



Introducing improved small-scale smoking technology for rohu fish smoking, Kale Township, Sagaing Region, Myanmar

Smoker operation and testing protocol guidelines



Implemented by:



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small-scale smoking technology
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**Myanmar Sustainable Aquaculture Programme
(MYSAP)**

**Bandara Rotawewa, International Consultant
Don Griffiths, Yu Maung, Khaing Kyaw Htoo, Silvia Kaufmann,
Florian Muehlbauer and Zin Win Htwe**

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Support the sustainable intensification of the aquaculture sector, thereby realizing its potential for food security, nutrition and sustainable livelihoods.

MYSAP is promoting small-scale aquaculture and improved human nutrition in three townships in Shan State and the Sagaing Region of Myanmar through its inland component MYSAP Inland which is being realized by WorldFish under a GIZ grant agreement. The two improved FAO FTT Thiaroye smokers constructed and tested with smokers in Kale Township, Sagaing Region, Myanmar were funded by the inland component of MYSAP.

The author wishes to express his thanks to the staff of MYSAP Inland and of the NGO Ar Yone Oo for their support in the field and for enthusiasm of the collaborating rohu smokers Daw Vuli from Pyin Khone Lay Village and U Lala from Nat Gyi Kone Village without whom this document could not have been produced.

1. Background

While many of the steps and processes outlined in this improved smoker operation and testing protocol are relevant to fish smoking in general, some of the steps and processes are specific to the fish smokers in Kale Township of the Sagaing Region of Myanmar who smoke and transport the riverine fish rohu (*Labeo rohita*) primarily to India and to the Chin State without refrigeration, chilling or vacuum packing under tropical conditions. As a result the moisture content (10%) specified in this document is specific to rohu.

Hot smoking adds value to rohu (*Labeo rohita*) fish in Myanmar and is an effective method of fish preservation. Hot smoking reduces the product's moisture content and gives a desirable flavor, appearance, and texture to the end product. The smoking process is outlined below.

