Pacific whiting affected by proteolysis during storage, *Journal of Food Science*, 61: 536-539.

Luten, J.B., Jacobsen, C and Bekaert, K (2006). Seafood research from fish to dish: quality, safety and processing of wild and farmed fish, Wageningen Academic Publishers, p.35.

Martinez, A. and Gildberg, A (2011). Autolytic degradation of belly tissue in anchovy (*Engraulis encrasicholus*). *International of Journal Food Science Technology*, 23: 185-194.

Nelson, J., Paetz, S., M and Joseph, R.T. (2004). The Fishes of Alberta, University of Alberta, p.654.

Nelson, R.T and Joseph, S (2006). Fishes of the World, John Wiley and Sons, Inc.
p. 2.

Putro, S. (2005). Better on board handling of oil sardines in the Bali Strait using chilled sea water. *Infofish Marketing Digest*, 86(1): 33-35.

Romer, A.S and Parsons, T.S (2011). The Vertebrate Body. 5th ed. Saunders, Philadelphia, p.576.

Royal Society of Edinburgh, (2004). Inquiry into the future of the Scottish fishing industry, p.128.
Shewan, J.M (2001). The Microbiology of Sea-Water Fish. In: Fish as Food, Borgstrom, G. (Ed.). Academic Press, FL, pp. 487-560.

Silva, A. J. M (2015). The fable of the cod and the promised sea. About Portuguese traditions of bacalhau, in BARATA, F. T- and ROCHA, J. M. (eds.). Heritages and Memories from the Sea, Proceedings of the 1st International Conference of the UNESCO Chair in Intangible Heritage and Traditional Know-How, University of Evora, Évora, pp. 130–143.

Sun, E and Da-Wen, (2008). Computer vision technology for food quality evaluation Academic Press, Pp.189–208.

Tawari, C.C and Abowei, J.F.N (2011). Traditional Economics of fish production in Kaduna State, fish handling and preservation in Nigeria. Asian Nigeria. ARPN. *Journal of Agricultural and Journal of Agricultural Sciences*, 3(6): 427-436.

Tys D and Pieters, M (2009). "Understanding a medieval fishing settlement along the southern Northern Sea: Walraversijde, c. 1200–1630" In: Sicking L and Abreu-Ferreira D (Eds.) Beyond the catch: fisheries of the North Atlantic, the North Sea and the Baltic, 900–1850, Brill, pages 91–122.

Undeland, I., Hall, G., Wendin, K., Gangby, I and Rutgersson, A (2005). Preventing lipid oxidation during recovery of functional proteins from herring (*Clupea harengus*) fillets by an acid solubilization process. *Journal of Agricultural Food Chemistry*, 53: 5624-5634.

United Nations Development Fund for Women (2003) *Fish processing* Food Technology Source Book Series (UNIFEM) Series, pp. 234-254.

Yorkowski, M. and Brockerhoft, H (2005). Lyso lecthinase of cod muscle. *Journal of Fish Res*, 22: 643 652.

Zohar, I., Dayan, T., Galili, E and Spanier, E (2001). "Fish processing during the early Holocene: a taphonomic case study from coastal Israel" *Journal of Archaeological Science*, 28: 1041–1053.

***