THE SIGNIFICANCE OF FISH HANDLING, PRESERVATION
AND PROCESSING IN THE DEVELOPMENT OF NIGERIA
INLAND FISHERY WITH SPECIAL REFERENCE TO
KAINJI LAKE

by
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ABSTRACT
The traditional approach to fish handling, preservation and
processing technology in inland fishery is critically examined
using the experience in Kainji Lake as a model. The need to up-
lift the fishermen technology is emphasised with the ultimate
expectations of improvement in fish quality.

INTRODUCTION
The inland waters of Nigeria comprise many rivers, lakes, ponds and
reservoirs situated within the 923 square kilometre land area.
Compared with inshore, coastal and brackishwater fishery, this sub-
sector is generally marked by low productivity. For example, out
of the estimated 482,000 metric tonnes of fish produced in the
artisanal sector, fish production from brackishwater was over
286,000 metric tonnes, while production from rivers and lakes were
estimated at 125,000 and 71,000 metric tonnes respectively (Anon, 1981).

In Kainji Lake area, gradual depletion of commercial fish landings
has been reported from an estimated 30,000 metric tonnes during the
early post-impoundment period (Bazigos, 1972) to 5,000 metric tonnes
in 1978 (Ekwemalor, 1978). Some authors (Meyboom, 1975) have
estimated losses arising from poor fish handling, preservation and
processing techniques as reaching an alarming 15%. On a national
scale, this loss is colossal and if not subjugated would further
aggravate the apparent paucity of this protein rich resource.
There is therefore, an urgent need to improve the artisanal fish
handling, preservation and processing technique in inland waters
with the hope of increasing fish production and supply through
improved techniques. This report is intended to appraise the
present fish handling, preservation and processing methods in
Nigeria Inland Fishery using Kainji Lake as a model and recommend
ways and means of improving on this practice in order to markedly
reduce wastage associated with conventional practices.

CATCHING AND HANDLING
Fish are caught in inland waters by the use of gill-nets, hooks,
cast nets and various traps. The fish when caught are thrown into
canoes or boats which range from primitive row - boats or canoes
made of floating woods to dug out canoes which in most cases are
not mechanized. In Kainji Lake, out of the estimated 5,000
fishermen operating on the lake, less than 300 of them have out-
board engines (Ekwemalor, 1978)). There are no fish handling
facilities on board canoes and the fish when caught are left on
the bottom of the canoe, under the intense sunlight, struggling
there in a pool of warm filthy water in which they later die of
asphyxia (Eyo, 1977). It has been observed (Eyo and Ita, 1977)
that the shelf life of fish preserved in the shade was longer than
those immersed in water or exposed to direct sunlight. In order
to minimize spoilage, fishermen should endeavour to shade their catches rather than expose them freely to intense sunlight or stock them in dirty water. By this practice and the fact that the fish are not gutted after hauling fishermen lose a good percentage of their catch through the invasion of bacteria into the tissues of the fish before they are landed.

a) Significance of Gutting

Gutting involves the removal of the viscera which harbour spoilage bacteria and digestive juices which attack the flesh of the fish post mortem. These bacteria and enzymes are ever present in the living fish. While the enzymes are involved in the digestion and the general enzymatic activities of the living fish, the bacteria proliferation is inhibited by the general metabolic reactions of the fish which includes the low pH of the gut, the anaerobic environment obtained in the gut and the enzymes and acid in the viscera which digest the bacteria and cause the condition of the gut to become unfavourable for their growth. At death these metabolic activities are slowed down, the bacteria lining the gut penetrate the nearby tissues causing putrefaction. The enzymes also penetrate the tissues causing autolysis and putrefaction. It is the need to stop these changes arising from the presence of the gut, that the gut is frequently removed in freshly caught fish.

Watanabe (1965 & 66) working on Tilapia in East Africa observed that gutting of this species is of value in reducing spoilage of the fish. However, when gutting is carried out it should be done in such a manner that the guts are fully removed as remains of the gut if not removed hastens spoilage. The remedy is to wash the gut in clean potable water.