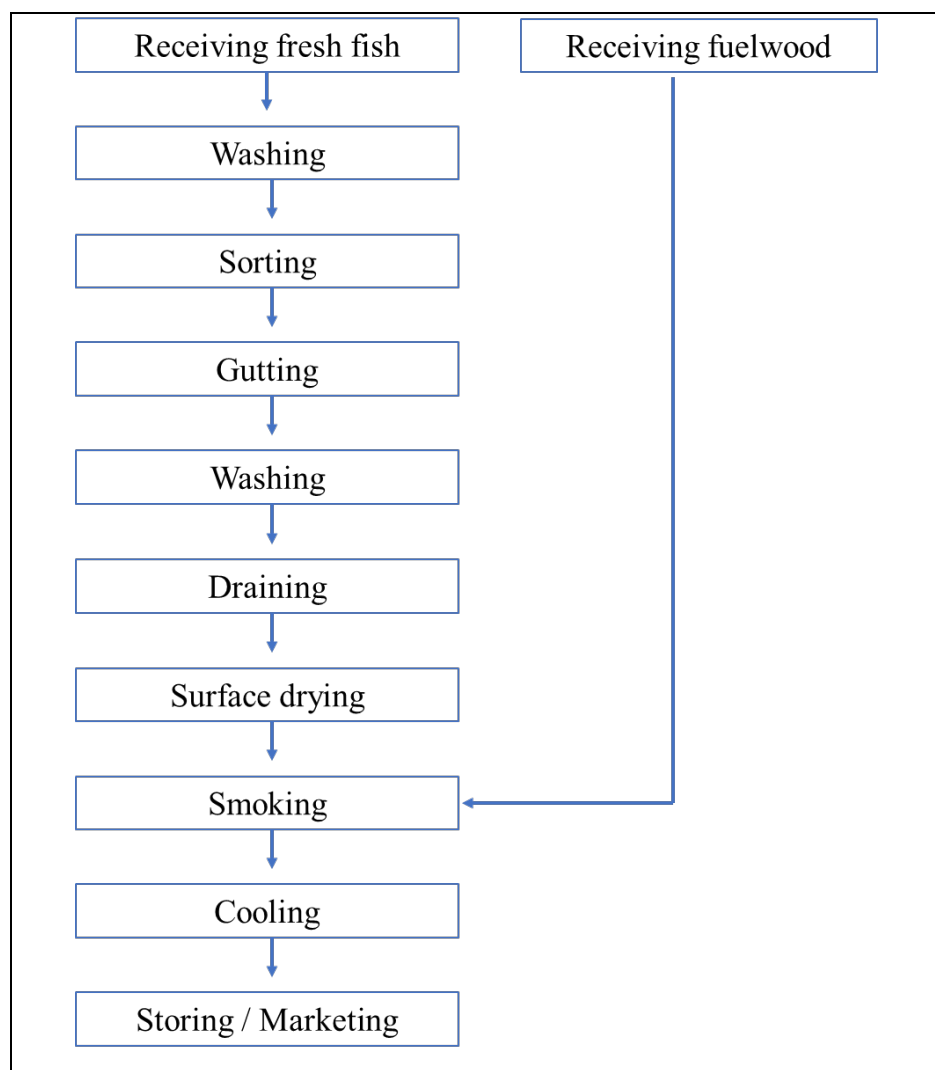


Figure 1. Flow diagram of the smoking process using the improved FTT smoker

2. Receiving fresh fish

The raw fish must come from a fish supply chain where food safety and quality control are adhered to, and the origin and handling of the raw fish must be known, and the fish known to be of suitable quality. Records of fish supplier names and fish quantity and types should be recorded daily to trace the fish's origin for safety aspects. After receiving fresh fish, record the supplier details, the quantity received, and the origin source for traceability purposes. The arriving fresh fish must be kept separate from any smoked fish products at the smoking facility. As soon as possible after arriving the fish should be rinsed with clean potable water to remove mud, sand, and other materials.

3. Sorting, gutting, and rinsing

After rinsing the fish should be graded into different sizes before being gutted. The fish size determines how long drying takes, with bigger fish taking a longer time to reduce to the moisture level down to the desired level. Gutting operations should be done in a separate area away from other processing operations, and gutting should be completed within a maximum of two hours from start to finish. Rinse the gutted fish quickly and thoroughly with potable water, to ensure fish food safety and hygiene.

4. Draining, and surface drying

Allow sufficient time for all excess water to drain from the fish. Lay the fish out on smoking racks and position the fish so that excess water drips off easily and drains away. Leave the fish for about 30 minutes to allow surface water to drain away.

Wood and sawdust smoke is deposited much more evenly on a dry surface than on a wet surface. An even deposit of smoke over a dried surface results in a smooth, attractive colour of the smoked fish product. An electric fan can be used create an air flow and to improve the surface drying process in a dry room which is free from dust and insects.

5. Smoking

"Smoking" is a process of treating fish by exposing it to smoke from smoldering wood or plant materials. This process is usually characterized by an integrated combination of salting, drying, heating and smoking steps in a smoke chamber. During the hot smoking process, fish is exposed to an appropriate combination of temperature for sufficient time to completely coagulate the proteins in the fish flesh. This process is generally sufficient to kill parasites, to destroy bacterial pathogens and spores of human health concern (The Codex Alimentarius Commission, 2009).

The rohu smoking process used in Kale Township, Myanmar can be classified as "Hot smoke drying". In Myanmar after processing (Hot smoke drying), the product is typically stored and transported without refrigeration at ambient temperatures. To suit the Myanmar storage, transportation without refrigeration under tropical conditions and value chain context it is recommended that the moisture content of the end smoked rohu product is a maximum of 10% in order to ensure the control of bacterial pathogens and fungal spoilage. (The Codex Alimentarius Commission, 2009).

5.1. Preparation of the FTT smoker for smoking

The kiln should be cleaned of any dust each day before smoking commences and when not in use should not be left open to rain. All containers that are to be used during smoking should be thoroughly cleaned in advance.

