APPENDIX/ANNEXE A

PROGRAMME

Monday 24 November 2008

Opening address by Ms Naima Bou-M'Handi, Chief of the Centre spécialisé de valorisation et de technologie des produits de la mer (CSVTPM), Morocco

Address by Mr Habib Halila, FAO Representative in Morocco, on behalf of the Director-General of FAO

Welcoming address by Mr Said Taleb, Director of the Cooperation and Legal Affairs Division of INRH, Morocco

Election of Chairman and meeting officers

FAO report on progress made since the first FAO Workshop on Fish Technology, Utilization and Quality Assurance in Africa
Presented by Yvette Diei-Ouadi, FAO, Rome, Italy

The effect of holding temperatures on the microbiological spoilage of African catfish – *Clarias gariepinus*
Presented by Margaret Masette, FBRC, Uganda

Improved live fish preservation using cages
Presented by Kenneth Werimo, KMFRI, Kenya

Improvement of the socio-economic conditions of a female cooperative for drying and brining of mussels: training, design of the process and putting in place of the HACCP
Presented by Younes Zenati, ISTPM, Morocco

From waste to product: some examples using mild technologies
Presented by Jean-Pascal Bergé, IFREMER, France

Promoting value-addition and improved small-scale fish processing in Lake Victoria
Presented by Caroline T. Kirema-Mukasa, LVFO, Uganda

Rapporteurs:
am: Mr Mgawe/Mr El Filali
pm: Ms Ndiaye/Mr Kharroubi/Ms Salaudeen

Tuesday 25 November 2008

Improved fish drying using a polythene solar dryer
Presented by Kenneth Werimo, KMFRI, Kenya

Dissemination of a new improved concept of artisanal drying and smoking of food: application in artisanal fisheries in Gabon
Presented by Serge Ekomi Ango, DGPA, Gabon

Adapting low cost shrimp drying technology: initial trials in Nanggroe Aceh Darussalam Province (NAD), Indonesia
Presented by FAO Secretariat

Post-harvest fish loss assessment on Lake Victoria sardine fishery in Tanzania – *Rastrineobola argentea*
Presented by Yahya I. Mgawe, MFDC, Tanzania

Addressing post-harvest losses in artisanal fisheries: some key considerations
Presented by Yvette Diei-Ouadi, Rome, Italy

Assessment of the effects of the smoke generation processes and of smoking parameters on the organoleptic perception, the levels of the most odorant compounds and PAH content of smoked salmon fillets
Presented by Thierry Sérot, ENITIIA, France

Commercial fish species identification with isoelectric focusing: application to breaded fish products
Presented by Maurizio Ferri, ASL, Italy

Rapporteurs:
am: Mr Bergé/Mr Sylla/Mr Khbaya
pm: Mr Ferri/Mr Njifonjou

Wednesday 26 November 2008

Comparative study of the bacteriological quality of water used in fishing industries in Senegal according to the treatment applied
Presented by Khalifa B. Sylla, EISMV, Senegal

The influence of dagaa-based poultry feed quality on chicken egg production within Lake Victoria basin
Presented by Margaret Masette, FBRC, Uganda

Histamine and microbiological change during the storage of semi-preserved anchovies
Presented by Fayssal El Filali, CVSTPM, Morocco

Quality changes and heavy metal analysis of marine water prawn and fresh water prawn stored in ice – *Penaeus notialis* / *Macrobrachium vollenhovenii*
Presented by Mutiat M. Saludeen, NIOMR, Nigeria

Production and export of fishery products: challenges facing the industry in Seychelles
Presented by Christopher Hoareau, VETFIQCU, Seychelles

Regulatory alternatives for European Union market access
Presented by Francisco Blaha, FAO, Italy

Rapporteurs:
am: Mr Sérot/Mr Radi/Mr Hoareau
pm: Ms Masete/Ms Diouf/Ms Kirema-Mukasa

Thursday 27 November 2008

Evaluating the opportunities, constraints and implications of eco and ethical fish labelling on the octopus value chain in Senegal
Presented by Mame Betty Lette Diouf, ENDA REPAO, Senegal

Post-harvest fisheries technological platform approach: entry point to addressing technological and sociocultural issues in artisanal fisheries
Presented by Oumoulkhairy Ndiaye, CNFP, Senegal

Situation analysis of long-distance fresh fish distribution along the coast of Tanzania
Presented by Yahya I. Mgawe, MFDC, Tanzania

Trading the shrimp trawling bycatch in the Central Gulf of Guinea: a dilemma for its negative/positive impact
Presented by Oumarou Njifonjou, IRAD, Cameroon

Rapporteurs:
am: Mr Zenati/Mr Ekomy Ango/Mr Werimo

Friday 28 November 2008

Field trip (Port of Agadir and CSVTPM premises)

Resolution, discussion and adoption of the recommendations of the Workshop

Closing

Technical Secretariat

Mr A. Jallow, FAO Regional Office, Ghana
Mr F. Blaha, FAO, Rome
Ms Y. Diei-Ouadi, FAO, Rome
Ms G. Loriente, FAO, Rome

APPENDIX/ANNEXE B

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APPENDIX/ANNEXE C

PRESENTED PAPERS/DOCUMENTS PRÉSENTÉS

THE EFFECT OF HOLDING TEMPERATURES ON THE MICROBIOLOGICAL SPOILAGE OF AFRICAN CATFISH – *Clarias gariepinus*

[EFFETS DES TEMPÉRATURES DE CONSERVATION SUR L'ALTÉRATION MICROBIOLOGIQUE DU POISSON-CHAT AFRICAIN]

by/par

Margaret Masette[1] and E.E. Ssebunnya

Abstract

Since the year 2000 capture fisheries in Uganda's water bodies have been declining due to a myriad of factors. In response, the Government of Uganda (GoU) has initiated aquaculture promotional campaigns to bridge the ever increasing gap between fish supply and demand. The African catfish *(Clarias gariepinus)*, one of the three aquaculture species being promoted, contributes to about 60% of the total aquaculture production. However, there is an information gap on its post-mortem keeping qualities. In this preliminary study to determine shelf-life at designated holding temperatures, a total of twenty-four (24) fish *(Clarias)* were collected and divided into two batches. One was held at ambient temperatures (24–28 °C) and the other chilled (0–4 °C) prior to microbiological analyses which included aerobic total plate counts (TPC) and isolation of major spoilers. Results indicated that both *Pseudomonas* and *Aeromonas* species were the major spoilers at ambient temperatures. However, at chilled temperatures only *Pseudomonas* species proliferate. As expected, samples held at chilled temperatures kept longer than fish held at ambient temperatures which concurs with other studies conducted on other fish species. By linear regression extrapolation and based on maximum allowable microbiological limits of 106, the shelf-life was estimated at about 13 hours and 29 days for fish held at ambient and chilled temperatures, respectively.

Key words: African catfish, Temperature, Spoilage

Résumé

Depuis les années 2000 la pêche de capture dans les eaux ougandaises est en déclin du fait d'une myriade de facteurs. En réponse le Gouvernement de l'Ouganda (GoU) a initié des campagnes de promotion de l'aquaculture pour combler le déficit entre l'approvisionnement et la demande. Le poisson-chat africain (*Clarias gariepinus*), une des trois espèces aquacoles en cours de promotion, contribue environ 60% au total de la production aquacole. Toutefois, il y a un déficit d'information sur ses qualités de conservation post-mortem. Dans cette étude préliminaire pour déterminer la durée de conservation à des températures définies, un total de 24 poissons (*Clarias*) ont été collectés et divisés en deux lots. L'un était tenu à températures ambiantes (24-28 °C) et l'autre réfrigérée (0-4 °C) avant les analyses microbiologiques qui incluent le dénombrement de la flore aérobie totale (TPC) et l'isolation des altérateurs majeurs. Les résultats indiquent que les espèces de *Pseudomonas* et *Aeromonas* sont les germes majeurs d'altération à températures ambiantes. Toutefois à basses températures seulement les espèces de *Pseudomonas* prolifèrent. Comme attendu, les échantillons tenus a basses températures se conservent plus longtemps que ceux à températures ambiantes, ce qui rejoint d'autres études conduites sur d'autres espèces de poisson. Par l'extrapolation de la régression linéaire et sur la base des limites maximales microbiologiques admissibles de 106, la durée de conservation a été estimée à environ 13 heures et 29 jours respectivement pour les poissons à températures ambiantes et basses.

Mots clés: Poisson-chat africain, Température, Altération

1. INTRODUCTION

Due to declined wild fish stocks in major lakes of Uganda (DFR, 2008), aquaculture is being promoted in various areas of Uganda (FAO, 2005) to meet nutritional requirements, income generation and employment among other benefits. African catfish *(Clarias gariepinus)* is the most cultured fresh water fish species with a contribution of about 60% of the total aquaculture production (FAO, 2005). It has an elongated body, a large head, depressed and bony with small eyes. The gill arch has an air breathing labyrinth organ arising from gill

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arches. The mouth terminal is large with four pairs of barbels. It has a long dorsal fin and dorsal fin spine (FAO, 2000). From other studies conducted on temperate fish, spoilage begins as soon as the fish dies and the rates differ among fish species (Huss, 1998) and regions (Roberts and Skinner, 1983). There are three specific bacteria known to cause most of the microbiological spoilage and these include *Pseudomonas* species (Adams and Moss, 2000, and Atlas and Ronald, 1984) *Aeromonas* species and *Shewanella* species (Roberts and Skinner, 1983). In Nile perch (*Lates niloticus*) kept at ambient temperatures these same bacteria were identified as the principal spoilers (Gram *et al*., 1989). Generally, 25% of fresh water fish catches in developing countries are lost due to bacterial spoilage. Gram, 1998 and Huss, 1998, attributed the high spoilage rate to elevated temperatures prevailing in tropical areas. Indeed, the most influential factor in fish spoilage is temperature as it accelerates bacterial as well as enzymatic and chemical spoilage reactions.

Currently, there is one fish processing plant in Uganda that is engaged in exportation of smoked African catfish to a niche market in Europe. On several occasions, the plant has incurred financial losses due to product safety concerns. The inability to comply with international safety standards and demonstrate due diligence in a highly competitive international fish trade is partly attributed to a narrow knowledge base prevailing in most developing economies. Undoubtedly, the technological inadequacies, skewed research policies and financial constraints among other drawbacks in many of these economies, have contributed immensely to the information gap in the post-harvest fisheries sector. Owing to their international significance, Nile perch and Nile tilapia species have attracted donor funds that were used to generate the limited available data. However, comparable information on *Clarias* and other species with less international value is completely missing from the Ugandan database on post-harvest. In view of the current promotional drives by the GoU to popularize *Clarias*, there should also be concerted efforts in the other direction to generate relevant local data about the species that will supplement information from other regions. Typically, formulation and subsequent compliance with safety and quality standards require the relevant input from various stakeholders which, in the case of *Clarias* and other low-value species, need contributions from local researchers. Generally, post-mortem information on most tropical fresh water species is either lacking or scanty.

Overall objective

- To generate post-mortem relevant data on farmed African catfish.

Specific Objectives

- To determine the effect of holding temperature on microbiological spoilage;
- To isolate major bacterial spoilers in fish held at chilled and ambient temperatures; and
- To estimate shelf life at different holding temperatures.

2. MATERIALS AND METHODS

A total of 24 live fish (*Clarias*) were randomly collected from Kajjansi Fisheries Research Station and transported to a Veterinary Medicine laboratory (Makerere University) for subsequent microbiological analyses. On arrival, the fish were killed and time of death recorded. The initial microbiological load (Total Plate Count - TPC) was determined using the spreading method (Refai, 1979) prior to division into two batches. Batch (A) was kept at ambient temperatures (24–28 °C) while Batch (B) at chilled temperatures (0–4 °C). Each batch was sampled at intervals of 2 hours, for 12 hours. Plates were incubated at 27 °C for 2 days on MacConkey agar. Formed colonies were counted and expressed in colony forming units (cfu)/g-1 of fish sample. Bacteria isolation was based on colonial morphology and biochemical tests (Freeman 1979; Buller, 2004; Carter and Cole, 1990).

3. RESULTS AND DISCUSSION

The microbiological spoilage in *Clarias* (Figure 1) showed a similar trend to that of other fish species. The bacteria on Batch (A) samples kept at ambient temperatures had a lag-phase of only two hours. The first two hours of the exponential phase was steep with a growth rate of 1.39cfu/sec. On the contrary, bacteria on Batch (B) samples kept on ice remained in lag phase for 10 hours and probably the batch may have reached the 1–2 weeks mark for tropical fish (Huss, 1995) if the study had continued for at least 4 weeks. The numerous studies conducted on temperate fish species showed similar spoilage trends. Available information on microbiological fish spoilage in temperate regions indicates that several factors play pivotal roles in its exacerbation. They include the thickness of the slime on fish skin (Murray and Fletcher, 1976) initial microbial load (Clucas and Ward, 1996) temperature (Huss, 1995) and handling practices. One of the few studies (Gram *et* *al*., 1989) conducted on fish species in the tropics and specifically Nile perch *(Lates niloticus)* showed similar spoilage trends.

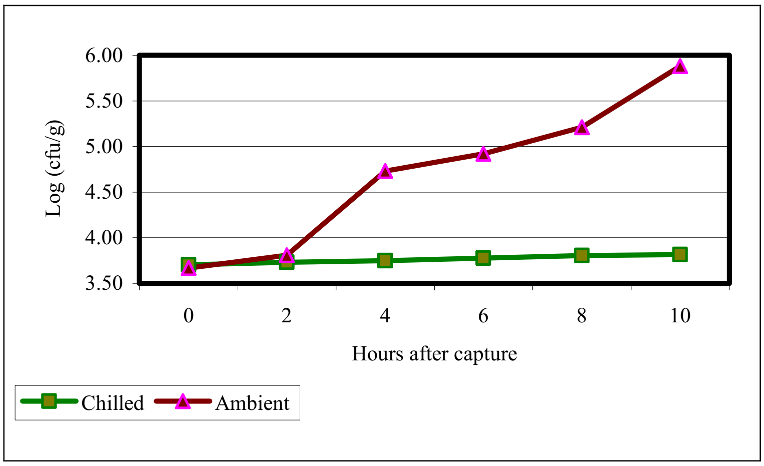

Figure 1. The spoilage of *Clarias gariepinus* kept at chilled and ambient temperatures

The initial microbial load of about 103 was a reflection of the environment at Kajjansi aquaculture farm. From the quality viewpoint, it was indicative of a commendable unpolluted farming system. At ambient temperatures, the rate of cfu/g-1 accumulation was 100–fold higher than under chilled temperatures. According to previous studies (Huss, 1995; Gram *et al*., 1989), ambient temperatures in the tropics provide ideal conditions for the existing aerobic mesophilic bacteria that naturally occur on the outer integument of the fish and in the intestinal tract (Roberts and Skinner, 1983). The increased mesophilic bacterial populations cause hydrolytic and oxidative deterioration of the fish tissue (Van Speekens, 1997). Furthermore, the by-products of the bacterial metabolism at ambient temperatures promote proliferation of more bacteria up to the threshold level that causes detectable spoilage (Adams and Moss, 2000). The presence of mesophilic bacterial population in fish muscle cause rapid spoilage (Huss, 1998). The slow spoilage rate exhibited by Batch (B) was due to inactivation of and eventual cessation of mesophilic bacterial growth attributed to change in membrane structure of the bacteria which in turn affects the uptake and supply of nutrients to enzymic systems within the bacterial cell (Adams and Moss, 2000).

Isolation of fish spoilage bacteria at different holding temperatures

At ambient temperatures, *Pseudomonas* and *Aeromonas* species were predominant in equal numbers whereas only *Pseudomonas* survived the low temperature (Table 1). This has been attributed to their short generation time (Devaraju and Setty, 1985). This concurred with previous studies (Roberts and Skinner, 1983, and Adams and Moss, 2000) which noted that *Pseudomonas* and *Aeromonas* were the major constituents of the spoilage flora of African catfish.

Table 1: Bacteria isolated at different storage temperatures

Storage temperature	Isolated bacteria
Ambient (24–28 °C)	*Aeromonas* species and *Pseudomonas* species
Chilled (0–4 °C)	*Pseudomonas* species

However, when chilled conditions are maintained only *Pseudomonas* species proliferate (Gram, 1989). The presence of *Pseudomonas* species at chilled temperatures confirms its psychotropic and mesophilic properties (Inglis *et al*., 1994). However, their proliferation rate is higher at chilled than ambient temperatures (Refai, 1979). On the contrary, *Aeromonas* species only proliferate at ambient temperature which demonstrates their mesophilic nature (Roberts and Skinner, 1983). However, in a mixed culture with *Pseudomonas* species at ambient temperature (Table 1), *Aeromonas* growth rate is low (Gram *et al*., 1989) and ultimately eliminated at chilled temperatures since they are specific spoilage bacteria of tropical fishes (Adams and Moss, 2000). Elimination of *Aeromonas* bacteria at chilled temperature inadvertently reduces microbiological spoilage of the respective fish species.

Shelf life of African catfish held at different temperatures

TPC on samples of African catfish under chilled and ambient temperatures follows the linear regression equation; Y = 1405.9X and Y = 73649X, respectively, where Y = Average TPC per gram of sample and

X = Time taken. According to several authors (Liston, 1980; Howgate, 1982; Connell, 1990) fish with a microbial load of ≥ 106 is regarded as spoilt and therefore if Y = 106 then X is 13 hours and 29 days at ambient and chilled temperatures, respectively, when a linear regression equation is applied.

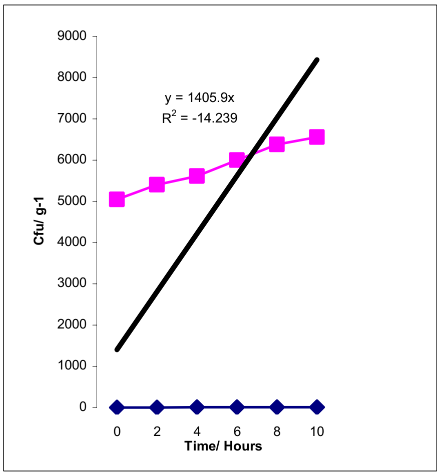

Figure 2(a). Linear regression curve for fish samples kept at chilled temperature

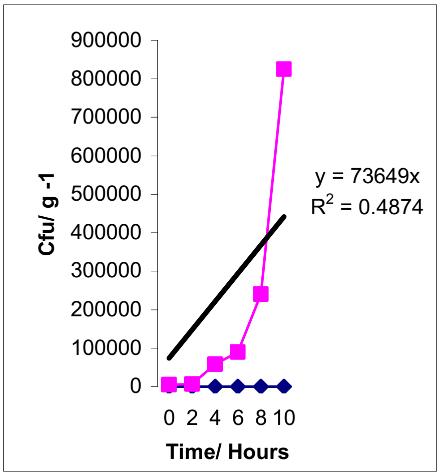

Figure 2(b). Linear regression curve for fish samples kept at ambient temperature

However, if logarithmic regression equation (Figure 3) is applied, the shelf-life reduces to 8 hours and 4 days at ambient and chilled conditions, respectively.

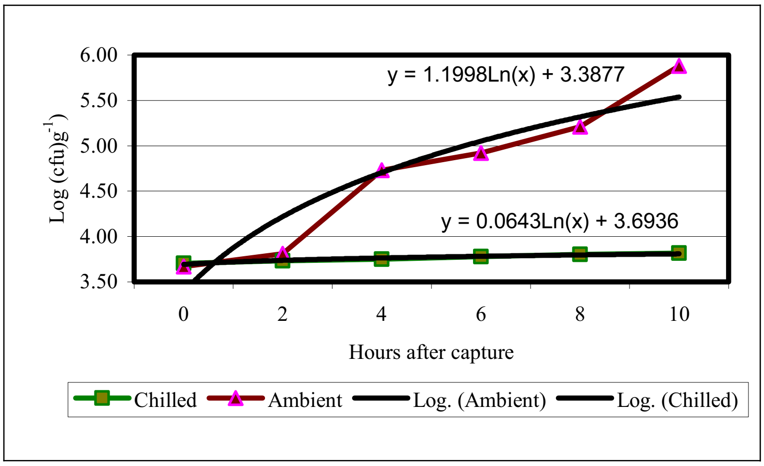

Figure 3. Logarithmic regression curve for samples held at both chilled and ambient temperatures

Evidently, the different trendlines on the spoilage curve indicate different shelf-life durations for the African catfish and, therefore, it is advisable to run the experiment until acceptable limits are naturally reached. However, according to previous studies on other tropical fish species like Nile perch *(Lates niloticus)* (Bagumire, 1998) and Nile tilapia *(Oreochromis niloticus)* (Clucas, 1981), the linear regression equation offers the most probable shelf life of catfish of 13 hours and 29 days at ambient and chilled temperatures, respectively. Although microbiological spoilage is highly influenced by temperature (Huss, 1998), it is not the sole determinant of fish spoilage. There are other influential factors like the initial microbial load at fishing ground or aquaculture system on the fish integument (Schwan, 1977), autolytic spoilage as well as oxidative rancidity (Clucas and Ward, 1996). Although these objective methods can be used to detect spoilage in fish and therefore shelf life, the ultimate judge of fish acceptability is the consumer, hence the need to conduct sensory evaluation tests concurrently.

4. CONCLUSIONS

Generally, the study demonstrated that African catfish follows a normal microbiological spoilage trend showing a faster spoilage at ambient temperatures than in chilled conditions. The major spoilage microflora consist of the renowned *Pseudomonas* and *Aeromonas* species, which proliferate faster at ambient temperatures than at chilled temperatures. However, only *Pseudomonas* species survive in chilled conditions. Based on agreed microbiological rejectable limits, the African catfish remained acceptable for human consumption for an appreciable period of time.

5. RECOMMENDATIONS

- Other aquaculture systems in the country should emulate the commendable water quality.
- For a definite determination of shelf life, sensory, microbiological and chemical tests should be conducted concurrently for prolonged periods of time: at least one month for samples kept at chilled temperatures and 20 hours for samples held at ambient temperatures.
- Funds should be made available to complete a comprehensive study.

6. REFERENCES

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IMPROVED LIVE FISH PRESERVATION USING CAGES

[AMÉLIORATION DE LA CONSERVATION DU POISSON VIVANT EN UTILISANT DES CAGES]

by/par

Kenneth Werimo[1] and John Malala

Abstract

Lake Turkana fish supply chain lacks cooling facilities for fresh fish preservation. The ambient air temperatures may rise up to 46 ºC while surface water temperature may reach 32 ºC. In a bid to maintain the quality of fresh fish, fishers have been preserving live fish by tying them on a string and immersing them in the lake water. The use of the string was found to be a very inappropriate method for preserving live fish in water since it causes stress to the fish, leads to low flesh quality and high mortality, resulting in income loss.

This study's objective was to design, test and adapt an appropriate live fish storage cage to reduce stress on fish, enhance fish quality and reduce fish mortality. The study used a specially built metal cage to preserve live fish after removal from the gillnet. The cage was immersed in the water and mortality was monitored and recorded for at least 14 hours.

The mortality rate of fish preserved in the special cage under water compared to that of fish preserved on a string was reduced from 15% to less than 1%. Normally dead fish are not packed for marketing purposes but are consumed locally or processed by sun drying. The market price of sun dried fish compared to the fresh one is about 50% lower. The special cage therefore improves the income of the fisher by a margin of more than 10%.

Key words: Live fish, Preservation, Mortality, Value loss

Résumé

La chaîne d'approvisionnement du poisson du lac Turkana manque d'installations de froid pour la conservation du poisson frais. La température de l'air ambiant peut atteindre 46 ºC alors que la température de la surface de l'eau peut atteindre 32 ºC. Dans la tentative de maintenir la qualité du poisson frais, les pêcheurs conservent les poissons vivants en les fixant à une ficelle et en les immergeant dans l'eau du lac. Il a été noté que l'utilisation d'une ficelle n'est pas la méthode la plus appropriée pour préserver le poisson frais dans l'eau puisque cela cause du stress au poisson, engendre une chair de mauvaise qualité et une mortalité élevée, d'où une perte en revenus.

L'objectif de cette étude était de concevoir, tester et adapter une cage appropriée de stockage de poisson vivant pour réduire le stress du poisson, améliorer la qualité et réduire la mortalité. L'étude a utilisé une cage métallique préfabriquée pour conserver le poisson vivant après l'avoir retiré du filet maillant. La cage est immergée dans l'eau du lac et la mortalité enregistrée pendant au moins 14 heures.

Le taux de mortalité du poisson vivant conservé en cage dans l'eau comparé à celui attaché a la ficelle a été réduit de 15% à moins de 1%. Habituellement, les poissons morts ne sont pas emballés pour la commercialisation mais sont consommés localement ou traités par séchage au soleil. Le prix de vente du poisson séché au soleil en comparaison au produit frais est d'environ 50% plus bas. Par conséquent la cage améliore les revenus du pêcheur avec une marge de plus de 10%.

Mots clés: Poisson vivant, Conservation, Mortalité, Perte de valeur

1. INTRODUCTION

Studies conducted during the Lake Turkana Research Project in early 2007 showed that there is high fish mortality when fish is preserved live in water, on a string. This method of preservation is used due to lack of cooling facilities to preserve fish the normal way once harvested. The only way to maintain fish fresh is to keep it alive. Fishers use an innovative method of tying fish on a string which is then suspended in water until the

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time to take the fish to the market. This method keeps the fish restricted but free to swim around and thus reduces stress; fish held on a string tend to struggle and suffer stress leading to high mortality rates, and those that survive are of low quality. The use of the string may, therefore, not be the most appropriate method for preserving live fish in water. There is a need to reduce the stress of fish, as well as to reduce the mortality rate. The use of a cage could improve on this hence the need to investigate its effectiveness. This study aimed at designing, testing and adapting an appropriate live fish storage cage to reduce the number of fish that die from being held on a string when immersed in water. The reduction in fish mortality increases the quantity of fish offered for sale and thus increases fishers' earnings. This contributes to increased income and thus improves the socio-economic status of the fishers.

2. METHODOLOGY

The method used by fishers/traders along Lake Turkana in order to preserve live fish is by the use of a string passed through the fish mouth/gills and immersed in water (Plate 1). The study used a specially built metal cage (Plate 2) to preserve live fish. The fish, after being caught (Plate 3) by a gillnet, was removed from the net and placed in the cage that was previously immersed in lake water. The mortality rate of the life fish was monitored for at least 14 hours, i.e. from 3 pm to 5 am.

Plate 1. Fish preserved on a string immersed in water

Plate 2. Fishing activity using gillnet as a seine

Plate 3. Prefabricated live fish preservation cage

3. RESULTS AND DISCUSSION

The mortality rate of fish preserved in the cage under water compared to those preserved on a string was reduced from 15% to less than 1% (Figure 1). Normally, dead fish are not packed for marketing purposes but are processed by sun drying. The market price of sun dried fish compared to the fresh one drops from K Sh 78 to about K Sh 14, representing 83% value loss.

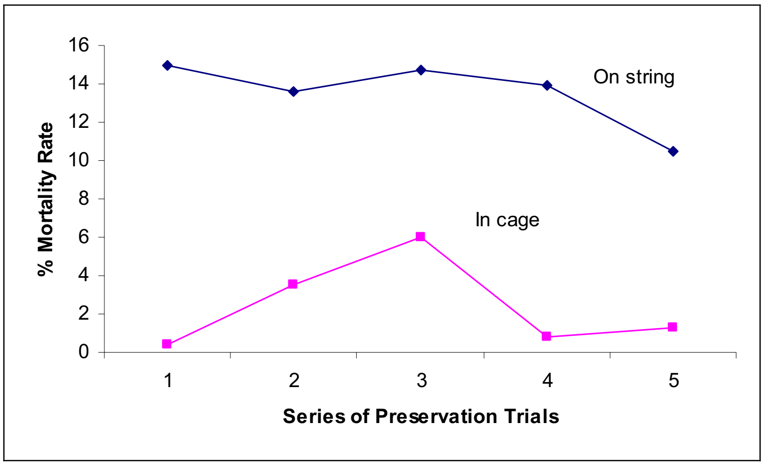

Figure 1. Mortality rate of fish kept in cage and on string

4. COST BENEFIT ANALYSIS

To evaluate the benefits of live fish preservation, a simple cost benefit analysis was conducted based on the cost inputs of the cage (see Table 1), the reduction in mortality of the fish preserved in the cage compared to the fish preserved on a string and the savings in terms of revenue. The results presented on Table 2 show that the payback period is about 13 days. The durability of the cage may be over 4 months.