With the distance from the point of harvest to the fishing camp generally far apart, fishermen often lose a good percentage of their catch before they arrive at the fishing camp. About 2 to 6% of the total catch are lost through spoilage prior to landing by a sample of 46 fishermen operating in stratum I on Kainji Lake (Table 1). These losses include spoilage arising from fish entangled over-night in gill-nets. Such losses would be minimised if improved handling techniques are available to the local fishermen.

Table 1 - Fish lost through spoilage among fishermen landings in stratum I

<table>
<thead>
<tr>
<th>Type of Canoes</th>
<th>No. of Fishermen Sampled</th>
<th>Average Catch</th>
<th>Quantity of Fish spoilt at landing (Av)</th>
<th>Loss through Spoilage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanized</td>
<td>21</td>
<td>38.48</td>
<td>2.14</td>
<td>5.56</td>
</tr>
<tr>
<td>Non-Mechanized</td>
<td>25</td>
<td>32</td>
<td>0.76</td>
<td>2.34</td>
</tr>
</tbody>
</table>

b) Influence of Rigor Mortis

The rigor mortis is associated with the stiffness of the entire body of the fish post-mortem. The duration of rigor is considered an important phenomenon in the shelf-life of fresh fish since bacterial spoilage is arrested during rigor until the resolution of rigor or tenderizing of the flesh. The onset of rigor mortis has been associated with the disappearance of Adenosine Triphosphate (APT) which energises the muscles (Bendall, 1951). Since the more glycogen the muscle tissue contains at death, the later the rigor mortis, it follows that death by exhaustion which depletes the glycogen content will also speed-up the onset of rigor.
This is very important in the small-scale fishery where fishermen inadvertently rely on the duration of rigor for fish handling. In the usual practice where fish are allowed to struggle and die of exhaustion, the duration of rigor mortis is reduced and the shelf-life of the fish is affected. Table 2 shows the duration of rigor in some species from Kainji Lake.

Table 2 - Differences in the duration of rigor mortis in some species from Kainji Lake

<table>
<thead>
<tr>
<th>Species</th>
<th>No. of samples</th>
<th>Mean Duration of Rigor (hr)</th>
<th>Temperature Range (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarotherodon galilaeus</td>
<td>9</td>
<td>5.14</td>
<td>30</td>
</tr>
<tr>
<td>Sarotherodon nilotica</td>
<td>7</td>
<td>5.14</td>
<td>30</td>
</tr>
<tr>
<td>Auchenoglanis occidentalis</td>
<td>6</td>
<td>3.15</td>
<td>29 - 34</td>
</tr>
<tr>
<td>Tilapia zilli</td>
<td>4</td>
<td>3.18</td>
<td>35</td>
</tr>
<tr>
<td>Bagrus bayad</td>
<td>4</td>
<td>3.51</td>
<td>29 - 35</td>
</tr>
<tr>
<td>Hyperopisus bebe</td>
<td>2</td>
<td>3.68</td>
<td>30 - 34</td>
</tr>
</tbody>
</table>

The fish were caught alive, stunned by piercing a needle into the cranium and kept under identical conditions in the laboratory and the rigor mortis duration observed by subjective method. From this preliminary work, it could be noticed that fish if properly handled by fishermen by stunning after capture and shading the canoe will keep in a wholesome condition for a minimum of 3 hours after capture. This period should be adequate for fishermen to transport their catches in inland fishery from the point of harvest to the fishing camp or port.

c) Cooling Facilities

Artisanal fishermen are also faced with losses arising from the absence of cooling facilities at the landing site. Since the high ambient temperature encourages proliferation of bacteria, cooling the fish will inhibit multiplication of spoilage bacteria thereby extending the shelf-life of the fish before they are sold to consumers. Roach (1974) recommended the use of flake ice machines in small-scale fisheries; however, care should be taken in the use of flake ice to avoid bridging-creating air space between the ice and fish. Disney et. al (1969) reported that one hour's storage of East African Tilapia species at ambient temperature (24°C to 30°C) is roughly equivalent to one day's storage in ice. Using four West African species, Amu and Disney (1973) observed a storage life of more than three weeks. It follows that the presence of ice will reduce spoilage in small-scale fishery but could the returns from the artisanal fishermen meet the purchase of ice plant? Apart from the fact that fishermen are obviously peasants, the location of many fishing villages far from electricity supply render it impossible for fishermen to consider any advantage they could derive from the use of ice. An ice plant producing 600 kg/24 hours of flake ice costs ₦3,700 as at 1975.

