



UGANDA NATIONAL
WOMEN'S FISH
ORGANIZATION (UNWFO)

AIRTEA

Strengthening Agricultural Knowledge & Innovation Ecosystem
for Inclusive Rural Transformation & Livelihoods in Eastern Africa



POST-HARVEST MANAGEMENT AND VALUE ADDITION OF FARMED FISH

PRACTICAL TRAINING MANUAL



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ON

POST-HARVEST MANAGEMENT AND VALUE ADDITION OF FARMED FISH

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ABOUT THIS TRAINING MANUAL

The contents of this training manual have been compiled mainly from literature and several practical sessions that have been conducted by the Uganda National Women's Fish Organisation (UNWFO) to their farmer groups across the country. This manual is a handbook that fish processors can easily refer to and regularly be used as a quick guide during the course of their production. Therefore, it has been written and set out in a manner that makes it easy for reading and cross-referencing. This manual provides guidance on post-harvest management and value addition of farmed fish.



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Background information

Uganda's aquaculture sub-sector is fast growing and constitutes a valuable segment of the economy because of increasing domestic consumption and export. In 2022, the sub sector contributed approximately 120,000 metric tons of fish (MAAIF, 2022). Aquaculture provides employment, household incomes, food and nutrition security to at least 30% of the local population (NPA, 2020). Production in the sub-sector has increased more than 4000 times in the last five decades. Currently, aquaculture contributes up to 22% of all the fish produced in the country (FAO, 2020). Aquaculture production is dominated by Nile tilapia, *Oreochromis niloticus* and African catfish, *Clarias gariepinus* (Kasozi et al., 2017). The growth of aquaculture production has been mainly due to the shift towards and intensification of private sector in establishing small and medium scale enterprises (Adeleke et al., 2021). In addition, the development of big commercial enterprises is also stimulated by increasing public support, expertise, foreign direct investment and interest in aquaculture. Despite all these advancements, efforts in aquaculture have concentrated mainly on production techniques at the expense of its business development and value addition. Therefore, there is a need to put critical emphasis on post-harvest handling, processing, marketing, and compliance regulatory requirements, which will enhance market access of aquaculture products.

Aquatic foods are considered nutritionally diverse and have been recognized as particularly nutritious, contributing essential fatty acids, micronutrients, such as iron and zinc, calcium, and vitamin A, as well as protein. However, they are highly perishable food products, which require perseveration to ensure safety and compliance with standards and regulations. Therefore, it is vital to preserve and process fish to maintain quality and to retain their nutritional value. The processing and sale of fish by-products additionally aims to increase the economic value. Furthermore, the development of new fish products in various forms is an important option to increase the added-value of products, avoid economic loss, reduce environmental impact, and supply consumers with a nutritious, low-cost, more stable shelf-life and convenient food. Thus, processing and value addition is vital in trade and market development as it opens lucrative markets for aquaculture products.

Common production systems for farmed fish



Fish ponds



Fish cages



Fish tank

Common Fish species



Nile tilapia



African catfish



Mirror carp

1.1. RECOMMENDED HARVESTING PRACTICES

1.1.1. Prior to harvesting

It is advisable to starve fish for 1 to 2 days depending on the temperature and fish species. The aim of not feeding the fish is to empty the stomach and intestines of its contents so as to improve freshness quality (Imsland et al., 2020).

When fish are to be harvested for market, ensure that the market has been arranged first and is ready to take the fish.

1.1.2. Harvesting

Ponds may be harvested with a seine net or by draining. Draining the pond marks the end of a production cycle because all the water from the pond will have been removed.

Clean and disinfect the designated place and equipment for harvesting fish.

1.1.3. Fish handling during and after harvest

- The primary objective of good fish handling practices is to preserve the quality of fish.
- Maintaining the quality of fish begins with good harvesting and transport practices.
- As much as possible, harvest fish based on your marketing plan.
- If fish are to be sold fresh, the best way to guarantee freshness is to sell the fish live or deliver it live to the customer, if possible.
- Clean the fish with clean running water, weigh, and grade immediately after harvest. Put the fish in clean containers with ice at 5°C immediately to minimize spoilage.
- Several factors can affect the quality of fish after harvest like delays, poor handling practices, poor fish temperature control, and unhygienic handling.
- All the fish harvested need to be weighed and recorded. The fish should be transported in clean containers preferably in ice boxes, Styrofoam boxes or refrigerated trucks to avoid deterioration.
- Do not place the fish directly on the ground. Keep the harvested fish in a clean container – the basket, basin, and tank.
- All the fish harvested need to be weighed and recorded. The Fish should be transported in clean containers preferably in ice boxes, Styrofoam boxes or refrigerated trucks to avoid deterioration.



1.1: Fish harvesting



1.2: Fish weighing



1.3: Transportation of fish

1.2. Poor fish handling practices

Due to poor handling, the fish get subjected to physical, chemical and biological hazards leading to increased microbial contamination and faster spoilage rates. This means that fish operators (fish farmers, processors, traders, and other stakeholders involved in fish farming operations) lose potential income.