Table 1. Materials and cost estimates for construction of fish cage (3ftx6.5ft)

S/No.	Item description	Quantity	Estimated cost (K Sh)
1	¾" box tube	3.5 pcs @ 650	8,640
2	Wire mesh	3.5 pcs @ 350	1,225
3	Tray wire	10m @ 350	3,500
4	Paint	1 L @ 800	800
5	Labour	3000	3,000
6		**Total**	**17,165**

Table 2. Mortality of fish preserved with and without the cage and savings in terms of revenue

Without Cage		**With cage**	
Total catch (kg)	200 kg	Total catch (kg)	200
Daily quantity loss	23 kg	Daily quantity savings (kg)	23
Expected price/kg (K Sh)	78	Expected price/kg (K Sh)	78
Actual price/kg (K Sh)	14	Actual price/kg (K Sh)	78
Daily value loss (K Sh)	1,495	Daily savings (K Sh)	1,495
		Investments cost (K Sh)	18,265
		Payback period (Days)	13

5. CONCLUSIONS AND RECOMMENDATIONS

Based on above results, the use of a specially-built fish preservation cage to preserve live fish may reduce mortality of the fish by up to 15%, resulting in higher prices for fresh fish and thus increasing the income of the fishers. The payback period of about 14 days makes investing in the usage of the cage a viable option. The live fish preservation cage concept needs to be expanded to cover parts of Lake Turkana area such as Todonyang (Nairobi area Lodwar town and Kakuma Refugee Camp. It is also recommended that Roto/Kentainers Limited (plastic containers manufacturers) be approached with a view of designing a plastic cage similar to the metal one to reduce costs and increase durability of the cage for fishers.

AMÉLIORATION DES CONDITIONS SOCIOÉCONOMIQUES D'UNE COOPÉRATIVE FÉMININE POUR LE SÉCHAGE ET MARINAGE DE MOULES: FORMATION, MISE AU POINT DU PROCÉDÉ ET MISE EN PLACE DU HACCP

[IMPROVEMENT OF THE SOCIO-ECONOMIC CONDITIONS OF A FEMALE COOPERATIVE FOR DRYING AND BRINING OF MUSSELS: TRAINING, DESIGN OF THE PROCESS AND PUTTING IN PLACE OF THE HACCP]

by/par

Younes ZENATI[1] and Farida SARF

Résumé

Dans le cadre de sa stratégie de développement du secteur artisanal et d'appui des populations de pêcheurs (village de pêche), le Département des pêches maritimes encourage les actions sociales et, en particulier, celles relatives à la parité hommes-femmes.

Dans ce contexte, plusieurs projets ont été initiés, notamment un projet d'appui aux coopératives de femmes conduit par l'Unité genre et développement (UGED) rattachée au Secrétariat général du Ministère de la pêche et financé par l'ONG italienne Centro Mondialità Sviluppo Reciproco (CMSR). Deux coopératives ont été choisies selon les critères prescrits au niveau des termes de références. Ainsi la coopérative des femmes de pêcheur Tigri, sise à Sidi Boulfdail Point de débarquement aménagé (PDA) au sud du Maroc a bénéficié d'une aide pour le développement d'activités rémunératrices.

La principale activité des femmes avant la mise en place du projet était la cueillette des moules, leur décorticage et leur vente à l'état séché. L'objectif de cet appui est la formation et l'encadrement des femmes pour développer leur capacité à l'autogestion ainsi que de leur permettre de travailler dans des conditions d'hygiène meilleures que celles dans lesquelles elles travaillaient, ce qui leur permettrait ainsi de garantir un marché plus étendu à leur produit. Dans ce contexte, deux conventions entre l'Institut spécialisé de technologie des pêches maritimes (ISTPM) et l'UGED ont été signées pour l'assistance technique au démarrage de la production dans les locaux construits au profit de la coopérative féminine Tigri. La première convention visait la formation et l'encadrement des femmes adhérentes. La deuxième convention a été signée pour l'élaboration d'un manuel d'Analyse des risques – points critiques pour leur maîtrise (HACCP).

Les objectifs de formation ont pu être atteints, puisque actuellement les femmes de la coopérative travaillent de façon autonome. La mise au point du procédé a été améliorée, mais un suivi avec une certaine fréquence, notamment pour étudier le vieillissement du produit, doit être fait.

Les changements proposés au niveau de la conception du local ainsi qu'au niveau des équipements et de la gestion devraient être pris en compte pour permettre l'adéquation de la production avec la démarche HACCP.

Mots clés: Groupement de femmes, Valorisation des moules, Environnement

Abstract

Within the development strategy of the artisanal sector and of support to fishers (fishing village), the Moroccan Department of Fisheries encourages social actions and particularly in relation to gender.

In this context several projects were initiated, in particular a project in support of women cooperatives led by the gender and development unit (UGED) within the General Secretariat of the Minister of Fisheries and funded by the Italian NGO Centro mondialita di sviluppo reciproco (CMSR). Two cooperatives were selected based on specific criteria in the terms of reference. Thus the women fishers' cooperative of Tigri in Sidi Boulfdail improved landing site in southern Morocco received assistance to develop income generating activities.

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Previously, the main activity of these women was to harvest mussels, peel and dry them, and sell them as such. The objective of this project aimed at training and supervising the women of the Tigri cooperative to build their capacity in self management, as well as enable them to work in more hygienic conditions than before, thus securing a better access to markets. In this regard, two agreements were signed between High Institute of Marine Fisheries Technology (ISTPM) and UGED in order to provide the necessary technical assistance in the inception of production in facilities constructed for the women's cooperative Tigri. The first agreement aimed at training and supervising the women members. The second was signed to develop a Hazard Analysis and Critical Control Point (HACCP) manual.

The training objectives were achieved, since the women of Tigri's cooperative are now working autonomously. The setting up of the process has been improved but there is still need for more follow-up and supervision, mainly to study the aging process of the product.

The recommended changes in the design of the facility, as well as in the equipment and management, should be taken into consideration to comply with the HACCP plan.

Key words: Grouping of women, Utilization of mussels, Environment

1. INTRODUCTION

Contexte et objectif

Les groupements de femmes exerçant l'activité de pêche au Maroc n'étaient reconnus que récemment grâce à une volonté politique visant la promotion de la femme dans le Secteur des pêches maritimes. Ces femmes apparaissent les plus pauvres sinon les plus vulnérables du secteur face à leurs conditions de travail et à la saisonnalité de leur activité.

Ainsi le Département des pêches maritimes a mis en place un programme de promotion des femmes marins pêcheurs et des femmes et filles des marins pêcheurs; ce programme a évolué par la suite vers le concept du genre et développement.

Dans la mise en oeuvre de certains projets relatifs au dit programme, le Département des pêches maritimes est appuyé par différents partenaires dont le Centro mondialitá di sviluppo reciproco (CMSR) et la Conférence épiscopale italienne (CEI) qui sont intervenus activement dans le financement d'un projet de développement local dans la région sud du Maroc, en faveur de deux coopératives de femmes et des hommes pêcheurs à Imsouane et d'une coopérative féminine à Sidi Boulfdail.

A Sidi Boulfdail, les bénéficiaires directes du projet sont les adhérentes de la coopérative féminine Tigri (20 femmes) qui collectent les moules et les transforment pour les vendre à l'état séché. Les bénéficiaires indirectes sont les autres femmes du douar Sidi Boulfdail et des douars proches qui exercent la même activité.

Le présent projet est géré et exécuté localement par l'UGED qui passe une série de conventions et de sous-traitance pour l'exécution de certaines actions avec d'autres organismes et ONG nationaux.

Dans ce contexte deux conventions entre l'ISTPM et l'UGED ont été signées pour l'assistance technique au démarrage de la production dans les locaux construits au profit de la coopérative féminine Tigri dans le cadre du même projet. La première convention visait la formation et l'encadrement des femmes adhérentes. La deuxième convention a été signée pour l'élaboration d'un manuel HACCP.

2. MÉTHODOLOGIE DE TRAVAIL

Étude socioéconomique

L'appréciation de la population cible s'est fondée sur le diagnostic participatif. Un entretien semi structuré a été administré aux groupements de femme et leur famille ainsi qu'un questionnaire individuel destiné aux femmes exerçant l'activité de ramassage des moules (rapport sur le diagnostic de l'activité de ramassage des moules à Sidi Boulfdail, UGED, 2004). Les données collectées ont été traitées par Excel et analysées dans une perspective de développement durable.

Assistance technique

Formation théorique sur l'hygiène de production (une journée)

a) Projection de diapositives
   La projection de diapositives est accompagnée de commentaires du formateur en langue arabe dialectal traduits simultanément en berbère par l'animatrice du groupe
b) Projection de l'enregistrement des femmes filmées en cours de production
   Cette technique est utile après la présentation purement théorique sur le processus de production car elle permet de montrer aux femmes de façon directe les erreurs qu'elles ont commises. Cette partie de la formation a été donc faite après la fin de la première production

Formation pratique sur le processus de production (6 jours (3+3))

Accompagnement et supervision des adhérentes en cours de production; il a été réalisé sur deux productions (deux marées). Dans la première production, les femmes ont travaillé selon leurs techniques propres tout en suivant les conseils de manipulations qui leurs sont données par le formateur. Cette phase est indispensable pour diagnostiquer les pratiques propres aux femmes et développer avec elles le processus de fabrication. La projection du film, après la fin de cette première production, a permis de synthétiser et de récapituler l'ensemble du processus en mettant aussi l'accent sur l'élément qualité.

Mise au point du procédé: Au cours de la deuxième marée, le travail des femmes a été supervisé en constatant les progrès réalisés dans l'application des prescriptions données au cours de la première visite.

Élaboration du manuel HACCP: Une troisième visite a été nécessaire où le plan de l'unité a été pris ainsi que la liste des équipements et du matériel. Une analyse des dangers et la détermination des points critiques ont été faites sur le processus de séchage et de marinage des moules en tenant compte des conditions d'une petite unité telle que celle-ci.

3. RÉSULTATS ET DISCUSSION

Diagnostic socioéconomique

La population cible est un groupe de femmes marins pêcheurs pratiquant le ramassage de moules dans le site de "Jeleb" à 36 Km au sud de Tiznit. Leur nombre est estimé à 20 femmes âgées de 18 à 35 ans appartenant au douar de Sidi Boulfdail. Ce dernier compte 163 foyers et une population totale d'environ 818 personnes dont 447 sont de sexe féminin.

La période de forte activité dure 4 mois et s'étale entre octobre et décembre quand les moules de grande taille sont disponibles. La collecte des moules se fait à marée basse à une fréquence moyenne de 2 séances par mois avec un pic de 8 pendant la période de forte activité. Les quantités de moules ramassées varient entre 25 et 50 kg par séance de ramassage et chaque séance dure environ 5 heures. Les moules sont ensuite transportées à dos d'âne, décortiquées et séchées. Le taux de conversion est de l'ordre de 1/14; c'est à dire que 14 kg de moules ramassées produisent 1 kg de moules séchées. Le prix de vente moyen ne dépasse pas 20 DH le kg et le revenu mensuel moyen par femme est de l'ordre de 300 DH par mois.

Les conditions de travail de ces femmes sont pénibles en raison de l'éloignement et de la dispersion des points de ramassage, de la difficulté d'accès à ces sites et de la baisse du rendement qui nécessite une multiplication de l'effort déployé. D'autre part le procédé de transformation des moules, effectué par ces femmes, ne respecte pas les normes d'hygiène et de qualité.

La majorité des femmes de la coopérative (18) sont analphabètes, sauf 2 entre elles qui ont un niveau de scolarisation primaire. Cependant elles montrent une motivation pour les cours d'alphabétisation accordés aux femmes du Douar.

En ce qui concerne l'écoulement du produit sur le marché, on peut dire qu'il existe un marché potentiel pour les moules séchées. En effet, dans une autre étude (Naji, 2006) commanditée par l'UGED concernant la commercialisation de moules et de poisson fumé, il ressort entre autre, que les femmes, en se groupant en coopérative, en dotant les moules d'un certificat sanitaire et en organisant mieux les opérations de commercialisation, celles-ci peuvent, en fournissant nettement moins d'efforts pour la mise en filet des moules fraîches, multiplier leur revenu par dix (le kilo de moule fraîche sera vendu au prix de la moule séchée). Cependant, toujours selon la même référence, c'est la mise au point de procédés de traitement sains et agrées, suivie d'un important effort de communication commerciale qui pourrait différencier et démarquer clairement le produit de la Coopérative du reste de l'offre du marché traditionnel.

Formation et encadrement
Compte tenu du diagnostic et afin de développer les capacités de promotion et d'autogestion de cette population, une animatrice a été recrutée pour accompagner les femmes durant la période d'exécution du projet. Pour ce qui est de l'encadrement, le projet a proposé en plus de la formation technique des femmes de la coopérative une série de formation qui comprend les volets suivant: alphabétisation fonctionnelle (utilisation des modules adaptés à cette population); formations sur les normes de sécurité, les conditions d'hygiène et de qualité; formation sur la gestion de la coopérative; formations diverses (civique, sanitaire);

Au cours des formations techniques théoriques et pratiques bon nombre de remarques ont été faites sur la démarche à suivre lors de la production dans une optique qualité:

- Eviter de déposer les caisses, panier ou marmites à même le sol.
- Distinguer entre les seaux de lavage de matière première, des moules décortiquées et des seaux de nettoyage (eau + détergent) par des couleurs différentes.
- Respecter la marche en avant, et à ce propos un schéma simplifié de l'unité avec les principales flèches de flux a été exposé et expliqué au cours de la présentation orale.
- Information sur les objets à proscrire au cours de la production comme bagues, boucles ou bracelets.
- Information sur les gestes à proscrire au cours de la production comme manger, boire ou éternuer sur le produit, etc.
- Couvrir le produit au cours du séchage et le rentrer chaque soir.
- Il serait intéressant et judicieux que toutes ces informations soient rappelées aux femmes par des pancartes expressives à l'instar de ce qui se fait au niveau des unités industrielles.
- De plus, une notice en arabe sur les instructions de préparation a été fournie à l'animatrice du groupe.

4. FORMALISATION ET MISE AU POINT DU PROCESSUS DE PRODUCTION

La période de formation a été aussi l'occasion de mettre au point le processus de fabrication. Les étapes de ce processus sont déjà connues par les femmes cependant certaines remarques ont été faites pour que la production soit en adéquation avec les normes de qualité internationalement reconnues.

a) Lavage et nettoyage des moules
Il est conseillé que les coquilles des moules soient bien lavées au niveau du site de la cueillette pour éviter d'une part une grande consommation d'eau potable au niveau de l'usine (ce qui a deux conséquences: débordement de la fosse septique et augmentation de la facture d'eau potable).

D'autre part, le sable qui s'incruste dans les coquilles mal dégagées se retrouve dans la chair lors de l'ouverture des coquilles au cours de la cuisson. D'autant plus que dans la conception de l'unité, il n'y a pas de possibilité de dégorgement des moules (pas de bassin de dégorgement).

Par ailleurs pour bien finaliser ce lavage, il a été aussi conseillé de procéder à un brossage des moules en les plongeant dans un bassin faiblement rempli d'eau. Ce conseil a même été mis en application et il a été effectivement constaté que cette technique permet une bonne friction des coquilles entre elles et avec la brosse. La présence d'eau permet de récupérer les grains de sable.

Cette étape est particulièrement importante à maîtriser si on veut éviter de retrouver des grains de sable dans les moules séchées.

b) Décorticage des moules
Ce travail est manuel et nécessite un lavage des mains immédiatement avant le commencement de la tâche. Par ailleurs, l'organisation de l'espace tel qu'elle a été prévue selon le plan de construction doit être revue car les femmes n'utilisent pas le potager conçu au départ: elles préfèrent s'asseoir et déposer les paniers sur les tabourets pour travailler. Des tables plastiques ont été donc introduites et mises au centre de la salle. Les femmes s'installent autour de ces tables, assises sur des tabourets pour décortiquer les moules. Or dans cette nouvelle organisation, le potager, en plus des tables placées au centre de la salle obstruent complètement le passage d'une extrémité à l'autre. Il est donc préférable de réorganiser l'espace: en effet l'élimination du potager ainsi que du mur séparant la salle de décorticage de la chambre, prévue au départ pour le rangement du matériel, permettrait de mieux organiser le travail dans la salle et notamment le respect de la marche en avant.

c) Évacuation des eaux de lavage de la salle de réception et de la salle de décorticage

L'absence de canalisations au niveau de ces deux salles complique l'évacuation de l'eau. En fait, ceci oblige les femmes à récupérer ces eaux dans des seaux et les sortir par l'entrée et le déverser juste devant l'usine; à la longue cette pratique aura des conséquences néfastes, notamment en matière de respect de l'environnement qui aura nécessairement un impact sur les conditions d'hygiène dans l'environnement direct de l'unité.

En outre, le déversement de ces seaux ne se fait qu'à la fin du travail pour des questions de bonnes pratiques mais aussi de disponibilité des femmes. Ce qui a pour conséquence une accumulation des seaux à l'entrée de l'usine et cause un encombrement et une obstruction du passage au niveau du couloir central entraînant à la longue une désorganisation dans le travail.

Pour cela on conseille qu'une tuyauterie d'évacuation soit réalisée dans chacune de ces deux salles.

d) Lavage des moules décortiquées

Les femmes avaient l'habitude de laver les moules décortiquées avec l'eau de mer. Cette pratique est à proscrire car l'eau de mer aussi claire qu'elle puisse paraître, est toujours chargée de grains de sable. Cependant les femmes jusqu'alors avaient toujours refusé de laver avec l'eau potable expliquant ceci par le fait que l'eau potable ferait perdre le goût aux moules. Cette hypothèse n'est pas à écarter totalement car la différence de salinité pourrait effectivement provoquer la diffusion de certains solutés vers l'eau de lavage (parmi lesquels les composés responsables du goût).

Afin d'éviter ce problème, il a été proposé un lavage répété des moules décortiquées dans une saumure légère (pour éviter la diffusion des solutés vers l'eau par phénomène d'osmose); le lavage répété par immersion dans plusieurs seaux successifs permet un meilleur dessalement, notamment pour les pièces se trouvant au fond du seau. En effet celles-ci se trouvent trop proches du décantât, rendant ainsi la séparation quasiment impossible.

e) Séchage des moules

Surface de séchage: la surface de séchage (séchoir inox) parait ne pas être suffisante pour traiter l'ensemble de la production d'une marée. Il est donc nécessaire de réaliser d'autres prototypes ou faire une extension de la surface de séchage en utilisant la terrasse.

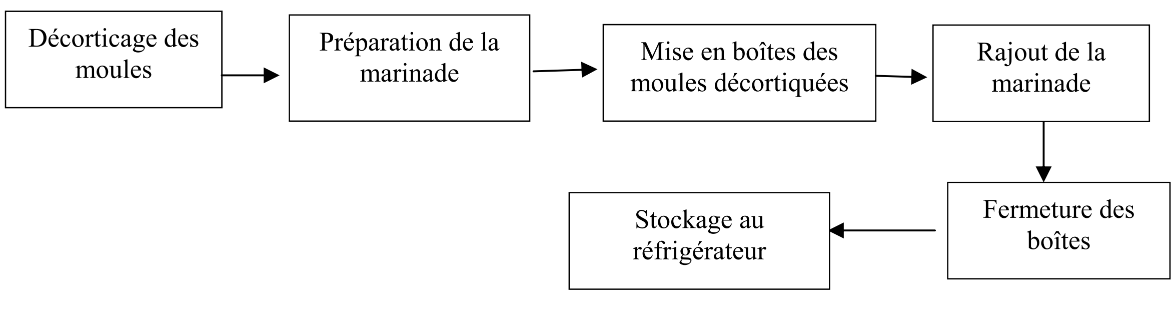
Une autre idée serait de fixer des grilles de séchage en étagère le long des murs de la cour destinée au séchage.

f) Alternative au séchage: marinage des moules

Il a été aussi donné de constater que la technique de séchage pourrait ne pas permettre une rentabilité suffisante surtout au départ où le produit n'est pas suffisamment connu dans son marché potentiel mais aussi par la capacité de production réduite de l'unité (surface de séchage réduite). Dans ce cas une transformation du même type pourrait être développée en parallèle avec la première et qui est le marinage.

En effet, le marinage des moules ne nécessite par rapport à ce qui existe déjà qu'un investissement en consommable additionnel peu coûteux. De plus la production ne sera faite que sur commande en petits lots, car la durée de validité de produit est restreinte par rapport au séchage, en effet La DLC de moules marinées existant déjà sur le marché est de six mois.

Le procédé suivant a été proposé et réalisé avec les femmes:



g) *Rejet des déchets solides*

Les déchets solides de même que les rejets liquides vont agresser l'environnement direct de l'usine si aucune action n'est entreprise pour organiser la gestion de ces déchets. Ainsi les coquilles des moules sont déposées en tas à trois ou quatre mètres de l'unité. Les femmes comptent s'en débarrasser par le passage des agriculteurs des environs à dos d'âne qui les prend pour en faire de la fumure après qu'ils soient séchés au soleil. Cependant, il reste qu'ils vont séjourner pendant un temps plus ou moins long avant qu'ils ne soient ramassés.

Les sacs plastiques ainsi que les cartons d'emballages sont jetés temporairement au cours de la production à peu près à la même distance, mais dans un autre endroit. En fin de production, ils sont incinérés.

L'idée d'incinération est peut être à garder puisqu' aucune autre issue ne parait être réalisable sauf qu'il faudrait aménager un foyer en brique à l'intérieur duquel seraient incinérés ces déchets, pour que ceux-ci ne restent pas exposés à la vue.

5. ÉLABORATION DU MANUEL HACCP

Sur la base de la bibliographie disponible sur les moules et leur transformation une description des produits moules marinées et moules séchées a été élaborée (Annexe I).

L'analyse des Dangers (Annexe II) et la détermination des points de contrôle critiques (Annexe III) ont donné:

- Pour le processus des moules séchées les PCC suivants: Réception des moules fraîches, séchage, Emballage et Stockage du produit fini;
- Pour les moules marinées, les étapes du procédé qui ont été retenues comme PCC sont: Réception des moules fraîches, Préparation de la marinade et Marinage et Stockage du produit fini.

Sur cette base le plan HACCP (Annexe IV) concernant la transformation des moules séchées et marinées a été dressé pour l'unité en question.

Cependant lors de l'établissement du manuel il a été relevé un certain nombre de remarques sur l'incohérence de certains points avec l'application du manuel HACCP; une série de remarques ont été faites lors de la remise du manuel au commanditaire pour que ces éléments indispensables soient pris en compte avant la validation du manuel HACCP et qui sont:

- **Équipement et installations:**
  Pédiluves, inscriptions de rappel pour le personnel, carrelage salle décorticage, évacuation déchets solides, piège à rat, matériel pour le contrôle de routine (thermomètre, pH mètre, densimètre) et l'étalonnage du matériel.
- **Gestion qualité:**
  Désigner un responsable qualité;
  Établir une convention avec la municipalité pour programme désinsectisation et dératisation;
  Établir, pour la phase de démarrage, une convention avec un laboratoire de contrôle et ce pour réaliser les analyses des produits finis vu la situation de la coopérative ne lui permettant pas de s'équiper pour faire ces propres analyses sur les produits finis.

6. IMPACT DU PROJET SUR LES CONDITIONS SOCIOÉCONOMIQUES DES FEMMES

Après la mise en place du projet en faveur des femmes de la coopérative "Tigri", les moules séchées ont une valeur nettement supérieure et leur prix de vente est passé de 20 DH le kg à 100 DH le kg ce qui a permis l'augmentation du revenu des adhérentes de plus de 200%.

L'introduction du procédé des moules marinées a permis aux femmes de diversifier leur production et garantir un travail pérenne même en période humide.

Les efforts du projet qui se sont articulés essentiellement sur les actions de formation et d'encadrement de la coopérative ont été d'un apport social positif. Les femmes, au cours du projet, ont développé progressivement les aptitudes, les compétences et la confiance en elles mêmes, qualités requises pour développer leur activité. Cette nouvelle situation leur a permis de s'ouvrir sur le monde extérieur, comme leur participation dans des ateliers ou foire en dehors du douar, voire même dans d'autres villes. Elle leur a permis aussi de développer leur capacité de gestion de la coopérative, comme par exemple leurs actions et relations avec différentes administrations, banques ou autres.

Le projet a eu aussi un impact positif sur l'environnement:

- Grâce aux bonnes pratiques d'hygiène, l'unité de valorisation produit des moules salubres et de qualité;
- Le travail au sein de l'unité de valorisation génère une propreté du douar et la côte avoisinante, les femmes ne travaillant plus au bord de la mer ou près de leur maison.

Le projet a été conçu de telle façon à inciter les femmes à respecter la réglementation. En effet, seules les moules de taille marchande réglementaire (6 cm ou plus) sont admises à la réception de l'unité de valorisation. Cette mesure préserve les gisements naturels grâce à une diminution de la pression de ramassage des moules de petite taille.

La mise en place de l'unité de valorisation près du point de débarquement aménagé de Sidi Boulfdail a valorisé l'activité de ramassage des moules dans la région. Sa position près de la station balnéaire Mirleft et son emplacement sur la route côtière reliant la ville de Tiznit à TanTan lui permet d'être un pôle attractif pour les touristes de la région et les voyageurs de passage. D'autre part, la dimension sociale et écologique du projet facilitera à la coopérative de trouver un marché potentiel au niveau des villes du royaume où l'exploitation des moules est interdite (problème d'insalubrité du milieu) ou inexistante. De même, elle lui permettra de diversifier sa clientèle actuelle (Marchés traditionnels) en essayant de conquérir d'autres segments de marchés, plus modernes et également plus lucratifs.

7. CONCLUSIONS ET RECOMMANDATIONS

Le projet d'appui à la coopérative féminine de Sidi Boulfdail constitue une opportunité pour le Département des Pêches Maritimes qui s'ajoute aux efforts actuellement consentis dans la région pour promouvoir le développement durable et la promotion socioéconomique des marins pêcheurs et des femmes marins pêcheurs. En effet, les résultats atteints montrent bien que le projet a pu contribuer au développement souhaité:

- Les objectifs de formation ont donc pu être atteints, puisque actuellement les femmes de la coopérative travaillent de façon autonome.
- La mise au point du procédé a été améliorée, mais un suivi avec une certaine fréquence, notamment pour étudier le vieillissement du produit doit être fait.
- Les changements proposés au niveau de la conception du local ainsi qu'au niveau des équipements et de la gestion devraient être pris en compte pour permettre l'adéquation de la production avec la démarche HACCP.
- L'augmentation du revenu des femmes ainsi que leur bien être au sein de l'unité de valorisation leurs permettront de réduire le temps du travail et être plus disponibles pour participer à d'autres activités culturelles dans la région.
- La structure de l'unité de valorisation des produits de la mer étant intégrée dans le cadre organisationnel du point du débarquement aménagé de la région favorise la participation des femmes à toutes les activités relatives au secteur ce qui renforcera son rôle dans le développement économique, l'équité sociale et la protection de l'environnement.

La pérennité du projet dépendra de la capacité des femmes à poursuivre les activités du projet, une fois cessé l'appui extérieur. Plusieurs facteurs interviennent et conditionnent cette pérennité:

- Les femmes de la coopérative ont exprimé des besoins supplémentaires en appui technique et en supervision même après l'achèvement du projet. Sachant que le succès du projet dépend de la capacité technique des femmes dans leur poste à exécuter toutes les activités prévues.
- Pour assurer un circuit de commercialisation efficient pour un tel produit de terroir, il est nécessaire pour la coopérative d'avoir une stratégie commerciale et d'élaborer un plan marketing, sachant que ces volets n'ont été que partiellement prévus dans les actions du projet.

