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Good practices for preprocessing and cooking farmed fish



In partnership with



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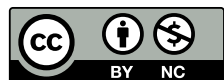
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Introduction

Fish is an important food for human consumption. Because of its high nutritional value, it can treat diseases caused by malnutrition, and it is especially suitable for children, pregnant women and breastfeeding mothers. More than one billion people around the world get their animal protein requirements from fish, which also contains minerals like phosphorous, iodine, calcium, magnesium and sulfur. In addition, there are a number of important fat-soluble vitamins in fish oil, including vitamins A and D. Fish oils are high in unsaturated fatty acids, especially omega-3, which helps reduce cholesterol.

Yet despite being highly nutritious, fish is difficult to process and spoils easily. This is why proper processing methods are so important, as they help preserve fish, prolong its shelf life and produce new products that consumers prefer. Fish processing also engages more women and youths in aquaculture activities, which improves their income.

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1. Fish preprocessing

1.1. Receiving and preparing fish for cooking or processing

This is a critical stage, as failure to comply with quality standards, use good hygiene methods and handle fish properly can cause problems with the final fish product.

There are signs that consumers can detect themselves, and they must take these into account when trying to buy high quality and nutritious fresh fish. Fish must be cooled with ice immediately after harvest, and kept at the same temperature when being transporting from farm to factory.

	Fresh fish	Rotten fish
Skin	Bright and lustrous	Discolored and faded
Mucous layer on the skin	Watery and transparent	Opaque or not transparent
Eye	Convex, with a transparent and lustrous cornea	Concave or flat, with a cloudy color
Gills	Red or bright pink, no mucous	Yellow to brown, with mucous
Odor	No smell	Foul smell that resembles ammonia
Body	Firm, shiny, does not leave a mark when pressed with a thumb	Not firm, leaves a noticeable mark when pressed with a thumb
Scales	Tight and stick to the skin, hard to peel	Easy to peel
Floating	Does not float when put in water	Floats when put in water
Blood	No visible hemorrhage when fish are cut open	Dark red blood that smells foul

Table 1. Characteristics of fresh and spoiled fish.

1.2. Recommendations for manufacturing fish hygienically

It is not recommended to peel shrimp or to skin fish (fillet). Nor is it recommended to cut open the belly of the fish or to remove the head and scales in the same place where fish waste and residue accumulate. This could contaminate the fish and increase bacteria.

The most common mistakes when processing fish manually outside of fish factories is washing the fish after cutting open the abdomen and removing the head and fillets. Washing should be done after each and every stage.

1.2.1. Gutting

Carry out this process carefully. First, wash the abdominal cavity with clean running water. When handling the fish, look for any cut or injury that could contaminate the fish and make it spoil quicker. If the fish was transported longer than 2 days, you can cut the belly open. If transported less than 2 days, cool it down immediately.

1.2.2. Cutting off the head

Of the various preparation options available, storing fish whole is best, followed by fish with their belly sliced open, and then fish with their belly sliced open and the head removed. As such, do not cut the head off unless you are processing the fish directly or extracting the fillets on the spot, as cutting the head off increases the area of contamination and penetration of microbes into the tissues of the fish, leading to a shorter shelf life.



Plate 1. Characteristics of fresh fish.

1.3. Popular fish recipes

1.3.1. Fried tilapia



Ingredients

- 1½ kg of tilapia
- 2 lemons
- 1 tbsp of salt
- 1 tbsp of ground coriander
- 1 tbsp of cumin
- 1 tbsp of black pepper
- 15 fresh minced garlic or 2 tbsp of garlic powder
- 1 tsp of paprika
- ¼ tbsp of turmeric

Instructions

1. Wash and clean the fish thoroughly under clean running water. Add salt and lemon, and soak for half an hour in water, then rinse. Use a sharp knife to make crosscuts in the body of the fish.
2. Mix the ingredients for the marinade with an electric mixer, then add lemon juice. Marinate the fish until the seasoning enters the cuts and soaks into the meat. Transfer the marinated fish into a bowl, then cover and place in the refrigerator for an hour, after which it will be ready to fry.
3. Prepare the flour in a flat dish. Dip each fish on both sides, and place it in deep hot oil until it becomes golden, then serve.
4. For crispy tilapia, use two plates, one filled with flour and the other with water. After coating the fish in flour, place it in water for several seconds, then take it out and dip it into the flour again. Put the fish immediately in the oil, and fry it on both sides for 10 minutes until the fish becomes crunchy and turns a golden color.
5. Serve the fried tilapia with rice, and either a green salad or a tahini salad.