Poor fish handling practices

They include the following:

- Placing the fish on dirty surfaces and containers
- Washing of fish in dirty water
- Throwing fish / displaying fish on bare ground
- Beating fish with stick after harvest to kill it, or stepping on fish
- Fish exposed to insect, birds and animal predation
- Delay in gutting the fish after harvest
- Use of dirty knives or other objects to remove the fish scales
- Fish in contact with chemical substances such as fuel, oil
- Use of chemical preservatives on the fish
- Use of dirty boxes, baskets, container and ice
- Keep fish flesh out of sunlight

1.3. Good fish handling practices

Proper fish handling practices promote good quality and safety of fish products.

Good fish handling practices

They include:

- Washing the fish in clean water to remove mud, sand and debris
- Sorting or grading the fish according to species or sizes
- Controlling the temperature of the fish
- Cooling the fish as quickly as possible by any convenient methods
- Separately keeping fish caught at different times since they will be at different stages of spoilage
- Small fishes be kept separate from large fishes, as they tend to spoil more rapidly than the latter
- Soft-bellied fishes to be kept separately, if the guts are being removed or the belly has burst, the body cavity has to be washed to remove any traces of the gut
- The container used for the transportation of fish should be cleaned after every use
- Training of fish handlers at every stage in the value chain to learn about and adopt good hygiene practices

Personal hygiene involves the good practices, behavior and attitude of the individuals handling fish to prevent diseases, maintain good health and quality of fish products. Good personal hygiene reduces spoilage and contamination to ensure production of safe and quality fish.

2.1. Poor hygiene practices

These are irresponsible behaviors and attitude on hygiene by fish handlers. Poor personal hygiene practices compromise the quality and safety of the fish.

Poor hygiene practices

Poor personal hygiene practices when handling fish include:

- Eating, drinking, smoking or chewing gum
- Wearing dirty clothes and using dirty hands
- Open cuts and wounds
- Having long and dirty fingernails
- Wearing jewelry and wrist watches which may harbor the germs
- Coughing and sneezing over the fish
- Suffering from diarrhea, vomiting or skin infections
- Not washing hands after the toilet
- Touching pets such as dog and cat
- Not washing hands before and regularly
- Washing hands with dirty water and without soap
- Wearing perfumes, nail vanish
- Not wearing PPEs

2.2. Good hygiene practices

Good hygienic practices involve those practices that ensure that fish are handled in a clean and safe manner, while avoiding the transfer of germs and diseases.

They include:

Washing your hands:

- Before handling fish
- After handling raw fish
- After touching rubbish/waste / waste bins
- After using the toilet
- After coughing or sneezing
- When hands are dirty

In addition, the following hygiene practices are required:

- (i) All fish handlers should have public health certificates of medical fitness obtained from public health officers
- (ii) Use only clean water that is free from contaminants in all post-harvest processes
- (iii) Use non-corrosive easy to clean work surfaces, preferably stainless steel (avoid use of wood, rusted and rough surfaces)
- (iv) The lay-out of the processing facility should have unidirectional flow from raw-material to product to avoid cross-contamination

- (v) Prevent rodents, insects, and other unwanted substances from coming onto the work or storage area
- (vi) Not to throw garbage around work areas. Use of covered cans or bins for collection of garbage
- (vii) Wear clean protective clothing all the time
- (viii) Ensuring all tools and utensils are clean and disinfected prior to use
- (ix) Not to spit or urinate close to the work area
- (x) Remove all jewelry before handling and processing fish
- (xi) Cover all open cuts, burns and scores with water proof dressing / plaster
- (xii) Avoid touching your ears, nose and teeth when working with food
- (xiii) Keep nails short and well structured
- (xiv) Never cough, spit, sneeze or smoke near food
- (xv) Do not eat or drink in areas where fish is handled, processed or stored



2.2 Hygienic Handling of fish

3.1. Understanding fish quality

Fish is a highly perishable commodity that requires great care during handling, processing, storage, and distribution. Spoilage starts as soon as fish is out of water.

Quality can mean different things to different people; appearance or presentation; odour, flavour and texture of the fish when eaten; nutritional value, price, food safety and consistency.

A safe fish is the one without contaminants. Contaminated fish can cause serious diseases to consumers and fish spoilage. The quality of the fish product affects the price. High quality is offered high price and poor quality offered low price.

The quality of the fish product affects the sale price, thus.

High quality = High price
Poor quality = Low price

Once the quality of the fish product is allowed to deteriorate it can never be regained. This means that everyone involved in the fish business, from the time fish is harvested, through processing to the vendor at the point of sale, must understand how to maintain quality in order to get the best possible price. There are four basic requirements for maintaining fish product quality..