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ANNEXE I

Description des produits

1. Description des moules séchées

Nom du produit	Moules séchées
Source de la matière première	Falaise sur le site de Sidi Boulfdail et environs
Caractéristiques importantes du produit final	Humidité ≤ 16%
Ingrédients	Sel et eau
Emballage	Sachet sous vide (150 g)
Mode opératoire d'utilisation des produits finals	Mettre le produit 24h pour réhydratation avant préparation
Durée de conservation	12 mois
Endroits ou les produits sera vendu	Marché local
Instructions d'étiquetage	Nom du produit; Poids net; date de production; DLC
Contrôle spécial de la distribution	Entreposé dans une zone sèche à température ambiante

2. Description des moules marinées

Nom du produit	Moule mariné
Source de la matière première	Falaise sur site Sidi Boulfdail et environs
Caractéristiques importantes du produit final	Température <4 °C pH ≤ 4, 5
Ingrédients	Eau; vinaigre; sel; oignon; poivre blanc; piment rouge; feuille de laurier: clou de girofle; coriandre en grains; fenouillet
Emballage	Bocaux en verre ou en plastique
Mode opératoire d'utilisation des produits finals	Consommer sans besoin de cuisson
Durée de conservation	6 mois < 4 °C
Endroits ou les produits sera vendu	Marché local
Instructions d'étiquetage	Nom du produit; poids net; date de production; DLC
Contrôle spécial de la distribution	Entreposage réfrigéré à < 4 °C

Diagramme de fabrication des moules séchées

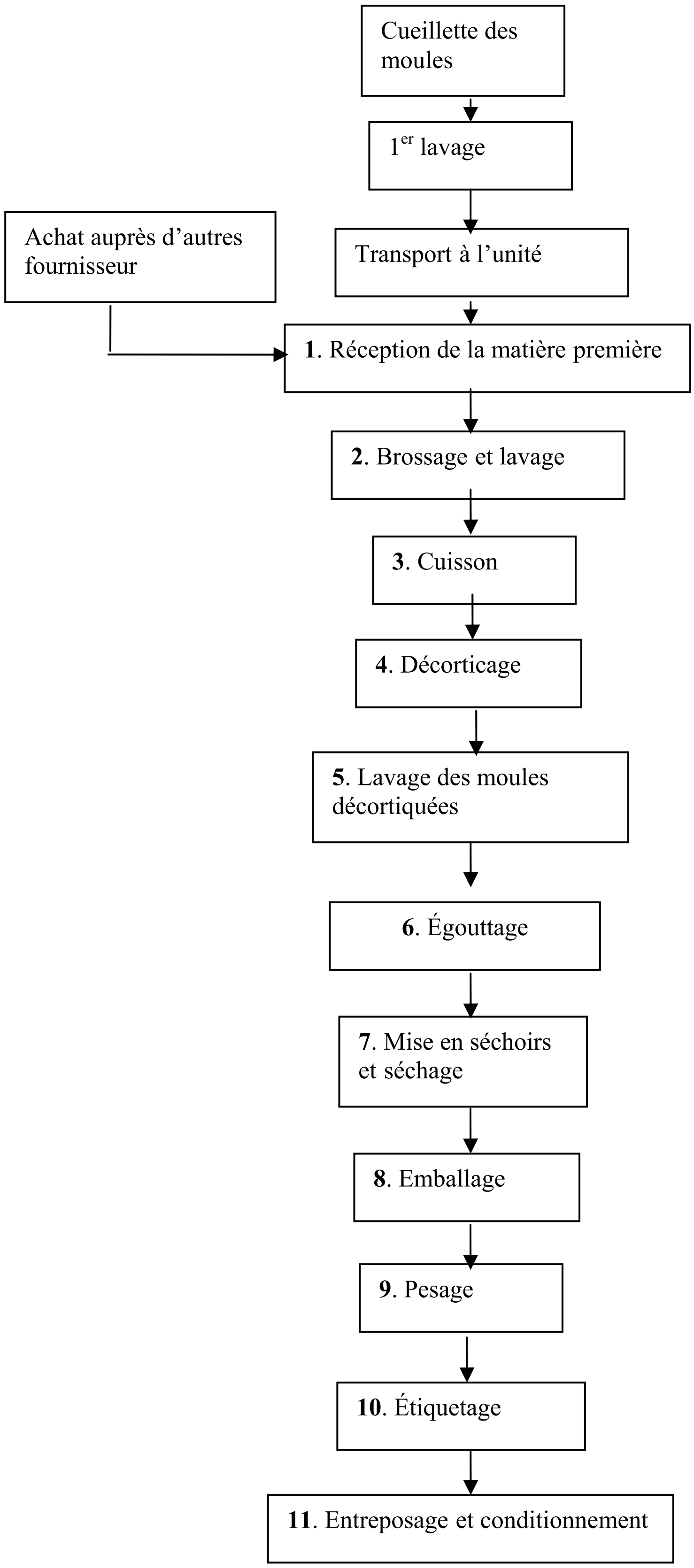
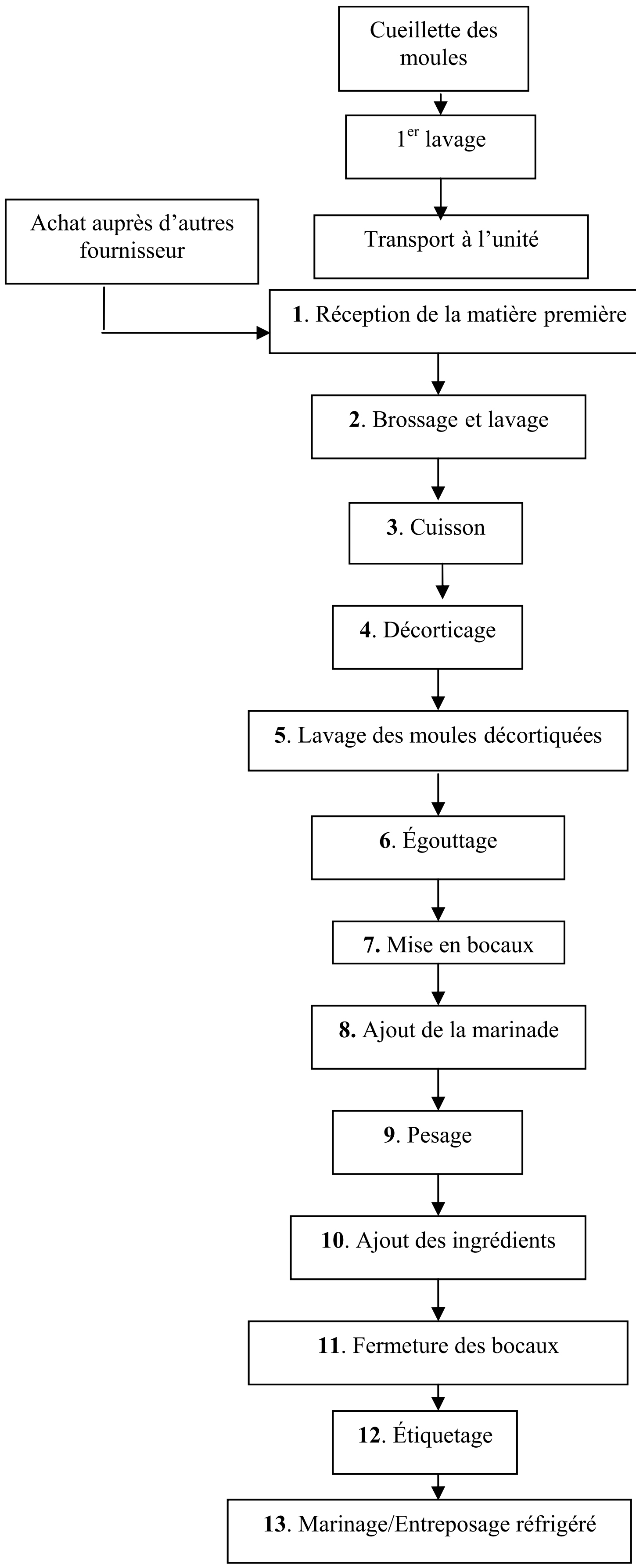


Diagramme de fabrication des moules marinées



ANNEXE II

Analyse des dangers: moules séchées

Étape dans le processus	Types de dangers	Dangers	Criticité	Justification éventuelle de son exclusion comme danger important	Mesures préventives
Réception	Dangers biologiques	Bactéries pathogènes	Élevée	-	La prolifération des bactéries dans les mollusques récoltés concerne les animaux morts, on peut prévenir ce problème par le contrôle temps/température (voir Annexe I, FC 001)
		Virus	Élevée	-	Zone de récolte salubre, certifiée par l'INRH (RNS) (voir Annexe I, FC 001)
		Biotoxines	Élevée	-	
		Parasites	Élevée	Tués par la cuisson lors de l'ouverture des moules	Traitement thermique et salage ultérieurs
		Amines biogéniques	Faible	-	-
		Bactéries d'altération	Élevée		Contrôle temps/température
	Danger chimique	Produits chimiques: métaux lourds et hydrocarbures	Faible	Zone de récolte contrôlée	Zone de récolte salubre, certifiée par l'INRH (RNS) (voir Annexe I, FC 001)
	Danger physique	Morceaux de coquilles Corps étrangers	Faible	Le produit est lavé et brossé avant d'être ouvert, tous les débris sont donc éliminés à cette étape	Sensibilisation et motivation du personnel Respect des bonnes pratiques de fabrication (maîtrise du lavage FC 007, procédure de fabrication P 001)
Brossage/ lavage	Dangers biologiques	Prolifération des bactéries	Faible	Les moules sont lavées par lots et acheminées vers la cuisson	Contrôle de la cadence de travail (voir Annexe I, FC 019)
	Danger chimique	Aucun	S.O.[1]	-	-
	Danger physique	Fils plastiques de brosses	Faible	Les moules sont encore fermées	Respect des bonnes pratiques de fabrication (voir Procédure Fabrication P 001)
Cuisson	Dangers biologiques	Contamination croisée par bactérie lors du transvasement et récupération des moules cuites ouvertes	Élevée	Le transvasement des moules cuites ouvertes se fait dans un keskass lavé auparavant	Respect des bonnes pratiques hygiéniques Sensibilisation du personnel à la contamination croisée (voir Annexe I, FC 013)
	Danger chimique	Aucun	S.O.		

[1] S.O. = Sans Objet

Étape dans le processus	Types de dangers	Dangers	Criticité	Justification éventuelle de son exclusion comme danger important	Mesures préventives
	Danger physique	Aucun	S.O.		
Décorticage	Dangers biologiques	Contamination croisée	Élevée	Sensibilisation du personnel à la contamination par les mains	Respect des règles hygiéniques Sensibilisation du personnel à l'hygiène. (voir Annexe I, FC 013)
	Danger chimique	Contamination par reste détergent	Faible	Contrôle de l'efficacité du nettoyage et désinfection	Propreté des équipements (voir procédure N & D et FC 012)
	Danger physique	Reste des coquilles	Faible	Contrôle des moules par le lavage qui suit	Respect des bonnes pratiques de fabrication; (voir: Procédure Fabrication P 001)
Lavage des moules décortiquées	Dangers biologiques	Croissances des bactéries		Lavage dans l'eau salée	Respect des bonnes pratiques de fabrication Respect des règles hygiéniques (voir Annexe I, FC 013)
	Danger chimique	Contamination par reste détergent	Faible	Contrôle de l'efficacité du nettoyage et désinfection	Propreté des équipements (voir procédure N & D et FC 012)
	Danger physique	Aucun	S.O.		
Égouttage	Dangers biologiques	Contamination croisée Croissances des bactéries	Élevée	Zone d'égouttage propre et sèche Les moules sont salées l'égouttage est rapide	Respect des règles hygiéniques Sensibilisation du personnel Contrôle du temps (voir Annexe I, FC 013)
	Danger chimique	Contamination par reste détergent	Faible	Contrôle de l'efficacité du nettoyage et désinfection	Propreté des équipements (voir procédure N & D et FC 012)
	Danger physique	Aucun	S.O.		
Mise en séchoir/ séchage	Dangers biologiques	Contamination par bactéries de l'air	Élevée		Élimination de toute la microflore ou presque par le salage + baisse rapide de l'humidité en surface
		Produit fini altéré à cause d'un séchage insuffisant	Élevée		Séchage solaire en 3 jours au maximum H% finale entre 12 et 15%
	Danger chimique	Contamination par reste détergent	Faible	Contrôle de l'efficacité du nettoyage et désinfection	Propreté des équipements (voir procédure N & D, FC 012)
	Danger physique	Dépôt de corps étrangers et de poussière sur le produit	Élevée		Respect des bonnes pratiques de fabrication: couvertures des séchoirs par les moustiquaires Ne pas sécher les jours de mauvaises conditions climatiques

Étape dans le processus	Types de dangers	Dangers	Criticité	Justification éventuelle de son exclusion comme danger important	Mesures préventives
Emballage sous-vide	Dangers biologiques	Recontamination lors du remplissage	Élevée	Mise en emballage avec gants jetables	Respect des bonnes pratiques hygiéniques, (FC 013)
	Danger chimique	Aucun	S.O.		
	Danger physique	Perforation du plastique	Élevée		Réglage du vide Plastique de bonne qualité Maîtrise du conditionnement
Pesage	Dangers biologiques	Aucun	S.O.		
	Danger chimique				
	Danger physique				
Étiquetage	Dangers biologiques	Aucun	S.O.		
	Danger chimique	Aucun	S.O.		
	Danger physique	Poussière empêchant le collage des étiquettes	Faible	Le personnel est sensibilisé au travail organisé	Emballages vides propres (FC015) Surfaces de travail nettoyées (FC013) Étiquettes rangées
Stockage	Dangers biologiques	Moules séchées altérées à cause d'une réhumidification au cours du stockage	Élevée		Emballage approprié et maîtrise des conditions de stockage (FC006)
	Danger chimique	Aucun	S.O.		
	Danger physique	Effritement des moules par pression des paquets	Élevée	Personnel sensibilisé sur la qualité marchande du produit	Maîtrise des conditions de stockage (voir Annexe II, P002: procédure de séchage des moules)

Analyse des dangers: moules marinées

Étape dans le processus	Types de dangers	Dangers	Criticité	Justification de son exclusion comme danger important	Mesures préventives
Réception	Dangers biologiques	Bactéries pathogènes	Élevée	Si les moules sont collectées près de l'unité, la prolifération serait négligeable	La prolifération des bactéries dans les mollusques récoltés concerne les animaux morts, on peut prévenir ce problème par le contrôle temps/température (voir Annexe I, FC 001)
		Virus	Élevée		Zone de récolte salubre, certifiée par l'INRH (RNS) (voir Annexe I, FC 001)
		Biotoxines	Élevée		
		Parasites	Élevée	Tués par la cuisson lors l'ouverture des moules	Traitement thermique et salage ultérieurs
		Amines biogéniques	Faible	-	-
		Bactéries d'altération	Élevée		Contrôle temps/température
	Danger chimique	Produits chimiques: métaux lourds et hydrocarbures	Faible	Zone de récolte contrôlée	Zone de récolte salubre, certifiée par l'INRH (RNS) (voir Annexe I, FC 001)
	Danger physique	Morceaux de coquilles Corps étrangers	Faible	Le produit est lavé et brossé avant d'être ouvert, tous les débris sont donc éliminés à cette étape	Sensibilisation et motivation du personnel Respect des bonnes pratiques de fabrication (maîtrise du lavage FC 007, procédure de fabrication P 001)
Brossage/ lavage	Dangers biologiques	Prolifération des bactéries	Faible	Les moules sont lavés par lots et acheminées vers la cuisson	Contrôle de la cadence de travail (voir Annexe I, FC 019)
	Danger chimique	Aucun	S.O.	-	-
	Danger physique	Fils plastiques de brosses	Faible	Les moules sont encore fermées	Respects des bonnes pratiques de fabrication (voir Procédure Fabrication P 001)
Cuisson	Dangers biologiques	Contamination croisée par bactérie lors du transvasement et récupération des moules cuites ouvertes	Élevée	Le transvasement des moules cuites ouvertes se fait dans un keskass lavé auparavant	Respects des bonnes pratiques hygiéniques Sensibilisation du personnel à la contamination croisée (voir Annexe I, FC 013)
	Danger chimique	Aucun	S.O.		
	Danger physique	Aucun	S.O.		

Étape dans le processus	Types de dangers	Dangers	Criticité	Justification de son exclusion comme danger important	Mesures préventives
Décorticage	Dangers biologiques	Contamination croisée	Élevée	Sensibilisation du personnel à la contamination par les mains	Respect des règles hygiéniques Sensibilisation du personnel à l'hygiène. (voir Annexe I, FC 013)
	Danger chimique	Contamination par reste détergent	Faible	Contrôle de l'efficacité du nettoyage et désinfection	Propreté des équipements (voir procédure N & D et FC 012)
	Danger physique	Restes des coquilles	Faible	Contrôle des moules par le lavage qui suit.	Respect des bonnes pratiques de fabrication; (voir Procédure Fabrication P 001)
Lavage des moules décortiquées	Dangers biologiques	Croissances des bactéries		Lavage dans l'eau salée	Respect des bonnes pratiques de fabrication Respect des règles hygiéniques (voir Annexe I, FC 013)
	Danger chimique	Contamination par reste détergent	Faible	Contrôle de l'efficacité du nettoyage et désinfection	Propreté des équipements (voir procédure N & D et FC 012)
	Danger physique	Aucun	S.O.		
Égouttage	Dangers biologiques	Contamination croisée Croissances des bactéries	Élevée	Zone d'égouttage propre et sèche Les moules sont salées l'égouttage est rapide	Respect des règles hygiéniques Sensibilisation du personnel Contrôle du temps (voir Annexe I, FC 013)
	Danger chimique	Contamination par reste détergent	Faible	Contrôle de l'efficacité du nettoyage et désinfection	Propreté des équipements (voir procédure N & D et FC 012)
	Danger physique	Aucun	S.O.		
Préparation de la marinade	Dangers biologiques	Contamination par des bactéries pathogènes	Élevée	Bonnes pratiques de manipulation et de la préparation Maîtrise de la recette de préparation Mesure permanente de pH de la marinade	Respect des quantités vinaigre et sel à préparer pH de la marinade ≤ 4,5 (voir Annexe I, FC 009)
	Danger chimique	Aucun danger détecté	S.O.		
	Danger physique	Présence des corps étrangers	Faible	Contrôle de la qualité des ingrédients avant l'utilisation	Utilisation des ingrédients de bonne qualité (Annexe I, FC 004)
Remplissage de boîtes par les moules	Dangers biologiques	Recontamination lors du remplissage	Élevée	Mise en emballage avec gants jetables	Respect des bonnes pratiques hygiéniques (voir Annexe I, FC 013)
	Danger chimique	Aucun	S.O.		
	Danger physique	Introduction de corps étrangers	Faible		Respect des bonnes pratiques hygiéniques (voir Annexe I, FC 013 et FC 003)

Étape dans le processus	Types de dangers	Dangers	Criticité	Justification de son exclusion comme danger important	Mesures préventives
Pesage	Dangers biologiques Danger chimique Danger physique	Aucun	S.O.		
Rajout de la marinade	Dangers biologiques	Croissance des bactéries pathogènes	Faible	Maîtrise du pH du produit et de la marinade (pH ≤ 4,5)	pH du produit mariné et de la marinade doit être inférieur à 4,5 (voir Annexe I, FC 009)
	Danger chimique	Excès de sel ou de vinaigre	Faible		(Voir fiche procédure préparation marinade P 003)
	Danger physique	Présence de corps étrangers	Faible	Contrôle des additifs à la réception, à l'entreposage et avant l'expédition	
Fermeture manuelle des boîtes	Dangers biologiques	Recontamination par les staphylocoques	Faible	Respect des règles d'hygiène - bonnes conditions de manipulation - vérification de la fermeture des boîtes	Sensibilisation et formation régulière du personnel (voir Annexe I, FC 018)
	Danger chimique	Aucun danger détecté	S.O.		
	Danger physique	Présence de poussière sur les couvercles	Faible	Vérification de la propreté des couvercles avant utilisation	Contrôle des emballages avant utilisation (voir Annexe I, FC 003)
Etiquetage	Dangers biologiques	Aucun	S.O.		
	Danger chimique	Aucun	S.O.		
	Danger physique	Poussière empêchant le collage des étiquettes	Faible	Le personnel est sensibilisé au travail organisé	Emballages vides propres (FC 003) Surfaces de travail nettoyées (FC 012) Étiquettes rangées
Marinage/ stockage	Dangers biologiques	Faible acidification du produit engendrant une contamination	Élevée		Emballage approprié et maîtrise des conditions de stockage (voir Annexe I, FC 021)
	Danger chimique	Aucun	S.O.		
	Danger physique	S.O.	-	-	-

ANNEXE III

Détermination des PCC: moules séchées

Étape du procédé	Dangers	**Question 1** Des mesures de maîtrise sont-elles en place pour le danger considéré? Si oui passer à la question 2. Si aucune mesure de maîtrise n'est en place et que la maîtrise à cette étape est nécessaire pour la sécurité du produit, il faut modifier l'étape, le procédé ou le produit.	**Question 2** Cette étape élimine-t'elle le danger ou en réduit-elle l'occurrence à un niveau acceptable? Si le danger est éliminé l'étape est un PC. Si non on passe à la question 3.	**Question 3** Une contamination peut-elle intervenir, ou le danger peut-il s'accroître, jusqu'à un niveau acceptable? Si oui on passe à la question 4, si non stop*	**Question 4** Une étape ultérieure peut-elle éliminer le danger ou en réduire la probabilité d'occurrence à un niveau acceptable? S'il n'existe pas d'étape cette étape est un PC Si oui stop*	PCC
Réception des moules fraîches	- Bactéries pathogènes - Virus - Biotoxines	Oui	Oui			Oui
	- Bactéries d'altération	Oui	Oui			Oui
Séchage	Contamination par bactéries de l'air	Oui	Non	Oui	Non	Oui
	Produit fini altéré à cause d'un séchage insuffisant	Oui	Non	Oui	Non	Oui
	Dépôt de corps étrangers et de poussière sur le produit	Oui	Non	Oui	Non	Oui
Emballage	Perforation du plastique	Oui	Non	Oui	Non	Oui
Stockage du produit fini	Moules séchées altérées à cause d'une réhumidification au cours du stockage	Oui	Non	Oui	Non	Oui

Détermination des PCC: moules marinées

Étape du procédé	Dangers	Question 1 Des mesures de maîtrise sont-elles en place pour le danger considéré? Si oui, passer à la question 2. Si aucune mesure de maîtrise n'est en place et que la maîtrise à cette étape est nécessaire pour la sécurité du produit, il faut modifier l'étape, le procédé ou le produit.	Question 2 Cette étape élimine-t'elle le danger ou en réduit-elle l'occurrence à un niveau acceptable? Si le danger est éliminé l'étape est un PC. Si non on passe à la question 3.	Question 3 Une contamination peut-elle intervenir, ou le danger peut-il s'accroître, jusqu'à un niveau acceptable? Si oui passer à la question 4, si non stop*	Question 4 Une étape ultérieure peut-elle éliminer le danger ou en réduire la probabilité d'occurrence à un niveau acceptable? S'il n'existe pas d'étape cette étape est un PC Si oui stop*	PCC
Réception des moules fraîches	- Bactéries pathogènes - Virus - Biotoxines	Oui	Oui			Oui
	- Bactéries altération	Oui	Oui			Oui
Préparation de la marinade		Oui	Non	Oui	Non	Oui
Marinage (en cours de stockage)	Prolifération des germes tolérants (acidophile et halophiles) à cause d'un marinage inadéquat	Oui	Non	Oui	Non	Oui
Stockage du produit fini	Prolifération des moisissures et levures à cause d'un mauvais stockage à une température < 4 °C	Oui	Non	Oui	Non	Oui

ANNEXE IV

Plan HACCP - moules séchées

(CCP)	Danger	Seuils critiques	Procédures de surveillance				Action(s) corrective(s)	Vérification
			Quoi	Comment	Quand	Qui		
Réception	-Moules insalubres -Moules altérées	Absence de toxicité < 300 coliformes fécaux/100 g de chair de mollusque ou < 230 *E. coli*/100 g de chair de mollusque	Salubrité de la zone de cueillette État bactériologique des moules cueillies	Contact du réseau de surveillance: certificat de salubrité de la zone Prise d'échantillon et analyse au laboratoire	À chaque marée (15 jours) À chaque marée (15 jours	Responsable qualité	Rejet du lot en cas de moules insalubre ou altérées	Le responsable du contrôle qualité vérifie et examine quotidiennement la fiche de contrôle à la réception donnée par le laboratoire et le certificat de salubrité donné par l'INRH et le registre des mesures correctives (FC 001 et FC 017)
Séchage	Développement de germes xérophiles et osmophiles	H% ≤ 55% après 24 heures de séchage H%≤ 18% après 72 heures	Humidité du produit	Mesure de l'humidité à l'humidimètre	En cours et à la fin de chaque séchage	Responsable laboratoire	Écarter le lot concerné, voir son innocuité. Si non contaminé remettre à sécher	Le responsable du contrôle qualité vérifie et examine quotidiennement la fiche de contrôle et le registre des mesures correctives (FC 006 et FC 017) Étalonnage de l'humidimètre
	Survie des spores de *Clostridium botulinum* Altération	Étanchéité des sachets Sachets non conformes	Sachets non étanches	Contrôle d'étanchéité Inspection visuelle sachets propres	Chaque journée de travail	Responsable laboratoire	- Écarter les pièces contenant des parasites visibles - Sensibilisation et motivation du personnel Respect des règles d'hygiène Contrôle des équipements de séchage - Suivie de la température et de degré d'humidité à cœur du produit. Une vérification visuelle minutieuse.	Contresignature des documents dans moins de 24 heures
Stockage	Altération thermophiles et xérophiles	Température de stockage: T< 40° C Humidité < 16%	Température et humidité de stockage	Thermomètre calibré Hygromètre	Deux fois par jour	Responsable laboratoires	Test bactériologiques	Le responsable du contrôle qualité vérifie et examine quotidiennement la fiche de contrôle du produit séché et le registre des mesures correctives (FC 006 et FC 017)

Plan HACCP - moules marinées

(CCP)	Danger	Seuils critiques	Procédures de surveillance				Action(s) corrective(s)	Vérification
			Quoi	Comment	Quand	Qui		
Réception	Moules insalubres Moules altérées	Absence de toxicité < 300 coliformes fécaux/100 g de chair de mollusque ou < 230 *E. coli*/100 g de chair de mollusque	Salubrité de la zone de cueillette État bactériologique des moules cueillies	Contact du réseau de surveillance: certificat de salubrité de la zone Prise échantillon et analyse au laboratoire	À chaque marée (15 jours) À chaque marée (15 jours)	Responsable qualité	Rejet du lot en cas de moules insalubre ou altérées	- Le responsable du contrôle qualité vérifie et examine quotidiennement la fiche de contrôle à la réception donnée par le laboratoire et le certificat de salubrité donné par l'INRH et le registre des mesures correctives (FC 001 et FC 017)
Préparation de la marinade	Développement des bactéries acidophiles, des moisissures, levures et lactobacillus	Respects des pourcentages Sel Vinaigre eau	Méthodes de préparation	Suivi de la fiche d'instruction de préparation de la marinade Mesure du pH de la préparation par le pH mètre	À chaque préparation de marinade	Responsable qualité	Le responsable qualité: - isole le produit affecté et évaluation de l'innocuité - Consigne les cas de non-conformité dans le registre des mesures correctives - signe et date la mesure corrective prise Détermine la source du problème et prend les mesures qui s'imposent pour éviter toute récidive	- Le responsable qualité vérifie et examine quotidiennement la fiche de contrôle du pH du produit et de la marinade (FC 005 et 009 et le registre des mesures correctives (FC017) Étalonnage régulier du pH mètre Étalonnage régulier du thermomètre (FC 015)
Marinage (1 ère semaine de stockage)	Faible acidification du produit engendrant une contamination	pH = 5,3 au cœur du produit après 24 heures et pH ≤ 4,5 après une semaine	Bon dosage de la marinade	Mesure de l'acidité dans le produit et dans le liquide de couverture Détermination de la teneur en sel du produit	À chaque marinage Après 24 heures et après une semaine	Responsable laboratoire	- Écarter les lots concernés, et faire test bactériologique - si test négatif (pas de croissance microbienne) refaire le marinage et garder le lot - si test positif croissance microbienne: rejet du lot - Sensibilisation et motivation du personnel - Respect des règles d'hygiène	- le responsable qualité vérifie et examine quotidiennement la fiche de contrôle du pH du produit et de la marinade (FC 005 et 009 et le registre des mesures correctives (FC017) Étalonnage régulier du pH mètre Étalonnage régulier du thermomètre (FC 015)
Stockage	Altération psychrophile et acidophile	Présence des bêtas bactéries, levure et moisissures pH ≤ 4, 5 T°≤ 6 °C	Contamination pH de la marinade	Analyse visuelle Présence de trouble dans la boîte Analyse microbiologique pH mètre calibré	À partir de la deuxième semaine de stockage du produit fini	Responsable laboratoire	- Séparer le lot concerné + Test bactériologiques + décision de garder les lots ou leur rejet selon le résultat du test bactériologique	- Vérification de la fiche d'enregistrement du réfrigérateur (FC 010 et FC 021) - et du registre des actions correctives (FC 017) Étalonnage thermomètre (FC 015)

FROM WASTE TO PRODUCT: SOME EXAMPLES USING MILD TECHNOLOGIES

[DU DÉCHET AU PRODUIT: DES EXEMPLES UTILISANT DES TECHNOLOGIES MODÉRÉES]

by/par

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Abstract

Due to rarefaction of fish products, environmental problems and an increase of the population, there is an urgent need to upgrade wastes into useful products, notably for food and feed applications. This presentation will expose how enzymatic hydrolysis can be useful for such purposes and can be easily applied into developing countries. Examples from Viet Nam, Tunisia, Madagascar and Senegal will be given.

