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This report was prepared during the course of the project identified on the title page. The conclusions and recommendations given in the report are those considered appropriate at time of its preparation. They may be modified in the light of further knowledge gained at subsequent stages of the project.

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PRESENT HANDLING AND DISTRIBUTION OF NILE PERCH

by

J. Bon

ABSTRACT

Present ways of handling Nile perch are chiefly artisanal. Catching and landing by canoes, transfer to fish banda, thereafter distribution to markets and processing sites are all steps in a chain which lacks modern facilities. An exception is the collection of fish by trucks carrying ice in insulated holds.

The inadequacy of these methods results in loss of freshness and depreciated market value. The need for improvement is stressed.

1. INTRODUCTION

Principal features of modern fish distribution systems are the application of refrigeration to lower the temperature of the fish, establishment of hygienic conditions and the exertion of care for the fish at all stages.

When such measures are insufficiently applied, as is the case with Nile perch from Lake Victoria, the shelf life of the fish is so brief that the fish can only reach markets at relatively short distances from the landing beaches. By processing the fish near the landing beach the fish products can be marketed further afield, but qualitative losses frequently occur (Poulter, 1982).

Delays in cooling Nile perch bought by filleting companies sometimes lead to marginal performance in export markets. Rough handling and lack of hygiene before and during distribution and processing add to the rapid decrease of the state of freshness of the fish.

2. PRESENT SITUATION

2.1 ON THE LAKE

The most commonly applied fishing technique is with gillnets. This method is known to yield some "dead" fish, i.e., fish that has drowned in the net. The only remedy to prevent fish from drowning is increasing the lifting frequency.

Fishing with baited hooks and lines produces fish which is still alive when hauled into the canoes.

On its way to the landing beach the fish is exposed to weather conditions unfavourable for the state of freshness (sunshine, warm air). Some fish are in contact with dirty water on the bottom of the canoes.

2.2 ASHORE

After landing, the fish are transferred from the boats and placed or thrown on the ground near the shoreline. Hereafter, the fish is taken to the fish "banda", a concrete roofed shed, where the fishermen's cooperative is responsible for selling the fish to prospective buyers.

Sometimes unnecessary delays occur before the fish is moved to the banda. In the banda itself fish can often be seen being thrown around or dragged over the concrete floor. Bandas have neither cooling facilities nor tapwater connection. After sale, the fish is not always taken away for transport and remains in the banda without provision being made to prevent early spoilage.

Before being transported inland, it is observed that some buyers take much care of the fish by washing them in lake water and packing them carefully in baskets. However, lake water near landing beaches is often polluted. During transport inland, either on bicycles or in pick-ups, the fish is in no way protected against high mid-day temperatures.

In many beaches insulated vans and trucks of filleting plants are waiting to be loaded. These do not always carry enough ice to cool the fish and keep it cool. Loading fish in such containers is often done in a rough way, bruising the fish.

Experiment (1)

At a typical fish landing beach in Wichlum, Western Kenya, fishermen are encouraged to land fish as fresh as possible. Their grading system for freshness distinguishes between fresh fish (A), moderately fresh fish (B) and fish which is close to spoilage (C). Price levels are KSh 4 for A, KSh 2 for B and KSh 1.50 for C.

At this beach it was observed that fishing boats are operating at sailing distances of up to 5-6 hours during normal weather conditions. On two different occasions in February and March 1988, three canoes were visisted on the lake, while they were lifting.

An assessment of the state of freshness of the fish immediately after catch showed that 24% of the fish were "dead" (see Fig. 1). This state is characterized by a loss of natural colours of the skin and by bleached cream-coloured gills. The remaining fish were mostly of grade-A freshness (red gills). During transport to the beach a large part of the catch lost its freshness and deteriorated to moderate (B). This state is characterized by a change in gill colour from red to pinkish (see Table 1, Quality Assessment Scheme).

Upon landing only 16% was still of grade-A freshness (see Fig. 2). This assessment was done by staff of the Kenya Marine and Fisheries Research Institute (KMFRI), and it appeared to correlate entirely with the opinion of some quality assessors employed by filleting companies. During these quality inspection sessions no fish was observed which was so totally spoiled that it could not be sold.

Figure 2 illustrates the difficult situation confronting the filleting plants. They are forced to buy fish of grade-B freshness unless they can afford to wait and fill up their vehicles with only fish of grade-A freshness.

From experience in the filleting industry in Europe it is known that grade-B fish can only be utilized as raw material for frozen fillets when they are thoroughly washed before, during and after processing. It is not sufficient to wash the fish only before filleting. Filleting must also be done on a table over which there is a constant flow of tapwater and the fillets have to be sprayed with clean tapwater, while moving on a conveyor belt. Even then sometimes the fillets from grade-B fish will not meet the prescribed microbiological standard (Bon, 1986).

Having described the conditions prevailing in Kenya's Nile perch handling and distribution system, it is obvious that there is an urgent need for quality improvement. This can only be effected by the introduction of the use of ice by the fishermen's cooperatives.

Experiment (2)

In further investigations carried out at Wichlum on two different occasions quantities of crushed ice were issued to canoe fishermen, while they were lifting their nets. The ice had been carried in an insulated container on board the cooperative canoe which was equipped with an outboard engine. The ice was placed between the fish to allow maximum exposure of the fish to the ice. The fish was then covered with a plastic sheet. After inspecting the fish on landing it was concluded that an ice:fish ratio of 1:2 was needed. The average temperature of the fish had dropped from 27°C (+/- 1.0) to 60°C (+/- 1.0).

Figure 3 illustrates the state of freshness at the time of landing, 4-6 h after lifting. It can be seen that the majority of the fish was of prime quality (grade-A).

Taking into account an estimated cost price for ice of KSh 1.50/kg (ice sells at this price in Kisumu), it can be calculated that, at a catch rate of 100 kg/boat, the cost of the ice was equal to the extra revenue created by the increased share a grade-A fish. At a catch rate of 200 kg/canoe a gross profit of KSh 100 could have resulted.

Since 100 kg is the average recorded fish weight per canoe per day (Rabuor, 1988), it can be generally concluded that the present premium system as practised in Wichlum will not encourage fishermen to buy ice for onboard use. This means that gillnet fisheries might not be able to provide the industrial filleting plants with sufficient quantities of fish with the required grade of freshness.

Insulated Container at Dunga

At Dunga, 5 km south of Kisumu, Nile perch is landed from the hook and line fishery. Its freshness upon arrival in the banda is mostly grade-A. However, after several hours of exposure to ambient temperature on the tables of the cooperative the fish deteriorate rapidly. Most fish dry at the surface and attract many flies.

In view of this unfortunate state of affairs, it was considered opportune to investigate if the installation of an insulated container could improve the situation. A container was ordered locally (Central Workshop, Nairobi). Specifications were a net content of 1 000 l, and insulating capacity sufficient to keep iced fish cool for 2-3 days. Following earlier recommendations the insulated box was to have a drainage hole and a lockable lid (Nyagambi, 1985). The price of the box was KSh 20 000 (1987).

The box was put at the disposal of the cooperative on 26 January 1988. During two weeks at regular intervals, quantities of crushed ice were taken to Dunga and put in the box. The cooperative manager was advised to use the box for keeping fish that could not be sold on the day of landing.

It was demonstrated to the staff how fish can be cooled while on the tables by applying ice and covers. In a similar way it was shown how packed fillets, as produced in Dunga, could be cooled until the time of collection.

It has appeared that the cooperative staff and their customers prefer to use the box as a cold place where fish and fillets can be kept until collection or despatch.

The cooperative society should now work out a pricing system which would enable them to pay for the ice, for the depreciation of the box, for interest on loans, etc.

3. CONCLUSIONS AND RECOMMENDATIONS

Nile perch taken by the gillnet fishery need to be cooled with ice already on board the fishing vessels, if they are to be fresh enough for purchase by the filleting plants.

Beaches where fish is landed by the hook and line fishery could benefit from the presence of insulated storage facilities with ice, to be maintained by the cooperative societies.

It is recommended to explore how premium systems based on quality grading could be adapted to allow for the use of ice by canoe fishermen.

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Table 1

QUALITY ASSESSMENT SCHEME FOR NILE PERCH STORED AT AMBIENT TEMPERATURE

Grade	Denomination	Symptoms				Score
		Skin colour	Gill colour	Eyes	Texture	
A	Freshness enabling local distribution if cooled: regional if cooled on board: nationwide distribution	natural brilliance, silver, pearl, gold	red, purple, maroon, no slime	transparent, yellow sheen, shape convex, pearl iris	firm, elastic, hard (when in rigor)	9 8 7
B	Reduced freshness, for quick sales only, if cooled: local distribution	greyish appearance, some loose scales (only at belly side) appearance sometimes still natural	pinkish, some white slime, sometimes red	swollen, turbid, red, bloody, lens white, iris white	reduced elasticity soft, sometimes slightly swollen belly	6 5 4
C	Insufficient freshness, not marketable, as such unfit for human consumption, sometimes for immediate consumption after frying, spoilt condition "dead" fish	deprived of natural colours, pale, bleached, loose scales, yellow slime on skin, fin-ends green, dried, wrinkled skin	bleached, green, brown, with much yellow brown slime	swollen or sunken shape, gas bubbles inside, iris blood-red	soft, sloppy, fingerprint leaves impression, swollen belly	3 2 1

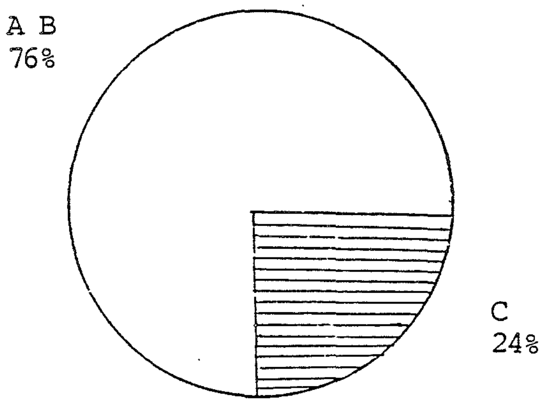

Fig. 1 Freshness at time of catch
(No. of fish 126, av. weight 4 kg)

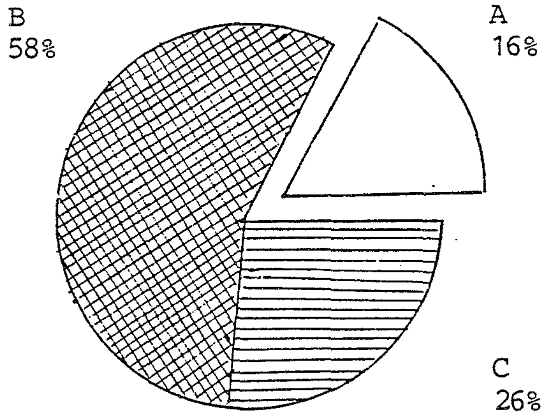

Fig. 2 Freshness at time of landing
(No. of fish 107, av. weight 4 kg)

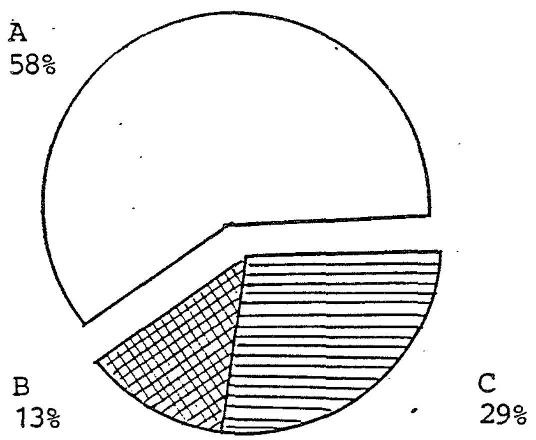

Fig. 3 Freshness at landing with ice
(No. of fish 45, av. weight 3.8 kg)

SPOILAGE OF NILE PERCH AT AMBIENT TEMPERATURE

by

L. Gram

ABSTRACT

The storage life of Nile perch at ambient temperature was investigated by sensoric, microbiological and chemical analysis. Fish retained a good quality for 8-9 h and spoiled rapidly thereafter having a storage life of 11-14 h. A characteristic sign of spoilage was greening of the gills, ends of fins and tail and of the flesh.

The total bacterial count rose from an initial 10^3-10^5 CFU/cm^2 to 10^7-10^8 CFU/cm^2 during storage. Especially those bacteria capable of producing hydrogen sulphide (H_2S) proliferated and these were found to be responsible for the spoilage. They could easily be counted on an iron agar where they appeared as black colonies.

The amount of total volatile bases (TVB) in the fresh fish was approximately 13 mgN/100 g. This figure increased slightly when the fish was rejected (19-22 mgN/100 g), but only in the completely spoiled fish were higher levels found, e.g., 60-70 mgN/100 g. Analysis carried out at the Technical Laboratory, Denmark, showed that the increase in TVB was caused by a reduction of trimethylamine oxide (TMAO) to trimethylamine (TMA) by the spoilage bacteria.

A short description of the above-mentioned methods, which are routinely applied when assessing fish quality, is also included.

1. INTRODUCTION

Within the last 20 years, several studies have been carried out to examine the quality changes which take place during storage of tropical fish species with subsequent determination of storage life (Poulter et al., 1981). Mostly, storage with ice has been evaluated, and few studies have given detailed descriptions of quality changes at ambient temperature. In view of the difficult conditions prevailing in many tropical countries, e.g., the lack of ice and chilled distribution systems, the ambient spoilage pattern of fish from warm waters requires much more attention.

The present study was undertaken in order to describe the quality changes occurring when Nile perch (Lates niloticus) is stored at ambient temperature.

The quality was assessed by methods applied in routine analysis of fish and fish products, and a short description of these follows.

2. QUALITY ASSESSMENT OF WET FRESH FISH

The term "storage trial" describes the experiment in which the quality changes and storage life of a given product are determined. This is done by storing the product under a known set of conditions - temperature, humidity and atmosphere - and at regular intervals during storage, samples (e.g., 1-6 fish) are removed for various analyses.

2.1 SENSORIC ANALYSIS

Whole wet fish was assessed by observing the gills, eyes and skin, the odour of the gills, looseness of the scales and texture of the flesh. Eating quality was determined by tasting a sample of the flesh after cooking for 20 min in water and evaluating the odour, flavour and texture.

For both assessments, a scoring system with a scale from 9 to 1 was used: scores 9-7 were given to first quality products retaining odours and flavours typical of Nile perch and showing no sign of spoilage. The score 6 was used to describe a "neutral" fish without the typical fish odours and flavours but also without off-odours and off-flavours. Second quality fish where early signs of spoilage were present with light off-odours and off-flavours scored 5 and 4; score 4 is considered the limit of acceptability. Samples found to be unfit for human consumption (rejectable), received scores 3, 2 and 1.

2.2 MICROBIOLOGICAL ANALYSIS

During storage, two types of bacteria were counted: a group capable of producing hydrogen sulphide (H_2S) and a group which did not possess this capability. This was done using an iron agar where the two groups can easily be distinguished. The former group appears as "black colonies" and the latter as "white colonies". The blackening of the colony is caused by precipitation of ferrous sulphide (FeS) which is formed when the bacteria produce H_2S from either thiosulphate or L-cysteine which are added to the agar together with ferric citrate (Gram et al., 1987).

The sum of the two groups, e.g., black and white colonies, is the total viable count of bacteria.

2.3 CHEMICAL METHODS

During spoilage of some fish species, the bacteria spoiling the flesh will produce volatile amines like ammonia and trimethylamine, which are detected as off-odours and off-flavours.

The amount of these amines is expressed by the level of Total Volatile Bases (TVB). Several methods have been developed for this analysis. At KMFRI the so-called Conway method was used; this involves liberating the bases from a watery extract of the sample, scavenging them in a known amount of acid and determination of the level by titration.

3. QUALITY CHANGES DURING STORAGE OF NILE PERCH AT AMBIENT TEMPERATURE

The results presented below have been collected during a number of storage trials carried out 5-6 June 1987, 4-5 February and 23-24 February 1988. All fish used were caught by trawl by the trawler OMENA of KMFRI.

In June 1987 fish of 3-5 kg were used, the water temperature was 25°-26°C and the storage temperature varied between 20° and 30°C. Several fish sizes were used for the storage trials in 1988: 1/2-1 kg, 3-5 kg and 10 kg. The water temperature was slightly higher; 27°C and the storage temperature 27°-30°C. The ambient spoilage of fillets prepared from 10 kg and 3-5 kg fish was also studied.

During storage, samples were removed every 3-4 h for analysis.

3.1 SENSORIC CHANGES

The estimated storage life of Nile perch at ambient temperature was between 11 and 14 h. Table 1 shows the results for the various samples examined.

Table 1

STORAGE LIFE OF NILE PERCH AT AMBIENT TEMPERATURE, DEPENDENT ON FISH SIZE AND ACTUAL STORAGE TEMPERATURE

Sample	Fish-size (kg)	Storage life (h)	Date	Temperature water storage	°C
Whole fish	1/2-1	11	23.2.88	27	27-30
Whole fish	3-5	11	4.2.88	27	27-30
Whole fish	3-5	13	5.6.87	25-26	20-30
Whole fish	10	14	23.2.88	27	27-30
Fillet	3-5	13	5.6.87	25-26	20-30
Fillet	10	14	23.2.88	27	27-30

The fish remained of good quality for 8-9 h whereafter spoilage occurred very rapidly. A slight bleaching of the gills and development of slime were the first signs of spoilage. The most characteristic feature was, however, greening of the gills, end of fins and tail and sometimes of the flesh. A detailed outline of the outer changes is given by Bon, "Present handling and distribution of Nile perch" (Chapter 1). In his assessment table, the off-odours and off-flavours developing in the fish flesh were described in the first stages as slightly sourish and lightly rotten, sulphidy, cabbage-like off-odours and off-flavours.

Table 1 shows that a slight variation is found in length of storage life. Fish caught in waters of "lower" temperature and stored also at "lower" temperature remained acceptable for a few hours longer than fish of similar size studied at slightly higher temperatures. When studying fish under exactly the same storage conditions, larger fish were found to keep better than smaller fish. No difference was observed between length of storage life of whole fish or fillets. A graphic presentation of the quality decrease is found in Figure 1, which also gives results of the microbiological and chemical analysis.

3.2 MICROBIOLOGICAL CHANGES

Initial bacterial counts varied between 3.10^3 and 5.10^5 CFU/cm^2 of which only 0-1% were capable of producing H_2S. The flesh was found to be sterile, but filleting transferred the bacteria to the flesh yielding counts per gramme comparable to those of the whole fish. The total count increased during the hours storage to 10^7-10^8 CFU/cm^2 with the hydrogen sulphide producing bacteria showing the most marked proliferation. At the time of rejection they had reached levels of 10^6 to 10^7 CFU/cm^2. Bacteria could be detected in the flesh after 7-8 h at ambient temperature; the majority being counted as black colonies on the iron agar. Isolation and characterization of a number of bacteria showed that those producing hydrogen sulphide were emanating the off-odours typical of spoiled Nile perch whereas bacteria growing as white colonies on iron agar did not produce offensive off-odours. Further work at the Technical Laboratory in Denmark identified these spoilage bacteria as Aeromonas sp. These bacteria have also been identified as spoilage bacteria in Australian studies of ambient spoilage (Gorczyka et al., 1985).

3.3 CHEMICAL CHANGES

In newly caught Nile perch, the level of TVB was between 9 and 13 mg N/100 g. At time of rejection, the amount had risen slightly to approximately 20 mg N/100 g and in the completely rotten fish 30-70 mg TVB/N100 g was found.

Analysis carried out in Denmark at the Technical Laboratory revealed that the increase in TVB was caused by a production of trimethylamine, TMA, arising from reduction of trimethylamine-oxide, TMAO, by the spoilage bacteria.

4. DISCUSSION AND CONCLUSIONS

The Nile perch was found to spoil very rapidly if no means of preservation (icing, smoking, salting) is applied; the storage life varying between 11 and 14 h. During the dry season where water- and air-temperature are relatively high, the fish will spoil more rapidly than fish of the same size caught in the rainy seasons. This is probably due to the faster growth of spoilage bacteria at the higher temperatures. Caught under similar conditions, fish of a larger size will be acceptable for a longer period of time than smaller sizes which may reflect the larger amount of flesh to be spoiled in the former.

All fish were considered first quality for approximately 8 h and it is recommended that processing of Nile perch (icing, smoking, salting or sun-drying) is done within this period. Quickly thereafter, the fish will be unfit for human consumption.

The amount of time and the materials available did not allow for an evaluation of the occurrence of pathogenic bacteria. It is, however, believed that in spoiled Nile perch high levels of potentially pathogenic bacteria could be found, since these grow at the same rate as the spoilage bacteria and are likely to be located in polluted waters near urban areas around the Nyanza Gulf.

The bacteriological investigations showed that the group of bacteria initially lowest in numbers, e.g., those producing hydrogen sulphide, were the most important in the spoilage, being responsible for the production of off-odours and off-flavours, developing during storage. These could easily be counted using an iron agar, where they appeared as black colonies and it thus enables a rough measurement to be made of the freshness of the fish. It is believed that these bacteria are also responsible for the greening of gills and other parts observed when spoilage progresses.

Results of the chemical analysis revealed that TMAO is found in high levels in Nile perch. This is surprising, since TMAO is normally found in marine fish only and thought to be absent from freshwater fish. Other studies of tropical fish have not included analysis for TMAO and it is therefore not known whether this occurrence is limited to Nile perch or is a general feature of tropical freshwater fish species.

