

FISH QUALITY AND PROCESSING IN MALAWI: RESPONDING TO CHALLENGES THROUGH INSTITUTIONAL CAPACITY BUILDING

Fanuel Kapute
Aquaculture and Fisheries Science Department
Faculty of Environmental Sciences
Bunda College of Agriculture
P.O. Box 219
Lilongwe
Malawi
fanuelkapute@yahoo.co.uk
fanuel@hafro.is

Supervisor
Margeir Gissurarson
MATIS-Iceland
margeir.gissurarson@matis.is

ABSTRACT

Fish processing and quality control in Malawi are still poorly developed. Traditional fish processing methods are widely employed resulting in considerable post-harvest losses. One of the major challenges to steady and sustainable development in fish processing and quality management is the lack of adequately trained personnel. This is directly reflected in poor institutional capacity.

This project analyses the situation in fish processing and quality management in Malawi to identify gaps that require improvement. Specifically, the project assesses the role of training institutions in Malawi in capacity building for fish processing and quality management. The institution under discussion in this project is the Aquaculture and Fisheries Science Department at Bunda College of Agriculture, Malawi which is responsible for training students in aquaculture and fisheries science at the undergraduate level.

Improvement in the teaching of fish processing and quality management in the Department of Aquaculture and Fisheries Science was identified as the major gap requiring action. The current teaching syllabus was thus analysed to identify weak areas. In conclusion, the project developed (as the major output) a teaching handbook for the Department of Aquaculture and Fisheries Science.

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1 INTRODUCTION

1.1 Malawi and the fisheries: A brief overview

Malawi (Figure 1), is a landlocked southern African country with a total area of 118,480 km² (World Fact Book 2002) and a population of about 13 million (NSO 2008). The economy is chiefly agro-based with an estimated GDP of US\$ 2.1 billion as of 2005.



Figure 1: Map of Malawi showing surrounding countries and position in Africa (About.com)

Though without a sea, about a quarter of the country is covered by water (Figure 1) that supports over 800 species of fish and nearly 15% of the global freshwater fish biodiversity (Commonwealth/GTZ 2007). Lake Malawi (about 30,000 km²), the third and tenth largest lake by area in Africa and in the world respectively provides most of the fish eaten in Malawi. Other water bodies include Lakes Malombe (390 km²), Chilwa (about 750 km²), Chiuta (about 200 km²) and the Shire River (the only outlet of Lake Malawi) (FAO 2005a, Marjorie *et al.* 1997).

1.2 Importance of fish and the fisheries sector in Malawi

In a country where more than 85% of the population live in rural areas (World Fact Book 2002) and over 65% live below the poverty line, i.e. on less than 1 US dollar per day, fish provides the most affordable quality source of dietary animal protein (Figure 2) (MPRSP 2005). In fact, about 70% of all dietary animal protein consumed by Malawians used to be from fish but this has declined to about 30% in recent years due to dwindling fish stocks (Banda *et al.* 2005). Increased demand for fish in Malawi because of high population growth (3.2%) (NSO 2008) cannot be met with a corresponding increase in capture fisheries.

Fish and the fisheries sector is also a source of income for the people of Malawi. Commonwealth/GTZ (2007) reports a local revenue of about M K2.6 billion (US\$ 24 million) from fish sales annually with fisheries contributing about 4% of the country's GDP.



Figure 2: A local Malawi dish (nsima) served with cooked smoked tilapia (gutted) and vegetables (MBERU and JICA / LMEP 2001)

More than 50,000 fishers are directly employed in the fisheries sector and over 350,000 people are involved in either fish processing, fish marketing, net making, boat building and other related activities (Commonwealth/GTZ 2007).

Lake Malawi is a centre of tourism due to the great diversity of fish species. Of much interest are the rock dwelling cichlids (local name: mbuna) which are popular aquarium fish (Figure 3).



Figure 3: Beautifully coloured aquarium fish from Lake Malawi (Mkoka 2003)

Reporting for the Malawi Export Promotion Council, FAO (2005a) indicates that in 1999 a total of 40,821 units of aquarium fish at a value of MK 8,476,768 (over US\$ 100,000) were exported to Europe, Japan, USA and South Africa. Ecotourism and aquarium trade is a source of foreign exchange to Malawi (Commonwealth/GTZ 2007).