Key words: Isoelectric focusing (IEF), Breaded fish products, Commercial fraud, Traceability

Résumé

Du fait de la raréfaction des produits de la pêche, des problèmes environnementaux et de la croissance de la population, il y a un besoin urgent d'améliorer l'utilisation des déchets en des produits utiles, notamment pour les applications alimentaires humaines et animales. Cette présentation exposera comment l'hydrolyse enzymatique peut être utile pour ces objectifs et peut être utilisée dans les pays en voie de développement. Des exemples du Viet Nam, de la Tunisie, de Madagascar et du Sénégal seront donnés.

Mots clés: Focalisation isoélectrique (IEF), Produits des pêches panés, Fraude commerciale, Traçabilité

1. INTRODUCTION

The raw materials that come from traditional fisheries and aquaculture can be regarded as a great and valuable source of proteins, both for animal and human consumption. However, a direct consequence of traditional fisheries practices is the large amount of wastes and by-products that they generate. They represent an economic and environmental problem since these biomasses are often underutilized creating disposal problems and environmental concerns (Folador *et al*., 2006). The marine by-products in general can be classified into three main groups:

- discards (portion of the total organic material of animal origin in the catch, which is thrown away, or dumped at sea for whatever reason; they comprise small-sized and non-targeted species with low commercial value);
- wastage on board (wastes generated by fish processing inside the vessels); and
- by-products and wastage on shore, due to fish processing and trade industry (Blanco *et al*., 2007). Out of the estimated 141.6 million tonnes of fish and shellfish landed each year worldwide (FAO, 2006), only one part is used for direct human consumption. Estimates of this direct use vary from 50–70% according to the type of species and the possibilities of processing.

Until recently, these by-products were commonly recognized as low value resources with negligible market value (Klompong *et al.,* 2007), thus they have often been dumped or used without treatment for animal feed or as fertilizer, even though the waste material was often high in protein and mineral sources. However, due to the worldwide decline of marine living resources' stocks, a better use of bycatch and by-products is deemed necessary.

Hopefully, there are promising opportunities in the upgrading of marine by-products by using mild processing techniques to convert them into products for many application fields. Mild techniques like pH shift, fermentation, enzymatic hydrolysis, filtration, centrifugation and compression are used in the processing and production of valuable products. This presentation will expose some examples of marine wastes upgrading (two

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fishes, one mollusc and one crustacean) by using mild technologies. All the work presented here is conducted by PhD students, to an unspecified extent, in relation to industries that generate these by-products. These are preliminary studies and a lot of work remains to be done, but the preliminary results are promising.

2. MATERIAL AND METHODS

Whatever biomass is studied, some common techniques are employed. They are first presented and then followed by more specific techniques. The general strategy adopted for all the cases is presented in Annex I.

Proximal composition

All the following analyses were carried out both on the starting biomass (marine wastes or by-products) and the resulting fractions after mild processing.

Dry matter and ash

The percentage of dry matter was estimated gravimetrically. Ash content was calculated by weighing the samples after overnight heating of the dried samples at 600 °C.

Protein

Total nitrogen content was determined in the raw material and the aqueous phase generated by hydrolysis using the Kjeldahl method. Crude protein was estimated by multiplying the total nitrogen content (%N) by factor 6.25.

Lipid

Lipids were extracted according to the Folch procedure (Folch *et al.,* 1957). Total lipid content was determined gravimetrically after solvent extraction and evaporation.

Mild technologies (bioprocessing)

Enzymatic hydrolysis

Two large-spectrum proteases (Protamex and pepsine) were used as they were non GMO, food accredited, industrial and not expensive. Moreover they could work in a large range of temperatures and pH.

Raw materials were mixed and homogenized with (or without) water before enzyme addition and hydrolysis were conduced into controlled temperature tanks (temperature is maintained toward the range of the activity of the selected enzyme) and the pH was monitored and sometimes controlled.

Fraction recovery

At the end of the hydrolysis, enzymes were inactivated (by increasing temperature or pH change), the solutions were filtered in order to remove the solid particles (such as bones). Liquid fractions were then centrifuged leading to an insoluble phase (sludge) and a soluble one (supernatant). In the case of fatty biomass, an oily phase can sometimes be recovered at this stage.

Biological samples

Tuna head

Yellowfin tuna *(Thunnus albacares)* was caught in the Pacific Ocean, stored in ice and brought to the seafood processing company "Hai Vuong" in Nha Trang, Viet Nam. Raw fish was filleted less than 36 hours after catch. Heads were collected, frozen and transported to IFREMER (Nantes, France). The heads were then thawed and ground and the minced materials were packed into plastic bags (0.5 kg per unit), frozen and stored at -20 °C, until they were used for the hydrolysis experiment.

Cuttlefish viscera

Cuttlefish (*Sepia officinalis*) was provided by the seafood processing company "Calembo" (Sfax, Tunisia). Mature individuals were caught in the Gabes Gulf by trawling during November 2005. The cephalopods were then immediately stored in ice and transported to the laboratory where they were eviscerated. The collected viscera were homogenized for one minute and then frozen at -80 °C until used. Endogenous enzymes were not inactivated. The cuttlefish viscera fraction included all the organs usually found in the abdomen of mature cuttlefish, and only the ink gland was removed.

Shrimp head
Heads of frozen cultivated shrimp (*Penaeus monodon*) and wild shrimp (mixture of *Penaeus indicus*, *Penaeus japonicus*, *Penaeus monoceros* and *Penaeus semisulcatus*) were collected from a processing factory (UNIMA Madagascar). They were sent to IFREMER (France) in frozen form and stored at -20 °C before use.

Backbones of tropical sole
Backbones from tropical sole (*Cynoglossus senegalensis)* were collected from a processing factory (Sénégal Pêche, Senegal) and sent to IFREMER in frozen form. They were kept at -20 °C before use.

3. RESULTS AND DISCUSSIONS

All these experiments were based on the same procedure, i.e. the bioconversion of biomasses by using industrial enzymes, in order to generate useful products (or fractions). All the preliminary trials were done in France at IFREMER's laboratory but, as the objective was the sharing of know-how and technology, all the procedures were adapted to local context (Viet Nam, Tunisia, Madagascar and Senegal).

As a first step, quantitative (tonnage, seasonality, availability, etc.) and qualitative (food grade or not) data regarding the raw material (wastes mainly from fish processing industries) were collected in order to define potential application fields (feed, food, etc.). At the same time, a biochemical characterization was conducted in order to identify potentialities (protein, lipid, other, etc.) and to identify the strategy to be adopted (protection of lipid, protein or peptide, etc.). Of course, the global strategy further adopted took into account the specific context (equipment, field of application, etc.).

This presentation will expose 4 examples of wastes upgrading for different purposes.

Tuna head
Regarding the different fish factories in Viet Nam, tuna factories are among the most important. Nowadays, tuna heads are generally considered as waste and are thrown away but, in some cases, are used in fishmeal factories.

After analysis, the proximal composition of the tuna heads was established: 61% of moisture, 16% of proteins, 11% of lipids and 11% of ashes. It appeared that this biomass had a relatively high content of protein and in a lesser extent of lipids. Moreover, the big quantities available and their quality (food grade) allowed the development of a strategy for producing food and feed products.

Initial experiments using different hydrolysis conditions (time length, nature of enzyme, temperature) were conducted in order to define the level of proteolysis and the protein solubility. As this was a fatty biomass, the lipid localization (sludge or supernatant) was also studied. This screening procedure lead to the selection of the enzyme Protamex, a ratio enzyme/substrate of 0.5, a temperature of 45 °C and a maximum time length of hydrolysis of 6 hours.

Regarding local considerations, two upgrading strategies were retained: feed pellet for shrimp and protein enrichment of fermented sauce (Nuoc Mam).

Viet Nam is one of the big producers of cultivated shrimp and thus a big consumer of raw materials for feeding (fish meal, fish oil, etc.). As the price of these materials has increased considerably, alternative strategies are welcomed. Different trials of substitution (partial or complete) of fishmeal (and also some proportion of fish oil) into the pellet have been done using fractions after tuna head hydrolysis (sludge, supernatant, mix, etc.).

The processing of fermented sauce is a traditional way of preserving fish in South-East Asia. Heavily salted fish with 2 to 3 parts water in closed tanks is used for fermentation over 6 to 12 months. Biochemically, fish sauce is a salt-soluble protein in the form of amino acids and peptides. The idea of this work was to determine if the enrichment of a fish sauce by a hydrolysate could improve its quality, thus different trials were done: different hydrolysates (after 2, 3 and 6 hours of proteolysis) were added to a fish sauce at different stages of maturation.

Therefore, such processes appear useful for converting waste (tuna head) into valuable products (pellets and fermented sauce). At this stage, different kinds of operators were associated: the producers who want to eliminate their wastes at a lower price and the final users who are pleased to find "new" raw materials. In case of success, an economic evaluation of this strategy will be conducted, implying new trials on a bigger scale.

Cuttlefish viscera

The cuttlefish (*Sepia officinalis)* is among the most exploited marine species in Mediterranean waters and particularly in the Gulf of Gabes (south-east of Tunisia) and the landings occur essentially in the fishing port of Sfax. The waste loads generated from the processing plants of marine species, in addition to the concentration of the conditioning activity on the shores, are becoming a major problem. Indeed, during transformation steps, large quantities of waste, including viscera, are generated and discarded. However, the proximal composition has revealed that viscera contain at least 15% of proteins and 5% of lipids, thus a processing strategy has been developed to reduce the polluting impact and to find some useful applications for them. As this material is not food accredited, only feed applications have been screened.

Due to local context, we chose to look for large-spectrum protease that can work in extreme pH conditions (out of the range of bacterial growth to avoid microbial development) but with middle temperature (to limit the processing cost). This screening procedure lead to the selection of the pepsin due to the high yield of protein solubility, its low cost and its working range (pH=2, temperature = 55 °C, maximum time length = 6 hours). For the application fields we decided to focus on aquaculture feed but with some extension compared to classical feed. Indeed, some antibacterial activities were screened notably against aquaculture pathogens. Some hydrolysates with both nutritional interest (amino acid composition) and biological activities (antipathogenic ones) were then produced. Preliminary trials for optimising the yield and the activity were also carried out.

This study was initially focused on environmental problems but as some valuable products were identified the project changed. Indeed, the wastes could now be converted into products for feed purposes, but a lot of additional work has to be done, such as *in vivo* trials for antipathogenic screening, upscaling of membrane process, etc. However, even without such data, fisheries that generate those polluting materials are interested and are following these studies.

Shrimp head

Shrimp production has developed well in Madagascar, with an increase of 7.3% of production per year. The average production is currently 16000t with 25% coming from aquaculture. In 2002, the shrimp wastes (due to local processing) were estimated at 4800t; most of time they are thrown away but sometimes they are turned into fertilizer or used in animal feed. However, shrimp wastes (head and shell) still contain useful components such as protein, lipid, astaxanthin pigment and chitin, the extraction of which is interesting for generating more marketable, valuable and acceptable products in a number of applications.

A bibliographic analysis has revealed that the crude shrimp head constitute a valuable biomass for biotechnological upgrading. Therefore, we decided to focus only on this raw material. For practical considerations and for PhD work purposes, only one species of shrimp (*Penaeus monodon*) coming from aquaculture has been studied. Heads are rich in proteins (49%)[1] and to a lesser extent in fat (17%) while chitin represents around 17%. Thus, enzymatic proteolysis would be able to generate fractions enriched in proteins and devoid in minerals and with a lower content of fat and such fractions could be useful for food or feed applications. Preliminary trials have demonstrated that pepsin is the more adapted enzyme due to the high proteolysis yield and the absence of bacterial contaminations. Moreover, in some conditions, interesting fractions were obtained i.e. hydrolysates with high nutritional value and with an inhibition of the angiotensin converting enzyme (link to hypertension). Such products are currently in evaluation with *in vitro* and *in vivo* (poultry) trials. A simplification of the whole process (hydrolysis + concentration) has been done in order to be transferred to local partners (laboratory and industry from Madagascar).

This approach is quite new in Madagascar and at the beginning we encountered some difficulties. However, as the preliminary results were satisfactory (poultry feed), shrimp producers are now interested. Indeed, one of them is now associated to the PhD work and is currently studying the implementation of such procedure. Nevertheless, a lot of work remains to be done, such as to study the effectiveness of such feeding supplementation compared to a classical feed, the cost of this transformation at big scale and the optimisation of this procedure for obtaining different products (feed for poultry, valuable hydrolysates, chitin, etc.).

Backbones of tropical sole

Among all the by-products studied here, backbones from *Cynoglossus senegalensis* are of the highest quality in terms of freshness and they possess a high nutritional value. Indeed, in some cases they are used for pulp production. The aim of this study was to put forward an alternative to this pulp which has very few market

[1] As chitin is rich in nitrogen that is also quantified by the Kjedhal method we have an overestimation of the total protein content into raw material but some corrections have been applied by using also colorimetric trials such as the method of Lowry and/or Biuret.

demands in spite of its quality. Enzymatic hydrolysis can constitute an interesting procedure for food purposes by generating nutritive products that can be used in food industries. However, on the other hand, bitterness has to be lowered and palatability has to be increased.

Due to these considerations, the enzymatic complex Protamex was chosen as this complex is used for different food/feed applications and its cost is not too high (€/15 kg). Interaction process/products have been studied, such as temperature and time of hydrolysis, ratio of enzyme, quantity of water and inactivation procedure. The purpose was to determine the effects of different processing parameters (quantity of enzyme, time, temperature, etc.) on the aromatic properties of tropical sole hydrolysates. Thus, volatile compounds are extracted, identified and quantified while the sensory properties of the final products are described by sensory analysis. In addition, *in vivo* trials on poultry are in progress in order to evaluate the nutritive effects (growth rate, palatability, yield of conversion, etc.).

As the raw materials used here are of very high quality, a process leading to "new" food products has been retained. Indeed, the first trials have revealed the very good sensory properties of the resulting hydrolysates. However, it is too early to estimate if this technology can be transferred to the industry, as those products are quite new and imply a new marketing strategy.

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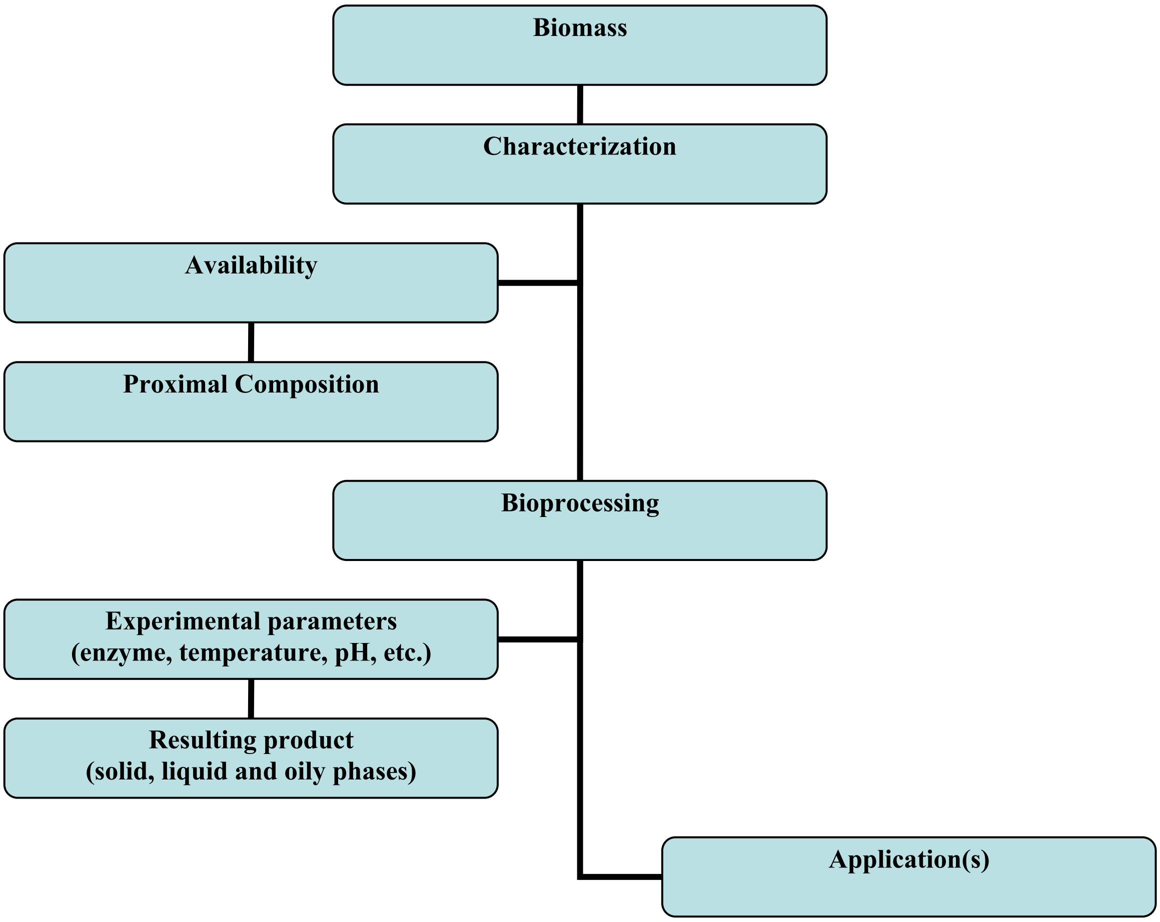
ANNEX I

General Strategy



PROMOTING VALUE-ADDITION AND IMPROVED SMALL-SCALE FISH PROCESSING IN LAKE VICTORIA

[PROMOUVOIR LA VALEUR AJOUTÉE ET LA TRANSFORMATION AMÉLIORÉE À PETITE ÉCHELLE AU LAC VICTORIA]

by/par

Caroline T. Kirema-Mukasa[1]

Abstract

Fish is an important commodity for the three East African Countries sharing Lake Victoria. This lake is the major source of fish exports contributing over US$300 million from international markets. Substantial amount of fish is also exported to regional markets in Central and Southern African Countries. New markets have also opened up in Southern Sudan. The challenge facing Lake Victoria fisheries is to meet the growing demand without compromising its sustainability. Fish quality standards were developed and harmonized under the EAC Sanitary and Phytosanitary Standards for capture, marine and aquaculture Volume 3. Improved methods of processing and adding value to fish and fishery products have been initiated, tested and demonstrated to the fish processors. Ecolabelling and fair trade aspects are viewed as possibilities of maintaining and guaranteeing market for the fishery products from Lake Victoria. The overall focus is to increase availability of fish to local consumption, regional trade and international markets with the intent of maintaining long-term sustainability of the fisheries resources of Lake Victoria.

Key words: Artisanal fisheries, Lake Victoria, Value addition

Résumé

Le poisson est une importante denrée alimentaire pour les trois pays d'Afrique de l'Est partageant le lac Victoria. Ce lac est la source majeure de poisson d'exportation contribuant pour plus de 300 millions de dollars EU provenant des marchés internationaux. Une quantité substantielle de poisson est aussi exportée sur les marchés régionaux dans les pays d'Afrique centrale et australe. De nouveaux marchés se sont aussi ouverts au Sud Soudan. Le défi auquel sont confrontées les pêcheries du lac Victoria est celui de répondre à la demande croissante sans compromettre sa durabilité. Les normes de qualité du poisson ont été développées et harmonisées dans le Volume 3 des Normes sanitaires et phytosanitaires de poisson de capture marine et d'aquaculture des pays d'Afrique de l'Est. Les méthodes améliorées de transformation et de valeur ajoutée du poisson et des produits de la pêche ont été initiées, testées et démontrées aux transformateurs de poisson. Les aspects de l'écoétiquetage et du commerce éthique sont vus comme des possibilités de maintenir et garantir le marché pour les produits de la pêche du lac Victoria. L'objectif global est d'augmenter la disponibilité du poisson pour la consommation locale, le commerce régional et les marchés internationaux tout en maintenant la durabilité à long terme des ressources halieutiques du lac Victoria.

Mots clés: Pêche artisanale, lac Victoria, Valeur ajoutée

1. BACKGROUND

Fish is an important commodity to the three East African Countries sharing Lake Victoria, namely, Kenya (6%), Tanzania (51%) and Uganda (43%). Lake Victoria covers approximately 68,800 km² and is the largest freshwater lake in Africa and second to Lake Superior in the world. The lake has a shoreline of 3,450 km with a catchment area of 194200 km² extending into Rwanda and Burundi. Lake Victoria's basin supports a population of 34 million people who derive their livelihood directly or indirectly from the resources within the basin (LVBC, 2007). Lake Victoria fisheries contribute 0.5% in Kenya, 2.5% in Tanzania and 2.6% in Uganda to the respective GDP, in terms of food, income, employment and foreign exchange earnings. Per capita, fish consumption is 5 kg in Kenya, 10 kg in Tanzania and 10 kg in Uganda, which are below the world average of 16.5 kg/person/annum. Lake Victoria's total fish production is estimated at one million tonnes, worth US$650m of which US$340 is generated at the shore and US$310 is generated from fish exports estimated at 86,000

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tonnes (LVFO, 2007). The Lake Victoria fisheries sub-sector provides employment to over three million people of which about 200,000 are fishers (LVFO, 2008).

Lake Victoria Fisheries Organization

Lake Victoria Fisheries Organization (LVFO) is a specialized and autonomous regional institution of the East African Community (EAC) responsible for coordinating and managing the fisheries resources of Lake Victoria. (EAC, 2000, 2003, 2004), The Partner States of Kenya, Tanzania and Uganda, with support of FAO, formed Lake Victoria Fisheries Organization through a Convention signed in 1994 to jointly manage the fisheries of Lake Victoria. The Organization started its operations in 1997. The objective of the LVFO is to foster cooperation among the Partner States by harmonizing national measures, developing and adopting conservation and management measures for the sustainable utilization of living resources of Lake Victoria for maximum socio-economic benefits. The main functions of the LVFO are to:

- Promote the proper management and optimum utilization of fisheries and other resources of the lake;
- Enhance the capacity of existing fisheries institutions;
- Provide a forum for discussion on the impact the initiatives have on the lake;
- Provide for the conduct of research on the living resources of the lake and its environment;
- Coordinate and undertake training and extension in all aspects of fisheries;
- Consider and advise on the impact of introduction of non-indigenous organisms into Lake Victoria;
- Serve as a clearinghouse and a data bank for information on the fisheries of the lake; and
- Promote the dissemination of information (LVFO, 1996, 1999, 2005).

Fish processing sector

There are two distinct fish processing subsectors on Lake Victoria, that is, the small-scale artisanal fish processing and large-scale industrial fish processing. Small-scale artisanal fish processing uses old traditional preservation methods which dates back to past centuries and now are the base of vibrant commercial enterprises. Artisanal fish processing contributes significantly to domestic and regional trade and is dominated by women who constitute 23% of the people directly involved in fisheries' activities at the beaches (LVFO, 2007). The main traditional methods are hot smoking, sundrying and salting, a combination of two or more of these methods and the recently introduced deep-frying. The sardine-like pelagic species are usually sundried and the bigger species are either smoked or salted/sundried. The processed products include the smoked, dried or salted Nile perch, smoked, dried or salted tilapia, sundried *Rastrineobola argentea* (dagaa/omena/mukene), sundried Haplochromines, smoked *Bagrus* sp. Smoked *Clarias* sp., smoked Barbus sp. and smoked *Synodontis* sp.

Industrial fish processing started in late 1980s and focused on the abundant Nile perch and there are 35 fish factories established along the shores of Lake Victoria. The major products include fillets and dried fish maws which are exported to international markets; and the by-products which are sold fresh or reprocessed into smoked, salted, sundried or deep-fried products by artisanal processors for the domestic and regional markets. Filleting of tilapia is limited as a precautionary measure for domestic consumption. It is mainly sold whole in fresh form or as smoked or salted/sundried products in the domestic or regional markets.

2. ISSUES IMPACTING ON FISH PROCESSING

The major concern in the Lake Victoria fisheries is the decline of the Nile perch fishery, the increasing regional illegal trade in undersized fish, particularly for the Nile perch and tilapia and the high post-harvest losses especially for dagaa/omena/mukene. These concerns further intensify the issues affecting fish processing, such as fish supply, market access and maintenance, source of fuel power and fish processing facilities with significant differences with regard to the nature of fish processing.

Fish supply

The fish stock of Lake Victoria is estimated at over 1,160,000 tonnes with insignificant changes over the years. Significant changes are shown in the species composition where the dagaa/omena/mukene has increased tremendously making it the dominant species. The Nile perch biomass has decreased and the haplochromines, which had almost disappeared, are recovering. In 2005 the Nile perch biomass was 543,736 tonnes, dagaa was 495,362 tonnes and that of haplochromines and other species was 438,663 tonnes. By 2008 the biomass for Nile perch had reduced to 298,644 tonnes, that of dagaa had risen to 1,110,145 and that of haplochomines and other species rose to 625,180 tonnes. Similarly, the dagaa constitutes about 60%, Nile perch constitutes 23%, tilapia 5%, Haplochromines 10% and other species 1% of the fish catches (LVFO, 2008).

The decline of the Nile perch fisheries has reduced fish supply to the fish factories and the small scale fish processors of Nile perch by-products with serious consequences. Over 10 fish factories on Lake Victoria have closed and the remaining 25 are operating under capacity (Pollard, 2008). The small scale, artisanal fish processors dependent on the Nile perch by-products are getting less raw materials as factories refined the filleting skills. The recovery rate of fillet has risen over the years from 30% (1988/2001) at the beginning of industrial fish processing to 43–49% in 2007 (Boeri, 2007).

The decline of the Nile perch fishery calls for value-addition to the limited catches and emphasize the urgent need to implement a recovery plan for the Nile perch fishery.

The increase in the dagaa fishery and other native species, which now constitutes over 70% of the catch, has increased fish supply to small scale artisanal fish processors. The challenge is to ensure that the fish is properly preserved, processed and basically used for human consumption.

Market aspects

Fish exports to international markets have declined from 91,200 tonnes valued at US$319.4m in 2005 to 86,000 tonnes valued at US$310m in 2007. Dagaa and the haplochromines, which now constitute over 70% of the biomass have low market value and fetch less income compared to Nile perch (LVFO, 2008). In 2007 the catches remained close to one million tonnes but the beach value dropped by 22% due to the decrease of high value Nile perch and dominance of low value dagaa and other pelagic species. The Nile perch catches dropped by 18% and the value decreased by 34%, whereas the dagaa catches went up by 33% the value increased by 19% (Muhoozi *et al*., 2008).

It is estimated that 80% of the fish catch is undersized (Johnson, 2008) and this represents an economic loss to the Partner States for it fetches less money than that at maturity size. Mugabira (2008) established that Uganda has a potential of earning US$500m in fish exports but loses over US$360m annually by earning an average of US$140 m due to harvesting of undersized Nile perch. The Nile perch fishery has continued to attract investments due to lucrative earnings, prompt cash payments and assured ready market. The increasing demand has precipitated the increase in fishing effort (in terms of fishers, boats, fishing gear, engines and fishing time) and the use of illegal gear. The total number of fishers rose from 129,305 in 2000 to 175,890 in 2006 and to 199,242 in 2008. The use of illegal gear, such as the monofilament nets, has increased by eight-fold from 2,293 in 2006 to 20,194 in 2008 (LVFO, 2008). The reduction in fish supply to fish factories and the stiff competition posed by the suppliers of small-sized farmed fish fillets (Bassa and Pangasius) from Asia has prompted the Industrial fish processors on Lake Victoria to implement self policing to eliminate the processing and marketing of undersized fish and to consider value-addition as an option (Borel, 2008).

The increasing regional illegal trade in undersized Nile perch and tilapia products is a major concern to the Partner States as it contributes to depletion of fish stocks in Lake Victoria (LVFO, 2007). Regional fish trade has expanded from Central and Southern African Countries to include new markets in Southern Sudan. Fish exports to regional markets are dominated by traditionally processed products of sundried dagaa, salted/sundried and smoked tilapia and Nile perch. Tanzania and Uganda are the main fish exporters, while Kenya is an importer. In 2005 Tanzania recorded exports to regional markets were about 3,000 tonnes of which dagaa comprised 1,700 tonnes (Odongkara, 2006.). In Uganda, fish exports to regional markets in 2007 were estimated at 21,000 tonnes valued at US$33m (Borel, 2008). Regular data collection on domestic and regional markets is hindered by logistical constraints including the permeable national borders, where fish can be taken across without passing through the customs border posts.

Domestic trade is dominated by fresh and smoked products of tilapia, sundried dagaa and Nile perch by-products as well as various products of native fish species. In 2007, the Nile perch by-products from factories were estimated at 98,748 tonnes with a value of US$74m (Pollard, 2008). The major concern is the lack of appropriate fish handling, preservation and processing facilities in local markets and artisanal processing areas. Nile perch by-products in transit from the fish factories and in the markets or artisanal processing areas are poorly handled. Fish quality and safety measures are mainly enforced to fish destined for international markets.