Bacterial reduction of TMAO to TMA caused an increase in the level of TVB during storage. During the period that the fish was considered acceptable for human consumption, the TVB-level, however, showed little change. It is therefore not very well suited as a quality index during the first 10-12 h of storage. Further storage did result in an increase of TVB and a high figure found in a given product can thus be taken as an indication of poor quality fish.

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QUALITY ASSESSMENT OF NILE PERCH
STORED AT AMBIENT TEMPERATURE (20^{o}-30^{o}C)

Denomination	Outer appearance					Grade	Score
	Skin	Gill colour	Gill odour	Eyes	Texture		
Freshness enabling limited local distribution	Natural brilliance, metallic, golden, pink-silver, scales firmly attached	Red-purple, maroon, no slime	Fresh, seaweeds	Transparent, yellow sheen, convex	Firm elastic, hard (rigor)	First quality	9 8 7
If preserved (cooled, frozen, salted, smoked, dried also regional distribution	Brilliance, few dull patches, scales firm	Reddish, little pinkish slime	Neutral fresh	Reddish, convex	Firm elastic		6
Reduced freshness, for quick sales	Greyish, darkening loss of metallic brightening	Bleached patches, slime	Light rotten off-odour	Red, milky flat	Soft	Second quality	5
If preserved: local distribution	Scales loose on the belly						
				BORDER LINE OF ACCEPTABILITY			4
Insufficient freshness: as such unfit for human consumption	Yellow slime, greenish fins	Green, slime	Rotten area strong off-odours	Sunken, turbid	Soft buttery finger-prints leaves impression	Rejectable	3 2 1

QUALITY ASSESSMENT OF NILE PERCH (cooked)
STORED AT AMBIENT TEMPERATURE (20^o-30^oC)

Odour	Flavour	Texture	Colour	Grade	Score
Typical of Nile perch, fresh, broth-like, steamed green vegetable weak, fresh	Typical of Nile perch, cooked cassava or sweet potatoes, weak broth	Succulent, form elastic, easy to swallow	Ivory-like, white, clear	First quality	9 8
Neutral	Neutral, taste-less	Succulent at first, then mealy	White		7 6
Weak rotten	Weak rotten	Soft, mealy,	White/greyish	Second quality	5 4
Rotten urea, sour, stinking	Rotten, sour, nauseating	Very soft, like butter, very mealy	Greyish, dark	Rejectable	3 2 1

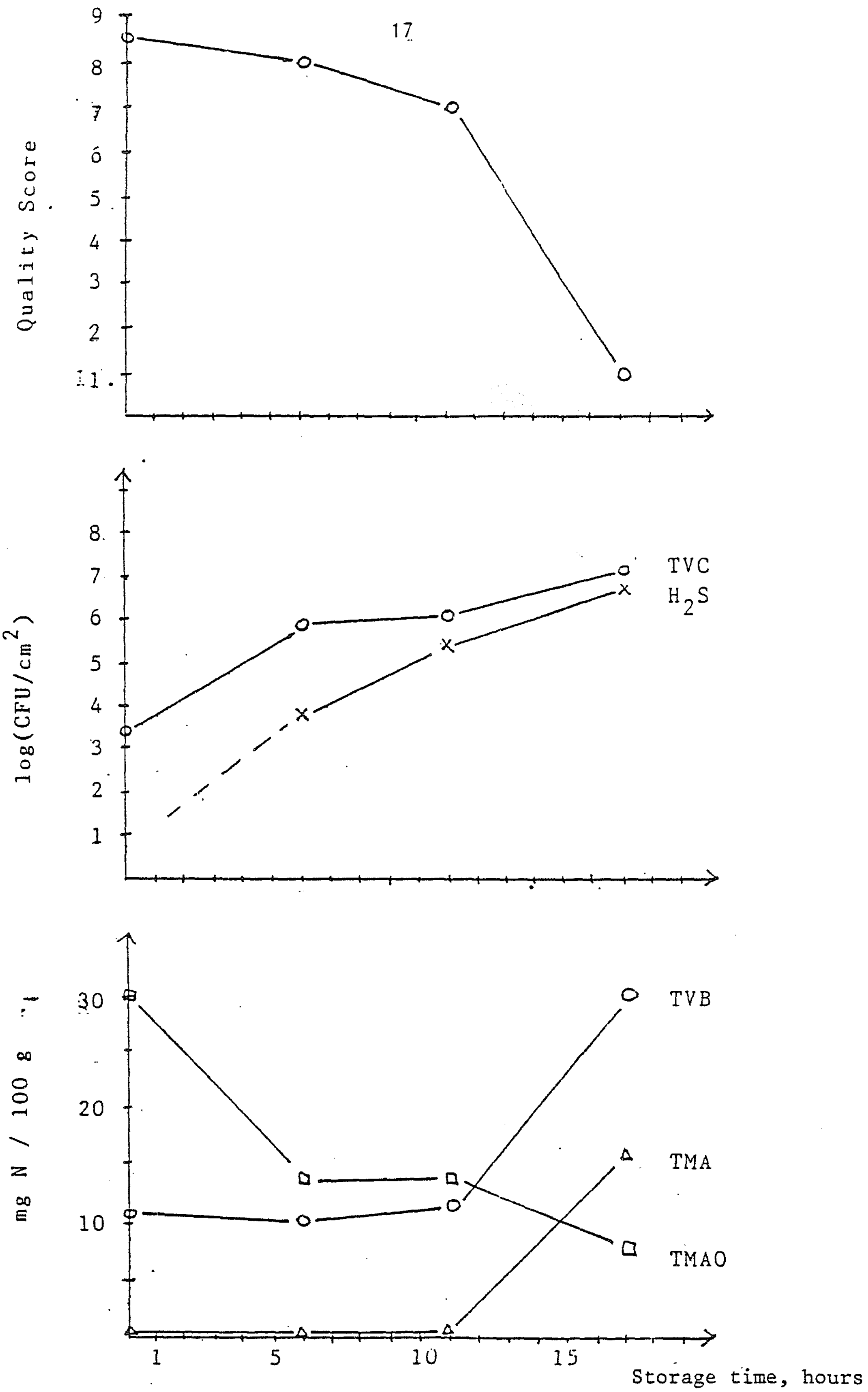

Fig. 1 Quality changes during storage of Nile perch at ambient temperature. Sensoric, microbiological and chemical changes shown as function of storage time.

DEVELOPMENT OF A STABLE SUN-DRIED FISH PRODUCT

by

L. Gram

ABSTRACT

The need for improvement in present handling practices of Nile perch has been stressed, and often the introduction of ice is recommended. At many landing beaches this may, however, not be possible due to lack of electricity, water, chilled distribution, etc. Therefore, work must be carried out aimed at improving artisanal processing and developing procedures at this level.

Today, Nile perch is preserved by frying, sun-drying or smoking. The use of salt is unknown and this therefore seems an obvious new method of preservation.

Laboratory experiments with spoilage bacteria isolated from Nile perch have shown that their growth could be inhibited by salt and the food preservative, sorbic acid. This paper describes the practical application of these parameters and it was found that the use of 15 g salt and 1.5-2 g potassium sorbate/kg fish flesh followed by 3-4 days of sun-drying resulted in a product stable at ambient temperature. When cooked, the product was well liked by local consumers.

1. INTRODUCTION

The catch, handling and processing of Nile perch are, as described by Bon (1988), almost exclusively done on an artisanal basis. Very rarely is water available and ice is never used by local fishmongers or processors at the landing beaches. The need for improvement of present handling techniques has been stressed (e.g., Bon, 1988) and mostly the introduction of chilling by ice is recommended. This is, without doubt, an ideal way of preserving Nile perch (Gram, 1987), but it is believed that in many places this will be very difficult, if not impossible. Requirements include clean water, ice-plants, technical maintenance, chilled distribution systems, etc. Thus, other ways of improving artisanal procedures must be also investigated.

Traditional methods of Nile perch preservation include frying, sun-drying (smaller fish) and smoking. Smoking is resource-consuming and can lead to serious de-forestation. In many artisanal fish communities - especially at the seashore - the use of salt as a fish preservative has been known for years, but this procedure is not commonly used at the landing beaches along Lake Victoria.

The present study describes preliminary experiments in the development of a preservation procedure applicable at artisanal level using dry-salting, sun-drying and sorbic acid. Sorbic acid is a common food preservative and was found to inhibit growth of spoilage bacteria isolated from Nile perch if used together with salt. The cost of sorbic acid is low and, unlike many other preservatives, it has not been associated with the development of cancer or food allergy.

The aim has been to use as little of the preservation parameters as possible in order to minimize the costs, but enough to ensure an ambient storage life of a few weeks and thus enabling distribution to local markets.

2. INHIBITION OF MESOPHILIC SPOILAGE BACTERIA

As described in Chapter 2 "Spoilage of Nile perch at ambient temperature", spoilage bacteria were isolated and identified. At the Technical Laboratory, Denmark, these were used for laboratory experiments where the spoilage bacteria were grown in various combinations of salt and sorbic acid at different temperatures. It was found that a combination of 5% salt and 0.1% sorbic acid effectively inhibited growth of spoilers at all temperatures from 0^{o} to $37^{o}C$. Neither salt nor sorbic acid alone, in the mentioned concentrations, could prevent proliferation.

Preliminary experiments on the practical application of these findings were carried out during the second phase of the project.

3. MATERIALS AND METHODS

3.1 FISH RAW MATERIALS

The purpose was, as described above, to develop a procedure to be used at artisanal level, and care was therefore taken always to use only fish which had only been kept at ambient temperature. Fish used were either purchased at Dunga Beach or caught on short fishing trips with the trawler OMENA.

Small fish were butterfly-cut from the back, and the guts and gills removed. Fish of 1-3 kg were filleted and the fillets treated. From larger fish, the fillets were cut in slices or strips before salting. None of the samples were washed before salting.

3.2 SALTING/SORBATE-TREATMENT

The weight of a given sample (fish flesh/fillet) was recorded and salt and potassium sorbate added on a weight to weight basis. A number of different treatments were tried; salt-concentrations ranging from 0 to 100 g/kg and potassium sorbate from 0 to 3 g/kg. Salt and sorbate were well mixed and then spread evenly on both sides of the pieces to be preserved.

4. RESULTS

4.1 EFFECT OF DRYING

In initial experiments fish were placed in plastic bags in order to keep the samples separate. This, however, caused accumulation of the drippings and, regardless of the amount of salt and sorbate used (up to 75 g/2 g per kg), the fish spoiled within two days.

In the following experiments, fish were placed on a rack overnight and taken outside for sun-drying the following 3-4 days. This procedure greatly enhanced the preserving effect. The weight was reduced to 50% after 2-3 days and to almost one-third after 4 days of drying. Thus the actual concentration of salt was 2-3 times higher than when the product was prepared.

During the rainy season, two successive days of cloudy, rainy weather followed the preparations for the salting/sorbate treatment. The majority of these fillets, which were not dried properly, either rotted or showed heavy infestation with maggots.

4.2 EFFECT OF SALT

During the trials, two types of salt were used of different coarseness, Ken salt and Ishwa salt. The latter, which is a very finely ground (table) salt, was found to be more effective than the coarser Ken salt when the same levels of the two were compared. The following results, giving amounts of salt used, are therefore only valid when a finely ground salt is used.

Fish samples prepared without salt (+/- sorbate) were (as expected) always spoiled the following day. Samples treated with 10 g salt/kg were, in general, rejected after 1-2 days; either because of bacterial spoilage (greening and rotten off-odours) because of the appearance of maggots. If proper sun-drying was possible for 3-4 days, 15 g salt/kg fish flesh successfully preserved the samples. Any salt level above this also proved effecient, but more than 25 g salt/kg resulted in a final product too salty for local consumers.

4.3 EFFECT OF SORBATE

The potassium sorbate purchased had been spray-dried and therefore appeared as small granules. These could not be evenly mixed with the salt and did not penetrate the fish flesh properly. Portions of sorbate were therefore ground to the same coarseness as Ishwa salt before mixing and spreading.

Sorbate seemed to have little effect on bacterial spoilage, since fillets where salt levels of 15 g/kg (or above) were used, preserved regardless of the addition of sorbate. After some days, however, samples without sorbate often developed spots of mould. This was not seen in sorbate-treated samples (2-3 g/kg).

The effect of sorbate on the development of maggots is not conclusive. In some trials all samples with sorbate were left untouched by maggots and all samples without were infested. Other trials showed less obvious effects since maggots also developed in sorbate-treated samples.

The use of 3 g sorbate/kg often caused a bitter chemical taste to develop, but this was not noticed when lower levels were used. Therefore the final products were prepared with 2 g/kg.

4.4 EFFECT OF FILLET THICKNESS

Trials were carried out where fillets of medium or large size fish were used (4-5 and 10-14 kg). If the thickness of the fillets was above 2 cm, these were, however, found to rot in the interior before enough salt had penetrated and/or enough water had evaporated during drying. Slicing the very large fillets and cutting the medium fillets in strips before salting/drying ensured proper preservation.

4.5 CONSUMER ACCEPTANCE

The finished product had a pleasant brown colour and was thought attractive to local consumers. A sample was given out and cooked in the following manner:

- the salted/dried fish is cut into smaller strips and cooked in water; the cooking water is thrown away

- in a separate pot, tomatoes, onions and other vegetables are cooked and the pre-cooked fish added

- finally 1/2 l of milk is added and the fish served with ugali (maize meal porridge)

The finished dish was very well liked by local consumers and other cooking suggestions were made: e.g., using coconut milk or a mixture of ground groundnuts and milk. This has yet to be tried.

5. DISCUSSION AND CONCLUSIONS

The results of the storage trials with salting/sorbate treatment and sun-drying of Nile perch showed that it is possible under (simulated) artisanal conditions to produce a product stable at ambient temperature.

From these experiments it can be concluded that:

- small fish (1/2-1 kg) can be processed if cut butterfly-fashion and the gills removed

- fillets of larger fish can also be preserved either as whole fillets or if the flesh is thicker than 2 cm, cut into slices or strips

- a combination of 15 g salt (finely ground) and 1.5-2 g potassium sorbate/kg followed by 3-4 days of sun-drying effectively preserved the fish

- the product should be eaten only after cooking, and as such was well liked by local consumers.

The data collected in this study are, however, only of preliminary and further work should be continued to determine the shelf-life of the product, the exact effect of sorbate on maggots, procedures to be followed during the rainy season, and the importance of the freshness of the raw material.

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CHEMICAL COMPOSITION OF THE EDIBLE PART OF NILE PERCH

by

K.E.O. Werimo

1. INTRODUCTION

Typical components in the edible parts of fish are moisture, protein, fat and vitamins. Fish meat has a fat content which normally ranges from 0.2 to 25%, proteins from 16 to 21%, minerals from 1.2 to 1.5%, moisture from 66 to 81%. Carbohydrates occur as a minor compound.

These chemical parameters vary considerably from species to species. Their variation further depends on sex, age, environment, season and diet. They are important in determining storage life, in selection of processing methods and in marketing. Furthermore, information on the value of these parameters is important in determining the nutritive value of a fish.

2. MOISTURE, PROTEIN, FAT, FATTY ACID, HISTAMINE AND MERCURY DETERMINATION

Samples of Nile perch were caught by the KMFRI trawler and held in coldstore until they were analysed.

Moisture content was determined by grinding a sample of the fish and drying a known quantity to constant weight. Percentage moisture content was calculated based on the wet weight. Protein content was measured using the Kjeldahl method. Analysis of fat content was done using different methods: these were the Fosslet determination method, the Van de Kamer method, and the Bligh and Dyer method. Samples of fillets were analysed by the TNO Institute for Fishery Products, IJmuiden, Netherlands for histamine and mercury content and for fatty acid composition of the fat.

The fat content analysis was carried out on fillets of different sizes and on both male and female Nile perch. Three portions were taken from the fillets and labelled A, B, C (see Fig. 1); sampling was done to find out if there is a significant difference in the fat content between parts A, B and C. The information will guide in the trimming of the fillet in order to obtain a better fillet for the export market.

3. DISCUSSION AND CONCLUSION

From the values obtained, Nile perch seem to have a moisture content of between 68% and 79%. It is also observed that smaller fish have a higher moisture content which decreases as the fish grows in size. Protein content appears to be higher in middle sized Nile perch. It can therefore be concluded that Nile perch weighing between 8 and 12.5 kg will have a protein content of at least 20%. As the fish grows, the protein content tends to decrease. Fat content shows an increasing trend from Part A to Part B to Part C. This implies that for Nile perch weighing more than 20 kg, the belly flap has to be trimmed off from the fillet to obtain a fillet of less than 20% fat. It also means that the belly flap portion is not suitable for hot-smoking since this will cause oil dripping and may cause fire in the smoking oven. For the production of good quality fillet with moderate fat content, Nile perch weighing 6-10 kg would be most suitable since the fat content will be about 2.9%. Some parts of the Nile perch, especially the belly flap, can contain up to 40% fat.

Histamine levels were determined from three samples. Sample A was frozen for 4 months, Sample B was kept at $0^{o}C$ but not iced for 7 days and Sample C was the frozen sample removed from the freezer and kept at ambient temperature for 2 days.

The values obtained on histamine analysis show that no health problems to the consumer are to be expected. Sample C, with 47.7 mg%, was completely rotten and was analysed to find out the maximum level of histamine that can be obtained in spoiled Nile perch.

The main objective of determining the fatty acid composition of Nile perch fat was to find out whether consumption of Nile perch can be considered beneficial in preventing coronary heart diseases. It is known that certain fish species contain high levels of n-3 poly-unsaturated fatty acids (PUFA) (mainly 20:5, 22:5, 22:6) which contribute to a lower risk of coronary heart diseases.

Health and medical research stress the valuable contribution of n-3 PUFA to the diet as against n-6 PUFA (mainly 18:2, 20:4 and 22:5) which is less desirable. The amount of n-3 PUFA in fish and consequently in the human diet and the incidence of coronay artery diseases supports the hypothesis of the biochemical role of n-3 PUFA, in the mechanisms of platelets aggregation, platelet-vessel wall interaction and the subsequent staving off of atherosclerosis.

It is also worth mentioning that Nile perch is unique in the sense that it contains two essential fatty acids, linoleic acid (1.6%) and linolenic acid (0.8%), that are known to occur otherwise in plants only.

Previous work done by Herzberg on the fatty acid composition of Nile perch from Lake Victoria has shown that the n-3 PUFA 22:6 was very high in concentration reaching a value of 29.4%. However, the author of the present paper found the concentration of the same fatty acid to be only 2.9%. This suggests that there is wide fluctuation of this fatty acid in Nile perch from Lake Victoria.

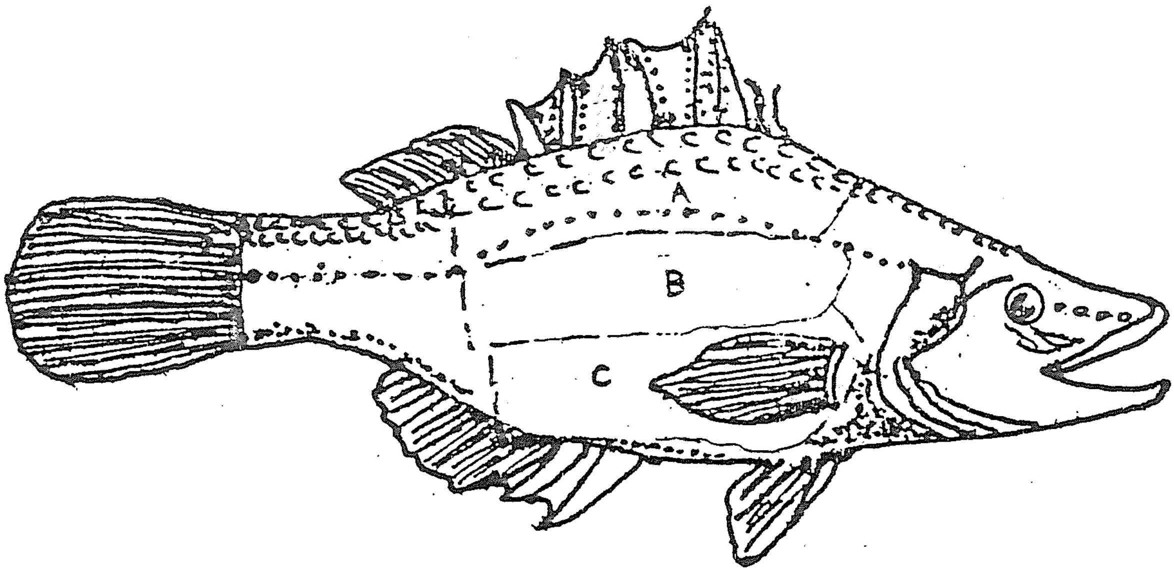

Fig. 1 Parts of fish taken for fat determination

Table 1

VALUES OF FAT, MOISTURE AND PROTEIN OF NILE PERCH

Weight kg	Number of fish	Length cm	Moisture %	Fat %			Protein %
				A	B	C	
				(see Figure 1)			
2-5	10	50-70	79	0.8	1.3	1.5	-
6-10	10	60-70	78.5	0.9	2.1	5.8	-
11-20	10	80-100	77.0	3.3	4.2	15	-
21-40	10	90-125	76.9	4.3	11.3	39.4	-
58	1	122	68	9	15	40	-
8.5-9.0	5	73-80	75.5	-	-	-	22.0
12.0-13	5	94-100	75.0	-	-	-	20.1
20	5	110	74.0	-	-	-	15.1

Table 2

VALUES OF HISTAMINE IN NILE PERCH FILLETS

Sample	Concentration of Histamine mg%
After 4 months frozen storage	0.1
Kept at $0^{o}C$ for 7 days	0.2
After 4 months frozen storage + 2 days ambient storage (spoilt)	47.7

Table 3

FATTY ACID COMPOSITION OF NILE PERCH

Fatty Acid	Concentration %
12:0	0.121
13:0	0.041
14:0/15:0	0.089
14:0	3.211
14:1	0.603
13:0/16:neo	0.396
15:1	0.286
16:0	24.286
16:1	16.228
16:2/17:0	0.916
16:2/17:1) 16:3)	0.143
16:2/17:1) 16:3)	0.783
18:0	8.876
18:1	28.391
18:2	1.592
19:1	0.385
18:3	0.847
20:0	0.355
20:1/18:4	1.045
20:1	0.111
20:2	0.036
20:3	0.118
20:3/20:4	1.812
22:0 a.i	0.196
22:0	0.130
20:5/22:1	2.654
22:3	0.215
22:5	0.169
24:1	2.518
22:6	2.885

Mercury level in Nile perch fillets was found to be 0.8 mg/g. This shows that the level of this contaminant in Nile perch is rather low and constitutes no health risk.