1.3 Categories of the fisheries sector in Malawi and current fish production

The fisheries sector in Malawi can be divided into capture fisheries and aquaculture (Banda *et al.* 2005). The capture fisheries, classified as either small-scale commercial or large-scale commercial (Commonwealth/GTZ 2007), are the major sector while the aquaculture sector is still almost entirely a subsistence activity, although the Malawi Development Corporation (MALDECO) Fisheries Limited has been developing aquaculture on a commercial scale. Malawi's capture fisheries are estimated between 40,000 and 70,000 tonnes, compared to less than 1500 tonnes produced by aquaculture (Figure 4).

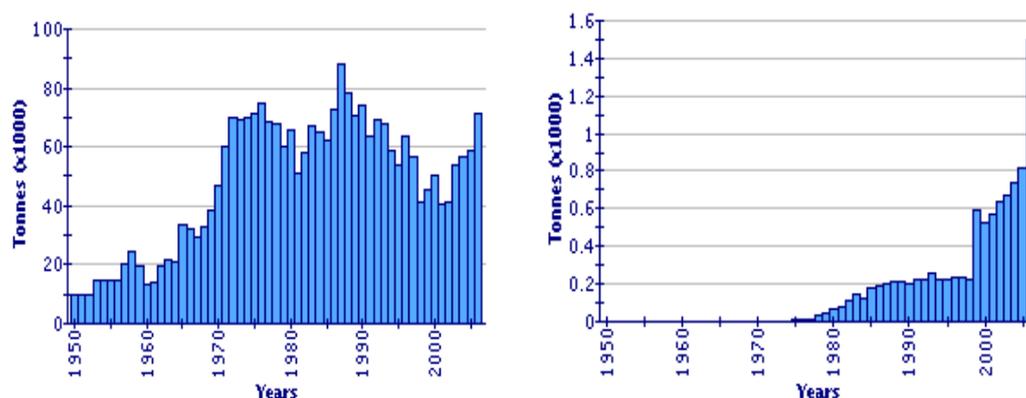


Figure 4: Capture fish production (L) and aquaculture production in Malawi (R) from 1950 (FAO 2005a)

Though reports are available on unexploited fish stocks from the deep waters in Lake Malawi (African Development Fund 2002), current production trends from the capture fisheries show a decline due to uncontrolled fishing (Commonwealth/GTZ 2007). Probably this could be due to the fact that exploitation of deep water stocks requires improved fishing gear and boats which most fishers in Malawi do not have. Efforts to manage the declining fisheries resources have so far not reversed this trend. Aquaculture has therefore become an area of increased focus by the Fisheries Department in Malawi to complement the capture fisheries (GOM 2000, Commonwealth/GTZ 2007).

Aquaculture in Malawi is mainly pond based and is not well developed though it started back in the 1950s. Current annual fish production from pond aquaculture is estimated at 1500 metric tonnes (ADiM 2005, FAO 2005a). Though data from aquaculture in Malawi is sketchy, the general increase in commercial aquaculture could explain the jump in production in 2005 (Figure 4). Two more large-scale production units were set up in 2004 in Malawi, one by MALDECO Aquaculture in Mangochi and the other by GK Aquafarms in the Lower Shire (FAO 2005a, pers obs.). MALDECO Aquaculture has invested in the cage culture of chambo (*Oreochromis* spp.), while GK Aquafarms produces *O. mossambicus* and common carp. GK Aquafarms have been allowed by the government to raise common carp as the Lower Shire is outside the catchment area for Lake Malawi. There is considerable potential for the development of aquaculture in Malawi (Commonwealth/GTZ 2007) due to good availability of perennial water and the conducive warm climate that favours fast fish growth. Perhaps one of the immediate challenges to aquaculture development in Malawi is the common use of slow growing indigenous species because of the ban on the use of exotic fish species in the catchment of Lake Malawi which includes most of the country (GOM 2000).

1.4 Justification for carrying out this project

A successful fish industry such as that in Iceland must ensure the necessary requirements are met throughout the chain, i.e. from production or capture of fish, to handling, processing, value adding up to marketing. This is what Malawi has to emulate in the intensification of fish production from aquaculture.