Energy source

Artisanal fish processing is still viable among local communities with very limited access to refrigeration (Kayiso, 2007) and other preservation facilities. Less than 1% of the 1433 fish landing beaches on Lake Victoria have cold rooms (Yongo *et al*., 2008). The majority of fishing villages lack constant supply of power such as electricity, solar or biogas. Only 4% of the fish landing beaches on Lake Victoria have electricity. The traditional fish processing methods of sundrying and hot smoking highly depend on sunlight and firewood as the main source of energy and these are greatly affected by the vagaries of nature. Post harvest losses are high (60–80%), particularly during the rainy season. Only 3% of the fish landing beaches have fish stores for dried products. An entire catch of dagaa may be lost due to rain.

Deforestation in the lake basin has been severe in the last few decades due to agricultural encroachment and increasing demands for fuelwood, charcoal, timber, and other purposes (LVBC, 2007). Many of the fish landing sites are established near the gazetted forest reserves, where collection of fuelwood is prohibited and nearby woodlands depleted. Artisanal processing can be sustainably carried out if processors living on lake shores are encouraged to plant and own woodlots (Kayiso, 2007). The challenge is to introduce small-scale fish processing methods that can reduce the post-harvest losses and reduce the effect of nature on the artisanal fish processing.

Facilities for artisanal fish processing

The lack of social facilities puts the artisanal fish processors in a vulnerable position. Lack financial services and lack of a saving and investment culture amongst the fisher communities hinder adoption and investment in improved processing methods. Less than 1% of the fish landing beaches have drying racks or driers and only 30% of the artisanal fishers, fish traders and processors have bank accounts (Yongo, 2008), in banks located in distant towns.

3. REGIONAL EFFORTS TO ADDRESSING CHALLENGES

Resource sustainability

The LVFO Partner States are signatory to the FAO Code of Practice for Responsible Fisheries and implement the Strategic Vision and the Fisheries Management Plan (FMP) for Lake Victoria. The Partner implement the Regional Plan of Action to prevent, deter and eliminate Illegal, Unreported and Unregulated (RPOA-IUU) fishing on Lake Victoria to eliminate illegal fishing and illegal trade in undersized fish. Similarly, the LVFO Partner States implement the Regional Plan of Action for Management of Fishing Capacity (RPOA-Capacity) on Lake Victoria to control fishing effort and reduce fishing pressure on the declining stocks (LVFO, 2004; 2007). Fishery specific management plans for the major commercial species including a Nile perch recovery plan have been adopted and incorporated in the revised FMP2 for implementation. The Industrial fish processors in partnership with the Competent Authorities are implementing self monitoring and control (self policing) to curb the processing and export of undersized fish. The fisher communities have been mobilized into 1069 Beach Management Units (BMUs) and members trained and strengthened to work in a co-management partnership with government to manage the fisheries of Lake Victoria. All these efforts aim at recovery of the fish stocks and increase fish supply for domestic human consumption, processing industry and fish exports.

Measures to maintain the market

Fish quality and safety

The LVFO Partner States implement the EAC harmonized Sanitary and Phytosanitary Standards, Measures and Procedures, Volume III (fish and fishery products), which were endorsed by the EAC Summit of the Heads of States in 2006 to ensure compliance with international fish quality and safety standards and enhance consumer confidence. The LVFO collaborated with the EU Project on Strengthening of Fishery Products Health Conditions (SFP) in ACP/OCT to develop a Field Manual for beach inspectors, which comprises a checklist and guidelines for sanitary inspection in small-scale fisheries. The manual has been used to develop a training module for fish handlers on-vessel and at the beach. Under the EU-funded IFMP, the LVFO is supporting the improvement of fish handling and preservation facilities at 18 fish landing beaches and another 15 beaches are being provided with social infrastructure of their choice, such as water and sanitation facilities, dispensaries and schools (LVFO, 2008).

Ecolabelling of Lake Victoria fishery
The LVFO conducted an ecolabelling pre-assessment with support of the German Technical Cooperation (GTZ) to get preliminary information and establish whether the fishery meet the requirement to apply for Marine Stewardship Council (MSC) ecolabel. The study identified a number of gaps in the information but also noted the good recruitment in the Nile perch fishery and recommended for implementation of a fisheries recovery program (LVFO, 2008). Aspects of fair trade for the Naturland label are also being piloted in Bukoba, Tanzania with GTZ support (Naturland Project, 2008). The efforts toward ecolabelling aim at maintaining and enhancing the position of Lake Victoria fish in the global market.

Promoting value-addition production

Value addition for Nile perch
The LVFO, through the CFC/FAO/COMESA/LVFO Fishery Project on Value-addition, contracted a processing consultant to assist the Industrial Fish Processors to produce value-added fishery products (VAP). The consultant noted that there was little incentive for adding value on the fillets. The chilled fish fillets which comprised 75% of the fillet exports were attracting good prices and the frozen fillets also had specialized markets. The by-products offered more opportunities for adding value to products destined for export and domestic markets. The industrial fish processors had problems disposing of the by-products safely, although some were being sold to feed manufactures and local traders. A lot of wastage was also observed at the artisanal fish processing areas for by-products. Trial productions were conducted at selected fish factory premises in Uganda, Tanzania and Kenya. An 'open day' exhibition was held in each country at the end of the exercise to view and share information on the products. Most of the VAP can be produced in mass factory production or by small scale fish processors. Boeri (2007) noted that over the years the filleting skills of the workers had improved with recovery rates in fillets rising from 30% in 1999/2000 to 43 – 49% in 2007. The average yields from the experiments on Nile perch show that 43% is fillets, 55% is by-products and 2% is waste. Further breakdown on the yields is shown in the table below:

Table 1: Average yields of different products from Nile perch

	Yield
Fillet	43%
Skins	7%
Trimmings	2%
Fats	2%
Cheeks	1%
Frames	41%
Maws	2%
Waste	2%

Source: *Boeri, 2007*

A manual on VAP was prepared (Boeri, 2007) and has been available to the Industrial Fish Processors.

The VAP from fillets include:
- Chilled weight controlled portions;
- Frozen fillets or portions,
- Batter and breaded fillets or portions; and
- Retail products. All these have potential in the export market.

The major issues identified in VAP from fillets include:
- The stiff competition posed by large and tough companies owning production facilities in Europe;
- The producers in Lake Victoria face long distance logistics, transport delays and the need for bigger stocks for sea containers (economies of scale);
- The VAP producing companies have to offer a variety of products to the retailers (supermarkets), which is not possible at present for the tilapia from Lake Victoria cannot compete with similar cheaper products from Asia in the international market. Aquaculture in East Africa has not yet developed to provide substantial amounts of tilapia in the market and capture fisheries may not be adequate to enable a VAP Company to meet its obligations regularly;
- The issues of traceability and verification of other ingredients other than fish in VAP with regard to consumer health requirements may be a hindrance;

- The need to invest in automotive lines of processing and packaging;
- The lack of skills and need to train workers in automated lines;
- The importation of materials for value-addition may outweigh the benefits accruing to VAP;
- The need for increased working capital compared for what is required for the simpler operations of chilling and freezing; and
- The lack of developed market for VAPs within the Lake Victoria region to provide for an alternative market.

The VAP from by-products include:
- Battered and breaded products from Trimmings and recovered meat; These can be exported in bulk for production and packaging in importing countries or for production of surimi, fish sausages, bologna and hams or sold in local supermarkets, schools and hospitals and restaurants;
- Dried bladders are exported to Asian oriental markets;
- Polyunsaturated concentrated oil can be recovered over low temperatures and the technology is simple for use by small-scale producers;
- Cheeks can be exported to international markets as mini-fillets and Cocochas have a good market in Spain. Collars, wings and chests can be sold in the regional and domestic markets;
- Eggs, sacks and stomachs can be exported to Eastern European Countries but volume restrictions with freight costs are the major obstacles;
- Leather and other skins and scales: Skins with scales removed are prepared into rolled hot smoked products for regional markets. Skins can be used to produce leather goods, clean fish skins without scales, muscles and fat layers can used in the manufacturing of gelatines and glues; and the scales can be used in production of ornamental products;
- Fish meal can be produced from the remains of the recovery process of the by-products from the fish heads and rest of the frames; and
- Fish silage can be produced from the remains of the filleting operations and value-added production.

The major issues to consider in VAP from by-products include:
- The need to carry out research to identify potential markets for the VAP by-products;
- The need to undertake an aggressive marketing strategy to promote consumer acceptance within the Lake Victoria region, such as schools, hospitals, supermarkets and restaurants; and
- The need to encourage small-scale producers to adopt the simplified appropriate technologies to improve the quality of the by-products and reduce wastage.

Value addition in artisanal fish processing
It is estimated that 80% of the dagaa caught is processed into animal feeds and only 20% is available for human consumption. The LVFO supported the promotion of improved dagaa processing in order to add value, improve the quality and quantity of dagaa for human consumption and reduce post-harvest losses. The LVFO Fish Quality, Safety and Product Development Regional Working Group (FIQA RWG) conducted demonstrations on improved processing methods, with the participation of over 140 artisanal fish processors, at selected beaches in the three Partner States. Kenya and Tanzania focused on sundrying, dry-salting and brining. Uganda undertook smoking, frying and fermentation. In Kenya, the products were sold to local traders. In Tanzania, dried and salted-dried products were packed separately in 400 g and 800 g packets and retailed locally. In Uganda, both the deep-fried and smoked dagaa products were tested locally and in major towns.

The results showed that it takes 4 hours to dry and get quality dagaa using raised racks, whereas it would take six hours on nets placed on the ground. Both fried and smoked dagaa products had a shelf life of more than one month and had market potential. The low price for dagaa and the lack of information on better paying markets hinder the adoption of improved technologies. The LVFO plans to replicate the lessons learned from an USAID/Promasidor Project in Mbita, Suba District, Kenya, which supports women groups of dagaa processors with provision of drying racks, storage facilities and a regular regional market. The public will also be sensitized on the nutritional value of dagaa to increase its intake. The FIQA RWG prepared a manual on the improved fish processing methods for use by the artisanal fish processors. The LVFO plans to activate the dagaa component of the CFC/FAO/COMESA/LVFO Project to provide for training and micro-financing of dagaa fish processors.

Regional plans for post-harvest fisheries

The LVFO Fisheries Management Plan (FMP) was updated in May 2008 and a special program for FIQA was included. The focus is to improve fish handling, processing and marketing to guarantee safety and quality of fish products and increase value at all levels. The activities planned include:

- Encourage innovative public/private partnerships for product and market development for all commercial species (Nile perch, tilapia and dagaa);
- Promote an improved role for BMUs in fish safety, quality and marketing chain (including traceability and the support to cooperatives in the marketing chain);
- Sensitize stakeholders and collaborate with partners to improve fish handling and preservation at landing sites, during transport (e.g. design and construction of fishing and transport boats) and in markets (e.g. use of ice);
- Improve processing, packaging, marketing and storage of dagaa to enhance product quality and marketability;
- Develop and maintain the capacity of fish quality and safety laboratories in the partner states;
- Promote the use of environmentally friendly and low cost fishing and fish processing technologies in line with reducing the carbon footprint of the fisheries sector;
- Assist BMUs and other stakeholders to access market information;
- Achieve certification to an eco-labelling standard for the Nile perch fishery and promote partnerships for full utilization.

5. RECOMMENDATIONS

The Partner States' Governments should consider undertaking the following:

- Improve fish processing facilities and sensitize the fish processors and traders to adhere to fish quality and safety standards in the domestic market;
- Extend rural electrification programs to fisher communities to provide for alternative source of energy for household and small-scale processing;
- Support the fisher communities to plant woodlots for fuelwood and environmental conservation;
- Support market research within and outside the region for the value-added products of the Nile perch and dagaa to increase human consumption, improve prices for the VAP and encourage adoption of improved processing technologies;
- Support the Fish Quality WGs to follow-up on the dagaa demonstrations to address the bottlenecks hindering adoption;
- Encourage small-scale processors to invest in recovering species such as Haplochromis to increase utilization for human consumption;
- Support FIQA RWG to simplify and disseminate the VAP Manuals for Nile perch and dagaa into popular versions and local languages to the local fish processors;
- Provide micro-financing to promote investment and adoption of improved technologies for value-addition production by small-scale processors;
- Support programs for recovery of the fisheries, ecolabelling, and aquaculture development; and
- FAO to consider supporting a program to popularize the adoption of improved fish processing technologies and increased human consumption of value-added products.

6. CONCLUSIONS

Promoting value-addition will increase the fish available for human consumption, reduce post-harvest losses and increase earnings of the fish processors. Reduction in post-harvest losses would be possible if the fisher communities are provided with stable supply of power at reasonable rates. The fish processors should be encouraged to invest in alternative and cheaper energy sources, such as solar and biogas, and to plant trees for fuelwood. Improvement of artisanal fish processors livelihood requires financial support in adopting improved technologies and identification of a reliable market for the improved products. The Fisheries Competent Authorities should make deliberate efforts to sensitize the public and enforce quality and safety standards in the domestic market. Government should endeavour to provide social facilities to enable the fisher communities to access services, save and invest to enable them make the right choices and wise use of their earnings.

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IMPROVED FISH DRYING USING A POLYTHENE SOLAR DRYER

[AMÉLIORATION DU POISSON SÉCHÉ EN UTILISANT UN SÉCHOIR SOLAIRE EN POLYÉTHYLÈNE]

by/par

Kenneth Werimo[1] and John Malala

Abstract

Post-harvest fish losses along Lake Turkana beaches were estimated to be about 60%. One of the main causes of loss was the low technology used in sun drying, resulting in high contamination of fish with sand. Further, the drying process is slow, resulting in a product that is of low quality with a short shelf life, consequently loss of income to fishers. It was therefore essential to identify, test and adapt appropriate technology to shorten drying time, improve product quality and increase shelf life of fishery products.

This study assessed the effectiveness and efficiency of drying fish using solar dryer made of polythene (PE) sheets compared to the traditional open drying. Five drying systems consisting of a bamboo solar dryer on the ground, a raised solar dryer, a plywood solar dryer with black and another with white polythene sheet, were tested. Fish was harvested, split, washed and dried using the different systems.

The temperature inside the drying chamber increased from 33 ºC to 56 ºC, representing an increase by factor of 69.6%. The temperature inside the fish increased from ambient temperature to a maximum of 62.9 ºC, indicating an increase factor of 90.6%. Comparatively, the maximum temperature attained under open drying was 42.5 ºC, which indicates an increase factor of 28.8%. The enhanced temperature during solar drying reduced drying time from 48 hours to 30 hours. The drying ratio in solar dryer was about 0.28–0.30 compared to 0.29 under open drying. The water activity attained within 30 hours under solar dryer was 0.39–0.41 compared to 0.39–0.55 under open drying.

The results demonstrate that solar drying is more effective and efficient than open drying. In addition, solar dried fish products are of higher quality, with significantly less sand, have a firm texture, fresh fish odour and an extended shelf life of over six months. Solar dryers also have lower operating costs than mechanized dryers. In conclusion, solar dryers shorten drying time, improve product quality, extend the shelf life of the products, reduce costs and thus improve income to fishers.

Key words: Polyethylene, Solar dryer, Drying time, Drying ratio, Product quality, Insect infestation

Résumé

Les pertes post capture du poisson le long des plages du lac Turkana ont été estimées à environ 60%. Une des principales causes de perte était la faible technologie utilisée pour le séchage au soleil, d'où un poisson hautement contaminé en sable. Par ailleurs, le procédé de séchage est lent, engendrant un produit de faible qualité avec une courte durée de conservation, par conséquent une perte en revenus pour les pêcheurs. Il était donc essentiel d'identifier, tester et adapter une technologie appropriée pour réduire le temps de séchage, améliorer la qualité du produit et augmenter la durée de conservation des produits de la pêche.

Cette étude a évalué l'efficacité de sécher le poisson en utilisant des séchoirs solaires construits avec des feuilles de polyéthylène (PE) comparés aux séchoirs traditionnels ouverts. Cinq systèmes de séchoirs comprenant un séchoir solaire en bambou sur le sol, un séchoir solaire surélevé, un séchoir en contreplaqué avec une feuille en polyéthylène noire et un autre avec une feuille en polyéthylène blanc, ont aussi été testés. Le poisson a été capturé, séparé, lavé et séché par les différents systèmes.

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La température à l'intérieur de la chambre de séchage augmentait de 33 ºC à 56 ºC, représentant une augmentation d'un facteur de 69,6%. La température à l'intérieur du poisson augmentait d'une température ambiante jusqu'à un maximum de 62,9 ºC indiquant une augmentation d'un facteur de 90,6%. Comparativement, la température maximale atteinte sous un séchoir ouvert était de 42,5 ºC, ce qui indiquait une augmentation par un facteur de 28,8%. La température améliorée pendant le séchage solaire réduisait le temps de 48 heures à 30 heures. Le ratio de séchage avec un séchoir solaire était environ 0,28-0,30 en comparaison à 0,29 sous séchoir ouvert. L'activité de l'eau atteinte en 30 heures sous séchoir solaire était 0,39-0,41 en comparaison à 0,39-0,55 sous séchoir ouvert.

Les résultats démontrent que le séchage solaire est plus efficace que le séchage ouvert. En plus, les produits de pêche séchés sont de qualité supérieure, ont significativement moins de sable, une texture ferme, une odeur de poisson frais et une durée de conservation prolongée de plus de 6 mois. Les séchoirs solaires ont aussi des coûts opérationnels plus bas que les séchoirs mécaniques. En conclusion, les séchoirs solaires raccourcissent la durée de séchage, améliorent la qualité du produit, augmentent la durée de conservation, réduisent les coûts et ainsi améliorent les revenus des pêcheurs.

Mots clés: Polyéthylène, Séchoirs solaires, Temps de séchage, Ratio de séchage, Qualité du produit, Infestation par les insectes

1. INTRODUCTION

Studies conducted by KMFRI in Lake Turkana in early 2007 indicated that fish post-harvest losses were about 60% (LTRP, 2007).One of the main causes of this loss was the low technology used in sun drying .The fish is simply split and spread on the ground to dry. This leads to long drying time, low product quality and hence short life of the product. The market value of the product is significantly reduced with subsequent low income to fishers. It is therefore vital to identify, test and adapt appropriate technology to shorten drying time, improve product quality and increase shelf life of fishery products. One option is the use of solar dryer technology. 'Solar drying' is the method of using sun's energy for drying but excludes open air drying. The justification for solar dryers is that they may be more effective than direct sun drying, but have lower operating costs than mechanized dryers. Solar dryers can be more effective than direct sun drying and have lower operating costs than mechanized dryers. This will shorten drying time; improve product quality, long shelf life, reduce post-harvest losses and thus improve income to fishers.

This study was one of the components of the Lake Turkana Research Project whose broad objective was to generate information for sustainable development and management of Lake Turkana fisheries for enhanced food security through reduction of post-harvest fish losses, provision of high quality fish and fishery products, increased income and improved socio-economic status of the fisher community. The specific objective of the study was to identify, test and adapt an appropriate solar dryer for fish along Lake Turkana, so as to produce high quality sun-dried fish products. One of the activities was to evaluate the quality of sun-dried fish products from solar dryer compared to the traditional drying methods.

2. METHODOLOGY

Experimental design

The experimental design included five sets of drying regimes, namely:

- Bamboo trays with white polythene on the ground;
- Plywood trays with white polythene on the ground;
- Plywood trays with black polythene on the ground;
- Raised trays with white polythene; and
- Artisanal drying method on the ground.

Tray construction

The bamboo trays were constructed from bamboo as shown in Plate 1. Bamboo slats comprising the arcs are attached to the horizontal frame by cutting a slit just large enough to insert the slats. UV-protected polyethylene

(PE) sheets are used for the cover. PE sheets accumulate less dust and can remain serviceable even after 31 months of use (Rouweler, 1995).

The plywood tray is constructed using plywood, mosquito mesh and PE sheets, Plate 2. The raised tray was built with timber and cedar poles fixed on the ground with ballast Plate 3. The PE sheets are fixed on open doors on the sides to allow for turning of the fish during drying. Plate 4 shows the artisanal raised drying rack that will still not prevent contamination of fish from sand. Materials and cost estimates for construction of bamboo and raised rack dryers are given in Annexes I and II.

Plate 1. Improved bamboo solar dryer

Plate 2. Plywood solar dryer

Plate 3. Improved raised fish solar dryer

Plate 4. Traditional raised fish dryer

3. FISH SAMPLE PREPARATION

All the trial fish samples were fished using gillnets. Immediately after landing, the fish were scaled, split and washed using lake water. The samples were allowed to drain and were placed in the individual trays to dry. The unit operations are shown in Figure 1.

Fresh tilapia (caught by gill nets)

↓

Sorting according to size

↓

Scaling, gutting

↓

Washing and draining

↓

Drying
(Bamboo trays - white Polythene: Wooden trays - white Polythene: Wooden trays -black Polythene)

Conventional (open air)

↓

Packaging in baskets

Figure 1. Process flow of improved drying of tilapia along Lake Turkana

During the drying process the parameters monitored were, weight changes, ambient temperature, temperature inside the drying chamber and in fish flesh. Temperature changes were monitored by a hand held thermometer. To compare the efficiency and effectiveness of the different drying systems, the drying ratio and product output were computed. The drying ratio is important in identifying a drying phase which does not correspond to the dryer's performance for a given product, and can assist in improving the drying system to improve the drying process. It is also useful for the end-user to check how advanced the drying process is, and the extent to which the dryer's characteristics change with time.

4. RESULTS

The white polythene solar dryer (Plates 1 and 2) gave better drying regimes than black polythene which generated a lot of humidity inside the chamber and thus affected the drying of the product.

The drying process took a minimum period of 24 hours and maximum of 30 hours in the solar dryers compared to the traditional drying method which takes up to 48 hours. The temperature inside the solar drying chamber increased from ambient temperature of 33 ºC to 39 ºC to reach a maximum of 62.6 ºC. Temperature inside fish during drying increased to a maximum of 62.9 ºC in the solar dryer, representing 90.6% increase from ambient temperature. Comparatively, the increase of temperature in fish under open drying rose to a maximum of 42.5 ºC i.e. 28.8% from ambient temperature. Product temperature profiles during the drying process indicate the relationship between temperatures at ambient, inside drying chamber and inside fish muscle. Drying rhythms indicate that the system is efficient and effective using raised rack as exemplified by the gradient of the weight loss versus time of drying. The time required to reach constant drying for both systems is approximately 24 hours.

The measured drying ratio in raised solar dryer was 3.01, bamboo 2.63 and artisanal (open) 2.93. The reciprocal of drying ratio in solar dryer was about 0.28–0.30 compared to 0.26 under artisanal drying, conforming to the values in the product datasheet of 0.25–0.33 (Rozis, 1997). Product output showed that raised solar dryer was more effective and efficient than the bamboo dryer and open drying. The water activity attained within 30 hours under solar dryer was 0.39–0.41 compared to 0.39–0.55 under open drying. This indicates that solar drying is actually more effective and efficient than open drying, as demonstrated by the narrow range of water activity. The solar dried fish product is of higher quality, since it has significantly less sand, has a firm texture, brown colour and fresh fish odour. Table 1 shows the drying parameters and organoleptic characteristics of the solar and artisanal dried products. The colour of the products was dark brown. After storage trials of up to six months there was no evidence of insect infestation.

Table 1. Drying parameters in different drying systems

	Drying Systems			
Drying Parameter	**Raised Solar Dryer**	**Bamboo solar dryer on ground**	**Tray solar dryer on ground**	**Conventional drying(Open Control)**
Ambient Temp (ºC)	32.0–37.0	32.1–39.3	32.1–39.3	32.1–39.3
Maximum T(ºC) in dryer	47.3	50	nd	38.1
Maximum T(ºC) in Fish	39.6*	50.0	48.4	42.5
Reciprocal of drying ratio	0.28–0.72	0.30–0.76	nd	0.26–0.72
Product output	1.6–31.5	1.5–28.3	nd	1.4–28.5
Water activity(aw)	0.39–0.41	0.39	0.39	0.39–0.55
Texture of product	Firm	Firm	Firm	Soft
Odour	Neutral	Neutral	Neutral	Fishy
Drying time	30 maximum	30	30	48
Insect infestation	absent	absent	absent	Evident within first week of drying

5. DISCUSSION

Foods are usually very well preserved if their water activity (a_w) has a value 0.2–0.4. At that a_w level bacterial growth and toxin production is zero, browning and enzyme activity are rather low, and food oxidation reactions have a minimum rate (Rouweler, 1995). Drying sometimes considerably changes the texture, colour, flavour, aroma and nutritive value of foods (Fellows, 1988).

The white polythene solar dryer gives better drying regimes than black polythene which generates a lot of humidity inside the chamber and thus affects the drying of the product. The drying process take a minimum period of 24 hours and maximum of 30 hours in the solar dryers compared to the artisanal drying method which takes up to 48 hours, and thus shortens the drying time by 37.5%. The enhanced temperature in the drying chamber and inside fish muscle hastens the evaporation of water from the fish, causing faster drying. In general, rapid drying and high temperatures cause greater changes to the texture than do moderate rates of drying and lower temperatures. High air temperatures, particularly with fish, cause formation of a hard impermeable skin. Flavours are lost at high drying temperatures. Longer drying times and higher drying temperatures cause greater pigment losses. The tested solar dryer attained maximum temperature of 62.9 ºC and drying time of 30 hours. From the drying rhythms observed the system is efficient and effective .The observed drying ratios are in agreement with data from the product data sheet described by (Rozis, 1997). The water activity attained within 30 hours under solar dryer was 0.39–0.41 compared to 0.39–0.55 under open drying. The narrow range of water activity indicated that solar drying is actually more effective and efficient than open drying. The solar dried fish product is of higher quality, since it has significantly less sand, has firm texture, brown colour and fresh fish odour.

Drying parameters and organoleptic characteristics of the solar and artisanal dried products indicated that drying process occurred within the recommended conditions as described by Rouweler (1995). The colour of the products was dark brown indicating that the drying process was slow. After storage trials of up to six months there was no evidence of insect infestation.

The improved quality and extended shelf life of the fishery products dried in solar dryer may be attributed to two factors:

- Drying under solar, hence higher internal temperatures, ensures that the adult *Demestes maculatus is* kept off from the wet, drying fish and hence no deposition of eggs in the fish occurs; and
- Attainment of lower water activity of 0.39–0.41 after 30 hours. The lower water activity inhibits the hatching of insect eggs that could have been laid.

Cost benefit analysis

To evaluate the benefits of the live polyethylene solar dryer a simple cost benefit analysis was conducted based on the cost inputs of the dryer, the increase in selling price of the dried fish product and period of replacing the polyethylene paper and, therefore, savings in terms of revenue. The results presented in Table 3 show that the payback period is about 6 days for dryer whose capacity is 50 kg of fish. The durability of the polyethylene paper may be up to 2 months.

Table 3. Investment analysis for polyethylene solar dryer

Without solar dryer		**With solar dryer**	
Total fish (kg) processed	50	Total fish (kg) processed	50
Expected Price/kg (K Sh)	80	Expected Price/kg (K Sh)	120
Daily value loss/kg	40	Daily savings (kg)	40
Daily value loss/50 kg	2,000	Daily savings/50 kg	2,000
		Investments cost (K Sh)	12,000
		Payback period (days)	6

6. CONCLUSIONS AND RECOMMENDATIONS

Solar dryers are therefore more efficient and effective than direct sun drying and have lower operating costs than mechanized dryers. Solar dryers shorten drying time; improve product quality, long shelf life for products, reduce post-harvest losses and thus improved income to fishers.

Due to the limited time dedicated to the studies on insect infestation, further investigation is required to ascertain the exact stage of the supply chain when the infestation occurs and thus mitigate preventative measures.

It is recommended that this technology should be available to the end users through selected pilot sites along the Lake Turkana shores to assess acceptability and effectiveness. There are at least five ideal sites for pilot study, namely: Longech, Namkuse, Nachukui (Northern Island), Todonyang, Ile Springs, Loiyangalani, Moite and Illeret.

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ANNEX I

Materials and cost estimates for the construction of a bamboo solar dryer

S/No.	Item description	Quantity	Estimated cost
1	Bamboo pole – 10’ long, 3" diam.	8 pcs @ 50	400
2	Bamboo pole - 6' long, 2" diam.	4 @ 50	200
3	0.125 mm X 240 cm UV-protected PE sheet	10m @ 350	3,500
4	1" common wood nails	1 kg @ 100	100
5	2" common wood nails	2 kg @ 100	200
6	Matt-1 pc	1 pc @ 120	120
7	Indirect costs		2,480
		Total	**7,000**

ANNEX II

Materials and cost estimates for the construction of a raised solar dryer

S/No.	Item description	Quantity	Estimated cost
1	Timber 2 x 2	100 ft @ 15	1,500
2	Cedar posts-9 ft	5 pcs @ 200	1,000
3	Timber 11/2 x 1 ft	60 ft @ 12	720
4	2" common wood nails	2 kg @ 100	200
5	1" common wood nails	1 kg @ 100	100
6	0.125 mm x 240 cm UV- protected PE sheet)	10 m @ 30	300
7	Wire gauze	10 m @ 350	3,500
8	Indirect costs		4,700
		Total	**12,000**

VULGARISATION D'UN NOUVEAU CONCEPT AMÉLIORÉ DE SÉCHAGE ET DE FUMAGE ARTISANAL DES ALIMENTS: APPLICATION EN MILIEU PÊCHE ARTISANALE AU GABON

[DISSEMINATION OF A NEW IMPROVED CONCEPT OF ARTISANAL DRYING AND SMOKING OF FOOD: APPLICATION IN ARTISANAL FISHERIES IN GABON]

by/par

Serge Ekomy Ango[1], Jean-Daniel Mbega and Essono Huguette Biloho

Résumé

L'activité de transformation des produits halieutiques, quoique fortement exercée au Gabon, est restée archaïque du fait de l'usage des fumoirs traditionnels et des conditions de travail pénibles. Le nouveau concept de transformation mis au point par l'Institut de recherche technologique a pour objectif d'améliorer les conditions de travail et la qualité des produits.