The smoking racks should be cleaned and free from rust. Coconut or vegetable oil should be applied with a piece of clean cloth to the metal wire mesh on the smoking racks to stop the wire from rusting and to form a non-sticky surface so the fish does not stick to the wire mesh.

5.2. Fuel for smoking

Fuel for smoking, whether wood, wood sawdust or plant material must come from a sustainable source and should be free from any chemicals that have been used to treat the wood because treated wood or wood sawdust will give bitter off-flavours and extra toxins. Woods, like conifers that contain a high lignin levels and eucalyptus tree species, should be avoided. During smoking polycyclic aromatic hydrocarbons (PAHs) are formed, and care should be taken to select a suitable tree species with wood and wood sawdust which minimizes the PAHs content during smoking. It is recommended that the potential of PAH formation for different locally available tree species wood or plant material is investigated, perhaps in collaboration with a local university.

The use of fuels other than wood and plant material for smoking food is to be prohibited. Fuels such as diesel, rubber (including tires), or waste oil should never be used even as a partial component, as they can significantly increase PAHs. Cinnamon, coconut shells, mangroves, rubber and softwood such as mango are not recommended. Coconut husks are however a sustainable alternative to fuel wood.

5.3. Hot smoking process

- Start a fire to heat up the smoking kiln, before loading fish onto the smoking racks.
- It is recommended that the smoking racks are loaded with fish all of the same size grade for smoking, i.e. do not have different sized fish on the same smoking rack.
- The smoking process normally has two phases, which are i) pre-cooking and ii) cooking. Generally, the total time, and the amount of time spent at each smoking stage depends on the fish species, its fat content, the fish size, and the type of smoked end product required based on consumer preference and storage.
- During the pre-cooking phase, only a small fire with a small amount of embers should be used in the furnace so the fish are not subjected to excessively high temperatures. If the fish are exposed to too high temperature during the pre-cooking phase a surface crust forms on the fish.
- The fish should be periodically turned over to stop the flesh sticking to the wire mesh on the smoking racks. Rotate the racks of fish during the smoking for even heat and smoke treatment. The pre-cooking period is normally for about 30 minutes at 30 - 40 °C temperature. (An innovative way of fish drying and smoking: FAO Thiaroye Processing Technique, 2017)
- After the pre-cooking period, the temperature should be progressively increased during the cooking phase by adding wood sawdust or fuel wood.
- During the cooking phase carefully monitor the heat / flames. Fat from the fish melts during smoking and will drip onto the oil tray and a fire may break out. Avoid loading excessive amounts of fuel wood into the furnace at this stage, but ensure the smoker furnace is kept hot. A cooking temperature of 85 °C is recommended for 3 – 4 hours during the cooking phase. The cooking time is dependent on the size and thickness of the fish, fish fillets or fish slices. (Ndiaye, et al 2014).
- If the smoker is loaded with several fish racks on top of each other, rotate the bottom racks periodically to ensure even cooking and smoking.
- Once the cooking stage is over, reduce the temperature inside the smoker and continue the drying process to give a hot smoked-dried product with an extended shelf-life. A temperature range of between 30 °C and 45 °C is recommended for the drying process.




6. Cooling

Once the smoking process is completed, cooling of the product should be done in a sanitary environment free of dust, insects. Do NOT transfer the product from smoking racks to plastic bags or any airtight containers until it has completely cooled, because moisture from the fish may be deposited on the container's inner surface and on the surface of the fish itself, promoting growth of moulds.

7. Maintenance of the FTT smoker and its accessories

The quality and shelf-life of the end smoked fish products is improved by careful maintenance of the equipment before, during and after its use. Daily maintenance for the FTT smoker (kiln, lids, racks, and furnace) requires regular cleaning inside and around the kiln and removal of ash and cleaning of wastes which sticks on the lids and the wire mesh of the smoking racks. The fat collection trays and racks must be cleaned daily to prevent excessive build-up of fat which can cause too much smoke and can ignite into a fire.

