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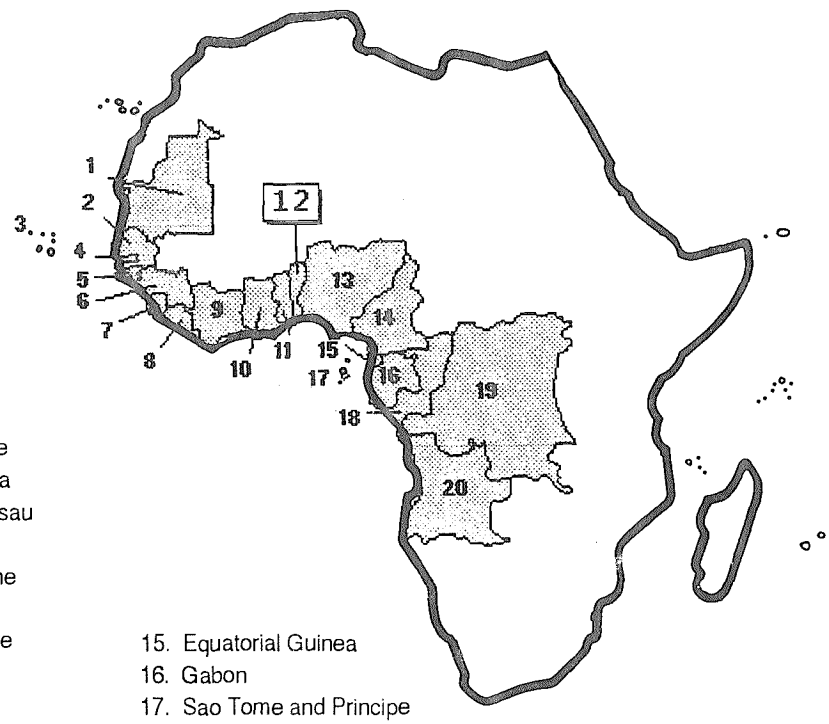
IDAF PROGRAMME

Technical Report N°66 April 1995

Workshop on Seeking Improvements in Fish Technology in West Africa

Pointe-Noire, Congo, 7 - 9 November 1994



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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Technical Report N°66 April 1995

Workshop on Seeking Improvements in Fish Technology in West Africa

Pointe-Noire, Congo, 7 - 9 November 1994

by

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Cotonou, April 1995

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Introductory Note

The Workshop on Seeking Improvements in Fish Technology in West Africa was organised by the Programme for Integrated Development of Artisanal Fisheries in West Africa (IDAF). It was held from 7 to 9 November 1994 in Pointe Noire, Congo, in conjunction with the 8th IDAF Liaison Officers meeting held in the same place on 3 and 4 November 1994.

In view of the importance of fish and fishery products in the socio-economic and cultural life of the populations in West Africa, the IDAF Programme and several other projects as well as instituitions, have in the past couple of years worked to improve fresh fish handling and fish processing techniques in many countries in the IDAF region.

Fish smoking and drying undoubtedly are the most important fish technologies in the region. However, the handling of fresh fish in insulated containers with ice has high development potential not only for internal markets but also for exports. There is therefore the need to look into aspects of fresh fish quality and import requirements at least of some of the major importers of artisanal fishery products from the region.

The objectives of the workshop were:

(i) to update information on fish technology in the region

(ii) to identify possible interventions in fish handling and processing in the artisanal fisheries sector that will ensure:

- increased earning capacity of fisherfolk;
- increased availability of fish for consumption;
- protection of the environment;
- protection of the health of processors and consumers.

This document contains the report of the workshop (pages *i-viii*) and the papers which were presented at the workshop (pages *1-57*). This document has been prepared by IDAF, INFOPECHE and by the Fish Utilization and Marketing Service of FAO Headquarters in Rome, Italy. It has been printed and distributed by IDAF.

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Report of the Workshop

Workshop on Seeking Improvements in Fish Technology in West Africa, Pointe Noire, Congo, 7-9 November 1994.

1. The workshop was held in conjunction with the 8th Liaison Officers Meeting of the Programme for Integrated Development of Artisanal Fisheries In West Africa (IDAF) which covers 20 coastal countries from Mauritania to Angola.

2. Participants of the workshop were the same as those of the 8th LOM and are found on pages iii to v. They consisted of the IDAF liaison officers, fish technologists from the subregion, FAO staff of IDAF and FAO Headquarters, staff of artisanal fisheries development projects and others.

3. The workshop was animated by Mr A. Tall of INFOPECHE with Mr F. Teutscher from FAO Headquarters and Mr A. Jallow of the Gambia serving as rapporteurs.

4. The objectives of the workshop were:

   (i) to update information on fish technology in the region

   (ii) to identify possible interventions in fish handling and processing in the artisanal fisheries sector that will ensure:

   - increased earning capacity of fisherfolk;
   - increased availability of fish for consumption;
   - protection of the environment;
   - protection of the health of processors and consumers.

5. The list of identified interventions will serve as a guideline for all projects, programmes, etc which have an interest in fish technology in West African artisanal fisheries, including IDAF itself, FAO's regular programme, INFOPECHE, the Regional Programme funded by the European Union on Improved Utilization of Artisanal Fish Catches in West Africa (ECOWAS), the Ghana/Netherlands Regional Training and Applied Research Programme on Artisanal Fish Processing.

6. Eight papers were presented on traditional fish processing technologies and on the use of ice. In addition participants gave information on fish technology in their respective countries.

7. With regard to fish smoking large smoking platforms are used for bonga, flat sardinella and other small pelagic species from Senegal to Sierra Leone. In this area it is the most important smoking technique. Improvements have been achieved in Gambia ("improved Chorkor oven") and in Sierra Leone ("banda-Chorkor hybrid oven").

8. As both improved ovens are similar and also to avoid confusion with the Chorkor oven the improved oven was given a new name: from now onwards it will be called bonga oven.

9. The bonga oven has the following characteristics:

- length from about 3m to 12m;
- width from 1.5m to 1.8m;
- height from 0.9m to 1m;
- sides are closed and are made from mud blocks, metal or fired bricks;
- it has stoke holes on one side;
- it can be reached from all sides;
- it is open inside or may have separation walls inside;
- it is covered by wire mesh supported by wooden poles or iron rods;
- it is generally placed in a smoke house.

10. The Chorkor oven is characterised in the first place by its superposable trays. It has been tested in many African countries but has generally not ben accepted. Among the technical reasons for non-acceptance are: large catches of small pelagics, in particular bonga, cannot be processed, large sized fish species cannot be processed, and its cost effectiveness is low compared to the bonga oven.

11. In general when introducing new technologies there has in the past been too much "technology push" and very little consideration for "market pull". In introducing the Chorkor oven this has often been done in an inappropriate way: wrong location, for groups instead of individuals, no proper prior consultation with users, short duration of demonstrations, no follow-up, often only the smoking was considered but not the raw material nor the marketing of the products.

12. Concerning fish drying there is a need to improve hygiene. Solar drying using plastic tents are technically suitable to produce high quality products but they have not proved to be economically justified. Apart from drying on elevated racks and using mosquito mesh for protection from flies, no other economically sound improved drying technologies can presently be proposed.

13. Salted pressed sardine is an intermediate moisture product. Research and development is being carried out on this product in Senegal. It allows high volume throughput at a low level of investment. First tests have been succesful, in particular in rural areas, and if the success is sustained the technology may be of interest to other areas with large volumes of small fish and where salted fish is accepted, such as in Cameroon and Congo.

14. There is a growing demand from supermarkets, hotels and restaurants for high quality fish. This includes fresh fish as well as cold smoked fish. Cold smoking requires well trained fish smokers and special equipment and is not suitable for traditional fish smokers.

15. With regard to fresh fish, there has been an increasing use of ice and insulated containers in artisanal fisheries in West Africa. The first appearance of insulated containers goes back to 1976 in Senegal when small fragile boxes were used allowing fishing trips of 2 days. Later such rudimentary boxes appeared in other countries as well. Also defunct freezers and refrigerators are now used throughout the region. In Senegal the technology was further developed and the Senegalese Food Technology Institute (ITA) has been contracted by the EU Programme to introduce it in the ECOWAS countries.

16. Promotion of fresh fish marketing and export through the use of ice and insulated containers is also taking place in other development projects and programmes, both within and without the ECOWAS sub-region.

17. Insulated containers and ice allow fishermen to make trips of up to 7 days thereby increasing their catches, increasing the value of their catches, and making considerable savings on fuel consumption. After the devaluation of the FCFA the exports of high value fish from the artisanal sector soared and profits of 4 to 8 times pre-devaluation levels were achieved.

18. Ice and insulated containers are not only justified for high value species. In Senegal and Gambia also bonga and sardinella are iced after landing and transported in insulated transport containers to markets in urban centres; in Gambia as far as 400km inland.

19. Expanded polystyrene is the most suitable insulation material. Dry plant material such as coconut coir, rice husks, banana leaves (leave base) have been tested. They work well as long as they are kept dry. Most of the time they got wet and contribued in a significant way to an increased weight of the containers and to reduced insulation characteristics.

20 Further work needs to be done on alternative insulation materials which are locally available. For extension purposes the only suitable technology at present is to use expanded polystyrene.

21 The participants showed interest in the import regulations in the EU, USA and Japan as well as in quality assurance including HACCP (Hazard Analysis and Critical Control Points). Most liaison officers were not familiar with these matters and requested appropriate information available for extension which should be understood by fishermen and fish traders.

22 The following recommendations were made:

a. Existing technologies should be the starting point for any activities on improved technologies. The existing technologies should be carefully analyzed in each phase of their operations. Furthermore, the whole range of activities from fishing to consumption should be considered and not a single step. In this light the relations between fishermen, traders and consumers should be taken into account and it should be realised that improvements usually result in a change in product characteristics and price.

b. The active participation and commitment of the target group should be assured.

c. Fish processors and traders should have access to credit to improve their operations.

d. Fish processors should be sensitized on matters of health, hygiene and environmental protection.

e. Community based agro-forestry activities should be encouraged by artisanal fishery projects to ensure the availability of fuelwood for fish smoking as well as for domestic purposes.

f. Smoke houses should be constructed and improved so as to reduce health risks from smoke as well as fire hazards.

g. Quality assurance programmes should be implemented in all countries. In this view the quality and safety of traditional products should be studied while products for export should comply with regulations in importing countries.

h. The use of ice and insulated containers must be encouraged. To this effect emphasis should be placed on training of fishermen and traders on improved handling, storage, and marketing of fresh fish while the availability of ice in artisanal fishing centres must be assured.

i. Insulated containers must be adapted to specific local conditions. In general, further studies must be conducted aiming at reducing their cost.

j. The exchange of successful experiences in fish technology will accelerate their introduction. This is relevant for:

- bonga ovens in Gambia and Sierra Leone which are of interest for all countries with large catches of small pelagic fish, in particular bonga,

- insulated containers in Senegal and Guinea, which are relevant for all countries,

- ice plants in Gambia and Senegal, also of interest to all countries

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Traditional fish smoking in Cameroon

by

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ABSTRACT

Traditional processing of fish in Cameroon is an important means of making fish available to consumers especially those remote from fish-landing sites and main distribution channels. This is important because fish is the most important source of animal protein in Cameroon and because facilities for handling marketing and distribution of fresh and processed fish are inadequate and inappropriate. Also, Cameroonians have an ever-increasing desire for fish.

The techniques used for traditional processing of fish in Cameroon need to be evaluated. This is especially true of traditional smoking in platforms (Bandas, etc.) which is tedious, time-consuming, fuel-inefficient and expose operators to high temperatures and smoke densities. The products are of variable and often of poor quality (short shelf life, low nutritional value and sometimes burnt, charred or fragmented).

In order to look at these problems due considerations have to be given to fresh fish quality, handling, landing and display techniques and facilities, pre-smoking, smoking and post-smoking technology. The involvement of govt, consumers, the private sector and especially fisherfolks/fishermen in designing techniques and technology, legislation etc. is imperative to enable awareness, participation and commitment. Education, improved technology, cooperation between all interest groups, institutions to provide soft credits and legislation and its implementation with provision for litigation will go a long way to improve fish and fish product quality, protect the environment and improve the well-being of the fisherfolks.

In this paper the term Banda is used for two different things: (1) the smoking oven, and (2) a smoked fish product.

1 History of the techniques

Traditional processing of fish in Cameroon is either by smoking, drying or salting prior to smoking, or drying. Whilst smoking is a major technique in the coastal regions, both smoking and drying are carried cut in the northern part of Cameroon, with a slight imbalance in favour of drying. Consumer attitudes, climatic limitations and traditional values are basically implicated in the choice of the technique used in a particular region. Traditional processing methods which are long-standing traditions of the people of Cameroon are important methods of making fish available to consumers, especially those remote from fish-landing sites and main distribution channels. This is extremely pertinent because fish contributes nearly to 30% (Seki and Bonzon, 1993) of animal protein in Cameroon and also because facilities for handling, landing, storage and distribution of fresh fish are grossly inadequate. An added advantage of traditional processing is the weight loss that occurs during the process due to dehydration, facilitating handling and distribution. Also, cured fish occupies an important place in the eating habits of Cameroonians.

Developments in traditional smoking have changed little over the years partly due to the values and attitudes of the fisherfolks and partly because of the attitudes, orientation and the low intensity of extension services. The application of filleting, splitting and/or scorching techniques to improve heat transfer and hygiene, and to facilitate cooking, is based on fish species, size, traditional attitudes and the market situation. These techniques have not been applied consistently, even within the same locality.

Pre-smoking treatment including the use of salt to shorten drying time and improve product quality has been quite limited (used more in the northern part of the country, industrially and in research) and controversial. Smoking platforms that are oval/round (drums) or rectangular/square, which are either closed (closed banda) or open (open banda), have hardly improved over the years. Storage and packaging practices have changed little. The drying of fish has been carried out over the years by the use of bare, cemented floor and much latter, raised platforms of bamboo, or mats.

2 Smoking ovens (kilns)

2.1 Smoking structures in the coastal areas of the South West Province (humid south)

Smoking platforms, locally known as Bandas, are shown on figure 1 and 2. These platforms range from 2.0 to 20.0 meters long, 1.0 to 5.0 meters wide and 0.8 to 1.20 meters high (1.5 to 2.5 meters for shrimp smoking). Materials for the construction of platforms which include wiremesh, bamboo etc. are supported by rods of bamboo or metals. The framework including the stands are also constructed of rods, pipes and poles of bamboo, sticks, timber or metals. Bandas are closed round but for the fireplaces with either roofing sheets or flattened petrol drums. Two hundred litres petrol drums are also used for smoking fish (Fig. 3).

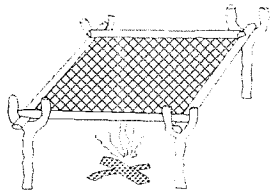

Figure 1: Banda (open)

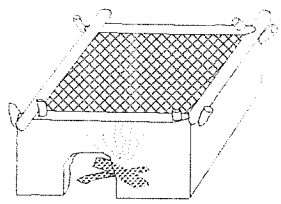

Figure 2: Banda (closed)

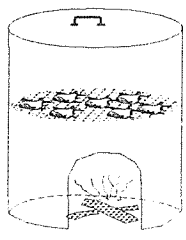

Figure 3: Fish smoker made from petrol drum

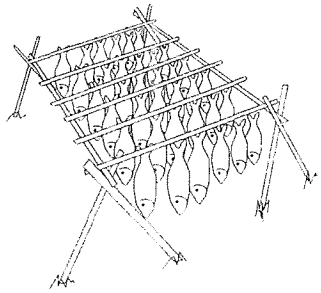

Figure 4: Rack for sun-drying of fish

2.2 Smoking kilns in coastal area (humid south)

2.2.1 Fish smoking ovens

Fish is smoked in a smoke house, constructed of walls with raffia mat or wood. The roof is also constructed of raffia. These smoke house has only one door of 1.0m wide stretching up to the roof and is located on one of the walls. The smoke house is 9.5m long, 6.0m wide and 2.2m high.

In the inside on either sides of the door are fixed two smoking trays of wiremesh one on top of the other. The first one which is 0.75m from the ground is used for smoking and the second which is 2.0m from the ground is used for stocking already smoked fish. The dimensions of these trays are 4.4 m by 2.6m

2.2.2 Shrimp smoking ovens

Shrimps are smoked in smoke houses of planks covered with raffia mats and recently aluminium sheets. These houses can take 3 to 4 smoking trays made of raffia mats each of dimensions 5.5. m long, 2.0. m wide and 1.8m high.

2.3 Chad Basin, Logone-Chari-Lake Chad

In this region, for the productio, of "banda", a product of different smoked species of fish (*Heterotis, Hydrocyon, Labeo, Lates* etc.). Fish is laid on platforms of wiremesh of 2-10m long, 1-2m wide and 0.75-1m high under which a light fire is kept.

2.4 Drying

Drying of fish in Cameroon is basically done by sun-drying. The structures include bare or cemented floor, raised platforms and other raised structures (Fig. 4). However, solar tents, domes and dryers are being experimented especially in areas with lower humidities and longer dry seasons.

