

Principles of Fish Smoking

Delivered by Seafish approved Senior Trainer: Ivan Jaines-White



Here to give the UK seafood sector **the support it needs to thrive.**

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1. Welcome

- Aspirations
- Video: from early beginnings
- Aims and objectives

Programme

1. Welcome:

- Aspirations
- Aims and objectives

2. Introduction to smoking:

- History
- Types of smoked products
- Types of equipment
- Types of kilns
- Food preservation methods

3. Raw materials and additives:

- Fish
- Salt , sugar and water
- Additives and flavours

4. Curing, salting and brining

- Salting
- The brining operation
- Managing the brine
- Hanging
- Practical considerations

5. Smoke generation

- Wood types, grades and flavour
- Smoke production methods
- Chemical makeup of smoke
- Reflection

6. The smoking process

- Preparation is the key
- Traditional chimney
- Mechanical horizontal
- Mechanical vertical
- The AFOS micro kiln
- Controlling the process
- Practical considerations
- Operating a micro kiln

7. Post smoking process

- Maturation
- Yield
- Staged weighing process
- Labelling and packaging
- Shelf life

8. Food safety issues

- General food hygiene
- When does fish start to spoil and why?
- Bacteria
- Temperature
- Bacterial multiplication
- Summary
- Allergens
- Cross contamination
- Guidance

9. Hobbyist or business

- Conclusions and discussions
- Next steps and post course support

Aspirations



- Lynn Noon and brother Keith Gibson proudly showing a range of smoked products they accomplished during a Seafish Smoking course using the AFOS Micro Kiln
- Smoked Salmon sides, Kippers. Haddock fillets, hot & cold smoked Mackerel and smoked Sprats
- *"We thoroughly enjoyed every minute of the smoking course we attended two years ago. Would highly recommend this not only to trade but anyone in the catering industry or individuals who are looking for new experiences on preparation and preservation of seafood."*



From small beginnings...

- [Introduction to Why we do What we do YouTube video](#)



Market/customer perceptions

- A question that is often asked being “is it really smoked or just flavoured?”:
 - Icelandic or Greek style yoghurt
 - Smoke flavoured chicken
 - Faux caviar
 - Smoke flavours

Aims and objectives

Aims

- To provide insights into:
 - ancient food preserving methods and significance in today's smoking processes
 - the history, art and science of smoking
- To provide an introduction to the brining, salting and smoking of fish
- To introduce key concepts, essential practices and useful insights into the production of smoked fish

Objectives

- To give you more confidence and understanding of how to safely produce smoked products

2. Introduction to smoking

- History
- Types of smoked products
- Types of kilns
- Food preservation methods

Origins of smoking

- Examples of early curing and smoking methods:
 - Curing (salting) drying, smoking. The origins of these methods of preservation are lost in the sands of time but each of those preserving methods have endured to this day, individually or combined.
- The enduring principles of the smoking process:
 - Centuries ago, although not understanding the science people would use salt curing and drying to remove moisture, one of the essentials for bacteria to survive. Salt is also a hostile environment for bacterial growth. Fish originally was heavily smoked for long periods to remove moisture.



Drum-type ovens

One of the common types of ovens in the tropics is one made from a 44-UK gal (200-l) oil drum. It is easily transported and especially convenient for individual fishermen who move from place to place following the fish, and whose catches are not large. However, since in the traditional drum-type oven the fish are smoke-dried in a single layer only, placed on top of the drum, the capacity of the oven is very limited. To increase the capacity of this type of oven, modified versions based on the results of numerous experiments are suggested allowing a seven-fold increase in capacity, to 35 kg (77 lb) per batch while the time of smoke-drying remains unchanged. Separate versions of the drum-type ovens are recommended for use on dry land, and for use in swampy areas or aboard fishing boats.

FAO Fisheries Technical Paper No. 104
(Distribution restricted)

3.43 : 3.42
3.41 : FIIP/T104
3.63 : 3.64



EQUIPMENT AND METHODS
FOR IMPROVED SMOKE-DRYING OF FISH IN THE TROPICS



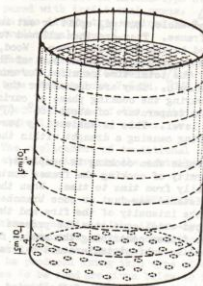
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ROME, 1971

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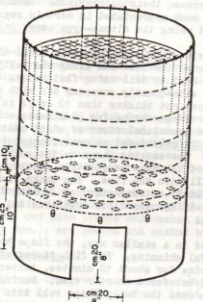
ANNEX 1

FIIP/T104 (En)

DRUM-TYPE OVENS



a) - For use on dry land



b) - For use in swampy areas or aboard fishing boats

(a) List of material needed for construction of drum-type oven - version for use on dry land

	Pieces
44 UK gal oil-drum	1
Welded iron rod netting, mesh 5 x 5 cm (2 x 2 in), # 60 cm (24 in)	7
Flexible iron wire, # 4 mm (1/8 in)	
Length: 20 cm (8 in)	3
30 cm (12 in)	3
40 cm (16 in)	3
50 cm (20 in)	3
60 cm (24 in)	3
70 cm (28 in)	3
80 cm (32 in)	3
Corrugated iron sheet, 60 x 60 cm (24 x 24 in)	1