- Chill the fish and keep it as cool as possible prior to processing or selling
- Do not damage or crush the fish
- Keep the fish clean
- Work quickly

3.2. Fish spoilage

Fish spoilage is a process of deterioration in the quality of fish, which changes its appearance, odour and taste. The action of microbes, enzymatic activity and oxidation of nutritive elements present in the fish are the common causes of fish spoilage. In addition to these, some other factors are also responsible like:

- Improper handling
- The high moisture content of the fish
- Weak muscle tissue
- Ambient temperature

3.3. Fish freshness and quality preservation

Quality can be measured by chemical or sensory methods. Chemical methods involve testing chemicals produced in the fish during spoilage while sensory evaluation using human senses can be done as indicated in the table 1 below.

Sensory Evaluation / Organoleptic assessment: The quality can be checked by using:

- (i) our eyes to look at the appearance of the fish product
- (ii) our hands to feel the texture of the product and
- (iii) our noses to smell it
- (iv) our tongue / mouth to taste cooked fish

The following table gives a numerical value (class) for differing qualities of fresh fish. It can be a useful tool in assessing quality. We simply describe what we see (appearance, colour), feel (texture), and smell.

Table 1: Quality evaluation of fresh finfish using sensory evaluation

	CRITERIA			
	Freshness Category			
	Extra	A	B	Unfit
Skin	Bright, iridescent pigment or opalescent, no discolouration	Pigmentation bright but not lustrous	Pigmentation in the process of becoming discoloured and dull	Dull pigmentation
Skin mucus	Aqueous, transparent	Slightly cloudy	Milky	Yellowish, grey, Opaque mucus
Eyes	Convex, black, bright pupil, transparent cornea	Convex and slightly sunken, black, dull pupil	Flat, opalescent cornea, opaque pupil	Concave in the centre, grey pupil, milky cornea
Gills	Bright colour, no mucus	Less coloured, transparent mucus	Brown/green becoming discoloured, thick opaque mucus	Yellowish, milky mucus
Flesh	Firm and elastic, smooth surface	Less elastic	Slightly soft, less elastic	Soft, scales easily detached from skin, surface rather wrinkle
Gill and internal odours	Fresh, smell of pond water	Neutral odour	Musty odour	Fruity and/or sulphide smell
Peritoneum on gutted fish	Smooth, bright, difficult to detach from flesh	Slightly dull, difficult to tear from flesh	Gritty, fairly easy to tear from flesh	Gritty, easily torn from flesh

Adapted from Connell, 1995



3.3 Bright clear eyes of fresh good quality fish

4.1 Understanding fish processing

In this context, fish processing refers to a series of actions applied by actors along the aquaculture value chain to preserve their fish from the time it is harvested until it reaches the consumer.

Points to note on fish processing

- (i) Fish should be processed in a proper place with good hygienic conditions
- (ii) Prior to fish processing, fish are dressed- this involves being sorted/graded, washed and cleaned then heads, tails, scales, fins, slimes are removed. Fish are then gutted. Dressing fish reduces the rate of deterioration as guts and gills are major contact for deterioration
- (iii) Any waste products from fish processing areas/center must be disposed in a responsible way that does not harm the aquatic and terrestrial ecosystems
- (iv) Fish waste should be kept and got rid of in a closed place that does not allow flies, rats and other pests to breed and be a nuisance
- (v) Finished products must be packaged and handled in a careful way to avoid contamination
- (vi) Fish by-products should be handled and kept well for use in value addition

4.2. Maintaining good environment and sanitation in fish processing areas

Control of hazards in aquaculture is of significant importance because, once introduced during the fish rearing stage, the hazards may not be eliminated or reduced by the subsequent processes in the chain and in fact may increase the risk of spread (Bagumire et al., 2020). Application of hazard management tools to avoid use of potentially contaminated inputs, implementing adequate hygiene and sanitation programmes is vital.

4.2.1. Poor sanitation practices

Fish is a perishable and potentially harmful food if not handled properly. There are many fishborne diseases associated with the environment in which the fish is grown, and with the way it is handled after it is brought out of the water, particularly if it is kept at room temperature.

Poor sanitation practices

They include:

- Lack of toilets or latrine
- Presence of vermin, pests and rodents
- Handling of fish and food on the ground or dirty surfaces
- Open pit latrine near fish handling areas
- Accumulation of rubbish, fish and food wastes
- Contamination from animal feces and bird droppings
- Use of dirty / contaminated water
- Poor fish storage areas
- Fly infestation on fish and food
- Poor rubbish and waste disposal
- Poor containment and drainage of waste-water

4.2.2. Good sanitation practices

Specific procedures must be followed to minimize the risk of such hazards causing illness to consumers:

They include:

- (i) Basic good sanitation knowledge like using clean water, keeping fish disposal in closed containers and controlling pests
- (ii) The processing area should be enclosed with a perimeter wall or fence and gate to restrict access
- (iii) Sweep and clean the processing area regularly to ensure that there is no rubbish lying around attracting flies, rats and other pests
- (iv) Use clean equipment and utensils at the fish processing area. The processing area should have a separate washing facility for utensils
- (v) Floor and walls should have easy to clean surfaces
- (vi) The processing area should have a raised receiving area for unloading of fish products
- (vii) Make sure there are good toilet facilities, which are kept clean
- (viii) Make sure there are hand washing facilities and covered waste bins
- (ix) Ensure that there are no trees or vegetation near the processing place as these are good places for insects and vermin to live

4.3. Fish processing practices

Fish processing practices refers to appropriate skills and knowledge being used by the fish processors in processing fish products after harvesting. Hence fish processing ensures a higher quality fish product.