3 Processing techniques/methods

3.1 Smoking

Generally speaking, fish is smoked whole gutted and ungutted, split into chunks, fillets etc. depending on species, size, consumer preference and suppliers specifications. The choice to salt or not prior to smoking is influenced by cost, availability of salt, consumer preference and traditional values. Fish is smoked head down, sparated by speaters (Bonga, Sardines etc.) on their backs, bellies or sides for a period of between 4 hours to 3 days. Temperatures reach between 30 to 180°C (LAUREL et al; 1971, EYABI EYABI, 1994 a) weight losses of between 30 - 75%, and fuel consumption between 1: 1.1 to 1 : 15. Fuel sources for traditional smoking include a wide variety of soft and hard woods. The choices are limited by availability, cost and tradition. Packaging of smoked fish is in baskets (cane, raffia, palm, coconut) with or without plastic linings; cardboard cartons with or without plastic linings; bags of all sorts (plastic, hessian, jute etc.) sometimes with plastic linings. Storage is under ambient conditions and transportation is by head,trucks, bicycles, canoes, motorcycles and all kinds of vehicles. Storage life is between a few

days to weeks and even months, depending on fish species, fresh fish quality, conditions of smoking, packaging and storage.

Considering specific sectors we have the following peculiarities:

3.1.1 Coastal area (humid south)

Fish

If the smoking of Bonga is carried out in the smokehouse described for this sector starting at 18H on a particular day; fire is lit with a combination of wet and dry mangrove wood. At about 18.30H the temperature rises to 50 to 90°C. On activation, the fire rises to 180°C. This fire diminishes and drops towards 10pm (22H) to 45°C. The next day the fire is lit again, this time with dry wood, then maintained with wet wood. At about mid-day the fish already smoked was placed in bulk to be resmoked. During a 3 days period, the fire is maintained successively with dry and wet wood. When drying is sufficient, the smoked product is stored in the upper trays of the smoke-house. Losses in weight are recorded as 33% at the end of 2½ hours smoking and 66% at the end of 2 days smoking

Shrimps

After washing, shrimps are spread on the platform at a thick-ness of 1 to 2cm. The fire is then lit from below at the middle of the oven/smoker. The smoking process takes about 24 hours or more. At the end, it is necessary to select the smoked shrimps to remove insufficiently dried products and dirt.

3.1.2 The Benoué basin (inland)

In this region, fish is heavily smoked and almost charred exteriorly. Upon transportation to distant places like Yaounde (km), it arrives heavily attacked by parasites and becomes fragmented.

3.1.3 Lake Chad Basin (Rivers Logone and Chari, Lake Chad)

Smoking is only used in this region for the production of "banda". The fish is scaled, eviscerated, and cut into pieces of the size of the human fist. Into these pieces of fish, pieces of sticks of papyrus plants are driven and then the fish is sun-dried on a papyrus mat. After several hours of sun-drying, the pieces are arranged on dry grasses and covered with old mats. They are lighted to burn and charred exteriorly, thus burning and drying the fish when it is sun-dried for between 4 to 7 days. Sometimes the fish is laid on wiremesh over very mild fire for several hours. The processed fish is stacked under the sun awaiting sales. This product, which is transported in jute bags to Nigeria, has the tendency of fragmenting into dust during transportation. Losses of more than 30% have been recorded due to microbial and chemical degradation and attack by biological agents.

3.2 Salting and drying

3.2.1 Sundrying

This technique is especially used to dry *Alestes spp* to produce dry 'salanga' which is an important fish product in Cameroon, Chad and the Central African Republic. The fish is opened through the back, gut removed, then allowed to dry under the sun for a day. A rod is transfixed at about 1/3 of the body of the fish from the head slowly towards the back. The rods are then suspended at a distance of 80cm from the ground and the product is dried between 8 to 10 days. The viscera are boiled in water to produce oil for human consumption.

3.2.2 Salting-drying

With big fish the head, gut content, scales, fins and backbone are all removed, thereby dividing the fish into two. After washing and scoring, fish is kench-cured on a mat placed on sand. The quantity of salt is equivalent to 8% of the fresh weight of the fish. The fish is again covered in a second mat for 12 hours in order to remove a good quantity of the water in the fish flesh. Next, the water is further pressed out by stamping and then the fish is suspended to dry either under the sun or in a shade for a period of 5 to 12 days, depending on the humidity and fish size. The final product is either whitish (white fish) or yellowish brown (fatty fish). Although fish treated this way has protection against the biological agents in the Chad Basin, the situation may not be the same in the humid tropics.

Small fish, in particular *Alestes spp*, are descaled, degutted, washed and the eyes removed. After scoring the fish is salted (8% of body weight). Rods passed through the eye orbits of the fish are suspended about 0.80m from the ground and fish are dried for 3 to 4 days. This product has a good shelf life under the dry climatic conditions of the Lake Chad area.

4 Economic analyses

Traditional systems of fish processing with emphasis on Banda production would have to consider the economics of production of different ovens in order to quantify for example the return-on-investments. In the light of the above, the following ovens will be evaluated:

4.1 Banda (open type)

Annual production cost	(FCFA)
Cost of land, land preparation and housing	500,000
Cost of banda	30,000
Cost of general overheads (labour, fuel, transportation, packaging, repairs, research and development = 40% of investment cost	212,000
Cost of fish (50 kg) a day for 100 days	1,500,000
Total production cost	**FCFA 2,242,000**

Annual sales of smoked fish

$$\frac{50kg\ wet}{day} \times 100\ days \times 0.4\ \frac{kg\ dry}{kg\ wet} \times FCFA\ 1340/kg\ dry\ fish =$$ **FCFA 2,680,000**

Annual profit **FCFA 438,000**

(= FCFA 87,6/kg wet fish)

4.2 Banda (closed type)

Annual production cost	(FCFA)
Cost of land, land preparation and housing	500,000
Cost of banda	35,000
Cost of general overheads (labour, fuel, transportation, packaging, repairs, research and development etc. = 40% of investment	214,400
Cost of fish (50 kgs) a day for 105 days	1,575,000
Total production cost	**FCFA 2,324,000**

Annual sales of smoked fish

$\frac{50kg\ wet}{day} \times 105\ days \times 0.4\ \frac{kg\ dry}{kg\ wet} \times FCFA\ 1340/kg\ dry\ fish =$ **FCFA 2,814,000**

Annual profit **FCFA 490,000**
(= FCFA 93/wet fish)

4.3 Chorkor oven (cement blocks)

Annual production cost	(FCFA)
Cost of land, land preparation and housing	500,000
Cost of oven (2 trays)	200,000
Cost of general overheads (40% of investment cost)	280,000
Cost of fish (50 kgs) a day for 130 days	1,950,000
Total production cost	**FCFA 2,930,000**

Annual sales of smoked fish

$\frac{50kg\ wet}{day} \times 130\ days \times 0.4\ \frac{kg\ dry}{kg\ wet} \times FCFA\ 1340/kg\ dry\ fish =$ **FCFA 3,484,000**

Annual profit **FCFA 554,000**
(= FCFA 85/kg wet fish)

4.4 Chorkor oven (mud)

Annual production cost	(FCFA)
Cost of land, land preparation and housing	500,000
Cost of oven (2 trays)	130,000
Cost of general overheads (40% of investment cost)	252,000
Cost of fish (50 kgs) a day for 130 days	1,950,000
Total production cost	**FCFA 2,832,000**

Annual sales of smoked fish

$\frac{50kg\ wet}{day} \times 130\ days \times 0.4\ \frac{kg\ dry}{kg\ wet} \times FCFA\ 1340/kg\ dry\ fish =$ **FCFA 3,484,000**

Annual profit **FCFA 652,000**
(= FCFA 100/kg wet fish)

4.5 Chorkor oven (bricks)

Annual production cost	(FCFA)
Cost of land, land preparation and housing	500,000
Cost of oven (2 trays)	200,000
Cost of general overheads (40% of investment cost)	280,000
Cost of fish (50 kgs) a day for 150 days	2,250,000
Total production cost	**FCFA 3,230,000**

Annual sales of smoked fish

$\frac{50kg\ wet}{day} \times 150\ days \times 0.4\ \frac{kg\ dry}{kg\ wet} \times FCFA\ 1340/kg\ dry\ fish =$ **FCFA 4,020,000**

Annual profit **FCFA 790,000**
(= FCFA 105/kg wet fish)

5 Constraints

The major constraints in the development of techniques and facilities for fish handling, processing, storage, distribution and marketing can be listed as follows :-

5.1 Education

The level of education and awareness amongst fishermen/fisherfolks, as regards to the resource, the importance of quality and nutritional education, is far from ideal.

5.2 Facilities for credit

Facilities to provide credit (money, inputs, technical assistance etc.) are inadequate and inappropriate.

5.3 Legislation and enforcement

Legislation on fishing zones, fishing efforts, raw and processed fish quality, acceptable norms, practices and techniques for handling, smoking, packaging, storage and distribution need to be reviewed and modified. There is also the need to put in place appropriate structures and personnel to enable enforcement and litigation.

Table 1: Socio-economic evaluation of different ovens

Type	Cost in FCFA	Life span in years	Repairs	Manoeuvrability	Acceptability
Banda (open)	30,000	3	Once every 3 months	Easy	High
Banda closed	35,000	4	Once every 4-6 months	Easy	High
Chorkor (Cement Blocks)	200,000	8	Once every 2 years	More and more difficult as the number of trays increases	Difficulties in handling trays. There is the need to improve the design.
Chorkor (Mud)	130,000	8	Once every 2 year	"	"
Chorkor (Bricks)	200,000	12	once every year	"	"

Source: Eyabi Eyabi (1994)

5.4 The quality of fish handling, marketing, processing storage and distribution

The techniques for fish handling at sea, on the landing sites, techniques for smoking, storage and distribution need urgent evaluation and modification. Traditional smoking for example has the following problems:

(1) Products are of poor and variable quality
(2) Fuel economy is poor
(3) Operators are exposed to high temperatures and smoke levels
(4) Traditional smoking is tedious
(5) It is very difficult to monitor the process of smoking.

6 Recent improvements and modifications

Traditional techniques for fish handling, smoking and distribution are grossly inadequate and in some cases inappropriate. The use of insulated containers is limited only to big towns and to store especially industrial catch. This technique is generally not available to artisanal fishermen.

In the area of pre-smoking treatment, the use of salt to facilitate drying, to improve flavour and to protect cured fish from biological microbial and chemical agents has only succeeded in the northern part of the country. The controlversy over the use of salt ranging from traditional values,consumer acceptability, cost and availability, its health implications, to mention a few, has come to stay. A good example of this controversy may be that the level of salt needed to give the required protection against spoilage may be too high on the basis of health and consumer acceptability. The need to identify food-grade preservatives including condiments to supplement, if not replace salt is an area of importance to research in our region. In this light, several chemicals and condiments are being experimented at the moment including citric acid, acetic and propionic acid, BHT, BHA, P.G, garlic, onion, pepper, ginger etc. (EYABI EYABI, 1990; IKEME, 1988). The results are yet to be conclusive.

In the area of smoking, many attempts have been made to improve the process. Some of the techniques have been rejected by the end users because they were not involved or not consulted during the development of the technology. However, the Chorkor oven described by BROWNELL (1986) as quite a revolution, has been a success in tropical west and central Africa. This technique which was introduced in Cameroon only a few years ago has reduced fuel consumption, improved product quality and reduced smoking time. It is still being evaluated in Cameroon. Its use is also limited at the moment.

The increased use of packaging which offers protection against mechanical, biological and chemical damage is in conformity with recommendations from research. These include cardboards lined with plastic, baskets lined with plastic and hessian or jute bags lined with plastics.

7 Recommendations and possible follow-up

Recommendations as regards the improvement of traditional smoking will take into account raw product quality, pre-smoking treatment, smoking and storage conditions. There is the need to improve education (formal and informal) with regards to the importance of the resource and also the importance of improved handling, processing storage and distribution. There is the need also to improve nutritional education.

Legislation on fish and fish product quality has to be enhanced and enforced. There is need for full participation of fisherfolks on policies relating to fish quality, processing and distribution. Traditional systems of smoking and storage (the product of the oven inclusive) have to be improved in the following areas.

- Pre-smoking treatment as an attempt to limit biological, microbiological, chemical and physical damage.
- Improve ovens with the objectives of limiting pollution from high temperatures and smoke, limit fire hazards and control nutritional damage and consequently improve product quality.
- Improve ovens in order to increase fuel economy and reduce smoking time.
- Improve ovens in order to make it possible for processing parameters to be monitored.
- Improve packaging and storage by protecting cured fish against biological, chemical and physical agents and by providing protection against biological agents, high temperatures and humidities.

As a follow-up, research trust and extension activities should go into improving the performance of the Chorkor oven by improving design (especially to improve insulation, reduce production cost and pollution) and to encourage fish smokers to use these ovens. The use of insulated containers should not only be encouraged but made obligatory. In view of the above, ice should be made handy and at a reasonable price.

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Contribution of improved Chorkor oven to artisanal fish smoking in The Gambia.

by

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ABSTRACT

Small-scale fisheries provide about 90% of the local fish supply in The Gambia. Fish is usually consumed in the fresh, smoked, or dried form. Poor catch handling, the lack of good transport facilities, and scarce ice and refrigeration facilities cause significant economic losses in the sub-sector. In order to increase the value of fish and fishery products, the traditional processing methods have been continuously improved to accommodate the almost 50% of the catch that is processed.

In the traditional processing, hot smoke-drying is the most significant fish processing method in the country. The bonga (Ethmalosa fimbriata) and catfish (Arius spp) are the two main species smoked. The technology developed is focused on the bonga, which is the most abundant species landed on the Gambian coast. Before 1985, the chorkor oven was unknown to Gambian processors. Traditional smoking houses with open ovens were the popular structures for the smokers. But these were inefficient and incendiary. The altona was also tried in the early 1980s, but was not accepted by the smokers.

Chorkor oven technology was tried at two key centres in 1985, and it was accepted as very efficient. However, it was not until 1989 that a study on the suitability of the Chorkor oven as a replacement for the traditional oven was conducted. In consultation with the smokers themselves the technology was improved to accommodate the large quantity of bonga usually handled by the coastal smokers. These improved ovens have a fuel efficiency of 0.43 and can smoke-dry the bonga to 37% of moisture content (63% loss of wet weight), which can keep for up to six months. Chorkor ovens have now almost entirely replaced the open ovens used in the country. Their introduction has resulted in a fuel wood saving of about 40 per cent, and a reduction in fish and capital loss to fire accidents. They are now the appropriate technology of the fish smoking industry in The Gambia.

1. Introduction

Losses in the small-scale fisheries sector are among the highest for all the food commodities within the entire post-harvest food system (Morrissey, 1988). Improper handling, preservation and storage techniques, and poor distribution and marketing problems cause an average of 30 per cent of the fishery harvest losses.

Small-scale fisheries provide about 90% of the local fish supply in the fresh, smoked, or dried form. Pelagic species with a Maximum Sustainable Yield (MSY) of 65,000 - 75,000 metric tonnes, contribute over 50 per cent of the coastal landings, and they are caught all the year round. Poor catch handling, the lack of good transport facilities, and scarce ice and refrigeration facilities

cause significant spoilage in the artisanal sub-sector. In order to reduce the spoilage and provide more fish and fishery products, a large part of the catch is processed.

In The Gambia, like in other parts of West Africa, hot smoke-drying is the main method of fish processing along the coast. The bonga (*Ethmalosa fimbriata*) represents 67 per cent of the coastal landings and can be caught year-round. The principal landing centres for this species are Bakau, Jeshwang, Tanji, Sanyang, and Gunjur. In some of these centres, up to 45 per cent of the catch is smoked and an average of 5 per cent is sun-dried (excluding the recent upsurge in shark drying in some major centres).

This paper describes the contribution of the Improved Chorkor Oven to the smoking of fish in The Gambia. This oven was introduced to reduce fuel wood consumption and the time spent in processing the fish, predominantly bonga.

2. History of the techniques

Before 1985 the Chorkor oven was unknown to fish processors in The Gambia. The half barrel and the traditional smoking house with open ovens were the widely used structures. The barrels were used in homes by women, who were small capacity smokers. This small capacity oven is still seen in some homes where it is sometimes used to smoke fish for domestic consumption. The traditional smoke houses were all thatched huts up to the late 1970s when the Department of Fisheries extended its revolving loan fund to include fish smokers.

Some of these smokers received cash loans that they used to buy corrugated iron sheets used in roofing their traditional smoke houses. The new roofing provided better protection against the rain, but the walls were still thatch or rhun palm leaves that were incendiary. The ovens within the houses were constructed of old fencing wire or German metal sheets supported by forked wooden posts. There is no protection on the sides from the fire. These ovens were not appropriate for the efficient smoke-drying of the bonga and catfish, the then two main species utilized.

In the early 1980s an Altona kiln was tried by the expatriate Fisheries Adviser, responsible for implementing an EU financed artisanal fisheries development project. The trials were done at Tanji and Gunjur. An Altona oven was eventually built at the Gunjur centre and was taken over by the centre in 1983.

By 1985, the need for improving the available ovens to make them more appropriate in reducing costs by reducing fuel wood consumption and labour became imperative. So, at the request of the Gambia Government, the IDAF Programme in Benin sent a Fish Processing Technologist to conduct a study, with the Department of Fisheries, on the possibility of improving the traditional method of fish smoke-drying. The Chorkor oven was built and tried at Gunjur and Tanji. The results were presented to the smokers and traders who assessed the final product and storage period. The assessment was positive for quality and cost effectiveness. A Chorkor oven was subsequently built for the women smokers at Gunjur, who used it until the second phase of the EU financed artisanal fisheries development project that started in 1988.

One aim of this project was to improve the traditional methods of smoking bonga to reduce fuel wood consumption and labour. A study on the suitability of the Chorkor oven as a replacement for the traditional platform was jointly conducted by the project staff and the Gunjur Fish Smokers Association. The efficiency assessment was also included in the exercise. The

association members unanimously concluded that the Chorkor oven is superior to the traditional oven. They not only embraced the technology in 1989, but made recommendations for improving the Chorkor oven to suit the quantity they smoke. The surface area of the oven was modified to accommodate the large quantities of particularly bonga that they deal with. The recommendations were accepted and implemented by the project staff and the present smoking houses and ovens were consequently designed by the project engineer. These are what are referred to in The Gambia as improved/modified Chorkor ovens, used by men and women smokers in the coastal fisheries centres.

