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CURRICULUM FOR ONSHORE AND OFFSHORE FISH HANDLING PERSONNEL

Meriam Masela Kambinda
Namibian Maritime and Fisheries Institute
P.O. Box 3228, Walvis Bay
Namibia
kambindamm@yahoo.com

Supervisors:
Prof. Hjörleifur Einarsson
University of Akureyri
hei@unak.is

Arnheiður Eyþórsdóttir
University of Akureyri
arnh@unak.is

ABSTRACT

The main goal of the project was to develop a curriculum for a training course for onshore and offshore fish handling personnel in Namibia. The Namibian Maritime and Fisheries Institute (NAMFI) is involved in training of deck officers, engineering officers, fisheries inspectors and observers. NAMFI pays little focus on fish as a raw material and its post landing handling. The project was intended to improve NAMFI'S training of fishermen and onshore personnel on fish handling and processing, and safety and quality of fishery products. The curriculum consists of two training courses, one for onshore fish handling personnel and one for offshore fish handling personnel. This project involved a study of the training programmes for Icelandic fishermen, officers and fish processing workers in order to improve the training in Namibia. A fish processing plant of Samherji hf. and a fishing vessel Björgúlfur EA-312 were visited in Dalvik North Iceland for that purpose. The results of the project consist of curriculum of two training courses; course topics were identified, course duration, objectives, learning outcomes, learning activities and power point slides for each topic were produced.

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1 INTRODUCTION

1.1 Overview of Namibian Fisheries

Namibia's coastline falls within the Benguela Current system, a system that is rich in pelagic and demersal fish, supported by plankton production driven by intense coastal upwelling. Such systems support a relatively low diversity of species, yet among the most productive habitats in the world. The Namibian coast is approximately 1500 km long and has a dry desert along its entire length. The coastline has few urban settlements because of the desert, unlike most other coastlines in the world, which tend to be very densely populated. For this reason Namibia's fishery is exclusively industrial. The entire coastline has only two fishing harbour; Luderitz in the south and Walvis Bay in the north. The lack of dense settlements means that there is not much pollution in Namibia's marine waters, which could badly affect the marine ecosystem.

The demersal fishery for mainly hake (*Merluccius capensis)* is the most valuable fishery in Namibia, and almost the entire catch is exported. The mid-water fishery for horse mackerel (*Trachurus capensis*) is second in importance. Finally, there is a smaller pelagic fishery with canned Pilchard (*Sardinops sagax*) as the most valuable product.

Before Namibia's independence in 1990, there was no legislation governing who could fish off the Namibian coastline. Numerous foreign trawlers were fishing in Namibian waters, where they were depleting the stocks of fish. In addition to depleting the stock, foreign fishing vessels were landing their catches at exclusively foreign ports, without generating any benefit for Namibians.

On independence in 1990, Namibia seized the opportunity to take control of its fishing industry. Namibia's fisheries developed into one of the most important economic sectors. Today it is one of the main contributors to the Namibian economy; the sector comes in second place after mining as the foreign currency earner; and it is the third largest economic sector in terms of contribution to the Gross Domestic Product (GDP). The sector also plays an important role in the creation of employment; it is estimated that the total employment in the fishing industry is about 13 700 people. Of this total, approximately 5 600 are employed onboard fishing vessels, approximately 70% of which are Namibians while 7900 are involved in onshore processing, of which nearly all are Namibians. Total employment in the aquaculture sector is estimated at 200 people (FAO 2005).

The Namibian fishing industry is relatively young but has developed tremendously and is one of the fastest growing industries in Namibia. Despite fast development there is room for improvements still e.g. on training.

1.2 Namibian Maritime and Fisheries Institutes (NAMFI)

The Namibian Maritime and Fisheries Institute is the only fishing institute in Namibia. The Ministry of Fisheries and Marine Resources as a Trust formally established it in July 1996. The primary responsibility of the institute is to provide maritime and fisheries training to Namibians in order to promote involvement of Namibians within the maritime and fisheries industries in Namibia and elsewhere. Thus building capacity in the field of maritime and fisheries sectors in and around Namibia. The Namibian Maritime and Fisheries Institute has three training departments, Navigation Department, Engineering Department and Safety at Sea Department.

The Navigation department offers fisheries training for Deck Officer Class 6 and Deck Officer Class 5. Candidate wishing to follow the path of Deck Officer training must have a Grade 12 certificate with good grades in English, Mathematics and Science. At the beginner level (Class 6) candidates complete 18 months of seagoing service onboard fishing and a six months training at NAMFI consisting of 12 modules (Table 1). At the higher level (class 5) candidates with a Deck Officer Class 6, complete 24 months seagoing service onboard a fishing vessel of which 12 months as an Officers in charge of a Navigational watch and a six months training at NAMFI consisting of 12 modules (Table 1). Upon satisfying all the requirements of the Ministry of Works, Transport and Communication-Directorate of Maritime Affairs (DMA), candidates are issued with certificates of competence for the level that they qualify for by the DMA.

In addition the Navigation Department train persons wishing to become Deck Officers onboard vessels other than Fishing Vessels under a structured training program leading to a qualification as holder of certificate of competence at Operational- Level Deck Officer Class 4/3 and Management-Level Deck Officer Class 2/1. The training at NAMFI is in accordance with International Standards (STCW-95 and STCW- 95/F international conventions)

The modules for Class 6 and 5 are 12 (Table 1). Of those 12 modules only two modules; Fishing Technology and Seamanship (a total of 120 hours) deal with quality and handling of fish, of which only six class hours at Class 6 level and 20 class hours at class 5 level is spent on this topic, which is not sufficient to get a good and in-depth understanding of quality control of fish. Therefore as the only fisheries Institute in Namibia it should be the responsibility of the institute to develop further training in fish handling and processing for onshore and offshore personnel for the Namibian fishing industry.

Table 1: Class 6 and 5 module courses.

Module courses/semester	**Total class hours ***
1. Terrestrial and Celestial Navigation	120
2. International Regulations for collision avoidance	120
3. Naval archtecture (Ship Stability and construction)	120
4. Electronic navigation systems (ENS)	80
5. Global Maritime Distress and Safety System (GMDSS)	120
6. Fishing technology	80
7. Seamanship	40
8. Meteorology	40
9. Mathematics	80
10. Maritime English	40
11. Maritime law	40
12. Engine Theory	40

* Note: one class hour referred to in Table 1 is 40 minutes.

Two topics are covered in Fishing Technology and Seamanship: Fish handling and preservation (Class 6); and fish handling and storage (Class 5). Of which students should be able to do the following after completing the course:

- Describe different staff hygiene requirements with regards to fish handling.
- Describe different cleaning and disinfecting requirements.
- Identify the equipment used in a fish processing plant onboard.
- Demonstrate the care and preservation methods of the catch.

- Identify hazards to fish handling in processing plants onboard fishing vessels (Gurirab 2006).

The Namibian Maritime and Fisheries Institute thus clearly lack a proper training programme for fish handling and processing. Little focus is on fish as raw material for further marketing and value adding processors. Therefore the project was intended to develop further training in fish handling and processing in order to improve on quality and safety issues within the Namibian fishing industry.

1.3 Goal

The main aim of this project was to develop a curriculum/syllabus in order to implement a course in fish handling and processing at the Namibian Maritime and Fisheries Institute for training (1) fishermen/sea going personnel and (2) fish processing workers. The course is intended to improve knowledge on the safety and quality issues; which will benefit the Namibian government, the Namibian fishing industry and the consumer of the Namibian fishery products. The main challenge that fishing industries in developing countries face is to comply with the consumer's expectations; particularly quality, and this is not an exception to the Namibian fishing industry; this course will especially benefit the country in terms of export prices as it is most likely that the consumer will be prepared to pay more for improved quality.

1.3.1 Objectives

- Review main issues that determine quality of fish, and identify main parameters used to determine quality of fish.
- Identify critical steps in onboard handling of the fish that may affect the quality of the fish.
- To explore situations onboard fishing vessels in Iceland in order to observe how fish is handled from catch to landing.
- Explore situations in onshore processing companies in Iceland to observe how the fish is handled from reception to final product.
- To gather information on the training/educational programs available for the Icelandic fisheries and identify opportunities which could benefit the Namibian fisheries.
- To gather information on the changes in Icelandic fisheries during the last decades.
- Draft a description, create learning outcomes and draft syllabuses for onshore and offshore fish handling and processing.
- Prepare lecture notes and/or slides for each course.