1.3.2. Fried tilapia fillets



Ingredients

2 Nile tilapia boneless skinless fillets
20 g of all-purpose flour
½ large egg
2 tbsp of bread crumbs
Salt and pepper to taste
Vegetable oil (for deep frying)

Instructions

1. Whisk the egg in a bowl until it foams.
2. Mix the flour, salt and pepper in another bowl.
3. Dip the fish fillet into the flour. Shake off any excess flour.
4. Place the fillet into the egg and then into the bread crumbs, using your hand to coat fish well with crumbs on both sides.
5. Fill a large deep-frying pan with 5 cm of oil and heat it up to 180°C.
6. Place the fish in the pan and deep-fry it until it is fully cooked. Use kitchen tongs to remove the cooked fish and then put it on kitchen paper to drain.

1.3.3. Tray tilapia



Ingredients

- 2 tilapia fillets
- 1 tsp of butter
- ½ tsp each of salt, pepper, cumin, coriander and dill
- ¼ tsp of garlic
- ½ lemon, sliced
- 1 tomato, sliced
- 1 green pepper, sliced

Instructions

1. Pre-heat the oven to 190°C.
2. Brush the baking tray with oil.
3. Place the fillets in the baking tray and place a spread pieces of butter on top.
4. Marinate the fillets with spices and garlic.
5. Spread the lemon slices on top of the fillets.
6. Arrange the slices of tomato and green pepper around the fish, and then sprinkle with salt and pepper.
7. Cover the tray with foil and place it into the oven for 15–20 minutes until the vegetables become soft and the fish is cooked and easy to cut with a fork.

1.3.4. Tagine of Nile perch fillets

Ingredients

1 kg of Nile perch fillets
4 fresh tomatoes
½ cup of lemon juice
2 large onions
2 cloves of large garlic
1 tsp of ground cumin
Salt and pepper

Instructions

1. Place the fillets into a large tray, and season them with salt, pepper, cumin and lemon juice.
2. Cut the onions into strips and spread them over the fish. Cover the tray and place it in the refrigerator for about 15 minutes.
3. Cut the tomatoes into strips and place them in an electrical chopper. Add garlic, a few drops of water, and salt, then grind everything into a smooth paste.
4. Remove the fish from the fridge and cut to preferred sizes.
5. Add the onions to the tomato paste and grind until the onions have disintegrated.
6. Put the tomato sauce in a tray on the fire until it boils. Then add the fish slices and leave it to half-cook over low heat for 20 minutes.
7. Transfer the fish and the sauce to an oven tray and put it in the oven for 10 minutes or until the fish turns golden brown.

1.3.5. Tilapia fillets in hot tomato sauce



Ingredients

4–6 fresh tilapia fillets
1 tbsp of salt
1 ½ tsp of hot chili sauce
¼ tsp of ground turmeric
9 tbsp of oil
1 tsp of fennel seeds
1 tsp of mustard seeds

175 g of finely chopped onions
2 cloves of finely minced garlic
2 tsp of ground cumin
400 g of tomato paste
1 tbsp of parsley, cut coarsely for decoration
2 tsp of ground cumin

Instructions

1. Dab the tilapia slices dry and season both sides with half a teaspoon of salt, half a teaspoon of hot chili, and the turmeric. Leave the fish to marinate for 30 minutes.
2. In a suitably sized pan, add 4 tablespoons of oil and heat on medium.
3. Once the oil is hot, add the fennel and mustard seeds. After a few minutes, when you hear the seeds popping, add the onions and garlic and stir until the mixture turns light brown. Add cumin, 1 teaspoon of salt and 1 teaspoon of hot chili sauce. Stir once.
4. Add the tomato paste, diluted with a few drops of water. Cook the mixture on low heat for 15 minutes.
5. Pre-heat the oven for 15 minutes.
6. In a large cooking pot (tray or a non-stick frying pan), heat 5 tablespoons of oil on medium to high. When the oil is heated, fry the tilapia slices on both sides until they turn light brown (semi-cooked).
7. Place the cooked fish in a deep casserole, pour over the cooked tomato sauce and put the casserole in the oven. Leave uncovered for 15 minutes or until the fish is fully cooked.
8. Serve the fish on a plate and pour the tomato mixture over it. Decorate with lemon slices and chopped parsley.