L'expérimentation sur site a conduit à l'analyse des paramètres de la nouvelle technologie à travers des applications concrètes et comparatives avec le système traditionnel existant. Les paramètres évalués concernent la durée du temps de travail, la qualité des produits (la teneur en HAP, l'apparence et le goût), la consommation en combustible (ratio bois/poisson), l'analyse des coûts des investissements, la valeur ajoutée, les capacités organisationnelles des acteurs. Il en ressort les résultats ci-après:

- la durée de fumage et de séchage du poisson est de sept heures et de huit heures pour le salage au maximum par rapport à deux à trois jours pour le fumoir traditionnel;
- la teneur en HAP des échantillons des fumoirs traditionnels donne 57 et 26 microg/kg de poids frais et ceux des prototypes 16 et 14 microg/kg de poids frais;
- la qualité sensorielle des produits des fumoirs traditionnels d'une même campagne de transformation est hétérogène mais homogènes pour le fumoir Bidul;
- la moyenne des ratios des différents essais en kg de bois consommé/kg de poissons donne pour les fumoirs traditionnels 3,12 et 4,66 et pour le fumoir Bidul 1,28 et 1,38.

Le fumoir Bidul peut faire l'objet de vulgarisation dans les communautés de pêche. Toutefois, des investigations sur l'amélioration du système de production des fumées froides doivent être poursuivies.

Mots clés: Transformation du poisson, Pêche artisanale, Gabon

Abstract

Fish processing is an important activity in Gabon but suffers from the use of traditional and outdated fish smoking kilns with severe effects on working conditions. The new concept of processing developed by the Technological Research Institute aims to improve the working conditions and quality of the products.

Onsite testing led to the analysis of the parameters of the new technology through specific and comparative applications with the existing traditional system. The evaluated parameters were the length of working time, the quality of products (content of PAH, appearance and taste), fuel consumption (ratio wood/fish), the cost analysis of the investments, the added-value and the organizational capacities of the stakeholders. The results were as follows:

- the duration of fish smoking and drying is seven hours and eight hours maximum for salting compared to two to three days in traditional smoking-rooms;
- the content of PAH of traditional smoking kilns is 57 and 26 microg/kg of fresh weight and those of the prototypes 16 and 14 microg/kg of fresh weight;
- the sensory quality of traditional smoking kilns' products of the same processing campaign is heterogeneous and homogeneous for the Bidul smoking kiln; and
- the average ratios of the various tests in kg of wood consumed/kg of fish is 3.12 and 4.66 for traditional smoking kilns and 1.28 and 1,38 for Bidul smoking kilns.

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The Bidul smoking kiln can be disseminated in fishing communities. However, research on the improvement of production of cold smoke systems must be continued.

Key words: Fish processing, Artisanal fisheries, Gabon

1. INTRODUCTION

Le poisson transformé (séché/fumé) est une ressource alimentaire importante au Gabon. Il permet aux populations à faibles revenus d'avoir accès aux protéines animales à moindre coût. Cette activité constitue la principale source de revenus pour les acteurs de ce secteur (producteurs) et d'autres ménages non directement impliqués dans les activités.

Malgré cette importance, le processus de production est resté archaïque et les conditions de travail sont très pénibles pour les transformatrices (en général des femmes, qui transforment le poisson frais en poisson fumé et salé). Elles manient les produits brûlants à mains nues dans les épaisses couches de fumées chaudes. Ce qui les expose/prédispose aux problèmes respiratoires et oculaires.

De plus, ces unités de production traditionnelles sont rudimentaires et ont un rendement énergétique faible ce qui entraîne une consommation importante de bois et de ses dérivés. Elles ne permettent pas d'obtenir de produits finis de qualité régulière et ces derniers renferment un taux élevé d'hydrocarbures aromatiques polycycliques (HAP), notamment le benzo(a) pyrène.

Dans le cadre de ses activités, l'Institut de recherche technologique (IRT) du CENAREST du Gabon a mis au point un nouveau concept de séchage et fumage des aliments (Figure 3) qui permet d'améliorer les conditions de travail des producteurs et la qualité des aliments.

Un site d'expérimentation a été installé au cap Estérias à Libreville au Gabon, dans l'Association des pêcheurs du cap Esterias (APCE). Ce site a pour objectif d'amener les futurs utilisateurs à prendre connaissance de la technologie et maîtriser son fonctionnement.

L'objectif de ce travail est, dans un premier temps, de comparer la consommation de bois et la teneur en benzo(a)pyrènes des produits finis du fumoir traditionnel et du fumoir Bidul; d'étudier les qualités sensorielles/visuelles et d'analyser l'impact du nouvel équipement au sein d'une communauté de pêcheurs artisanaux.

2. MATÉRIELS

Sites d'études
Les travaux ont été réalisés sur trois sites:

- site de production habituel des producteurs de poissons séchés et fumés situé au Pont Nomba;
- site d'essais situé à l'IRT;
- site pilote situé au Cap Estérias auprès de l'APCE.

Matériels de terrain
- Pour l'étude sur la consommation de bois, nous avons utilisé une balance de précision de pesée;
- Pour l'étude sur la teneur en benzo(a)pyrènes, les échantillons collectés en sachets ont été identifiés à l'aide d'étiquettes.

Matériel de laboratoire
Les analyses des échantillons pour l'obtention des teneurs en benzo(a)pyrènes ont été réalisées par l'Institut européen de l'environnement de Bordeaux en France (IEEB). IEEB est un laboratoire d'hygiène et de santé du groupe Institut Pasteur de Lille.

3. MÉTHODOLOGIE

Pour l'étude sur la consommation de bois, la méthode suivante a été utilisée:

- Pour obtenir le poids moyen des sardines à fumer, nous avons estimé que trois sardines font en moyenne un kg. A chaque campagne, nous comptons le nombre de sardinelles dans une rangée et le nombre de rangée sur le fumoir. Nous avons ensuite multiplié ces deux valeurs. Puis, nous avons divisé la valeur obtenue par 3 pour avoir le poids en kg de sardinelles à fumer.

Exemple lors de la première campagne de séchage et fumage sur le fumoir longitudinal:

- Il y avait 28 rangées de sardinelles, à chaque rangée il y avait en moyenne 25 sardines soit 28 x 25 = 700 sardines sur le fumoir; nous avons don c: 700/3 = 233, 33 kg soit à peu près 234 kg de sardinelles;
- Pour le bois, les différentes formes de morceaux de bois utilisé étaient pesées et le nombre de morceaux de bois utilisés pour chaque forme était compté et multiplié par le kg du morceau de bois de cette forme. Ensuite on additionnait le poids en kg de toutes les formes de bois utilisés.

Exemple lors de la première campagne de séchage et fumage sur le fumoir longitudinal, un morceau de bois d'une longueur de 12 cm, et large de 5 cm, avec une hauteur de 2 cm, pèse 2 kg et les 30 morceaux de cette forme ont été utilisés Nous avons estimé donc que 30 x 2 = 60 kg de morceaux de bois de cette forme ont été utilisés.

Pour déterminer la teneur en benzo(a)pyrènes, nous avons procédé de la manière suivante:

- Dans chaque fumoir, afin d'avoir une valeur moyenne de la teneur en benzo(a) pyrènes en fonction du nombre de fumoirs utilisés, nous avons pris trois sardines séchées et fumées, l'une de chaque côté du fumoir et une au milieu du fumoir. Nous avons réalisé trois campagnes de mesures et nous avions obtenu neuf échantillons pour le fumoir longitudinal qui est le plus utilisé. Nous avons réalisé deux campagnes de mesures et nous avons quatre échantillons pour le fumoir rond, le moins utilisé. Nous avons réalisé deux campagnes de mesures et nous avons obtenus quatre échantillons pour le fumoir Bidul. Tous les échantillons ont été mis chacun dans un sachet portant chacune une étiquette. Ce sont ces échantillons qui ont été envoyés au laboratoire IEEB à Bordeaux en France.

Pour l'intégration du fumoir dans l'environnement des producteurs et son appropriation par ces derniers, deux ateliers ont été organisés:

- un atelier de formation des formateurs sur l'appropriation de la technologie du nouveau fumoir. A cet effet, des explications sur le fonctionnement de l'équipement et sensibilisation les séminaristes sur le bon usage de cet équipement ont été faites;
- un atelier sur les techniques de fumage et de salage qui sont utilisés sur ce nouveau concept. Des explications ont été données sur le processus de séchage notamment le rôle de l'eau dans les aliments et le fumage du poisson et de la viande, avec insistance sur les rôles de la température, la vitesse du flux et la densité de la fumée. Ces paramètres qui sont très importants pour la fabrication des séchoirs et le bon déroulement du séchage/fumage des produits.

Ces ateliers étaient accompagnés de séances d'essais sur le prototype.

Une étude comparative des paramètres économiques des produits frais et transformés de l'activité de pêche a été réalisée. Les paramètres économiques de l'investissement et l'appréciation par le marché des produits transformés ont été étudiés. L'APCE disposant d'une grille évolutive des revenus pour une période donnée, une étude sur l'organisation des acteurs face au nouveau concept de transformation a été réalisée. Cette étude avait pour but d'analyser le processus organisationnel des acteurs par rapport à la nouvelle technologie et d'apprécier le temps mis, les aléas, la quantité et la qualité des produits obtenus pour une séance de transformation afin de les aider à mieux organiser leurs activités.

Par ailleurs, un système de suivi/évaluation participatif a été mis en place pour mieux apprécier les changements attendus de ce projet dans la communauté de pêche du Cap Estérias.

4. RÉSULTATS ET DISCUSSION

Consommation de bois

Figure 1: Fumoir longitudinal du pont Nomba

Figure 2: Fumoir circulaire du pont Nomba

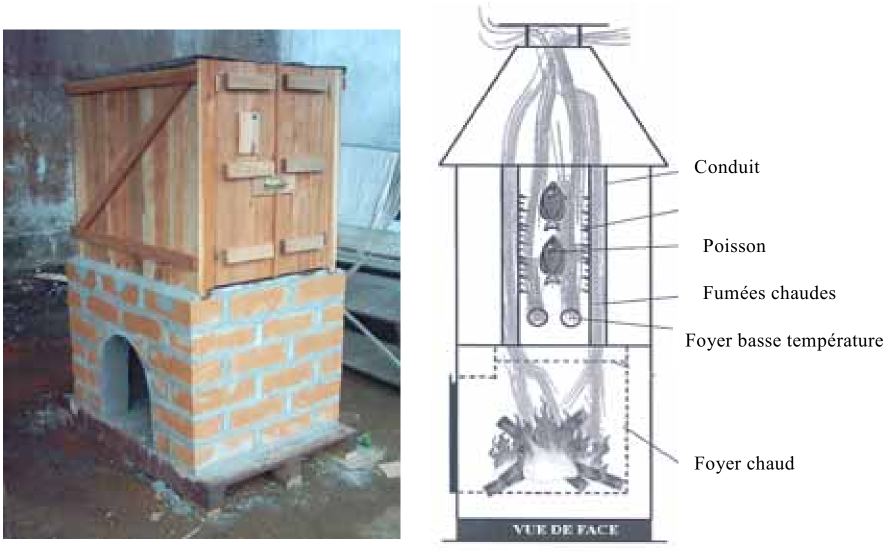

Figure 3: Fumoir Bidul et son principe de fonctionnement

Il faut noter conformément au Tableau 1 qu'il faut 4,17 kg de bois pour fumer un 1 kg de poisson pour le fumoir longitudinal alors que pour le fumoir Bidul il faut 1, 29 kg de bois pour sécher et fumer 1 kg de poisson. Ceci est dû principalement au fait que le fumoir Bidul a un foyer de combustion fermé et ses parois conservent la chaleur (briques en ciment ou terre battues) alors que le fumoir longitudinal a un foyer ouvert donc une bonne partie de la chaleur produite par la combustion de bois s'échappe et n'intervient pas dans le processus du séchage des poissons. La chaleur qui sert réellement au séchage des poissons dépend en fait de l'orientation du vent. Ce qui entraîne une qualité très variable de poissons séchés et fumés dans un même fumoir pendant la même campagne de séchage et fumage.

Tableau 1: Ratio moyen bois/poissons des différents fumoirs étudiés

Fumoirs	Longitudinal du pont Nomba	Circulaire du pont Nomba	Bidul du Cap Estérias	Bidul de l'IRT
Ratio moyen *	4,17	3,09	1,37	1,29

* Ratio moyen (kg de bois/kg de poissons)

On constate aussi que le fumoir circulaire consomme plus de combustible que les deux prototypes de fumoirs Bidul, car il faut 3, 09 kg de bois pour fumer et sécher 1 kg de poisson pour le fumoir circulaire. Ceci est dû au fait que les parois du fumoir Bidul sont en briques (standard fait à partir du ciment ou en terre battue), alors que celles du fumoir circulaire sont en tôle. Ce dernier n'est pas un bon conservateur de chaleur et cela se ressent lorsqu'on le touche pendant le fonctionnement. Il est tout brûlant et cela est dû tout simplement au fait que la tôle est un bon conducteur de chaleur.

Le même constat est fait entre le prototype Bidul construit à partir des briques standard à l'intérieur du foyer de combustion (fumoir Bidul de l'IRT) et celui construit avec les briques en terre battue (fumoir du Cap Estérias). En effet, les briques en terre battue conservent mieux la chaleur que les briques standard.

Dans le fumoir traditionnel les poissons sont posés verticalement sur le fumoir et sont maintenues dans cette position grâce aux cales qui sont interposés entre les rangées de poissons. À chaque phase du séchage ou du fumage, il faut repositionner les poissons ce qui rend le procédé très long car on doit trier des centaines de poissons. Dans le fumoir Bidul, les poissons sont accrochés sur des supports qui sont installés sur les claies. De ce fait, l'installation des produits dans le fumoir met un peu plus de temps. Mais cette opération se fait une seule fois alors que dans le fumoir traditionnel la disposition des poissons se fera plusieurs fois pendant la production.

Teneur en benzo(a)pyrènes

Tableau 2: Les teneurs en benzo (a)pyrènes des sardines séchées et fumées

Fumoirs	Fumoir circulaire du pont Nomba	Fumoir longitudinal du pont Nomba	Fumoir Bidul du Cap Estérias		Fumoir Bidul de l'IRT
Teneur en benzo(a)pyrènes (microg/kg de produit fini)	57	26	17	16	14

Le tableau ci-dessus montre que:

- Le fumoir circulaire utilisé au pont Nomba a une teneur en benzo(a)pyrène plus élevée. L'une des raisons est que les sardines sont en contact avec les fumées chaudes les plus élevées de tous les quatre autres fumoirs sur lesquels l'étude a été menée;
- Les teneurs en benzo(a)pyrènes du fumoir Bidul sont moins élevées que les fumoirs du Pont Nomba, cela confirme bien les données bibliographiques; et
- Les variations des teneurs en benzo(a)pyrènes entre les fumoirs Bidul du Cap Estérias et celui de l'IRT sont dues à la présence des fuites au niveau du système de production de fumées froides.

On remarque que plus le système de production de fumées permet d'obtenir les fumées moins chaudes, moins élevé est le taux de benzo (a)pyrènes des produits obtenus.

Qualité sensorielle, durée de conservation

L'obtention des produits de bonne texture (homogène) et de très bon goût; les séances de dégustation ont été organisées sur le site pilote, à IRT et à l'assemblée nationale. Il a été noté une appréciation toute particulière des produits issus de ce fumoir notamment la couleur, la réduction de l'odeur de la fumée et le cadre travail approprié aux mesures d'hygiènes.

Analyse coût- bénéfice du fumoir

Le fumoir Bidul offre la possibilité de transformer les espèces nobles, de produire du poisson salé et de transformer la volaille (nature et assaisonnée). Les matériaux utilisés pour la construction du fumoir Bidul sont durables et moins coûteux. Le coût de construction d'un fumoir Bidul est plus élevé au départ, mais devient moins coûteux du faite de sa durabilité (exemple celui de IRT) par rapport au fumoir traditionnel où on assiste à un renouvellement des matériaux à chaque campagne de transformation (données chiffrées en cours).

Une forte valeur ajoutée des produits transformés: Les produits issus du fumoir Bidul ont une valeur ajoutée plus élevée que ceux du fumoir traditionnel du fait de la qualité des produits. La majorité des ventes sont faites sur commandes et concernent uniquement les gros poissons.

Intégration du fumoir Bidul dans l'environnement et son appropriation par les producteurs

La capacité de transformation du fumoir Bidul dépend des dimensions de celui-ci. Malgré la rapidité de transformation et la qualité des produits observées, il convient de dire que le fumoir traditionnel, a une plus grande capacité de transformation (500 à 2000 sardinelles pour une campagne de transformation). Toutefois, il existe des possibilités de mettre en place des fumoirs Bidul de grande capacité; afin d'avoir un outil plus performant.

Pendant les consultations, et les ateliers ainsi que les différents essais, les membres de l'APCE étaient très attentifs et participatifs.

Des échanges fructueux ont eu lieu entre les séminaristes, les membres de l'association et les techniciens sur le fonctionnement du prototype et son impact.

Les résultats des enquêtes menées dans la localité et dans les marchés révèlent:

- Une forte demande en produits transformés (fumés et salés);
- Un marché potentiel d'écoulement avec établissement de partenariats, des contrats sont signés entre l'association et les différents établissements de la localité (restaurants et l'école nationale des Eaux et Forêts);
- Possibilités d'étendre le marché d'écoulement sur Libreville.

Pour ce qui est de l'analyse organisationnelle, on note:

- Une certaine dynamique dans la répartition du travail en équipe;
- Une réduction du temps de travail;
- Une amélioration des conditions de travail;
- Le respect des normes d'hygiène lors de la manipulation des produits.

En matière de suivi/évaluation, les quatre domaines de changement retenus donnent les résultats suivants:

Pour l'augmentation des revenus à travers la valeur ajoutée des produits transformés: actuellement on ne peut pas mesurer les indicateurs d'augmentation de revenus. Les productions actuelles de l'association ont servi à faire de la promotion. Toutefois, l'étude a déjà identifié les opportunités de commercialisation formelles qui seront exploitées par l'association et elle se prépare en conséquence.

Pour l'amélioration de la nouvelle technologie par la forte contribution des communautés en vue d'une meilleure adaptation en milieu réel: Les pêcheurs ont énormément contribué à l'amélioration de la technologie par des propositions concrètes qui ont été acceptées et exécutées pour certaines par les techniciens sur la qualité des supports la hauteur du fumoir, le placement d'une cheminée pour la fumée, etc.

Les populations se sont bien appropriées la nouvelle technologie. Elles manipulent actuellement le fumoir sans l'aide des techniciens. On note une grande motivation de leur part.

Pour la protection de l'environnement: l'association n'utilise pas le bois de mangrove, le bois utilisé est récolté dans la forêt à des quantités moins importantes par rapport au fumoir traditionnel. On note l'absence d'épaisse couche de fumée et le respect des normes hygiéniques. Le travail s'effectue dans un environnement propre.

Pour le renforcement des capacités organisationnelles des communautés en matière de gestion d'une infrastructure communautaire: on note une répartition des tâches et des équipes de travail. Des équipes de quatre personnes ont été mises en place et travaillent sur la base d'un calendrier établi par l'association.

Les acteurs manifestent un intérêt tout particulier envers le nouveau concept, ce qui suscite de la motivation au sein de l'association.

5. CONCLUSIONS

Le fumoir Bidul est une innovation importante pour les activités de transformation qui occupent une place importante dans la sous région en général et au Gabon en particulier. Ce fumoir offre plusieurs opportunités aux acteurs et répond à certaines préoccupations de l'administration des pêches. Cette étude a montré qu'il existe des possibilités d'amélioration du système actuel de transformation des produits halieutiques. Cet nouveau concept présente un double avantage aux acteurs; à savoir: celui de fumer et de saler le poisson de manière efficace à l'aide d'un même outil.

Contrairement au fumoir traditionnel dont la consommation en bois et ses dérivés (sciure et copeaux) est importante, pour un rendement énergétique faible; les produis finis sont d'une qualité irrégulière et les teneurs en hydrocarbures aromatiques polycycliques (HAP) sont importantes, notamment le benzo(a)pyrène.

Le fumoir Bidul permet d'avoir un rendement énergique très élevé, la teneur en HAP très réduite, bien qu'au dessus des normes fixées. Il permet d'obtenir des produits homogènes et une organisation de travail en équipe.

6. RECOMMANDATIONS

Pour la consommation de bois

Pour avoir un bon rendement énergétique, il faut que le foyer de combustion du fumoir soit fermé. De ce fait, une amélioration de l'isolation des parois et une réduction des fuites sont obligatoires. Pour cela, il faudra chercher des matériaux locaux que l'on trouve facilement dans le pays qui puissent remplir ce rôle. Ces derniers doivent intégrer l'environnement des producteurs. Cela permettrait une meilleure adaptation de l'outil.

Pour la détermination de la teneur en benzo(a)pyrènes

Au cours de ces travaux, il a été confirmé, que lorsque les fumées chaudes produites sont en contact direct avec les produits, les poissons séchés et fumés ont un taux élevé en benzo(a)pyrènes. Le nouveau système mis en place permet de réduire considérablement cette teneur. On se rapproche un peu plus de la norme européenne (5 microgrammes/kg de poids frais).

Pour avoir le meilleur taux en benzo(a)pyrènes, il faudra améliorer le système de production des fumées de pyrolyse afin de refroidir au maximum les fumées avant qu'elles arrivent sur les produits. L'idéal serait de fumer les poissons avec les fumées froides. Malheureusement. Le système de production de fumées froides adapté à l'environnement des producteurs artisanaux du Gabon n'existe pas.

Pour l'intégration de l'environnement et l'appropriation du fumoir Bidul par ces producteurs

Actuellement, les membres de l'association APCE sont très intéressés par cet équipement. Il serait mieux de poursuivre l'accompagnement de l'appropriation et mesurer l'ensemble des indicateurs retenus auprès de cette association.

Mettre en place des fumoirs Bidul de grande capacité dans les communautés de pêche à intense activité de transformation.

De vulgariser ce fumoir dans les autres communautés de pêche ayant des bases organisationnelles et dans les communautés de pêche continentale.

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ADAPTING LOW COST SHRIMP DRYING TECHNOLOGY: INITIAL TRIALS IN NANGGROE ACEH DARUSSALAM PROVINCE (NAD), INDONESIA

[ADAPTER UNE TECHNOLOGIE DE SÉCHAGE DE CREVETTES À COÛT FAIBLE: ESSAIS INITIAUX DANS LA PROVINCE NANGGROE ACEH DARUSSALAM (NAD), INDONÉSIE]

by/par

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(presented by Yvette Diei-Ouadi)

Abstract

Small-scale fish drying is practiced in many tropical countries in Africa, Asia and Latin America. It is an important livelihood activity for many low-income earners and women in fishing communities. Traditional sun drying is less effective during rainy seasons and cloudy conditions, when drying becomes difficult or impossible.

A simple low-cost, improved dryer that may also be appropriate for small-scale processors in parts of Africa was tested using a participatory process that involved processors, local government as well as fisheries training school staff.

Using ideas from the dryers seen being used by processors in coastal Cambodia, a prototype dryer was built using zinc sheeting (1 mm) riveted on a metal bracket frame. Air is blown into the chamber using a standard "table top" electric fan (45W, 220V). Charcoal burnt in stoves is used inside the chamber to generate heat for drying. The fish are dried on wooden framed drying racks (dimensions) placed over the chamber. Anchovy (*Stolephorus commersonnii)* were used for the initial drying trials.

Results from initial tests indicate that processors can see that the dryer will enable them to continue processing fish in the rainy season. It also reduces processing time and produces good quality boiled (cooked) and then dried product. It can also be used to produce a purely dried product, but the latter is not of as good quality as the traditional sun dried product.

Work is continuing to test the appropriateness of the technology and whether processors find it convenient to use and financially beneficial.

The work is an activity of the American Red Cross funded FAO project OSRO/INS/601/ARC: "*Rehabilitation and sustainable development of fisheries and aquaculture affected by the tsunami in Aceh Province, Indonesia which is implemented in partnership with the Dinas Kellautan dan Perikanan (DKP), the Fisheries Department of Indonesia*".

Key words: Drying, Small-scale, Charcoal oven, Indonesia

Résumé

Le séchage du poisson à petite échelle est pratiqué dans plusieurs pays en Afrique, Asie et Amérique Latine. Cette activité est une source importante de moyens d'existence pour de nombreux petits salariés et femmes dans les communautés de pêche. Le séchage traditionnel au soleil est moins efficace pendant les saisons de pluie et les conditions nuageuses, quand le séchage devient difficile ou impossible.

Un séchoir amélioré, à faible coût, et qui peut aussi être approprié pour les transformateurs à petite échelle dans des parties de l'Afrique a été testé en utilisant un processus participatif qui implique les transformateurs, le Gouvernement local de même que les employés de l'école de formation en pêche.

En utilisant les idées d'un séchoir en cours d'utilisation sur la cote du Cambodge, un prototype de séchoir a été construit en utilisant des feuilles de zinc (1 mm) rivées sur un cadre en support métallique. L'air est soufflé dans

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la chambre en utilisant un ventilateur électrique normal de table (45W, 220V). Le charbon brûlé dans les foyers est utilisé dans la chambre pour générer la chaleur pour le séchage. Les anchois (*Stolephorus commersonnii)* étaient utilisés pour les essais initiaux de séchage.

Les résultats des tests initiaux indiquent que les transformateurs peuvent s'apercevoir que le séchoir leur permettra de continuer de transformer du poisson pendant la saison de pluie. Il réduit aussi le temps de transformation et donne un produit bouilli (cuit) puis séché de bonne qualité. Il peut aussi être utilisé pour produire un produit purement séché, mais ce dernier n'est pas d'aussi bonne qualité que le produit traditionnel séché au soleil.

Le travail est en cours pour tester l'adéquation de la technologie et si les transformateurs trouvent commode de l'utiliser et financièrement bénéfique.

Le travail est une activité du projet de la FAO financé par la Croix Rouge Américaine OSRO/INS/601/ARC: "*Réhabilitation et développement durable des pêches et de l'aquaculture affectées par le tsunami dans la Province de Aceh, Indonésie*" *qui est mis en œuvre en partenariat avec le Dinas Kellautan dan Perikanan (DKP), le Département des Pêches de l'Indonésie.*

Mots clés: Séchage, Petite échelle, Séchoir de charbon, Indonésie

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This work is an activity of the American Red Cross funded FAO project OSRO/INS/601/ARC: Rehabilitation and sustainable development of fisheries and aquaculture affected by the tsunami in Aceh Province, Indonesia which is implemented in partnership with the Dinas Kellautan dan Perikanan (DKP), the Fisheries Department of Indonesia. The Sekolah Usaha Perikanan Menengah (SUPM) Fisheries Training School in Ladong provided facilities and mechanical engineers for the initial trials and the small-scale women fish processors from Kreung Raya village provided advice on the dryer design and processing method.

1. INTRODUCTION

Small-scale fish drying is practiced in many tropical countries in Africa, Asia and Latin America. It is an important livelihood activity for many low-income earners and women in fishing communities. Traditional sun drying, whilst an effective and low-cost method of preservation, is less effective during rainy seasons and cloudy conditions when drying becomes difficult or impossible, thus putting a stop to an important livelihood activity. When drying takes place during these difficult periods, losses can result from poor quality final products and insect infestation.

Traditional sun drying of salted and un-salted fish is practiced in some coastal areas of Nangroee Aceh Darussalam (NAD) Province, northern Indonesia. Anchovies, shrimp, reef fish and octopus are dried by women processors mainly on racks. The final product is destined for the local market as well as export to neighbouring countries such as Malaysia. Rain from October to January hampers processing activity when losses are frequent and processing activity has to be abandoned.