3. Types of smoking ovens

Up to 1992 five types of ovens were used for fish smoking in the country: the barrel oven for bonga and catfish, the Altona kiln for shark and skate smoking, the traditional open oven for bonga smoking, the improved traditional oven for bonga smoking, and the improved Chorkor oven for bonga and catfish smoking.

3.1 Barrel oven

This oven is made from empty 200 litre oil drums. One third or half of the empty barrel is used. A grill or wire mesh is placed on top of the treated barrel. The bottom is cut out and placed on a sandy base. An inlet opening for the wood is then carved out of the bottom for wood users or left whole and sawdust or wood chaff put at the bottom for smoking. The fish, usually placed flat on the grill or wire mesh, is covered with old sacks, old cardboard, old iron sheets, or local available material that the mainly female smokers deem to be efficient in containing the heat in the barrel chamber.

3.2 Altona Kiln

The kiln at Gunjur, which is no longer used, has 10 ovens placed in parallel rows of five with a central path for access to the hearth openings. A cart with six metal shelves can be pushed in and out of each oven on two metal rails. The walls of the ovens are made of heat resistant fire bricks. The fish is supposed to be placed on the shelves and supervised during smoking through rectangular openings at the top and bottom of each of the metal doors.

3.3 Traditional Oven

The traditional smoking house is either a thatched or corrugated iron roofed hut. The smoking platform in it is either a metal bar with perforations or a simple metal grill supported by wooden (forked) or iron posts. The platforms vary in size from 12 to 17 metres long, are 1.40 metres wide, and are 60cm high. The completely open space under the platforms is used for the fuel wood. The roof and side wall openings allow smoke to escape. The smoking houses that contain the open ovens are very incendiary.

3.4 Improved Traditional Oven

This oven is built with locally moulded mud bricks with an average length of 10 metres, width of 1.5 metre, and height of 0.94 metre. The metal or wooden posts are replaced by low mud walls, which usually have 8-13 fuel wood stoke holes of about 50 cm wide. The top, on which the fish is packed, has either a fencing wire mesh or a German metal with circular perforations.

3.5 Improved Chorkor Oven

The oven has been standardized in the smoking houses by the Project Engineer. The ovens are 7.68 metres long, 1 metre high, and 1.49 metre wide with a metal grill top. Each oven has a dozen 47 cm wide stoke holes. Each smoking house has four of these ovens, which are built with cement and red burnt bricks procured from a local factory.

4. Smoking Techniques

The smoke-drying of bonga, shark, skate, or catfish preserves the respective species by combining the smoke from the burning wood that kills bacteria that may cause spoilage, the extraction of the moisture by the heat generated by the fire that inhibits most spoilage organisms, and the cooking of the fish flesh at high temperature to kill bacteria and destroy harmful enzymes. The duration of storage of the smoked fish depends more on the cooking and the state of dryness than the smoke itself. So the preservation objective is common to all the techniques applied in The Gambia by using the oven types described above. However, the fuel wood consumption and efficiency of the ovens, among other elements, vary with the oven type.

4.1 Barrel Oven

The heat produced within this type of oven is evenly distributed on the fish being smoked and very high temperatures for drying the fish are produced. It can, therefore, produce a very dry product that can be stored for long periods by using a low fuel wood quantity - wood chaff, small wood splits, or sawdust.

4.2 Altona Kiln

According to the bonga smokers, products smoked in the kiln do not get dry enough and deteriorate in quality very fast. The product also breaks easily during packing. It is observed that its deficiency is a result of a bad choice of materials and not a construction fault, because the shelves are fixed on the cart and do not allow rotation. It also consumes (relatively) more fuel wood within a smaller capacity chamber.

The operators seem to be ignorant of the suggested FAO operation conditions. These conditions required a pre-drying of two hours at 80° C, followed by roasting for two hours at 90 - 110° C, followed by drying for 11 hours at 80° C. Complying with these instructions might improve the product quality and shelf life.

4.3 Traditional Oven

The use of this oven is a technique that stacks bonga on the wire mesh side by side in rows and belly-down. The bonga is put head-down at an angle of about 30° to the horizontal. Once the stacking is complete, the fire is lit under the fish. The fire is controlled by dousing it periodically or pulling out high burning logs. The fire is usually difficult to handle because it can reach up to 147° C.

The first smoking period lasts for about 10 to 12 hours before turning. After three days the fish is packed in layers of two or three depending on the size. The smoking then continues until the fish is dry enough to sell. The fresh dry product (which loses 25 - 45% of moisture)

keeps for a maximum of four days, and the hard-dry product (which loses 62 - 84% of moisture) can keep for up to six months.

A comparative fuel efficiency study conducted on the traditional oven of 1.44m x 17m showed that such an oven can take 1408kg of bonga, which can be smoked to loose 67.8% of its weight -i.e. 32% of moisture content. This exercise used 1470kg of wood, resulting in a fuel efficiency of 1.04. In another trial, the bonga smoke-dried to 31.9% of moisture content was 1669kg, and it used 1340kg of wood. This trial gave an efficiency of 0.8. These trials gave an average fuel efficiency ratio of 0.94. The wood used was Terminalia macroptera (Wolloh) and Pterocarpus erinaceus (Keno).

The smoked bonga is usually packed in boxes that measure, on average, 77cm x 60cm x 40cm, and these boxes can take up to 400 pieces of smoke-dried bonga (hard-dry).

4.4 Improved Traditional Oven

The design of this oven makes it relatively more fuel efficient than the traditional oven. The packing of the fish and its handling during smoking are the same as in the traditional oven.

Its performance is very close to the improved Chorkor oven, discussed below. These improved traditional ovens, usually made of mud bricks, are cheaper and can be made from locally produced material - that makes them quite appropriate for sustainable development.

4.5 Improved Chorkor Oven

Each of these ovens can take at least 800kg of wet bonga per smoking session. The fish is packed on the metal grill platforms the same way as on the traditional oven platforms; head-down at an angle of about 30° to horizontal, and belly-down.

The smoking periods (fires) range from three (for a 3 - 4 days storage requirement) to five for a six months storage. This technique combines the fuel efficiency of the Chorkor oven (0.43 in a national study that produced a product that lost 63% of wet weight) and a large capacity for the quantity of bonga smoked by the men smokers along the Gambian coast. The high efficiency is the effect of a sealed fire box that reduces heat loss and fuel wood requirement.

5. Evaluation of different techniques

5.1 Barrel oven

The cut out barrel ovens are relatively light and convenient for individual smokers to move around within their homes. The size that makes them transportable renders them unsuitable for smoking large quantities of fish. They are used mainly for smoking small quantities consumed in the homes or sold in local markets. The species commonly used is catfish. These ovens are not appropriate for a large scale commercial venture, especially not for the bonga smokers.

5.2 Altona kiln

There were high expectations for improvement in working conditions when the Altona was introduced at Gunjur. But the smokers later realized that the oven required high investments.

It was also relatively too sophisticated for the local environment. So it could not be adopted by the smokers. The one at Gunjur was used mainly by foreign shark and skate smokers, who have since abandoned it. Its shed is now being restructured for another use. That means that the technology has been totally rejected in The Gambia, at least for now.

5.3 Traditional oven

The traditional ovens have a large capacity but are inefficient in fuel wood consumption, because of the relatively uncontrollable wind effect through the open spaces between the supports. The wooden supports and the thatched or even corrugated iron sheet roofed smoking houses are a fire hazard. There were cases at Gunjur and Tanji where the houses burnt with the fish being smoked and the batch being stored. Such accidents can put smokers completely out of business, especially if capital is tied up in a stored consignment. The open spaces under the platforms expose the smokers to intense heat, which is unbearable when one stands over the platform for long hours. A lot of heat is also lost from the open spaces because of poor fire control. The high heat loss requires long smoking times and more fuel wood. The increasing storage of fuel wood, the increasing cost of transportation, and the vigilance of the forestry officials is increasing the price of fuel wood. This increase is raising operational costs to the smokers and reducing their profits, especially at a time when the markets are getting fewer fuel wood because of border restrictions. The cost to the health of the smokers, like nose, eyes, and bronchial problems experienced, is also of concern in the search for better technology.

5.4 Improved traditional oven

The improved traditional ovens consume less fuel wood because of the fire protection on all sides of the platform, except the stoke holes. This relatively lower heat loss and fire risk reduced the processing cost to the smokers. These ovens are more economical and more acceptable than the original traditional ones.

5.5 Improved Chorkor oven

The improved Chorkor ovens have become the answer to the search for an appropriate technology that will reduce fuel wood consumption, create a better working environment, and reduce operational cost. These ovens, compared to the traditional ones, have been more acceptable to the smokers, particularly the bonga smokers. They see them as easier to use and more economical. They have combined the efficiency of the Chorkor oven, well known in the sub-region, and the large capacity required for smoking the large quantities of bonga landed and smoked in the coastal landing centres. These enclosed ovens have presently almost entirely replaced the open ovens until now used in the country. Their introduction has resulted in a fuel wood saving of 40 per cent and a reduction in fish and capital loss to fire accidents. The lower cost of processing, because of the introduction of the improved Chorkor, now releases funds for the purchase of additional fish that raises the income of the fish smokers - men and women. With the loss of forest cover and the decreasing availability of fuel wood, this technology could not have come at a more appropriate time in the development of the country's fish processing technology.

The improved Chorkor oven was designed as a remedy to the problems observed in the other ovens prevailing in the country up to 1989. It has provided more efficiency and a higher capacity, which are the major needs of the mainly bonga smokers. But this appropriate technology

has two major problems that are presently being studied: smoke density in the smoking houses, and the costs of replacing the more expensive red burnt brick ovens and concrete cement smoking houses.

A fuel efficiency comparative study, conducted by the Department of Fisheries with IDAF assistance, was done in 1992 for the improved red brick Chorkor oven and the traditionally built improved mud Chorkor oven. The conclusion is that the ovens showed no significant difference in performance. Therefore, the cheaper mud block Improved Chorkor Oven is the more appropriate smoking apparatus for the country. At least one smoking house with improved Chorkor ovens is presently being built at Kartong Fisheries Centre. The result of the study was communicated to the centres and it seems to have been accepted as a means of avoiding the high replacement cost of the present ovens and smoking houses financed from project funds.

The solution to the smoke density problem, which is causing eye, nose, and bronchial problems, has still not been found. There is a need to re-design the smoking houses to exhaust the smoke adequately without compromising the security of the equipment and the products being processed and stored in them. The modification exercise seems to lack funds and the centre management committees responsible for these houses are still unwilling to invest in these houses. They are claiming that their funds are insufficient for modifying all the houses, and they cannot do some and leave the others. Meanwhile, the saddle of the roof of some of these houses are removed during the dry season for an effective exhaust. Unfortunately they are returned during the rainy season - which is not a healthy working period for smokers.

6. Recommendations

The search for an appropriate technology in the smoking of bonga and catfish in The Gambia has produced five smoking oven types: the barrel, altona, traditional, improved traditional, and the improved Chorkor. The most efficient, and, therefore, the most appropriate is the improved Chorkor. It is a combination of efficiency and adequate capacity for the large bonga catch, and it can be constructed with local materials.

As it has been established that bonga smoking is a major sub-regional activity and the problems of the smokers are identical, the improved Chorkor oven should be adopted in the respective national extension and training programmes as the most suitable technology for fish smoking. Its adoption will reduce pressure on our fuel wood, promote (efficient) cost-effective operations, and accommodate our large bonga landings.

Once adopted, The Gambia can serve as a good source of information for extension materials. The coastal centres can readily be used as demonstration sites for national and international visiting extension agents and smokers, whose missions can be financed by IDAF or the other regional fisheries programmes.

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Chorkor/banda hybrid in Tombo, Sierra Leone.

by

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1. Introduction

Tombo is a major artisanal fish landing site. The artisanal fishing fleet in this locality varies in size between the "Ghana type" planked canoe, which may be up to 20 metres in length, down to the smallest canoes which are around 6 metres in length and may be dugout or planked. The main type of equipment employed is large encircling gill nets for "Herring" and "Bonga", drift nets for small pelagic species and cast nets which are used purely for a subsistence purposes.

Ice is not available on the landing site, nor is it carried on board the canoes. The catch composition of the ring net fishery at Tombo is about 48% of the weight of *Sardinella spp*, about 42% of the weight of *Ethmalosa spp* and about 10% of the weight of other species.

Tombo village depends entirely on the fishing industry. Since the project's inception in 1980, the annual fish landing has increased from 2,000 metric tons in 1981 to around 12,000 metric tons in just over a decade. About 90% of these landings are persevered by hot smoking. For decades, the processors in this locality have employed the traditional Banda and later the Fante Banda to smoke-dry their fish. These are raised platforms with open or closed sides above the fire-place. The Fante Banda, which was preferred over the traditional Banda by the fish processors because of numerous advantages, also had several limitations which on the economic, health and environmental level. In an effort to counteract these limitations, and at the request of the women processors who were basically interested in improving heat drying techniques to produce a better end product, the project introduced the Altona oven. This technically efficient innovation, which was looked upon as a solution to most of the problems of the fish processors, met with serious acceptance problems and was eventually discontinued.

The failure of the Altona oven programme, for reasons that have been detailed in earlier reports, motivated the project to embark upon investigating ways of upgrading the Fante Banda to achieve the following goals :

- fuel efficiency;
- comparative quality of product output;
- familiarity with traditional organisation and social role as in Fante Banda operations;
- acceptability and possibility of innovation uptake;
- cost efficiency.

The outcome of this venture was the Chorkor/Banda hybrid. The external features of this hybrid replicate those of the Fante Banda.

2. Description of the Chorkor/banda hybrid

The hybrid designed and constructed by the project in 1988 has a total length of 4.66 m, a width of 1.98 m and a height of 0.98 m. The total surface area provided by the innovation of three compartments was 7.13 m^2 with a main average tray capacity of 170 dozens herring. Each compartment can accommodate two sets of trays for better heatcontainment. Another energy preservation feature is the reduced fire-place aperture to reduce radiation and tray by-pass above.

As in the Fante Bandas, the three arched fire-places are centrally located. The operations of this improved device is very similar to the commonly employed Fante Banda and therefore requires only minor training for more efficient fuel wood usage.

As mentioned earlier, second sets of trays are provided for each of the three compartments to sit on the Banda top. These top trays specifically serve the purpose of re-smoking previously fresh-dried fish, in conjunction with fresh fish on the lower trays at no extra fuel wood demand. This tray stacking is of course a borrowed characteristic from the Chorkor smoker. The trays are rigidly constructed from weld mesh on a welded angle iron frame. This portability affords easy access for cleaning and the nature of fabrication provides for durability and minimal material use.

To ascertain its functionality and efficiency, initial trials were carried out on the hybrid by the project processing personnel. After these trials, the facilities were made accessible to local fish processors for use, on payment of rental fees. To allow as many processors as possible to gain access to the facilities, processing was conducted on a rotational basis. Supervision and verbal instruction on flame control, the need for conservation of fuel wood and the importance of the main Hybrid features were emphasized.

During the period under review, from the latter half of 1988, right through April 1992, monitoring was carried out on a regular basis regarding fuel wood utilisation against the quantities of fish smoked, smoking times, end product quality and participants' response to the hybrid and the rehabilitated Chorkor under normal commercial operations. Access to the facilities has continued on a rotational basis under supervision throughout this period, while new participants continue to appear on the scene. One hundred and four observations of processing have been recorded for the hybrid and 32 for the Chorkor oven for comparison. All through this period, re-smoking was done only twice in conjunction with fresh fish. The fact is that the majority of the processors do not re-smoke their products, as most of them process fish overnight and depart at dawn to market their products, their processing targets being fresh to medium dried fish for proximal markets. Other contributing factors include the fish processors rotational policy, different fish landing times and purchasing and processing of fish.

Out of the 104 observations recorded during this period for the hybrid, 30 carefully selected observations are included in this report for the smoking of herring on a total of 51 trays. In total 6,516 dozen herring, weighing 3,972 kilograms needed 881 kilograms of fuel wood for fresh drying, while the 20 observations for the smoking of 3,740 dozen bonga weighing 4,466 kilograms, required 838 kilograms of fuel-wood for fresh drying.

On the whole, a mean average of 3 hours and 3 minutes is required to heat dry a tray of fish containing an average of 136 dozen herring each at a density of 71.52 dozen/m^2 The end product generally showed a fresh weight loss of 30-40% (fresh or soft dried).

Results obtained from the fuel wood usage gave a mean average of 22.19% of fresh herring weight required as fuel wood for processing to the fresh dried state and 13.64% of fresh bonga weight to produce fresh dried bonga. These results might seem impressive, but it must be cautioned that varied fuel wood consumption rates were observed due to the following factors:

a. *Human factor* : Some newly introduced processors tend to build big fires, hence unnecessarily increasing wood consumption, sometimes causing the few cases of charring that have been observed.

b. *Combustibility* : A variety of wood species with different combustion rates are employed in the processing industry in Tombo. The combustion rate affects the processing requirement level.

c. A wide variation of *wood weight* per stick, ranging from between 1.3 to 0.25 kg was recorded. One cannot completely exclude the element of error, because only samples of wood were taken from each batch. Wet rain soaked wood weighed heavier and showed a slow combustion rate, but had changed towards the latter stages of burning.