4.3.1. Good fish processing practices

Good fish processing practices

- Fish that should be processed should be fresh and in good condition
- Fish should be washed in clean water thoroughly to remove blood, slime and scales
- Fish should be sorted/graded; accordingly, large fish are separated from small fish
- Fish processing should be done under good conditions where there is no chance for bacteria growth
- Equipment and utensils used for fish processing should be kept clean in good condition
- Waste fish products should be kept in a closed place that does not allow flies, rats and other pests to breed
- Any waste products from processing must be disposed of in way which does not harm the environment, water or land
- Finished products must be packaged and handled in a careful way to avoid contamination and so they remain safe to eat

4.3.2. Poor fish processing practices

Poor fish processing practices

- Fish processing practices conducted in poor hygienic locations.
- Failure to clean and wash fish prior to processing.
- Failure to quickly remove viscera and gills.
- Use of inappropriate equipment such as dirty knives, broken glass to process fish products.
- Fish processed with dirty utensil and equipment.
- Fish waste products disposed around the processing workplace.
- Encouraging presence of flies and other insects and;
- Use of chemicals such as pesticides or insecticides on the equipment during the final stage of fish processing.

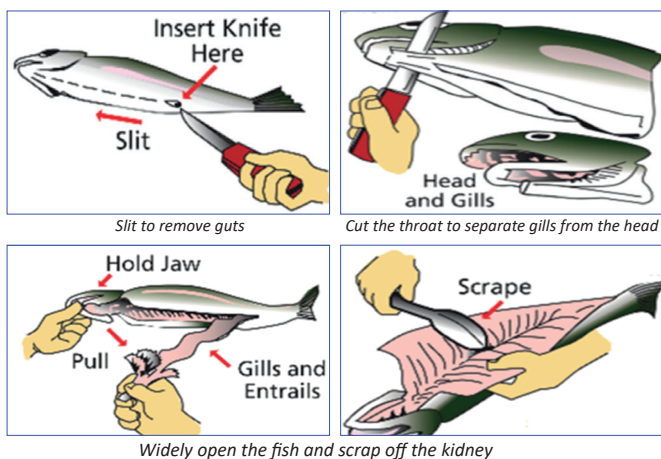
4.4. Dressing of fish

Dressed fish means a fish with the head attached but with the gills and the entire gut or viscera (stomach, liver, intestine, gonads) removed. Dressing reduces rate of deterioration while in storage.

Dressing of fish

The process involves the following:

- Thoroughly clean chopping board or flat surface, and knife you will be using to gut your fish
- Wash your hands, remove fish from ice box and place the fish with the belly facing you on a clean chopping board or flat clean
- Make a slit from the anus, along the belly of the fish to the gills (or just under the pelvic fins), taking care not to puncture the internal organs
- Lift gill cover and carefully cut gill attachments for easy removal
- Carefully grab hold of the gills and remove fish gills pulling the entire gut along. The gut and gills should come out as one complete piece making sure the stomach does not burst open
- Clean fish thoroughly in fresh running water before icing or cooking



4.1: The process of fish dressing

4.5. Chilled fish

Chilling is the process of cooling fish or fish products to a temperature approaching that of melting ice. The purpose of chilling is to prolong the shelf-life of fish through slowing the action of enzymes and bacteria. The most common means of chilling is by the use of ice.

Chilled fish is kept in layers of ice at a ratio of 1:2 of fish to ice in insulator boxes.



4.2: Chilled fish

4.6. Frozen fish

For longer storage period, dressed fish can be frozen below 0°C to retain the freshness, nutritional value, and taste. Freezing is an efficient method of fish preservation but it must be emphasized that it does not improve product quality. Provided the temperature is low enough (below -18°C), bacterial action will be stopped by the freezing process. Chemical, biochemical and physical processes leading to irreversible changes will still occur, but at a very slow rate.