2 MATERIAL AND METHODS

To achieve the goal and objectives of this study, consultations with the Supervisors from University of Akureyri, Iceland were conducted. After consultations it was decided to develop two courses for onshore and offshore fish handling personnel, respectively. Topics for each course were identified. The learning objectives, learning outcomes and activities for each topic were identified after literature studies from different sources. A processing plant of Samherji hf. in Dalvik Northern Iceland was visited. The Quality Manager gave a tour in the processing plant where information was gathered on employees' education and training and how the fish is handled from landing through the processing line. The trawler Björgúlfur EA-312 in Dalvik Northern Iceland was visited where information on how fish is handled from catch to landing

was gathered. Previous experience onboard the Icelandic factory trawler Venus taken in 2001 was also of use.

3 RESULTS

3.1 Icelandic fishing vessel

The vessel Björgúlfur EA-312 in Dalvik Northern Iceland was visited. From that visit it was clear that the quality of raw materials affect the quality of the final products and the best raw material would result in the best final products.

The fishing trip starts with taking clean fishing tubs and ice in port. The length of the fishing trip is seven days; this is to ensure that the processing plant is supplied with top quality raw material. The fishing vessel has to supply the processing plant with a certain amount of fish after each fishing trip but if they cannot catch this amount of fish after seven days of fishing they have to return to offload and buy the rest from the fish market to ensure that the fish is not older than seven days.

The vessel is equipped with fishing equipment and devices to ensure that the fishing gear has little bad effect on the quality of the fish. These devices calculate how much fish is coming into the trawl, the opening of the trawl, and weight of the trawl to ensure that the fish is not compressed in the cod end. The trawl is hauled in every three hours or as soon as there is certain amount of fish in the cod end to ensure that the fish is not compressed, has not been dead for hours and to have a steady flow of fish in the factory for gutting and bleeding.

The fishing quota, the time of the year and previous fishing experience determines the next fishing ground; the main species targeted by this fishing vessel is cod *(Gadus morhua)*; the by-catch consists mainly of species like haddock (*Melanogrammus aeglefinus*) and redfish *(Sebastes marinus).*

After trawling for three hours or when they have a certain amount of fish in the trawl the trawl is hauled in. The fish comes in from the deck and it is manually released into the factory. In the factory, fish is sorted (species), graded (size), gutted, and bled. First step is a deep throat cut or killing the fish. The next step is gutting, where the roe and liver are collected, and the rest of the offal is discarded. The fish is put on a conveyor belt, which takes it to the washing tanks for half an hour to bleed in seawater and get properly washed. The disadvantage of using seawater for washing and bleeding the fish is that during summer time seawater is warmer; therefore more ice is needed to chill the fish. After bleeding the fish is conveyed into the hold where it is cooled and iced. The fish is packed into tubs with alternating layers of ice; first layer is ice, fish is arranged with belly down and head touching the wall of the tub, this is to make it easier to empty the tubs in the processing plant. The process is summarised in Figure 1.

After work on the main species is complete the other species like haddock which are gutted at the same time as the main species and bled in smaller tanks are released to the washing tanks and into the hold. The fish that do not need gutting and bleeding like redfish *(Sebastes marinus)* is taken straight into the hold for icing.

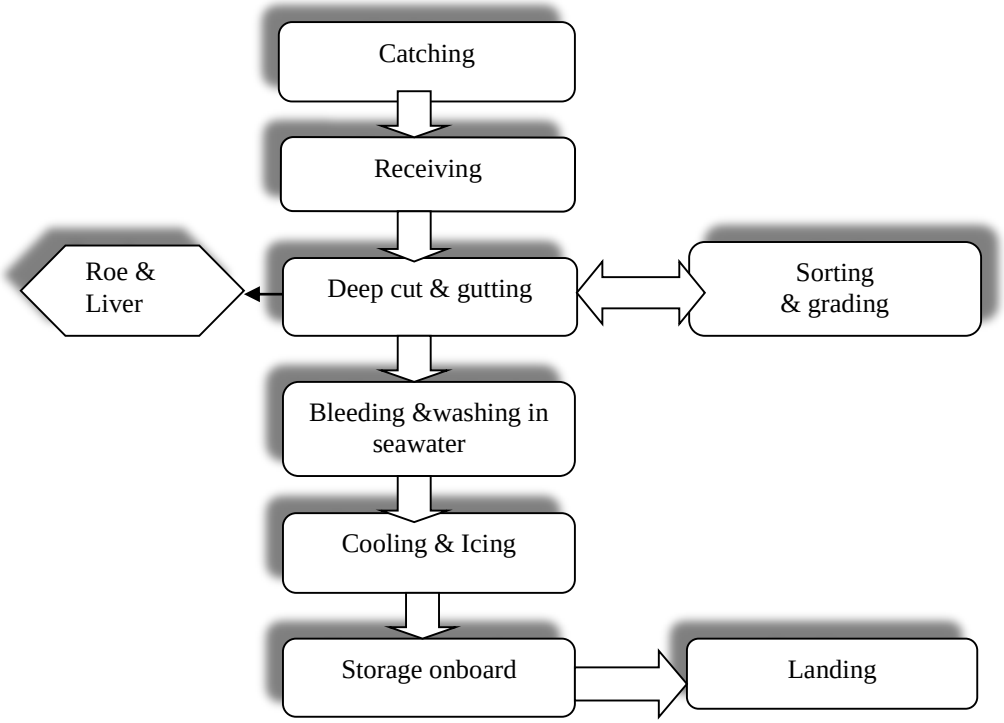

Figure 1: Raw material handling.

Fishing tubs are marked with the number of trawl, date of catch, fishing ground, species, depth of water, temperature of water, and trawling time; this information is useful in the processing plant for traceability and processing; the fish that was caught on the first day and first trawl is processed first (FIFO). This is one of the many developments in the Icelandic fisheries; in the seventies trawlers were storing fish in plastic boxes, in the eighties they changed to insulated plastic tubs, and in the nineties the plastic tub's height was reduced to ensure that the fish at the bottom is not compressed. Landing the fish is made easier by using plastic tubs and time of landing reduced. The tubs are manufactured in such a way that the water is drained out, only fish and ice remains in the tub.

3.2 Processing plant in Iceland

The processing plant Samherji hf. in Dalvik Northern Iceland was visited. The company runs a large and advanced whitefish plant producing fresh and frozen fish product. Samherji as a food producer takes care of the entire process from catching to the market and has to comply with strict regulations regarding quality and processing. The employees of Samherji get the education and training needed to be able to do their job in the best possible way so that both their expectations and the customer´s are met. From this visit it was learned that employees in the processing plant are trained at doing specific tasks - the specific training programme for processing workers includes the following: Personal Hygiene; fish processing, quality inspection, special courses in fish processing; HACCP; quality control; sensory evaluation; and fork lift licence. Some training applies to all employees while others are for selected employees only. The company is involved in processing two species, cod *(Gadus morhua)* and haddock (*Melanogrammus aeglefinus*) into the following products:

- Fresh loins graded in different sizes to customers demand.
- IQF portions produced and graded to weight requirements, glazed and unglazed.

- Loins, pieces of all variations, tails, formed shape, A-grade mince, and blocks.

The raw material is received gutted and bled from the fishing vessels, iced in tubs and is brought straight into chill storage. Each tub has a tag marked with the following information: number of trawl, date of catch, fishing ground, species, depth of water, temperature of water, and trawling time. This information is necessary for traceability and processing (FIFO –First In First Out, the fish that was caught on the first day and first trawl is processed first). The forklifts then move the tubs to an automatic emptying machine. After emptying of tubs, the raw material is de-iced and then processed as follow: The first step is heading by machines. The yield is recorded before and after heading; quality checks for handling defects, e.g. how much flesh is on the head, and temperature control are recorded every two hours. The next step is filleting by machines; quality checks for filleting defects, temperature control and yield are recorded every two hours. The fish fillets are then put into brine with salt concentration of 1.5% to bring the temperature to 1° C. Before skinning, the fillets are put into chillers for 8 minutes to reach super chilled temperatures (-1°C) to make the flesh firm for higher yields and quality after skinning; the temperature of -1°C is maintained.