1.3.6. Slices of tilapia with green wheat (*Freekeh*)



Ingredients

½ kg of fish fillets	1 medium onion, chopped
1 tbsp of minced garlic	1 large tomato, chopped
1 piece of green chili pepper	3 cloves of garlic, sliced
Juice of 2 lemons	1 cup of green wheat (<i>freekeh</i>), washed and soaked in water
Vinegar	Oil
2 tbsp of green coriander, minced	1 stick of celery, minced
Salt, pepper and cardamom	1 stick of leak, minced
Fish spices	½ cup of tomato juice
Ground dry cumin and coriander	¼ cup of lemon juice

Instructions

1. Cut the fish into medium-sized slices.
2. Mix the garlic, green chili pepper, lemon juice and vinegar, and mince in an electric chopper.
3. Transfer the mixture into a large pot, add the fish spices, cumin and coriander, salt and pepper, and mix well with a few drops of oil.
4. Marinate the fish, fully submerged, in the mixture and leave for 30–60 minutes.
5. Remove the fish from the marinade, coat with flour and then fry in oil.
6. Put a few drops of oil in a tray with the chopped onions and stir continuously until soft.
7. Add the slices of garlic and stir until they turn golden brown. Add 1 teaspoon of marinade.
8. Add the *freekeh* to the mixture of onion and garlic, then spread the celery and leak and stir well on the hob.
9. Add the chopped tomatoes to the *freekeh* and stir well. Pour the tomato juice, fish spices, cumin, coriander, salt, pepper and 1 pod of cardamom.
10. Prepare an oven tray. Put ⅓ of the *freekeh*, spread the pieces of fish on top and cover with the rest of the *freekeh*. Finally, pour 2 tablespoons of tomato sauce on top with some minced coriander.
11. Pre-heat the oven to 180°C. Place the tray in the oven and cook for approximately 15 minutes or until the *freekeh* is fully cooked.

1.3.7. Fish *hawawshi* (pita bread stuffed with fish meat)



Ingredients (stuffing)

100 g of minced fish meat
2 tbsp of oil
Fresh coriander
Parsley and dill
1 green hot chili, minced
2 cloves of garlic, finely minced
Ground black pepper
Salt
1 small onion, cut into slices
Juice of 2 lemons
2 tbsp of mozzarella cheese
¼ tsp of hot sauce

Ingredients (dough)

½ cup of flour
2 tbsp of yoghurt
1 tsp of dry yeast
1 tsp of oil
3 tsp of salt
1 small egg

Instructions

1. Heat the onion, garlic, minced green hot chili (semi-cooked) and then remove from heat.
2. Combine all the *hawawshi* ingredients, including the fish, with the cooked onion, garlic and minced green hot chili (stuffing).
3. Combine all the ingredients needed to make the dough, except the egg.
4. Let the dough ferment for 20 minutes.
5. Knock the dough with your hands to release the air and cut it into small balls, (size of a clementine) using a roller to flatten each ball into a small round shape.
6. Mix the stuffing between two of the round pieces.
7. Whip the egg briefly and brush the top layer with it.
8. Pre-heat the oven to high.
9. Arrange the fish *hawawshi* in the oven so that they do not to touch each other and then cook for 10 minutes or until the surface of the bread turns golden brown.

1.3.8. Steamed mullet



Ingredients

2 pieces of mullet, cleaned well
3 lemons, sliced
100 g of carrots, chopped
100 g of courgettes, cut into rings
100 g of onions, cut into rings
20 g of minced garlic
50 ml of soy sauce
20 g of salt
5 g of black pepper
20 g of yellow mustard

Instructions

1. Use a sharp knife to cut the fish open and then flatten the halves into the shape of a butterfly (*singari*). Add the lemons, garlic, soy sauce, salt, black pepper and yellow mustard on top of the fish.
2. Leave the fish in the refrigerator for a minimum of 1 hour.
3. Remove the fish from the fridge and top with the carrots, courgettes and onions. Pre-heat the oven to 100°C. Place the prepared fish on a stainless steel rack and put it in the heated oven with a dish of hot water below to create steam (or over a hot water bath on the hob, kept covered until completely cooked).