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TECHNICAL AND SOCIAL ASPECTS OF TRADITIONAL PRESERVATION OF NILE PERCH

by

J. Peyton

ABSTRACT

The importance of mbuta (Nile perch) to the local artisanal fishermen, small-scale processors, and consumers cannot be overestimated. Their industry is in a period of dramatic change and they have virtually no control over it.

Traditional smoking is perhaps inadequate but can be improved. The economics of present changes have been presented from only one perspective... there are others, involving a very significant percentage of the local population.

1. INTRODUCTION

The Diocese of Maseno South fish processing team, in conjunction with ITDG of the UK, have for some seven months been working with two beach communities in South Nyanza towards understanding the importance of Nile perch (Lates niloticus) - hereafter referred to as mbuta - to the local population with a view to improving their handling, processing and marketing activities wherever possible.

The first phase of the work has been mainly research into social and technical parameters; this being carried out at a time when the local industry is facing serious outside pressure, thereby offering an insight into a dynamic situation rather than a stable, static one.

It is disturbing that,in some areas, the potential problems of a particular avenue of development/utilization are overlooked and often ignored.

2. TRADITIONAL SMOKING

As a method of preservation, fish-smoking is a well established technique along the Kenyan shores of the lake. The traditional kiln - or lunyo - has long been employed; it is cheap to construct, made basically of mud and wattle. Design and to a lesser extent operation vary locally.

Fish are split or "steaked" maintaining the skeletal framework as a support and then stacked horizontally on weldmesh trays within the lunyo. Pre-drying, although practised, is not common.

Generally the lunyo is fired twice, on two consecutive days, with the trays being alternated in the intervening period. On removal, the fish are quickly packed in wicker baskets and sold to traders, or taken to market by the processors.

3. TECHNICAL ASPECTS OF OPERATION

The traditional techniques are now being adapted to deal with the two ecological changes; the shortage of fuelwood, and the replacement of traditionally preferred species by mbuta in the landings, e.g., mbuta landings 1974, 136 t; 1984, 41 319 t (Fisheries Statistical Bulletins).

To date part of the work has been to fully record, analyse and understand the present operational characteristics with a view to introducing technological improvements.

The term "smoking" should not be taken as an accurate description of the processing technique. The very high fat/lipid content in mbuta demands that an alternative type of "smoking" is employed. This involves raising the temperature of the fish pieces as rapidly as possible to almost 100°C (depending on the thickness of the fish and positioning in the lunyo). To achieve this, internal kiln temperatures may reach almost 200°C. A significant "blaze" is employed to achieve this, consuming large amounts of fuelwood - in the most extreme cases 1 kg wood:1 kg fish (removed).

When oil droplets from the fish cease, the fire is killed and the fish allowed to cool gradually, stabilize at around 23°C, and are then alternated within the kiln. The process is then repeated.

4. LOCAL ECONOMY AND FOOD SECURITY

The importance of fishing (artisanal) and small-scale processing to the local economy cannot be overemphasized. At "beach" communities, apart from support industries (shops, carpenters, etc.), virtually all income generates from fishing (men) and processing/marketing (women). Apart from the night-time pelagic fishing for Engraulicypris argenteus (omena), this income is based on the fishery for mbuta.

The following information on Nyanza Province provides a background on which to base a discussion:

(i) In 1982 the World Bank estimated that about 75% of the households were below the poverty line.

(ii) Norbat Zonneveld (1985) in JICA Master Plan, estimates that in 1983, to achieve 100% fish protein adequacy in the area with a population of 5 million, more than 48 000 t of fish would be required as an input to local diet.

(iii) A wealth ranking exercise in which the author participated, as yet undocumented, puts fish processors and crew members firmly in the poorest section of the community.

From the landings statistics for 1984, when over 54% of landings were mbuta, and bearing in mind that this has steadily increased since, it is clear that amongst the artisanal fishing community, the catching, processing and distribution of mbuta is a major industry and the products a major food source to a poor community with access to very little other affordable animal protein.

The changing patterns of processing and marketing could have very serious negative nutritional and economic effects on the most vulnerable sections of the community.

5. EFFECTS OF CHANGE

The traditional processing and marketing exercises are rapidly being eroded; hence the threat to local economy and food security. The profusion of insulated trucks and fish collector boats, in conjunction with the higher prices offered for fresh fish are very quickly wiping out the localized artisanal industries.

Whereas there are undoubted benefits from this type of development, the negative aspects should also be highlighted.

(i) It was found that in most areas where trucks are operating, community leaders complain of the lack of fish for local consumption.

(ii) Due to the pricing structures within the marketing channels, a significant number of women processors cannot compete with the direct purchase methods of the trucks. The only income-generating activity for one of the poorest sections of the society is being eroded.

(iii) Contrary to what many believe, the increased price for fish does not necessarily translate into a large cash injection to the fishermen (again in the poorest sector). The "fishermen" are mainly only crew men being paid a very little sum. Few crews own the boat and therefore the catch. The real beneficiaries of the price increase are the boat-owners - often absent, and by definition not poor.

(iv) Initially established to maintain hygiene levels and exercise quality control, the "bandas" in the smaller beaches are often having the opposite effect. Mbuta, which on landing is in excellent condition, will often lie ungutted, unwashed in a 3-ft deep pile, in high ambient temperatures for 6-7 h while awaiting the arrival of a truck to purchase.

Before the advent of trucks, the same fish would have been sold immediately and processed. It is interesting that only when the truck fails to appear, when the fish are very distinctly "off", will the processors be allowed to purchase.

(v) As a result of the above, and with very poor handling techniques themselves - fish after purchase lying in the sun for two hours, ungutted, very rough treatment of the fish by the truck operatives, etc. - it is obvious that with some companies, the quality of raw material arriving to be processed at the plant, must be very low indeed.

EFFECT OF HANDLING PRACTICES ON THE KEEPING QUALITY OF NILE PERCH AND ITS PRODUCT CHARACTERISTICS

by

I. Abiya

ABSTRACT

Nile perch *Lates niloticus* has over the recent past established itself as the major fishery of the Nyanza Gulf (Kenya waters) of Lake Victoria. This is evident from the fact that whereas in 1968 it comprised less than 1% of the total landings, in 1986 it claimed over 50%. In 1986, 103 163 t of fish were landed from Nyanza Gulf, out of which 56 975 t consisted of Nile perch. The fish are landed mainly by the artisanal fishermen. In the face of the ever increasing Nile perch landings, lack of improved handling and processing facilities around the major landing beaches continues to orchestrate the production of low quality Nile perch products, and also some post-harvest losses. Handling practices of Nile perch from harvesting to landing and during distribution still leave a lot to be desired and tend to affect the keeping quality of the fish.

This paper endeavours to gain an insight into some of the handling practices and how they affect the keeping quality of the fish and gives suggestions on some of the approaches that could be made towards improved handling.

The paper also touches on product characteristics of traditionally processed Nile perch.

1. INTRODUCTION

Nile perch was very successfully introduced into Lake Victoria during the late 1950s and early 1960s. Its notable success in the Nyanza Gulf may be partly attributed to the high influx of nutrients from some six major rivers draining into the Gulf and in the process causing a high biological productivity, and also the shallowness of the Gulf which tends to enhance the re-circulation of bottom nutrients in the food chains within the Gulf.

It is piscivorous, feeding mainly on fish fry and a fresh-water shrimp Caridina niloticus.

At some beaches landing of Nile perch registered as much as 10 t/day, with the potentialities of much higher catches. The major limitations centre around lack of improved handling facilities at the beaches, such as ice and clean running water. This compels the local Fishermen's Cooperative Societies to dispose of the fish as fast as possible by selling it cheaply to filleting companies which often have refrigerated trucks and also to local processors who often settle for the lower grades suitable for smoking and deep-frying.

The popularity of Nile perch fillet has been recognized both locally in the hotel industry and abroad in some European markets. This has given rise to many private enterpreneurs venturing into the filleting business, both for local consumption and export.

The bulk of processed Nile perch comes from traditional processors who more commonly either smoke or deep-fry the fish alongside major landing beaches and in the nearby fishing villages. The fishmongers carrying out the processing, however, appear to be unaware of the need for proper hygienic standards of handling and processing. This, coupled with the absence of prescribed codes of practice for handling and processing, results in poor quality end-products. Smoking of Nile perch has helped a great deal to promote its popularity around the Nyanza Gulf and even beyond. Nile perch is known to be fatty and most consumers had previously discredited the fish on this account. Smoking has offered a suitable means of processing that reduces the fat and enhances its sensory appeal to the consumers.

Deep-frying of Nile perch is carried out to some extent, using either ordinary cooking fat and oil or melted Nile perch fat.

2. PROBLEMS LIMITING FISH QUALITY

2.1 DELAYS IN HANDLING

Fish easily deteriorates especially at high tropical ambient temperatures and its quality and that of its products depend largely on the mode of handling and storage, right from the time of harvesting to the time it reaches markets, filleting plants and local processors. At most landing beaches nearly all the fish are landed by artisanal fishermen most of whom use traditional fishing vessels propelled by sail or paddles and which lack cooling facilities on board.

To maintain a high quality, the fish should be cooled as fast as possible, care being taken to avoid bruising; and cleanliness should be emphasized to avoid contamination and rapid spoilage.

Most artisanal fishing crafts are constructed such that contamination and even bruising of the catches is sometimes inevitable. The vessels are mostly non-motorized and without ice on board; they take a long time to reach the landing beaches and the fish are exposed to high temperatures. In these conditions there is a considerable reduction in the keeping time.

At the landing beaches, the fishing vessels are unloaded, and during this process fish are sometimes subjected to very rough handling. Large Nile perch may be seen being dragged on the ground and the smaller ones carelessly thrown onto a wheelbarrow and taken to a nearby shed or banda, most of which lack necessary facilities - clean running chlorinated tapwater for cleaning the fish, fish tables and fish containers - and rely on water drawn directly from the lake which often is contaminated. At most landing beaches ice is not available for preserving landed fish and for the artisanal fishermen to carry on board their vessels.

After the fish have been landed, they are displayed to the buyers, then subjected to transportation, handling and storage, and distributed to markets, filleting plants and local processors. Transportation is done on a large scale by fishmongers to inland markets, even though most filleting plants based in Kisumu, Nairobi and Mombasa own refrigerated trucks which visit major landing beaches and are used for transporting the fish to the respective destinations.

Some filleting is also done in certain landing beaches from where the fillets are transported to Kisumu, sometimes uniced. The fishmongers often encounter transport problems. Available transport usually lacks facilities for fish preservation and takes a further 1-3 h to reach inland markets; thus by the time the fish is offloaded at the market place, its quality has dropped considerably. Transportation is done in open pick-ups, bus racks and in some areas bicycles are used.

The poor condition of some access roads, which become impassable during rainy seasons, also poses a problem. Contamination is accelerated by the habitual use of perforated baskets, and jute bags or sacks which are never washed.

2.2 DELAY BEFORE ICING AND ITS EFFECT ON QUALITY

As most of the Nile perch landed from Nyanza comes from artisanal fishermen to whom ice is not available, delays before icing of the catches in most cases is almost unavoidable, and more so since the fishing vessels are very slow, being non-motorized and often taking more than two hours to reach the fishing grounds where nets are set and a further two hours or even longer to land the catches. The time between the fishermen setting their nets and landing their catches often takes up to 18 hours, resulting in a wide disparity in the quality of the fish. The earliest fish caught in the net will have the lowest quality, having stayed in the water much longer at ambient temperatures ranging between 25° and 28°C, whereas the last fish to be caught just before harvesting will be of the highest quality. During the loading into the refrigerated and insulated trucks, it is common to see the fish carelessly thrown into the trucks, resulting in some being bruised. The fish are often transported whole to the premises where filleting is carried out.

Thus the fish caught by the artisanal fishermen are not iced until after they have been landed, and sometimes until they reach the processing premises; this involves a long delay before the fish are cooled. For high quality products, it is necessary to minimize this time lapse to ensure that the fish are sold or processed before the keeping time expires. Long delays before icing affect quality characteristics of the Nile perch fillets. Fish iced immediately after capture in trawl nets are often whiter than those iced several hours later which tend to become pinkish. Minimizing delays before icing may thus help improve considerably the quality of fish fillets exported from Kenya to external markets where there has been a consistent demand especially for Nile perch fillets. This further strengthens the need for ice-plants to be built at major landing beaches.

Presently, attempts are being made to advise the local Fishermen's Cooperative Societies on the advantages that are bound to accrue from the use of insulated containers once ice becomes readily available. Artisanal fishermen would also be encouraged to carry ice on board their fishing vessels to enable them to ice their fish catches immediately after harvesting. This is the only way by which fishermen may be able to reap maximum returns through minimized fish spoilage. It would also guarantee fish consumers the availability of high quality fillets, both locally and abroad.

The normal keeping time of Nile perch at ambient temperatures is between 20 and 24 hours. Cooling at 0°C in melting ice extends the shelflife to 20-24 days. Cooling at about -18°C as in the case of fillets intended for local distribution and export extends the keeping time to some 12 months. The fish has a tough skin which does not readily yield to bacterial invasions.

Cleanliness and sanitary conditions existing in a filleting plant may also influence product quality. To enforce maintenance of proper standards of hygiene in such processing plants, the premises and facilities for processing shall be regularly inspected to ensure that their conditions meet suitable levels of hygiene. Moreover, the premises have to meet certain basic requirements before they can be approved and licensed by the Fisheries Department.

2.3 CHEMICAL INDICES OF SPOILAGE

Quality characteristics of some fishes have been studied based on accumulation of total volatile bases (TVBs) and also on autolytic degradation of nucleotides in terms of % K-value and hypoxanthine. These when related to sensory assessment and bacterial load analysis could provide important information on the quality deterioration and spoilage pattern in Nile perch, both at ambient conditions of temperature and humidity and also during cold storage. Tropical freshwater fish are characterized by very low initial TVB values such as 7 mg N-TVB/100 g in fresh _Tilapia_ and _Haplochromis_ (Adebona, 1980). During storage, TVB value rises due to autolytic and bacteriological spoilage. However, at temperature of about 0°C formation of TVB may be significantly reduced or halted and spoilage may then take a different course from that at higher temperatures. A similar effect of chilling on the formation of TVB in muscles of freshwater fishes has been observed by Moriyama (1964) who found great differences in TVB values among freshwater fish species in the early stages of spoilage.

This implies that without further research TVB value may not be reliable as a quality indicator. However, investigations have suggested that TVB value is more reliable during ambient storage, unlike in ice storage where the melting ice is likely to leach out the volatile bases.

Estrada _et al._ (1984) working on mesophilic spoilage of tilapia (_Oreochromis niloticus_) found a TVB value of 15 mg N-TVB/100 g at rejection after 16 1/2 h of ambient storage (27°C and 92% relative humidity). Sumner _et al._ (1984), recorded TVB values exceeding 30 mg N-TVB/100 g at rejection for _O. niloticus_ stored in ice. Some investigators have reported fluctuations in the levels of both TMA and TVB throughout iced storage and may be of questionable value as quality indicators in some fish species.

On the other hand, % K-value and hypoxanthine levels could be more useful as indices of spoilage. K-value is normally less than 5% in very fresh fish but may rise up to 100% at rejection. It has also been reported that hypoxanthine concentrations of about 2 u moles/g causes bitter flavour (Jones, 1961).

A K-value of 60% has been set by some Japanese workers (Saito et al., 1959) as a limit of acceptability for some fish species. They have also set a 20% K-value as freshness limit for some fish. Tilapia kept at ambient conditions was observed to reach this value in about 7 h. This implies that for tilapia, delays before icing should not exceed 7 h. Similar investigations could be made for Nile perch in order to determine the limiting duration before icing.

Assessment and characterization of bacterial loads are equally important in studying the spoilage pattern of Nile perch.

3. PRODUCT CHARACTERISTICS

The major processing methods around Nyanza Gulf are hot smoking and deep-frying. The processing procedures and facilities do not permit the production of high quality products.

3.1 HOT SMOKING

This is carried out largely in mud-walled often rectangular smoking ovens. Fish to be smoked are just gutted and washed and then cut into smaller pieces, and left in the open to drip dry so as to prevent case-hardening during smoking. Generally, the washing is not well done and leaves blood traces on the fish. During smoking, the smoke density and temperature are controlled crudely by opening or closing the door or shutter, and also by adding or reducing firewood. The smoking process takes between one and three days depending on the size, thickness and quantity of the fish.

Well-smoked fish would normally have yellowish or golden brown colours, the texture would be moderate and the flesh well cooked inside. The majority of fish smokers, however, rarely approach these desirable quality characteristics. The problem lies in the lack of suitably approved guidelines governing smoking of fish, or codes of practice. Usually some products are over-processed becoming very hard and brittle, some with blackened or charred characteristics. The under-processed products do not have sufficient smoke and heat treatment, and thus the inside remains raw. Such products are usually targets for blowfly attacks due to their high moisture contents.

3.2 DEEP-FRYING

In order to cope with high landings of Nile perch and also to satisfy the diversified market demands for processed fish products, a number of processors also carry out deep-frying of the fish along the major landing beaches of the Nyanza Gulf.

Deep-frying is done either using the ordinary cooking fat and oils, or Nile perch fat extracted from the belly.

Fish are gutted, split, washed and then chopped into small sized steaks which are then split open and pre-dried on mats or raised racks. The pre-dried steaks are then dipped in boiling fat or oil and left to cook until the colour of the steaks changes to golden brown. Some processors add salt to the boiling fat or oil to increase firmness in the texture of the steak, and its shelflife.

The products deep-fried in cooking fats and oils have been observed to show superior quality characteristics to those deep-fried in Nile perch fat.

The observations indicate that fish deep-fried in cooking fats and oils may have a longer shelflife and are often lighter in colour as opposed to those deep-fried in Nile perch fat, which are darker in colour and whose shelf-life appears to be no more than three days. They are suspected to be more prone to blowfly infestation.

However, further investigations could be necessary.

4. RECOMMENDATIONS

As the fish-eating communities in Kenya continue to grow, Nile perch is increasingly recognized as a convenient and acceptable cheap source of protein.

Two points should be emphasized here. One, the majority of consumers do not often have the opportunity of eating high quality fish. Two, there are serious post-harvest losses which call for improvements to revolutionize the current handling and processing procedures. Following are recommendations which could help to achieve this important goal.

(a) There is a need for installation of ice plants at all the major landing beaches. This will ensure availability of ice to the fishermen for immediate icing of their catches.

(b) Once ice is readily available, the Fishermen's Cooperative Societies should be encouraged to use insulated containers to preserve their excess catches. This will help them stabilize their pricing system for Nile perch in order to reap maximum returns from the fish sales.

(c) All personnel involved in fish handling and processing should be educated on the need to maintain high standards of hygiene and cleanliness.

(d) Codes of practice on all processing methods should be worked out and recommended for implementation. This is the only way by which standards for Nile perch products can be formulated. This will ensure production of high and uniform quality.

(e) Improvements on the existing traditional processing methods are urgently needed. The smoking ovens currently in use should be improved to ensure high quality and uniformity of product, ease of operation and low consumption of firewood. In this respect, the adoption of Chorkor ovens is recommended.

(f) For sun-drying, use of solar-tent driers should be encouraged. This is necessary in order to prevent infestation of drying fish by blowflies and beetles, to protect the fish from contamination with sand and dirt, and also to ensure faster and uniform drying of the fish.

5. CONCLUSION

Much remains to be done to improve handling and processing of Nile perch in Kenya. This calls for the concerted efforts of the Fisheries Department in conjunction with all involved in fish handling, processing and quality control.

The first step should be a thorough study of all the traditional processing methods with a view to accurately diagnosing the major flaws which give rise to quality defects in the final products. This will provide an important base from which to formulate more exact codes of practice for all the curing methods. The Kenya Bureau of Standards has recently undertaken to formulate the national standard specifications and codes of practice for handling, processing and distribution of fish.

The availability of quality standards will render quality and sanitary inspections more effective. The codes of practice which will be issued to all involved in the fishery industry by the

Fisheries Department through its extension services, are essential to ensuring high and uniform quality products both for the local consumers and export.