3. Comparative production performance : Fante Chorkor and Hybrid

The production performance of the Chorkor and hybrid while operating and monitored jointly under similar conditions and locality, revealed some interesting comparative results as can be noted from the table 1 below. Figures for Fante, Banda are culled from Tombo Banda Survey and other Internal Reports.

Table 1: Performance of the three types of smokers

Item		Fante Banda	Chorkor	Hybrid
Average carrying capacity (Herring)		73 doz/m2	71 doz/m2	72 doz/m2
Fuelwood required as % of fresh fish weight	Herring	*68	**26	**22
	Bonga	36	15	14

* Hard dried herring; ** = Soft dried herring

The fuel-wood requirements for a soft dried single-tray fish are similar for both the Chorkor and hybrid but almost doubled in the Fante Banda operations. It required 68% of fresh fish weight to hard-dry on the Fante Banda, while for the two observed re-smokings on the hybrid, no extra fuel wood was required to process from the soft dried state to the hard-dried state, since this was done concurrently with fresh fish.

When first smoking (fresh fish) and re-smoking (soft-dried) was carried out at the same time, it was observed that a much higher fuel wood efficiency utilisation percentage was indicated. For example, 224.6 kg of fish which comprised of 89.6 kg of soft dried herring and 135 kg of fresh herring required only 32.5 kg of wood to produce 87.75 kg of soft-dried and 56 kg of hard-dried herring, giving an efficiency percentage of 14.5% of wood weight consumption.

4. Introduction of the hybrid to the processing industry

After a series of demonstrations, the innovation was introduced to the local processors. The response was remarkable, since its mode of operation is, to a large extent, similar to that of the popular Fante Banda. It takes care of the social aspects and maintains a cheaper solution to the prevailing processing constraints as far as the local processors are concerned. Furthermore, it retains the joy of seeing the fish while smoking is in progress.

The 1992 Banda Survey revealed that over 70% of the fish processing industry in Tombo had taken up the idea of this new innovation. This is quite a remarkable success. Even the less than 30% Fante and traditional Banda owners indicated when interviewed that they were in the process of changing over to the partitioned innovation. The current drastic drop in catch resulted in a large quantity of wood being used to dry relatively few dozens of fish on the Fante Banda.

5. Slight modification

During the transfer period, some areas that needed modification were identified and promptly corrected. Foremost were the fabricated hybrid trays. The processors reasoned that such tray would be too expensive to construct and maintain. So instead of using moveable trays, the hybrid was modified to accommodate static trays similar to those commonly employed with the Fante Banda. When the hybrid wall reached the required height during construction (0.80-1.15 metres), holes were bored through the upper layer of the mud blocks (polymerised clay) at about 20-30 cm apart. These holes accommodate the iron poles or banda sticks which hold the wire mesh above the fire. The closely spaced iron poles support the weight of the wire mesh and fish and the iron poles or banda sticks can be simply pulled away and maintenance to the oven walls effected.

The mimic hybrid accepted by the processing industry in Tombo has no room for double moveable trays. End products or products for re-smoking occupy one compartment, usually the rear where a fire can be set for re-smoking as required.

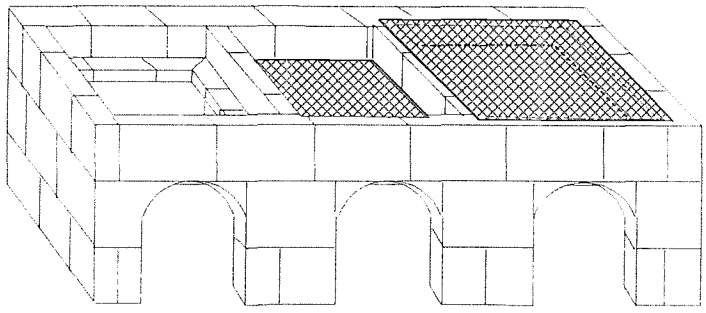

Figure 1: Chorkor/banda hybrid

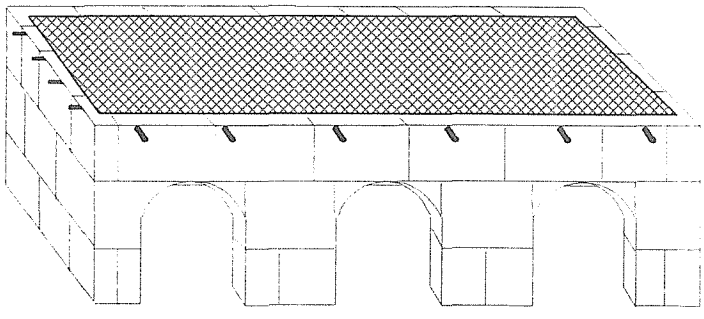

Figure 2: Mimic Chorkor/banda hybrid

6. 1992 Banda survey

The survey involving all the Bandas in Tombo, that is : mimic hybrid Fante and the traditional Tombo Banda, commenced on July 16 and was completed on July 20. Bandas in any given locality were treated separately. Measurements of Banda height, width and length were carried out by the enumerators.

7. Results

290 Bandas were enumerated. Out of this grand total, 206 comprised of the mimic hybrid, 74 "Fante" ovens and 10 traditional or Tombo Bandas. The total surface area of all the 290 Bandas totalled 4,550 m^2 which covers 74% of the total surface area.

Out of 290 Bandas enumerated, 284 were housed, 6 were unhoused, 176 were new, 16 unused and 98 were undergoing repairs. 16 Bandas were out-of-use during the survey due to

unavailability of poles and wire mesh at the time, but efforts were under-way by the respective owners to purchase these materials and recommence fish processing.

8. Discussion/conclusion

The Chorkor/Banda hybrid potentially combines the best of both Chorkor/Altona with that of the Fante Banda. Interviews with local processors revealed some contributing factors as to why this new innovation was widely accepted. This has been the greatest area of success in the project's bid to introduce appropriate technological innovations to the target community. One important factor is the novel delivery method employed, which was one of a participatory approach. The device was jointly developed by the Processing Section of the project and the target group, with frequent consultations between both parties during the construction phase. Trials after completion of construction works were jointly undertaken, after which the target processors were given full access to utilise the facilities on a rational fee paying basis.

The numerous advantages of the new device were recognised and determined by the users themselves, which served as an impetus for them to invest in the construction of their own privately owned hybrid-type mimics, without any further intervention of the project. Different levels of adaptations were introduced during the construction of the mimics, due to financial limitations of the owners and their individual levels of investment. However, the overall result was one of significant levels of fuel efficiency and fuel wood utilisation.

There is a general lesson to be learned here by other would-be development Agencies in artisanal fisheries Development. That is : any meaningful behavioral and attitudinal change can be brought about by the passive, low investment method. Any innovation that is technically efficient and takes cognisance of the social and labour needs of the target group will be easily accepted and adopted, provided the advantages are easily recognised and are rationally equitable to the new investment required. If the level of technology is within the absorption capacity of the recipients, they will willingly invest in such technology and use it on a sustained basis, without the need of any outside coercion or outside investment. A loans and credit programme, for example, was not necessary in this case.

The cost of materials and labour for the construction of both the hybrid and the Fante Banda of similar dimensions is almost the same. The annual maintenance cost to the oven is very minimal and major repairs to the oven walls can be affected every 5-6 years when in continuous operation for some 250 days per year.

At a time when the cost of fuel wood is sky-rocketing and the price for the fish is affected by its high cost, the hybrid can economically employed by using one compartment to smoke-dry fish in a relatively short period. The hybrid can also handle large quantities of fish while at the same time giving a uniformly dried end-product. With proper flame control, the fish/fire wood ratio is maximised and no charring occurs.

The above observations and the results of the hybrid when compared to the data of "Fante" Banda performance clearly demonstrate the superiority of the hybrid over the "Fante" Banda. Although of comparable performance with the Chorkor oven, the size of the Chorkor combined with the changing of trays disqualifies it for large scale processing akin to the processing industry in Tombo. Comparatively, the construction cost of an average hybrid (Figure 2) is very similar to "Fante" Banda of the same size, save that more clay blocks and labour are

employed in the former. As illustrated in Tables 2 & 3. These figures were calculated in July 1992 during the Banda Survey.

Indications are that the mimic hybrids are better constructed than the Fante Banda and as a result, the annual repair and maintenance cost is very minimal, if any. Only the chicken wire needs to be changed very frequently.

Because it is not a rigidly constructed as the mimic hybrid Banda, the annual repair and maintenance cost is about 10% of the total construction cost. The overall survey results show that the mimic hybrid, making up 74% of the total surface area of the Bandas in Tombo, has been a major success in he processing industry. Although the number of Bandas have been reduced from 301 in 1988 to 290 in 1992, the total surface area has actually increased by 667 m^2. The reason for the reduction in number is that Banda Houses that once housed three or four Fante or traditional Banda, now house one or two mimic hybrids with larger surface areas.

Table 2: The construction cost of average mimic hybrid (1320-1330 dozen herring) (Figure 2)

Items	Notes	Cost (Leones)
Mud blocks	Including fabrication cost 500 at Le.40 Each	20,000
Wire mesh (second hand)	2 rolls at Le. 4,500 per roll	9,000
Metal poles	Second-hand Le.700 each (35-40)	32,000
Chicken wire	Maker price at Le. 800/m, 12m	9,600
Labour	Mason's pay	6,500
Total		77,100

Table 3: The construction cost of "fante" banda 960-980 dozen herring capacity

Items	Notes	Cost (Le)
Mud blocks	Including fabrication cost 410 at Le. 40	16,400
Wire mesh	Second hand 2 rolls at Le 4,500/roll	9,000
Metal poles	Second-hand Le. 700 each (35-40)	32,000
Chicken wire	Market price at Le. 800/m, 12m	9,600
Labour	Mason's pay	5,000
Total		72,000

The surface area of the Chorkor/Banda hybrid (Figure 2) is 7.15 m^2 and has a capacity of 510 dozen herring. With a total Banda surface area in Tombo of 4,550 m^2, the total capacity of Tombo Banda is 325,000 dozen herring. Using the average weight per dozen of fresh herring of 0.7 kilograms, the total capacity of Tombo Bandas is 227 tons of herring.

During the survey period, four Banda houses were discovered empty. When interviewed, the owners explained that they had demolished the Fante Bandas and were awaiting the dry season to get mud blocks to construct the hybrid types.

At present it seems that the Chorkor/Banda hybrid cannot be improved beyond its present level and is adequately geared towards a sustainable fish supply, specifically processed for the local/traditional consumer market. The section however, will continue to investigate other possible ways whereby a more fuel-efficient device could be developed and introduced in the near future.

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Traditional Fish Processes: Technology, Quality and Evaluation

by

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1. Introduction

1.1 Traditional food processing

The methods used for food processing in most African countries are classified as traditional because of their strong links with local traditions (Sefa-Dedeh, 1993). These methods may be similar to modern food technologies in terms of the scientific principles underlying the unit operations. The major differences may be in the mode of application and effects on product quality (Sefa-Dedeh, 1993). Traditional technologies for processing foods in general may have all or some of the following characteristics (Sefa-Dedeh, 1989):

(a) simple and small-scale operations;
(b) low capital costs;
(c) labour intensive;
(d) unhygienic processing condition;
(e) variability in process;
(f) poor quality control;
(g) home-based;
(h) time consuming.

1.2 Traditional fish processing

Very simple methods have been used to convert the highly perishable fresh fish into shelf-stable forms. Some of the resulting products have unique but desirable quality attributes (Sefa-Dedeh, 1993; Plahar et al., 1991; Nerquaye-Tetteh, 1982; N'jai, 1986). Traditional methods for processing fish include salting, fermentation, drying and smoking either alone or in various combinations. These products are collectively referred to as cured fish. Traditional technologies used to prepare cured fish have been widely documented (Plahar et al., 1991; Sefa-Dedeh et al., 1989; Motohiro, 1988; Nerquaye-Tetteh, 1982, 1986; Dhatemwa, 1982; Nyagambi, 1982; Curran et al., 1986; Maembe, 1982; Azeza, 1982; Kandji and Conway, 1982). Most of the documentation gives detailed processing steps with little information on product quality characteristics. Control of the processing conditions is virtually non-existent (Watanabe, 1982). Variations in product type and quality are common. Notable among the causes of variations in product quality are differences in the freshness of the starting material, the preparation of the fish prior to curing and the methods used for curing the fish. Differences in fish species may also be reflected in the quality of cured fish (N'jai, 1986; Nerquaye-Tetteh, 1982).

2. Raw materials

2.1 Fish

Different fish species are used for the various products (Table 1). A wide range of species can be used to make products such as fermented autolysed fish, "momoni". On the other hand, a product such as salted dried tilapia, "koobi", is species specific. Generally fish with a higher fat content is smoked. The fat contributes to the development of flavour and colour.

Table 1. Predominant raw material used for processing fish products

Product	English Name	Local Name	Scientific Name
Dried Fish	European Anchovy	Abobi (E) Keta School Boys (G)	*Engraulis encrasicolus*
	Trigger fish	Ewurafua (F)	*Balistes forcipatus*
	Round sardinella	Eban (F) Pepawaano (F)	*Sardinella aurita*
Salted Fish	Sea catfish	Kpontunwili (G) Kpotue (E)	*Arius spp*
	Tilapia	Mpatoa (F)	*Tilapia spp*
	Trigger fish	Ewurafua (F)	*Balistes capriscus*
	Ghanaian rockfish	Fii Efin (F)	*Pontinus accraensis*
	Smooth hammerhead	Paa () Taile (G)	*Sphyrna zygaena*
	West African Spanish mackerel	Safur (F) Apaa dentsi (F)	*Scomberomorus tritor*
	Sea bream	Wiriwiriwa (F)	*Pagellus erythrinus*
	Sting ray	Tantre (F) Pepawaano (F)	*Trygon margarita*
	Smooth hound	Woweow (F)	*Mustelus mustelus*
	Bigeye grunt	Ebue (F)	*Brachydeuterus auritus*
	Senegal jack	Akuanu (G)	*Caranx*
	Blue shark	Semire (F)	*Scoliodon terreanovae*
Smoked Fish	Tilapia	Mpatoa (F)	*Tilapia spp.*
	Sea catfish	Kpotonwili (G) Kpotue (E)	*Chrysichthys spp.*
	Long finned herring	Kanfena (F)	*Ilisha melanota*
	Frigate Tuna	Opuku (F)	*Auxis thazard*
	Anchovy	Keta school boys	*Engraulis encrasicolus*
	Round sardinella	Eban (F)	*Sardinella aurita*
	Shark		
	Lesser African Threadfin	Sukwei (F)	*Galeoides decadactylus*
	Mudfish/Catfish	Adwen (F)	*Clarias spp.*
	Largehead hairtail		*Trichiurus lepturus*
Salted Dried Fish	Tilapia	Mpatoa (F)	*Tilapia species*
Fermented Fish	Shark Octopus	Amoni (G)	
	Frigate Tuna	Opoku (G)	*Auxis thazard*
	Crevalle jack	Gbaa (G) Epae (F)	*Caranx hippos*

2.2 Fuel types

Various plant products are used to generate heat and smoke in fish processing. These include: firewood, sawdust, sugar cane pulp, corn cob, and dried pineapple peels. The use of these materials is dependent on availability and preference of the processor. Apart from firewood, all the materials are by-products of other processing operations. The type of fuel may affect heat generation, and the development of flavour and colour in the fish.

2.3 Salt

Salting is an important operation. Two types of salt may be used for fish processing: coarse and fine crystals. Fine salt crystals are used to achieve fast penetration of salt into the fish tissue. The chemical and microbiological quality of the salt can affect the quality of the final products.

3. Processing Methods

3.1 Unsalted dried fish

This is a fish product which is relatively easy to process. Usually very small sized fish is used. Fish drying is practised mainly in areas around the coast, e.g. Mankoadze, Mankessim, Winneba and Keta. Fish types which are dried are anchovy (*Engraulis encrasicolus*), and small herring (*Sardinella aurita*).

Fish to be processed by this method is washed with either tap or seawater, spread out on the ground or raised platforms and dried in the open sun. The drying process is continued for a period of 3-6 days.

3.2 Salted dried fish

3.2.1 Salted dried trigger fish (Balistes capriscus)

Trigger fish is cured without scaling. This is because the skin and scales of the fish are used in such a way that scaling is impossible without removing the skin as well. There are two types of salted dried trigger fish products: gutted and un-gutted. Fresh trigger fish is normally gutted before brine salting but when the fish samples are of poor freshness (showing signs of deterioration) they are not gutted. The fish is immersed in brine prepared by adding solar salt to sea water in the salting vat, covered with polypropylene sheet and weighed down with large stones. After 24 hours, it is vigorously stirred in the brine and dried (2-5 days) on the ground or on a raised platform until the product is sufficiently dry. This product is locally called 'ewurafua'. The production of 'ewurafua' was reported by Nerquaye-Tetteh (1986).

3.2.2 Salted dried blue shark (Scoliodon terreanovae)

The fish is decapitated and blood in the head drained by soaking in sea water. The mid-bone is removed and the flesh is cut into chunks. The head and the flesh are dry-salted (24 hours) by the battery method in salting vats. The salted product is washed with sea water, rinsed and the flesh vigorously rubbed with fine salt and dried (3-5 days) on straw on the ground or on a raised platform. This product is locally called 'kako'.

3.2.3 Salted dried tilapia fish (Oreochromis niloticus)

The fish is scaled, gutted through a slit at the anal opening and washed clean. If the fish is large but not very fresh it is cut open dorsally from the head to the end of the dorsal fin near the tail such that the two fillets are joined ventrally. After removing the entrails and washing the opened fish, fine salt is rubbed into the flesh and the two halves brought together. This is to reduce further deterioration of the fish. For large fresh fish however, salt is placed in the cleaned gut before they are arranged together in layers alternating with salt. The fish is covered with polyethylene sheet and weighed down with stones. Salting takes 1-3 days after which the fish is rinsed in brine and sun-dried (3-7 days) on a raised platform. Salted dried freshwater tilapia fish is locally called 'koobi'.