Fish quality standards used by the Malawi Bureau of Standards need to be reviewed. There is a need to incorporate standards for fish from aquaculture such as on handling as well as to deal with current emerging and re-emerging risks/issues in fish and fish processing.

Unfortunately, the area of fish processing and quality management is not well developed in Malawi (pers. obs.) due to shortage of trained/skilled personnel in the Malawi Department of Fisheries and institutions of higher learning such as colleges and universities which are responsible for providing training in this field. The Aquaculture and Fisheries Science Department at Bunda College of Agriculture, is the only institution that offers specialist training in aquaculture and fisheries science at the undergraduate level in Malawi (AQFSD 2006, Asgeirsson *et al.* 2004). However, the department still lacks capacity in terms of trained staff in fish processing and quality management and consequently appropriate training materials. Out of the 13 teaching staff in the department, only five have PhDs while the rest have masters degrees. None of them have specialist training in fish quality save one member of staff who is currently on such training in Iceland (from September 2008 to March 2009). Fish processing and quality management has been taught by staff from the Department of Animal Science due to the shortage of trained lecturers in that field in the Department of Aquaculture and Fisheries Science. It is only for the last two years that one member of staff was assigned to specialise in fish processing and quality management. The need for capacity building in fish processing and quality management (which includes the development of proper training and teaching materials) is therefore urgent.

1.5 Objectives

The major objective of the present study is to describe the current situation and identify areas and topics of special importance to be included in a teaching manual/handbook on fish handling, processing and quality management to be used for teaching university students in the Department of Aquaculture and Fisheries Science at Bunda College of Agriculture. Specifically the study intends to:

- Review the current status and trends in fish handling, processing and quality management in Malawi.
- Review and analyse the current teaching syllabus by the Aquaculture and Fisheries Science Department at Bunda College of Agriculture and identify areas which need improvement.
- Develop a handbook or manual for the Department of Aquaculture and Fisheries Science at Bunda College of Agriculture to be used for teaching students at undergraduate level.

2 METHODS

An exhaustive literature search including books, journal articles, government/FAO publications, internet sources etc. was conducted in this review. In addition, information was collected from training institutions that are directly or indirectly involved in fisheries or fish processing and quality management in Malawi. The Laboratory Technician in the Department of Aquaculture and Fisheries Science at Bunda College provided a list of all materials that are available in the laboratory and the department in general.

As a way of complementing the theoretical information obtained through the literature search, hands-on practices in fish quality assessment were done at the University of Akureyri laboratory for four days. These included biochemical, physical and sensory assessment for fresh fish quality. This was particularly useful for the development of the practical section in the handbook.

3 FISH PROCESSING AND INSTITUTIONAL CAPACITY BUILDING IN MALAWI: SITUATION ANALYSIS

3.1 Fish processing and marketing in Malawi

Fish is highly perishable. Utmost care should be exercised during handling and processing to avoid compromising its quality and safety. The processing and supply of fish products is a huge global business. Like other sectors of the food industry it depends on providing products which are both safe and which meet consumers' increasingly demanding requirements for quality (Bremner 2002).

In Malawi, fish processing is chiefly traditional and processing methods include sun drying (Figure 5L) which is used for small-sized fish and smoking (Figure 5R) which is used on larger fish.



Figure 5: Traditional fish processing methods in Malawi (L = sun drying, R = smoking) (MBERU and JICA/LMEP 2001).

Very small sized fish especially *Engraulicypris sardella* (local name: usipa) are boiled then sun dried. This is common during the rainy season when the period of sunshine is short, i.e. there is more cloud cover (Figure 6L). Bigger fish are gutted then sun dried or later smoked (Figure 6R). Other small species such as utaka (*Copadichromis spp*) are pan-roasted (MBERU and JICA/LMEP 2001, Commonwealth/GTZ 2007).

There is growing interest in improving fish processing in Malawi. For example, the Icelandic International Development Agency (ICEIDA) is currently involved in a collaborative effort (started in 2005) with local villagers developing a fish processing facility in one of the villages near Lake Malawi (ICEIDA News, undated).