Fillets are skinned from the chillers; quality checks for skinning defects, temperature control and yield are recorded every two hours. After skinning, the tails are cut off and sent directly to an IQF freezer, the loins with belly flap go further for trimming; continuous quality checks are made for trimming defects, e.g. worms, blood spots and bones. An ongoing inspection of the final products is carried out. The products are packed according to product types and put in the cold/chill store. The processing steps and quality checks are summarised in the flow chart for loins (Figure 2).

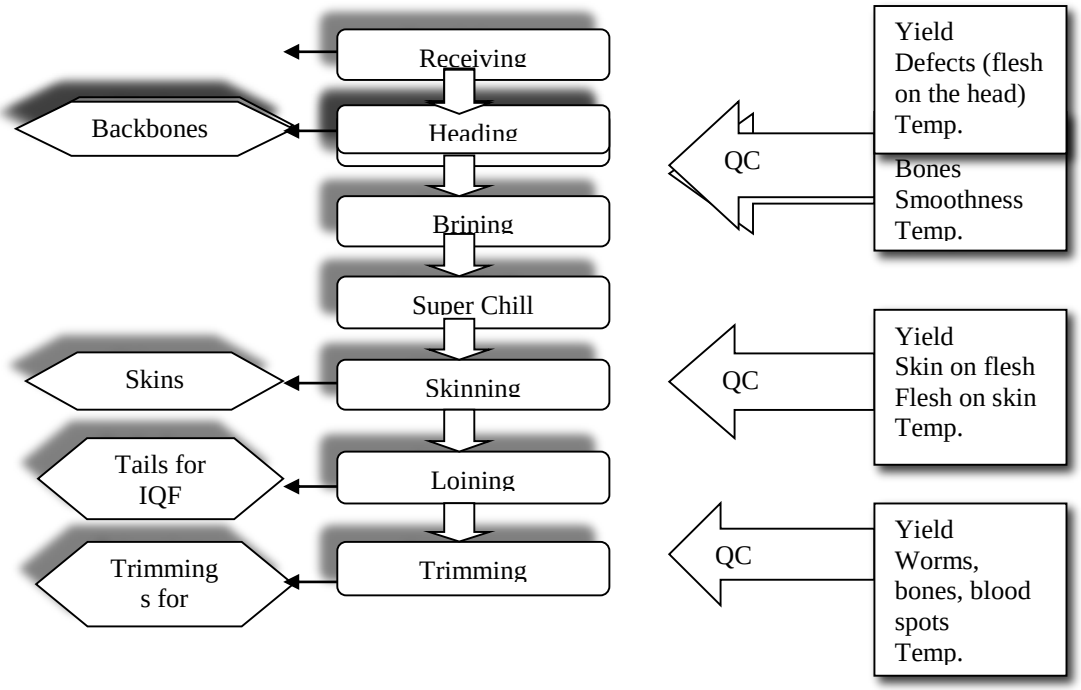

Figure 2: Flow diagram for production of loins.

Waste from production is kept to a minimum; almost the whole fish is utilised; the heads and backbones are dried in a different factory for the Nigerian market; the skins are sent to another company for gelatine production, the trimmings are minced. The rest of the waste is sent for fishmeal production.

The factory operates one processing shift and as a part of the company's quality system, the processing plant is cleaned every day after each shift by a team of eight people. Every morning, cleaning checks by (ATP measurements), foreign bodies and cleaning residuals checks are carried out before work commences. A team of cleaning inspectors carries out a thorough inspection of the whole processing plant once a month; they inspect that everything is cleaned properly, checks are done on places that are hard to clean but need to be cleaned, e.g. underneath chairs and tables, inside pipes. An independent team of inspectors inspect the processing plant once every 4 months. Once a year a team of Inspectors from EU inspect the processing plant. Samples are taken every day, pooled at the end of the week and sent to ProMat laboratory for analysis of total plate count at 30°C, *faecal coliforms, Listeria, Salmonella, Psedomonas, Campylobacter, Staphylococcus aureus*. From these test conclusions can be made of whether fish has been treated properly, the processing plant is properly cleaned and employees are practicing personal hygiene. The machinery is checked for contamination every two weeks.

In the past years Samherji has been successful in marketing various seafood products globally. The company has been a big player in selling frozen and fresh ground fish products on the UK market and Europe.

3.3 Other changes in Icelandic fisheries

What happens onboard the fishing vessel directly affects what happens in the processing plant. In the past few years the relationship between fishermen and land-based fish processors was not good; it was more competition instead of working together. The fishermen were only concerned about catching as much as they could in the shortest time and supply the land processors with more fish no matter what quality, this meant processors often had to work with raw material of poor quality, which resulted in bad quality end product. Today this relationship has improved tremendously; fishermen are working closely with the land-based processors to ensure top quality products.

The good relationship between fishermen and land-based processors resulted in increased value creation. The growing demand from the consumers for the production of fresh fillets and IQF portions has also made it even more important for the land-based processors to be able to control the supply of raw material. In the past 15-20 years fishing vessels stayed longer at sea, where today the fishing trips for fresh fish do not exceed seven days and are controlled by the market. Fishing vessels are called in earlier if there is more demand for fresh fish.

Until the nineties the value chain in the Icelandic fishing industry was greatly influenced by the export licences that were granted to the marketing and sales organisation. Today the market controls the value chain. One of the greatest changes in the value chain came in 1987 with the establishment of the fish markets. Fishing companies/fishing vessels started to specialise in certain species and sold other species through the fish markets (Knútsson 2010).

The increased training for Icelandic fishermen also resulted in the improved quality. The curriculum for fishermen at the Seamen school includes two modules which deal with quality,

fish handling and processing techniques, with much emphasis on correct handling at all stages. In the eighties the Ministry of Fisheries launched a training programme in quality and hygiene for employees in fish processing plants of which on completion of this course the employee gets a pay raise and the right to be called specialised fish processor.

3.4 Training programmes in Iceland

The Skipstjórnarskólinn (Seamen School) under Tækniskólinn offers training to persons wishing to become Deck Officers onboard a fishing vessel. Two module deals with catch handling and processing; one module is taken at the beginner level and the other at the higher level. The duration of each module is four class hours per week, which is a total of 72 class hours. The modules cover basic methods on maintaining quality of fish from catch to final product, emphasising on the importance of correct handling at all stages; processing methods and quality assessment methods; onboard chilling and storing; value adding according to processing methods. The modules are as follows:

Module 1: AFV112 Handling and processing of fish (catch).

On completion of the course, the student should:

- Have acquired knowledge and understanding to ensure correct handling of fish regarding quality and value.
- Be familiar with processing methods and quality assessments on fish and fish products.
- Have gained knowledge on adding value to raw material by different processing methods and according to different markets.

Module 2: AFV202 Handling and processing of fish (catch)
Prerequisites: AFV112

On completion of the course, the student should:

- Have acquired knowledge on national and international regulations regarding seafood processing, including processing, storing, export and markets for Icelandic seafood.
- Be familiar with onboard and onshore processing for fresh, frozen and processed fish.
- Have the skills to be in charge of production activities onboard and onshore processing plants.

The committee for education in fish processing under The Ministry of Fisheries launched a basic course for employees in fish processing in the eighties. The course is divided into 10 different topics, duration of 4 hours each. The following six topics are mandatory:

- Fish processing - quality management from catch to final product.
- Ergonomic issues - physical body work and working conditions.
- Safety at the work place.
- Hygienic issues and bacterial growth.
- The employee, the economy and wage systems (rights and duties of employees, insurances, unions etc.).
- Cooperation, communication and spirit at the work place.

Furthermore, to complete the course the student must select four of the following topics:

- Markets and environmental issues.
- Personal improvement.
- Multiculturalism.
- First aid.
- Quality inspection.

3.5 Fish utilization in Namibia

Fish is an important component of the human diet and a large industry exists to provide a large variety of consumer products in which fish is a major component (Bremner 2002). Namibian fishing industry is a part of this large industry. Namibia as a country has potential to increase its export output from fisheries and contribute to the national economy.