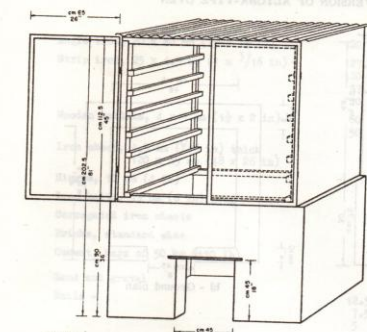
(b) List of material needed for construction of drum-type oven - version to be used in swampy areas or aboard fishing boats

	Pieces
44 UK gal oil-drum	1
Welded iron rod netting, mesh 5 x 5 cm (2 x 2 in), # 60 cm (24 in)	5
Iron rods, # 5 mm (1/8 in)	
Length: 60 cm (24 in)	2
Flexible iron wire, # 4 mm (1/8 in)	
Length: 20 cm (8 in)	3
30 cm (12 in)	3
40 cm (16 in)	3
50 cm (20 in)	3
60 cm (24 in)	3
Corrugated iron sheet, 60 x 60 cm (24 x 24 in)	1

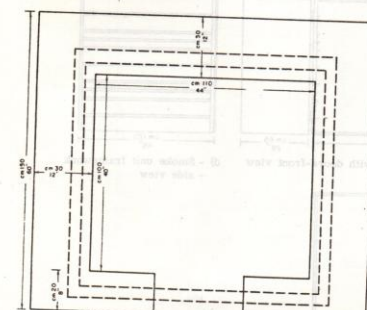
FIIP/T104 (En)

SIMPLE VERSION OF ALTONA-TYPE OVEN

ANNEX 2



a) - View



b) - Fire-box, ground plan

(c) List of material needed for construction of simple version of Altona-type oven

	Length	Pieces
Wooden battens - 2 x 2 cm (3/4 x 3/4 in)		
130 cm (49 1/4 in)	4	
120.5 cm (47 1/2 in)	4	
112.5 cm (44 1/4 in)	2	
100 cm (39 3/8 in)	2	
4 x 4 cm (1 1/2 x 1 1/2 in)	122.5 cm (48 1/4 in)	14
4 x 2.5 cm (1 1/2 x 1 in)	112.5 cm (44 1/4 in)	4
65 cm (25 5/8 in)	4	
Strip iron - 750 x 50 x 4 mm (30 x 2 x 3/16 in)		2
Corrugated iron sheets, 60 x 100 cm (24 x 39 3/8 in)		10
Clay blocks (dried), 20 x 10 x 10 cm (8 x 4 x 4 in)		300
Slings, 10 cm (4 in)		4
Nails - 1.5 cm (3/8 in)	1.5 kg (3 lb)	
2.5 cm (1 in)	0.5 kg (1 lb)	

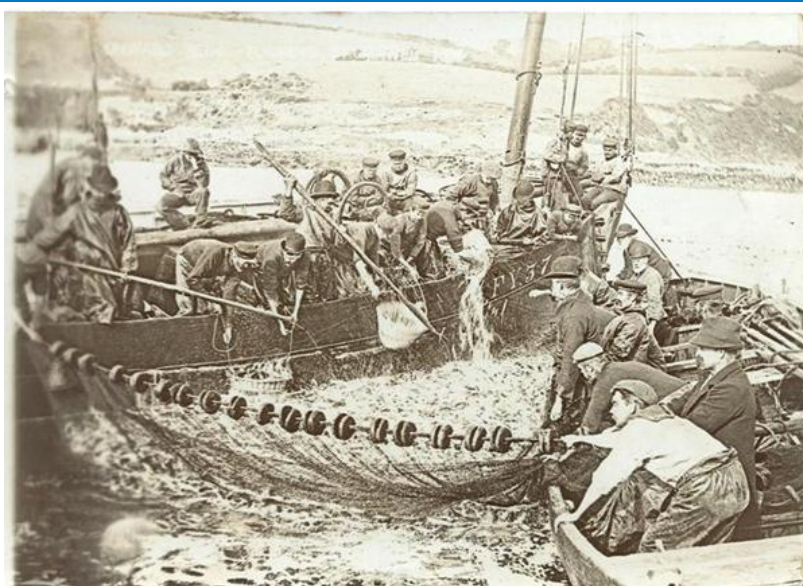
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Types of smoked products

- Hot
- Cold
- Intermediate
- Salted
- Brined
- Flavoured
- Whole
- Species
- Method

Types of kilns

- Traditional chimney
- Mechanical horizontal
- Mechanical vertical
- The AFOS Micro kiln
- Homebuilt