During the low-production periods or seasonal rest periods, metal accessories should be protected against rust by keeping them under shelter and away from rain and moisture and by regularly coating the wire mesh of the smoker trays with vegetable or coconut oil. If rust appears on wire mesh or metal surfaces, the wire mesh and metal surfaces should be scraped free of rust and re-painted with two layers of rust-proof paint and one layer of food-safe paint. Damaged equipment must be repaired. (Ndiaye et al., 2014).

 <p>Double compartment kiln</p>	<p>The kiln and environment</p> <p>At the end of each day's production remove all the accessories and clean the inside and the surroundings.</p>
 <p>The lids</p>	<p>At the end of each day's production remove all the lids, clean with soapy water, rinse and dry.</p>
 <p>The racks</p>	<p>At the end of each day's production remove the smoker racks, clean with soapy water, rinse and dry.</p>

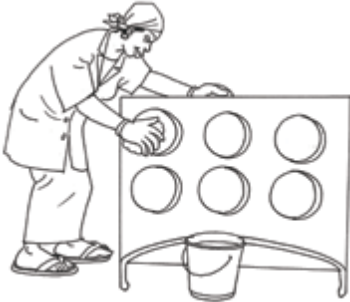

 <p>The fat collection tray</p>	<p>At the end of each day's production remove the fat collection trays, clean with soapy water, rinse and dry.</p>
 <p>The furnace</p>	<p>At the end of each day's production remove the furnace out of the smoker and empty all the ash and put the furnace back into position.</p>

Figure 2. The illustrations were extracted from Ndiaye, et al 2014 with written permission.

8. Assessing the moisture content of smoked fish

Assessing the weight loss during cleaning and gutting and at other stages in the smoking process enables the producer to calculate an appropriate sale price for the final product and to ensure that a profit is made by the business. The moisture content of the smoked products produced directly influence the shelf-life of the product. An assessment of weight loss at different stages in the smoking process from receipt of the fresh fish to achievement of the end product was conducted to access how the traditional smoking method and the improved FTT smoker compared in terms of weight loss during smoking, the moisture content in the fish after smoking, the duration of smoking (pre-cooking to end of drying), and the amount of fuelwood and sawdust used, the cost and the impact on net profit, by the collection of data from the field.

These parameters are important for costing and comparison against the traditional smoking process of the piloted improved FTT smoking technology.