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<table>
<thead>
<tr>
<th>Species</th>
<th>Number of Sample</th>
<th>Total Weight (gm)</th>
<th>Mean Weight (gm)</th>
<th>Mean Weight Loss Resulting from Dressing (%)</th>
<th>Mean Wt. Loss Resulting from Smoking (%)</th>
<th>Mean Total Loss in Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lates niloticus</td>
<td>18</td>
<td>221550</td>
<td>12308.33</td>
<td>15.50</td>
<td>39.13</td>
<td>54.64</td>
</tr>
<tr>
<td>Sarotherodon galilaeu</td>
<td>99</td>
<td>39425</td>
<td>398.23</td>
<td>20.47</td>
<td>51.84</td>
<td>72.31</td>
</tr>
<tr>
<td>Hydrocyclus forskali</td>
<td>6</td>
<td>3930</td>
<td>655</td>
<td>13.48</td>
<td>47.2</td>
<td>60.69</td>
</tr>
<tr>
<td>Tilapia zilli</td>
<td>3</td>
<td>835</td>
<td>278.33</td>
<td>20.36</td>
<td>51.5</td>
<td>71.85</td>
</tr>
<tr>
<td>Sarotherodon nilotica</td>
<td>2</td>
<td>335</td>
<td>167.5</td>
<td>19.40</td>
<td>56.71</td>
<td>76.12</td>
</tr>
<tr>
<td>Citharinus citharus</td>
<td>2</td>
<td>250</td>
<td>125</td>
<td>20.00</td>
<td>64.00</td>
<td>84.00</td>
</tr>
<tr>
<td>Distichodus rostratus</td>
<td>2</td>
<td>330</td>
<td>165</td>
<td>18.18</td>
<td>57.56</td>
<td>75.76</td>
</tr>
</tbody>
</table>
FISH PRESERVATION

The preservation methods commonly encountered in inland fishery are curing and freezing. Fish curing is usually done by smoking and sun-drying whereas, freezing is carried out using cold-store or domestic freezers.

1) Traditional Curing of Fish

(1) Fish Smoking

This is by far the commonest and perhaps the oldest method of fish preservation in the country. Earlier observation that 90 - 95% of the total fish catch is being processed into the dried fish by fishermen (Meyboom, 1975) appears to have been overtaken by events. Recent evidence (Ita and Eyo, 1982) indicate that most fishermen would rather sell their catches in the fresh state than process them. The reasons are not far fetched.

1. The inevitable loss in weight following dressing and smoking which also affect the market price (Table 3). This loss accounts for 50 - 80% of the fresh weight.

2. Additional labour needed for wood collection and additional cost if wood is to be purchased.

3. The possibility of getting the fish charred through neglect and the use of traditional and obsolete smoking methods. This tends to produce smoked fish with matt surface and charred appearance often rejected by consumers.

It is not uncommon, however, to observe some fishermen living in fishing camps without access roads being fully engaged in smoking because of the absence of a ready market. In Kainji Lake area, most smoking is conducted by fish mongers in fishermen camps and the processed products are transported to the southern markets where they are marketed.

It is not intended to elaborate on the traditional fishing methods as this has been done elsewhere (see Meyboom, 1975; Rawson, 1966; or the Chemistry of Fish Smoking (Eyo, 1980), suffice it to mention here that two smoking kilns have been developed in the country whose performances have been found suitable for adoption by the fishermen: the NIOMR kiln and the Kainji gas kiln (Eyo, 1981) (patent No. RP: 5137). The former uses firewood for heat and smoke production, while the latter uses the common cooking gas for heat production and woodshavings and sawdust for the production of smoke during the smoking process. However, a fisherman may not be able to afford any of these smoking kilns inspite of their obvious advantages, unless the kilns are sold at subsidized rate.