Food preservation methods

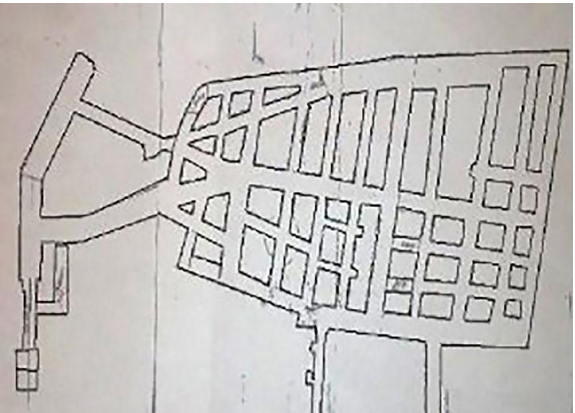
- Temperature reduction: long term - freezing and short term – chilling
- Water activity methods: curing, smoking, salting, drying:
- Fermentation often relies on A_w reduction
- Heat treatment: enclosed: cans, jars etc
- pH: Pickling and marinading

Temperature reduction



*Gustav Backmann and Siberian
ice tunnels*

Credit Siberian Times



- **Freezing** is frequently thought of as a recent technology.
- There is no doubt advances in rapid freezing have advanced considerably in the last 50 years but it has been used as a food preservative for 1,000s of years in different parts of the world using the regional permafrost. The practice continues today but is being affected by climate change with ice cellars on the same parallels as Siberian permafrost experiencing rising temperatures.
- Good quality frozen product can be used for smoking & subsequent storage. As an example, the vast majority of mackerel used for hot smoking is frozen within a few months of the year when the fat content is at the required level. The same is true of Herring used for smoking.



Water activity methods and moisture reduction

- **Curing, brining, smoking, salting and drying:**
 - Each of the above methods will preserve fish and meat protein as individual applications or a combination of each as in the smoking process.
 - Removing moisture and imparting salt deprives bacteria of one of the essentials for growth.
 - Products will have shelf lives of a few days to several years.



Examples of smoked products

- Schillerlocken
- Salmon, Trout
- Sea Bream steaks
- Greenland Halibut steaks
- Kippers, Bloaters, buckling
- Mackerel, Sprats, Sardines
- Cod, Haddock, Coley and Pangasius
- Eels, Arbroath Smokies
- Smoked Roe
- Oysters, Mussels
- Other non-seafood products

Protected geographical food and drink names

- Arbroath smokies
- Traditional Grimsby smoked fish
- Cheddar cheese
- What others?

Non seafood smoked products

- Salt
- Spices
- Cheese
- What else?
- Water
- Oils
- Beer
- Pheasant
- Partridge
- Duck
- Goose
- Guinea Fowl
- Turkey
- Ostrich
- Venison
- Boar
- Skippy
- Brisket
- Chicken
- Sausage
- Hams
- Bacon

3. Raw Materials and Additives

- Fish types and characteristics
- Salt, sugar and water
- Additives and flavours

Fish types and characteristics

- Whitefish (demersal) Cod, Haddock, Coley, Whiting
- Oily fish (pelagic) Salmon, Tuna, Mackerel, Herring, Sardines, Pilchard, Sprats, Anchovy
- Oily fish (other) Greenland (Mock) Halibut, Eels, Red Bream
- Shellfish Oysters, Mussels, Scallops, Clams

Salt, sugar and water

- Food grade salt
- Sugar – white or brown
- Potable water

Additives and flavours

- Flavours – how many can you name?
- Pre or post smoking?
- Colours

Can you name some flavours?

- Beetroot cured
- Gin, Juniper, Grapefruit & Lime
- Rum, Lime and Ginger
- Whisky and Orange
- Whisky and Maple Syrup
- Lavender and Citrus
- Raspberry Vodka and Blueberries
- Tequila, Coriander, Chilli and Lime
- Fennel and Pernod
- Gin and Orange
- Chilli Smoked Salmon
- Cracked Black Pepper
- Honey and Bourbon
- Roasted Salmon with Honey Glaze
- Hot Smoked Mackerel with Cracked Black Pepper
- Dill
- Garlic
- Lime
- Piri Piri
- Chilli
- Coriander
- Crushed Nuts

Colours and other additives



Food dyes in fish smoking

- Main dyes used are natural in origin:
 - Annatto - Seed
 - Turmeric - Rhizome
 - Curcumin - Turmeric
- Do you know of any other forms of dye?

15-minute comfort break

Reflection on course so far

- Observations
- General comments
- Questions

4. Curing, salting and brining

- Salting
- The brining operation
- Managing the brine
- Hanging
- Practical considerations

Cold-smoking Salmon

- [Cold smoking Salmon YouTube video](#)



Salting

- Reflecting on the hand and machine salting in the video, are there any observations or questions at this time?