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PROGRESS MADE ON THE CONSTRUCTION AND USE OF CHORKOR OVENS AT NAIVASHA WILDLIFE AND FISHERIES TRAINING INSTITUTE

by

J.F.M. Nyagambi

1. INTRODUCTION

The technique of using smoke to preserve fish is not new in Kenya as it has been practised for many years. Whether the smoke curing involves traditional methods or mechanized operations, the quality of the final product depends on the skill and experience of the operator in both pre-smoking and smoking treatments.

The main limitation of the traditional smoke-drying techniques is that it is difficult to control fire and invariably an unevenly smoked product is obtained. In addition, the capacity of a traditional smoking oven is limited to 50-80 kg of fish a day, and there are often surplus fish which are lost as they cannot be smoked and therefore cannot be preserved. Another disadvantage is that the smoke oven has no roof and therefore the fish cannot be protected from the rain.

It is envisaged that the FAO funded project, which includes the construction for training purposes of four Chorkor ovens at the premises of the Naivasha Institute, will propose solutions for the improvement of smoking methods throughout Kenya as the trainees are drawn from all parts of the country. Consequently, the standard of smoked fish is expected to improve in these areas where the trainees will be assigned.

In order to achieve countrywide dissemination of the Chorkor oven technique, a target group of fisheries assistants who are currently undergoing a two-year certificate course at the Institute are being trained in the construction and operation of the Chorkor oven. The results of this work are discussed later in a technical description of the modifications proposed to suit local conditions.

2. TERMS OF REFERENCE FOR FISHERIES ASSISTANTS ATTACHED TO THE PROJECT

Under the day-to-day supervision of the project leader, the officers are required to perform the following:

(i) Clear and level the ground; calculate height of the oven walls from the drawing; dig a trench 12 inches deep and 8 inches wide for the foundation

(ii) Mix concrete and chip the building stone blocks to the size required

(iii) Carry out the construction work under the supervision of the mason

(iv) Assist the carpenter in making trays

(v) Evaluate different smoking practices

(vi) Evaluate different storage practices to determine the optimum methods of long-term storage for smoked fish.

It is expected that the trainees will be able to instruct members of the fishing and fish processing communities on the new practices of fish-smoking on completing their two-year certificate course.

3. CONSTRUCTION OF CHORKOR OVENS

Four Chorkor ovens are under construction at the Fisheries Field Station. The ovens are rectangular, about twice as long as wide, with two stoke holes in front of each oven. The foundation is dug in the ground about 12 inches deep and 8 inches wide and a dividing wall built in the middle. Stone blocks are used and the normal building procedures followed.

As already mentioned, the trainees are playing a major role in the construction of the oven. There are four construction alternatives: a clay mud oven, a packed-clay-mud faced with cement oven, a clay-mud blocks (bricks) oven and a cement-block with mortor oven. The fourth alternative was chosen to start with; the other three will be constructed for comparison purposes in the future.

For the trays, hardwoods and softwoods are used for frame construction. Weld mesh and coffee tray wire mesh are also used for the construction of trays. It is hoped to be able to compare the various materials used during the smoking process in order to determine the most appropriate material for future use. The target date of completion of the Chorkor oven is April 1988.

4. MODIFICATION OF THE CHORKOR OVEN

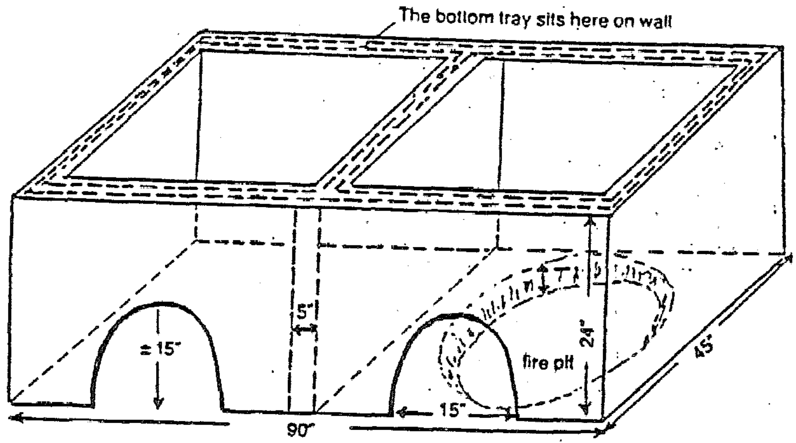
The modification of the Chorkor oven is not structural and therefore does not alter the anticipated operations from the original design. It is related to the working conditions of fishermen and fish processors. Investigations have indicated higher catches during the rainy seasons in many parts of the country. The wet season affects the dispersal of fish and some areas are rendered inaccessible by road. It is in this period that the fishermen/fish processors are required to smoke more fish under wet conditions. The need for comfortable rain-free working space is necessary and hence it is proposed that a shelter will be included in the final construction plans.

5. CONCLUSIONS

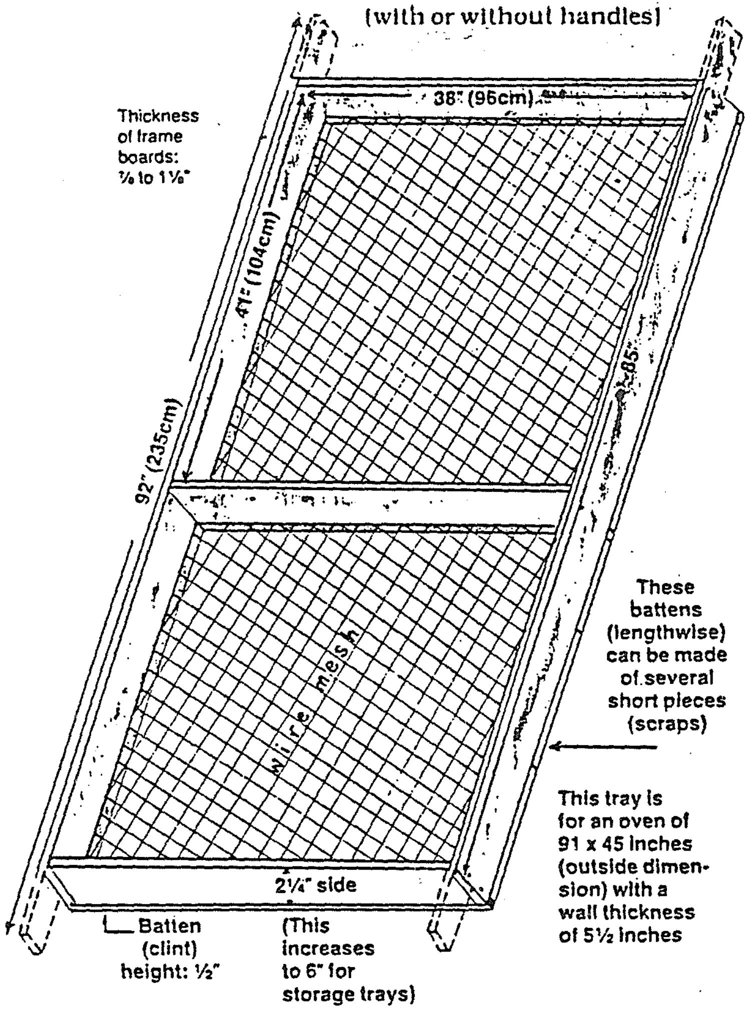
The Chorkor ovens at the Institute are being built with local materials which include stones from a nearby quarry. It is envisaged that the construction of similar Chorkor ovens in other parts of the country will also make use of locally available materials, such as bricks, mud, etc.

The construction of the Chorkor ovens at the Fisheries Field Station is underway. The certificate course participants will be guided in the construction and operation of the newly introduced Chorkor ovens in their training period. The fisheries assistants will be closely involved in informing the fishing industry of these developments. It is envisaged that once the trainees are able to construct and operate the Chorkor ovens, they will also be able to transmit their knowledge to the fishing communities.

It is hoped that use of the Chorkor oven will be diffused throughout the country. Agricultural exhibitions play an important role in Kenya's agricultural development; and the Institute hopes to display Chorkor ovens at the shows in Nairobi, Mombasa and Kisumu. This could later be extended to the District Headquarters in line with the District Focus for Rural Development Strategy. It is also hoped to involve women's groups.



TOP VIEW OF SMOKING TRAY



THE HANDLING, PROCESSING AND MARKETING OF NILE PERCH (LATES NILOTICUS) IN TANZANIA

by

P.O.J. Bwathondi
and
O. Mosille

1. INTRODUCTION

The introduction of Nile perch into Lake Victoria and its rapid reproduction in the 1980s has completely changed the fishing industry of the lake. The appearance of large quantities of huge and fatty fish posed a series of problems to both the fishermen and the processors. Consumers needed to adjust their feeding habits and traders had to look for additional markets for the increased landings of Nile perch.

The formerly multi-species fishery of the lake has more or less collapsed, except for tilapiina, Schilbe and Alestes in restricted gulfs. The dagaa fishery (Rastrioneobala or Engraulicypris argenteus) is still flourishing although threatened by the changes in the diet of Nile perch. The Nile perch catches contributed up to 60% of the total landings and sometimes as much as 90% in the trawl catches. Some 123 895 t of Nile perch of a total landing of 216 407 t were caught in the Tanzanian waters of Lake Victoria in 1986. This figure should increase by 1987. It is anticipated that the catches of Nile perch will soon reach the optimum and then start to decline.

2. HANDLING

The Nile perch fishery could be grouped in two categories, namely:

1. The artisanal fishery which comprises the canoe fishery (using gillnets), beach-seine fishery and longline fishery;

2. The industrial fishery which consists of 13 trawlers.

In addition to the factory-made gillnets, large varieties of materials are used to construct the nets. These include nylon threads from the rejected motorcar tire cords (twine), split nylon cords from polyethylene ropes, fibre from the fertilizer bags. The mesh sizes range from 6 to 12 inches with most of them being 7.5-8 inches. The nets are set late in the evening and hauled very early in the morning. The fishermen land their catches between 07.00 and 12.00 h depending on the distance of the fishing ground from the shore. The longliners also set the lines in the evening and leave them overnight. Hauling time of the beach-seine varies according to the size of the net and the length of the rope, but ranges from 1 to 10 hours. Once the fish are landed at the beach, they are piled up on the sand and sold immediately by bargain to wholesalers, retailers or consumers. No fish are left littering the beaches unless the catches cannot be sold. Fish are transported by pick-ups to distant markets. Processors who are also at the beach take their share and process them immediately. There are special choppers at the landing sites who prepare the fish for processing.

Most fish caught by trawlers are either sold to wholesalers or frozen and transported to Dar-es-Salaam and other big towns.

3. PROCESSING

There are two main processing techniques deployed on the Tanzanian part of Lake Victoria.

3.1 SMOKING

On landing, the large fish (above 5 kg) are immediately taken to the choppers who chop the fish in different sizes at a charge of KSh 5-10 depending on the size.

Fish weighing between 1 and 6 kg are split open from the dorsal side, cleaned and put on the smoking kilns. When large quantities of fish are involved, they are carried by wheelbarrows to the smoking site; if they are few they are transported singly being left to drip in the sun for 2-3 h over meshed wire lifted from the ground or over rows of crossed wooden sticks.

Smoking is done using the Altona and the Chorkor type kilns constructed of mud and wattle or dried mud and blocks or bricks. A few concrete blocks and cement kilns are constructed by the fish institutes and training centres. Trays of welded mesh are used to hold the fish in the kilns. It usually takes up to 24 h to dry the fish. Most fish processed this way has a shelflife of up to 4 weeks.

The smoking method has been found to be quite successful although the problem of the fish catching fire when fish fat is used has not yet been solved. This has restricted the size of fish to be smoked. The top of the kilns are not usually covered and as a result smoking cannot be done during rainy days.

3.2 FRYING

Once bought large fish are taken to the choppers where they are cut into several pieces, washed, sun-dried and fried in a pan of oil heated over firewood. The fat from Nile perch is commonly used for frying the fish. This usually takes about 30 min depending on the size of the piece. The shelflife of fried products is 7 days.

Swimbladders of Nile perch are collected, cleaned and dried; this is usually done by women. These women also boil the fat from the Nile perch and sell the oil at KSh 70/litre. The swimbladders are sold at KSh 100/kg.

Small quantities of frozen Nile perch are transported fresh or frozen by air to the city of Dar-es-Salaam. The Railways Corporation has refrigerated wagons which occasionally transport the fish to the city.

4. MARKETING

Marketing of Nile perch is solely in the hands of small-scale traders except for one commercial company, the Victoria Products Company, which owns 4 trawlers. The Company transports fresh fish to the city. Filleting and canning of Nile perch are also being considered by this company for export purposes. A filleting and canning company is being established in Musoma; first trials have given good results.

The smoked and fried products are being transported either by the processors themselves or by traders to different parts of the country. Some dried fish are taken to neighbouring countries by trucks and buses. Packing is very poor. An improvement on the present packing techniques is preferred to allow maximum ventilation. Woven baskets covered by dry grasses are commonly used.

5. CONSTRAINTS

During the rainy season, marketing and transporting fish are serious set-backs due to the very bad condition of the roads. Further, the constant use of firewood as a source of fuel is making the lake area barren. Other sources of energy should be explored. Despite the problems encountered during the rainy season the different groups involved in the Nile perch fishery have adapted quite successfully. The stock is exploited sufficiently and there is little post-harvest loss (except during the rainy season); consumers have changed their feeding habits; and now most people eat Nile perch. Nile perch is presently being distributed to almost all parts of Tanzania enabling most Tanzanians to utilize this precious protein. Above all it has provided employment to many people in the lake area.

Currently there is a project to be carried out in collaboration between TAFIRI and ODNRI (UK) to look into the possibility of increasing the shelflife of processed fish by treating it with insecticide to stop infestation by *Dermestes* beetle.

SPOILAGE OF NILE PERCH AT TEMPERATURES AROUND $0^{o}C$

by

L. Gram

ABSTRACT

The sensoric, microbiological and chemical changes occurring during storage of Nile perch in ice were studied. Trials were carried out with trawled fish. Fish caught by gillnet were iced upon landing. Two trials were also conducted where fish were inoculated with psychrotrophic spoilage bacteria at a level of 10^5-10^6 CFU/cm^2.

Trawled fish iced after 0, 3 and 6 h at ambient temperatures remained first quality for 2-3 weeks and were considered acceptable for 30 days. Fish iced after 9 h at ambient temperature were of second quality and stayed at this level for 2 weeks. Fish kept for 12 h at ambient temperature were found to be spoiled, and icing did not improve the quality.

The fish caught by gillnet maintained first quality for 2 weeks and were rejected after 27 days of storage. Fillets prepared from the same fish were unacceptable for human consumption after 22 days.

Inoculation with spoilage bacteria shortened the shelflife significantly to 14-15 days and care must therefore be taken to ensure hygienic handling of Nile perch in all steps, also when icing is applied.

Initial bacterial levels, 10^3-10^6 CFU/cm^2 decreased 10-100 times during the first days of iced storage and rose slowly during storage to 10^9 CFU/cm^2 when the fish spoilt. Hydrogen sulphide producing bacteria constituted only 0.1-1% of the total flora throughout storage and were not found to be responsible for the spoilage. During iced storage, the initial H_2S producing bacteria,

Aeromonas, disappeared and a new group, Shewanella putrefaciens, evolved as black colonies on iron agar. These were, however, not found to be responsible for the spoilage, since the offensive off-odours typical of spoiling iced Nile perch were caused by growth of Pseudomonas sp. They did not show significantly on the media used and could therefore not easily be counted.

1. INTRODUCTION

The iced storage life of tropical fish has been investigated in several studies, and prolonged storage life has often been reported compared to that of fish from temperate waters (Poulter et al., 1981) The most widely accepted theory accounting for this is the lower number of psychrotrophic (potential) spoilage bacteria found on tropical fish compared with fish from colder waters (Shewan, 1977).

The present study was undertaken to determine the storage life of Nile perch and the effect on this of a high level of psychrotrophic bacteria. Since most Nile perch are landed by canoes that do not carry ice, the storage life of newly landed fish caught by gillnet was studied. Also fish iced after certain storage periods at ambient temperature (3, 6, 9 and 12 h) were investigated.

2. QUALITY CHANGES DURING STORAGE OF NILE PERCH KEPT IN ICE

One trial was carried out in May-June 1987 with fish bought at Wichlum Beach. The fish were selected as fresh as possible upon landing and it was estimated that they had been caught 6-7 h earlier. Half of the fish were filleted, placed in open plastic bags and iced. Half of the whole fish and half of the fillets were inoculated with 2 strains of psychrotrophic spoilage bacteria (Pseudomonas sp.) isolated from iced spoiled tropical fish.

Trials carried out in February 1988 used trawled fish caught by the OMENA on 4 February. Two lots of fish, 1/2-1 kg and 3-5 kg, respectively, were iced immediately after catch and a number of fish were stored at ambient temperature (approximately 30°C) for 3, 6, 9 and 12 h before icing.

During all storage trials, samples were removed 1-2 times per week for sensoric, microbiological and chemical analysis (see Chapter 2 "Spoilage of Nile perch at ambient temperature").

2.1 SENSORIC CHANGES

Whole fish bought at Wichlum, fillets from these and trawled fish iced after 0, 3 and 6 h at ambient temperature showed almost identical sensoric changes as storage progressed. Appendix 2 shows the various stages. No off-odours or off-flavours were detectable during the first 2-3 weeks of storage, whereafter light rotten, sulphide odours developed. These grew more pronounced when the limit of acceptability was passed after 22-30 days. Fillets kept for the shortest time, 22 days, whole fish from Wichlum, 27 days, and trawled fish slightly longer, namely 28 and 30 days for small and large specimens, respectively. After 9 h at ambient temperature light off-odours and off-flavours had developed. ~~Sufficient~~ icing, however, arrested spoilage and the fish remained as second quality for 15 days. Unfortunately, not enough fish were kept for this storage trial and the exact shelflife has therefore not been determined. The fish kept for 12 h at ambient temperature had passed the point of rejection and no improvement was seen following icing.

The samples contaminated with psychrotrophic Pseudomonas sp. deteriorated rapidly compared to non-contaminated samples. The sensoric changes were found to be alike, but occurred earlier in the contaminated fish samples. Their shelflife was 14 and 15 days for fillets and whole fish, respectively.

An outline of the trials and the various storage lives is shown in Table 1. Figure 1 shows an example of the sensoric as well as the microbiological and chemical changes during iced storage of Nile perch.

Table 1

STORAGE LIFE OF NILE PERCH AT TEMPERATURES AROUND $0^{o}C$; DEPENDENT ON SIZE, BACTERIAL LOAD AND METHOD OF CATCH

Sample	Fish size (kg)	Hours at ambient temp.	Iced storage life (days)	Date	Catch	Inoculation
Whole fish	1/2-1	0	28	4.2.88	trawl	-
Whole fish	3-5	0	30	4.2.88	trawl	-
Whole fish	3-5	3	30	4.2.88	trawl	-
Whole fish	3-5	6	30	4.2.88	trawl	-
Whole fish	3-5	9	>15	4.2.88	trawl	-
Whole fish	3-5	12	--	4.2.88	trawl	-
Whole fish	3-5	6-7	27	7.5.87	gillnet	-
Fillet	3-5	6-7	22	7.5.87	gillnet	-
Whole fish	3-5	6-7	15	7.5.87	gillnet	+
Fillet	3-5	6-7	14	7.5.87	gillnet	+

2.2 MICROBIOLOGICAL CHANGES

The initial level of bacteria varied between 10^3 and 10^6 CFU/cm^2 where the number of H_2S-producing organisms ranged from 10 to 10^5 CFU/cm^2. The highest counts were found on fish kept at ambient temperature before icing, and the cooling resulted in a 10-100fold decrease in the bacterial level. After a week, a slow rise was seen during the rest of the storage period. The number of black colonies rose parallel to the total count, constituting

0.1-1% during the whole storage period. When the fish was spoiled, TVC had reached a level of 10^9-10^{10} CFU/cm^2. The initially sterile flesh was invaded after 2-3 weeks of storage and this coincided with the sensoric detection of off-odours and off-flavours. As reported by Gram in Chapter 2, Spoilage of Nile perch at Ambient Temperature Aeromonas sp. were appearing as black colonies on iron agar when analysing fish stored at ambient temperature. Icing, however, eliminated these and a tentative identification of bacteria from black colonies appearing after 2, 3 and 4 weeks in ice found these to be Shewanella putrefaciens (formerly: Alteromonas putrefaciens). This bacteria, which is the main spoilage bacteria of fish from temperate waters was, however, not of much importance in the iced spoilage of Nile perch. Investigation of bacterial cultures at the Technical Laboratory, Denmark, showed that a number of bacteria growing as white colonies (non-H_2S-producing bacteria) were producing the off-odours typical of spoilage. They were identified as Pseudomonas sp. and did not differ in appearance on the iron agar from non-spoilage bacteria.

2.3 CHEMICAL CHANGES

Very little change was observed in the amount of Total Volatile Bases (TVB) during iced storage. From the initial 13 mg N/100 g the figure rose to 14-24 mg N/100 g in the spoiled flesh.

Analysis for TMA and TMAO carried out at the Technical Laboratory, Denmark, showed no significant change in either of the two.