2. Minced fish products and processed fish

Sometimes, fish take a long time to sell, or are not sold at all. Two possible reasons why are that scales and small bones are often left inside the fish, or that consumers do not like the shape or taste.

In this case, it is often better to mince the fish to produce such products as kofta (balls), burgers, fingers and sausages. The best fish to mince is carp (*Al Mabrouk*).



Plate 2. Filleting common carp and grass carp.

2.1. Traditional fish recipes

2.1.1. Fish fingers



Ingredients

- 1 kg of fish fillets
- 1½ cups of corn flour
- 1 egg
- Bread crumbs/spiced
- 1 tbsp of ground dried garlic
- 1 tbsp of ground black pepper
- 1 tbsp of ground cumin
- 1 tbsp of milk powder
- 1 tbsp of salt

Instructions

1. Clean the fish thoroughly.
2. Skin the fish to cut out the fillets.
3. Rinse the fillets with clean cold water.
4. Slice the fillets lengthwise into small strips and shape them into fingers.
5. Mix the garlic, black pepper, cumin and salt together and mix well with the fingers.
6. Place the seasoned fish fingers in the freezer for 20 to 30 minutes.
7. Mix the corn flour, egg yolk and powdered milk together with a pinch of salt. Add a little water to make the dough soft.
8. Remove the fingers from the freezer and dip them into the dough.
9. Turn the dough-covered fingers in a bowl of bread crumbs and freeze them. Alternatively, you can either fry them partially and then freeze them, or fry them directly in a hot deep fryer.

2.1.2. Fish kofta (balls)



Ingredients

1 kg of minced fish
½ cup of corn flour
1 egg
Boiled potatoes
Bread crumbs
Skim milk powder
Dried ground garlic
Dried ground onion
1 tsp of ground black pepper
Ground cumin
Fresh parsley and coriander
1 tbsp of salt

Instructions

1. To make the dough, mix the flour, egg, milk powder, salt and black pepper, and then add 200 ml of water.
2. Dip the kofta pieces into the mixture and then turn them over in the bread crumbs until fully coated. Place them on a foam dish and wrap with polyethylene bags. Each dish should contain ½ or 1 kg of pieces.
3. Enclose the product data card and use an electric sealing machine to close the bag. The card should include the method of freezing, date of production, best before date and cooking instructions.
4. Freeze the pieces at minus-18°C
5. Cook partially or fully on medium heat and then consume immediately.

2.1.3. Fish burgers



Ingredients

100 g of minced fish
1 small onion, cut into strips
2 cloves of garlic, finely minced
1 carrot, shredded
Fresh coriander
Dill
Parsley
1 chili pepper, minced
1 tsp of ground black pepper
Fine salt
Lemon juice
1 egg
2 tbsp of bread crumbs
1 tsp of mayonnaise

Instructions

1. In a medium-sized frying pan, fry the onion, garlic and chili pepper, then remove and set aside.
2. Mix all the remaining ingredients together with the onion, garlic and the cooked pepper.
3. Make small balls out of the mixture and then flatten into burgers. Make the sure that all burgers are the same size so that they cook evenly.
4. Set a frying pan on a medium heat and then add oil.
5. Place the burgers in the frying pan, making sure that they do not to touch each other, and fry them without a lid for 10 minutes on each side, or until the burgers turn golden brown. They can also be barbecued on an electrical grill or a coal-fired grill.

2.1.4. Fish sausages

Ingredients

- 1 kg of fish meat
- 15 g of tail fat
- 1 tsp of salt
- 2 tbsp of bread crumbs
- 2 tbsp of starch
- ¼ tbsp of red chili
- ¼ tbsp of ground black pepper
- ¼ tbsp of nutmeg
- ¼ tbsp of fine sugar
- ¼ tbsp of ground cinnamon
- ¼ tbsp of ground cardamom
- ¼ tbsp of minced garlic
- 20 g of crushed ice
- ¼ tbsp of full fat or skimmed milk
- ¼ tbsp of dried ground thyme
- ¼ tbsp of ascorbic acid (optional)

Instructions

1. Thaw the fish, if frozen, then mince and add crushed ice to ensure the temperature does not exceed 15°C during the mincing process.
2. After 1–2 minutes of mincing, add the salt to form a jelly or emulsifier.
3. During the kneading, add the rest of the ingredients, saving any fat tissues for the end of the mincing and emulsifier process. For red sausages, add a natural (lycopene) or artificial color. Ascorbic acid could also be added.
4. Use natural or synthetic materials to make the casings.
5. Cook the sausages in water for 20 minutes at 85°C.
6. Cool the sausages for 30–40 minutes in a water tank or a basin. If the casings shrink after they are cooled, soak them in hot water for 10 to 30 minutes.
7. Pack and then freeze the sausages for sale or storage.