3.3 Wet salted fish

3.3.1 Wet salted fermented fish ('farfasi')

The criteria for the selection of fish for the production of 'farfasi' are a) price and b) fat content. Fatty fish dries very slowly, consequently, the risk of insect infestation, spoilage by micro-organisms and physical damage during processing by sun-drying and smoking is high. Inexpensive and fatty fish is normally converted into 'farfasi'. Farfasi production is restricted to small fish such as mackerel (*Scomber japonicus*) and burrito (*Brachydeuterus auritus)*.

The fish is immersed in curing vats containing a mixture of sea water and solar salt, covered with boards and weighed down with large stones for three days. After bringing, the fish is scaled but not gutted. The entrails are however removed if they are exposed due to belly bursting or mechanical damage. The fish is rinsed with salt solution and placed in a bowl. A second salting stage involves arranging the fish in layers in the salting vats alternating with layers of granular salt. The layers of salt at the base of the vat and that over the topmost layer of fish are thicker than those sandwiched between layers of fish. An approximate ratio of 3:1 (fish to salt) is used. The vats with the fish are first covered with polypropylene sheets followed by 10-15cm of beach sand. The sand ensures a uniform pressure on the fish pile. The sand is covered with polyethylene sheet which is anchored with stones. After 5-7 days, the product is ready for sale but it is usually kept in the salting vats until it is sold. The processors indicated that the product should be moist and this is ensured by storing it in vats and controlling its exposure to the atmosphere during marketing. This product can be used as condiment or in place of fresh fish after desalting.

3.3.2 Salted Fermented Fish ('Momoni')

Many fish species can be used for this product. When fresh fish is used for momoni processing it must be soaked in water for 2-3 days to allow the flesh to become soft and flabby and initiate autolysis. In most cases poor handling and preservation practices lead to partial deterioration of the fish at sea and the fish does not need to be soaked in water.

The fish is scaled, de-gutted, washed and arranged on a layer of salt spread across the base of a drum, or cemented tank. The batch is soaked in concentrated brine solution for about 1-3 days. Alternately a basket could also be used instead of a drum, in which case the basket is lined with jute sacks and layered with salt. The method of spreading salt is dependent on the size

of fish. The salt is spread on every 2 layers of large fish whilst with small fish, it is spread on over 5-6 layers. Salt is spread on the final layer of fish and the whole arrangement covered with a sack.

To assist in de-watering, heavy stones may be placed on the fish and allowed to stand for 1-3 days. The fish may then be washed before drying. The fish is then smeared with salt and dried on raffia mats in the sun for 3-4 days. After drying the excess salt on the fish is rubbed off and kept for use during processing of the next batch. This product is more often used as a condiment or flavouring agent than being the main source of protein in a meal.

3.4 Smoked Fish

Different sizes of fish are used for fish smoking in Ghana. They range from small anchovies (*Engraulis encrasicolus*) to fairly large fish such as Frigate mackerel (*Auxis thazard*). The objectives of smoking the fish include preservation to increase shelf life, and a wider market for the fish landed by the fishermen. The smoke particles also play a significant role in the development of flavour and texture.

The fish smoking method is the same irrespective of the source (marine or freshwater), type and size of the fish. Differences may however be found in the initial preparation of the fish prior to smoking. Traditionally, fish is not filleted before smoking but large fish is normally cut into pieces.

After the initial preparation (scaling, gutting, cutting), the fish is rinsed with water and usually air-dried before smoking, this allows any adhering water to be removed prior to smoking. In some cases, steaming of the fish is done. Only hot-smoking is practised in Ghana. Two types of smoked fish are produced: soft-smoked and hard-smoked fish. Soft-smoked fish has a high moisture content (60% or more) and a short shelf-life. Unsold soft-smoked fish is re-smoked to further reduce the moisture content; the product may take the characteristics of hard-smoked fish. Sometimes the processors set out to produce hard-smoked fish for storage. Hard-smoked fish products can also withstand rough handling during transportation and marketing.

Table 2: Summary processing steps in traditional fish processing

a. Salted dried fish

Process Type	OPERATION								
	Wash	Cut	Scale	De-gut	Age	Dry	Salt	Drain	Pack
1	5	2	1	-	4	6	3	-	-
2	2	-	-	1	3	5	4	-	6
3	2	-	-	1	-	4	3	-	-
4	6	3	1	2	4	7	5	-	-
5	-	-	1	2	4	5	3	-	6
7	-	-	-	1	2/5	6	3	-	4
8	5	1/4	-	-	-	6	2	-	3
9	3	2	-	1	1	5	4	-	-
10	1	-	-	-	-	4	3	-	-
11	-	-	1	2	2	8	5	-	6/3
13	3/7	2	-	1	1	9	4/8	-	5
14	5	2	-	1	1	7	3/6	-	-
15	2	-	1	3	3	4	-	-	-
16	2/6	-	-	1	1	7	5	-	3
17	2/6	1	-	-	-	7	5	3	-
18	3	-	1	2	2	-	4	5	-
19	3	2	-	1	1	7	4	-	5

b. Wet salted fish

Process Type	OPERATION								
	Wash	Cut	Scale	De-gut	Age	Dry	Salt	Drain	Pack
1	2/7	-	1	-	5	9	4/10	6/8	3
2	-	-	1	2	4	6	3/5	-	-
3	2	-	-	1	4	5	3	-	-

c. Smoked fish

Process Type	OPERATION								
	Wash	Cut	Scale	De-gut	Roast	Pre-Dry	Smoke	Skew	Salt
1	-	-	1	2	-	-	4	-	3
2	2	-	1	-	-	-	4	-	3
3	3	-	1	2	-	-	5	-	4
4	-	-	-	1	-	-	3	2	-
5	1	-	-	-	3	2	4	-	-
6	3	2	-	1	-	4	5	-	-
7	1	-	-	-	-	-	2	-	-
8	1	-	-	-	-	2	3	-	-
9	-	2	-	1	-	-	3	-	-
10	-	-	-	-	-	1	2	-	-
11	2	-	-	1	-	-	3	(	-
12	2	-	1	-	-	-	3	-	-
13	-	-	1	2	-	-	4	3	-

4. Processing steps

For the same type of traditional processed fish, it has been found that different processing steps are followed by different processors. These differences may be linked to the type or species of fish and/or experience of the processor. This has implications for product quality. The traditional fish processor is versatile in the development and modification of processes to address current realities.

5. Equipment

The equipment needed for the reservation of fish depends on the process being applied. In Ghana simple equipment such as trays and knifes are commonly used in all the processes (Table3). All equipment is made from local raw materials.

Table 3. Equipment used

Product	Tray	Tank	Wire	Skew	Bowl	Knives	Sack	Basket	Oven	Mark
			Mesh Stick							
Salted Dried Fish	+	+	-	-	+	+	-	+	-	+
Dried Fish	+	-	-	-	+	+	+	+	-	+
Smoked Fish	+	-	+	+	+	+	-	+	+	+

5.1 Driers

Drying systems for traditional fish processing are very simple. In most situations they are dependent on the natural sun drying. Driers may be made of simple wood surfaces, woven palm fronds and sheets on dry grass.

The use of solar driers has been suggested (Curran et al., 1986, Sefa-Dedeh et al., 1989). They are designed to trap the energy from the sun for drying fish under hygienic conditions. Sefa-Dedeh and Osei (1994) reported the design of a flat surface and dome-surfaced solar drier for fish. They found that the solar-dried fish dried faster and was darker in appearance but could not develop the same intensity of flavour compared to the open sun-dried samples.

5.2 Ovens

There are 5 main types of traditional smoking ovens. These are:

(a) cylindrical (round) mud oven with or without thatch cover;
(b) cylindrical (round) metal oven;
(c) rectangular mud oven;
(d) rectangular metal oven;
(e) Chorkor oven.

5.2.1 Cylindrical (round) mud oven

This oven is built from mud and are of different sizes. Typically it has a height of about 80 cm, interval and external diameters of 110 and 140 cm respectively.

At a height of about 50 cm above the ground a ledge is built on which sticks can be arranged to support the various layers of fish. To protect the oven from destruction by rain, ply-wood, aluminium sheets or flat metal drums are used to cover the top. These are reinforced by placing heavy stones on the covering. A few of the processors use thatch made from straw, to cover the oven.

The women themselves build the ovens. The life span of the ovens is extended by re-coating them with mud as often as possible after smoking. Sticks about 3-c in diameter are used to make a tray on the hedge. Fish to be smoked are placed on these sticks.

Problems associated with the use of this oven are:

(1) excessive handling of the fish being smoked results in breakage of fish; this lowers the market value of the product;
(2) difficulty in controlling the heat leading to non-uniform heat transfer;
(3) loss of heat and smoke through the stoke hole.

5.2.2 Cylindrical (round) metal oven

This oven is made by cutting a 44-gallon drum into two halves and supporting it on stones. Perforations are made about 10 cm from the top to allow metal strips to be inserted to make trays to hold the fish. The cylindrical metal oven is widely used in Ghana and other West

African countries. It is light weighted and easy to handle. In addition to the disadvantages encountered with users of the cylindrical mud oven, the metal oven is easily subject to rusting and corrosion and is relatively more expensive.

5.2.3 Rectangular mud oven

Materials used for construction of this oven are the same as those used for the cylindrical mud oven. It works on the same principles and bears all the disadvantages of the round oven.

5.2.4 Rectangular metal oven

This oven is built using flattened metal barrels. The main framework of metal is built in a rectangular shape, and can be extended lengthwise depending on the specified smoking capacity. Wire mesh are used to make trays. The wire mesh are cleaned with wooden planks and placed on top of the oven. Two or three of such trays may be placed on the oven. This oven is similar to the chorkor smoker except that the base is made of metal instead of mud.

5.2.5 The Chorkor oven

The Chorkor smoker (essentially an improvement of the metal rectangular oven) is accepted by most fish smokers.

Materials needed for construction are mud (the more the clay content the better; concrete leads to excessive cracks and is not recommended), iron rods (preferably serrated), lumber (wawa board), wire mesh (20 gauze) and nails. The oven may be referred to as 'single tray' or 'double tray' depending on the number of smoking compartments which allow for the stacking of rectangular trays. The double oven is essentially two single models in one.

Advantages of the Chorkor oven over the traditional smoking ovens are:

(a) fairly even smoking;
(b) reduced breakage of fish;
(c) less handling of fish;
(d) high smoking capacity.

The disadvantages include:

(a) requires two people to handle trays;
(b) high initial cost and investment;
(c) high cost of materials for construction and unavailability of right quality of wire mesh on the market.

6. Problems associated with traditional methods for handling and processing of fish

Sun-drying, salting and hot-smoking are important operations in traditional processing of fish. These operations, while contributing to the development of the flavour, texture and colour of the cured fish products can create conditions which would be unfavourable for the growth and multiplication of spoilage agents (e.g. insects and micro-organisms) in the fish thus extending its

shelf-life. Reports however suggest that much of the losses incurred in the cured fish sector in developing countries might be attributed to problems associated with fish processing technologies used (Walker and Wood, 1986; James, 1984; FAO. 1981). Limitations of traditional methods for handling and processing fish include inadequate protection of fish before, during and after processing, slow drying rates, poor quality curing salt, difficulty in controlling smoking temperatures, ineffective packaging and poor storage conditions.

Technically, sun-drying is limited to dry climatic conditions and under humid or wet conditions, drying will be slow if not impossible. The implication is that the activity of spoilage organisms in association with the fish would continue with little inhibition if at all, until such time as the moisture content of the fish is reduced to levels which are too low to support their growth. Smoked fish with a moisture content of less than 10% was found to be less susceptible to insect attack (Wood and Walker, 1986). Walker and Wood, (1986) observed that insect infestation of fish dried in the open sun began on the first day of drying reaching maximum levels on the third day of drying but declined when the moisture content of the fish dropped to 20% by the fifth to sixth day. Such long exposure of fish to the environment would permit more spoilage agents to infest it. It is therefore not surprising that insects are believed to be the major cause of losses in cured fish in developing countries particularly in areas where poor environmental sanitation prevail (Poulter et al., 1988; FAO, 1981). Visual observations placed losses of unsalted fish due to blow-fly infestation between 25-30% during humid conditions in Bangladesh (Doe et al., 1977). Cured fish losses as high as 51% have been observed in Malawi; if the fish is large, all of them may be damaged by insects because of the slow rate of drying in the open sun (Wood and Walker, 1986)

Salting can reduce the susceptibility of the fish to insect attack (Walker and Wood, 1986; FAO, 1981) but this is dependent on the concentration of salt in the fish. Walker and Wood, (1986) observed that salted fish was susceptible to insect infestation until the concentration of salt in the fish reached 8% based on dry weight. This observation has an impact not only on the quality of the salt in terms of chemical composition, but also on the method of salting and duration of the salting process. The quality of solar salt which is commonly used for curing fish varies with the source (Sefa-Dedeh, 1973; Owusu, 1971). The concentration of sodium chloride in solar salt produced from different parts of Ghana was found to be below the standard level of 96.6%. Variations in the concentration of sodium chloride in solar salt would present problems with respect to the effective quantity to be used particularly if there are no facilities for determining sodium chloride content. The presence of chemical impurities such as sulphates of calcium, magnesium and sodium as well as chlorides of calcium and magnesium (Clucas, 1982; Sefa-Dedeh and Youngs, 1976; Owusu, 1971) might impede the rate of penetration of sodium chloride into the fish (Lupin, 1977). A lower level of impurities in the curing salt is desirable in view of the observation that blow-flies infest salted fish prior to salt penetration (FAO, 1981). Other contaminants such as copper and iron in the curing salt might enhance the development of undesirable rancid flavours by catalysing the oxidation of the unsaturated lipide in the fish (Lupin, 1977). The microbiological quality of the curing salt on the shelf-life of the salted products deserve mention. Solar salt is noted for its poor microbiological quality (Sefa-Dedeh and Youngs, 1976; Lupin. 1977; FAO, 1981). Since most of the micro-organisms on solar salt are salt tolerant they persist on and contribute to losses of the salted products even when they are sufficiently dry. The *Halococcus sp.* are responsible for the browning and reddening of salted fish products (Sefa-Dedeh and Youngs, 1976; FAO, 1981).

Hot-smoked fish is particularly susceptible to fragmentation much of which is believed to be related to the high temperatures used and rough handling of the final products (FAO, 1981). Smoking temperatures are generally above 80°C and may exceed 100°C (Watanabe, 1982; FAO, 1981). The generally high temperatures to which the fish is subjected, might in part be attributed to difficulties encountered in the manual control of the flaming firewood; in the process some of the fish might become charred. Excessive handling of the fish during smoking might also contribute to the fragility of hot-smoked fish. To partially dry the fish at sub-cooking temperature (25°C) to reduce its moisture content to 50% before hot-smoking might minimize the susceptibility of the products to fragmentation by 50% (Wood et al., 1986). The practice of re-smoking the fish at suitable intervals during storage to kill or drive away infesting pests (Plahar et al., 1991; Wood et al., 1986; FAO, 1981) renders the fish excessively dry and highly susceptible to fragmentation.

Post-processing handling of the fish would also have an impact on the shelf-life of the products. These include packaging, marketing techniques and storage conditions. It is noteworthy that while moist fish is attractive to blow-flies, *Diptera sp.*. Fish which is sufficiently dry is unattractive to blow-flies but highly susceptible to infestation by beetles, *Dermestes sp.* (Wood and Walker, 1986; FAO, 1981). The extent of damage of fish by beetles is proportional to the storage. Some cured fish products are resistant to beetle attack and this is believed to be related to the composition and the texture of the fish (Wood and Walker, 1986). Effective packaging would control insect infestation of the final products. Traditional packages are generally not impermeable to moisture, insects and micro-organisms (Essuman, 1988; Wood et al., 1986; FAO, 1981) and offer little protection from physical damage. Storage is done under ambient conditions and may be in the open, under sheds or in rooms. The shelf-life of the products would therefore be weather-dependent.

During marketing, cured fish is normally unprotected and excessively handled by potential buyers. Such practice subjects the fish to contamination by micro-organisms and insects.

Attempts have been made particularly in the areas of improving the efficiency of sun-drying and traditional smoking techniques to reduce losses of the cured fish. These have focused on the design and construction of solar dryers and fuel efficient smoking ovens (FAO, 1981).