A simple drying technology using charcoal as the heat source, rather than the sun, is used by some small-scale fish processors in coastal areas of Cambodia to dry shrimp. A small electric fan is used to blow heat from the charcoal through the brick or metal sheet drying chamber and over the shrimp. The shrimp are boiled first, drying is rapid and can be practiced inside a shed or building and thus during times of rain. See Annex I.

This report describes initial trials to see whether the charcoal shrimp drying technology can be adapted for use in NAD province, Indonesia, to dry anchovies, a particularly high value product. If successful, then the drying activity of mainly women processors could be extended into the rainy season when catches are also high, giving the women more income earning opportunity. The work is an activity of the American Red Cross funded FAO project OSRO/INS/601/ARC: *Rehabilitation and sustainable development of fisheries and aquaculture affected by the tsunami in Aceh Province, Indonesia* which is implemented in partnership with the Dinas Kellautan dan Perikanan (DKP), the Fisheries Department of Indonesia.

As similar dried products are produced in Africa and similar challenges are faced by small-scale processors there, the results of these trials are likely to be of interest to African extension agents, researchers, development agencies and small-scale fish processors.

2. INITIAL TRIALS: THE APPROACH

Whilst the technology itself is an important aspect of the intervention, it is widely recognized that the approach and socio-economic context of introducing new technology is as important as technical issues. The approach taken has tried to recognize this, keeping the technology low cost and simple as well as engaging with all stakeholders and involving them in the decision making process from the start. Initial discussions introduced the improved dryer idea and led to a consensus on trying to adapt and test the improved drying technology. By means of video and photographs, the charcoal drying technology was introduced to key stakeholders from a fisheries training school, the Provincial and District Fisheries Department and a small-scale women fish processors group. It was generally thought that the drying idea had potential and should be tested. The fisheries training school agreed to provide a testing area on their campus and engineering staff to help build a prototype dryer. District fisheries staff would be involved in the trials and the women fish processors would provide the fish and act as advisers regarding the design ad operation of the dryer and in the assessment of the final products.

The process has tried to be participatory and inclusive and involve key stakeholders, both outside and inside the project, in the decision making process. This has taken time and patience, but it is hoped that in the long run this will prove to have been worthwhile in setting a firm base on which to work.

3. DRYER DESIGN AND CONSTRUCTION

Using ideas from the dryers used in Cambodia a prototype dryer was built using zinc sheeting (1 mm) riveted on a metal bracket frame. Two sizes of drier were built: First with a chamber of 2m x 1m x 1m high, and then a larger version measuring 3m x 1.2m x 1.5m high. In both cases, an opening was cut in one end of the chamber so that air could be blown in using a standard “table top” electric fan (45W, 220V). Charcoal stoves were placed on the floor in a line down the centre of the chamber. The fish are dried on wooden framed drying racks (dimensions) which are placed on the chamber. These racks are exactly the same as those normally used by processors to sun dry fish. Only the nylon/plastic mesh normally used was replaced with fine iron wire mesh gauze as it was assumed that the nylon mesh would be affected by the heat generated from the charcoal stoves. Annex 1 shows the dryer and racks. The cost of constructing the larger drier used in the trials was approximately US$210 and a breakdown of the costs is shown in Annex II.

4. INITIAL TRIALS

Anchovy (*Stolephorus commersonnii)* and other species of anchovy are commonly sun dried by women processors in NAD. In good sunny conditions it takes about 6 hours to dry fresh anchovy to a 75% weight loss preferred by the market. Anchovy is also traditionally boiled in seawater before sun drying. It is estimated that 50% of anchovy landed is processed in this way. *Stolephorus commersonnii* was used in the initial drying trials. The first trial focussed on drying fresh anchovy and used the smaller dryer. The results from this suggested the technology maybe better suited to drying boiled anchovy rather than fresh. A second trial was conducted using a larger dryer. This involved drying boiled anchovy and then also fresh anchovy. The approximate operating costs based on the trials are shown in Annex 3 along with indicative market prices for the final products. However, the main running costs are seen as charcoal, kerosene, electricity and labour. The latter is difficult to calculate, but with three charcoal stoves burning the larger dryer uses approximately 2.5 kg of charcoal per hour equivalent to US$0.9 per hour and electricity costs for the fan are US$0.002 per hour. Not including labour, the largest operating cost is that of the raw material (fish) estimated at 88%. Other costs need to be factored in for the boiling process, as here we are concentrating on the cost of drying only.

Annex III shows the cost of drying 15 kg of fresh anchovy (1 tray) is US$35.7. Assuming a 2nd grade product is produced with a 50% weight loss, then the net income is estimated to be US$31.6 to US$39.5. The same annex shows the operating costs for a similar quantity of boiled anchovy. These are US$33. For boiled anchovy the drier can produce a high value 1st grade product. The net income, assuming a 50% weight loss, is US$39.5 to US$55. This equates to a net profit of US$6.5 to US$22, which represents between 16% to 40% margin and assumes no marketing costs. On paper the cost of producing 2nd grade dried product does not look financially viable, whereas producing 1st grade boiled product is, providing the market price is 2.5 to 3 times that of the price of fresh fish. Please note that these calculations do not take into consideration the cost of replacing the dryer and it is not known at this stage its lifespan.

Key findings from the work so far are:

- The larger dryer was used to produce a 1st grade boiled and dried product in approximately 1 hour with an overall 45% weight loss. This is a much shorter time than the traditional process. The larger drier can produce a 2nd grade dried (non-boiled) product in 3 to 4 hours, with a weight loss of 50%. A margin of 16% to 40% is estimated if boiled products are dried and this assumes that the cost of boiling is minimal.
- It does not appear to be economically viable to produce un-boiled products based on the cost of raw material and market prices for 2nd grade product.
- The greatest cost is that of the fresh fish, which constitutes up to 88% of the costs of production.
- Capacity of fresh fish drying racks for anchovy is estimated to be 15 kg. Drying capacity could be increased by stacking the trays on the dryer. With four trays then approximately 60 kg of fresh fish could be dried. Fuel efficiency could be improved by building a more insulated chamber e.g. using bricks.
- Drying fresh fish which are still wet results in the fish sticking to the mesh of the rack and removal causes physical damage and a low (3rd) grade product.
- Sun drying or allowing the fish to drain on the rack for approximately 2 hours prior to drying helps to reduce the stickiness of the fish and enables a 2nd grade product to be produced.
- Dried fresh anchovy tends to look like it has been boiled first, especially with the smaller drier. The larger drier enabled less intense high temperature drying and is likely to be the most appropriate size.
- The product produced by the smaller drier had a smoky flavour. It was undecided whether this was a positive or negative attribute. There was no smoky taste detected in the product produced by the larger drier.
- Not surprisingly, the highest drying temperatures and most effective area for drying were at the back of the drier. On the larger drier the fish on this area of the tray dried more quickly and temperatures of between 50 °C and 90 °C were recorded. To even out the drying process, the trays were periodically rotated.
- Raising the drier chamber from 1m to 1.5m reduced the intensity of heat reaching the product and the risk of over cooking the product. It also reduced the risk of colour change and smoky taste of the final product. An informal tasting assessment of final products showed that the final products are acceptable. Nevertheless, the higher drier was more difficult to operate as to light the charcoal it was necessary for someone to climb into and out of the chamber, which was not easy due to the 1.5m height. This problem is not seen as a major constraint since it can be overcome by using steps on either side of the drier.

5. CONCLUSIONS

Processors can see that the dryer will enable them to continue processing fish in the rainy season and suggest the dryer is better for boiled product, but can also be used to produce a 2nd grade un-boiled product. The advantages of processing in the rainy season are that this is a time of large anchovy catches, yet as processing is risky and fewer products are produced, the final product selling price can also be high during this period. Furthermore, the dryer reduces the time taken to dry boiled anchovy by 3 hours, thus saving time and enabling the processors to do other activities.

So far the trials have been conducted by the project team in conjunction with the processors who have assisted with the construction of the wooden drying trays, procurement and preparation of the raw material and assessing the quality of final products. The next step is for processors to have the opportunity to use the dryer themselves, initially with support from the project. Field testing of the dryer is now planned to take place in the village during the current rainy season. It remains to be demonstrated whether the drier is acceptable and if it will be used independently by the processors, although from initial trials it can be seen to be technically beneficial during the rainy season and economically viable for drying boiled anchovy. Meanwhile, questions that remain to be answered include:

- How will the processors cope with operating the dryer, bearing in mind that it is a different process from the one normally used?
- If the dryer is only used during the rainy season, what will happen to it during the rest of the year?
- Is it justifiable to just use the dryer during the rainy season?
- What is the lifespan of a drier?

ANNEX I

Photos of dryer and processing

Figure 1. Dryer used for shrimp in Cambodia

Figure 2. Dryer adapted for anchovy, Indonesia

Figure 3. Setting the charcoal stoves before drying

Figure 4. Dryer designed for drying racks normally used by processors

ANNEX II

Cost of dryer

Item	Price (Rp)	Quantity	Total (Rp)	US$
Metal elbow	32,000	14	448,000	
zinc plate sheets	54,500	8	436,000	
Wire net for drying rack	25,000	11 m	275,000	
charcoal stoves	75,000	3	225,000	
Mini standing fan	150,000	1	150,000	
Spike/rivets	60,000	1 box	60,000	
Labour(total payment)	100,000	4 persons	400,000	
TOTAL			**1,994,000**	**210**

US$1 = Rp 9,500

ANNEX III

Operating costs

Drying 1 tray of un-boiled anchovy for 4 hours

Item	**Unit Price**	**Quantity**	**Total**	**US$**
Fresh anchovy	20,000	15 kg	300,000	31.6
Charcoal	3,500	10 kg	35,000	3.7
Kerosene	4,000	1 litre	4,000	0.4
Electricity	15	4 hour	60	0.006
			339,060	**35.7**

Drying 1 tray of boiled anchovy for 1 hour

Item	**Unit Price**	**Quantity**	**Total**	**US$**
Fresh anchovy	20,000	15 kg	300,000	31.6
Charcoal	3,500	2.5 kg	35,000	0.9
Kerosene	4,000	1 litre	4,000	0.4
Electricity	15	1 hour	15	0.002
			339,060	**32.9**

Indicative market selling price of final products to processor

Grades	**Price/kg (Rp)**
1	50,000–60,000
2	40,000–50,000
3	30,000–40,000

POST-HARVEST FISH LOSS ASSESSMENT ON LAKE VICTORIA SARDINE FISHERY IN TANZANIA – *Rastrineobola argentea*

[EVALUATION DES PERTES POST-CAPTURE DU POISSON DANS LA PÊCHERIE DE LA SARDINE DU LAC VICTORIA EN TANZANIE]

by/par

Yahya I. Mgawe[1]

Abstract

The Lake Victoria sardine *(Rastrineobola argentea),* locally known as *dagaa*, is a very important species in supporting sustainable livelihood in the country and the region. Dagaa is produced and processed in villages increasing the net income benefits to rural areas. It contains a combination of proteins, fatty acids, vitamins and micronutrients that provide a high level nutritious diet for good health. This fish, which can be purchased at T Sh 100 per 100 grams, is affordable to the majority of people all over the country.

However, the dagaa fishery is associated with high level of post-harvest fish loss. The loss assessment study conducted between 2006 and 2008 revealed that total production of fresh dagaa in Tanzania stands at about 197,200 tonnes per annum. More than 95% of the catch is sun-dried before being distributed in local and regional markets. The output doing drying is about 35% giving a total of about 70,000 tonnes of dried weight equivalent. It implies that this fishery could by itself contribute to at least 4 kg per caput fish supply or generate about T Sh 140 billion given a local price of T Sh[2] 2,000 per kg for best quality dagaa.

Based on the study, physical and quality losses in this fishery are extremely high standing at about 5% and 27% of the total value, respectively, and in terms of weight about 3,660 tonnes or 5% of dried dagaa is lost as physical loss, whereas quality degradation occurs to about 36,190 tonnes or 52% of total dried dagaa. In addition, the study identified the type and causes of the loss and generated other Indicative Quantitative Fish Loss Data (IQFLD) along the supply chain, as determined by field-tested fish loss assessment methods: Informal Fish Loss Assessment Method (IFLAM), Load Tracking (LT) and Questionnaire Loss Assessment Method (QLAM).

Key words: Post-harvest, Physical loss, Quality loss, Financial loss

Résumé

La sardine du lac Victoria *(Rastrineobola argentea)*, connue localement sous le nom de dagaa, est une espèce très importante pour assurer des moyens d'existence durables dans le pays et la région. Dagaa est produit et transformé dans les villages et augmente les gains de revenu net des zones rurales. Dagaa contient une combinaison de protéines, d'acides gras, de vitamines et de micronutrients qui fournissent un régime nutritif d'un niveau élevé pour une bonne santé. Ces poissons, qui pourraient être achetés en 100 T Sh pour 100 grammes, sont accessibles à la majorité des personnes dans tout le pays.

Cependant, la pêche du dagaa est associée à un niveau élevé de perte post-capture du poisson. L'étude d'évaluation de perte conduite entre 2006-2008 a révélé que la production totale du dagaa frais en Tanzanie est d'environ 197.200 tonnes par an. Plus de 95% de la prise est séchée au soleil avant d'être distribuée sur les marchés locaux et régionaux. Le rendement du séchage est environ de 35%, ce qui donne un total d'environ 70.000 en tonnes équivalent poids sec. Ceci implique que cette pêche pourrait par elle-même contribuer au moins à 4 kg par personne en approvisionnement de poissons ou générer environ 140 milliard T Sh si on considère un prix local de 2.000 T Sh par kg pour la meilleure qualité de dagaa.

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[2] US$1 = T Sh 1,100

Sur la base de l’étude, les pertes physiques et de qualité de cette pêche sont extrêmement élevées, environ 5% et 27%, respectivement, de la valeur totale et, en termes de poids, environ 3.660 tonnes ou 5% de dagaa sec sont perdus en tant que pertes physiques tandis que la dégradation de qualité se produit à environ 36.190 tonnes ou 52% du dagaa sec total. En outre, l'étude a identifié le type et les causes de la perte et a produit d'autres données Quantitatives Indicatives de Pertes du Poisson le long de la chaîne d'approvisionnement, comme déterminé par les méthodes d'évaluation de perte de poissons testées sur le terrain: IFLAM, LT et QLAM.

Mots clés: Post-capture, Perte physique, Perte de qualité, Perte financière

1. INTRODUCTION

The post-harvest fisheries could make a contribution to realization of Millennium Development Goals (MDGs) especially those targeting; food security, poverty reduction and improved health. The sector begins immediately after the fish has been caught. Hence, it includes all people’s activities at all stages from capture to consumption. It involves a number of groups of stakeholders playing different roles in handling fish on board, unloading, processing, storing and in distribution.

In addition, post-harvest fisheries is inter-linked with other socio-economic services taking place in fishing communities to include education, health and other undertakings. The linkages make it important to work on ways that can secure greater post-harvest benefits to include areas such as reduction of high Post-Harvest Fish Losses (PHFL) occurring in small-scale fisheries all over the world.

Regarding post-harvest fish losses, the FAO Code of Conduct for Responsible Fisheries (CCRF) urges states to achieve full utilization of aquatic resources particularly those suitable for direct human consumption, by improving practices through out the production and supply chain in fisheries and eliminating wastage (FAO, 1995).

This assertion has been adopted by a number of countries including Tanzania, where a fisheries policy (URT 1997), recognizes existence of several constraints in the fisheries sector to include poor fish handling practices and inadequate processing methods. The policy statement number 7 states the aim of the country on improving fisheries product utilization and their marketability.

But getting beyond declarations has been problematic, partly owing to lack of data and concrete information regarding type, causes of fish losses and indicative quantitative loss levels. Indeed, such data and information are crucial in understanding the magnitude of losses before deciding appropriate and cost-effective intervention, given limited resources available especially in developing countries.

Collection of PHFL data and information on small-scale fisheries, however, is considered to be a difficult undertaking given a dispersed nature of many small-scale and less developed fishing operations. Also, lack of simple and cost-effective fish loss assessment methods has been a stumbling block to conducting regular assessment of the losses.

Of late, however, FAO and the Natural Research Institute (NRI) have come up with three methods: Informal Fish Loss Assessment Method (IFLAM), Load Tracking (LT) and Questionnaire Loss Assessment Method (QLAM). These are considered to be simple, user friendly and cost-effective fish loss assessment methods in small-scale fisheries.

The methods have been field tested in Tanzania through a study conducted in 2006–2008. The study focused on Lake Victoria and the marine waters focusing dagaa fishery, which constitutes about 46% of fish landing from Lake Victoria fisheries.

The importance of this fishery on food security and sustainable livelihood can not be over-emphasized. The survey on poverty and nutrition conducted in 2000 (URT 2002), where the nutritive value of different food stuff was analysed according to cost, nutritional value and economic efficiency, found out that the dagaa from Lake Victoria purchased at T Sh 100 had the highest score (200) followed by soy beans (172). This shows that dagaa is an extremely economical food item. And can contribute in Tanzania’s endeavour to eradicate poverty and to improve nutritional intake through securing an inexpensive, nutritionally rich food item.

Hence, understanding losses in the dagaa fishery and ultimately reducing it has a great potential to provide all Tanzanians and others in the region, physical and economic access to sufficient, safe and nutritious food to meet their dietary needs for an active and healthy life.

2. OBJECTIVES

The objectives of the Post-Harvest Fish Loss Assessment (PHFLA) study in Tanzania were:

- To field-test three loss assessment methods: IFLAM, LT and QLAM;
- To use the three loss-assessment methods in identifying type and causes of PHFL occurring in Lake Victoria sardine fishery and generate Indicative and/or Quantitative Fish Loss Data (IQFLD); and
- To collate interventions that are being made in reducing post-harvest fish losses.

3. METHODS

The PHFLAstudy was conducted by using three loss assessment methods as indicated above:

The Informal Fish Loss Assessment Method (IFLAM)

This method is basically a qualitative method relying on Participatory Rural Appraisal (PRA) principles. Literature review, Semi-Structured Interviews (SSI) and field observation were conducted guided by properly designed check-lists. Key informants were interviewed to verify information collected from large groups' interviews.

Again, the information generated from the SSI was used in drawing up a flow diagram, which made it easier to collect Indicative and/or Quantitative Fish Loss Data (IQFLD) along the supply chain. Historical and frame-survey data were used as raising factor in extrapolation with area and season variations considered when analyzing the qualitative data.

The Load Tracking (LT)

In conducting LT, samples of Lake Victoria sardine were tracked for over 1000 km, right from the fishing ground on Lake Victoria to Dar es Salaam, which happens to be the largest wholesale market for the dagaa in Tanzania. The exercise was repeated by using the same handling, processing and distribution procedures as applied by local operators.

Weight measurements on losses were taken at each critical stage along the supply chain to include; fishing, processing, storage, packing and transportation to wholesale market. Other important parameters such as output doing sun drying of dagaa, number of days taken for dagaa to change colour from silvery to brownish and mean quantity of broken portions or fragments were also collated. Similarly, moisture content of dagaa getting to the wholesale market in Dar es Salaam was determined by a moisture metre in laboratory.

The Questionnaire Loss Assessment Method (QLAM)

QLAM was conducted through administration of questionnaires. The exercise involved: development of questionnaire, piloting phase, review of questions and administration of questionnaires at a full scale. It involved 125 respondents including fishermen, processors, traders and key informants. QLAM was used in validating data and information generated by IFLAM. Also to fill-in information gaps that were not captured during the IFLAM study.

Study sites

Figure 1. Map of Tanzania showing Study sites
○ and LT route

Site selection for the initial phase, IFLAM study, was based on analysis of historical data on Tanzanian fisheries' profile. The data suggest that Lake Victoria fishery is the most important in the country. It produces over half of total fish landing, employing more than 60% of fishers in the country and sustains fish export trade. Hence anything happening on this lake has high impact on the country. Four different study sites were selected on Lake Victoria fishery (Figure 1). These were:

- Kibuyi village in Mara region (Eastern side of the lake);
- Kirumba Mwaloni in Mwanza - the largest fish market for cured products in East and Central Africa;
- Yozu-a small island in Sengerema district (about 120 km from Mwanza);
- Bukoba custom in Kagera region (Western side of the lake).

On marine waters, Dar es Salaam and Mafia Island were selected as study sites. The former is the largest consumer market of fish in the country with Dar es Salaam Fish Market Complex and Kariakoo market receiving huge amount of fish on a daily basis whereas the latter is the most productive marine fishing area.

Whereas the IFLAM study report provided an opportunity to rank and prioritize the losses from different fisheries, which led to the decision to follow up the study by conducting a thorough LT and QLAM assessment on Lake Victoria dagaa fishery.

Operational definition

The operational definitions of important terms were adopted from Ward and Jeffries (2000). They have defined post-harvest as the period of time from when a fish is separated from its growing medium including the time a fish enters a net. On the other hand, physical loss refers to fish that is not used, which is either thrown away or consumed by animals/insects, while quality loss is the fish that has undergone changes (due to spoilage or physical damage) and is sold for a lower price than if no/minimal deterioration in quality had taken place.

4. RESULTS AND DISCUSSION

Fisheries profile

Fishing on Lake Victoria is carried out by more than 98,000 small-scale fishers using about 29,000 small canoes with an average crew size of 3–4 fishers per canoe. Heavy investment on Lake Victoria fishery has been directed on Nile perch, which is a high value export-oriented fishery. This development has resulted in an over capacity of Nile perch fishery as depicted by the high number of gill nets, long lines and beach seines targeting the perch (Table 1).

Table 1. Lake Victoria fishing effort statistics for 2007

Item	Kagera	Mara	Mwanza	Total
Total number of landing sites	168	151	315	634
Total number of fishermen	18,953	22,741	56,321	98,015
Total number of fishing vessels	6,799	6,022	16,911	29,732
Number and type of fishing gears				
Number of gillnets	107,243	99,850	208,079	415,172
Number of traps	0	5	87	92
Number of hand lines	6,570	4,869	24,040	35,479
Number of long lines	716,754	1,177,882	2,240,752	4,135,388
Number of beach seines	288	333	1,054	1,675
Number of scoop nets for dagaa	880	108	6	994
Number of cast nets for dagaa	8	18	4	30
Number of lift nets for dagaa	12	52	306	370
Number purse seine nets for dagaa	448	1,252	3,143	4,843
Others (unspecified)	0	1	37	38
Engines				
Number of Outboard engines	1,211	1,037	4,168	6,416
Number of Inboard engines	0	0	0	0

Source: *United Republic of Tanzania (URT) 2008*

Dagaa fishing is done mostly by purse seining method (Table 1) with light attraction mechanism. Fishers use an average of 4–5 pressure lamps and dagaa nets ranging between 6–8 mm mesh-size. Fishing is usually done during dark moon period, which is about 15–20 days per month. Good harvest is experienced between November and April, when a fishing unit of 4 people catches about 1–2 tonnes of fresh dagaa per night. Production of dagaa declines to an average of 400–700 kg per night during the lean season (May-October).

Most of the catch is processed by sun drying on sandy beaches, rock areas and on grass locally known as *kinshwi*. The method has little control over contamination by sand, dirty and attacks from insects and pests. As a result the end product tends to contain a lot of sand, the quality suffers and the product fetches low price adding to quality loss. And during the rainy season the method becomes just ineffective in handling increased volume.

Generally, data and information on Lake Victoria fish landing have always been scant; however, the Tanzania Fisheries Research Institute (TAFIRI) conducted a Catch Assessment Survey (CAS) between July 2005 and August 2006, which generated reasonably acceptable data (Table 2).

Table 2. Total fish landing on Lake Victoria fishery (July 2005–August 2006)

No.	District	Nile perch	Lake sardine	Tilapia	Others	TOTAL
1	Biharamulo	2,679.40	964.3	1,487.60	1,075.10	6,206.40
2	Bukoba	3,795.40	1,425.60	728.60	273	6,222.60
3	Bunda	5,254.70	8,716.30	2,643.60	923.90	17,538.50
4	Geita	5,279.30	360	2,465.30	2,173.70	10,278.30
5	Magu	5,383.20	6,160.80	1,549.20	4,231.50	17,324.70
6	Misungwi	697.90	473.50	430.30	823.70	2,425.40
7	Muleba	13,156.10	37,860.30	4,498.50	3,128.60	58,643.50
8	Musoma	14,864.10	17,997.90	6,697.80	1,968.30	41,528.10
9	Mwanza	4,271.70	8,134.00	2,962.40	521.20	15,889.30
10	Sengerema	24,224.10	25,883.30	27,800.90	1,630.30	79,538.60
11	Tarime	11,141.20	15,480.20	5,816.70	22,929.50	55,367.60
12	Ukerewe	19,295.70	73,746.00	23,836.10	3,215.10	120,092.90
	TOTAL	110,042.80	197,202.2	80,917.00	42,893.90	431,055.90
	% of Total	**25.5%**	**45.7%**	**18.8%**	**10.0%**	**100.00**

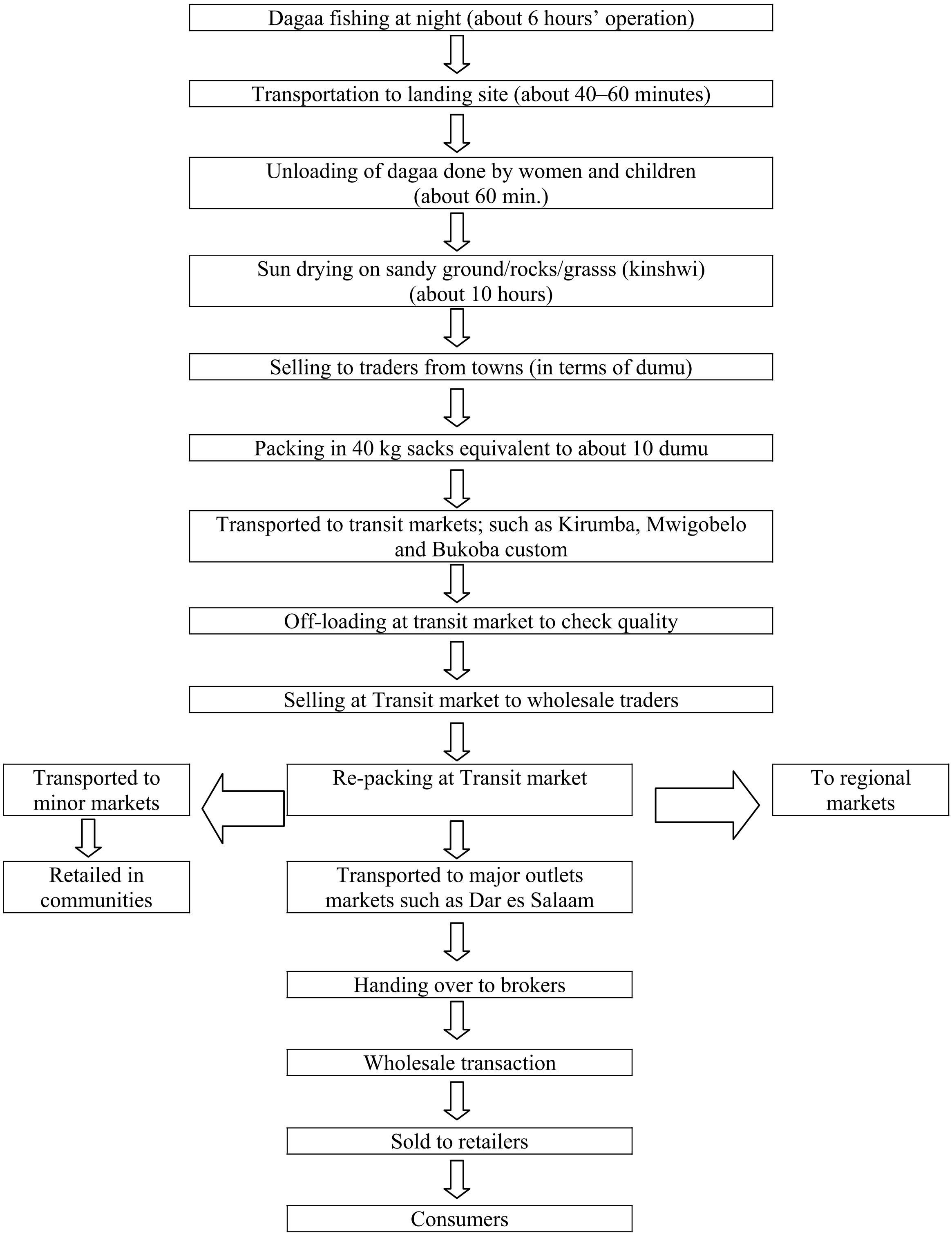
Source: *TAFIRI: Takwimu za mapato ya uvuvi Ziwa Victoria*

The data on Table 2 suggest that dagaa constitutes about 46% of total fish landing on Lake Victoria fisheries followed by Nile perch and tilapia in that order. However, when it comes to value dagaa has the lowest value of all fish species caught on the lake.