The total production from marine fisheries in 2005 was recorded at 552 160 tonnes (FAO 2005). The Namibian catches not transhipped at sea are landed in Lüderitz or Walvis Bay for processing and value addition. Processing activities include gutting, heading, filleting, skinning, portioning, canning, fishmeal and fish oil production.

The country exports more than 90% of its fisheries production in various product forms, primarily to international markets including EU, USA, the Far East as well as African markets. Hake (*Merluccius capensis)* is currently processed into the following products: fresh gutted fish on ice for airfreight overseas; frozen retail packs sold directly to end-consumers through retail outlets such as supermarkets, frozen food stores and European distributors; frozen catering packs, either frozen headed and gutted fish or frozen fillets (skin-on or skinless) and also fish mince, blocks, sausages, roes, loins, portions and wings.

Monk (*Lophius vomerinus*) is processed into various product forms, the main products include skin-on/tail-on individually wrapped portions or skin-off and tail-off individually wrapped portions processed at sea and packed frozen into 10 kg boxes for food service trade. A very small amount is processed into 200 gram retail packs of frozen boneless fillets, processed ashore for retail markets and the frozen fillets or deboned tails sold in small volumes to exclusive restaurants.

Horse mackerel (*Trachurus capensis*) is frozen at sea into block frozen 30 kg packs. These packs contain three 10 kg blocks of whole, round quick frozen horse mackerel. Other processing involves sun-drying and fishmeal production. Pilchard (*Sardinops sagax*) is almost entirely canned.

Rock lobster is processed ashore and product forms include cooked or uncooked frozen whole lobster and tails. Orange roughy *(Hoplostethus atlanticus)* and alfonsino (*Beryx splendens)* are processed into large fillets or as bagged glazed smaller frozen skinless fillets for retail trade.

Tuna (*Thunnus albacores)* and large pelagic (swordfish, marlin, yellow fin tuna, bigeye tuna and shark) are gilled and gutted, then blast frozen at sea. Sharks are processed into gutted, headed and tailed trunks. Cultured oyster and abalone are exported live and frozen (FAO, 2005).

The domestic market for marine fish products is extremely limited due to the small size of the population (2 million). The main fish species dominant in the domestic markets are horse mackerel, small size hake (baby hake) snoek (*Lepidopus caudatus)* and dentex/red fish (FAO, 2005).

3.6 Harvesting and onboard handling

Seafood is harvested with different methods and gears: Nets (Gill, Trawl, Trap, Purse), hooks (long lines), pots, dredges and harpoons, etc. The initial quality and microbial load of fresh finfish is affected by the methods of harvesting. It is therefore of utmost importance to maintain quality from this point. Abusive handling at harvest will be unfavourable to quality and shelf life at the retail level.

However, little data is available to compare microbial load of fish landed by different harvesting methods, but trawled fish usually carries more microbial loads than line caught fish. The increase is due to dragging of trawls along the ocean bottom, which stirs up the mud and contaminates fish; to compaction of fish in the trawl, which causes gut contents to be expressed, and physical abuse of sliding on deck and exposure to ambient temperature and sunlight. Longer tow result in lower quality as the cod end of the trawl becomes very full, and fish, which may have been dead for hours, is bruised and crushed from the compression (Martin 1994).

The amount of stress the fish endures during capture or just prior to death also affects post harvest quality. Active fish such as tuna and mackerel may be exited and die in a furious state when harvested by purse seining. Fish harvested by gill netting die after an exhausting struggle. Rigor mortis sets in quickly and earlier signs of deterioration occur during icing. Long lining or hooks is the desired harvesting methods for minimising stress and maintaining post harvest quality. The fish is brought onboard quickly and killed to minimise the stress and its associated quality deterioration (Martin 1994).

It is critical that the fish is handled in a quality conscious manner as soon as it is caught and landed onboard. The fish should be handled carefully, quickly and efficiently. The fish unsuitable for human consumption should be removed from the catch as soon as possible. Bleeding, gutting and grading where appropriate for the species should be conducted without delay. It is important to protect fish from the adverse effects of the elements and chilling of fish should commence as soon as possible. Fish should be washed with clean seawater or potable water. Handling of fish with gaff hooks, picks and forks should be avoided, as it breaks the skin and unattractive holes introduce spoilage bacteria and accelerate quality deterioration. Care should be taken that fish is not damaged or contaminated during sorting, gutting, bleeding, weighing and during transfer (Huss 1995).

Certain ground fish should be gutted, bled and gilled onboard fishing vessels. The main advantage of gutting is to prevent autolytic spoilage. During feeding periods the fish contain many bacteria in the digestive system and strong digestive enzymes are produced. These enzymes will be able to cause a violent autolytic spoilage, which may give rise to strong off-flavours especially in the belly area and may even cause belly-burst (Huss 1995). It is a common experience for many fish species that the quality is better maintained and shelf life increased, if they have been gutted as soon as they are landed onboard. On the other hand gutting the fish means exposing the belly area and cut surfaces to the air therefore rendering them more vulnerable to oxidation and discoloration. Therefore, many factors such as the age

of the fish, species, and amount of lipids, catching ground and catching methods should be taken into consideration before deciding whether or not gutting is advantageous. The advantages of gutting are: Gutting makes subsequent chilling more effective, removes digestive enzymes to prevent autolytic spoilage, prevents undesirable bacteria in the fish intestines from spreading, and prevents parasites such as nematodes in the gut from penetrating the flesh.

A number of sources recommend that fish should be gutted as well as bled before storage onboard fishing vessels but there are some questions of whether bleeding of fish at harvest is beneficial to quality in all situations (Martin 1994). The benefit of bleeding may vary with location of catch, species and time of year. Bleeding method or practice varies according to fish species.

Redfish, pelagic fish and many flatfishes are commonly not bled or gutted at sea. For most white fish species proper bleeding is very important for the colour and appearance. Bleeding is most effective when the fish comes onboard alive and is properly cut within few hours after capture.

Common bleeding and gutting procedures are illustrated in Figure 3. Note that application of gutting and bleeding procedures may not be applied in all fish species at harvesting.

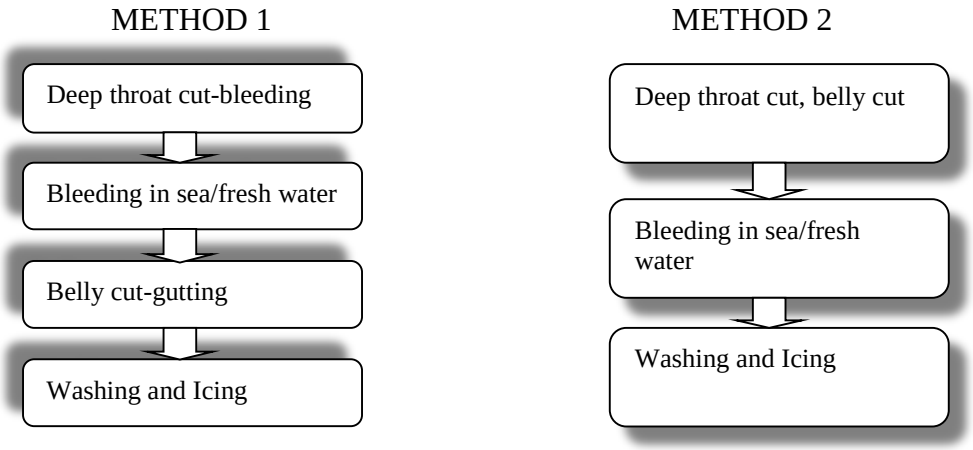

Figure 3: Bleeding and gutting procedures.

It is well known that both enzymatic and microbiological activities are greatly influenced by temperature (Huss 1995). Fish should be cooled down to temperature of melting ice 0°C as quickly as possible (Martin 1994).

Many bacteria are unable to grow at temperatures below 10°C. Figure 4 shows the effect of temperature on the growth rate of the fish spoilage bacterium *Shewanella putrefaciens.* At 0°C the growth rate is less than one-tenth of the rate at the optimum growth temperature (Huss 1995).