Salting and salt/sugar variations

Salt:

- Breaks down protein
- Helps to preserve
- Removes water
- Improves flavour

Sugar:

- The sugar can be a variation to the smoked Salmon process
- It can be added to the salting (or brining) process
- Sugar improves the storage quality of foods. A high concentration of sugar inhibits the growth of bacteria



The brining operation

Essential measures:

- Brine strength
- Time in brine
- Pellicle formation
- Temperature

Managing the brine

Essentials in making up brine

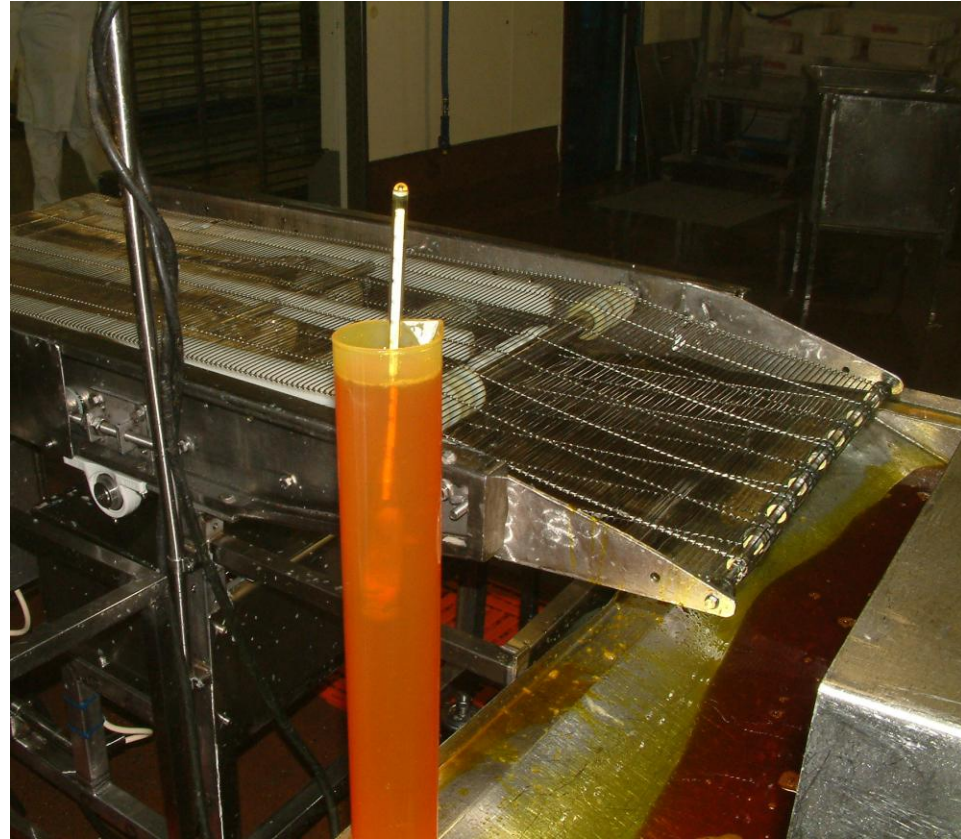
- Salt to water or water to salt?
- Brine strength?
- How long in the brine?
- Ensuring consistency
- Adding colour

Small scale measuring equipment

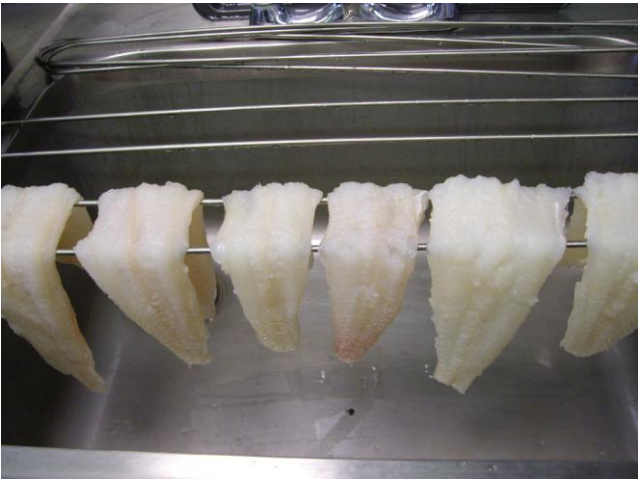
- Brinometer
- Thermometer
- Weigh scales and measuring jugs
- Timer



Measuring brine strength



Hanging and traying to allow essential draining and setting of pellicle



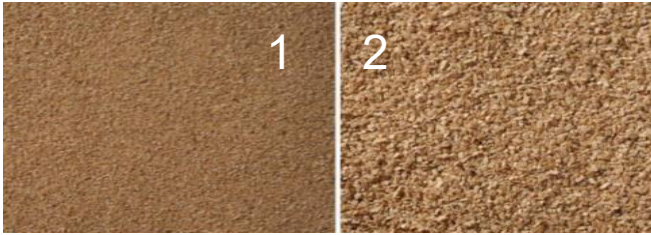
Practical considerations

- Where – raw material, brine container?
- How – where will product be placed after brining?
- How long before smoking?