The pH which was measured throughout storage varied between 6.4 and 7.3 but no constant trend was observed. It was noted that the pH of smaller fish (1/2-1 kg) was mostly higher than in larger fish (3-5 kg) stored for the same period.

3. DISCUSSION AND CONCLUSIONS

Nile perch kept approximately 4 weeks when stored in ice. This is much longer than reported by Mlay et al. (1982), who found a storage life of 13 days. The findings of this study are thus in agreement with other results where fish from warm water have kept very well when iced.

Icing after storage at ambient temperature brought the ongoing spoilage to a halt, if the fish had not already passed the limit of acceptability. Thus, if sufficient ice is used, even second quality fish can be distributed over longer distances.

Fish caught by gillnet were acceptable for a slightly shorter period than trawled fish which had also been kept at ambient temperature. This may be due to the rough handling of gillnet - caught fish compared to trawled fish, and/or to an underestimation of the time spent at ambient temperature.

The shelflife of fillets was significantly lower than of similar whole fish, indicating that the skin offers some protection against spoilage bacteria and their enzymes during iced storage. This effect was, however, not seen when the initial level of spoilage bacteria was high, since contaminated fillets and whole fish spoiled at the same rate. Since contamination drastically reduced storage life, it is recommended that care is taken to handle Nile perch under strict hygienic conditions, also when iced.

It is interesting to note that even though TMAO was found in extremely high levels (for a freshwater fish species), this molecule was not reduced during storage. It is not possible from these trials to conclude why the Shewanella putrefaciens, which normally reduce TMAO to TMA, did not participate in the spoilage.

Even though a number of general conclusions regarding iced storage life of Nile perch can be drawn on this basis, it is urged that further work is done to investigate the behaviour of the spoilage bacteria and the significance of TMAO in a tropical freshwater fish.

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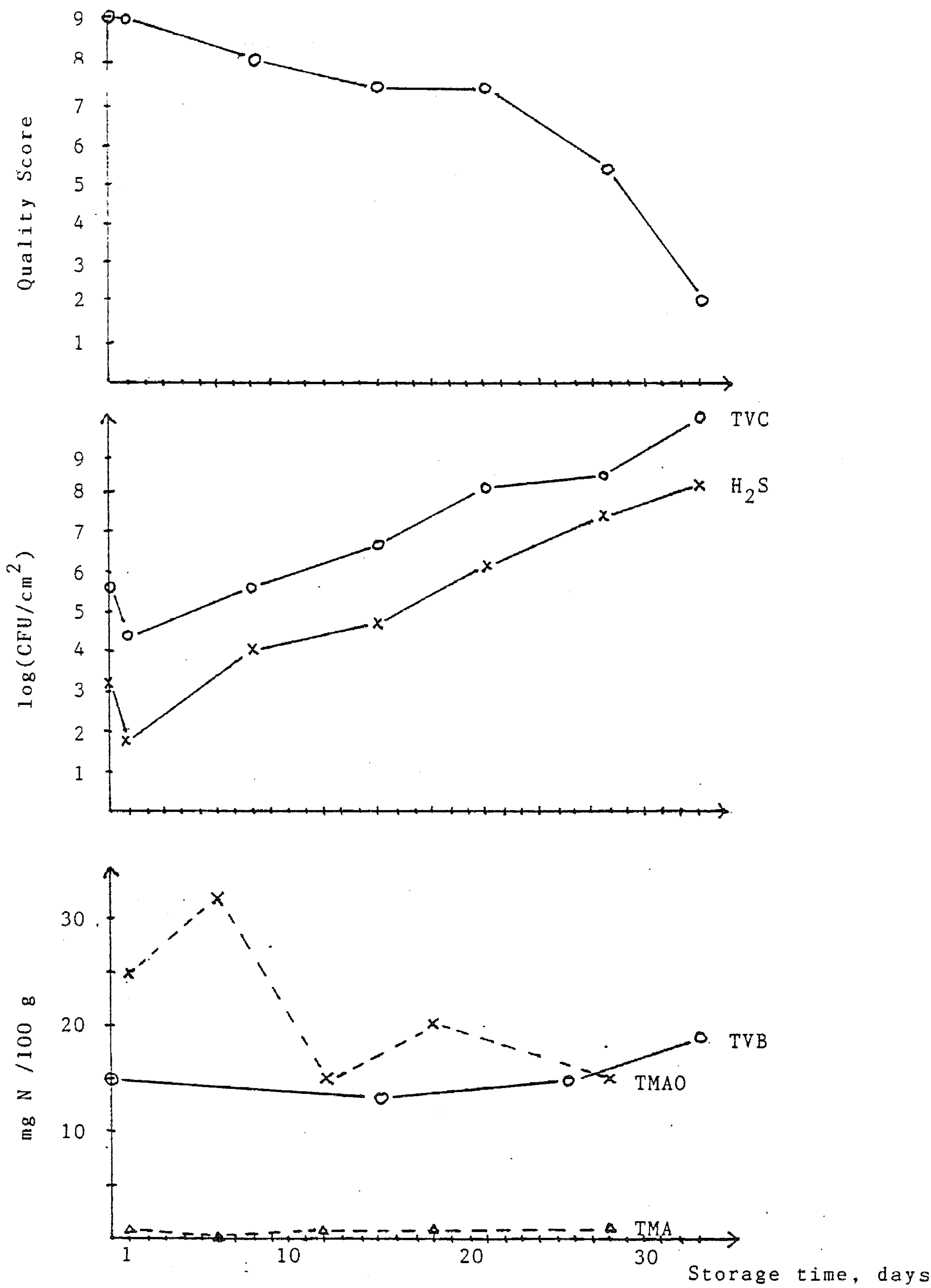

Fig. 1 Quality changes during storage of Nile perch at temperatures around 0°C. Sensoric, microbiological and chemical changes shown as function of storage time

Appendix 1

Quality Assessment of Nile Perch Stored at $0^{o}C$ (Iced)

Denomination	Outer appearance					Grade	Score
	Skin	Gill-colour	Gill-odour	Eyes	Texture		
Freshness allowing distribution nation-wide, if kept in ice	Natural brilliance, metallic, golden, pink-silver Scales firmly attached	Red, purple, maroon, no slime	Fresh, seaweeds	Transparent, yellow sheen, convex	Firm, elastic	First quality	9 8
	Brilliance, few dull patches, darkening scales, firm	Reddish, bleached patches slime	Neutral, light sour	Reddish, yellow sheen	Firm, reduced elasticity		7 6
Reduced freshness allowing for regional distribution or local distribution if kept in ice	Dull, few metallic patches, dark on dorsal side, yellow streaks on belly area, scales loose at belly area	Reddish with brown, bleached patches slime	Light stinky slightly rotten, sour	Red, turbid, flat	Soft, reduced elasticity	Second quality	5 4
				BORDER LINE OF ACCEPTABILITY			
Insufficient freshness, as such unfit for human consumption. Sometimes suitable for immediate consumption after frying.	Dull, dark, yellow slime, scales loose	Reddish, brown, thick slime	Rotten, stinky, sulphur	Red, bloody, concave	Very soft, finger-prints leave impressions	Rejectable	3 2 1

Quality Assessment of Nile Perch (Cooked) Stored at $0^{o}C$ (Iced)

Odour	Flavour	Texture	Colour	Grade	Score
Typical of Nile perch, fresh, broth-like, steamed vegetables	Typical of Nile Perch, cooked cassava or sweet potatoes, creamy	Succulent, firm, elastic, easy to swallow	Ivory-like, white, clear	First quality	9 8
Weak, fresh	Weak broth	Succulent at first then light mealy	White		7
Neutral	Neutral, sweetish				6
Light off-odour, sour, muddy	Lightly rotten	Soft, mealy	White-greyish	Second quality	5 4
Rotten cabbage, sour	rotten, sour mouldy	Very soft, like butter	greyish, dark meat	Rejectable	3 2 1

PRODUCT AND BY-PRODUCT DEVELOPMENT FROM NILE PERCH
(A summary table)

by

J. Bon and J. Ogunja

SMOKED PRODUCTS

Processing Method	Hot Smoking	Cold Smoking (smoke drying)		
Raw material	fillet (skin-on)	fillet (skin-off)		
Dressing method (1)	trimming	trimming		
Salting	brine (10%)	dry salt		
Duration	short (1 h)	long (overnight)		
Removal of salt	rinsing	soaking, scraping		
Dressing (2)	-	slicing (thin) slicing (thick)		
Further treatment	-	colour bath soaking, colour bath		
Drying	short (1 h)	long (24 h)	medium (4-5 h)	
Temperature	30°C	30°C	30°C	
Smoking (cold)	short (1 h)	short (2 h)	short (1 h)	very short
Temperature	45°C	50°C	40°C	35°C
Smoking (hot)	2 h	--	--	--
Temperature	65°C	--	--	--
Total time in kiln	4 h	26 h	5 h	1 h
Weight loss (%)	12%	23%	20% (est.)	15% (est.)
Keeping time				
in freezer	1 month	1 month	several months	
in fridge	1 week	3 days	2 weeks	
Character	cooked, juicy product, ready for consumption as cold or hot starter or main dish	salt-cured product, to be cut into thin transparent slices, as cold starter (salmon-style)	meat analogue snacks, with varying salt content	
Price range	KSh 25-30/kg	KSh 100/kg		

Kisumu, 28 March 1988

FISH FEED BASED ON SILAGE OF NILE PERCH SKELETON AND AZOLLA WATERPLANT

by

P.B.O. Ochumba, J.O. Manyala and J.O. Achuku

ABSTRACT

Since dairy meal is becoming increasingly expensive in Kenya and threatens the fish rearing industry, a systematic study was initiated on the possibility of using aquatic plants and Nile perch silage. The water plants, *Azolla niloticus*, *Lemna perpusilla* and *Pistia striatotis* were tested as a fishmeal for *Tilapia zillii* and riverine fishes. Low growth rates were achieved in the tilapias. The value of the *Azolla* protein in fish diet is discussed in relation to dietary requirement in cultured fish. This study demonstrates that the water plant *Azolla niloticus* together with Nile perch silage as a supplement can be used as a complete diet for cultured fish. It is hoped that the project will help provide detailed information on the nutritional value of the water plant *Azolla niloticus* and its long-term susceptibility to various inclusions as a complete feed, and conduct least cost feed formulations to make recommendations as to the maximum inclusion levels.

1. INTRODUCTION

The dominance of expensive dairy meal as feed for tilapia and cultivated fish has challenged fish nutritionists for many years. Successful replacement by other protein feeds have been reported mostly of animal origin: milk, meat, krill (Visla *et al.*, 1982). Since dairy meal is becoming increasingly expensive in Kenya and threatens the whole fish-growing industry a systematic study was initiated on the possibility of using the aquatic plants *Azolla niloticus* Decne and *Lemna perpusilla* Torrey mixed with Nile perch (*Lates niloticus*) silage and rice bran. It is hoped to develop through the project studies a suitable feed that can be used either as a supplementary diet in fishponds or as a complete diet in tanks based on *Azolla niloticus*.

The waterfern *Azolla niloticus* belongs to the family of Salviniales and is mainly of interest for its nitrogen-fixation, green manure and hydrogen-producing qualities (Ashton and Walmsley, 1984). The geographic distribution of the plant are the upper reaches of the Nile to Sudan, Congo, Malawi, Mozambique, Tanzania, Uganda, Zaire, and Zambia (Demalsy, 1953; Wild, 1961; Reed, 1965 and Kornas 1974). This study reports its presence in the sheltered bays and backwaters of the Sondu-Miriu River where they are protected from wind and wave action. The maximum density of *Azolla* layer is subject to considerable variation. Gopal (1967) reported a maximum yield of 37.8 t/ha freshweight containing 2.78 t dryweight in a temporary pond.

Azolla can double its biomass in 3-5 days (Lumpkin and Plucknett, 1980). The use of silty water is recommended to reduce dependence on fertilizers for *Azolla*. Trials are repeated using the plant together with rice bran and the potential use of Nile perch silage mixture.

2. MATERIALS AND METHODS

The waterplant fern *Azolla niloticus* was collected from the Sondu-Miriu River and grown at the Sangoro Riverine Laboratory (70 km from Kisumu) in concrete lined earthen ponds (11.45 x 26.4 m, ca 302.28 m^2, depth 1.1 m). The substratum was fresh-water organic mud of clay/silt. Harvesting was done on a weekly basis using a beach seine. The harvested waterplants were sun-dried and weighed by a spring balance. Seed plant of 25 g dry weight in z was fixed in a constant area of 60 m^2 (1.5 kg dryweight seed plant). Daily growth observations were made for a period of 8 months from June 1987 to February 1988. Yields are given in kilogramme dryweight. Temperature was measured with mercury in a glass thermometer.

The dried *Azolla* plant was ground and made into pellets using a multi-purpose food processing unit (Muller-Saarbrucken) fitted with a mixer, mincer and cutter. The feeding experiments were performed in large asbestos tanks (152 x 92 x 49 cm^2) filled with river water. Each tank was stocked with 100 fry of Tilapia zillii of average size 1.7 cm. A mixture of ground Azolla and rice bran in the proportion 1:1 was also tested separately from Azolla and rice bran.

The experimental fish were fed 3% of the equivalent body weight with the tested feed three times per day. Half the volume of water in the tanks were replaced with fresh river water every three days. Freshwater was introduced into the experimental tanks on a weekly basis when six experimental fish were sampled at random. Individual standard lengths to the nearest 0.1 cm were recorded. Records were maintained of daily food intake and mortality. A series of trials of the Azolla feed on other riverine fishes: Barbus, Labeo, Clarias and Schilbe were also carried out.

3. RESULTS

The mean growth of Azolla during the experimental period was 3.4 g dryweight m^{-2} day^{-1} (range 3.0-4.7) (Figure 1). The monthly Azolla production and temperature variation are shown in Figure 2. The Azolla production varied from a minimum of 6.6 kg dryweight day^{-1} in July 1987 to a maximum of 9.9 kg dryweight day^{-1} in October 1987. Temperature variation followed a similar pattern as that of the Azolla (range 2^{o}-$28^{o}C$)

In feeding trials with the experimental feeds, it was found that Tilapia consumed Lemna and Azolla first when these plants were provided in combination with Pistia. The overall growth rates of experimental fish showed that fish fed on a mixture of Azolla and rice bran grew slightly (20.7%) faster than those fed on Azolla alone (19%) and those fed on rice bran alone(14.5%/day) (Figure 3). The decline in growth rate could be due to the low digestability of plant proteins. The chemical composition of the whole dried and ground Azolla is shown in Table 1. The mature riverine fishes kept at the Laboratory are given only Azolla feed.

4. DISCUSSION

There was a sustained production of Azolla to feed Tilapia fingerlings of 3 cm and above at the rate of 3% bodyweight (15-30 g). At the minimum rate of production of 3 g dryweight m^{-2} day^{-1}, the total daily production for an area of 302 m^2 is 906 g. This amount of Azolla could feed 100 fingerlings of Tilapia per day.

At a maximum production of 4.7 g dryweight m^{-2} day^{-1}, this would amount to 1 420 g dryweight which could feed 160 *Tilapia* fingerlings/day with a daily consumption per fingerling of 9 g. The most favourable temperature for *Azolla* growth is between 20° and 30°C. The experimental results indicate that *Azolla* and rice bran can be useful as a complete feed for herbivorous fish. The locally cheap available Nile perch skeleton silage was added and tested, and was found to form a complete diet.

The low growth rates achieved in the trial experiments could be due to anti-nutritional factors that could be improved by a supplement such as Nile perch silage. Fish silage as a nutritional supplement can minimize any negative attribute from the plant *Azolla*. Extensive incorporation of plant proteins in cultured fish diets may be desirable since they are less expensive and more available.

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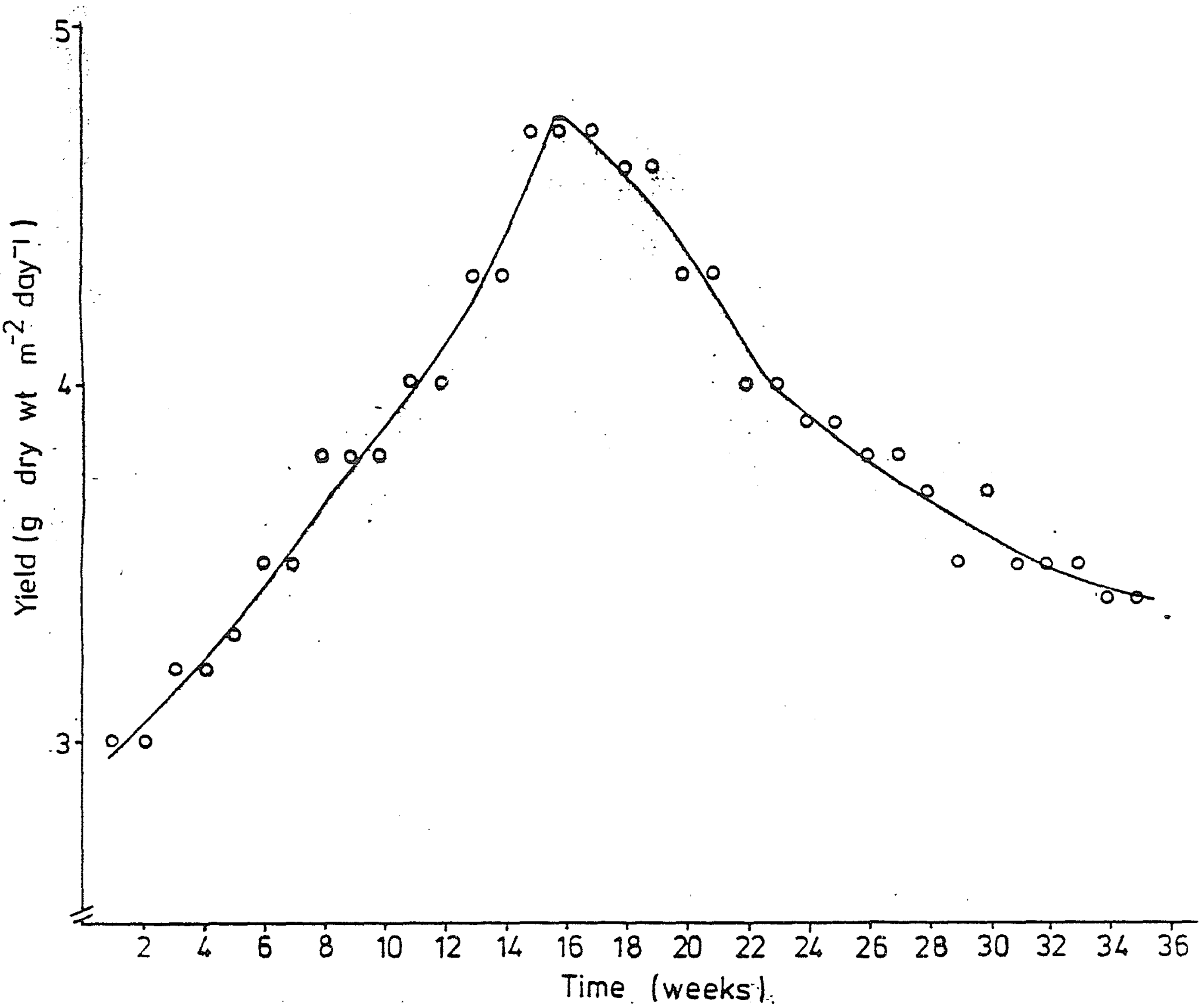

Fig. 1 Production of <u>Azolla</u> in g dryweight m^{-2} day^{-1}

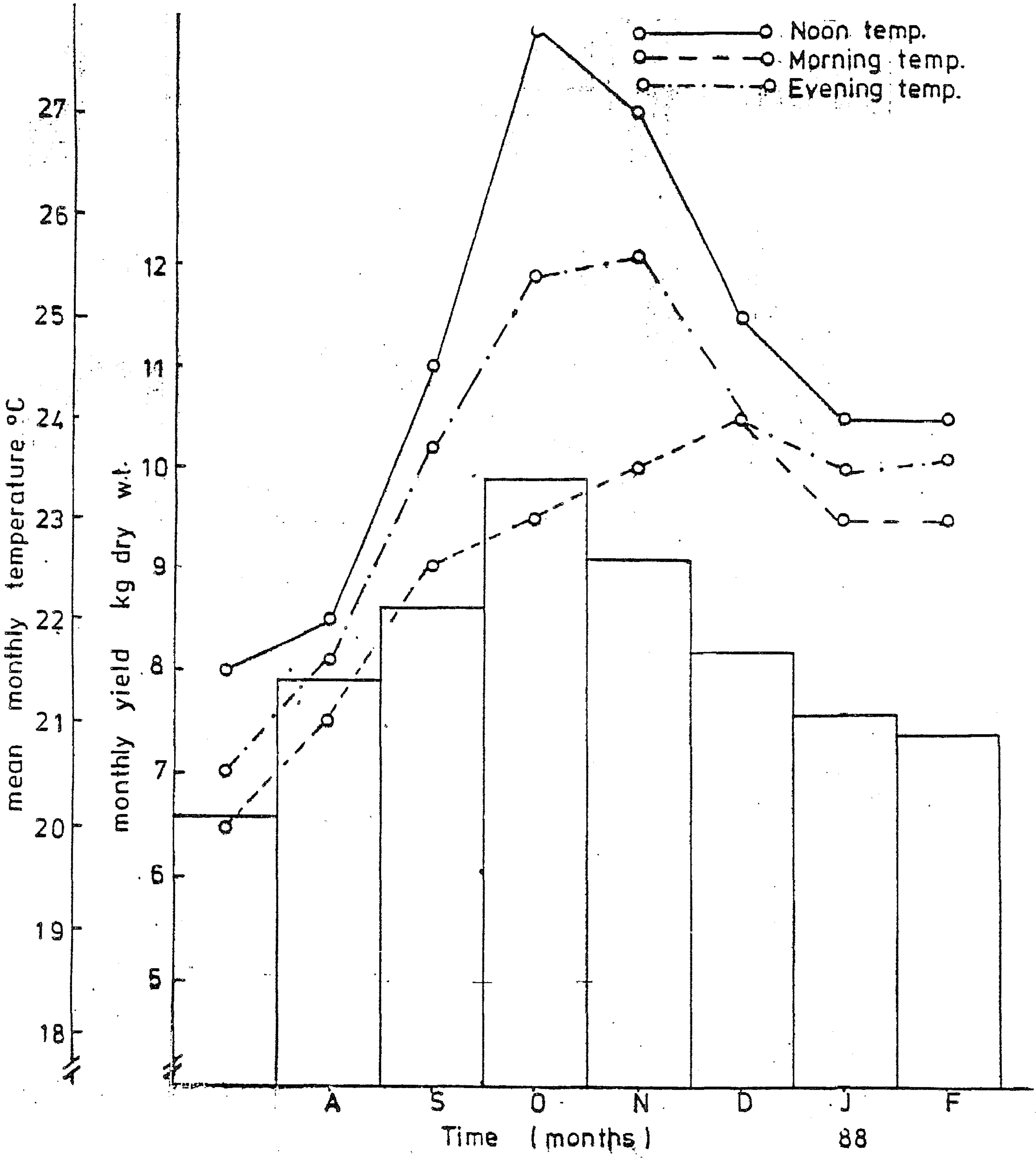

Fig. 2 Variations in monthly yield of Azolla and monthly variations in temperature