Freezing Procedure:

- (i) Tightly wrap good quality dressed fish individually in plastic wrappers
- (ii) Place the individually wrapped pieces into a sealable freezer bag or wrap tightly in aluminum foil. Do not pack more than 1Kg of fish for fast freezing
- (iii) Place the wrapped fish packages in freezer. When placing fish in the freezer, do not stack a lot of packages together in one area
- (iv) Periodically check to ensure that your freezer is working well
- (v) Once frozen, label and dispatch to the market. Keep it frozen at all time during transportation and marketing



4.3: frozen fish

4.7. Fish fillet

A fish fillet is the flesh of a fish which has been cut or sliced away from the bone by cutting lengthwise along one side of the fish parallel to the backbone.

Requirements

- Sharp filleting knife
- Clean smooth (non abrasive) filleting board in clean environment
- Clean water
- Cooling box

Filleting Procedure:

- (i) Rinse the slime off the fish to obtain more grip of the fish during filleting
- (ii) Lay the fish on its side on a cutting board. Cut the fish behind its gills and pectoral fin down to, but not through, the backbone.
- (iii) Without removing the knife, turn the blade and cut through the ribs toward the tail. Use the fish's backbone to guide you. Turn fish around and finish cutting fillet away from the backbone
- (iv) Turn the fish over and repeat on the other side
- (v) Remove rib cage after the fillet is cut
- (vi) To skin the fish fillet, place its skin side down on the cutting board; insert the knife blade about a 1.3 cm from the tail. Grip the tail firmly and run the knife blade at an angle between the skin and the meat
- (vii) Wash the fillet with cold safe potable water, let it drain a little and immediately chill it in ice at a ratio of 1 to 1 (fish to ice) in clean Styrofoam or any other insulated container or freeze the fillets as above



4.4: Making fish fillet



4.5: Packed fish fillet

4.8. Fish sausages

There are various types of fish sausages depending on the processing procedures and ingredients used. Common types include fresh, cooked, smoked and uncooked smoked sausages.

Fish sausage ingredients

- High quality dressed fish flesh without bones, scales and skin
- Pure and finely granulated salt
- High quality fresh seasonings and spices
- Nitrates and nitrites for preserving and imparting unique colors, texture, and flavors
- Binders or extenders
- Fresh water to rehydrate the binders and extenders and to replace the expected moisture loss during smoking and cooking
- Ice for fish handling made from safe drinking water
- Sausage casings-natural or synthetic

Equipment required:

Digital thermometers, weighing scales to measure the weight of fish in kg and of the ingredients in grams, grinders, bowl cutter, stuffer, freezer, stainless steel tables and knives, protective wear.

Procedure

- (i) Wash the fillets in clean potable water then hold the fillets in ice flakes at below 5°C.
- (ii) Check the fillets for any pieces of bones and remove them when found
- (iii) Weigh the fish and other ingredients while keeping each item separately in individual labelled containers
- (iv) Grind or mince the fillets with a mincer
- (v) Mix the fillet with other ingredients in the bowl cutter until you cannot identify / isolate a single ingredient from the rest
- (vi) Stuffing: Fit the ready casing onto the stuffer horn and continue pumping the stuffer until all the batter is stuffed into the casing
- (vii) Carefully twist the stuffed casing to form appropriately sized single sausages
- (viii) Pack the sausages in appropriate polyethylene bags, seal them and attach your label
- (ix) Keep the packed fresh fish sausages in the cold room or freeze at -10°C
- (x) The product can now be dispatched to the market



4.6: Cooking fish sausages



4.7: Packed fish sausages

4.9. Salted and dried fish

Fish can either be wet or dry salted

Equipment /utensils:

Clean salt containers, clean containers for making brine, insulated containers for holding fish, containers for wet salting, plastic bucket, woven or perforated containers for dry salting, polyethylene sheets, heavy weight wood planks, drying racks, solar drier or sun drying stands, weighing scale, digital thermocouple probe thermometer

Procedure for salting:

- Wash the fish in clean portable water
- Weigh the cleaned fish; and calculate the right amount of salt for brining or dry salting

Wet Salting

- (i) Prepare brine by mixing four parts of clean water with one part of salt
- (ii) Submerge the dressed fish in the brine solution
- (iii) Stir the mixture every 20 minutes
- (iv) Brining takes about 30 minutes for light salting, or up to 24 hours for medium salting



4.8: Wet salting

Dry Salting

- Prepare a ratio of fish to salt of 2 parts fish to 1 part salt
- Put salt on the fish but allow the juices and brine (pickle) to drain away
- Separate the layers of fish by layers of salt, while final layer being salt
- Place the container lid on top of the stack and ensure that the lip presses the fish down for faster salt penetration and water removal
- Restack the fish every 24 hours, so that the fish previously on top end up on the bottom
- Salting time varies from 3 days to a week, depending on the type and size of fish



4.9: Dry salting

Salted and dried fish

- Drying is often used in combination with salting for additional preservation
- It can be sun dried or by using solar or mechanical means. Solar or mechanical dryers allow drying regardless of weather conditions. They also produce more uniform products but their costs are higher than that of drying racks for sun drying
- Dry on raised platform
- Do not sun-dry on dirty surface like bare ground to avoid foreign matter contaminating the fish



4.10: Drying fish on raised platform

4.10. Smoked fish using improved kiln

Smoking preserves fish by exposing it to smoke from smouldering wood or plant materials. Smoking prolongs shelf life, and increases / enhances fish flavor. It provides a physical barrier against microorganisms and can result in the deposition of beneficial antimicrobial and antioxidant compounds like phenols and carboxylic acid (Asamoah et al., 2021).