5. Smoke generation

- Wood types grades and flavours
- Smoke production methods
- Chemical makeup of smoke
- Practical considerations

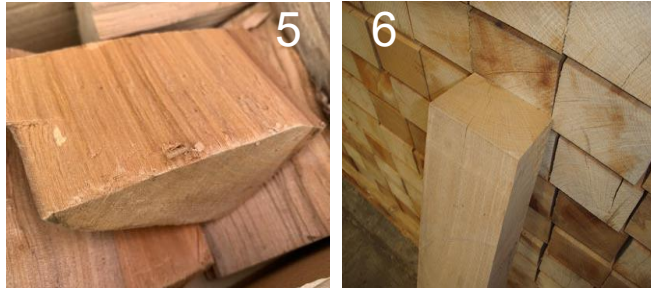
Wood types, grades and flavour



Different woods, wood blends and size will affect the smoking process and product in a number of ways



Softwoods: Juniper and Pine will add colour to the product



Hardwoods: Oak, Manuka, Hickory, Chestnut, Walnut, Ash, Apple, Cherry, Beech, Alder and Mesquite will add flavour



Blends are used to combine those features and can be an effective marketing aid

Food grade wood products free of contaminants are essential

Ashwood – smoking chips



Smoke production methods



- Smoke pit
- Smoke box
- Electrical/hotplate methods
- Friction wheels
- Others:
- Smoke guns



Chemical makeup of smoke

- Wood smoke is a very complex collection of (more than 300) chemicals
- The chemical makeup varies depending on wood type and temperature of burning:
 - low temperatures promote “aldehydes” production
 - higher temperatures promote “phenol” production
- Aldehydes impart a desirable smoked flavour
- Phenols impart a less desirable disinfectant flavour
- PAHs – Polycyclic Aromatic Hydrocarbons (see Seafish [guidance](#))

Reflection on wood types

Sawdust, chips, hardwoods, softwoods:

- What quality must each of the above have?
- Name some of the types of wood used?
- What do each add to the smoking process?
- Can they be mixed/blended?
- What are the implications of using composites such as plywood, sterling board, MDF?

6. The smoking process

- Preparation is the key
- Traditional chimney
- Mechanical horizontal
- Mechanical vertical
- The AFOS micro kiln
- Controlling the process
- Operating a micro kiln

Preparation is the key

- Good raw material
- Recognising product variations
- Standard operating procedures
- Brine consistency-measuring
- Brine immersion
- Salt content

Which fish is the King Salmon?



40-minute lunch break

Types of kilns

- Traditional chimney



Traditional chimneys



Traditional cold smoking video



[Traditional cold smoking YouTube video](#)

Observations – questions?

Reflecting on the video, what observations or questions at this time do you have in respect of:

- type of business?
- quantity of fish in brine?
- salting?
- product?
- environment?

This video was made some years ago before the change in ownership.

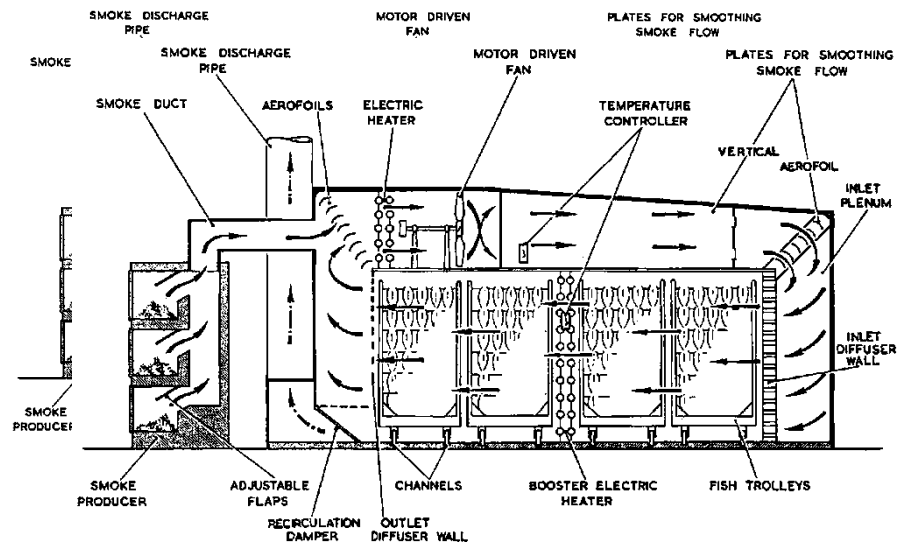




Reflection on course, so far

- Observations
- General comments
- Questions

Mechanical kilns – horizontal smoke flow



AFOS smoking kiln



Mechanical kilns – vertical smoke flow





Factory scale equipment – whitefish mechanical video

- [Whitefish mechanical YouTube video](#)



Observations – questions?

Reflecting on the video, what observations or questions at this time do you have in respect of:

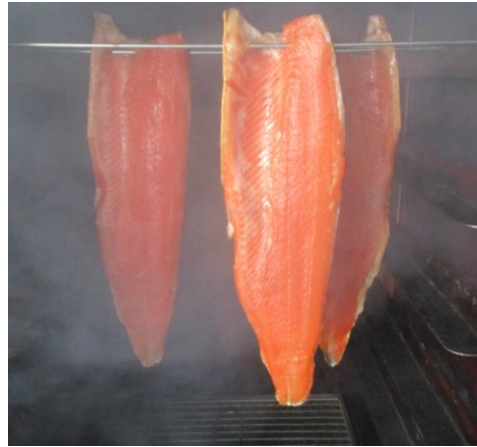
- type of business
- quantity of fish in brine
- product
- environment?