GROWTH PATTERN OF TILAPIA ZILLII ON THREE FEED COMPOSITIONS

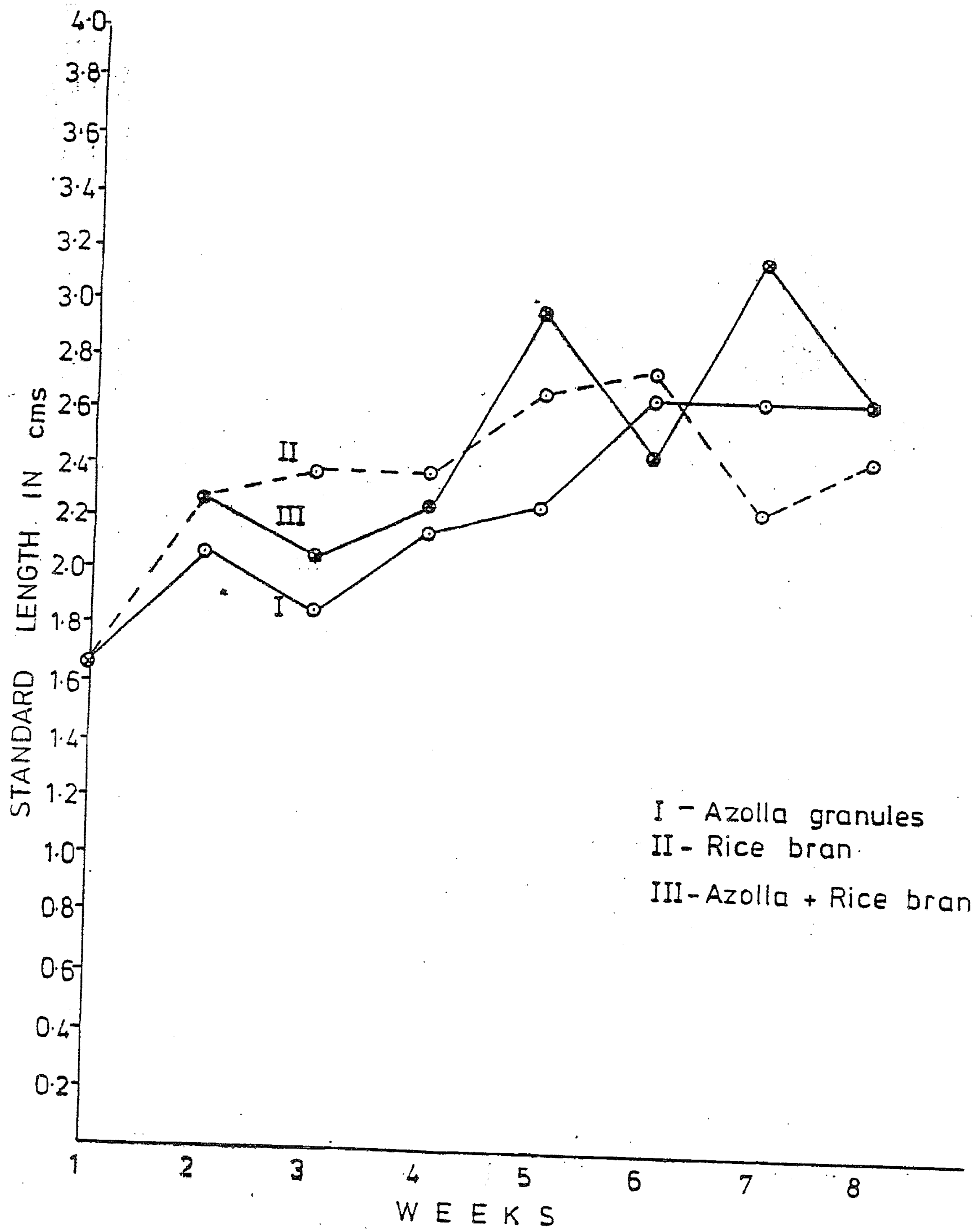

Fig. 3 Growth rules of *Tilapia zillii* on three experimented feed compositions

Table 1

CHEMICAL COMPOSITION OF AZOLLA NILOTICUS
MIXED WITH RICE BRAN

	Azolla niloticus	Rice bran
Protein	19.1%	12.5%
Carbohydrate	3.2%	
Fibre	7.2%	16%
Fat	4.0%	1.3%

PROCESSING OF FISH SKINS INTO LEATHER AND LEATHER PRODUCTS

by

J.M. Muriuki

ABSTRACT

After being soaked the skins are limed using hydrated lime and sodium sulphide in order to loosen and split the fibres as well as to remove the scales.

Further loosening of the fibres is carried out with ammonium salts, in bating by use of enzymetic bates followed by pickling in acid and brine solution.

A simple-bath chrome tannage or replacing syntan tannage is given until a reasonable shrinkage temperature or thermal stability is attained.

The tanned pelts are then fat liquored, dyed, staked, made into a crust and then finished into any fashion required. The fully finished leather can be made into classic shoes, belts, wallets, bags, etc. According to further laboratory investigations the fish leathers (mbuta) were found to possess higher durability and elastic properties than those from bovine hides or skins.

1. INTRODUCTION

Fish skins are by-products of filleting industries as cattle hides and goat/sheep skins are by-products of meat industries.

In a country like Kenya with a plentiful supply of Nile perch, there is a massive waste of skins where after filleting they are normally thrown away or fed to animals, e.g., pigs.

It was due to this realization that the Kenya Industrial Research and Development Institute (KIRDI) in collaboaration with the Kenya Marine and Fisheries Research Institute (KMFRI) initiated and embarked on this particular project aimed at proper utilization of wasted skins. Various experiments on processing had been carried out by KIRDI Leather Section on both laboratory and pilot scales. Most of the experiments whose techniques are available were based on the conventional leather tannage with a few modifications to suit the unique properties of the fish skins.

The availability of the Nile perch skins is promising but the quality is doubtful due to the fact that it is a waste product and hence there are no proper handling and preservation methods. It will be recommended that while KIRDI tries to establish the best processing method with least environmental pollution, least costly and easily adaptable, KMFRI should work on the best flaying and preservation methods, as a good leather of high quality can only be made from a raw material of high quality.

This would require a greater cooperation and coordination not only between the two institutes but also with other interested agencies like FAO and UNIDO whose support in any form (financial or technical) is valuable to a national project of this calibre. As it will be noted from the project proposal, most of the objectives have been accomplished especially the technical aspects, apart from a few improvements which are required and are being worked on.

Different fashionable leathers and articles had been made although with a few constraints due to lack of proper equipment and literature. It should be noted that very little is known about where fish skins are being tanned into leather and efforts to obtain information even from the reputable chemical manufacturers and journals has been unsuccessful. Therefore, this work is based purely on laboratory and pilot trials and discussions with other leather experts.

2. TANNING

2.1 INTRODUCTION

Generally tanning is the essential step of leather manufacturing but various preliminary cleaning processes are required to separate collagen protein fibres from other proteins not used in leather-making.

Non-collagenous or loose proteins are removed by soaking and liming while connective tissues are mechanically removed by fleshing. The interstitial proteins are extracted by bating with proteolytic enzymes at a controlled pH and temperature. The cleaned skin material nearly pure collagen is pickled to adjust the pH and then tanned using the appropriate tanning materials.

The tanned collagen or pelt is chemically and thermally stable and of higher resistance to micro-organisms as compared to pure or raw skin. The process of tanning varies depending on the nature of the skin or hide and the destination of the finished leather.

The fish skin differs from goat or sheep skin in that its corium is made up of loose interwoven fibres forming layers.

This will require some modifications in normal conventional tannage especially in liming as it is difficult to split this type of fibre. Also made difficult by the nature of fibres is later work of shaving, staking and buffing.

<u>Conventional Chrome Tannage</u>

Soaking Liming Removal of scales	Fleshing	Deliming Bating Pickling Degreasing Bleaching Tanning	Retanning Fat liquoring Dyeing (Crusting)	Staking Buffing Finishing

2.2 SOAKING

The objective of soaking is first to remove dirt and curing salts and second to reverse the water content of the pelt to a level close to that in the flayed skin.

First soaking was done with little mechanical agitation unlike the second soaking. Sodium sulphide was added as a sharpener together with detergents and preservatives. The detergents help to remove the fat as well as the strong fish smell concentrated in the fatty tissues.

2.3 LIMING

In the liming the fibres are split, some loose proteins are removed or dissolved and eventually the skins are swollen. As the fish skins have dense interwoven fibrestructure which feels like plastic stronger liming is required. In this case a higher percentage of lime and a little sodium hydroxide were added and allowed to run for about three days.

After liming and washing the swollen pelts were re-fleshed and the remaining loose scales which remained after soaking and liming were scraped off.

Fresh skin scales are easily removed during soaking. Drying has other disadvantages with regard to the quality of the leather as the fats become oxidized and become fixed on the fibres, and complicate subsequent processing, such as tanning.

2.4 DELIMING/BATING

After fleshing the pelts are delimed to a pH of about 8.5 by the use of ammonium salts which also act as a buffer. Sodium bisulphite which has a bleaching action particularly on sulphide stains and other pigments is recommended.

Complete deliming is ensured by making a clean cut in the skin and checking the pH, in the case where ammonium salts are used the pH is around 8.0. Bating is then carried out after deliming in the same bath using enzymatic bating agents which attack the hide substance partially, opening it up for ensuing tannage. In the bating further removal of interfibre proteins takes place, the pelts become very soft with supple feel and show thumb prints.

Longer bating is desirable in the case of fish skins where about 1% of the bate is used and allowed to run for about 1 h to ensure complete fibre splitting as in the case of liming.

2.5 PICKLING

The main objective of pickling is to adjust the pH suitable for a particular tannage and modify the fibrestructure. Pickling was carried out by use of sulphuric acid, formic acid and sodium chloride where the salt is used to suppress the acid plumping.

The pH is lowered from 8.5 to 2.5 which is suitable for chrome tannage where the pelt becomes cationic. It has a lower pH and the chrome penetrates without fixing on the surface. The addition of formic acid introduces formate ion; this produces a masking effect which assists the penetration of chrome.

2.6 TANNING EXPERIMENTS

Various tannages were introduced in the trial experiments which ranged from chrome, alum mimosa, formaldehyde and syntan. The chrome tanned leathers were found to have a higher shrinkage temperature (thermally stable) but hard and empty. For that reason mimosa, a vegetable tanning, was therefore incorporated to improve the emptiness.

Syntan/chrome combined tannage was introduced and also the use of replacement syntans which resulted in soft light coloured leathers. Chrome retanned leathers with mimosa and syntans were found to be of better quality.

After tanning the leathers were retanned, degreased, dyed and then fat-liquored. Details of each experiment are available in the KIRDI Library. Complete degreasing is necessary as the presence of natural fat makes finishing difficult and results in leathers which feel greasy. Paraffin degreasing is recommended if facilities are available although warm aqueous degreasing proved to be sufficient.

2.7 FINISHING

The main objective of finishing is to protect the leather from mechanical damage, moisture, dirt and to obtain the desired fashionable appearance. It also levels out uneven drum dyeing and gives the leathers a particular feel. In the case of fish skins the grain side is not even or uniform due to scale pockets which make finishing more difficult than with other leathers.

Due to this, various experiments were carried out without much success. In the initial experiments the scale flaps were trimmed which involved a lot of work and also affected the natural fish look or scale pattern. Instead of trimming, slight buffing on the grain side was carried out where some of the loose flaps were removed and others aligned in a pattern, making the grain side more uniform. In the normal pigment the finishing scale pockets are not sealed and the patterns are easily interrupted as the flaps are not bound firmly onto the leather.

In later development work the leathers were impregnated with a binder on the grain side in order to seal the pockets, plated and then finished. Liquid dyes were used in the first coat, soft and medium resins in the second, and then the lacquer, followed by a kiss plating. This type of finish popularly known as aniline finish is recommended in this case as it is translucent and does not hide or cover the scale pattern which is the required fashion.

3. JUSTIFICATIONS

Processing of fish skins into leather is a new development not only in Kenya but throughout the world. Now that reptile skins are rare due to the protection of wild animals from being killed, fish skin leather can now be taken as an alternative.

Fish are in plentiful supply; they are a valuable source of human food and their skins a useful by-product. Apart from acting as a substitute for reptile skins in the world market, fish leather can be used like any other leather product to meet the high demand in the shoe and leather goods industries. At present the world supply of cattle hides and goat/sheep skins is insufficient and susceptible to climatic and seasonal changes.

During or after the drought seasons, there is a shortage of animals for slaughter and hence a low supply of hides and skins. At such times, fish skins and leather can maintain the market demand.

From laboratory investigations, leathers made from Nile perch weighing above 30 kg was found to possess higher tensile strength than that of cattle hide. Due to this high strength, Nile perch leather produces a better industrial leather if properly processed.

Articles made from these experimental leathers attracted many visitors at the Nairobi international show, and all of them were sold.

There are many justifications which demand further exploration and at this stage when economic survey and study are still underway, the viability of the project is predictable. The fact that the project aims at utilization of wastes (skins) making them into useful commercial products and at the same time reducing environmental pollution are the major factors to consider.

BACTERIOLOGICAL QUALITY CONTROL OF FISH FILLETING PLANTS

by

J.O. Oundo

1. INTRODUCTION

In the last few years, in Kenya the demand for fish fillets has risen substantially both locally and for export; and there has been a considerable increase in the number of fish processing plants in the country. The main freshwater fish filleted is the Nile perch, *Lates niloticus*.

The target market for the fish fillets are the affluent consumers who are discerning and ready to pay a good price for a good product. As fish is a highly perishable commodity a quality control service should be established to monitor the quality of the products of these plants to ensure that the final product meets the required standards set out by the International Committee on Microbial Safety of Food (ICMSF) and also meets the requirements of the importing countries.

This paper discusses some of the methods which are used in quality control and which can be applied by the Kenya Marine and the Fisheries Research Institute Kisumu Laboratory.

2. QUALITY CONTROL

2.1 ASSESSMENT OF FISH QUALITY

The word quality is widely used and has many meanings. In the fishing industry the term "Quality Fish" is often related to expensive species or to fish size. The processor is interested in the yield and the profit he can obtain. He must therefore be concerned with all aspects of quality, including those required by Governmental bodies. The consumer is interested in the sensory appeal or eating quality of the fish and fishing products. On the other hand, Government authorities are responsible for fair trading practice and possible health hazards and thus are concerned with hygienic handling of fish and fish products at each stage of production, correct descriptions, labelling, weight and measures and the absence of harmful agents like parasites, chemicals or pathogenic micro-organisms.

2.2 QUALITY CONTROL BY CRITICAL POINTS

The quality of the end-product is dependent on the quality of the raw material, and inferior quality raw material will not result in a first grade end-product. The aim of quality control is to achieve as good and as consistent a standard of quality in the product being prepared as is compatible with the market for which the product is designed, and the price at which it will sell.

Since the end product of fish filleting products is aimed for the export market and the affluent local consumer, it thus follows that very high qualities have to be maintained throughout the production process.

In controlling the products of the filleting plants several critical points are selected which are the most likely danger spots. The first is to view the whole production line from the arrival of the truck with the fish up to the storage of the fillets in the blast freezers. The quality control procedures can be described under the following subheadings.

2.3 INSPECTION OF REFRIGERATED TRUCK

The vehicle used in bringing the fish to the plant is inspected for cleanliness, adequacy of ice and the temperature of the fish. The fish temperature should be as low as possible, ideally around 0^{o} Celsius. The delivery truck should also be very clean because it is this point which can determine the eventual quality of the products. If the truck is dirty then contamination is likely with subsequent lowering of quality or even total spoilage of the fish.

2.4 RAW MATERIAL

Once the fish has been unloaded from the truck, a sample is checked for microbiological quality. A check should also be carried out for presence of spoiled fish and if found these should be removed. The microbiological tests are done to determine the total bacterial count per gramme or centimetre square of fish or skin respectively.

2.5 PROCESSING

The accepted raw material is then washed in running tap water which should be of good microbiological quality. If the water is not of good quality then it can also be a source of contamination. The washing area should be cordoned off from the rest of the processing line.

During quality control inspection the quality of the water is checked visually for cleanliness, absence of coliforms and it is ensured that the wash basin is kept scrupulously clean. There should be a water flow-off drainage from the wash basin so that dirty water does not pool in the basin.

2.6 FILLETING TABLE

The next critical point in fish filleting plants is the filleting table. Ideally the table should be sloping towards the operator and with a spray of tap water to keep the table clean at all times. The total bacterial count is carried out on the table by swabbing during quality control inspection. The tables should be made of easily cleaned material, e.g., stainless steel plates. The workers at this table should not have open sores and the level of hygiene should be very high to prevent faecal contamination of the fillets.

2.7 TABLE FOR WASHING FILLETS

This table should be kept absolutely clean to prevent any bacterial contamination which could be introduced onto the fillets. It should be noted that the fillets obtained are sterile and should as far as possible be maintained so. To ensure that the products being passed at this stage are of the highest standard and that they are risk-free, a sample is taken of the fillets together with a swab of the table for microbiological analysis to determine the total bacterial count and the presence of coliforms which will give an indication of presence of pathogens. It is also at this stage of final sorting that the highest quality fillets are passed for packing and distribution to the consumers both local and for export.

The selected fillets are then washed in clean running tap-water and placed on a very clean wire rack on a table to allow the water to drain off. They are next packed in polyethylene bags and stacked in cardboard boxes for storage in the coldroom at freezing temperature of up to -20°C. The products are left in the coldroom until a consignment is ready for delivery to the distributors, consumers or exporters.

3. METHODS

Many methods have been proposed for assessing the various aspects of fish quality. Some of them have proved to be unsuitable for the purpose and others are only useful in very specific situations or for a limited number of fish species or products. The methods described below are some of the more important tests which are normally carried out and which can be done during the quality control inspection of fish filleting plants by the microbiology section of KMFRI Kisumu Laboratory.

3.1 ORGANOLEPTIC ASSESSMENT

The fish is initially checked for freshness by examining the texture, skin appearance, gill coloration, firmness of scales, odour and the absence of yellowish green mucus. These are the qualities which a consumer normally checks before buying or rejecting the fish because they are an indication of the state of freshness of the whole fish. The fish is then either accepted for further processing or rejected and not presented for filleting. A 3-grade system is used for this assessment where:

Grade 1: No spoilage evident

Grade 2: Signs of pronounced spoilage, acceptable

Grade 3: Signs of pronounced spoilage, rejected

Only grade-1 fish are used for filleting. The disadvantage of this method is that it is highly subjective, and determination of grade is variable depending on the person assessing.

3.3 MICROBIOLOGICAL METHODS

The aim of these examinations is to give an impression of the degree of freshness, the hygienic quality of the fish, the standard of hygiene during handling and processing, and the possible presence of bacteria or organisms of public health significance.

3.3.1 Standard Plate Count (SPC) and H_2S Producing Bacteria

The SPC is the number of organisms which develop into clearly visible colonies when the test is carried out under standard conditions and procedures. It gives a comparative measure of the overall degree of microbial proliferation and the hygiene applied during fish handling and processing.

The SPC count is done using iron agar which contains sodium thiosulphate, L-cysteine and ferric citrate. This means that the bacteria able to produce H_2S from sodium thiosulphate and/or L-cysteine form black colonies due to the formation of FeS. These bacteria are true spoilers of fish. Only small numbers of spoilers are normally found on fresh fish but the portion may increase during storage at low temperatures. Hydrogen sulphide producers are not spoilers of fish in ice but only at ambient temperatures. The level of SPC tolerated is between 10^4 and 10^6 bacteria/g of fish and this is the upper limit; anything above this number is not acceptable (Jay, 1978).