Requirements: Smoking trays, smoker (smoking) unit, source of smoke/heat and packaging material

Procedure: Use quality dressed fish, and if big, split it longitudinally and spread it out

DO NOT use leftover fish after days selling as this produces poor quality smoked fish

- (i) Wash the fish again to clean off all the dirt and blood
- (i) Place the fish on smoking trays wiped with vegetable oil and allow it to dry for about 1 hour

Advantages of improved techniques for fish smoking

- (i) Efficient firewood use
- (ii) Improved heat and smoke circulation
- (iii) Reduction of smoking time
- (iv) Increase of quantities that can be smoked at once
- (v) Use of trays reducing tediousness of the process
- (vi) The trays form a chimney to trap the smoke and heat
- (vii) Heat and smoke required during the smoking process can be regulated
- (viii) Uniformly smoked product of better quality in terms of colour, shape and taste
- (ix) Handling of the fish during the smoking process greatly reduced
- (x) The product acquires a higher market price
- (xi) Reduces the levels of Polycyclic aromatic hydrocarbons (PAHs)



4.11: Ordinary smoking kiln



4.12: Improved smoking kiln)

Products from improved smoking kiln



4.13: *Smoked Tilapia*



4.14: *Smoked catfish*

4.11. Fish frying

Frying is one of the methods for value addition. The fish can be fried whole or cut into pieces. Spices and salt can be added to improve on the taste.



4.15: *Pieces of fish being spiced*



4.16: *Fried fish*

Ready to eat fish products



4.17: *Fish fingers*



4.18: *Fish "Mchomo"*



4.19: *Whole Tilapia*

4.12. Fish Oil

Fish oil is one of the value added products from fish, fish by-products or fish waste which is rich in omega-3 fatty acids for good health. Preparation techniques involve transforming raw fish / fish waste products into oil for human consumption or different uses.

Uses of fish oil

- As lubricant in the tanning and texture industries.
- In soap making;
- In cosmetics and skin healing products
- In health products like fish oil concentrates;
- To coat the hulls of the wooden boat as preservative against fouling
- As cooking oil for frying fish and other food products

4.13.1. Preparation of fish oil

Fish oil is found in the flesh, head, frames, fins, tails, skin and guts of fish in varying quantities.

Steps to follow before the extraction of fish oil

Before oil can be extracted, several steps must be followed:

- Place the fish or fish waste in clean cooking utensil / container
- Ensure that the quantity of fish / fish waste does not exceed the quantity of water in the cooking utensil/container
- Boil/heat the fish / fish waste for 30-45 minutes to separate water from oil
- After boiling of the fish, separate fish bones and meat from the soup using fine mesh sieve
- Allow the soup to cool for 20-30 minutes. A layer of oil will be seen on the top of the soup
- Use a table spoon to scoop the oil from the soup or decant off the oil
- Place oil in a cooking utensil to boil for a while to remove the remaining water content.
- Separate oil from liquid by fine mesh sieve which separates matter of varying densities
- The oil should be stored in a clean glass / container
- The concentrated leftover liquid (soup) should be boiled for about 90 minutes to remove water content to produce super saturated soup.
- Allow the super saturated soup to cool for a period of one hour or more depending on the weather condition to form fish jam / fish soup.

4.14. Packaging of fish products

Role of packaging

- I. Protect the products - physical, chemical & biological agents, adulteration, tempering, contamination, damage.
- II. Help for easy distribution and handling during display
- III. Serve as a communicator & provide information about product
- IV. Add value to the product with high quality and attractive packaging
- V. Help to minimize the cost of product
- VI. Help to extend shelf-life of product

Types fish packaging

1. Bulk packaging
2. Wholesale packaging
3. Retail packaging
4. Air freight packaging

Bulk packaging material should be

- Suitable size to handle any type of fish comfortably
- Easy to manage, carry and clean
- Designed with proper insulation to maintain temperature like Styrofoam boxes
- Designed to allow draining out of melted water
- Protect the fish from crushing, spoilage, environmental pollution and pilferage
- Easy to store and effective for transporting chilled fish
- Available at a reasonable cost



4.20. Packed fish products

4.15. Storage of fish products

Storage facilities and conditions depend on the type of fish products. Chilled and frozen fish products are stored under refrigeration at temperatures of $0\pm 2^{\circ}\text{C}$ and -18°C respectively. Raw fish should be stored in a refrigerator or ice box within 2 – 3 hours after catching.