Mechanical kilns – vertical smoke flow



Operating a micro kiln

- History of the kiln
- Capabilities and limitations
- The controls
- Micro kilns in action

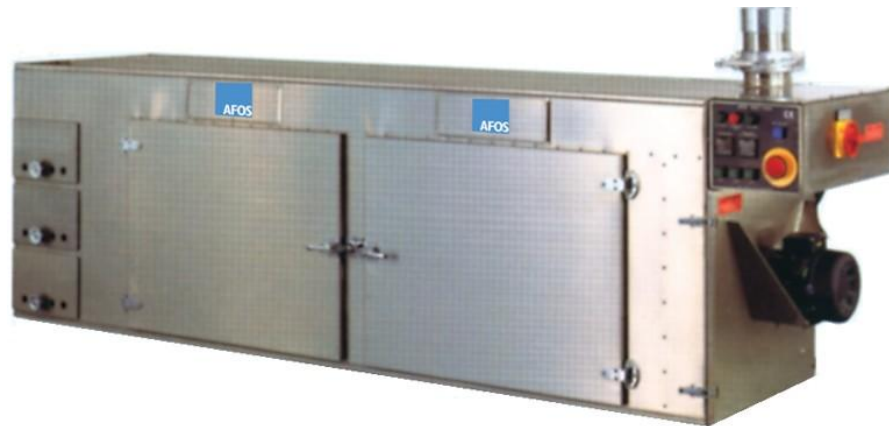




Micro kiln controls

- Time
- Temperature
- Smoke density
- Airflow
- Humidity

Domestic to small scale commercial applications



7. Post smoking processes

- Maturation
- Yield
- Staged weighing processes
- Labelling and packaging
- Shelf life

Maturation

- Maturation is a process during which the smoke flavours penetrate the product over time
- It will continue during chilling, overnight in a chillroom and will continue during transport
- Chilling smoked fish is an essential part of the process before it is packed. If not chilled, bacteria will form and the quality will be affected to the point of it being wasted
- Maturation is a relatively short process over, for example, 24 hours compared to 28 day matured meats

Yield – what is it?

- In simple terms, yield is the actual output from a given quantity of materials after undergoing a process
- Yield can be good, bad or in line with expectations
- Yield can be assessed at various stages
- What is a general perception of post smoked yield from a cold smoking process such as skin on Haddock fillets compared to a post hot smoking process of skin on Mackerel fillets?

Staged weighing processes

Weighing is important at a number of critical points during the process.

- To ensure that the weight of raw material when received is not below the purchase weight:
 - Pre brining weight after skinning or trimming
 - Pre smoking weight after brining
 - Post smoking weight
 - Post smoking trimmed weight
 - Packed weight

Labelling and packaging

- Accurately labelled products and ensuring consumers are aware of ingredients are essential to avoid allergen related illnesses and wellbeing issues
- Guidance on labelling from Seafish
- Guidance on allergens from Seafish

Shelf life

- Who are the people most likely to be interested in shelf life apart from the consumer?
- Quality - using good quality raw material
- Keeping it that way

Process – storage – distribution – retail display

- Moisture reduction
- Shelf life validation
- Laboratory testing
- Environmental Health Officer (EHO)

8. Food safety issues

- General food hygiene
- When does fish start to spoil and why?
- Bacteria
- Temperature
- Bacterial multiplication
- Summary
- Allergens
- Cross contamination
- Guidance

General food hygiene

- A scientific review by the Food Standards Agency (FSA) estimating that around ---?---- cases of foodborne illness occur every year in the UK

2.4 million

- This is up from the 2009 estimate of approximately 1 million
- **Top five culprits:**
 - *Campylobacter*
 - *Clostridium perfringens*
 - *Listeria monocytogenes*
 - *Salmonella*
 - *Norovirus*

are responsible for 98% of the 180 deaths but it is not possible to rank the five pathogens. Total deaths could be as low as 113 or as high as 359

- The UK recorded 57 deaths due to *Salmonella* in both 2017 and 2018, according to data compiled by the European Centre for Disease Prevention and Control (ECDC)