Solar dryers provide the fish with some protection against dust and infestation; in some trials fast drying rates have been achieved (Sachithananthan et al., 1986; N'jai, 1986; Curran et al., 1986; Curran and Trim, 1982; Doe et al., 1977). Temperatures in the range of 50-60°C reached in the dryers may kill or retard the activity of infesting insects (Sachithananthan et al., 1986; Doe et al., 1977). Curran et al., (1986) observed that while high temperatures reached in solar dryers could increase drying rates and kill infesting insects, the quality of the cured fish products might be detrimentally affected. They indicated that if the fish is fermented, a greater degree of temperature control might be necessary to prevent cooking. In order to prevent cooking, temperatures reached in the solar dryers must not exceed 50°C. Under such low temperature conditions the growth of insects in association with the fish would not be inhibited; in fact the warm conditions might enhance their growth (Curran et al., 1986). With respect to drying rates, solar dryers are unable to compete with open air drying (in dry seasons) especially in the initial stages, when drying rates are dependent on air flow rates, that is during the constant rate period. In the latter stages however, drying rates are dependent on the temperature of the drying air. The inclusion of mechanical blowers in the solar dryers can improve air flow rates but would increase the cost of the dryers making them less acceptable to fish processors in developing

countries. Fast drying rates in solar dryers compared to open sun drying appear to be product-dependent and location-specific. Sachithananthan et al., (1986) reported that drying of fish was faster and losses lower in solar dryers than open sun drying in Aden, but Curran et al., (1986) observed no difference in drying rates in Gambia. They attributed the differences in the performance of their solar dryers to differences in the state of the fish before drying. Curran et al., (1986) used fermented fish which required the use of low temperatures to prevent cooking. Such products would suffer high losses if infestation is not controlled before and after drying by effective packaging and storage conditions (Walker and Wood, 1986). Several smoking ovens have been developed (Brownell and Lopez, 1986; FAO, 1981; Essuman, 1986) to improve the efficiency of the traditional ovens in terms of fuel consumption, labour and product quality. Most of the designs were abandoned for various reasons ranging from cumbersome operating procedures to high cost of construction and maintenance. The Chorkor oven developed by the Food and Agriculture Organization (FAO) and the Food Research Institute of Ghana in collaboration with the traditional processors in Chorkor, a suburb of Accra in Ghana, appears to be more acceptable in terms of costs and fuel efficiency and has been adopted by fishing communities in some African countries, including Ghana (Brownell and Lopez, 1986; Nerquaye-Tetteh, 1989). The use of the Chorkor oven also minimizes handling of the fish. It is evident that issues regarding hygienic quality and insect infestation of traditionally cured fish as well as energy efficiency of the processes have been given considerable attention with varying degrees of success. There appear however to be inadequate studies into other aspects of traditional fish processing which impact on the quality of the finished products other than those related to storage stability and nutritional quality. The need for studies into processing variables and their effects on fish components which contribute to the development of the quality of the cured fish has been stressed.

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Introduction of insulated fish containers in West Africa

by

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ABSTRACT

The appearance of the first insulated container in Senegal dates back to 1976. About a hundred canoes were already using them in 1982. The Dakar Institute of Food Technology was involved in the dissemination and improvement of the insulated containers, not only in Senegal but also in other West African countries and thus gained much experience in the area. ITA's prototype was designed according to well defined technical and economic criteria which met the needs of the fisherfolk. Containers are used to facilitate the handling of the fish and also to reduce losses after catches and risk of fish spoilage. Icing techniques and a rigorous hygiene will ensure quality fish, leading to more substantial revenues.

The use of insulated containers in the boats, seems to be evolving from one container to two or three smaller containers, which offer in total more volume that one big container.

1. Technical features of the containers

Fresh fish marketing requires that the fish reaches the consumer or those in charge of processing it during the "iced storage life": the time the quality of the iced fish is acceptable for consumption or processing. This time depends on the time/temperature history of the fish after it died.

Without ice, large fish cannot be consumed after one day and smaller ones not after half a day. Unless the fish can be sold and consumed quickly, it will be necessary to use ice to market fresh fish from the fishing boat to the consumer. Another very important advantage of the use of ice in a canoe is that it allows fisherfolk to remain at sea for longer periods. Thus they can fish in a larger area which is less exploited and therefore more productive. Fuel expenses are considerably reduced.

2. Current situation

The absence of adequate structures (insulated containers) for the conservation of catches in the canoes is an obstacle to the use of ice in artisanal fisheries. Indeed, a high demand for fresh fish is an incentive for production. This is not only the case for large pelagic or demersal fish but also for small pelagic species. However, in the latter case the other links of the chain have not been able to adjust to the surplus of fish unloaded, which led to considerable losses due to a high production.

Two factors account for this situation:

socio-economic factor: living conditions on board and the selling price of the pelagic fish do not encourage the crew to handle the catch with care.

technical factor: a very large proportion of the canoe flotilla does not have the equipment necessary to preserve the quality of the fish.

3. Use of artisanal insulated containers

Since 1987, the use of insulated containers has known a remarkable breakthrough. Despite the shortcoming in insulated insulation, the artisanal case allows a 48 hours fishing expedition and time as well as fuel savings. However, an examination of the caught species shows that it is necessary for the fisherman to return home quickly and often sell his catch at any price.

The artisanal container was generally made of wood in a galvanized iron sheet coating. Polystyrene plates were attached to the wooden frame inside without protection.

These poorly insulated containers were fragile, have low loading capacity (less than 200 kg) and were not adapted to the shape and hydrodynamic features of the boat, thus reducing the duration of the expeditions (2 days maximum).

Attempts were being made to use ice on board the boats but the containers were inadequate and needed to be improved and generalized. The fisherfolk understood this fact and were even willing to buy old freezers or refrigerators to be used as insulated boxes.

4. Design of an improved insulated container

The improved insulated container technically deals with problems related to preservation on board the boats and the improvement of the quality of the unloaded fish, thus permitting higher selling prices. The experiments conducted to determine the duration of preservation, the evolution of the freshness quality of the fish transported and stored in an insulated container with ice, prove the utility of this device.

The use of more effective means of preservation at sea can be complemented by taking the same measures on shore in order to cover the period between unloading and selling to the customers: this led us to construct transportation and storage containers.

4.1 Container construction

The following principles will need to be followed:

- the entire structure of the container must be filled with expanded polystyrene or high density (25kg/m^3) polyurethane foam of 5 to 10 cm thickness (1cm for each day of storage time or trip length);
- the lid (hatch) must be airtight and insulated;
- the outer sides and the top must be reinforced for effective protection and to provide shading;
- containers must be adapted for 10 to 18 m long boats;

- the container must have about 0.8 to 1 ton fish load capacity;
- its weight will be about 200 kg;
- the container must not be definitely fixed to the boat and must be easily removable.

Required material:

- expanded polystyrene or polyurethane foam;
- hard wood or fir wood;
- light white timber (samba);
- plywood.

4.2 Details of construction and main improvements

The number of plywood boards depends on the volume of the container and varies between 7 and 12. The marine plywood designed to resist water is the best, but due to its scarcity in certain countries and to its cost, the usual plywood which is 6 to 12 mm thick can be used.

The polystyrene which serves as insulating material does not have a fixed price. In general it is made in sheets of 2m by 1m. Six to twenty of them are needed for large containers. When it can be found polyurethane can be used in plates. Air is a good insulator but since it is a gas, the thermal conversion plays a greater role of thermal transfer than conduction. However, all material such as expanded polystyrene which can hold air in small spaces offers excellent thermal barriers.

In practice a thicker insulation is used which further reduces heat loss and has the following features:

- waterproof, i.e. non-absorbent;
- spoilage proof;
- light but strong with a good compression strength particularly for the planking;
- cheap;
- non toxic;
- non-flammable.

The timber is cut into 4×4cm slats. It must be strong since it constitutes the breadth of the container. The plywood is fixed on to the slats (border, stays, cover), one container can take up to 12 to 36 slats.

Small beams serve as support to the bottom planks which vary from 2 to 3 according to the size of the case which is determined by the bottom of the boat.

The boats which must carry containers are rather long with a rectangular bottom section.

The containers must be adjusted to the bottom and to all the other determined measures of the boat (width, length, median width) and the number of compartments.

To be efficient, the design of a container must take several factors into consideration. The container must have a constant weight, be strongly built, easy to handle, have adequate drainage, be easy to repair and must be economical.

4.3 Transportation containers.

The dimensions and capacity of the containers must take into account some criteria such as the size of the fish, the fish-ice stowing density, drainage of waste water. They must have sufficient length to receive most of the fish caught (up to 80 cm). Their weight, capacity included, must not exceed 70 kg for small containers, what two men can carry. These small containers can be locally made in different shapes and volumes and be fixed or removable.

The ice, particularly when it is in blocs, must be easy to carry over long distances with minimum losses.

The small containers known as transportation containers are mostly appropriate for small pelagic fish which are caught here in large quantities and require rapid processing and icing with minimum effort to avoid crushing the fish.

Sometimes, on the suggestion of the main beneficiaries, these containers are used to refrigerate baits and serve as third compartment.

The external body of these containers is in plywood (6 mm) with an inside coating made of 4 kg of galvanized iron sheet of 0.14mm thickness.

The main problem posed by the transportation of small fishing expeditions in ice, consists in assuring that the temperature upon arrival is still close enough to 0°C to be accepted by the recipient, and this without increasing the weight of the expedition by additional ice nor an additional protecting insulation.

The entire fish can be transported in boxes of about 60 cm in depth, mixed with crushed block ice or flake ice and between two layers of ice, 40 cm for the pelagic and fat fish. The cover has two holes where the ropes fixing the cover will pass. Mounting this container requires three hours of labour and two unskilled workers.

The storage container is made like the old freezing devices with a top loading cabinet.

4.4 Technical obstacles.

The major technical problems encountered were:

- ensuring the air-tightness of the containers with galvanized iron sheet inside coating;
- protecting the ordinary plywood in order to use it because of lack of marine plywood;
- making the device as functional as possible by adapting it to the context for which it is meant.

4.5 Improvements.

- The improvements consisted essentially in changes in the original design in order to allow for a more extended use of the containers as well as addressing the above mentioned technical obstacles.

- The weights of the containers were reduced by abandoning red wood for "fraqué" wood or fir wood which are lighter and easier to work with.

- The suppression of the excrescence of openings with double cover, permitting fisherfolk to better use the top surface of the container.

- A space was created between the containers and their support in order to facilitate the draining of meltwater and to avoid heating due to friction.

- A resin was developed from polystyrene dissolved in petrol to protect hydrophobic surfaces made of ordinary plywood.

- The joints of galvanized iron sheets were filled with cement mixed with wood glue.

- Lateral protection planks were made to protect against shocks and thus preserve the container.

- The joints of plywood were filled jute threads soaked in polystyrene or tar resin.

- Aluminium galvanized sheets were used for inside coating of the containers for more lightness.

5. Recommendations

- One important feature common to all good models is the fact that an adequate air-tightness is assured for the insulating layer. When water permeates the insulation this results in a higher thermal leak in the container, a heavier weight to carry and ice loss. Sufficient ice must be used so that at the end of the journey there still is enough left to allow for the fish to be entirely protected.

- Although it is preferable that containers be light, they must resist compressions and stresses to which they are generally submitted including loading shocks, vibrations and distortions during the journey.

- The design of the container must take into consideration the weight and loading dynamics. The insulation must assure part of the resistance thanks to the joining of inner linings, hence the obvious advantage of the polyurethane foam and the expanded polystyrene.

- The exchange of air between the insulated space and the external atmosphere can lead to thermal transfer. The hot air can enter through the external coating of the surfaces of the case. If the inner coating is not tight, air circulation inside the insulation will be increased.

- The construction must be made with a minimum of joints. The joining done with wood screws and nails are not tightly sealed; if they are, they rarely remain so. It is thus advisable to use a mastic compound for joints or sealing tapes which must be regularly checked. So, thanks to the fisherfolk (the major target groups), we were able to discover and appreciate polystyrene dissolved in petrol or cement mixed with wood glue which

were used as ersatz for air-tightness in replacement for mastic and sealing tape deemed too expensive.

- The main problem facing a case designer is that the case must be easy to clean, profitable in terms of use of space and easy to make and repair.

6. Conclusion

The perfect container meeting all required conditions and norms does not exist yet. This case must meet the following specifications:

- have standardized dimensions, weight and capacity for a given country;
- be sufficiently resistant to withstand relatively rough treatment but light enough once filled with fish and ice, to be handled easily;
- be economical in terms of price;
- be made of light material in order to reduce costs;
- have good insulating properties in order to prevent rapid temperature increases of the product;
- be able to contain most of the catches up to 80 cm in length so that none of them is folded or put out of shape;
- be prepared for draining so that when the case is full of meltwater, the blood and mucus of the fish can easily flow out;
- have surfaces compatible with hygiene, without fissures or edges where dirt can settle and easy to clean and disinfect;
- be aesthetic;
- be easy to repair if slightly damaged;
- have an average lifetime of 3 to 5 years;
- have a volume which can carry the adequate mix of fish and ice without topping the edge of the case;
- be equipped in such a way that the lower edge of the case is not in contact with the deck (risks of temperature increase and dampening of the case).

While introducing new technology it is important to examine closely the power relations between fisherfolk, dealers and consumers which are involved in the distribution in order to assess the probable impact of the technology and determine who has access to the technology and under what conditions.

The aim of the improved technology is to reduce losses after catch and preserve the acceptability of the product and make it more valuable so that fisherfolk can increase their revenues.

N.B. *Users prefer the insulated container with inner coating made of galvanized aluminium sheet because it is lighter and less costly. Plywood is expensive. Marine plywood cannot be found since it is very costly, while galvanized sheet is available everywhere.*

7. Economic analysis

The following questions often recur:

- the life-span of the container;
- the frequency of major repairs and their costs.

The appropriate duration for a projection analysis is one year in general in artisanal fisheries where fisherfolk have limited savings and their revenues are subject to seasonal fluctuations. Inflation is not taken into consideration.

7.1 Generalities.

The process of heat transfer from the environment to the inside of the container occurs by conduction through the structure of the container. This transfer is determined by the surface of the linings, their thickness, the difference between the external and internal temperature and time:

$$Q = K \times S \times (T_e - T_i) \times t$$

Q = Quantity of heat permeating the container in a time t [in joules J]
K = Constant of heat transfer [W/m², °C]
S = Surface [m²]
T_e = external temperature [°C]
T_i = internal temperature [°C]
t = time [s]

In practice

$$K = \frac{1}{\frac{e_w}{\lambda_w} + \frac{e_i}{\lambda_i}}$$

e_w = thickness of the external linings of the wood [m]
e_i = thickness of the insulator [m]
λ_w = coefficient of thermal conductivity of the wood [W/m², °C]
λ_i = coefficient of thermal conductivity of the insulator [W/m², °C]

The value of the wood thermal conductivity coefficient is 0.15 to 0.25 W/m², °C, that of the insulator 0.025 to 0.035 W/m², °C.

Example of calculation (with containers designed by ITA and average ambient temperatures)

Surface area of insulated container: 5m²; T_e = 30°C; T_i = 0°C; t = 24 h x 3600s/h = 86,400s. The lining is made of 15mm wood plus 5cm of expanded polystyrene.

Thus

$$K = \frac{1}{\frac{0.015}{0.15} + \frac{0.5}{0.025}} = 0.48 \frac{W}{m^2,°C} = 0.48 \frac{J}{m^2,°C,s}$$

$Q = K \times S \times (T_e - T_i) \times t = 0.48[J/m^2,°C,s] \times 5[m^2] \times (30-0)[°C] \times 86,400[s] = 6,220,800\ J = 6,220.8\ kJ$

Since 300 KJ are needed to melt one kg of ice at 0°C, the melting of ice in the insulated container would be:

6220.8 [kJ/day] / 300 [kJ/kg ice] = 21 kg ice per day.

7.2 Results of comparative tests of ice melting

Average melting rates were defined for each type of containers. A quantity of 350 kg ice was used in each container (container not full).

	Meltage (%) after 12h	Meltage (%) after 24h	Meltage (%) after 48h
Artisanal container	15	35	48
Improved container	9	23*	36

* This compares well with the calculated value of 21 kg ice per day.

7.3 Results of comparative tests of preservation of fish quality

The ice and fish proportions are 0.5 kg of ice for 1 kg of fish (ratio ice:fish = 1:2).

	Improved Container	Artisanal container	Without container
Duration of fishing trip	4 days	3 days	1 day
Ice	600kg	850kg	0kg
Petrol	120 litres	100 litres	80 litres
Catch	1300kg	900kg	120kg
Ambient temperature	30°-32°C	30°-32°C	30°-32°C
Fish quality 1	70%	12%	0%
2	28%	35%	2%
3	1.5%	53%	75%
rejection	0%	0%	23%

7.5 Exploitation accounts

The data collected by the fishing period (with monitoring forms) permitted to establish an average exploitation by expedition and by type of fishing according to the presentation framework which was already used by the Boussarah Center to study fishing with ice and without ice in Guinea.

The financial assessment tables were prepared on the basis of three hypotheses:

- a high hypothesis of 7 fishing trips per month;
- an medium hypothesis of 5 fishing trips per month;
- a low hypothesis of 3 fishing trips per month.

Recurring financial charges are rather low in artisanal fisheries and were not taken into consideration since they were not available.