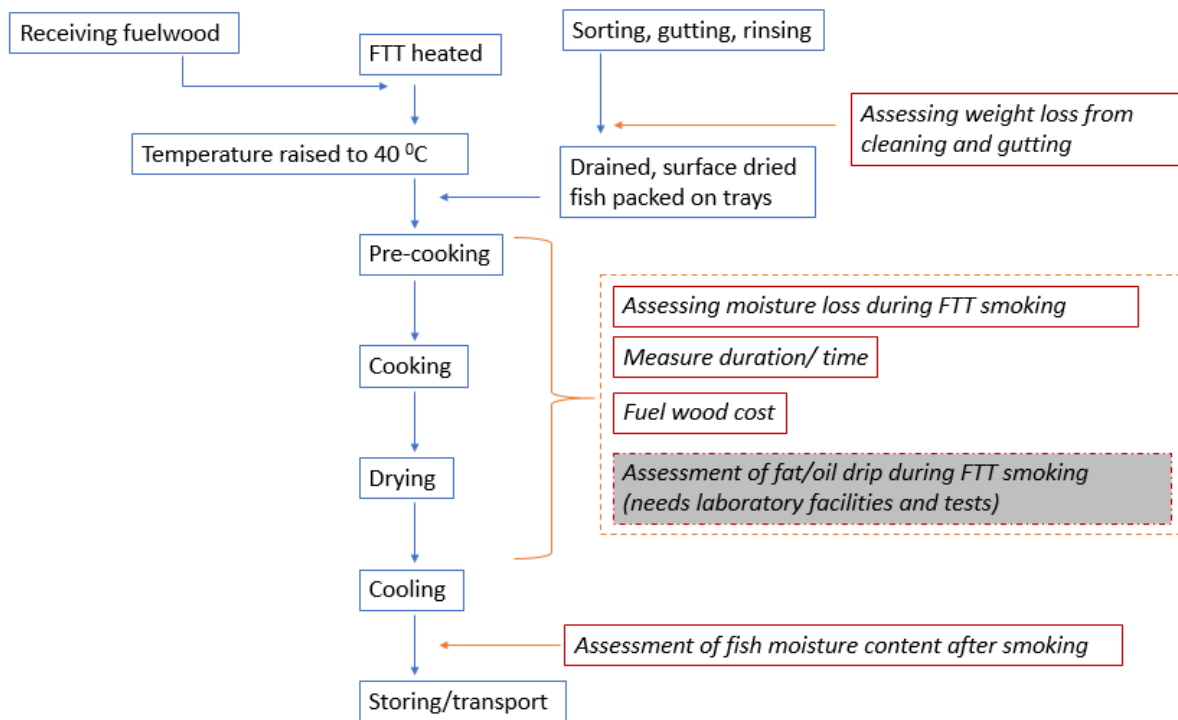


Figure 2. Collection of parameter data at different smoking process stages

8.1. Assessing the weight loss due to cleaning and gutting

Steps:

- After rinsing, grade the fish into different sizes (small, medium, and large)
- Weigh a sample of fish (about five Viss) after draining off the excess water = (x)
- Gut, clean and rinse the fish sample
- Allow excess water to drain away
- Weigh the fish sample again (w)
- Continue the process for different suppliers and estimate the average weight loss due to cleaning and gutting for the different size grades of fish.

Table 1. Sample weights recording table for before and after gutting

Fish sample	Weight of raw fish before gutting and cleaning (Viss)	Weight after gutting, cleaning, draining, and surface drying (Viss)
S1		
S2		
S3		
S4		
S5		
S6		
Average	x	W

$$\text{Average weight loss due to cleaning and gutting} = \frac{x - W}{x} * 100$$

8.2. Assessing the moisture loss during FTT smoking

The weight loss of fish during smoking is mainly due to water loss, but is also due to loss of fat and / or oil. The proportion of water, oil and fat lost varies with the species of fish that is being smoked. During this study at the village level it was not possible to determine what proportion of the weight loss during the hot smoking was attributable to water, oil and fat loss. At a later date MYSAP may follow up with a laboratory study to determine this. For now because the oil and fat content of rohu is relatively low, it has been assumed that the majority of weight loss from rohu during the hot smoking practiced in Kale Township was due to moisture loss.

Steps:

- The moisture content of traditionally smoked rohu and rohu from the improved FTT Thiaroye smoker will be assessed.
- Different size grades of fish will be assessed from both the traditional and the improved smoker.
- Randomly select six fish of each size grade from the traditional and the improved smoker after gutting, cleaning, draining and surface and weigh and label each individual fish as shown in the table below.
- Use a thin metal tag or tin sheet (hole/ cut to denote numbers) to label the fish.
- Randomly place the fish on the smoking racks with six fish of each size grade smoked by the traditional and by the improved smoker process following the normal smoking practices in terms of time and heat for the traditional smoking process.
- Observe and record the record duration of each phase, the type of heating material used etc., (e.g., sawdust or fuelwood and a combination).
- At the end of the smoking, process let the fish cool down.
- Find the 6 fish of each size grade smoked by both smoking methods and weigh the fish using the same digital balance and record the weight at the table displayed below (record weight in grams with 1 number after the decimal point).