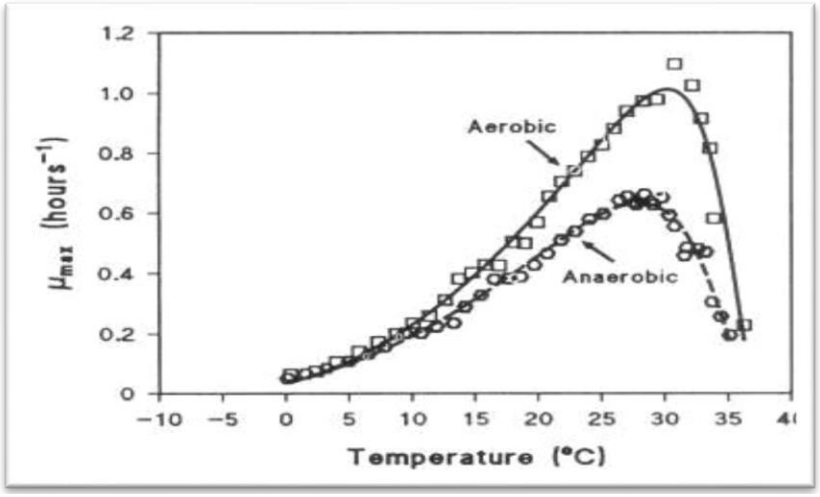

Figure 4: Effect of temperature on the maximum specific growth rate (µmax) of *Shewanella putrefaciens* grown in a complex medium containing TMAO (Huss 1995).

To obtain top quality of fish, it is recommended to lower the temperature of fish by placing it in chilled brine (slurry of crushed ice and seawater). After 24 hrs the fish is placed in fresh ice and kept there until arrival in port. Shelf life of fish is reduced by each hour delay in icing or exposure to ambient temperature. The relationship between spoilage and temperature can be seen in Figure 5.

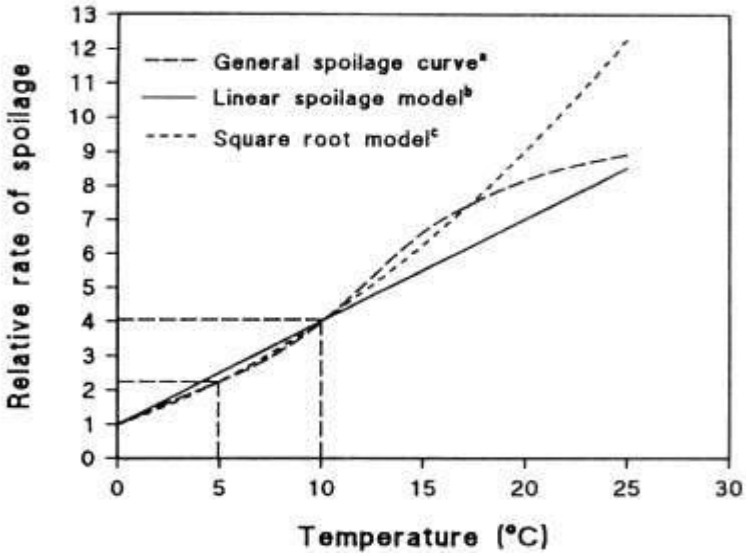

Figure 5: Effect of temperature on the relative rate of spoilage of fresh fish products (Huss 1995).

Ice is produced in different shapes, the most common in fish processing is: flake ice, plate ice, tube ice, block ice, and slurry/liquid ice. Block ice is ground before being utilized to chill fish. There is always the question of which is the "best" ice to chill fish. Flake ice will allow for an easier, more uniform and gentle distribution of ice around fish in the box or container will produce very little or no mechanical damage to fish, and will chill fish quicker than the other types of ice.

On the other hand, flake ice tends to occupy more volume of the box or container for the same cooling capacity and if wet, its cooling capacity will be reduced more than in the other types of ice (higher area per unit of weight). According to Huss (1995), the quickest method to chill fish is with chilled water or chilled seawater, although the practical difference with flake ice is not great.

The question of how much ice to use is based on a number of different factors such as:
The thickness of the fish layer, distance between one fish and another, type of fish box/tub used, how the ice is distributed over the fish, position of the box in the cold storage room or hold, time, temperature and storage conditions.

Off load of the catch should be done as quickly as possible, and it is beneficial to avoid the hottest time of the day. Off loading during cooler times of day can help reduce the chances of increased temperature of the catch. Off loading of fish should only commence once all the necessary equipment, containers, and personnel are ready, and all preparatory work is completed. It is important to remember that every stage of handling from harvest to consumer affects the quality.

3.7 Post mortem changes in fish

According to Bremner (2002) fish spoilage are deteriorative changes in the sensory characteristics of a product such as appearance, flavour, odour and texture. The most dramatic change is the onset of rigor mortis. After the fish is captured and slaughtered the blood circulation stops and the supply of oxygen required to fuel forming of energy molecules (ATP) is not available in sufficient amount to keep the muscle elastic. Glycogen is broken down to enable production of energy (ATP) in the muscle, but as the glycogen level decreases, ATP production also falls. The interaction of the muscle proteins, actin and myosin stops, because the required ATP to fuel the reaction is depleted. After glycolysis ceases due to inhibition of regulatory enzymes, the muscles passes into a state of death stiffening known as RIGOR MORTIS.

The subsequent enzyme catalysed reactions result in the resolution of rigor mortis. The resolution makes the muscle relax again and it becomes limp, but no longer as elastic as before rigor. Rigor mortis concludes with autolysis, and subsequent microbial spoilage and chemical spoilage.

The rate in onset and resolution of rigor varies from species to species (small sized fish species such as sardines and mackerel undergo rigor mortis earlier and faster than large fish species) and is affected by temperature, handling, size and physical condition of the fish. The method used for stunning and killing the fish also has an influence the onset of rigor (Huss 1995).

According to Bremner (2002), it is normally best to delay the processing of the fish until after resolution of rigor mortis to avoid serious quality problems such as gapping and toughness, blood stains, loss of water holding capacity and softening of fish flesh.

Autolytic changes cause problems in ungutted fish, as on slaughtering the fish, enzymes in the gut and flesh, previously involved in metabolic activities, start catalysing autolysis (self digestion). Many proteases have been isolated from fish muscle and the effects of proteolytic breakdown are often related to extensive softening of the tissue. The most obvious examples of autolytic proteolysis are the commonness of belly bursting in fatty fish species such as

herring and capelin. The low molecular weight peptides and free amino acids produced by protein hydrolysis hasten the growth of spoilage bacteria by providing a superior growth environment for such organisms. The induction of bacterial spoilage in capelin by autolysis also results in the decarboxylation of amino acids, producing biogenic amines, thus lowering the nutritive value of the fish significantly (Huss 1995).

Bacterial activity is the main cause of fish deterioration, particularly due to the specific spoilage bacteria. Microorganisms are found on all the outer surfaces (skin and gills) and in the intestines of live and newly caught fish, but are not able to cause any spoilage because of the natural defensive mechanism in the fish. Autolytic changes ease bacterial entry into the fish flesh. However, bacterial flora on newly caught fish depends on the environment in which it is caught rather than on the fish species. Fish caught in very cold and clean waters carry lower numbers than fish caught in warm waters (Huss 1995).

According to Huss (1995), lipid hydrolysis and oxidation are two distinct reactions in fish lipids of importance for quality deterioration. The prime stage of lipid oxidation result in production of a range of substances (hydro-peroxides) associated with unpleasant taste, rancid odour, and brown and yellowish discolouration in fish tissues. Some substances may also contribute to texture changes by binding covalently to fish muscle proteins. The various reactions are catalyzed by microbial enzymes or by intracellular enzymes from the fish itself. The relative significance of these reactions depends mainly on fish species and storage temperature. Fatty fish are vulnerable to lipid degradation which can create severe quality problems even on storage at subzero temperatures.

Oxidation is initiated by formation of radical. Radical reacts with double bond of fatty acids. The large amount of polyunsaturated fatty acid moieties found in fish lipids makes them highly vulnerable to oxidation by an autocatalytic mechanism. Hydrolysis is more profound in ungutted than in gutted fish because of the involvement of digestive enzymes. During storage a considerable amount of free fatty acids appears. Triglyceride in the depot fat is sliced by triglyceride lipase originating from the digestive tract or excreted by certain microorganisms. Cellular lipases may also play a minor role. A summary of these changes is illustrated in Figure 6.