(II) Fish Salting and Sundrying

This practice is limited to the arid parts of the country where dry season extends to most parts of the year. In the Lake Chad area, Alestes sp. is sundried for local consumption (Osuji, 1976).

In Kainji Lake region, the potential for the production of salted sundried fish was investigated using the following species: Hydrocynus sp., Tilapia sp., Lates sp., Alestes sp., Mormyrus sp., and Gymnarchus sp., Chrysichthys sp. and Bagrus sp.

It was reported that the production of salted sun-dried fish is feasible in this region in the dry season and will help to reduce wastage if practiced by the artisanal fishermen (Eyo, 1979 & 1980).
b) Fish Freezing

Freezing techniques as practiced in intensive commercial fishery is virtually unknown to artisanal fishermen engaged in inland fishery. A few well-to-do fish mongers within Kainji region acquire Cabinet Freezers for freezing of fresh fish before they are transported in Cold-Vans to distant markets. Since the cabinet freezers are not designed for freezing but for short term storage of products, freezing is characteristically slow and in some instances fish tend to show signs of incipient spoilage while still in the cabinet freezer.

The Blast and Plate Freezers which are specially designed for fast freezing are expensive and unavailable in our local shops. They have to be imported into the country. Furthermore, fishermen catches may not warrant the use of such sophisticated equipment which are designed for fishing industries with enough profits to meet operational cost.

c) Cold Storage

Cold stores are expensive and beyond the capability of the average fisherman (the price of a cold store of 23 tons capacity is about N23,000.00). A few fish mongers and government corporations tend to use the cold store as freezing equipment rather than for storage of frozen fish. Inability to comply with the mechanism of cold store management as shown by the absence of equipment necessary to maintain the 'Cold Chain' result in products from the cold store lacking in appearance, flavour and texture when thawed. The performance of the cold store is affected by poor cold store management and frequent breaking down of the cooling equipment is common occurrence. Scarcity of fish in certain seasons also keep some cold stores idling for a long period.

FISH PROCESSING

Fish processing which includes canning, production of fish meal and fish protein Concentrates (F.P.C.), fish silage and comminuted fishery products are absent in inland fishery. The reason is not far fetched. The high capital needed in setting up a fish processing complex coupled with absence of organized fishery in this sector, militate against embarking on viable fish processing technology. For example, it would be uneconomic to set up a fish meal plant when fish offals are not abundant in commercial quantity to keep the machinery working all year round. Adequate source of fish is paramount when considering improvements in the utilization of fish and fishery products in inland fishery.

RECOMMENDATIONS

From the foregoing it would be observed that the quality of fish available for consumers is dependent on the operational techniques adopted by the artisanal fishermen. Still, little has been done to improve their technology which invariably will enhance fish quality and quantity. Based on this, the following recommendations are considered applicable to the present status of our inland fishery.

1. Government intervention to salvage the current technology of the fishermen through the River Basin, and other authorities should be intensified through the setting up of a well coordinated pilot scheme in strategic locations. Such a scheme should show special concern in the innovation of fishing gear methods, handling and preservation practices by providing improved technology at subsidized rate to fishermen.
2. It is becoming increasingly obvious that the price being paid for technology transfer is gradually escalating, thus fisheries research should aim at improving the traditional methods rather than borrowing costly exotic technology which in many cases are neither practicable nor applicable to our indigenous inland fishery.

3. Research findings already available should not be locked up in drawers, but should be translated into simple terms and made available to the artisanal fishermen through active extension and liaison services. Unlike extension workers in agriculture, the fisheries extension workers have not been seen so far to make the much needed impact.

4. Recommendations on improvement in fisheries technology cannot be implemented unless the stock is available. Given the low production from the domestic sector, greater emphasis should be placed on the management of the existing stock as reported by Ita (1982) and aquaculture practices should be intensified to boost fish production from the inland sector.

CONCLUSION

The method adopted by the artisanal fishermen in fish handling, preservation, and processing technology, lends itself to wastage through spoilage during handling; and poor quality product following preservation. Efforts aimed at improving the current traditional practice should be made by a joint participation of fisheries research technologists and extension workers. Technology transfer with its resultant high cost may not meet the aspirations of the traditional fishermen.

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