Calculate the moisture reduction during both smoking processes using the following formula:

$$\text{Moisture Content \%} = \frac{w-d}{w} * 100$$

w = average wet weight (g) of raw fish before smoking

d = average dry weight (g) after smoking

Table 2. Sample weights recording table for after gutting and after smoking

Fish sample	Weight (g) after gutting, cleaning, draining, and surface drying	Weight (g) at the end of the smoking process
S1		
S2		
S3		
S4		
S5		
S6		
	Average weight (g) of fresh fish before smoking = w	Average weight (g) of smoked fish samples = d

8.3. Assessment of moisture content in the fish after smoking

- The same labeled fish that were used above will be used for this assessment.
- Place the samples in a glass petri plate and dry them in an electric oven at $100\pm 2^{\circ}\text{C}$ for 16 -18 hours
- Allow the samples to cool and weigh using the same digital balance.
- Calculate the weight loss using the formula below.

$$\text{Moisture content of the fish after smoking \%} = \frac{d-d_2}{d} * 100$$

The weight loss is the moisture content of the sample and will be an average of the six fish samples for each size grade.

Table 3. Sample weights recording table for after smoking and after oven drying

Fish sample	Weight (g) at the end of the smoking process	Weight (g) of the oven-dried sample at $100\pm 2^{\circ}\text{C}$ after 16 -18 hours
S1		
S2		
S3		
S4		
S5		
S6		
	Average weight (g) of smoked fish samples = d	Average weight (g) of oven-dried samples = d_2

8.4. Cost of firewood and sawdust for the smoking process

The cost of firewood and sawdust including transportation should be used for cost analysis of the end product. While introducing and testing the improved smoker and preparing this guide, the consumption and cost of fuel has not yet been assessed in any detail, due to the particular circumstances restricting movements and of the difficulty on operating remotely for this international consultancy. At a later date, as resources permit, this should be tested and the results should be integrated into the guideline. It would also be useful to investigate how the different fish size grades (small, medium, large) impact the fuel consumption and costs.

Steps:

- Interview the smoker to determine the quantity and the cost of firewood and sawdust used for smoking the fish using both the FTT and the traditional smoking method
- Purchase two batches of firewood and sawdust and keep and store them separately. Protect the sawdust and firewood from rain and dripping water
- Label the two batches as “Fuel for FTT” and “Fuel for traditional”
- Use respective firewood and sawdust batch for fish smoking separately using FTT and traditional system. Use of total capacity of FTT and the traditional system is recommended
- For accurate estimation load the smokers to full capacity, whether the traditional smoker or the FTT smoker
- Weigh the amount of smoked fish produced from each system separately for both FTT and the traditional system
- Determine the amount of firewood and sawdust quantity used and get a general estimate of the costs for both systems
- The cost of firewood and sawdust is calculated using the following formula

$$\text{Cost of firewood and sawdust per unit of smoked fish} = \frac{\text{Cost of firewood and sawdust used}}{\text{total quantity of smoked fish}}$$

8.5. Time taken to complete smoking process

The time taken to the smoking process (from first loading to end of smoking) is highly dependent on the efficiency and stability of temperature inside the kiln. We have not considered how differing fish size grades (small, medium, and large) have impacted on the situation in the field because of the difficulty in operating remotely in the field. If the resources permits, further testing can be done to fine-tune the results.

Table 2. Time recording table for traditional system and FTT

Traditional smoking			FTT		
Occasion	Raw fish quantity (Viss)	Time taken to complete the smoking process (From first loading to end of smoking) (Hours and minutes)	Occasion	Raw fish quantity (Viss)	Time taken to complete the smoking process (From first loading to end of smoking) (Hours and minutes)
1			1		
2			2		
3			3		
4			4		

9. Sensory evaluation of smoked fish

Sensory evaluation is a technique that analyses and measures the response of consumers to food items. This evaluation will compare smoked fish (rohu) using by both traditional Kale smoking and by the improved FTT Thiaroye smoking technique. The assessments will be conducted with traditional and FTT products side by side but without identification.