3.3.2 Coliform Bacteria

The International Committee on Microbial Safety of Food (ICMSF) (1974) recommends testing for the presence of *Escherichia coli* as an indicator of post-harvest contamination, particularly a contamination of faecal origin. This test is carried out violet red bile agar or MacConkey broth and confirmation by Eijkman test at 44°C using MacConkey broth. A limit of less than 100 *E. coli* per gramme of fish is recommended. Testing for *E. coli* is not used as an indicator of faecal contamination in frozen fish since *E. coli* are normally killed when the fish is frozen.

3.4 FAECAL STREPTOCOCCI

These are not normally found in fish from uncontaminated water, and their presence may, therefore, be regarded as an indicator of post-harvest contamination of faecal origin and general poor hygiene during handling and processing. Due to their high resistence to low temperatures, faecal Streptococci are useful as an indicator of organisms in frozen fish and fish products (Huss, 1986). They are detected using the CLED medium (Cysteine-Lactose-Electrolyte-Deficient medium) where they appear as yellow colonies about 0.5 mm in diameter. Most microbial standards recommend a limit of less than 100 faecal Streptococci per gramme of fish.

3.4.1 Staphylococcus

The number of Staphylococcus accepted in fish and fish products is 100/g of fish (Jay, 1978). The ICMSF gives a level of 1 000/g of fish as acceptable and a range of 2 000 as not acceptable. They are isolated by the use of Ludlum's medium where after 48 h incubation Staphylococcus aureus appears in dark grey or black shiny colonies and Staphylococcus albus appears in small pale colonies. For isolation of Staphylococcus 8% salt agar or milk agar are also used. S. aureus can cause food poisoning by the production of preformed enterotoxin or through the growth of enterotoxigenic strains in the intestinal track and conservably elsewhere in the body.

3.4.2 Salmonella

This bacteria should not be isolated in fish and fish products at all. Even the presence of one Salmonella colony is reason enough to condemn the fish or fish product as unsuitable and unsafe for human consumption (Baker and Breach, 1980). This organism is isolated using the selenite F (modified) broth or Salmonella Shigella agar (SS Agar). All microbial standards recommend the total absence of Salmonella in food.

4. RECOMMENDED MICROBIOLOGICAL LIMITS FOR FRESHWATER FISH

Test	Just accepted level	Not acceptable
1. SPC	10^4-10^6 g^{-1}	10^7 g^{-1}
2. Coliforms	4 g^{-1}	Over 10 g^{-1}
3. Staphylococcus	Less than 100 g^{-1}	10^3
4. Salmonella		

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FISH PROCESSING AND QUALITY CONTROL IN WESTERN KENYA

by

S.W. Nyagudi

1. INTRODUCTION

Nile perch is one of the most important fish species in Lake Victoria. In the past, consumer attitude was negative as it was a very large and fatty fish.

The Nile perch fishery is aimed at increasing the fishermen's income and promoting its consumption both locally, nationally and particularly internationally since it constitutes more than 70% of the total catch and is thus a valuable source of foreign exchange. Investors have consequently concentrated their activities on the processing of Nile perch fillets, and most of the fish processing industry is now directed at this production.

Handling of Nile perch along the beaches has been of low standard since the fishermen lack the necessary facilities. The fish processing industries are often situated in an urban area far from the landing beaches. The fishermen who cannot afford expensive equipment and infrastructure must rely on traditional techniques of sun-drying, frying and smoking. Improved post-harvest technology practices should be applied to produce fish of better quality, which should result in increased consumption of Nile perch and thus ensure higher incomes for the fishermen.

Reduction in post-harvest losses could be achieved through collaboration with cooperative societies. Government support is essential because the fishermen lack skill, capital and the facilities needed to develop adequate fish handling procedures.

2. FISH PROCESSING

In many parts of Kenya the problem of preserving fish rapidly and inexpensively still remains a major deterrent to fully utilizing local fisheries resources. With the lack of freezing and canning facilities, salting, drying and smoking still represent the most convenient if not the most satisfactory methods of preserving fish. A high percentage of salted or dried fish is lost either through decomposition or rodent and insect infestation. In humid conditions, smoked products of Nile perch and other fish are subject to losses incurred by insect and microbial attack. However, salted, dried and smoked fish are widely accepted and could make a valid contribution to food requirements if losses during the various stages of distribution could be reduced.

Along the Lake Victoria beaches, various traditional smoking kilns are constructed for the purpose of smoking; and the smoked product has a ready sale on the local markets.

Problems are encountered during and after processing. Heavy losses of dried fish occur through pest infestation at two stages:

- during drying
- during storage and transportation

Fresh fish with a high moisture content is subject to heavy blowfly infestation; Drosophilla and housefly larvae are normally found on fish. The occasional spraying of insecticides is being done inexpertly with harmful results to consumers. In the case of sun-dried fish, these are attacked by beetles during transportation, in storage and even at consumer level.

3. QUALITY CONTROL

Fish quality has been observed to be of acceptable standards at certain temperatures. Organoleptic assessment indicates that at 10°C fish can be stored for 3 months and can be acceptable for a further 9 months, and at 30°C the quality of the fish was maintained at a high level for at least 12 months.

Measurement of peroxide values should be determined to ascertain whether lipids are the most important factor affecting keeping quality. Fatty fish like Nile perch generally have a shorter frozen storage life than the leaner fish.

Although most processors in the region understand the importance of high quality standards to meet the export market, it has not been possible to improve standards because of the lack of refrigerated vessels. The fish remains 1-2 weeks at some beaches before being transferred to coldstores. Quality changes in fish should be observed from the time of catch to the time of consumption.

4. REDUCING BLOWFLY SPOILAGE DURING SUN-DRYING

During the rainy season up to 30% of fish wastage is caused by blowfly maggots during the sun-drying of freshwater fish, e.g., Haplochromis and Nile perch.

The flies lay their eggs in the mouth or the gills of the fish on the first or second day of drying and after 24 h incubation they hatch into maggots. The maggots grow rapidly to the pupae stage in 3-4 days and feed on the fish leaving only the skin or bones. Pyrethrum is a suitable insecticide; it is highly repellent and photolabile and leaves little residue, has low mammalian toxicity in conditions of high temperature and high relative humidities which are optimum for the maturation of the blowflies, Chrysomya albiceps, C. chloropyga putoria and C. regalis.

Pyrethrum synergized by Piperonyl butoxide has several advantages over other insecticides. It has a repellent as well as an insecticidal action, i.e., the flies are not attracted to lay their eggs inside the fish so the possibilities of infestation are reduced; it degrades in sunlight and in cooking; and, as already stated, has a low mammalian toxicity.

Bacteria such as *Staphylococcus aureus*, *Clostridium perfinges*, *Bacillus cereus* and *Shigella* frequently cause outbreaks of food-borne diseases. *Clostridium botulinum* and *Staphylococcus aureus* develop a potent toxin which can cause a serious illness or even death hence the need for high quality control measures.

NILE PERCH FISHERY IN LAKE VICTORIA

by

J. Siwo

1. INTRODUCTION

The Nile perch fishery has become as vital a fishery for the lake as the cod fishery for the oceans. It is a new fishery which has emerged at astonishing speed. Paradoxically, it repelled and at the same time attracted potential consumers for various reasons at the initial stages of its appearance in significant quantities in the catches.

Nile perch has been the cause of interesting and conflicting controversies. It has become an ambiguous topic of study in the scientific field and also raised many intrinsic socio-economic issues that need the attention of policy-makers and planners.

The current evaluation of Nile perch points to a product with high commercial value, high yields, and prospects of improved and sustained yield over a long period of time.

In Lakes Albert, Kyoga, Turkana and Amin, Nile perch has co-existed with other species similar to those in Lake Victoria. It can thus be concluded that the balance between predator and prey swings erratically until it reaches a balance on the homeostatis plateau. This theory remains valid when all other physical and chemical conditions are constant. However, when ecological and limnological conditions vary, stock distribution by species may likewise vary. Such a case is evident in Lake Turkana where drastic recession of water levels has caused sharp and corresponding decline in Nile perch and tilapia stocks. Other emergent stocks such as _Clarias_, _Synodontis_ and _Protopterus_ are also increasing in Turkana.

It has been observed by many fisheries scientists that different fishing techniques can also result in changes in stock levels. There is a tendency to exert more fishing effort to catch those species with highest economic value. Now, Nile perch is the target for more fishermen than all the other species together. Recently fishing communities started to realize that stocks of species which had declined were in fact on the increase. A detailed study of some statistical data will show the current stock trends which basically depict _succession of species_. The most recent statistics, however, begin to depict replenishment of certain species such as _Tilapia_ _niloticus_ (_Oreochromis_), _Schilbe_, _Labeo_ and _Rastrineobola_ _argenteus_ (dagaa or omena) (see Appendix).

It is thus essential to monitor the effect of fishing mortality on the dominant _Lates_ _niloticus_ which has now displaced the minority species by its rapid proliferation (see Appendix which gives a breakdown of the various gears used to capture fish in Lake Victoria).

It is observed (see Appendix) that the perch is subject to high fishing mortality by nearly all fishing methods. In the long run, this can greatly reduce the Lates niloticus population through the entire range of age groups. A gillnet selectivity experiment will illustrate this phenomenon for further data analysis.

It will be imperative to protect the breeding grounds and nurseries so as to ensure that juveniles and prime stocks, i.e., spawning population, are protected to optimum levels.

General distribution of the Nile perch population started with high concentration of catches within the gulf and on the Uganda side of the external gulf wing. It then spread out towards Tanzania. After the building of Mbita causeway, a reverse situation occurred whereby more Nile perch is now available mainly in the waters beyond the island at the neck of the gulf. A number of theories have been advanced: industrial and agro-chemical pollution, eutrophication of algae which is depleting oxygen resources and probably other harsh physico-chemical conditions that might have developed after the construction of the Mbita causeway. It will be of interest to study the cause of these periodic shifts to which predator-prey population also seem to respond. Whereas the Nile perch population has declined in the gulf, stocks of other species on which it preyed are now increasing, e.g., Haplochromis, Schilbe, Tilapia niloticus, Oreochromis and to a lesser extent, Protopterus.

Fishing mortality is the cause of depletion of many fisheries resources elsewhere in the world. The herring and cod fisheries of the North Atlantic became exhausted through overfishing by the many trawlers and purse-seiners of the North European countries. The rich Ungwana Bay (Kenya Coast) prawn and fish resources became depleted by the late 1970s when a large and unwarranted fleet of trawlers including two offshore and deepsea trawlers invaded the area. The most destructive of these trawlers was M/T AEGINA 82 m length with a capacity of 2 200 t and 2 700 HP, followed by M/T KUSI 40.5 m length, 352 t capacity and 1 400 HP. These trawlers devastated the meagre Kenya inshore fisheries; most of them aimed at crustaceans and discarded the by-catch. The artisanal fishermen had to move to other grounds and they later abandoned trawling.

At the moment, there are four commercial trawlers in the gulf of which two are considered too big and too efficient for the limited resources. Trawling in the gulf should be discouraged otherwise a problem similar to that experienced along the marine coast will occur. Those who are engaged in fish processing should be allowed only to process and not to fish. Only 5 trawlers, the length of which should not exceed 40 ft, should be allowed in the gulf at any one time daily and these should include research vessels. In all cases, haulage of catch should be manual, and not mechanized, using the winch.

Trawlers not only have unfair advantage over the artisanal fishermen in harvesting large catches but they also destroy fishing gears. These commercial concerns who engage in both fishing and fish processing represent fierce competition to the artisanal fishery, and are not concerned about the rapid depletion of the fish stocks. It is imperative that the Department of Fisheries as a matter of urgency limit trawling in the gulf as proposed above. The commercial entrepreneurs engaged in fish processing/marketing should concentrate on that alone and not depleting the resources and jeopardizing the employment of artisanal fishermen and fishtraders.

2. EFFECT OF GEARS ON LAKE VICTORIA FISH STOCKS

A gear survey should be carried out with the aim of improving catchability efficiency of the existing selective gears such as gillnets, line gears and mid-water seine nets.

It has become evident over the years that certain fishing gears can threaten recruitment. These gears tend to catch the entire cross section of the population of nearly all species at all times of the year.

3. THE SEINE GEARS

The most dangerous gear in this category is the beach seine. To seine is to surround a shoal of fish and haul ashore or on board the vessel. On Lake Victoria there are three categories of seines (see Appendix). With the exception of the mid-water seine, all the beach seines, whether mosquito seine or 28 mm beach seine, are the gear most likely to have a negative effect on recruitment when used along the lake shore at depths within 5 m offshore. This contour demarcates that crucial waterbody which constitues the fish breeding and nursery grounds. It is therefore in this area where breeding stocks, juveniles and even fish breeding nests and eggs are most vulnerable to fishing and any other disturbing human activity. Breeding grounds and nurseries therefore require the type of protection that is accorded to national parks.

It is therefore imperative to evolve seining methods other than beach-seining to halt this drastic depletion of the stocks. This has occurred to *Tilapia esculenta* (ngege makwar) which was a breeder in the shallow, sandy closed bays. Apart from other factors that might account for the extinction of certain species of Lake Victoria, unscrupulous fishing methods and particularly beach seining have been the main cause of diminishing fish stocks by species and area. Predation by Nile perch has been magnified since it co-exists with the same species in other lakes such as Turkana, Albert, Kyoga, etc.

Ecological variations and agro-industrial pollution that result in physical and chemical changes in water quality also contribute to fluctuations in population trends.

The biggest challenge is therefore to protect the breeding grounds and nurseries. These grounds have been identified and only need publicizing as areas prohibited from fishing. The well known breeding/nursery grounds are:

1. Lake Kanyaboli
2. Lake Sare
3. Urima Beach
4. Arongo Beach
5. Ambowo Lagoon
6. Alum Lagoon
7. Angalo Bay
8. Nyareya Bay
9. Kamasengre Bay
10. Kuja/Migori Sedimental flat forming Karungu/Sori Bay

4. TRAP GEARS

Wire and barricade traps should be prohibited to allow replenishment of the riverine/anadromous species such as <u>Labeo</u> (ningu), <u>Barbus</u> (fwani), <u>Schilbe</u> (sire) and <u>Alestes</u> (osoga).

The beach seines should be replaced by Danish seines and mid-water ring/surrounding nets and possibly small-scale purse-seines.

5. GILLNET GEARS

Gillnets are the predominant and most effective gear in Lake Victoria. It can be very selective provided that the undermeshed sizes that capture juveniles of certain species in some areas during certain seasons of the year can be controlled and abandoned accordingly. Not all types of gillnets can be used in breeding/nursery grounds since they will scare and disturb these delicate stocks.

In a multispecies fishery as found in Lake Victoria, gillnet selectivity is restricted to parameters that accommodate specific genetic age groups. It is, however, evident that most species aggregate in particular grazing grounds and usually move in colonies of their own species. In other grounds, the species mix together while feeding or preying upon others.

Some of the old fish industry regulations (chapter 378 of Kenya laws) specified a range of mesh sizes that are allowed and those that are prohibited. The rules as they are now allow the use of gillnets, mesh size 2 1/2 inches, 4 inches and above but prohibit the use of other mesh sizes except for the mosquito and beach seine measuring 10 mm and 28 mm mesh size respectively.

Apart from the seine nets that catch Engraulicypris (omena or dagaa) and mixed species, the 2 1/2 inches was hitherto known as the Labeo (ningu) net and the 4 inch gillnet as the Tilapia (ngege) net.

The Labeo population has since diminished and the Labeo net is now mainly used for catching Synodontis and Schilbe. It is a dangerous net that now catches the juveniles of Nile perch and Tilapia, and should therefore be restricted to only areas where Labeo, Synodontis and Schilbe are predominant.

The Fish Industry Act (gillnet rules) was originally promulgated after fisheries scientists determined by population assessment that certain gears were dangerous all the year round while others were dangerous seasonally. The peak breeding season for most fish species of the lake was also determined to be between 1 April and 31 July of a calendar year. Seining was therefore prohibited during the peak breeding season.

With little variation in the rain pattern, the peak breeding season has remained the same for all species and the closed season rule remains valid.

The Tilapia gillnet (4 inch mesh) was meant to harvest mature sizes of Tilapia esculenta, variabilis, leucesticta and zilli. All four species have disappeared from the catches and have given way to the predominant, hardy and adaptable Tilapia niloticus. A mouth brooder, robust and aggressive, T. niloticus grows to far larger sizes than any of the other tilapias. It is also a ferocious fighter and has thus managed to co-exist with a voracious perch that preys upon all other species. Because of its larger size and higher growth rate, T. niloticus caught in a 4-inch mesh appears to be immature; fishermen have thus reverted to meshes ranging between 5 and 8 inches. Biometric data should be collected to analyse the gillnet selectivity curve that would portray a true picture at what sexual maturity stage T. niloticus is caught in 4-inch mesh. The gillnet selectivity can be applied to all other species so that a critical study of the standing stock can be taken with a view to revising some of the conservation regulations.

6. LINE GEARS

A fairly rapid succession of species has occurred in Lake Victoria due to three major factors:

1. The famous Uhuru or Independence floods that swept the country during 1961-1962 torrential rains. The floods altered the ecosystems along the shoreline, creating a muddy swampy shoreline where sandy beaches existed.

2. Recruitment of Nile perch (mbuta) in the fishery with significant catches appearing since 1977 and evolving into the predominant fishery of this lake at present. Nile perch is a giant predator preying upon all other species and virtually reducing the target species, Haplochromis (fulu) to zero. The sluggish Bagrus (seu) and vulnerable T. esculenta were also victims. Nile perch remains the most important commercial fishery in the lake.

3. A marked change in water quality, especially of the Nyanza gulf, has occurred as a result of extensive use of agro-industrial chemicals. Later, the closure of Mbita Channel also contributed to further deterioration of the gulf's water quality.

The consequence of these ecological changes is that certain fishing methods are also being gradually abandoned and new methods evolved.

The longline fishery, the simplest and cheapest commercial fishery, was aimed at harvesting Bagrus, Clarias and Protepterus. These three species, especially Bagrus, have diminished drastically in number. Unlike other tilapias, T. niloticus is heavily harvested by line gears. Nile perch is also being caught in large numbers by longlining; it is easily attracted by live bait, especially Haplochromis and small Clarias.

Longline gears are very selective and are best recommended for cropping fish stocks. It will therefore be appropriate to develop longlining by introducing modern longliners. A mechanized longliner using a simple winch can probably land commercial quantities of Nile perch.

7. POND AND DAM SEINES

Many fish-farmers in the lake basin area are usually unable to harvest their fish ponds. The field extension staff are currently both inadequate and ill-equipped with the seine nets. Non-harvesting of fish ponds in good time causes congestion in the ponds and retardation of growth. One of the main causes of low motivation in fish-farming is lack of equipment and technique for harvesting the ponds. During this development plan period, subsidy funds should be provided to make harvesting gears for fish-farmers and to train them how to crop their ponds, using these gears for a better yield.

Appendix

Fishing Gears of Lake Victoria

Fishing gears of Lake Victoria can broadly be grouped into four categories as follows:

1. Traditional gear
2. Gillnets
3. Seine nets and
4. Line gear

Gear	Fish caught
(1) Traditional Gear (TG)	mainly anadromous species - Labeo, Barbus, Schilbe, Clarias
Group "A" TG 1.1 - Weirs	
TG 1.1 - Osadhi	mixed species
TG 1.2 - Kira	mixed species
Group "B" TG 2 - Barricades	
TG 2.1 - Osadhi	mixed species
TG 2.2 - Kira	mixed species
Group "C" TG 3 - Baskets	
TG 3.1 - Ounga	mixed species
TG 3.2 - Sienyo	mixed species
Group "D" TG 4 - Seine	
TG 4.1 - Megwanja (papyrus)	knitted traditional (seine)
Group "E" TG 5 - Tong	
TG 5.1 - Bidhi	Protopterus and Clarias mainly

	Group "F" TG 6 - Line	
	TG 6.1 - Olou	Fishing line - Oreochromis, Clarias, Bagrus, Protopterus
(2)	Gillnets (NG)	Labeo, Synodontis, Schilbe
	Group "A"	
	NG 2.1 Labeo gillnets (2·1/2-3 inch)	Nile perch juveniles Tilapia juveniles
	Group "B"	
	NG 2.2 Tilapia gillnets (4-8 inch)	Tilapia, Nile perch (immature), Clarias, Barbus
	Group "C"	
	NG 2.3 Nile perch Gillnets (6-12 inch) mostly size 7-8 inch	Nile perch, big Oreochromis
(3)	Seine nets (SG)	Tilapia (all sizes) Nile perch (all sizes)
	Group "A"	
	SG 3.1 beach seine (28 mm)	mixed species
	Group "B"	
	SG 3.2 mosquito seine (10 mm)	mainly Rastrineobola but also mixed species

Mosquito seine has been developed into three types:

1. Beach - mosquito seine
2. Ring net
3. Surrounding net, all are applied using attraction lamp

(4)	Line gear (LG)	Oreochromis
	Group "A" - LG 4.1 Hand line	Clarias, Nile perch
	Group "B" - LG 4.2 Pole-and-line	Large Nile perch, Tilapia, Clarias, Protopterus, Bagrus
	Group "C" - LG 4.3 Longline Mustad hook No. 6	medium to large size Nile perch

Baits

1. Earthworm
2. Food remains
3. Live bait - Haplochromis, Clarias
4. Artificial bait

Group "D" - LG 4.4 Tackle line for sports fishing	large Nile perch

Note: Most of the gear above are catching Nile perch. Fishing mortality for Nile perch is therefore very high and hence the need to control the non-selective gear such as seine nets and undermeshed gillnets.