2.1.5. Fried catfish steaks



Ingredients

- 1 kg of catfish, cut into steaks
- 1 tbsp of fresh garlic, minced
- 1 tbsp of garlic powder
- 1 tbsp of onion powder
- 1 tbsp of cumin powder
- 1 tbsp of ground black pepper
- 1 tbsp of fine salt
- 1 tsp of lemon juice
- 4 small cartons of natural yoghurt

Instructions

1. Remove the heads of the catfish and drain the blood.
2. Remove the guts and wash the fish thoroughly.
3. Remove the skin.
4. Cut the fish crossways into medium-sized steaks.
5. Place the steaks in water and add vinegar.
6. Leave for 5 minutes and then rinse with cold water.
7. Empty the yoghurt into a big bowl, then mix the spices and add them to the yoghurt.
8. Coat the fish steaks with the mixture, then cover and keep in the fridge for 1–2 hours.
9. Take the steaks out of the marinade, rinse off any excess liquid and coat well with the flour.
10. Fry the steaks in oil on medium heat until they turn golden brown.

2.2. Non-traditional fish recipes

2.2.1. Tilapia fillets with lemon and parmesan cheese



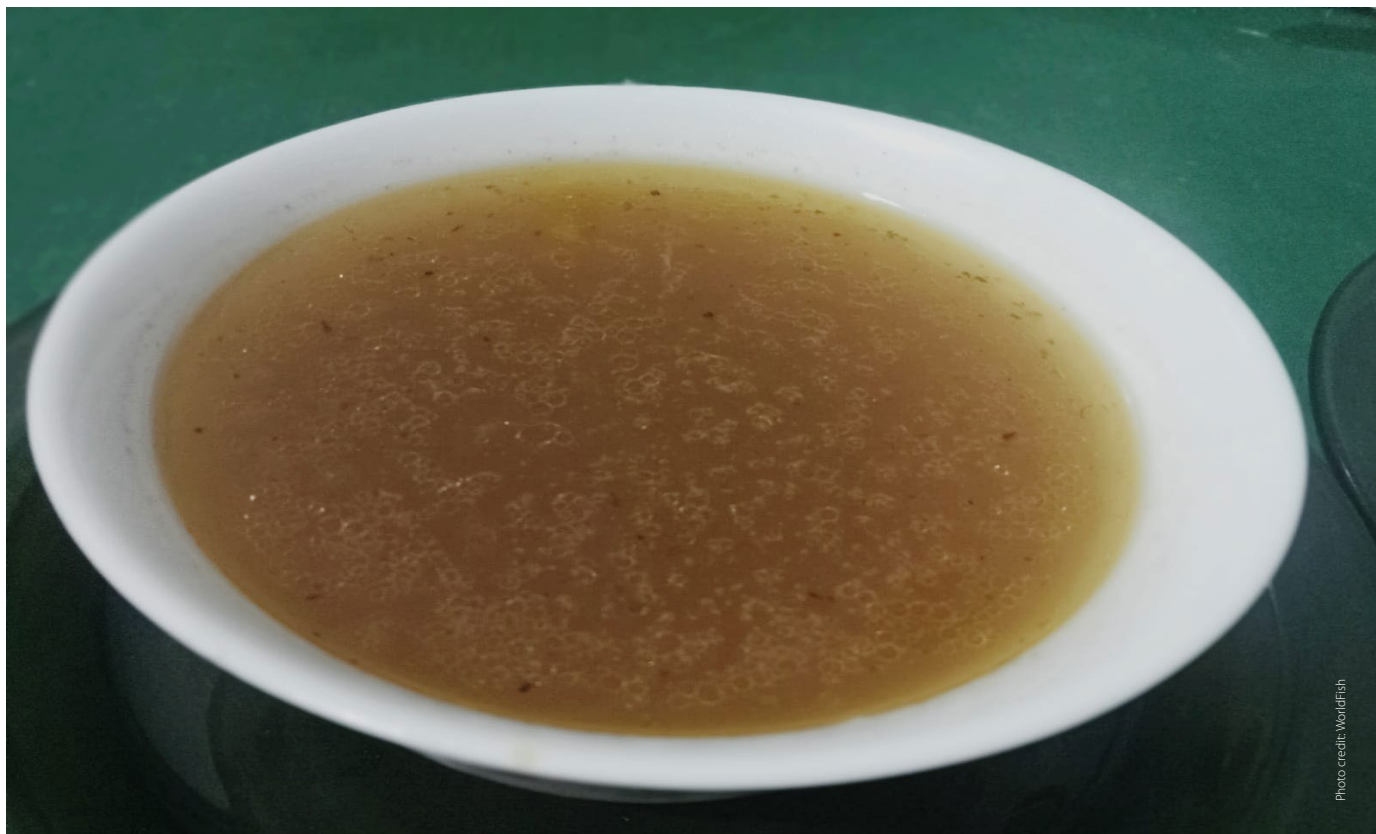
Ingredients

6–8 strips of fresh tilapia fillets
3 tsp of soft butter
2 tbsp of lemon juice
250 ml of mayonnaise
150 g of parmesan cheese, shredded
¼ tbsp of onion powder
¼ tbsp of dried celery
Pinches of salt and pepper to taste

Instructions

1. Rinse the tilapia strips under cold water, drain well and cover with butter and lemon juice.
2. Mix the parmesan cheese, butter, mayonnaise, lemon juice and spices together.
3. Place the tilapia strips in a tray greased with oil. Put them under the grill for 2–3 minutes, then turn them over and cook for another 2–3 minutes.
4. Take the strips out and cover them with the mixture.
5. Put them under the grill for 2 minutes until they turn golden brown. Serve the grilled tilapia strips garnished with slices of lemon and fresh parsley.

2.2.2. Tilapia and mushroom soup



Ingredients (makes 1 kg of fish stock)

500 g of tilapia, cut into pieces

25 g of mushrooms, cut into small pieces

1 onion, cubed

Celery stick, minced

1 tbsp of vegetable oil

1 clove of garlic

Cardamom and mastic

Fine salt

Ground black pepper to taste

Instructions

1. Remove the head, fins and guts, clean the fish well and rinse with salted water.