9.1. Sensory evaluation method

- a. Find a clear area to hold the sensory test. Try to make sure that it is away from noise, cooking smells and traffic fumes which may distract the people (assessors) taking part in the test.
- b. Select the assessors voluntarily.
- c. Explain and make sure the people taking part know what is expected of them.
- d. A sample size of between 20 to 30 persons is recommended, perhaps done in batches of 5 people to make management easier.
- e. Place as many samples in serving containers as there are people taking part in the test.
- f. Each test person will be given one traditional sample and one improved sample to test.
- g. Code each sample with a random number or letter.
- h. Check that you have enough glasses of drinking water for the people taking part.
- i. Ask each person to taste one sample at a time and record their responses.
- j. After testing one sample they should wash their mouth out with drinking water before tasting the second sample.
- k. If the people do not understand the language (in the case of village people), explain well before the test. Distribute the test card with a pen/pencil to mark his/her responses. The person conducting the testing may mark the responses on behalf of the assessor.
- l. If you request to test several samples, allow time between samples so that assessors can record their opinions.

A typical tasting kit could contain:

- Serving spoons/tongs
- Cups and plates
- Paper towel
- Rubbish bag
- Labels and pens

TEST CARD

Directions: In front of you will be a sample of smoked fish. Please evaluate the samples. For each listed attribute, check descriptive terms that best describe the product according to your visual and taste preference. Do not hesitate to give comments at the end.

<u>Colour</u>	Golden brown, glowing	Golden brown, less luminous	Brown, dull	Dark brown, dull	Dark brown, very dull
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<u>Odour</u>	Pleasing odour, natural smoke odour	Slightly pleasing odour, enough smoky odour	Almost neutral with a slightly disturbing odour	Strong disturbing odour, the smell of ammonia	Strong ammonia odour and rancid
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<u>Appearance</u>	Great	Good	Okay	Bad	Awful
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<u>Saltiness</u>	Just right	Moderately salty	Slightly salty	Very salty	Bland
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<u>Texture</u>	Very soft	Soft	Slightly hard	Hard	Very hard
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<u>Taste/Flavour</u>	Tasted great	Flavourful	Acceptable	Off flavour	Flavour did not appeal to me
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<u>General acceptability</u>	I liked very much	I moderately liked	Liked slightly	I neither like nor dislike	I dislike
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Comments:

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How does is this smoked rohu different from the product you usually buy?

Can you please give any suggestions on how the product could be improved?

9.2. Scoring table

The scoring table below should be filled out by an enumerator to summarize the results of the test cards filled in by each individual.

Score table

Table 5. Sensory evaluation score table

Tester	Colour	Odour	Appearance	Saltiness	Texture	Taste/ flavour	General acceptability
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
N							
Average							

Scoring: Food samples are scored on a scale, between like and dislike, between five from left to one for the right side of the test table. Share the summary of the scoring table for interpretation.

10. User reflections over the technology

The user's preferences over the new technology reflect the continuation and the adoption of the FTT. Let the user rank the most preferred features of the FTT from the below list.

Steps:

- Administer the questionnaire individually
- Explain the content in simple terms that the fish processor can understand easily
- Each fish processor should select only ten preferred characteristics among those listed in the table
- The most preferred feature is ranked as 1 and least preferred as 10
- Write down any suggestions, improvement needs below the table in the given space

Table 3. FTT user preferences ranking table (adopted from Mindjimba, 2020)

Name of the processor:		
No	Features	Rank
1	Security (protection against product thefts/animals)	
2	Can be used as temporary storage (overnight store)	
3	Kiln processing capacity (smoked fish quantity)	
4	FTT construction cost	
5	The time needed to smoke the fish	
6	Preserving your health (less exposure to heat and smoke)	
7	Easy to use and less physical exhaustion	
8	The finished products quality and appearance	
9	The possibility of carrying out other activities while smoking the fish	
10	Less amount of fuel used per smoking session/given quantity of product	
11	Other fuels can be used (e.g., rice bran, coconut husks)	
12	Product marketability	
13	Ability to use FTT for smoking other products (pork, chicken, yams, corn, etc.)	
14	It does not pollute the environment	
15	Protection from rain, wind, dust etc.	
16	Use of FTT with neighbors	
17	Any other factor (please specify)	

Suggestions for improvement:

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