7.4 Cost of a medium size container

Item		Weight/Quality	CFA Franc
6mm plywood		12	60 000
slats	4/4cm	29	14 500
	8/6cm	4	20 000
nails	04	(5kg)	
	06	(2kg)	
	08	(1kg)	
	010	(2kg)	10 000
cellulo-basic glue		6 pots	6 000
polystyrene		75.6kg	37 800
paint		25	10 000
manpower			25 000
PVC		0.5	375
		0.5	250
Total			218 625

Empty weight: 240 kg; Capacity: 900 kg of fish + 450 kg of ice = 1350 kg

Equipment	Average price		Amortization period
	Guinea (G.F)	In Gambia (Dalasis)	
Boat	2 000 000	16 000	5 years
Nets (500m)	270 000	12 000	3 years
Container	599 970	5 600	
Engine (40CV)	900 000	15 000 - 18 000	

9. Example of fishing without ice

Pelagic fishing with net, 200 fishing trips a year. Prices in Guinea Francs

Sales		**+10 000 000**
Fixed charges	navigation taxes	22 000
	caretaking	100 000
	boat repairs	240 000
	net repairs	250 000
	engine repairs	220 000
Variable charges	fuel	3 800 000
	food	3 750 000
	fishermen's share	4 733 333
Total charges		**-13 135 333**
Gross margin		**+4 864 667**
	depreciation of boat	-400 000
	depreciation of engine	-425 000
Net margin		**+4 039 667**

Table R. Source: Boussarah Centre

FISHING WITH ICE IN GUINEA

HYPOTHESIS I: Annual Exploitation
36 fishing trips
Price: Guinea Francs

RECEIPTS	LINE	NET
Sales	8 984 300	7 207 500
Variable charges:		
- fuel	3 690 000	1 879 200
- bait	784 100	
- food	538 000	354 000
- ice	1 050 000	788 400
Gross margin	2 922 200	4 185 900
Fixed charges:		
- navigation taxes	21 600	21 600
- boat repairs	186 000	186 000
- net repairs		79 200
- container repairs	132 000	132 000
- engine repairs	138 000	138 000
Depreciation:		
- boat	396 000	396 000
- engine	300 000	300 000
- container	133 320	133 320
- net		90 000
Net margin	1 615 280	2 709 780
Cash flow	2 444 600	3 629 100

1000 F.G. = 500 CFAF

HYPOTHESIS II: Annual Exploitation
60 fishing trips
Price: Guinea Francs

RECEIPTS	LINE	NET
Sales	15 003 781	12 036 525
Variable charges:		
- fuel	6 162 300	3 138 264
- bait	1 309 447	
- food	898 460	591 801
- ice	1 753 500	1 316 628
Gross margin	4 880 074	6 990 453
Fixed charges:		
- navigation taxes	21 600	21 600
- boat repairs	186 000	186 000
- net repairs		79 200
- container repairs	132 000	132 000
- engine repairs	138 000	138 000
Depreciation:		
- boat	396 000	396 000
- engine	300 000	300 000
- container	133 320	133 320
- net		90 000
Net margin	3 573 154	5 514 333
Cash flow	4 402 474	6 433 653

HYPOTHESIS III: Annual Exploitation
84 fishing trips
Price: Guinea Francs

RECEIPTS	LINE	NET
Sales	20 063 367	16 817 500
Variable charges:		
- fuel	83 610 000	43 848 000
- bait	1 829 566	
- food	1 255 333	826 000
- ice	2 450 000	1 839 600
Gross margin	6 818 468	9 767 100
Fixed charges:		
- navigation taxes	21 600	21 600
- boat repairs	186 000	186 000
- net repairs		76 200
- container repairs	132 000	132 000
- engine repairs	138 000	138 000
Depreciation:		
- boat	396 000	396 000
- engine	300 000	300 000
- container	133 320	133 320
- net		90 000
Net margin	5 511 548	8 290 980
Cash flow	6 340 868	9 210 300

A comparison of fishing with nets in tables 1, 2, 3 and R leads to the following observations:

- The net margin in the medium hypothesis is already higher than the profit made in the case of fishing without ice. If we withdraw the fisherman's share on the basis of the formula of 2/3 for 1/3 (fisherman's share) in accordance with the structure of tableR.

- As for the high hypothesis, the net margin is higher for fishing with ice than for fishing without ice, as shown below:

  8,290,980 x 2 : 3 = 5,527,320 F.G. against 4,039,667 F.G.

Moreover, we can draw some conclusions on the basis of the following ratios (fisherman's share = 1/3 of net margin): variable costs/turnover; CV/CA; fixed costs/turnover; CF/CA and (CV+CE)/turnover.

FISHING WITH NET				
		CV	CF	CV + CF
		CA	CA	CA
Fishing with ice	Hypothesis 1	0.419	0.204	0.74
	Hypothesis 2		0.122	0.69
	Hypothesis 3		0.087	0.66
Fishing without ice		0.68	0.047	0.77

The fixed cost/turnover which is relatively higher in fishing with ice than in fishing without ice, decreases slightly with the increase of the number of fishing trips by year. Between hypothesis 2 and hypothesis 3 this ratio falls by 234%.

The clearly lower ratio of variable charges to turnover and of cumulated charges to turnover in fishing with ice beyond 60 fishing trips a year in comparison with 200 fishing trips in fishing without ice, demonstrates the economic advantage of the former.

The results expressed in cash-flow seem to us to reflect better the reality of the fisherman who does not bother with the notion of depreciation since the life of the investment has no meaning for him because he considers his boat as a "definitive acquisition".

The amount of investments was estimated on the basis of average costs of the fishing equipments (boat, net, engine, container).

Moreover, we were not able to establish the actual share of the fisherman since it was not possible to identify a regular formula in order to distribute profits between the boat owner, the fisherman and other crew members.

The costs of repair were approximately determined on the basis of the information provided by the fisherfolk (the classification of these charges and variable costs does not seem appropriate in this particular case).

The results of the exploitation permitted to compare fishing with ice and fishing without ice and to give evidence of the economic advantage of the former.

Example of the exploitation of a container in Guinea Conakry

- Costs of the container made in Guinea

Type of container	Container on board			Storage container		Transportation container		
Characteristics	1	2	3	1	2	1	2	3
Capacity (kg)	1 800	1 275	1 200	1 000		150		
Cost (FCFA)	225 000	200 000	150 000	200 000*		50 000		

The storage container has a relatively high cost due to the fact that its inside coating is made of galvanized sheet

Record of monitoring:

Fishing technique	Line
Duration of expedition	18
Crew	6
Expenditures:	
- ice (kg)	945
- fuel (litres)	200
- lubricant (litres)	4
- food (FG)	21 300
- bait (FG)	22 000
Results:	
- weight of fish (kg)	317
- species	seabream
- value	341 300
Savings:	
- ice (kg)	300
- fuel (litres)	15

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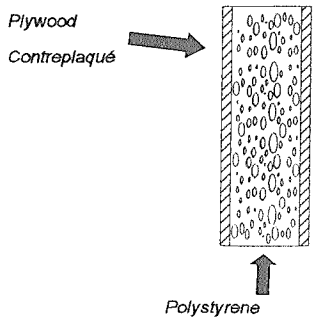
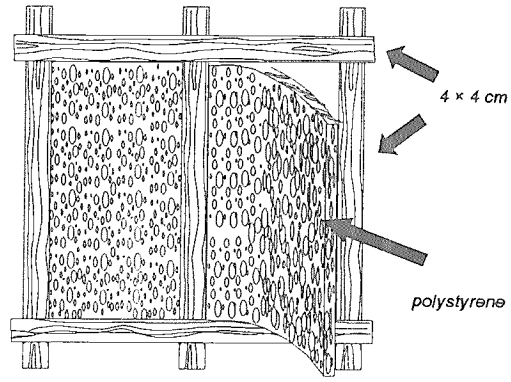
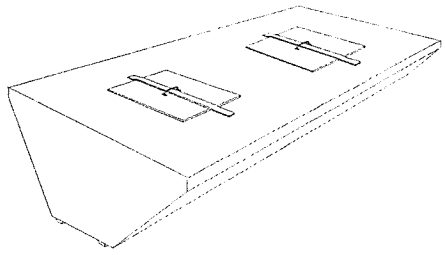
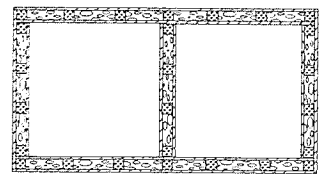




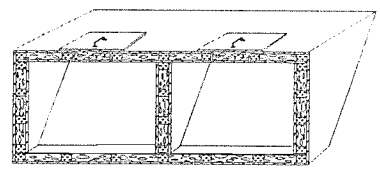


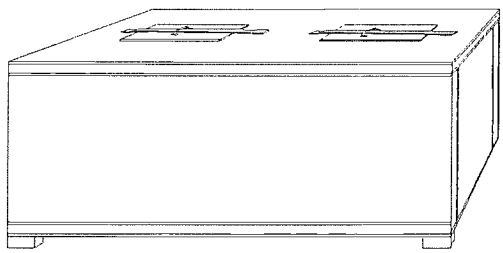
On-board insulated container

Conainer iosotherme de bord



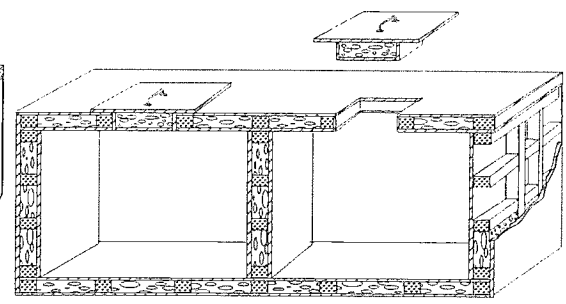
Vertical cross section





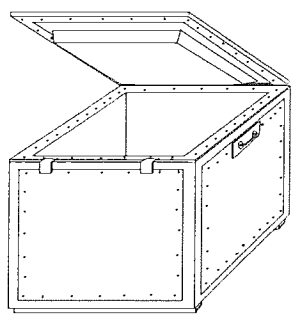
Storage container

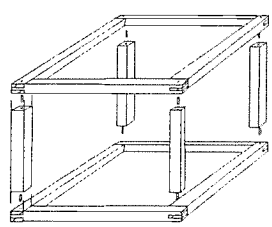
Container de stockage



Vertical cross section

Coupe vertical





Transport container with frame

Container de transport avec chassis

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Contribution of insulated fish containers to fresh fish marketing in The Gambia.

by

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ABSTRACT

Gambian artisanal fishermen supply most of the fish protein needed and are obliged to land fish of the best possible quality. In order to land the good quality fish, especially from distant operations, the fish needs to be chilled with ice. The ice and the fish are preserved in insulated containers. These containers, despite the high tropical temperatures, are not effectively used in the country because of the poor availability of ice.

A review of the history, types, acceptability, and constraints of insulated containers in the country has revealed that the technology is accepted by the fishermen and fish mongers. The present users supply fresh fish and earn more with it than the non-users. However, the lack of ice production facilities in the major coastal sites is increasing the cost of ice for operators who have to transport the ice from several kilometres away.

Therefore, the provision of cost effective ice production facilities to supply cheap ice at the major fishing centres should be given priority in artisanal fisheries development. It is only with such infrastructure that one can effectively promote the use of insulated containers in the country.

1. Introduction

The Gambia's artisanal fisheries, to minimise conflict with industrial vessels, are juridically limited to an area between the shore and 12 nautical miles off the coast within the continental shelf area of 3900 Km^2. The artisanal sub-sector produces at least 80 per cent of the total fish production. The fishing was for a long time done in manually operated dugout or planked dugout canoes. Since 1964 this mode has been rapidly modernized with the introduction of outboard engines.

Pelagics like the bonga (*Ethmalosa fimbriata*) dominate the catch landings. But several commercially valuable demersal species are also landed along the coast. A significant amount of this landing is sold fresh through middlemen or directly to customers at the beach. The pelagics caught in ring nets are landed fresh throughout the year. The state of freshness of the demersals varies seasonally. A large quantity of this group, caught in set gill nets and usually left in the water overnight, spoils before landing. The spoilage is due to high water temperature, poor handling, and the distance covered.

The fishermen, like other artisanal fishermen in the sub-region who supply most of the fish protein needed, are obliged to land fish of the best possible quality. This goal has been

gradually made difficult by the depletion of fish resources in the artisanal fishing zone because of trawler encroachment and increasing numbers of artisanal fishermen. This new situation is forcing the fishermen to operate in areas that are far from the landing site. Some fishermen save on operational cost by spending a few days at sea instead of moving back and forth with very small catch. This system is still predominantly practised by foreign fishermen.

In order to land good quality fish from the distant operations the fish needs to be chilled with ice. The chilling reduces the activity of bacteria and enzymes, and that retards spoilage. The ice to be used at sea and the fish caught and chilled, need to be stored for the duration of the fishing and the journey back to base. Insulated containers seem to be the only means of reducing ice loss and maintaining a low temperature that extends storage life. This paper describes the contribution of insulated containers to fish technology in The Gambia.

2. History of the techniques

The most common fishing practice for Gambian and foreign fishermen has always been the setting of a bottom or surface gill net overnight and collecting the catch the next day, and operating ring nets that are active gears. Before the arrival in the late 1980s of some Senegalese fishermen who spent several days at sea using set nets, this method of fishing was not practised in The Gambia. These fishermen targeted very highly priced demersal species like the black grouper and received ice from their contractual partners in the industrial sub-sector. They operated here seasonally and only on contract to the high paying companies. During this time the Gambian fishermen continued to cover their daily catch with wet jute bags to protect it from the sun and reduce the temperature on the fish surface. Some of them requested assistance from the Department of Fisheries to improve the preservation of their catch .

In April 1990, the West Africa Regional Programme for the Improvement of Post-harvest Utilization of Artisanal Fish Production was launched in Abidjan, Cote D'ivoire. This EU financed programme invited national governments to submit national action programmes that can be financed within the budget of the Regional Programme. One of the action programmes The Gambia submitted was the construction and trial of insulated containers in coastal fishing centres. The request was approved and the Programme provided an expert from the "Institut de Technologie Alimentaire" (ITA) in Dakar, Senegal, who worked with national staff for about two years.

By November 1990 six insulated containers, three for canoes, one for a fish distribution vehicle, one for female fish mongers, and one for male fish mongers, were completed. These containers were tried with ice supplied by the Programme on request from the operators. The containers performed satisfactorily and more requests were received. But the low budget allocation could not accommodate all the requests. The Programme, however, offered the fishermen and fish mongers a practical training course on the improvement of the fresh fish preservation techniques.

In 1991 the EU financed Artisanal Fisheries Development Project supplied over 66 $1m^3$ fibreglass insulated containers for use in the respective coastal centres. The use of these containers is still hampered by the lack of ice producing or selling facilities at major fishing centres. Some of the industrial companies supply ice to their contractual partners who use some of the containers. But the containers are too big for most of the artisanal canoes. The commissioning of the ice plant at Bakau (10 Kilometres from the capital, Banjul) is helping some of the $1m^3$

insulated container users, because they can readily buy ice at 1 Gambian Dalasi per kilogram (1 US Dollar = 9.3 Gambian Dalasi). The availability of ice at this site is also attracting canoe container users from Bakau and abroad.

3. Types of insulated fish containers

A fundamental consideration for an insulated container is that it should be of the correct size and shape for its purpose. It should also be big enough to contain ice and fish mixed in it on a ratio of about 1:1 - common in tropical countries.

The insulated containers introduced by ITA, are constructed from ordinary plywood (marine plywood is not available in The Gambia), hardwood, polyurethane foam (normally collected from packaging containers), nails, an improvised glue (by dissolving polyurethane foam in petrol), white oil paint (for the exterior), and jute bag strands (dipped in the glue and filled in the gap between nailed plywood). The canoe containers are designed to fit into the shape of the canoe and can be easily removed when not in use. The ones meant for the fish mongers and the distribution vehicles are rectangular bigger sized ones, with two hatches and two top covers (for the fish mongers) and one main hatch with one top entrance and one side opening for the rear of the vehicle. The details are provided in the attached diagrams extracted from an ITA manual. Canoe containers from Senegal are still available and new ones are being constructed at Bakau, but the ones built by the Programme have all been destroyed by the water, sun, and wind effect on the ordinary plywood.

The EU furnished insulated containers of fibreglass reinforced plastic rectangular structures. These have a single opening hatch on hinges. They were imported from Holland.

Some fish mongers use old broken-down refrigerators and freezers for keeping iced fish. These are not hygienic and are corroded easily by sea water.

4. Acceptability and constraints

At the end of the trial conducted by ITA an evaluation was done and it showed that the fish mongers and the fishermen accepted the containers. They all realized the need for it and wanted it sooner rather than later. The main concern of the users and the national authorities is the availability of the proper materials and ice. Marine plywood, which gives better protection against the sea water, is not commercially available in the country. Importing it solely for insulated container construction is not economically feasible. Relying on the ordinary plywood, as observed in the trial, is not a wise investment for the operators. The lack of ice production facilities in the major coastal sites increases the cost of ice because its transportation from Banjul or Brikama (both several kilometres away) is expensive. The ice plant at Bakau is improving the situation around Bakau, but it is not yet servicing the other centres. So, until ice is readily available at the sites or very close to them, the promotion of insulated containers will continue to be ineffective in the country.

The fibreglass containers distributed at the centres are also affected by the lack of cheap ice. The users depend on the industrial companies in Banjul who supply ice for preserving sole fish and other high value species that they buy from the fish mongers. Some of these containers have not been used for several months because the users cannot afford to buy ice and transport it to their base of operation at the present cost - the Bakau Centre sells flake ice for 1 Gambian Dalasi per kg. This price is cheap enough, but the quantity produced is never enough for Bakau buyers and the operators in the other centres. The price of the imported fibreglass containers is

also exorbitant to the artisanal operators. Some of the operators sometimes cannot even pay for the rental charge levied by the centre committees on their insulated boxes. That means that the continuous use of this type of insulated container is not sustainable. A local fibreglass technician has confirmed that he can construct the same type of container for less, but the funds are not yet available to engage him in the work. Meanwhile, it has been established that the fibreglass reinforced plastic insulated containers have been accepted by the operators.

Presently the canoe containers are confined to Bakau and Brufut (where a small company operates and supplies ice to contracted fishermen), where ice is readily available. The centres still have the fibreglass containers, but they are not used as frequently as intended by the authorities who formulated the project that provided them. Despite the poor utilization, even though the need is obvious, there is still no significant national programme on the use of insulated containers and ice in The Gambia. Such a programme is now imperative, because of the increasing demand for good quality fish from restaurant and hotel operators. This is a consequence of the growing tourism industry in the country, and the increasing demand of the urban consumers who are also getting more sophisticated in their food habits.

5. Recommendations

The tropical temperatures in The Gambia and the distance now covered by artisanal fishermen is increasing the need to use insulated containers. But these containers cannot be used without an adequate and cheap supply of ice. Therefore, the provision of cost effective ice production facilities at the major coastal fishing centres should be a national priority in artisanal fisheries development.