Figure 6: Boiling (L); gutted and sun-drying fish (R) (MBERU and JICA/LMEP 2001).

Recently, the MALDECO Fisheries Limited, by far the largest fish production and processing company in Malawi, proposed to enter into a joint venture to construct a fish processing facility in the southern lakeshore district of Mangochi (UNDP 2008). The fish processing facility aims to produce high-quality tilapia (local name: chambo) fish fillets for both the local market and export within the southern African region.

Though some local fish traders are able to transport their fish iced to distant rural and urban markets from Lake Malawi (Figure 7L), MALDECO remains the only company transporting frozen fish because they own shore-based facilities, ice plants and chill storage facilities (Commonwealth/GTZ 2007, Press Corporation Limited 2009). Dried and smoked fish is sold to markets far away from the lake owing to the longer shelf life (Figure 7R).

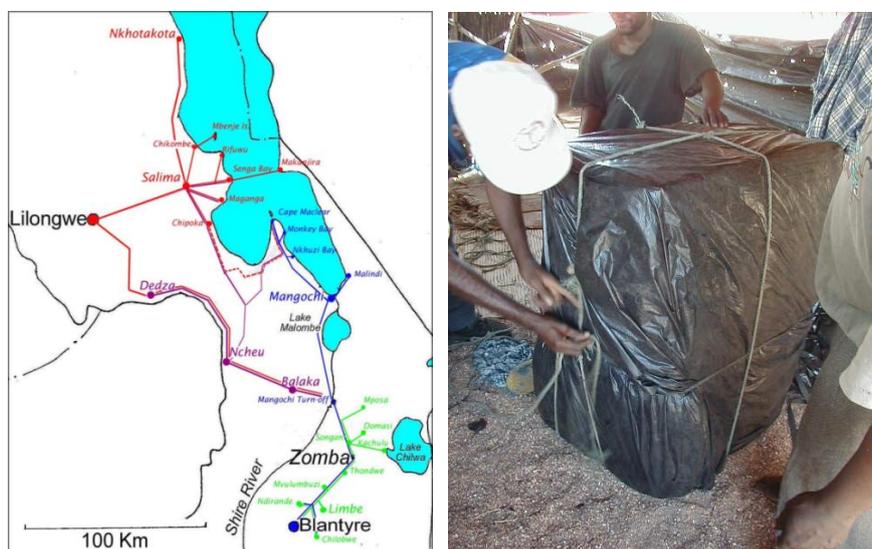


Figure 7: Major fish transportation routes from Lake Malawi (southern Malawi) (L) and dried/smoked fish packaging (R) ready for transportation to market (MBERU and JICA / LMEP 2001).

On the other hand, fresh fish without ice is sold in the vicinity of the lake as fish without ice would go bad after long transport.

Due to declining fish stocks in Malawian waters, the country imports more fish and fish products than it exports. In 2003 Malawi imported 598 tons (US \$714 thousand) but only

exported 22 tons (US \$75 thousand) (FAO: 2-WRI undated), but this excludes figures on most fish trade with neighbouring countries such as Mozambique which is informal (Commonwealth/GTZ 2007). Earlier documents report export values that are also relatively small for example 0.1 tons worth US \$250 in 1998 and 159.5 tons about US \$170,000 in 2002 (Commonwealth/GTZ 2007). Fish is imported from countries such as Zimbabwe (Lake Kariba), South Africa, Namibia (horse mackerel), Thailand, Mozambique and Tanzania (Commonwealth/GTZ 2007).

3.2 Initiatives by the Government of Malawi to increase fish production

Efforts to develop the fish processing industry in Malawi will not be successful until there is enough fish available for processing. There is a national programme to increase fish production from both aquaculture and capture fisheries (Government of Malawi 2009). The Department of Fisheries in Malawi intends to promote fish production through the following strategies (Government of Malawi 2009):

- Strengthening user institutional capacity for fisheries resource management and governance.
- Managing all fisheries according to operational management procedures.
- Updating legislation and policy in line with other national policies and legal instruments.
- Restructuring, reorganising and strengthening the Department of Fisheries for effective internal, national and international communication.