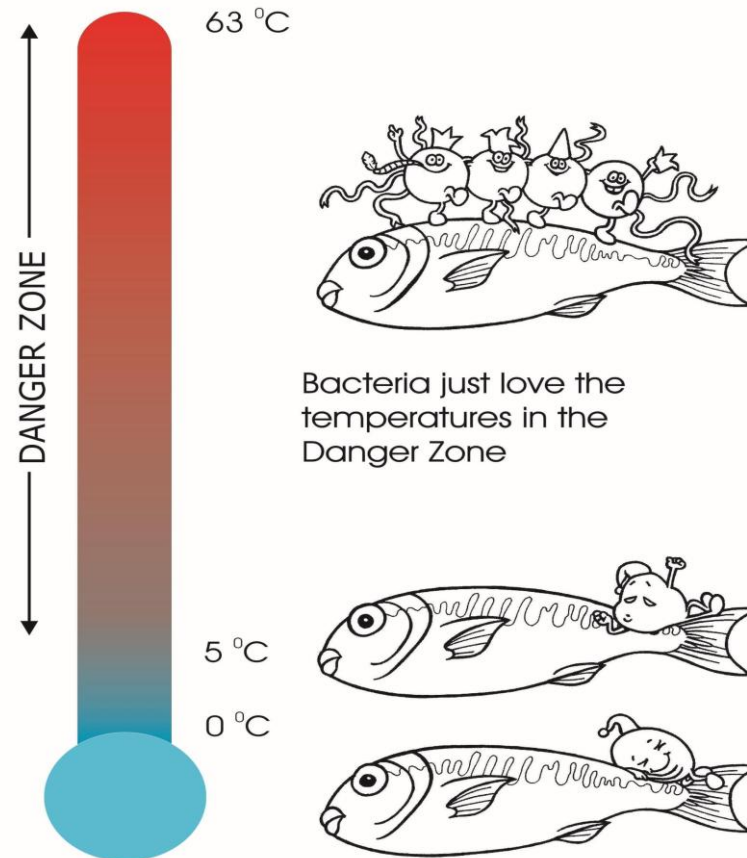
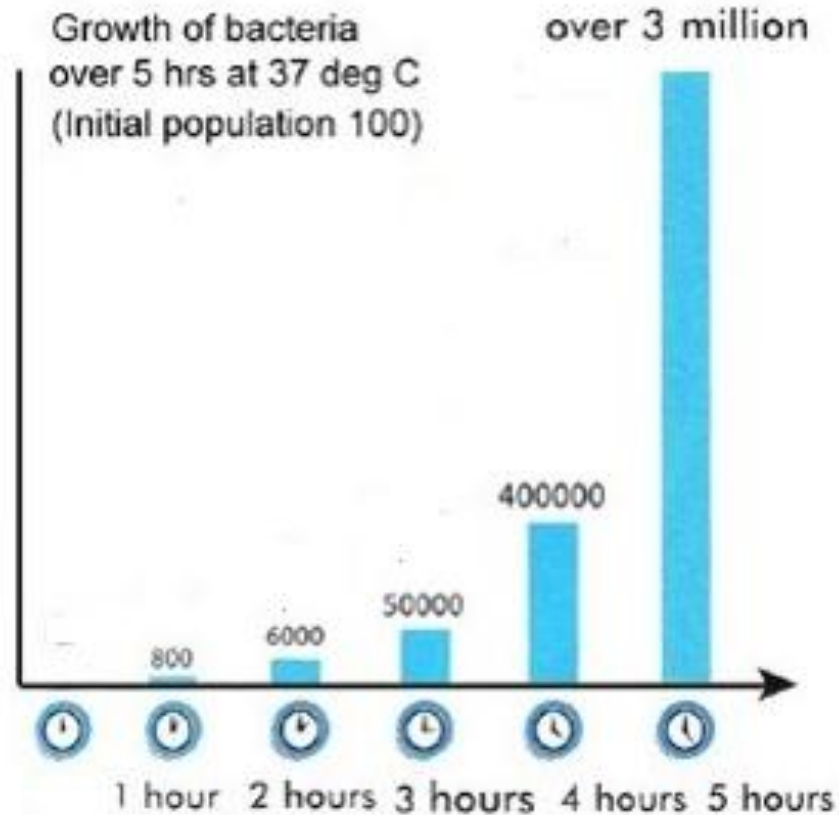
When does fish start to spoil and why?

- From the moment it dies
- Bacteria cause fish to spoil
- The more bacteria on the fish the quicker it will spoil
- Bacterial growth will be slowed considerably between 0°C and 5°C

Bacteria

- What are they?
- What do they do?
- Where are they?
- How do they live?
- What do they need?
- How do we control them?

Temperature and bacterial multiplication



Ready to eat products



Implementing a sampling programme to evidence that the finished product is absent of *L.monocytogenes* in 25g before it leaves the control of the business.

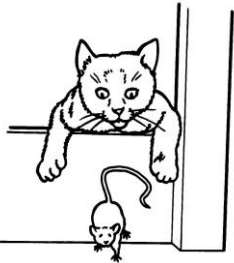
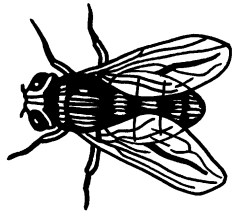
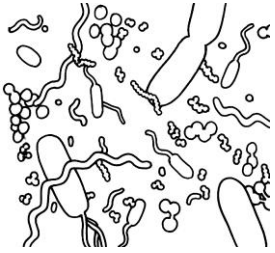
Carry out sufficient shelf life testing to evidence that the finished product will reach the end of its shelf life without exceeding the 100cfu/g limit as specified by Council Regulation (EC) No. 2073/2005. Once an appropriate shelf life has been determined, the finished product should periodically be submitted for laboratory analysis to ensure that the shelf life remains compliant.