During storage, ensure:

- i. Cleanliness and vermin control of the storage area
- ii. First-in-first out (FIFO) principle to apply
- iii. Proper labelling and marking
- iv. Appropriate product storage conditions of temperature and humidity
- v. Products are kept off the ground on pallets or in containers
- vi. Appropriate product stacking rates
- vii. Fish is protected from contamination
- viii. Maximum storage time depending on shelf life
- ix. Storage temperature monitoring

5.1. Fish transportation

Transportation refers to a system or means of conveying fish from fish farms to processing areas or to fish markets. Transport can be done by means of vehicles of all kinds depending on type of fish product: cars, trucks, boats /canoes, motorcycle, bicycle or by foot. Fish should be transported in clean containers and food grade materials.

Fish can be exposed to high temperature during transport and is subject to damage due to poor handling and transportation. Some fish transporters fail to use appropriate transportation means and practices like use of ice and insulated boxes/containers which affects the quality of fish.

Improved fish transport

Fish can be exposed to high temperature during transport and is subject to damage due to poor handling and transportation. Some fish transporters fail to use appropriate transportation means and practices like use of ice and insulated boxes/containers which affects the quality of fish.

5.2. Fish marketing

Fish becomes a product for trade once it is out of the water. Fish marketing is anything that you do to get the fish product in the hands of the customer, satisfying needs and wants.

It is important to strive and influence consumers to purchase fish products. This can be done through:

- (i) Getting the attention of your customers,
- (ii) Creating awareness about the products
- (iii) Motivating customer to make the buying decision.
- (iv) Convincing them to buy and use the product
- (v) Convincing them to buy again.
- (vi) Getting feedback from customers and continuously improving
- (vii) Fulfilling market requirements and certification standards

5.3. Importance of marketing

The customer does not always know what products may be available in the market. Marketing therefore helps to:

- (i) Stimulate demand and build a customer base for selling the products produced.
- (ii) Promotes the utilization of products for consumers by creating or opening channels through which products can be sold and received by customers.
- (iii) Promotes the enterprise's unique products features by building upon its comparative advantages against the competition from similar products or other products that may substitute one's product.
- (iv) Enables the producer to interact and obtain feedback on products from customers which enhances competitiveness.
- (v) Increases the opportunity for higher turnovers and thus improves the likelihood for growth and sustainability of the enterprise.

5.4. What is a market?

Markets create an arena that enable the producer answer the following key questions when developing market-oriented production and business plans.

- (i) What to produce? This includes the species, size, the quantity, quality and the price the consumer is willing to pay for the product.
- (ii) How much to produce? How much of each species? What size and quality to produce at different periods?
- (iii) How to distribute production? What mechanisms will be used for distribution? What type of net- works will be used?

5.5. Types of Markets

Markets are described based upon their:

- (i) Location e.g. Nakasero market, Kajjansi fish market
- (ii) Product e.g. catfish market, tilapia market
- (iii) Time e.g. September to October catfish or tilapia market.
- (iv) Level e.g. retail market, wholesale market etc.
- (v) Targeted clients, e.g. niche or luxury markets

5.6. Collective Marketing

Independent small-holder farmers can secure large markets and obtain economics of scale if they form clusters and associations. Such an arrangement enables them to synchronize their production to ensure that market receives the quantities it demands consistently throughout the year. This helps avoid the problem of too much production coming into the market at the same time with a consequent fall in fish prices or post-harvest losses.

5.7. Good fish handling practices in the fish market

Good fish handling practices

- Clean fish and remove undesirable parts when necessary;
- Arrange the fish on a first in, first out basis;
- Use clean tables / stands to display the fish and fish products;
- For dressed fish, arrange with the bellies down to allow melting ice drain away to reduce spoilage;
- Keep fish away from non-edible products;
- Avoid selling fresh fish without ice;
- Spoiled fish should not be sold;
- Appropriately wrapped and packed sold fish in carrying bags;
- Avoid using harmful and prohibited substances for treatment of fish like formalin.

5.8. Personal hygiene requirements of fish seller in the market

Personal hygiene requirements

- Maintain good personal hygiene and sanitation
- Clean hands before handling and after handling fish;
- Wear clean protective clothes, gloves and gum boots while selling the fish;
- Regularly change the gloves and protective wear when dirty;
- Don't work in fish market when suffering from contagious diseases, cuts and open wounds;
- Smoking, spitting, chewing pan, eating, etc should be strictly avoided.

6.1. Product branding

For easy market penetration, loyalties, and traceability, use unique product brand and packaging which adhere to UNBS standards for packaging and labelling.



Brand name

Form of product

Product name

6.2. Product traceability

Use product batch numbers and bar codes for identification and tracking of the specific product movements. It is important to know the source of the fish.