The Department of Fisheries is also involved in carrying out research and outreach activities in both aquaculture and capture fisheries (Department of Fisheries 2001). To effectively achieve the above objectives, the following five thematic areas (action plans) have been developed (National Environmental Policy 2004) viz.:

- Action plans for capture fisheries

The idea is to enhance fish production from capture fisheries by utilising unexploited (deep water) resources plus improving efficiency of production for both large and small scale fishers. This is being implemented through an on-going project on Lake Malawi funded by the African Development Bank (African Development Fund 2002). This, however, calls for improvements in post harvest (value adding and processing) by improving processing facilities and marketing.

- Action plans for aquaculture

Several action plans exist for aquaculture development in Malawi (National Environmental Policy 2004) viz.: To develop management regimes for different culture systems and to promote intensive fish farming as well as to develop technologies that would promote restocking of fish. One of the initiatives related to the latter action plan is the Chambo Restoration Strategic Plan (CRSP) (Banda *et al.* 2005) which proposes the building of hatcheries along Lake Malawi to breed chambo (Malawi tilapia) for release of fingerlings into the lake.

Contrary to the prohibition of introduction of exotics, the aquaculture action plan also provides for identification of ‘viable’ and ‘acceptable’ exotic species that can be used in

aquaculture using acceptable guidelines. One of the species under consideration especially for cage culture on Lake Malawi is *Oreochromis niloticus* (Nile tilapia). This appears to be one of the most controversial plans bearing in mind that the introduction of *O. niloticus* into Lake Victoria resulted in the disappearance of the endemic species in the lake due to hybridization with the indigenous species (LVFO 2009). Locally, some fish farmers ‘illegally’ grow common carp (*Cyprinus carpio*) due to its fast growth (ADiM 2005).

Development of fisheries management plans

These action plans chiefly aim at fisheries research to generate information (status) on fish resources (unexploited deep water stocks), monitoring and management. Although catches in Lake Malawi have dwindled, there seem to be more unexploited stocks from the deep waters in the lake (Figure 4). The African Development Bank Fisheries Project on Lake Malawi also aims to promote processing of fish which is in line with government goals (MPRSP 2005).

Implementation of management plans

The aim is to disseminate research results (from both aquaculture and capture fisheries) to be used for the management of the fish resources (research-extension link).

Empowerment of local fisheries management authorities

It has been shown that effective management of common resources is possible when the communities are involved (Pomeroy and Rivera-Guieb 2005). This involves the devolution of power to local fisheries management authorities such as Beach Village Committees (BVCs). This action plan also seeks to facilitate the formation of local organisations as well as developing and signing of management agreements.

3.2.1 Strategies

To effectively implement all the action plans, the Government of Malawi has drawn a long list of strategies which include the promotion of aquaculture development as a means of increasing the supply of fish and decreasing pressure on capture fisheries; empowering local communities to manage fisheries resources; and developing plans for integrated pollution control to enhance the quality of fish habitats.

3.3 Training (capacity building)

The component of training stands out as one of the government’s areas of focus for capacity building which is one of the major challenges. There is only one government sponsored fisheries training institution in Malawi (FAO 2005b) namely the Malawi College of Fisheries (MCF) located in the southern lakeshore district of Mangochi.

- The Malawi College of Fisheries (MCF)

The Malawi College of Fisheries is responsible for the development of capacity, knowledge and skills by providing appropriate training programmes for the Department of Fisheries in Malawi and in the SADC region (FAO 2005b). The college conducts two year fisheries management training programmes at certificate level (Kaunda 1994, FAO 2005a). The entry requirement into the programme is the Malawi School Certificate of Education (O level

equivalent). Upon completion of the course, graduates are assigned to work as Fisheries and/or Aquaculture Technical Assistants (TAs) in various Fisheries Department offices in Malawi. They work as research assistants (if posted at a fisheries research centre) or extension personnel (field offices). With the growing interest in aquaculture development, some fisheries assistants have lately been employed as aquaculture extension personnel by NGOs which are supporting aquaculture programmes such as World Vision International. The Malawi College of Fisheries also mounts short training courses for the user communities such as fishermen (FAO 2005a).

Teaching staff at the Malawi College of Fisheries have previously generally only had formal training to the certificate or diploma level. Just over half of the current teaching staff are graduates of Bunda College (Aquaculture and Fisheries Science Department) (pers. obs.).