Reduce the shelf life of the product to 5 days or less. This complies with Foods Standards Agency guidance that *L.monocytogenes* should not grow to levels exceeding 100cfu/g within 5 days.

Examples

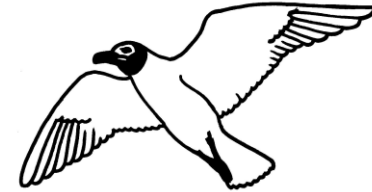
- [FSA and UKHSA warn of listeria risk with Baronet soft cheeses](#)
- [Listeriosis in England and Wales: summary for 2020](#)
- [Recall for fish linked to deadly UK Listeria outbreak](#)

Summary



- Bacteria are everywhere
- Pests and vermin must be excluded
- Cats are not approved pest controllers
- Food handlers must meet minimum standards
- Smoking process does require sufficient space to function
- Bacteria require almost no space

○ 500
million
bacteria !



Allergens

The 14 allergens are:

- **celery, cereals containing gluten** (such as barley and oats), **crustaceans** (such as prawns, crabs and lobsters)
- **eggs, fish, lupin, milk, molluscs** (such as mussels and oysters)
- **mustard, peanuts, sesame, soybeans, sulphur dioxide and sulphites** (if they are at a concentration of more than ten parts per million) and
- **tree nuts** (such as almonds, hazelnuts, walnuts, Brazil nuts, cashews, pecans, pistachios and macadamia nuts)

Source: Food Standards Agency

Key facts about allergens

- In the UK, about ten people die every year from food-induced anaphylaxis
- For those at greatest risk, the tiniest trace of food allergen can trigger severe symptoms and, in some cases, cause fatal or near-fatal symptoms
- People suffering severe reactions need emergency expert help from a trained paramedic, usually with injectable adrenaline
- Those who are aware of the risk can find the day-to-day unpredictability of living with food allergy risks stressful
- Teenagers and young adults seem to be at particular risk of severe reactions

Seafish [guidance](#) on allergen labelling laws

Cross contamination – ensuring a safer product

There are a number of actions you can take to prevent cross-contamination with allergens. These include:

- **Cleaning utensils before each usage**, especially if they were used to prepare meals containing allergens
- **Washing hands thoroughly** between preparing dishes with and without certain allergens
- **Storing** ingredients and prepared foods separately in closed and labelled containers
- **Keeping ingredients** that contain allergens separate from other ingredients

Source: Food Standards Agency

Reflecting on the journey so far...







What do I need to smoke fish?

- **Sawdust/wood chips** - should be commercial food grade, virgin wood or uncontaminated whisky barrels for example. Hardwoods versus softwoods – effects
- **Salt** - pure vacuum dried (PVD) salt is good all round salt, but rock salt used in some applications
- **Brine Tank** - container of appropriate size for scale of operation for mixing brine and immersing fish
- **Brinometer** - practical low cost instrument for measuring brine strengths
- **Smoker** - several models available ranging from home use, small high street business, farm shop to the high volume factory models, however, the basic principles remain the same
- The smoker seen in this course is the AFOS Micro Kiln, with a vertical smoke flow similar to a traditional chimney

9. Hobbyist or business

- Practical considerations when setting up a small-scale commercial business, adding to an existing facility or just a hobby
- Where will it be done?
- Qualifications – what do I need?
- How do I achieve a food safe environment, HACCP policy?
- What will be the process flow to avoid cross contamination?
- What are the regulations on hot & cold smoked product regarding process flow, product storage pre and post smoking, equipment use?
- Allergen controls – will allergens be used?
- What form of packaging will be used?
- Prosecution and penalties are imposed on businesses found to be guilty of negligence and malpractice in respect of food safety
- The hobbyist is not immune from prosecution under common law if a product is gifted to someone who then suffers from salmonella or other forms of food poisoning or suffers anaphylactic shock from an undisclosed allergen presence.

Next steps and post course support

- Courses and support
- Coaching and consultancy
- Other training
 - Food hygiene and HACCP

Courses and support

- Other smoking courses
- Support materials
 - Post course guidance and notes will be emailed to learners after the training course
 - Can refer to these if you choose to complete the optional post course exam

Other training

- Food Hygiene
 - Elementary – self study
 - Intermediate - eLearning
- HACCP
 - Introductory – remote via Microsoft Teams
 - Elementary - eLearning
- Health and Safety
 - Elementary – self study

Conclusions and discussions

Coaching and consultancy

Coaching and consultancy is available ranging from on line to on site presence.

Details can be obtained from todays trainer:

Ivan Jaines-White
email: ivan.jaines-white@outlook.com
mobile 07788 598661

Thank you

Here to give the UK seafood sector **the support it needs to thrive.**

The Seafish logo, featuring the word "seafish" in a white, lowercase, sans-serif font. Above the letters "f" and "i" are three small, white, diamond-shaped icons arranged in a row.

seafish