2. Place the fish in a deep pot over the hob and add the cardamom, mastic and minced stick of celery.
3. Add the mushroom pieces and stir well.
4. Add 2 cups of water, leave the mixture to boil vigorously and then add the onion.
5. Place the fish pieces in the pot, cook for 30 minutes and season with salt and pepper.
6. Filter the fish soup through a sieve and serve it in bowls.

3. Salted fish products

3.1. Salted fish process (*fesikh*)

1. Choose a good type of fresh fish, preferably mullet or broad sardine. Make sure that the texture of the skin is soft, the gills are red and the fish does not smell bad.
2. Clean the fish well and dry it fully using a strainer.
3. Cover the fish with a piece of cloth to keep out insects and dust, and leave it for 2 days.
4. Use a large wooden barrel, or clay pots, to drain any harmful substances, water and any excess salt out of the fish, as these containers are porous. Specially prepared plastic containers can also be used. It is preferable to add small amounts of spices (turmeric) and chili pepper to the salt during the salting process.
5. Place and stack the fish beside each other, with the head of each fish beside the tail of another, to maintain a flat surface. Cover the first layer with salt and spices, then add another layer of fish the same way until the barrel is completely filled. Make sure that the final layer is covered with salt and spices.
6. It is important to store the barrel in a place that is not exposed to the sun. Do not open the barrel for at least 2–3 months. If the cover is removed before this and exposed to the air, the fish will spoil.
7. The shelf life of the salted fish (*fesikh*) is 6 months to 1 year in good storage conditions.



3.2. Signs of spoiled salted mullet fish

Eyes: For unspoiled salted fish, such as mullet and sardines, which are suitable for consumption, it is important to check the eyes, which should be slightly cloudy. If the fish has spoiled, the eyes will look brown and yellowish.

Skin: Unspoiled fish will be bright and shiny, while spoiled fish will have curly skin, look faded, feel slimy and smell rancid.

Muscles: The muscles in unspoiled fish will appear shiny, gray and red. If the fish are spoiled, they will look cloudy and yellowish to brownish.