However, due to the ever increasing demand for training in fisheries reflected in many areas such as NGOs funding fish farmers' training, the capacity of the government alone is by far too small to meet this demand. Since the Malawi College of Fisheries only offers fisheries training to the certificate (technical) level, challenges still exist regarding training of staff to the professional level. Other institutions are, therefore, also involved in fisheries training to support government policies.

- The Natural Resources College (NRC)

Unlike the Malawi College of Fisheries, the Natural Resources College which used to be under the government has now been privatised. It is also involved in training of staff at the technical level (diploma) in different fields (NRC 2006). NRC runs training programmes in natural resources and environmental management and agriculture. There are five two-year diploma courses and one certificate course of one year duration (NRC 2006). Nevertheless, the fisheries section is not fully developed because there is only one fisheries module known as *Sustainable Aquaculture and Fisheries Management* which is taught as a component within a major non-fisheries related course (Pers. obs., NRC 2006).

To address the problem of capacity building at professional level, institutions of higher learning in Malawi are also involved in teaching and training in fisheries and aquaculture. The Aquaculture and Fisheries Science Department at Bunda College of Agriculture and Chancellor College (both constituent colleges of the University of Malawi) teach fisheries and aquaculture courses as well as conducting various forms of research in aquaculture and fisheries (FAO 2005b).

- Chancellor College (Biology Department)

Chancellor College only offers fisheries courses to 3rd and 4th year students majoring in biology (Chancellor College 2009). There are chiefly two fisheries and aquaculture related courses that are taught within the Biology Department, i.e. Freshwater Biology (3rd year) and Fish Biology (4th year). However, the syllabus for Chancellor College, as far as training in fisheries science is concerned, is by far behind that of Bunda College. Students in their 1st and 2nd years take 12 courses (without a fisheries related course), eight courses in their 3rd year and seven in their 4th year, where freshwater biology and fish biology are taught in the 3rd and 4th years respectively. Fish processing is not taught.

- Bunda College of Agriculture (Aquaculture and Fisheries Science Department)

The Aquaculture and Fisheries Science Department at Bunda College of Agriculture (Figure 8) is the only institution in Malawi awarding a degree in Aquaculture and Fisheries Science at undergraduate level (AQFSD 2006, FAO 2005b). It aims at becoming a centre of excellence in aquaculture and fisheries science in the Southern African Development Community region (AQFSD 2006).



Figure 8: Aquaculture and Fisheries Science Department (AQFSD 2006)

The Department has previously awarded a diploma (two years of study) in agriculture (with a major in aquaculture) (Asgeirsson *et al.* 2004, AQFSD 2006). Both local and regional (e.g. Mozambique and Zambia) students are enrolled in the four year BSc programme in Aquaculture and Fisheries Science. Apart from teaching, the department also conducts research in aquaculture and fisheries and extension outreach activities.

Students in the Aquaculture and Fisheries Science BSc programme at Bunda College have 11, 14, 15 and 12 courses in years 1, 2, 3 and 4 respectively. All courses in the 1st and 2nd years are basic (no fisheries related courses). Out of 15 courses in the 3rd year, 10 are fisheries related and nine in 4th year out of 12 courses. Fish processing and quality management is taught in the 4th year and also to students from the Agri-business and Agricultural Economics departments (Faculty of Agriculture 2000). In the new (revised) curriculum fisheries related courses will be introduced in the 2nd year.

- Teaching staff

The Department of Aquaculture and Fisheries Science is one of the most understaffed at Bunda College. Each lecturer has a minimum of two courses per semester whilst lecturers in other departments have one course or even none. As earlier stated, the department has 13 teaching staff (five PhDs and eight MSc).

- Teaching materials and facilities

Though it lacks the capacity to offer an up to date programme on fish processing and quality management, the Department of Aquaculture and Fisheries Science is one of the few

departments at Bunda College that has modern infrastructure which was provided by the Japanese Government. This includes a relatively new wet and dry laboratory. The wet laboratory is used for culturing fish for research purposes and carrying out practicals that require fresh fish. The dry laboratory (Figure 9) is the chemistry and microbiology laboratory.