3.8 HACCP and hygiene

HACCP is an acronym that stands for Hazard Analysis Critical Control Point. HACCP is a preventative system and a tool used to protect the food supply against biological, chemical and physical hazards. The system was utilized by the Pillsbury Company's project on food production to supply food to the U.S space program in the sixties and exposed to the public during the 1971 National Conference on Food Protection (Huss 1994).

Today the HACCP system has gained international acceptance and is used in food industries including the seafood industry to ensure safer food products for consumers. The HACCP system is not a zero-risk system; it is a system to minimize the risk of food-safety hazards. The system is designed to determine food safety hazards, identify preventative measures, establish controls, and identify critical control points and proper monitoring. Hazards are defined as biological, chemical or physical agents that are reasonably likely to cause illness or injury in the absence of its control.

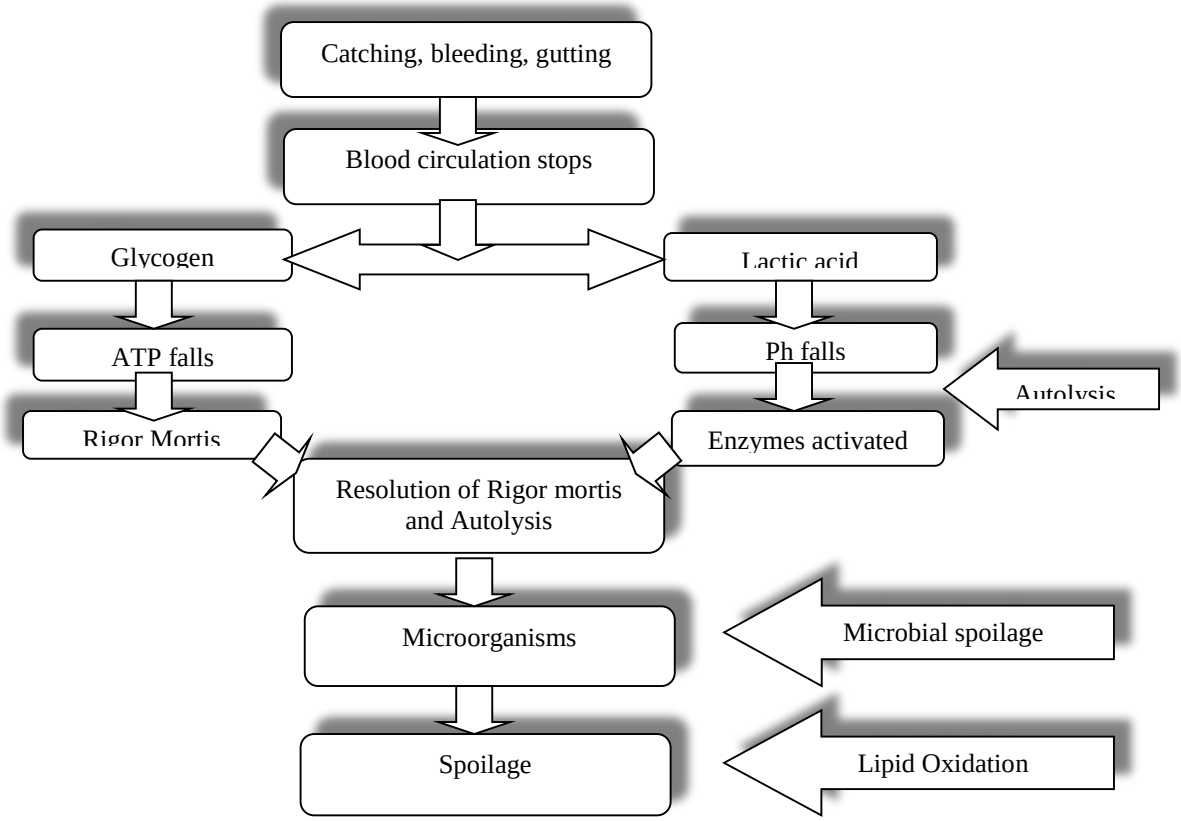

Figure 6: Post mortem changes.

The traditional approach to food safety assurance was based on applying codes of Good Hygiene Practices (GHP) and Good Manufacturing Practices (GMP) in food processing which has certain limitations and shortcomings. With these systems the confirmation of safety and identification of potential problems are only obtained by testing the end products. In contrast, the HACCP system clearly identifies food safety problems, where and how they can be controlled or prevented (Huss 2003). However the HACCP system is not a stand-alone system, as it must be built on Good Manufacturing Practices like sanitation and personal hygiene to make it work. HACCP and GMP complement each other (Bernard 2001).

In seafood industry the HACCP system is used to ensure food safety from harvest to consumption. Fish handling personnel can contaminate the final product directly with pathogens from their skin or hands, digestive system or respiratory tract. They can also function as an intermediary vector carrying bacteria, viruses, or parasites from raw material or the environment to the product. Seafood can also be contaminated during processing; directly through products contact surfaces (e.g. processing equipment- a great variety of utensils and equipment is used in the fish industry), indirectly through other ways (e.g. drains, floors, washrooms surfaces), people and animals, air, water, harbour water or sewage. For these reasons, employee hygiene and appropriate food handling practices are very important. A key element in any hygienic programme is the prevention of cross-contamination. The main preventive measures to avoid cross-contamination are: a clear and effective separation of raw material and cooked or ready-to-eat products during processing, proper handling and storage, proper employee hygiene, clothing and handling practices, restricted and controlled traffic or movement about the plant (employees, product, equipment), adequate cleaning and disinfection of processing areas and use of potable water (Huss 2003).

4 SUGGESTIONS – THE TRAINING PROGRAMME

After consultations, literature studies and visits to fishing vessels and processing plants in Iceland, it was decided to develop two courses: 1) Offshore curriculum. The curriculum deals with fish handling onboard fishing vessels. The quality of the fish starts here; therefore it is important for fishermen to get the in-depth understanding of quality control of fish. 2). Onshore curriculum is intended for both land based/onshore and offshore processing plant workers.

4.1 Who should attend?

The training programme is intended for fishermen; officers, ratings/crew forming part of the onboard fishing vessels fish handling team, land based fish handlers and processing plant workers; it is also important for trainees to have prior experience in fish handling and processing and be literate in English (read and write).

4.2 Learning outcomes

As stated earlier it is of vital importance that NAMFI students get an in-depth understanding of the importance of proper handling of fish as a raw material. For offshore curriculum students should be able to:

- Explain the crucial role of quality in international trade of fishery commodities.
- Describe the main processing steps from catch to landing.
- Demonstrate proper hygienic practice.
- Identify critical components of fish safety and shelf life, including the importance of water quality, temperature, proper hygienic procedures and physical handling.

For the onshore curriculum students should be able to:

- Explain the crucial role of quality in international trade of fishery commodities.
- Describe the processing steps from receiving the raw material to final product.
- Demonstrate proper hygienic practice.
- Demonstrate the use of fish processing equipment.

4.3 Outline of the course-CURRICULUM

OFFSHORE FISH HANDLING (PROCESSING)

1. Fish as a trade commodity.
2. Fish as food.
3. Quality assessment methods (quality and safety).
4. Stunning, Rigor mortis and Post rigor changes.
5. Post harvest handling for quality and safety.
6. GMP/GHP; HACCP (Hazards and hygiene).

ONSHORE FISH HANDLING AND PROCESSING

1. Fish as a trade commodity.
2. Fish as food.
3. Fish processing (fresh or frozen).
4. GMP/GHP; HACCP (Hazards and hygiene).

4.4 Course overview

OFFSHORE FISH HANDLING (PROCESSING)

Table 2 gives an example of how the training programme could be organized.

ONSHORE FISH HANDLING AND PROCESSING

Table 3 gives an example of how the training programme could be organized.

4.5 Lecture content

ONBOARD FISHING VESSEL FISH HANDLING (PROCESSING)

It is suggested that the lectures should include the issues in Table 4.

ONSHORE FISH HANDLING AND PROCESSING

It is suggested that the lectures should include the issues in Table 5.

Table 2: Offshore fish handling (processing).