Most of the Nile perch, over 70–80%, caught on Lake Victoria is being exported to the European market, while the remaining amount is dry-salted or fried for the domestic and regional markets. On the other hand, the tilapia *(Oreochromis niloticus)* is the most popular fresh-water fish species in the domestic market fetching relatively high price, which tend to exclude large segment of local consumers. As a matter of fact, increased price of Nile perch and tilapia has made the dagaa to remain the cheapest source of animal protein for the great majority of people in the country and within the East and Central African regions.

The flow diagram

The dagaa is widely distributed in local and regional markets, as presented below:



Post-harvest fish losses

The benchmark data for assessment of post-harvest fish loss in dagaa fishery was determined by using the three PHFLA methods mentioned above. The results are shown in Table 3.

Table 3. Benchmark for PHFL assessment on dagaa fishery

No.	Benchmark	Measure
1	Estimated Fresh dagaa landing (tonnes)	197,200
2	output doing sun drying	35%
3	Estimated weight of dried product (tonnes)	70,000
4	Estimated production during dry days	60%
5	Estimated production during wet days	40%
6	Average price/kg of best quality (T Sh)	2,000
7	Average price/kg for changed colour product (T Sh)	1,500
8	Average price/kg for animal feed quality (T Sh)	200
9	Difference between best and animal feed quality (T Sh)	1,800
10	Moisture content	10%

US$1 = T Sh 1,100

The study identified different types of losses that exist in the dagaa fishery right from capture to wholesale markets, as presented in Table 4.

Table 4. Types of assessed fish losses

Physical loss	Quality loss	Other losses
Physical damage during fishing	Presence of bycatch	Unfair marketing practices
Animal predation	Quality degradation through rain	Levy evasion
Discarded after prolonged rain (rotten)	Change in colour before being sold	
Theft	Fragments/breakages	
Sinking during transportation		

Based on results obtained (Table 5), it implies that losses in terms of value is about 32% with physical loss representing about 5% and quality loss about 27%. Also, about 3,660 tonnes or 5% of dried dagaa is lost as physical loss each year, while the quality of about 36%, 190 tonnes or 52% of dried dagaa is degraded. Obviously, these figures could go up when other losses, not captured in this study, such as the one caused by insect infestation are taken aboard.

Table 5. Indicative quantitative PHFL in dagaa fishery (Tanzania)

No	Reasons for loss	%	Fresh wt. (tonnes) Equivalent	Dry wt. (tonnes) Equivalent	Loss in billion T Sh
ESTIMATED DAGAA LANDING			197,200		
1	Physical damage during fishing	0.9%	1,775	621	1,242.40
2	Animal predation	2.0%	3,944	1,380	2,760.80
3	Discarded after prolonged rain (nyambore)	4.0%	3,155	1,104	2,208.60
4	Theft	0.1%		35	70.00
5	Sinking sacks during transportation	0.7%		520	1,040.00
6	Presence of bycatch	2.5%		1,750	3,500.00
7	Quality degradation through rain	11.0%	22,400	7,840	14,112.00
8	Change in colour before being sold	30.0%		21,000	10,500.00
9	Fragments/drying grass (chekencha)	8.0%		5,600	10,080.00
TOTAL PHYSICAL AND QUALITY LOSS					45,513.80
1	Unfair marketing practices	11.0%		7,700	15,400.00
2	Loss due to insect infestation	Not quantified			
3	Loss in terms of levy evasion	Not quantified			

Source: *Mgawe and Mondoka 2007, 2008 (US$1= T Sh 1,100)*

Fishing stage
PHFL during fishing is mainly associated with stepping on fish done by crew onboard the canoe due to the lack of separating boards. The weight measurements taken during the study suggest that about 0.9% of dagaa, equivalent to over 621 tonnes, is thrown over board due to physical damage caused by this practice. This loss is estimated to cause physical loss of over T Sh 1.2 billion. Similarly, lack of Good Hygienic Practice (GHP) to include: dirty canoe and fishing gears, lack of drainage system and poor personal hygiene of fishers on board could be sources of contamination at the fishing stage causing spoilage and quality loss of the raw material.

Unloading of the catch
The unloading of fish at the beach is done immediately after getting back to the landing site, about 03.00–05.00 am, before dawn. The catch is taken to the drying ground straight away minimizing chances for loss at this stage. Although a portion is given away to relatives, this is considered to be a livelihood support to strengthen social networks in fishing communities.

Animal predation
The traditional method of drying dagaa in the sun on sandy beaches, rocks or on drying grass locally known as Kinshwi has little control over attacks from insects, birds and domestic animals. Fishers employ different tactics to deal with the problem including placing watch-keepers and butchered birds as scaring mechanism for the growing flock of birds roaming around drying places. These coping strategies notwithstanding, about 2% of dagaa is lost through animal predation. The loss is equivalent to about T Sh 2.8 billion, a loss to crew, canoe owners and watch-keepers.

Discarded after prolonged rain (nyambore)
Dagaa takes about ten hours to dry-up and get sold in the evening if the weather is favourable. However, the situation is very challenging during the rainy season. The quality of dagaa is heavily degraded if it rains before completion of the drying process. The grade of the product is lowered from that for human consumption to that for animal feed. When there is prolonged rain on two consecutive days, the whole lot rots and gets discarded as nyambore (unsuitable for human consumption and animal feed). In addition, a big portion of dagaa placed on rocky areas adjacent to the lake is easily washed back to the lake.

Re-drying of dagaa on the third day could make sense; unfortunately this option is not practical due to limited drying spaces. As a matter of fact, fishers are compelled to pay T Sh 50,000 per month, as an average fee for using small drying space capable of handling about 150 dumu at a time. Such open spaces are few in number thus have to be used for fresh batches caught on consecutive days.

The estimated physical loss associated with rain is 4% of the amount produced during the rainy season, which is calculated to about T Sh 2.2 billion. The loss affects financiers, fishers, processors and the children cum guards.

Theft
Theft stands at about 0.1% of dried weight subjecting traders to a loss of about T Sh 70 million. Nevertheless, this was the least of physical losses identified during the study being an improvement from the 4% reported a decade ago (Ward, 1996). The positive trend could be a function of successful introduction of community-based security system developed under what is locally known as sungu-sungu.

Sinking sacks during transportation
After the drying process, the product is transported to major transit markets by using transport canoes. Most of the canoes are propelled by outboard engines but they are small and unstable to withstand strong winds. Splashes of water enter the canoe and soak the fish, in such cases the load becomes heavier compelling a skipper to throw a certain number of sacks over-board for the sake of stability and safety.

Sometimes these canoes capsize dropping the whole load of dagaa. Such scenario occurs about four times per transport canoe per annum. The problem is more pronounced during windy seasons, particularly in February, May, June and December of each year. It was estimated that 0.7% of dried weight is lost equivalent to a loss of over T Sh 1 billion.

Unfair marketing practices
Selling of dried dagaa takes place immediately after the sun drying process in the evening. The product is collected into heaps before being measured in a 20 litres container locally known as dumu. The mean weight of dried dagaa is 4 kg per dumu (sd=0.26), selling at about T Sh 3,500 in fishing villages.

The price is determined through an open bidding process governed by the law of supply and demand. According to existing procedures, it is the owner himself who measures the product into dumu. He does it so sparsely to avoid compact-filling of dagaa in the dumu. However, when a trader gets to a market he would not be allowed to measure it; it is the secondary buyer at the market who takes the measurement by pressing or compact-filling the dumu. In the process a sack of 9 dumu from a fishing village will measure 8 dumu only, generating a loss in weight of about 11%. This unfair marketing practice causes huge loss of over T Sh 15 billion affecting primary traders. Dagaa fishers are not alone in being affected by such arrangements as Nile perch fishers are equally affected by the practice, whereby weighing scales are adjusted to reap unsuspecting sellers.

Sometimes primary traders mix up good and bad quality dagaa in sacks. The trader may get high price out of the adulteration practice. But it happens quite often that a trick is detected and the whole lot treated as bad quality product fetching low price.

Presence of bycatch

An increased level of bycatch *(Haplochromis* spp.*)* is another cause of losses to fishers and traders. The volume of bycatch in dagaa landings seems to be increasing over time probably due to decreasing population of its main predator: the Nile perch. At the moment, bycatch constitutes about 6% of the catch. Most of it is sorted out and given free of charge to people who happen to be at the landing site. Failure to sort it out lowers the quality of dried product resulting into low prices.

Despite the effort to sort out the bycatch at the fishing village, it represents about 2.5% of dagaa reaching the wholesale market. Usually, the amount is deducted from the total and classified as unwanted material, causing a loss of about T Sh 3.5 billion to fish traders.

Quality degradation through rain

In addition to physical loss caused by rain (4.3.4), the rainy season creates drying and storage difficulties because most of the days experience unfavourable drying conditions (low temperature and higher relative humidity). Hence higher volumes of poor quality products are produced during the rainy season.

Figure 3. Dagaa soaked with rain water

Figure 4. Rain water washing dagaa back to the lake

As if that is not enough, demand declines mainly due to declining number of traders visiting fishing villages during the rainy season to avoid the risk involved over quality loss. Also, availability of substitute goods such as green vegetables and transportation difficulties makes it difficult to sell out the product in good time. Consequently, increased proportion of dagaa is degraded selling as animal feed as opposed to human food. The study estimated that the quality of about 11% of the catch, landed in wet season, is degraded causing a loss of over T Sh 14 billion per annum.

Change in colour before being sold

Colour change from silvery to brownish, as a function of biochemical processes including fat oxidation and autolysis is considered to be a major indicator used by customers in determining quality of dagaa. High water content and prolonged storage are some of the factors that accelerate the rate of change. The colour tends to change after a period of about 10 days depending on drying conditions. The dagaa dried on rocks seems to take a bit longer before it can change colour compared to drying on sand or Kinshwi. The study estimated that 30% of the dried product is sold after the colour has changed causing a loss of over T Sh 10 billion per annum.

Fragments/drying grass
Fragmentation is another cause of high post-harvest loss. Initially, it was being assumed that the problem was closely related to poor road and bad transportation. However, the study found that this could hardly be the case for areas connected with improved tarmac roads such as Lake Victoria area and Dar es Salaam.

Rather, it was found that the problem rests with government regulations on levy per sack instead of per kgme and the arrangement of charging transport cost by using sacks as units. These two arrangements entice traders to over-pack the dagaa into large sacks through a practice locally known as lumbesa. In the process they increase proportions of fragments.

Figure 5. Stepping on dagaa to make it portable

Figure 6. Compact packing to reduce transport cost and levy paid per sack regardless of weight

Brokers at a wholesale market will take out sample of dagaa for assessing fragment level and determining quantity of unwanted material such as grass and bycatch contained in sacks. The results from repeated experiments suggest that fragments constitute 8% of the load sold in wholesale markets. Hence, it is being estimated that over T Sh 10 billion is lost through fragmentation.

On the other hand, large quantity of grass found in dried dagaa is another problem causing quality degradation. This is mostly associated with dagaa dried on grass (*kinshwi),* a common practice in Kagera region of Lake Victoria. It was estimated that kinshwi constitutes about 5% of dagaa load getting to markets.

Loss through levy evasion
Over 50% of dried dagaa from the Tanzanian side of Lake Victoria is believed to be sold in the regional market through cross-border trade. The common practice is that a trader would purchase dried dagaa from fishing villages or at a transit market declaring to be sending it to towns located closer to border areas but within the country. This enables him to evade paying the export levy. On getting to border towns he would store his product in large warehouses constructed in respective areas to facilitate the cross-border trade. The actual crossing takes place at night when law enforcers are out of sight. This practice makes the government lose potential revenue from cross-border trade.

Interventions being made

Initiative towards reduction of post-harvest losses in dagaa fishery has so far included trials on using raised drying racks, the use of solar driers and application of smoking method. Also, some attempts have been made to produce value added products such as brined and spiced smoked products for the supermarket outlet. Based on field observation, however, there is more to be done in improving processing and storage technologies if tangible reduction of PHFL has to be realized.

On the other hand, strengthening of regional cooperation is gradually paying dividend by opening up the bottle-neck to rewarding market though harmonization process should continue so that increased volume of dagaa is sold out through legal cross-border trade.

Stakeholders perceptions

Stakeholders perceive that increased productivity and profitability of dagaa fishery rely heavily on reducing PHFL and securing access to rewarding local and regional markets. Low level of technology and literacy, unfavourable weather conditions and remaining trade barriers in accessing the regional market are factors that have been highlighted to be affecting initiatives to reduce PHFL in dagaa fishery.

5. RECOMMENDATIONS

The three PHFLA methods, IFLAM, LT and QLAM, have proved to be effective tools for assessing fish losses in small-scale fisheries. Hence, it is worth applying the same methods in other similar fisheries.

In view of existing complexity and the magnitude of losses in dagaa fishery especially during the rainy season, it would be ideal for public and private institutions to assist in promoting technical innovation and the use of improved technologies in the post-harvest handling, processing and storage of dagaa. Such intervention should focus on production of improved quality products and prolonging the shelf-life of dried dagaa.
Institutions that facilitate appropriate innovations and technology development transfer have to be assisted to address technological challenges of improving processing and storage technologies, including problems associated with drying on grass or bare sandy ground.

The regional governments should help to create conditions that will enable increased cross-border trade in dagaa by harmonizing policies, quality standards and customs procedures. Such measures will open-up existing bottle-neck in accessing the regional market and facilitate speedy distribution of dagaa reducing storage time and quality loss.

It is important to conduct a thorough study in order to determine the nature and remedy for biochemical colour change problem, which is causing high quality loss. Similarly, it is important to search for better selectivity methods in order to reduce the amount of bycatch especially *Haplochromis* spp., in dagaa catches, while looking for better ways of utilizing the increasing bycatch volumes.

6. CONCLUSIONS

IFLAM, LT and QLAM have proved to be effective methods in assessing PHFL in small-scale fisheries worth taking up. On the other hand, increased productivity and profitability of dagaa fishery will depend on reducing post-harvest dagaa losses and securing access to rewarding local and regional markets. This calls for harmonization of regional trade policy in order to eliminate trade barriers and establish basic quality standards and custom procedures. Making markets work for the traders will also benefit not only those involved in the post-harvest sector, but also the harvesting sector by providing an outlet for its catch and potentially by improving prices.

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ADDRESSING POST-HARVEST LOSSES IN ARTISANAL FISHERIES: SOME KEY CONSIDERATIONS

[ABORDER LES PERTES POST-CAPTURE EN PÊCHE ARTISANALE: QUELQUES CONSIDÉRATIONS CLÉ]

by/par

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Abstract

While artisanal fisheries are said to incur high post-harvest losses, with data from 15% to 75% (FAO, Mills, Moes) commonly quoted, in many cases the key factors behind these figures have not been meaningfully clarified. This makes planning and implementation of effective loss reduction strategies difficult, and risks wasting already scarce development resources.

Reducing post-harvest losses may be addressed through technical or non-technical measures. Solutions might be within or outside the fisheries sector and therefore an effective loss reduction strategy rests upon a systematic loss assessment and a holistic approach to identification and planning of the interventions. This requires that all stakeholders (government officers, development practitioners, policy-makers and researchers, etc.) have a common understanding of these considerations that are elaborated on in this paper. These are mainly the terminology about the type of loss, the stepwise approach to quantifying the losses, the participatory approach, the issue of quality and spoilage within post-harvest loss assessment, the non-existence of universal established solutions to post-harvest losses, paying attention to existing coping strategies and to the socio-economic context within the fisheries.

Keywords: Post-harvest losses, Loss assessment, Small-scale fisheries

Résumé

Alors que les pêches artisanales sont connues pour avoir de fortes pertes post capture, avec des données de 15% à 75% (FAO, Mills, Moes) communément citées, dans de nombreux cas les facteurs clés guidant ces données n'ont pas été minutieusement clarifiées. Ceci rend difficile la planification et la mise en œuvre de stratégies efficaces de réduction des pertes et risque le gaspillage de ressources de développement déjà rares.

Les pertes post capture peut être réduites à travers les mesures techniques ou non techniques. Les solutions peuvent être dans ou en dehors du secteur de la pêche et par conséquent une stratégie efficace de réduction de perte repose sur une évaluation systématique et une approche holistique pour l'identification et la planification des interventions. Ceci exige que tous les acteurs (agents gouvernementaux, agences de développement, décideurs politiques, chercheurs, etc.) aient une compréhension commune de ces considérations élaborées dans ce document. Ce sont notamment la terminologie à propos du type de perte, l'approche par étape pour quantifier les pertes, l'approche participative, la question de la qualité et altération dans l'évaluation des pertes post capture, la non existence de solutions universelles établies pour les pertes, tenir compte des stratégies endogènes existantes et du contexte socioéconomique dans la pêche.

Mots clés: Pertes post-capture, Évaluation des pertes, Pêche à petite-échelle

1. INTRODUCTION

Post-harvest losses are said to occur all over the world in any type of fishery from production to point of final sale to consumer, although the type and level of loss as well as who is affected varies according to the type of fishery, post-harvest activities, skills, knowledge and infrastructure and access to equipment and facilities. This variation and the influencing factors will have important implications for any eventual loss reduction measures.

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While artisanal fisheries are said to incur high post-harvest losses, with data from 15% to 75% (FAO, Mills, Moes) commonly quoted, in many cases the key factors behind these figures have not been meaningfully clarified. This makes planning and implementation of effective loss reduction strategies difficult, and risks wasting already scarce development resources.

The process of assessing losses is therefore key to reducing them effectively. Assessment leads to a good understanding of the type, cause, effects and perceptions of losses. FAO is currently in the process of producing a comprehensive document which compiles the data from field loss assessment studies and methodological guides in fish loss assessment for the extension officers and fish operators, as a result of long-lasting joint initiatives with the Natural Resource Institute (NRI) in developing fish loss assessment methodologies (Ward and Jeffries, 2000).

This paper introduces some of the key issues to be considered in terms of assessing and reducing post-harvest fish loss (PHFL) associated with small-scale fisheries. It builds upon lessons learnt from implementing pilot fish loss assessment studies in selected sub-Sahara African artisanal fisheries, especially the recently implemented two-year FAO Africa regional post-harvest loss assessment (PHLA) programme (2006–2008). By sharing these lessons the paper aims at easing the understanding and providing institutions and development practitioners with the basic information required to effectively address post-harvest losses. Key issues discussed in terms of the post-harvest loss assessment process and the identification of loss reduction strategies follow below.

2. PHLA PROCESS

Standard terminology to describe different types of losses

PHFL are associated with the complete loss of fish protein from the post-harvest food chain, the spoilage of fish and quality degradation that occurs post-harvest, as well as losses due to market forces. One of the important aspects to assessing losses is that there is a common understanding of what these different losses are. The following are definitions that can help develop this common understanding:

- Physical loss: should be understood as fish that is not used, is either thrown away (accidentally, voluntarily or as authorized). It also includes losses due to insects and birds/animals. Such losses are expressed either in percentages, volume (kg, tonnes) or financial terms;
- Quality loss: refers to fish that has undergone changes (due to spoilage or physical damage) and is sold for a lower price than if no/minimum deterioration in quality had taken place;
- Market force loss: induced/led by market changes or developments, where the fish operator has to sell their product at a price below his/her expectations. The loss is the difference in expected price and realized price within a certain market environment[1].

All three types of losses can have financial implications for fishermen, processors and traders (operators). Different approaches may be necessary to address these different types of loss; therefore, it is important to report or describe post-harvest losses as physical, quality, market force or, in some situations, as a combination of the different types.

Field experience has shown cases of close relationship between these types of losses (e.g. change in quality or fish thrown away because of market developments/oversupply, drastic price changes) that should be well figured out by a loss assessor as they are likely to influence the type of information to be conveyed, the way loss data are expressed and the eventual required interventions. The illustration of this consideration is schematized in Figure 1 based on information on losses associated with fresh tilapia in Kenya and Uganda (Load Tracking (LT) country reports). It can be seen that market forces, such as over supply, lead to both physical, quality and market force losses.

[1] Other causes may be inadequate price information or market information, or barriers preventing the producer from gaining access to the right market with the right product at the right time.

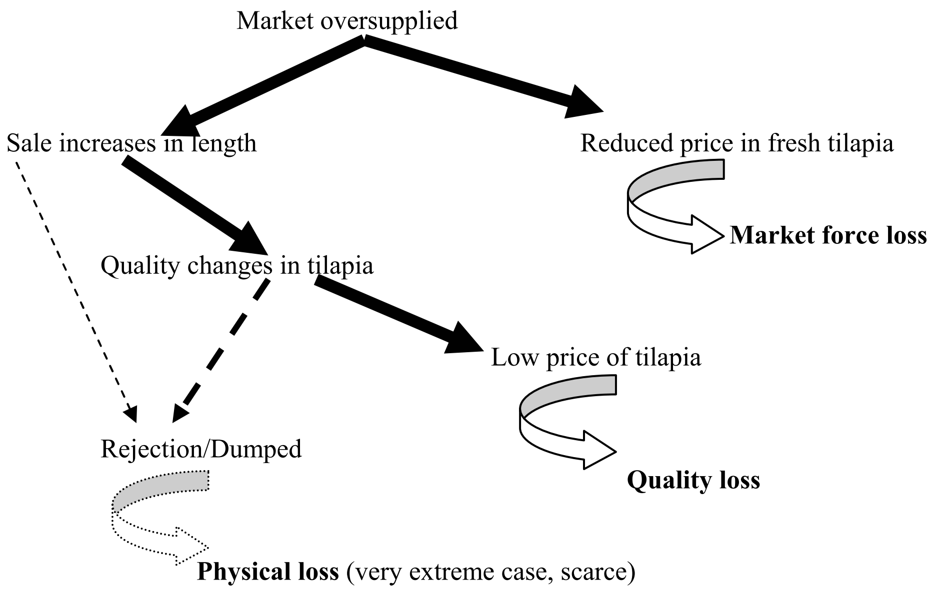

Figure 1. Occurrence of different types of losses in a mono specific fishery (tilapia)

A stepwise approach to quantifying the losses

There may be several different types of loss occurring in a particular fishery, distribution chain or geographical area. Some losses may be more important and some minor and, at the same time, development resources to tackle losses may be restricted. Often, therefore, there will be a need to prioritize losses after an initial qualitative assessment using a method such as Informal Fish Loss Assessment (IFLAM) (Ward and Jeffries, 2000) so that attention can be paid to the more significant losses which can then be quantified using LT and a questionnaire survey approach (QLAM) (Ward and Jeffries, 2000) and, if need be, addressed.

Participatory approach

The assessment process and subsequent planning processes should aim to be as participatory as possible and involve all key stakeholders. This will help develop a more accurate understanding of losses, develop a sense of ownership of the process and solutions to losses by fishermen, processors, traders, government, NGOs, associations. Involving fish operators right from the beginning is a prerequisite to collecting reliable fish loss data. Importantly the type of data to present to them is also noteworthy to encourage their willingness and sense of ownership and responsibility to take actions to control losses, including individual initiatives. In fact, the restitution sessions and reflection of the PRA-based flow diagram-centered approach demonstrated that field data are more self-explanatory and, moreover, figures on financial losses are powerful awareness-raising tools and raise the question of who feels more affected by a given type of loss. It is also important to recognize the different interests of operators, consumers and government. While most fish operators are interested in the financial impact of losses, consumers are often focussed on the price they pay for fish its quality and safety, while development practitioners and government officers are often concerned with ensuring food security, promoting trade and long term resource sustainability.

The issue of quality and spoilage within PHLA

Most stakeholders in the distribution chain can determine quality, and different qualities of fish are often associated with different value/price. The difference between the potential value of fish or product if no/minimum deterioration had taken place and the actual value of the fish after it had undergone change (low quality due to spoilage or fragmentation) gives an indication in financial terms of the extent of quality loss. In the process of identifying quality loss (expressed in volume terms or percentage of the landings or given consignment), it is often practical to apply indigenous quality indicators understood easily by all, as these often relate to price differences. Scientific assessments to determine the level of spoilage or changes occurred can be useful but may not be effective in raising factors for the operators' awareness, hence may not help fishermen or processors to get a better price. More scientific assessments of quality can show differences in quality, but the differences in quality may not be directly translated into price differentials, which is what operators relate to.

Vast quantities of fish are traditionally smoke dried in Africa. The issue of fragmented (broken smoked fish) fish has been extensively elaborated during the implementation of the PHLA programme and it was reported that depending on whether fish has been thrown away or eaten by insects/animals or physically damaged but sold for consumption (often sold for animal feed also), it can be considered either physical or quality type loss.

3. IDENTIFICATION OF LOSS REDUCTION STRATEGIES

Non-universal established solutions to post-harvest losses

Reducing PHFL will most likely rely on a combination of improvement in awareness, knowledge and skills, as well as technical, financial, infrastructural and policy support. While acknowledging the importance of common control measures (such as maintaining the cold chain, improving processing technology), assessing loss stresses the fundamental fact that no one size fits all in addressing fish losses. Therefore, one must keep in mind that solutions to post-harvest losses may not necessarily always be technical and may rely on actions outside the post-harvest, or the fisheries sector as a whole. Some losses may be controlled as a result of a slight intervention, e.g. law enforcement, to deter illegal fishing or downstream to post-harvest or even, sometimes, just a shift in the pattern of fish utilization, e.g. curbing the trend in fishmeal towards human consumption fish production, may have a great impact on the magnitude of losses within a given fishery.

Paying attention to existing coping strategies

Learning and applying lessons from elsewhere is an important approach to reducing losses. Cases of effective indigenous loss prevention or reduction measures have been reported within some fishing communities in Ghana and Tanzania IFLAM country reports. The PHLA programme found examples of some noteworthy coping strategies to control losses, especially during processing. In particular, techniques such as the prevention in Ghana of insect infestation during fermentation and the use of a bird repellent ghost in Tanzania to reduce physical loss during natural drying of *dagaa* (see Figure 2) are ideas that should be disseminated to other communities in the countries concerned, as well as to operators in other countries experiencing similar losses.

Figure 2. Birds' predation during drying of fish was minimized by placing within the drying fish dead birds to generate deterrence!

This highlights the importance of searching out existing coping strategies as well as learning lessons from other attempts at reducing losses and sharing this information with operators to design effective practical loss control measures.

Paying attention to the socio-economic context within the fisheries

As well as understanding the technical reasons for and potential solutions to losses, it is also important to understand the cultural and socio-economic context of the operators concerned and reflect this in loss reduction initiatives. As a matter of emphasis of the non-universal established solutions to post-harvest losses, assessing post-harvest loss enables one to appraise the relevance or extent of limitations of the assumption that technical interventions to reduce losses (e.g. in fresh fish) will ensure quality preservation, and therefore increase the value of the fish and income of the operator. This, of course, can guide in seeking the actual adequate loss reduction measure. Field observation in Tanzania and Uganda highlighted that the improvement in the return was not systematic since any quality rewarding development is intimately linked to the critical issue of the purchasing power of the fishmonger, fish processor or the final consumer; hence the socio-economics within the community at stake and the economic feasibility of the adoption of technical solutions play an important role. It was stressed that such good quality fish is denied to the smallest operators who, in certain communities, form the major part of the buyers. As an alternative, even considering the negative effect of the time/temperature on the quality of raw material (hence a low value end product), these operators refrain from buying (or intentionally delay the transactions) until the seller/fisherman in a desperate search for customers is forced to cut the price in order to get rid of a deteriorating consignment. The picture below reports an interview of a fresh fish operator in one of the biggest fish markets in Dar es Salaam, Tanzania.

"A few buyers would show up in the morning, when the price is high and the fish is still fresh. As time goes, the quality of fish is degraded compelling a trader to reduce the price in order to attract more buyers who can save his neck from heavy physical loss at the end of a day. Failure to use ice results into huger quality losses!"

Figure 3. Interview of fresh fish trader awaiting desperately buyers

As part of the loss reduction process policy measures also need to be considered and it may be necessary to ensure that the objective of the loss reduction intervention is met. For example, if improving quality leads to an increase in price and to fish becoming less affordable to low-income consumers, then policy change to promote the food security of this group should be seen as a remedy. This may involve encouraging greater access to alternative and cheaper sources of protein, including cheaper species or fish products. Failing to consider these knock-on effects of reducing losses may mean that some stakeholders lose out and find themselves to be more vulnerable to poverty and food insecurity.

4. CONCLUSIONS AND RECOMMENDATIONS

Reducing post-harvest losses in artisanal fisheries should consider both technical and non-technical measures. Solutions might be within or outside the fisheries sector and therefore an effective loss reduction strategy rests upon a systematic loss assessment and a holistic approach to identification and planning of the interventions. This requires that all stakeholders (government officers, development practitioners, policy makers and researchers, etc.) have a common understanding of these considerations and are involved in the decision making processes regarding loss assessment and reduction.

As a matter of upgrading the understanding among all people involved, the experience gained from the implementation of the PHLA and lessons learnt from similar field programmes should be documented and shared amongst development practitioners worldwide.

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