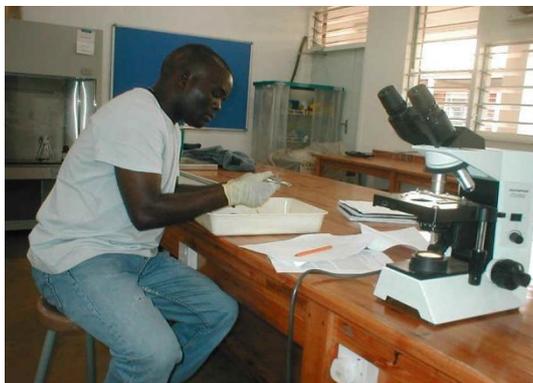


Figure 9: Part of the laboratory in the Aquaculture and Fisheries Science Department (AQFSD 2006)

The only challenge is the chemicals (consumables) that are required for daily use in the laboratory due to financial problems in the department. The department has a large water reservoir with ponds (Figure 10) where students carry out experiments with live fish.



Figure 10: Departmental fish ponds and hatchery (far back) (AQFSD 2006)

A well designed fish hatchery (Figure 10) is also situated near the fish ponds with an ultra violet system to sterilise the water before it goes into the hatchery.

- Teaching of Fish Processing and Quality Management

Fish processing and quality management is taught to BSc students in Aquaculture and Fisheries Science in their 4th (last) year of the BSc programme at Bunda College of Agriculture. The course has also drawn interest from other departments at the college. As a result, students majoring in Agricultural Economics (AEC) and Agriculture Business Management (ABM) also take part. The course has 2.5 credit hours and is taught during the first semester for 14 weeks.

- Old and current fish processing and quality management syllabi

During the review of the Aquaculture and Fisheries Science syllabus in 2008, several topics were incorporated into the old syllabus viz: value adding, traceability, international and national quality fish standards and a quality assurance system, the hazard analysis critical control points (HACCP) (Table 1 – shaded areas).

Table 1: Old and current list of topics in the fish processing and quality syllabus for the Aquaculture and Fisheries Science Department

| Old syllabus | New syllabus |
|--|---|
| <ul style="list-style-type: none"> • Fish muscle biology • Fish microbiology • Rigor mortis • Fish spoilage • Gaping • Fresh fish handling • Quality control • Fish processing • Fish preservation • Principles of fish preservation • Methods of fish preservation • Pests and pest control | <ul style="list-style-type: none"> • Fish muscle biology • Fish microbiology • Rigor mortis • Fish spoilage • Gaping • Fresh fish handling • Quality control • Fish processing • Value adding • Principles of fish preservation • Methods of fish preservation • Pests and pest control • Traceability of fish products • International and national quality standards • Hazard analysis and critical control points (HACCP) |

3.4 Non Governmental Organisations involved in aquaculture development in Malawi

Non Governmental Organisations (NGOs) in Malawi have and continue to contribute to the development of aquaculture in rural areas (ADiM 2005).

- The WorldFish Center

The WorldFish Centre formerly known as International Centre for Living Aquatic Resource Management (ICLARM) is the only international non-governmental organisation which is actively involved in aquaculture research in Malawi such as integrated aquaculture-agriculture (IAA) technology and selective breeding programmes to mention but a few (FAO 2005b).

- The Japan International Cooperation Agency (JICA), Icelandic International Development Agency (ICEIDA) and Food and Agriculture Organization of the UN (FAO)

JICA and FAO have been involved in various fisheries and aquaculture development projects in Malawi as well as fisheries infrastructure development and training (FAO 2005b, AQFSD 2006). JICA has supported several aquaculture programmes at the National Aquaculture Centre in Malawi (ADiM 2005) and constructed infrastructure (Figures 8, 9 and 10) for the Department of Aquaculture and Fisheries Science at Bunda College of Agriculture (AQFSD 2006). ICEIDA has been instrumental in the establishment of the Department of Aquaculture

and Fisheries Science at Bunda College through provision of scholarships to national and regional students at Diploma, BSc and MSc levels. ICEIDA has also provided funding for teaching staff in the Department of Aquaculture and Fisheries Science to carry out own research (Asgeirsson *et al.* 2004, AQFSD 2006).