Day	Topic /Lecture	Time	Theme	Assignment
1	1.1	9-10	Introduction	
	1.2	10-12	Fish as a trade commodity- fisheries production, fisheries trade.	
	1.3	14-16	International and national laws and regulations, fisheries' economic role.	
2	2.1	9-11	Fish as food – nutritional value, Chemical composition	
	2.2	14-16	Fish spoilage (Autolytic, Bacterial, chemical)	
3	3.1	9-11	Quality assessment methods (sensory, chemical and microbiology)	
	3.2	11-13		Sensory evaluation
	3.2	14-16		Sensory evaluation
4	4.1	9-12	Stunning, Rigor mortis and Post rigor changes	
	4.2	14-16		Visit/practical class.
5	5.1	9-11	Bleeding, gutting, and chilling. Ice and icing methods, Tubs and boxes	
	5.2	11-13	Freezing and other preserving methods	
	5.3	14-16		Icing/practical class
6	6.1	9-13	Hazards and Hygiene	
	6.2	14-16		Visit processing plant/practical class
7			Evaluation	

Table 3: Onshore fish handling and processing.

Day	Lecture /topic	Time	Theme	Assignment
1	1.1	9-10	Introduction	
	1.2	10-12	Fish as a trade commodity- fisheries production, fisheries trade.	
	1.3	14-16	International and national laws and regulations, fisheries' economic role.	
2	2.1	9-11	Fish as food – nutritional value, Chemical composition	
	2.2	14-16	Fish spoilage (Autolytic, Bacterial, chemical)	
3	3.1	9-12	Fish processing in processing plant.	
	3.2	12-13		Practical class
	3.3	14-16		Practical class
4	4.1	9-13	Hazards and Hygiene	
	4.2	14-16		Visit processing plant
5			Evaluation	

Table 4: Offshore fish handling (processing).

Topic /Lecture	Name:	Should include at least:
0	Introduction	Introduction of lectures, participants, program, practical matters, learning outcomes.
1	Fish as a commodity	FAO-statistics, nations, species, fish in global trade, production methods and consumption, Namibia International and national laws Fisheries' economic role.
2	Fish as food	Structure, yield, appearance (e.g. colour), chemistry (incl. protein quality, and nutrition PER etc), water and WHC. Fat and oxidation. Flavour compounds. Microbiology (at time of harvest SSO and process microbiology)
3	Quality assessment methods	Sensory methods, chemical methods and microbiological methods.
4	Stunning, Rigor mortis, Post rigor changes	Stunning methods and Rigor mortis,
		Sensory changes, autolytic changes, bacterial changes, lipid oxidation.
5	Post harvest handling for quality and safety	Bleeding/gutting – bleeding and gutting methods Chilling -Ice, different types of ice and icing methods, tubs and boxes – effect on quality and safety. Freezing- Other –salting, drying, smoking, preservatives, canning, heating.
6	GMP/GHP; HACCP	Good manufacturing practice, good hygiene practice, Introduction to HACCP Overview of hazards in seafood
	Test	Written and practical tests
	Evaluation	Written examination
	Certificate	

Table 5: Onshore fish handling and processing.

Topic /Lecture	Name:	Should include at least:
0	Introduction	Introduction of lectures, participants, program, practical matters, learning outcomes.
1	Fish as a commodity	FAO-statistics, nations, species, fish in global trade, production methods and consumption, Namibia International and national laws.
2	Fish as food	Structure, yield, appearance (e.g. colour), chemistry (incl. protein quality, and nutrition PER etc), water and WHC. Fat and oxidation. Flavour compounds. Microbiology (at time of harvest SSO and process microbiology)
3	Fish processing (fresh or frozen) • Other	• Heading, filleting, skinning, trimming, brining/chilling, packing, labeling. • (Salting, drying, smoking, preservatives, canning, heating)
4	GMP/GHP; HACCP	Good manufacturing practice, good hygiene practice, Introduction to HACCP Overview of hazards in seafood
	Test	Written and practical tests
	Evaluation	Written examination
	Certificate	

4.6 Lecture syllabuses

ONBOARD FISHING VESSEL FISH HANDLING (PROCESSING)

1. FISH AS A TRADE COMMODITY

Duration: 4 x 40 minutes lecture

❖ **Objectives:**

- To give students an overview of global fisheries production including Namibia.
- To provide an understanding on international fish utilization and trade.

❖ **Learning outcomes:**

At the end of the lesson, students will be able to:

- Discuss total world fish production and Namibia's contribution to world production.
- Discuss production methods and consumption of fishery products. (Namibia).
- Discuss the international trade of fishery commodities.
- Discuss the role of fisheries to the Namibian economy.

❖ **Syllabus:**

- FAO-statistics, fisheries production, nations, species.
- Production methods and consumption, Namibia.
- Fish in global trade, (international and national laws).
- Namibian fisheries' economic role.

❖ **Activities:**

- Power point lectures.
- Visits.

❖ **Points for discussion**

- Fish consumption and the main fish species dominating the domestic markets.
- Importers of the Namibian fish.
- The importance of fisheries to the national economy.

❖ **Additional information**

- Handout material power point slides.

2. FISH AS FOOD

Duration: 4 x 40 minutes lecture

❖ **Objectives:**

- To make students knowledgeable about health promoting components found in fish and seafood.

❖ **Learning outcomes:**

At the end of the lesson, students will be able to:

- Discuss the nutritional elements of fish.
- Discus chemical composition of fish.
- Explain fish spoilage.

❖ **Syllabus:**

- Nutritional value of fish.
- Chemical composition.
- Autolytic changes.
- Bacterial changes.
- Chemical changes.

❖ **Activities:**

- Power point lectures.
- Hands on demonstrations.
- Visits.

❖ **Points for discussion**

- Importance of fish to human diet.

❖ **Additional information**

- Handout material power point slides.

3. QUALITY ASSESSMENT METHODS

Duration: 2 x 40 minutes lecture
3 hours practical class

❖ Objectives:

- To gain knowledge about the methods used to assess the fish freshness.
- To gain a practical experience in sensory evaluation of raw fish kept in ice at different temperatures and different days.

❖ Learning outcomes:

At the end of the lesson, students should be able to:

- Explain the difference between quality and safety.
- Name the quality assessment methods.
- Explain how the different methods can be used, (sensory evaluation).
- Carryout sensory evaluation of raw fish.

❖ Syllabus:

- Quality vs. safety.
- Sensory methods.
- Instrumental methods:
    - Chemical methods.
    - Microbiological methods.
    - Physical methods.

❖ Activities:

- Power point lectures.
- Hands on demonstrations.
- Visits to fishing vessels/processing plants.

❖ Points for discussion:

- Difference between quality and safety.
- Methods of evaluating fish quality.
- How and where sensory evaluation can be applied.

❖ Additional information

- Handout material power point slides.

4. STUNNING, RIGOR MORTIS AND POST RIGOR CHANGES

Duration: 3x40 minutes lecture
2 hours visit/practical class

❖ Objectives:

- To give students an understanding that fish quality changes are a sequential phenomenon that starts immediately after fish is captured and slaughtered.
- To give students an understanding of the main quality changes of fishery products, and how the final product is affected by these changes.

- To give students an understanding about the importance of killing and killing methods to some fish species after capture.

❖ **Learning outcomes:**

At the end of the lesson students will be able to:

- Explain post mortem changes in fish.
- Explain the importance of stunning and killing in some fish species.
- Discuss the effect postmortem changes has on quality of the final.
- State the postmortem changes control measures.

❖ **Syllabus:**

- Rigor mortis.
- Stunning and killing methods.
- Autolytic changes.
- Bacteriological changes.
- Lipid oxidation and hydrolysis.

❖ **Activities:**

- Power point lectures.
- Hands on demonstrations.
- Visits.

❖ **Points for discussion**

- The effect of Rigor mortis on quality.
- Species that require special killing methods.

❖ **Additional information**

- Handout material power point slides.

5. POST HARVEST HANDLING FOR QUALITY AND SAFETY

Duration: 4 x 40 minutes lectures
2 hours visit/practical class

❖ **Objectives:**

- To give students a practical experience about fish handling onboard to maintain good fish quality.
- To increase the students' knowledge about the effect of gutting, bleeding, and chilling on the quality of the final product.