Texture: Unspoiled fish will feel tender, and the meat will be easy to remove from the bones. In spoiled fish, the texture will feel sticky, and the meat will not be easy to remove from the bones.

Smell: Unspoiled fish has a very distinctive pleasant smell, while spoiled fish smells rancid.

Taste: Unspoiled fish that consumers like usually tastes salty, while spoiled fish has a rancid, sticky-sweet taste.

3.3. Salted fish recipes

Consumers enjoy eating sardines, as they are delicious, affordable and have many other benefits. Sardines are rich in protein in addition to having many vitamins, the most important being B12 and D.

3.3.1. Salted sardines



Ingredients

- 1 kg of fresh sardines
- 200 g of pure salt
- 1 tsp of chili powder
- 1 tbsp of vinegar or lemon
- 1 tbsp of olive or vegetable oil

Instructions

1. After buying fresh sardines, do not wash or cut open the belly, as this can spoil the sardines during the salting process.
2. Use a strainer to drain any excess water and juices that might have formed while being frozen.
3. In a small bowl, mix the salt and chili powder together.
4. Place the mixture into the gills, and coat the outer openings so that they are fully covered, then repeat with the rest of the mixture.
5. Arrange the seasoned sardines in sealed plastic bags in alternating layers on top of each other.
6. Pack the bags in clean plastic boxes and close tightly. Place the boxes in a very well-ventilated place for 1 week to 10 days.
7. Remove the salted sardines from the boxes and wash and clean them well to remove any remnants of the mixture. The salted sardines are then ready to eat.

4. Smoked fish products

Smoking fish is one of the oldest methods of preservation. In this process, the fish are preserved with smoke by burning hardwood or sawdust. This gives the fish a pleasant taste, smell and color, as well as other features.

4.1. Smoked fish processing

The smoking process includes the following steps (in order): washing or rinsing, salting, removing excess salt, partial drying, smoking, and wrapping and packaging.

4.1.1. Washing or rinsing

This involves washing and spraying the fish with clear tap water to clean the surface of the fish quickly and easily.

4.1.2. Salting

There are three options for the salting process: dry, wet and mixed.

In dry salting, salt is used in alternating layers with the fish, with the first and last layers being salt. However, this is a slow process and requires a lot of water. It also hardens the fish hard, making them unable to hold water. The end product will be high in salt, but it will last longer than the other two methods.

In wet salting, different concentrations of brine are prepared up to a saturation level of 26% salt. The salting time depends on the salt concentration, as the higher the concentration of the saline solution (brine), the less time that is needed, and vice versa. The salting time also depends on the type of fish being processed, whether small, large, sliced, fat or fleshy.

Mixed salting is a combination of the other two methods. The fish are mixed with dry salt first, then placed in salting containers or barrels and sprayed with brine.

Salting fish first allows them to partial dry before smoking. It also has an anti-microbial effect and acts as a preservative agent that decreases the humidity. This gives the fish the desired taste after smoking, and improves the texture and color of the fish.

4.1.3. Removing excess salt

This is done by soaking the fish in water at a rate of 1:1 by weight for 1–2 hours.

4.1.4. Partial drying

Partial drying prepares the surface of the fish for the smoking process, as 10 percent of the moisture is found on the surface of the fish. This process is carried out either in normal air temperatures for up to 6 hours or at a temperature that is higher than normal (artificial drying) for only about 1 hour.

4.1.5. Smoking

Two traditional methods are used in smoking: cold and hot. Both burn solid wood sawdust to smoke salted and partially dried fish. Other smoking methods include electric smoking and using smoking fluids.

Cold smoking takes place in kilns or airtight compartments called smoking houses, which may or may not be separate from the place where the smoke is generated. Smoking houses where the fish are smoked in the same place that the smoke is generated must be at least 3.5 m high, while smoking houses that are separate

from where the smoke is generated must be 2 m high. If the fish are partially dried inside the smoking house, the top must be left open. If they are dried outside the smoking house, the top must be closed.

Hot smoking involves smoking lightly salted fish at a temperature of 70°C–80°C. This is a quick method that lasts for 2–3 hours and gives the fish a soft texture. The drawback is that the shelf life is shorter because of the high moisture ratio and lower salt concentration.