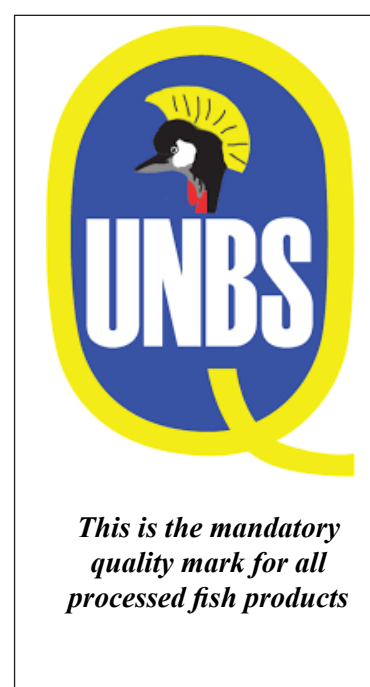
Traceability documents include: Fish Movement Permit, Fish Health Inspection Certificate, and Export Certificate for those exporting farmed fish.



Bar code

6.3. Product certification

- (i) Product certification demonstrates that a product has passed performance test, quality assurance tests and meets qualification criteria as described in the standard.
- (ii) It gives confidence to customers that the product is safe and of good quality and provides a competitive edge compared to other competing products.
- (iii) In Uganda, for product certification, it should meet the UNBS quality Mark (Q -Mark).
- (iv) Certification procedure, requirements and cost can be obtained from UNBS website (<https://www.unbs.go.ug/>) or visit their head quarter or regional offices for more information.
- (v) UNBS mandatory quality mark is for all processed foods
- (vi) Certification creates market access



7.1. What is record keeping

The objective of commercial fish farming is to produce fish for sale and earn profits. Record keeping refers to the orderly and disciplined practice of storing business records. It is done to enable track cash at hand, performance of the business and to understand the hidden and unexpected costs in the business.

7.2. Advantages of keeping records

With correct records, as a fish processor or trader you can:

- (i) Make good decisions concerning your business after knowing its performance (profits, income, amount in debt, loans etc.) and take corrective actions in time.
- (ii) Successfully apply for a loan (from finance institutions, such as banks or the government) because you can show how well your business is doing and how organized it is.

7.3. Types of Records

Cash records

These records contain details of income and expenditure. There are three types of cash records:

- (i) Expenditure records (money spent)
- (ii) Income records (money received), and
- (iii) Commitment records (goods sold on credit or bought on credit)

Physical records

These are records are about other issues concerning the business like the details on:

- (i) How many items of a good have been produced (e.g. processed Tilapia),
- (ii) When they were produced,
- (iii) When and where they were taken to the market, and
- (iv) How many are in stock
- (v) List of debtors and creditors
- (vi) Bank records – bank statements and loan records
- (vii) Employees

Quality Control Records

- (i) Hygiene check-list
- (ii) Medical certificates
- (iii) Sensory records
- (iv) Temperature records

Food safety is assurance that food will not cause harm to the consumer when consumed according to the intended use. Thus, consumer safety must be given priority by ensuring safe and wholesome products while minimizing negative impact on consumers, environment, and workers during production, postharvest (handling, storage and distribution) and value addition. The food safety hazards are of three types namely: biological, chemical and physical.

1. Biological hazards include diseases causing organisms and spoilage microorganisms like molds, Salmonella sp and vibrio cholera.

Control of biological microorganisms' contamination in fish is by:

- Ensure personal hygiene.
 - Ensure that fish is always handled in a cold environment.
 - Use clean packaging containers and transport means.
 - Do not use dirty and waterlogged storage facilities.
 - Implementing Good Manufacturing Practice (GMP) and Hazard analysis and critical control points (HACCP)
2. Chemical hazards include pesticides and other chemical residues. Other chemicals of concern are heavy metals.

Control of chemicals hazards in fish products is by:

- Ensuring safe use of pesticides in control of pests and diseases
 - Avoid siting ponds or cages in areas with excessive use of agro chemicals in agriculture fields.
 - Site ponds and cages in areas with no industrial waste and where there is quality/ safe water for the fish.
 - Implementing GMP and HACCP.
3. Physical hazards may include bones, sand, staple pins, wood or metal pieces.

Control of physical hazards is by:

- Implementing GMP and HACCP
 - Ensure proper removal of bones in boneless products like sausages
 - Good handling and processing techniques
 - Metal detection where possible
4. All fish products should conform to food safety standards as described by Uganda National bureau of standards (UNBS). Thus, Good Aquaculture/farming practices, Good hygienic practices, good manufacturing practices and Employee Hazard Analysis Critical Control Systems MUST be adhered to.

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The Uganda National Women's Fish Organization (UNWFO) is a member of African Women Fish Processors and Traders Network (AWFISHNET) and the Current Chair of Eastern Africa Women and Youth in Fisheries and Aquaculture Network (WIFA-N EA). UNWFO was established in 2019 as a forum through which Ugandan women and youth could share experiences at national, regional and international levels, build the capacities of its members to adopt best practices, improve the access of women's fish products to local, regional and international markets.



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