❖ **Learning outcomes:**

At the end of the lesson students will be able to:

- Identify critical steps in onboard handling of the fish that may affect the quality of the fish.
- Explain the effect of good handling practices on quality and storage life of fish.
- Demonstrate gutting, bleeding and icing of fish.

❖ **Syllabus:**

- Effect of harvesting methods on quality.
- Onboard handling (Bleeding/gutting).
- Cooling and Chilling.
- Freezing.
- Other (Salting, Drying, Smoking, preservatives, Canning, heating).

❖ **Activities:**

- Power point lectures.
- Hands on demonstrations.
- Visits.

❖ **Points for discussion**

- Gutting and bleeding effect on quality.

❖ **Additional information**

- Handout material power point slides.

6. GMP/GHP; HACCP (Hazards and hygiene)

Duration: 4x 40 minutes lecture
2 hours visit/practical class

❖ **Objectives:**

- To provide understanding in food safety assurance.
- To give students knowledge of their roles and responsibilities in protecting fish and the fish products from contamination and deterioration.

❖ **Learning outcomes:**

At the end of the lesson students will be able to:

- Discuss good hygienic practice/good manufacturing practice.
- Demonstrate proper hygienic practice.
- Explain the HACCP system (Hazards and control measures).

❖ **Syllabus:**

- The HACCP system (Hazards in fish products).
- Hazards control measure.
- Good manufacturing practice/Good hygiene practice.

❖ **Activities:**

- Power point lectures.
- Hands on demonstrations.
- Visits.

❖ **Points for discussion**

- Personal responsibilities.
- Personal experience.

❖ **Additional information**

- Handout material power point slides.

ONSHORE FISH HANDLING AND PROCESSING

1. FISH AS A TRADE COMMODITY

Duration: 4 x 40 minutes lecture

❖ **Objectives:**

- To give students an overview of the Global fisheries production including Namibia.
- To provide an understanding in International fish utilization and trade.

❖ **Learning outcomes:**

At the end of the lesson, students will be able to:

- Discuss total world fish production and Namibia's contribution to world production.
- Discuss production methods and consumption of fishery products. (Namibia).
- Discuss the international trade of fishery commodities.
- Discuss the role of fisheries to the Namibian economy.

❖ **Syllabus:**

- FAO-statistics, fisheries production, nations, species.
- Production methods and consumption, Namibia.
- Fish in global trade, (international and national laws).
- Namibian fisheries' economic role.

❖ **Activities:**

- Power point lectures.
- Visits.

❖ **Points for discussion**

- Fish consumption and the main fish species dominating the domestic markets.
- Importers of the Namibian fish.
- The importance of fisheries to the national economy.

❖ **Additional information**

- Handout material power point slides.

2. FISH AS FOOD

Duration: 4 x 40 minutes lecture

❖ **Objectives:**

- To make students knowledgeable about health promoting components found in fish and seafood.

❖ **Learning outcomes:**

At the end of the lesson, students will be able to:

- Discuss the nutritional elements of fish.
- Discus chemical composition of fish.
- Explain fish spoilage.

❖ **Syllabus:**

- Nutritional value of fish.
- Chemical composition.
- Autolytic changes.
- Bacterial changes.
- Chemical changes.

❖ **Activities:**

- Power point lectures.
- Hands on demonstrations.
- Visits.

❖ **Points for discussion**

- Importance of fish to human diet.

❖ **Additional information**

- Handout material power point slides.

3. FISH PROCESSING

Duration: 2 x 40 minutes lecture
3 hours visit/practical class

❖ **Objectives:**

- To increase the students knowledge about good handling practices of raw material to ensure good quality of the final product.
- To give students a practical experience about fish processing in the processing plant.

❖ **Learning outcomes:**

- At the end of the lesson, students will be able to:
- Describe the processing steps from receiving raw material to the final product.
- Demonstrate the use of fish processing equipment.
- Carry out fish processing exercises.

❖ **Syllabus:**

- Reception of raw material and storing.
- Heading, filleting and skinning, portioning.
- Trimming (removing pin bones, worms, blood spots).
- Packing, weighing and labeling.
- Use and handling of processing equipment (Machine, knives).

❖ **Activities:**

- Power point lectures.
- Hands on demonstrations,
- Visits.

❖ **Points for discussion**

- Practical exercises.

❖ **Additional information**

- Handout material power point slides.

4. GMP/GHP; HACCP (Hazards and hygiene)

Duration: 4x 40 minutes lecture
2 hours visit/practical class

❖ **Objectives:**

- To provide understanding in food safety assurance.
- To give students knowledge of their roles and responsibilities in protecting fish and the fish products from contamination and deterioration.

❖ **Learning outcomes:**

At the end of the lesson students will be able to:

- Discuss good hygienic practice/good manufacturing practice.
- Demonstrate proper hygienic practice.
- Explain the HACCP system (Hazards and control measures).

❖ **Syllabus:**

- The HACCP system (Hazards in fish products).
- Hazards control measure.
- Good manufacturing practice/Good hygiene practice.

❖ **Activities:**

- Power point lectures.
- Hands on demonstrations.
- Visits.

❖ **Points for discussion**

- Personal responsibilities.
- Personal experience.

❖ **Additional information**

Handout material power point slides.

4.7 Certificate

The attendees will get a "Certificate of Attendance" issued and approved by Namibian Maritime and fisheries institute. The certificate should include a text defining the scope and content of the course.

The training programme of onboard fishing vessel fish handling (processing) equals 6 units and the training programme of onshore fish handling and processing equals to 4 units.

4.8 Finances

The new courses will be additional modules to the current curriculum. The courses will need to be test run on a small number of students, the use of lecture rooms, teaching material e.g. computer, over head projectors, fish and ice etc., additional activities e.g. visiting fishing companies. Therefore there will be some cost involved in running the programmes.

4.9 Implementation of the course

It is suggested that the course in offshore fish handling (processing) be implemented within the main curriculum of Namibian maritime and fisheries institute under the department of Navigation. This course covers issues in onboard handling that may affect the quality of fish and as stated earlier it is important for the Namibian fishermen to get an in-depth understanding of proper handling of fish as a raw material for the quality and safety.

The course in onshore fish handling and processing is intended for processing plant workers who do not need to take the main course curriculum offered by the Namibian Maritime and Fisheries Institute; therefore it is recommended that this course be run as a 5 days module course anytime since the processing plant workers are land based.

It is recommended to run a trial course on a small number of students before running a new course in full. This will helps to assess the course materials, practical activities and timetable.

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LIST OF REFERENCES

Bernard, D.T. (2001). *Hazard Analysis and Critical Control Point*. 4th ed. Florida: Seafood HACCP Alliance for Education and Training.

Bremner H.A. (2002). S*afety and quality issues in fish processing*. Cambridge: Woodhead publishing limited.

Food and Agriculture Organisation (FAO) (2005). Fishery Country profiles. *Namibia-National Fishery Sector Overview.* [December 2009] <http://www.fao.org/fishery/countrysector/FI-CP_NA/en >

Gurirab, M. J. (2006). *Curriculum for Fishing Technology and Seamanship Courses*. Reykjavik: UNU/Fisheries training programme. [December 2009] <http://www.unuftp.is/static/fellows/document/johnson06prf.pdf>

Huss, H.H. (1994). *Assurance of seafood quality*. FAO Fisheries Technical Paper 334. Rome: FAO.

Huss, H.H. (1995). *Quality and Quality changes in fresh fish*. FAO Fisheries Technical Paper 348. Rome: FAO.

Huss, H.H. (2003). *Assessment and management of sea food safety and quality*. FAO Fisheries Technical Paper 444. Rome: FAO.

Knútsson, Ö. (2010). *Changes in strategic positioning in the Icelandic fish industry's value chain.* University of Akureyri. Unpublished manuscript.

Martin, A.M. (1994). *Fisheries processing*. Biotechnological applications. London: Chapman and Hall.

APPENDIXES (PPT PRESENTATIONS)

1. Fish as a trade commodity.
2. Fish as food.
3. Fish processing (fresh or frozen).
4. Quality assessment methods (quality and safety).
5. Stunning, Rigor mortis and Post rigor changes.
6. Post harvest handling for quality and safety.
7. GMP/GHP; HACCP (Hazards and hygiene).