ECONOMICS OF NILE PERCH PROCESSING AND DISTRIBUTION IN KENYA

by

E.O. Tettey

1. INTRODUCTION

1.1 HANDLING

Inadequate handling facilities and delays between capture and distribution have contributed greatly toward fish spoilage. On landing, the fish are dumped on the sandy beaches and transferred, often in wheelbarrows, to the bandas where they are weighed, graded and often filleted and sold to buyers. At no stage in this chain is ice used. Even beyond this point, ice is seldom used, except by filleting companies which send insulated trucks or containers to purchase fish. However, it has been demonstrated that the use of ice for chilling fresh fish enables the fishermen to keep their fish in good condition for longer periods, sometimes up to 2 weeks.

1.2 TRANSPORT

Although the present system, which relies on transporting fish in baskets, is cheap and quite effective, quality problems arise especially for fish transported to distant areas. Outside the provincial capital, Kisumu, or the other major cities - Nairobi and Mombasa - there are no chill or cold storage facilities. The majority of fish is therefore landed and distributed without any form of preservation, except for curing of the fish which is on the verge of spoilage.

Under a 20-year development plan to be implemented by the Lake Basin Development Authority, five coldstores are to be located in major fishing towns along the Kenyan shores of Lake Victoria. The plan needs to incorporate ice-making facilities to give the fishermen easy access to ice. From capture to cold-storage, the use of ice could substantially add to the quality of fish especially if the deliveries cover long distances.

2. USE OF ICE

An evaluation of the use of ice on board a 7-m unmotorized canoe shows a 58% rate of return on investment against a rate of 20% for a similar canoe operating without ice under the same conditions. Ice now sells at KSh 15/block or KSh 1.50/kg at most landing centres and tends to be expensive for the fishermen. This has been one of the major factors preventing the fishermen from adopting the use of ice.

However, if more ice-making facilities become available, especially in towns closer to major fishing villages, transportation costs will drastically reduce making it more affordable and thereby stimulating its use by fishermen. It is difficult to promote the use of ice, in spite of the potential benefits that could accrue. This is because a 7-m canoe operator, fishing for 250 days out of the year, has to spend KSh 18 750 on ice, representing 18% of his total expenditure.

On land, the use of ice to preserve fish is equally beneficial. This is manifested in the operations of the industrial filleting companies which depend on icing to maintain the quality of their fish while in transit from the landing centres to the processing plants.

3. INDUSTRIAL FILLETING

Industrial filleting of Nile perch is a highly capital intensive endeavour. Today, an investor requires in excess of KSh 6 million to establish a filleting plant in Kenya with the following basic capital inputs:

- building covering an area of 800 m^2
- an 8-t coldstorage facility
- a blast freezer with a capacity of 6 t
- an ice plant with a production capacity of 2 t/day
- 5 insulated trucks with a capacity of 5 t each, and
- filleting tools and accessories

The initial capital outlay is even higher if working capital is considered. Extras like skinning machines, plate freezers could add substantially to costs.

Expenditure on raw Nile perch constitutes the single most important cost item for the typical filleting company, accounting for almost half of the total cost. Transportation costs are also unusually high considering that the raw fish has to be purchased at the landing centres along the shore of Lake Victoria, transported to Mombasa, Nairobi or Kisumu for processing, and then the finished products are further transported to the port of Mombasa for shipment. Of the KSh 14.6 million total costs incurred by the typical plant, transportation costs accounted for KSh 3.1 million or 21%. Maintenance costs are also a substantial share of the total expenditure as are the other fixed cost items such as interest and depreciation charges.

Despite the high initial capital outlay together with the large operation costs, industrial filleting is still one of the most attractive Nile perch processing options in the country today. Nile perch filleting plants have mushroomed over the past few years. Not only has the number of plants multiplied, but production capacities have also expanded.

The substantial revenue generated has spurred on this activity. Although filleting yields account for only a third of the fresh fish weight, the frozen fillets sell on the average for KSh 33/kg as against KSh 4/kg for the raw fish. In addition, filleting companies generate additional income from the by-products. With the exception of Nile perch skins which are currently thrown away by most companies, the skeleton fetches KSh 1 to 2/piece (depending on size) or KSh 0.50/kg and the dried swimbladders sell at KSh 45/kg.

Estimates from this study indicate that a typical filleting company which handles 1 800 t of fish annually would break even covering its total costs after processing 601 t of raw Nile perch, i.e., a third of its annual production volume. A rate of return on investment of 69% was further derived for this activity. Industrial filleting of Nile perch is undoubtedly a very profitable endeavour but the high initial charges restrained entry into this activity.

4. INDUSTRIAL SMOKING USING AFOS SMOKING KILN

Since the industrial production of frozen fillets is viewed as too capital-intensive and beyond the means of several would-be investors, there has been a need to develop processing options which could be easily adopted, and also afforded. Technologists at the project have initiated industrial smoking with the aim of designing medium-sized cottage industries which could be more affordable.

However, it has been realized that industrial smoking using Afos smoking kilns, if adopted as an independent processing activity, could incur higher costs than the revenue it can generate, especially at the price buyers are currently willing to pay.

Such activity could be made economically feasible if:

- the quality of the final product is improved to command higher prices than the current KSh 25/kg which consumers are willing to pay, or

- integrated into an existing industrial filleting plant to absorb some of the cost of capital as well as fixed costs, or

- the scale of production were substantially increased -

- or any combinations of the above.

Further work by project staff has however revealed promising results. A consumer survey conducted in Mombasa using the tourist industry as a target market showed that "cold" smoked Nile perch fillets produced by the project, if marinated, would be readily accepted by the tourist hotels at a price of KSh 100/kg or more. This could turn industrial smoking of Nile perch into one of the most lucrative processing options.

4.1 HOT SMOKED NILE PERCH FILLETS

Excluding working capital, a potential investor would need a little more than KSh 2 million to establish a plant with the following amenities to produce smoked Nile perch fillets:

- a building covering an area of 500 m^2
- 5 Afos smoking kilns with a capacity of 25 kg of Nile perch fillets each
- cold storage facility with a capaity of 2 t
- ice plant with a production capacity of 2 t/day
- a 3-t light truck and
- filleting tools and accessories

For the industrial smoking option also, the raw fish constitutes the greatest share of total costs; KSh 0.75 million or nearly a third of the KSh 2.3 million total costs incurred. For the variable cost items, utilities also take a substantial share. Transportation costs feature less prominently here than for the industrial filleting option.

At a price of KSh 25/kg, the revenue generated from hot smoked Nile perch fillets was much lower than the costs incurred in the production process. This implies that the processor could not break even in this operation. A negative rate of return on investment of 26% was derived for this activity meaning that for every KSh 100 invested, only KSh 76 could be recovered.

4.2 "COLD" SMOKED NILE PERCH FILLETS

Operating costs incurred by "cold" smoking is even higher than in hot smoking. For hot smoking, after filleting, brining, washing and draining, the fillets stay in the oven for a total of 4 h.

For "cold" smoking, after filleting, brining, washing and draining, the fillets stay in the kiln for 24 h drying at temperatures not exceeding 30°C, and are then "cold" smoked or smoke-dried for another 2 h at temperatures less than 50°C. In effect, electricity requirements for "cold" smoking far exceed those for hot smoking. Estimates from this study indicate that utility costs for "cold" smoking are 70% higher than for hot smoking.

Besides higher operating costs, proceeds from "cold" smoked products are much lower than those generated from hot smoked products since the product weight for "cold" smoked Nile perch fillet is extremely low, 26% of the fresh weight. At KSh 25/kg, hot smoked fillets yielded KSh 1.8 million (including revenue from swimbladder and skeleton) as against KSh 1.4 million for "cold" smoked fillets per annum, from processing 187.5 t of raw Nile perch in each option.

However, there could be a break-through particularly for "cold" smoked fillets. The tourist hotels would like to serve them as "starters", but the current fillets produced by the project need to be marinated before they could be accepted. At a price of KSh 100/kg for th final product, "cold" smoking of Nile perch fillets using Afos smoking kilns could yield an unprecedented rate of return on investment of 87%. For an annual production volume of 187.5 t of raw Nile perch, a processor would breakeven after processing 59 t.

Currently, the tourist hotels are serving "cold" smoked sailfish fillets produced locally as starter. They are sold at KSh 125/kg. Thus if identical products are developed from Nile perch for a much lower price of KSh 100/kg, this would gain much of the market and the benefit to be accrued to the processor could be quite considerable.

5. TRADITIONAL PROCESSING

Historically, while the industrial products have been targeted mainly for the export or tourist market, the traditional products are developed primarily to meet local demand. Of the 87 000 t of Nile perch produced in the country in 1987, less than a quarter was processed into frozen fillets for export. The bulk was cured prior to utilization locally, underlying the importance of traditional fish processing in the economy.

The traditional processes often employed include hot smoking, sun-drying and frying. Several hundreds of people, particularly wives of fishermen, are engaged in these activities. The major obstacle to entering into these activities or expanding is working capital. Some processors often have to sell off all their cured products before they can accrue enough money to purchase fish for another curing operation.

Despite the financial uncertainties and other difficulties encountered, traditional fish processing still offers one of the best options for people in fishing communities to earn their livelihood.

5.1 SMOKING

It costs a little more than KSh 4 000 to construct a 5 x 9 x 7 ft rectangular oven, and acquire other basic fish smoking materials, but to the artisanal fish processor this represents a substantial capital. Unlike industrial fish processing, fixed costs are less significant for this processing option. Fixed costs incurred from artisanal smoking operations represent only 5% of the total costs. What constitutes a major cost item in this activity is expenditure on raw fish. Nearly three quarters of the total expenditure is spent on purchasing raw Nile perch.

This problem appears to be worsening with filleting companies offering higher prices to obtain the best quality fish, in effect, driving up raw fish prices. The traditional fish smokers are today earning 35% returns on their investments. But the viability of this operation would depend to a large extent on the actions of filleting companies, with regard to the pricing system of the raw fish. Fresh Nile perch prices reportedly exceeded KSh 7.00/kg at some landing centres, primarily due to competition between filleting companies. This could translate into KSh 3.00-4.00/kg for the lower quality fish which the artisanal processors often procure. At such prices, a significant number of these traditional fish smokers could be out of work.

5.2 SUN-DRYING

Although sun-drying incurs lower operating costs than smoking, revenue generated here is quite low. For the typical operator, sun-drying a total of 46.8 t of Nile perch annually still yields a revenue of KSh 126 360 despite a price of KSh 9.00/kg for the final product. This is the direct result of a rather low product weight equivalent of the sun-dried fish - 30% of the fresh fish weight.

Of the 46.8 t of Nile perch handled each year, the processor could cover all his costs after processing 12.9 t. A rather low rate of return on investment of 8% was derived for this activity. What then attracts people into sun-drying is perhaps the relatively lower capital requirements. The initial capital outlay required here is KSh 3 000, which can be more easily afforded by artisanal processors.

5.3 FRYING

Frying appears to be the most lucrative of all the traditional fish processing options, with a rate of return on investment of 60%. A processor handling 41.6 t of Nile perch a year will break even after processing only 5.7 t. In spite of this bright outlook, artisanal smoking still remains the most commonly employed option of curing Nile perch in Kenya.

Perhaps it is consumer preference of smoked Nile perch over the fried product which far outweighs any other consideration. While a substantial demand exists for smoked Nile perch, fried Nile perch has less appeal. The marketing of fried Nile perch often presents problems since it easily breaks into pieces and becomes less attractive to the consumer.

In addition to the high economic returns, the frying of Nile perch has other benefits. Substantial quantities of oil are recovered from the fish during the frying process. This by-product is often sold as cooking oil in the domestic market.

6. UTILIZATION OF BY-PRODUCTS

6.1 SWIMBLADDERS

Swimbladders are used as raw material for the manufacture of isinglass, an additive used in the brewery industry. It acts as a clarifier during the storage of draught beer and wine. Some samples of swimbladder were dried in the laboratory by researchers attached to the project. They were then sent to a UK-based isinglass factory for evaluation. The results were promising.

It was however recommended that the swimbladders should not be exposed to excessive temperatures during drying as this can denature the collagen content into gelatine. The manufacturer was willing to pay KSh 120/kg CIF or more for this product, underlying the economic potential of the by-product.

6.2 SKINS

Utilization of Nile perch skins into leather products is still at the experimental stage: work on the transformation of the skin into leather has been carried out by the Kenya Industrial Research and Development Institute (KIRDI) and the Bata Company, both in Nairobi. Sample products compared favourably with those produced from animal skin. It appears economically feasible to transform Nile perch skins into leather, although no study has yet been undertaken to support this. However, before an entrepreneur invests in such activity, the regularity of supply of adequate Nile perch skins to feed the plant has to be ascertained.

6.3 SKELETON

Skeleton refers to the remains of the Nile perch after filleting. There exists a great demand for Nile perch skeletons in Kisumu, Nairobi and Mombasa where the filleting plants are located. At a retail price of KSh 4.00-5.00/kg, fried Nile perch skeletons have become very popular especially among those at the lower levels of the socio-economic strata.

An evaluation of this processing option indicates that it is even more profitable to fry the skeleton than frying the meat. This is true since the skeleton is virtually sold at give-away prices while the fried product still has a strong and steady market.

There is an urgent need to improve the handling of Nile perch skeleton, from the processing plants to the frying sites. A potential danger for product contamination exists if conditions are not improved.

There are other potential uses of Nile perch by-products. These include:

- the production of fishmeal or silage for animal feed;
- the extraction of fish oil to be used as cooking oil.

However, these options have not yet been studied in detail.

7. DISTRIBUTION AND MARKETING

7.1 FISH PRICES

While the average prices for major fish species in Lake Victoria have more than doubled since 1975, the growth in Nile perch prices has been less dramatic. According to estimates by KMFRI, the average price of Nile perch was KSh 1.59 in 1975. This grew to KSh 2.01 in 1986, an increase of 25% in more than a decade. On the other hand, the price of tilapia has increased by 146% over this same period. But as filleting companies begin to compete for top quality fresh Nile perch, prices for this species is bound to increase sharply in the next few years.

Nile perch continues to be one of the cheapest fish in the country. Still, traditional beliefs and myth discourage its utilization especially in areas close to the lake. Tilapia is much preferred and currently sells for KSh 8.00 to 10.00/kg in most landing centres. It is the most expensive freshwater fish in the country today.

A striking observation is the development of prices in the distribution chain, from the canoe operator to the final consumer. Along the shores of Lake Victoria, Nile perch sells for between KSh 2.00/kg and KSh 4.00/kg depending on quality. By the time it reaches the final consumer, the price has multiplied to KSh 8.00/kg in Kisumu, KSh 18.00/kg in Nairobi and KSh 25.00/kg in Mombasa. Similarly, processors sell their smoked Nile perch to wholesalers at an average price of KSh 8.00/kg. This is then retailed for KSh 13.00/kg in Kisumu, KSh 15/kg in Nairobi and KSh 20.00 in Mombasa.

Usually, the fish product passes through a number of middlemen and a profit margin is added at each level of the distribution chain. Transportation costs also add substantially to fish prices and this is to a considerable extent manifested in prices obtained in Kisumu, Nairobi and Mombasa for identical products.

7.2 MARKETING SYSTEMS

Although the freshwater fish distribution network in Kenya is as complex as in other parts of the region, two distinct marketing systems become apparent: the first involves the filleting companies which send insulated trucks to the landing centres to purchase fresh fish, where ice is used to preserve the quality of the fish while being transported to the processing plants. The second involves fishmongers who are almost exclusively engaged in cured fish distribution and trade. Lacking cold storage facilities, the fish is either smoked, sun-dried or fried before it enters the distribution chain. Here, the fishmongers normally use baskets as containers for the fish products and utilize public transportation to send them to the market.

7.3 EXPORT MARKETS

Israel has been the major recipient of Kenya's frozen Nile perch fillets, taking more than half of both the volume and value of exports in 1987. Nearly a quarter of the volume and value of this product went to the Spanish market in the same year. Other important markets for Kenya's Nile perch products include Netherlands, Australia, France, Japan and Belgium.

In 1987, a total of 4 082.5 t of frozen Nile perch fillets, worth KSh 134.7 million were exported. This represented over 12 000 t of raw Nile perch. In 1988, both the volume and value of Nile perch exports could double. This follows the rapid increase in the number of filleting companies and the expansion in processing capacities of existing plants. Discussions with officials of major filleting companies indicate that some 2 160 t of raw Nile perch are currently being processed per month into fillets for the export market. If this production volume holds through to December, then over 25 000 t of raw Nile perch will be processed into fillets for export. This translates into 8 500 t of fillets worth KSh 280.5 million at the 1987 average price of KSh 33.00/kg.

Except for Samaki Industries which occasionally produces some Nile perch steaks for the UK market, exports from all other filleting companies are currently limited to one product form - frozen fillet. The potential to diversify into the production of other value added products does exist but the Nile perch filleting industry is still in its infant stage and it will take a while before this is realized. Apparently, Afro Meat Company Ltd. produces cold smoked sailfish fillets in vacuum pack for the tourist hotels in Mombasa and intends to do likewise for Nile perch.

Besides the frozen fillet trade, a significant smoked Nile perch trade exists but is seldom recorded. Smoked Nile perch are reportedly exported to Zaire but the extent of this trade and the regularity are not yet clear: supplies are accumulated in Nairobi municipality market where they are transported by road. Due to the short shelf life of smoked Nile perch, such activity has to be well organized to ensure that the products reach their destination in acceptable condition.

There is also a dried swimbladder trade particularly with Asian importers. Little is known about this trade not because it is not recorded, but rather because it is still in its infant stage. Dried swimbladder exported to Asia fetches an average price of KSh 45.00/kg FOB. Indications are that this trade will thrive and expand in the years ahead.

LAKE VICTORIA FISHERIES AND LAKESHORE COMMUNITIES: LOOKING AT LATES FROM A DIFFERENT PERCH (Summary)

by

J. E. Reynolds

1.1 A brief mission was carried out during July-August 1987 in order to conduct a preliminary assessment of socio-economic aspects of the Nile perch fisheries in Lake Victoria. Statistical and other documentary sources were reviewed and direct observations collected during short field visits around the lakeshore in Kenya, Tanzania, and Uganda.

1.2 There has been intensive controversy over the role of Nile perch in the lake, with some observers taking the view that the dramatic proliferation of the introduced predator has had disastrous consequences for the ecology of the lake and its dependent fisherfolk, and others taking milder or more positive views.

1.3 Background literature and press accounts are reviewed and main points of argument over the "Nile Perch Question" identified and discussed. These points bear on issues of ecological disruption caused by the depredations of Nile perch on endemic fish species flocks; the loss of crucial subsistence and commercial resources for lakeshore communities; resentment towards Nile perch by local people; adverse social and environmental impacts due to local processing methods used on the fish which place great demands on scarce fuelwood supplies; and the general economic displacement of artisanal fishermen and petty traders occasioned by the presence of Nile perch.

1.4 Recent trends in the fisheries of each country's portion of the lake are examined, and current observations based on the field visits reported. It is stressed that vital statistical and other documentary information on the circumstances of those involved with harvest and post-harvest sectors of the fisheries is quite deficient.

1.5 The main points of argument in the Nile perch controversy are reconsidered in light of the country situation reviews. Impressions gathered during the course of these reviews cannot be regarded as definitive because of the preliminary and brief scope of the mission, but they suffice to show that the impact of Nile perch has been both profound and ambiguous.

1.6 There seem to be grounds to dispute allegations that the fish have been an economic tragedy and have no appeal for fisherfolk and consumers.

1.7 On the other hand, some serious or potentially serious problems give cause for concern. These relate to issues of equity - access to productive resources and distribution benefits - in both the harvest and post-harvest sectors of the fisheries. Apparent trends towards depletion of fuelwood supplies associated with lakeside processing vast amounts of Nile perch, and the existence of distribution and marketing system constraints, are worrisome questions as well.

1.8 Although much has been written about the consequences of the Nile perch establishment in Lake Victoria, it seems that ecological, biological, and other technical aspects of the situation have received by far the most research attention. A comprehensive appreciation of the human welfare dimension is still lacking, even though planning and development initiatives require socio-economic perspectives in order to be most effective.

1.9 It is strongly urged therefore that work be mounted in each of the riparian states to fully and systematically develop these perspectives. In this connection, a series of further questions for urgent research is recommended. Investigation of these questions should aim at the formulation of pilot initiatives for the implementation of measures to:

(a) develop Nile perch products along lines best suited to local tastes, existing practices, and needs.

(b) sustain the role of small-scale fisherfolk in Lates harvesting to meet both subsistence and income requirements.

(c) encourage appropriate post-harvest preservation techniques as determined by local priorities and available resources.

(d) foster women's participation in fish buying and selling networks on both local and wider scale, perhaps through small business or cooperative arrangements.

(e) encourage other small business ventures involved with various aspects of lakeshore Lates production (e.g., processing and sale of fish by-products).

(f) Develop ways in which the Nile perch fisheries may be exploited with minimal conflict between artisanal and intermediate-scale enterprises and larger, capital-intensive concerns.

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