Once the source of ice is reliable, a credit scheme for constructing insulated containers from locally available materials should be initiated. While the containers are delivered, a search for more durable and cheap alternative materials should begin, if possible with assistance from regional or international institutions that have the relevant expertise and experience. Such a search should also utilize the expertise of the local fibreglass technician who can eventually construct cheaper fibreglass containers.

The availability of the right materials, design, and funds should be a precursor to a national sensitization programme that will increase the awareness of the operators to the use of ice and insulated containers. When these requirements are fulfilled, the preservation of fresh fish will be strengthened and the availability of fresh fish will also be increased to the delight of the locals and the growing crowds of foreign gourmets.

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Fresh fish quality and European import requirements

by

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1. Introduction

Consumers are becoming increasingly aware of the advantages of premium quality seafood products and are starting to pay higher prices for better quality. As a net result, governments have tended to tighten up regulations and to introduce a new approach based on Hazards Analysis Critical Control Points (HACCP) for seafood quality assurance. This new approach is based on consumers influence and it is safe to say that levels of surveillance and inspection will increase in the future.

As these changes happen, fresh fish exporters are starting to realize the benefits of maintaining high quality standards. This combination of events is encouraging fishermen in developing countries to improve their handling strategies and increase their return pay unit of catch.

Although quality standards in developing countries are on the increase, the average quality of fresh fish seafood currently being sold on the domestic market can best be described as medium to poor. This is largely the result of inefficient transport and storage practices within the fish industry.

Efficient transport and storage practices are especially important within the fish industry due to the highly perishable nature of the product - fish begins to spoil as soon as it is captured. Much of the spoilage is a result of changes of temperature.

This article describes the public health aspects of seafood consumption, handling and quality assessment of fresh fish, the import standards and regulations for seafood sold in EU and the HACCP concept and its use.

2. Public health aspects of seafood consumption

Seafood has traditionally been a popular part of the diet in many parts of the world and in some countries it constitutes the main supply of animal protein. Today, even more people turn to fish as a healthy alternative to red meat. The low fat content of many fish species (white fleshed, demersal) and the effects on coronary disease of the w- 3 polyunsaturated fatty acids found in fatty (pelagic) fish species are extremely important aspects for health conscious people.

However, consumption of fish and shellfish may also cause diseases due to infection on intoxication. According to statistics available, it is clear that the great majority of fish borne diseases are related to pathogenic micro-organisms (bacteria, viruses), presence of biotoxins, histamine or parasites. Only very few are caused by chemicals, pesticides, heavy metals or other foreign materials. Figure 1 shows diseases transmitted by fish in the United States.

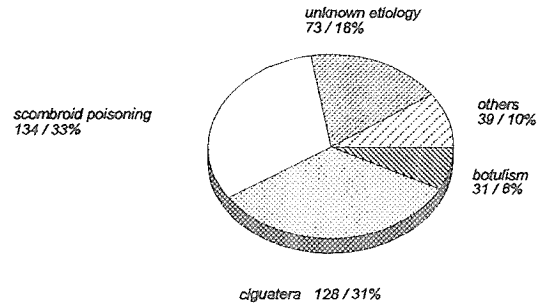

Figure 1: Diseases transmitted by fish in the US from 1970 to 1984 (No of outbreaks / %) (Data from Bryan 1980, 1987)

3. Handling fresh fish

Fresh fish products begin to spoil immediately after being taken out of the water. While spoilage can be controlled to some extent, it can never be reversed. Among the factors that can control the rate of spoilage, by far the most important, is temperature. The lower the temperature, the slower the process of deterioration. However, fresh fish products must not be exposed to temperatures below freezing point (-1° C), which could result in a different commodity, i.e. frozen fish products. Above the freezing point, fish deteriorates at rates that rapidly increase with the rises in surrounding temperature. Thus for example, fish which could still be edible for 20 days if kept at 0°c, could become inedible in 5 days at 5° C, in only 24 hours at 22° C and much earlier at higher temperatures (Tall et al. 1993).

Fresh fish trade requires products to be kept for days in an acceptable quality. Immediately after harvest, the fish should be cooled down to (and maintained at) as close to 0°c as possible, i.e. within the so-called chill temperature range. Chilled storage facilities should therefore be installed on fishing vessels in the form of insulated or refrigerated holds or contraries. They are also needed at landing places, depots, fish processing plants, wholesale and retail markets. Chilled storage is also required during transport, and such is provided in insulated or refrigerated road vehicles or vessels.

For chill storage requirements of the medium-scale and small-scale fish trade, refrigerated chill rooms are by far the most important and useful, followed by insulated rooms, chilled or refrigerated seawater stores, refrigerated or non-refrigerated insulated cargo containers or ice boxes.

The main feature of chill store facilities is the ability to maintain the temperature of stored fish within the chill temperature range. Another common characteristic is that they represent spaces enclosed by a thermically insulated envelope and have a source of refrigeration such as ice.

The thermical insulation is necessary to keep the flow of heat from outside the envelope into the enclosed space moving at as slow a rate as possible. The source of refrigeration is required to make up for heat leakage into the space, which although very much reduced by

insulation, can never be completely avoided. It should be emphasized that the source of refrigeration is normally not meant to cool the fish down. Therefore, fish should still be kept iced.

4. Fresh fish quality assessment

4.1 Sensory assessment

Sensory assessment is the use of one or more of the five senses to judge, or form an opinion on, some aspects of quality. These senses are: sight, smell, taste, touch, and hearing (Table 1).

Stale, bad or putrid fish are easily recognized by sight, smell or taste, and quality assessment of fish in this condition presents little difficulty. There are, however, many occasions where it is necessary to assess quality at some intermediate stage of loss of freshness or some intermediate stage of deterioration. For example, absolutely fresh fish commands a better price than fish that is less fresh but still not stale. To assess the degree of freshness or deterioration, objective sensory assessment based on descriptions should be used. The starting point is to construct a scoring system for freshness (Table 2).

4.2 Non-sensory assessment of fresh fish

Non-sensory assessment are laboratory methods used to assess the freshness of a fish.

Hypoxanthine which gradually increases in amount in fish as time goes on and can be used as a measure of the duration of icing. Like hypoxanthine, the K-value measures the extent of the breakdown of ATP. The HPLC procedure used to measure hypoxanthine can allow the K-value, also to be calculated.

Most of marine fish contains a substance called trimethylamine oxide (TMAO). Certain bacteria that occur naturally on the skin and in the guts of fish and sea water can break down TMAO to trimethylamine. The amount of TMA produced is a measure of the activity of spoilage bacteria in the flesh and so is an indicator of the degree of spoilage. TMA can be measured by coloured solution or alternatively by gas chromatography.

Ammonia and trimethylamine are examples of bases; another base, dimethylamine (DMA), can also be formed during spoilage of fish, together with traces of others. These bases, other than ammonia, are known chemically also as amine. The combines of total amount of ammonia, dimethylamine and trimethylamine is called the total volatile base (TVB) content of the fish and is the commonly used estimate of spoilage. These freshness indices are presented in Table 3 below with the time in ice and a sensory score.

Table 1. Some quality aspects of fish and fish products, and the senses used to assess them.

Sense	Aspect of quality
Sight	General appearance and condition, size, shape, physical blemishes, colour, gloss, identity
Smell	Freshness, off-odours and flavours, taints, oiliness, rancidity, smokiness
Taste	Freshness, off-tastes and flavours, taints, oiliness, rancidity, smokiness, astringency, the primary tastes of acidity, bitterness, saltiness
Touch	General texture, hardness, softness, elasticity, brittleness, roughness, smoothness, grittiness, fluidity, wetness, dryness, crispness presence of bones
Hearing	Brittleness, crispness,

Table 2. Classification and scoring system for freshness based on odour and flavour of raw and cooked fish

Freshness	Odour/flavour	Grade	characteristics	Score
Acceptable	No off-odour/flavour	I	Odour/flavour characteristic of species	10
			very fresh, seaweedy	9
			Loss of odour/flavour	8
			Neutral	7
				6
	Slight off-odour/flavour	II	Slight off-odours/flavours such as mousy, garlic, bready, sour, fruity, rancid	5
				4
Limit of acceptability				
Reject	Severe off-odour/flavour	III	Strong off-odours/flavours such as stale cabbage, NH_3. H_2S or sulphides	3
				2
				1

It is not possible to lay down rules for deciding what values of any of the freshness indices should be regarded as indicating any particular stage of spoilage or acceptability. There are differences between species, the kinds of bacteria causing spoilage may vary, the methods of analysis, as noted for TVB, can effect the values and the mode of handling may influence the results. Ideally, the relationship between the freshness as measured by sensory assessment and the various freshness indices described, should derived for the species of interest, using well defined methods, and for the particular handling procedure concerned. This is not always done: it is common for a particular level of, say, TMA or TVB to be taken as an indicative of an acceptable degree of spoilage in a range of species and without reference to the handling procedure or the measurement technique.

Table 3. **Sensory and non-sensory evaluation fish stored in ice**

Days in ice	Sensory score	Hypo-xanthine	TMA	TVB
2	9	2	1	19
5	8	5	1	20
8	7	9	2	22
11	6	14	5	27
14	5	21	11	37
17	4	30	24	56
20	3	43	45	8

5. Import standards and regulations for seafood sold in EU

The single European market came into effect January 1, 1993. In preparation for this event, a wealth of legislation over many fields of activity had to be harmonized to become EC legislation. Food laws were included in this harmonization program with the aim that member states could have confidence in the safety of foods produce anywhere within the EU.

Broad classes of food commodities are subject to separate legislation and two directives apply to fishery products. There is the council directive of 22 July 1991, laying down the health conditions for producing and marketing fishery products (91/493 EU), and the council directive of 15 July 1991, laying down the health conditions for producing and marketing live bivalve mollusca (91/492/EU).

The directive for producing and marketing of fish products

General provisions

The July 22, 1991 directive consists of three parts: a preamble of 2 pages, which states the reasons for the directive, and its principles; 5 pages of provisions of the directive, which define the legislation, and 13 pages of a technical annex laying down conditions for handling, processing and storing fishery products.

Article 2 of chapter 1, General provisions, defines terms used in the directive. Some, like "chilling", are general technological terms and have no special meaning in the context of the directive, but some terms are worth picking out for their importance in the application of the directive.

Article 3 defines the conditions of handling and processing fish products and duties of the competent authority. One of the duties is the approval of establishments. The latter should

comply with technical requirements for construction, equipment, and operation specified in the annex to the directive. An approved establishment is given a registration number, and a competent authority must submit a list of approved establishments to the commission.

Application to exporting countries

Though the primary objective of the directive is to harmonize practices within the Community, it is a principle of the directive that its provision should apply equally to imports from "third countries" and that there should be a common import control system applied by all member states of the Community. Article 10 of the directive is quite clear:

> *Provisions applied to imports of fishery products from third countries shall be equivalent to those governing the placing on the market of community products.*

What this means is that the EU requires fishery products intended for export to the Community to be processed under conditions that are an equivalent to those prevailing in the Community and to have been subjected to inspection and control equal to that applied in the Community. This principle of equivalence is being applied to imports by other countries importing fishery products, particularly by authorities in the U.S. and Canada.

Product standards

The thrust of the directive is control over the safety of fishery products by control over conditions for processing, storage, and distribution, not by control of the quality of end products. The directive, though, does have some requirements for testing products.

Freshness

Fitness for human consumption is tested by sensory evaluation. There is a separate council regulation, 103/76, which requires that fish must be inspected at first sale, essentially when landed, and classified into grades of freshness which are defined by sensory attributes for fish considered suitable for human consumption (Table 4). Fish which is not fresh enough to be classified into one of these grades is deemed unfit for consumption.

Histamine

The directive specifies a sampling scheme and limits for histamine that can be applied to fish of the scombridae or clupeidae families. A sample of nine units are taken and analyzed individually. The following criteria are specified:

- the mean value must not exceed 100 ppm;
- two samples may have a value of more than 100 ppm but less than 200 ppm;
- no sample may have a value exceeding 200 ppm.

Contaminants

The directive requires that "fishery products must not contain in their edible parts contaminants, such as heavy metals and organochlorines, present in the aquatic environment at

such a level that the calculated dietary intake exceeds the acceptable daily or weekly intake for humans". This principle has still to be translated into concentration limits.

Microbiological criteria

The Commission may lay down microbiological criteria for products, including sampling plans and methods of analysis, where there is a need to protect public health. One set of criteria, for cooked crustaceans and mollusca, has been issued (CEC, 1992).

Table 4. Freshness ratings: Council Regulation (EU) N° 103/76 OJ N° L20 (28 January 1976)

Parts of fish Inspected	Criteria			
	Marks			
	1	2	3	0
Appearance				
Skin	Bright, iridescent pigmentation, no discoloration Aqueous, transparent mucus	Pigmentation bright but not lustrous Slightly cloudy mucus	Pigmentation in the process of becoming discoloured and dull Milky mucus	'Dull pigmentation Opaque mucus
Eye	Convex (bulging) Transparent Cornea Black, bright pupil	Convex and slightly sunken Slightly opalescent cornea Black, dull pupil	Flat Opalescent cornea Opaque pupil	'Concave in the centre Milky cornea Grey pupil
Gills	Bright colour No mucus	Less coloured Slight traces of clear mucus	Becoming discoloured Opaque mucus	'Yellowish Milky mucus
Flesh (cut from abdomen)	Bluish, translucent, smooth, shining No change in original colour	Velvety, waxy, dull Colour slightly changed	Slightly opaque	'Opaque
Colour (along vertebral column)	Uncoloured	Slightly pink	Pink	'Red
Organs	Kidneys and residues of other organs should be bright red, as should the blood inside the aorta	Kidneys and residues of other organs should be dull red; blood becoming discoloured	Kidneys, residues of other organs and blood should be pale red	'Kidneys, residues of other organs and blood should be brownish in colour
Condition				
Flesh	Firm and elastic Smooth surface	Less elastic	Slightly soft (flaccid), less elastic Waxy (velvety) and dull surface	'Soft (flaccid) Scales easily detached from skin, surface rather wrinkled, inclining to mealy
Vertebral column	Breaks instead of coming away	Sticks	Sticks slightly	'Does not stick
Peritoneum	Sticks completely to flesh	Sticks	Sticks slicks slightly	'Does not stick
Smell				
Gills, skin, abdominal cavity	Seaweed	No smell of seaweed or any bad smell	Slightly sour	'Sour

' Or in a more advanced state of decay

The annex

The annex contains the detailed conditions and requirements for handling, processing, storing and dispatching fishery products from landing at ports to packaging and transport.

The separate chapters and sections include the following:

- conditions applicable to factory vessels;
- requirements during and after landing;
- general conditions for establishments on land;
- general conditions relating to premises and equipment;
- general conditions of hygiene;
- premises and equipment.

Special conditions for handling fishery products on shore:

- conditions for fresh products;
- conditions for frozen products;
- conditions for thawing products;
- conditions for processed products (canning, smoking, salting, cooked crustacean and molluscan, shellfish products, mechanically recovered fish flesh);
- conditions concerning parasites;
- health control and monitoring of production conditions;
- packaging;
- identification marks;
- storage and transport.

The various chapters are written as brief codes of practice for the operation under consideration, and any factory vessel, market or establishment that is already operating to good manufacturing practices will meet the requirements of annex.

6. The HACCP concept and its use

For the improvement of fish quality products, FAO, through its training project, is promoting the use of HACCP in the fish industry and the fish inspection services worldwide.

HACCP is a logical, simple, but highly specialized system of food control designed in a systematic fashion for preventing public health and other problems from occurring. The technique applies to production through consumption and is unique from a regulatory perspective in that it is a non-traditional type of non continuous inspection representing innovative state-of- the- art technology.

The theory behind the HACCP concept is that if properly implemented, governmental inspection frequencies should be much less in facilities or on products employing HACCP as opposed to those operating solely under Good Manufacturing Practices (GMPs) or when examining food products for which there is a unknown production and control history. Further, proper deployment of a HACCP system overcomes many of the weaknesses inherent in traditional inspection schemes, by a focus of resources that should offer a more appropriate cost/benefit ratio (ICMF, 1988).

Major fish importing countries based their legislations on HACCP. These countries are the USA, Canada and EU.

HACCP is a systematic approach to food safety, food hygiene and economic fraud, consisting of the following seven principles:

a) identification of hazards, analysis and determination of measures to control them;
b) identification of critical points;
c) establishment of critical limits for each critical point;
d) establishment of monitoring and checking procedures;
e) establishment of corrective action to be taken when necessary;
f) establishment of verification and review procedures;
g) establishment of documentation concerning all procedures and records.

The important feature is the system of record keeping which would have to be available for inspection by the authorities. The control points would be such as temperature checks, net weight, supervisory controls, use of additives, etc.

With HACCP system industry has to take more responsibility for quality or levels of inspection will increase. The system also means that exporters will not be able to ask their authorities for certificates of condition but will have to demonstrate their capacity to produce the standards.

7. Conclusion

The fish industry in developing countries is steadily improving the quality of fresh fish destined for export to developed countries, mainly at Rungis market (France). One notable example are the following species: grouper, goatfish and sole exported to France. Because there is essentially a price reward system for fresh fish of high quality at Rungis, fishermen in developing countries have a monetary incentive to provide high quality fish.

Quality assurance based on HACCP is the new approach adopted by major fish importing countries (USA, Canada and EU) and FAO, through its training projects, is preparing the developing countries to implement HACCP in their fish inspection services and the fish industry. Fresh fish exporters that implemented the HACCP system in their establishments will be rewarded because the level of re-inspection at port of entry in importing countries that have based their legislation on HACCP will be highly reduced.

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