	Cold smoking	Hot smoking
Smoking temperature	15°C–30°C	40°C–80°C
Smoking time	Several days, according to the type and size of the fish	Several hours, according to the type and size of the fish
Effectiveness and efficiency	Slow	Seven times faster than cold smoking
Changes that occur to the smoked product during curing	The natural decomposition and breaking down of the histological structure occurs by the action of natural enzymes and microbial enzymes	Denitrification of proteins occurs in the muscles and partial catabolism of collagen
Texture	Drier, less moisture, hard texture	Dehydration occurs, less moisture, softer texture
The effect on the phenol content of the smoked product	Increased phenol content, which also depends on the amount of fat in the fish and the smoking time	A lower incremental rate of the phenol content because the smoking time is shorter
The effect on the carbonyl content in the smoked product	No difference in effect between the two methods	No difference in effect between the two methods

Table 2. The difference between cold smoking and hot smoking.

4.1.6. Wrapping and packaging

The smoked fish is packed in wooden boxes in alternating layers of fish and cellophane paper. The boxes are closed tightly and the product data card is placed inside. Packing can be done in specially prepared plastic bags for this purpose, with the product's information written on it, and vacuum-sealed to make it easier to sell.

4.2. Signs of spoiled smoked fish

Micrococci can cause rotting or dry spoilage. Signs include dry skin, wrinkles and a faded shine. A layer of oily fat makes the skin appear brown and the muscles turn yellowish brown. The fish will also smell very bad.

Wet rot is caused by types of bacteria such as *E. coli*, *bacillus fluorescence*, *Proteus* and *Pseudomonas eruginosa*. Signs include moist muscles, stickiness, mucous and sticky viscera. Here too the fish will smell very bad.

4.3. Smoked fish recipes

4.3.1. Smoked catfish fillets



Ingredients

- 2 kg (minimum) of large catfish fillets
- 500 g of fine salt
- 2 tbsp of vinegar

Instructions

1. Slaughter a catfish and drain its blood.
2. Skin the catfish and remove all the bones to make fillets.
3. Wash the fillets well under clean running water.
4. Place the fillets in a salty solution, add a little vinegar and let stand for at least 4 hours.
5. Drain the solution and allow the fillets to air dry.
6. To smoke the fish, place sawdust in a box connected to the smoking chamber. Light the sawdust and allow the smoke to surround the fish (incomplete combustion). For best results, use citrus wood, which gives the fish a good flavor.
7. Arrange the fillets on specially designed griddles in the smoking chamber, and allow the smoking process to continue.
8. Place the fish high enough so that the heat source does not burn them, but make sure that smoke is still coming through the sawdust.
9. Place the smoked fillets in foil dishes and wrap them.

5. Health and safety recommendations for preparing and processing fish

- Make sure all new staff have health certificates and carry out periodic health checks.
- Do not allow any worker to come into direct contact with the fish if they have any wounds on their hands that are not covered with proper medical tape.
- Staff must wear special uniforms, including headwear and gloves.
- Immediately isolate any workers who exhibit any of the following symptoms: a cold, fever, vomiting, diarrhea, festering wounds, sore throat or hepatitis C.
- Apply strict disciplinary regulations to prevent smoking in the area of fish processing.
- Promote a personal hygiene policy to make sure that healthy habits and behaviors are applied across all processing stages to prevent any contamination of the fish.

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Annex 1. List of participants in the expert workshop to review the manual

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Dr. Mohammed Abd El-Hadi	Fish processing researcher	National Institute of Oceanography and Fisheries
Dr. Hany Al Minshawi	CEO	Summer Moon Co. For Seafood
Ms. Nevin Mohammad Mustafa	Fish processing factory manger	Summer Moon Co. For Seafood
Chef. Yasser Ramadan Al-Masry	Professional chef	Egyptian Chefs Association
Chef. Islam Kamel Ali	Professional chef	Egyptian Chefs Association
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About WorldFish

WorldFish is an international, not-for-profit research organization that works to reduce hunger and poverty by improving aquatic food systems, including fisheries and aquaculture. It collaborates with numerous international, regional and national partners to deliver transformational impacts to millions of people who depend on fish for food, nutrition and income in the developing world.

The WorldFish headquarters is in Penang, Malaysia, with regional offices across Africa, Asia and the Pacific. The organization is a member of CGIAR, the world's largest research partnership for a food secure future dedicated to reducing poverty, enhancing food and nutrition security and improving natural resources.

For more information, please visit www.worldfishcenter.org