- Other Non Governmental Organisations

The majority of NGOs focusing on food security are involved in small scale aquaculture development throughout Malawi. These include World Vision International, Action Aid, Churches Action in Relief and Development (CARD), Christian Service Committee, Immanuel International, Concern Universal and Oxfam to mention but a few.

3.5 The Malawi Bureau of Standards (MBS)

The Malawi Bureau of Standards is the government institution responsible for quality inspection of all commodities in Malawi which include fish (Chimatiro 1997, Malawi Bureau of Standards undated). The Malawi Bureau of Standards aims at monitoring and enforcing quality standards of commodities among many activities. This includes fish and fish products in all producing and selling points in Malawi.

3.6 Challenges to establishing an effective fish processing/preservation and quality management system in Malawi

As a developing country, development of a vibrant fresh fish quality control, processing and preservation in Malawi is hampered by many problems, both social and economic. These have led to the continuation of primitive fish quality and processing methods in Malawi. The main challenges include the lack of knowledge and infrastructure.

Traditional fish processing methods, sun drying and smoking, are most common in Malawi (MBERU and JICA/LMEP 2001). Fishermen, local fish processors and fish traders (middle men) have little knowledge of fish quality, processing, preservation and handling.

The distance from Lake Malawi, where most of the fish is caught, to retail markets is often very long (Commonwealth/GTZ 2007). This is compounded by poor road conditions and vehicles that are not designed for transportation of fresh fish. There is also a lack of fresh fish facilities and services such as availability of ice, refrigerators etc. in the retail markets due to lack of electricity and inadequate ice production machines. As a result, fresh fish without ice is sold in areas closer to the lake (Commonwealth/GTZ 2007).

The conditions on most fishing boats are not conducive to fresh fish preservation, e.g. lack of ice and refrigeration on boats and poor and/or unclean fish handling materials such as boxes and shovels.

- Lack of consumer awareness of fish quality standards

When fish arrives at the markets, consumers buy irrespective of the condition it is in apparently due to the high demand for the product. Most consumers lack basic fresh fish sensory knowledge such as fresh fish flesh condition.

- Poor enforcement of fish quality control regulations

Without adequate trained personnel (fish inspectors), enforcement of fresh fish quality control standards in selling outlets is almost non-existent in Malawi. Few available trained personnel know only but a little as far as fresh fish quality control standards are concerned.

The problems mentioned above are in most respects a result of lack of adequate trained or skilled personnel in fish quality and processing who are responsible in sensitising the general public in fish quality standards. The Malawi Fisheries Department which is responsible for employing fish inspectors now only has very few of them in the fresh fish markets in Malawi leaving the situation out of control. This is in sharp contrast from other government departments like the Veterinary Department where veterinary officers are widely spread across all parts of the country. Meat inspection is conducted in many markets even in the remotest rural areas.

4 RESULTS AND DISCUSSION

4.1 Gaps/challenges in fish processing and quality management in Malawi

Malawi currently still imports more fish than it exports (FAO: 2-WRI undated, Commonwealth/GTZ 2007). The Malawi Department of Fisheries appears to be unable to assume responsibility for the management of all fisheries resources (MPRSP 2005) though reports show abundant stocks in the deeper (offshore) waters of Lake Malawi (African Development Fund 2002). Regulations, action plans and strategies formulated to develop fisheries and aquaculture in Malawi have not yet brought about the intended results (outputs).

The impact of NGOs on the development of aquaculture in Malawi is still not significant as fish production from aquaculture is still low (ADiM 2005). None of the NGOs are involved in fish processing. In fact, fish from aquaculture is not processed due to low production rates though the issue of value adding would be important here.

Information on fish processing in Malawi is scanty and almost unavailable. For example, there is almost no information available on fish from the Malawi Bureau of Standards (Malawi Bureau of Standards undated), the only government body entrusted with enforcement of fish quality standards in Malawi. It appears that the Malawi Bureau of Standards is active when it comes to consumer products other than fish (pers. obser) possibly due to lack of capacity (trained personnel) for the same.

It is evident that fish processing and quality management are not well established in Malawi (MBERU and JICA/LMEP 2001, Commonwealth/GTZ 2007). For example, the Ministry of Industry, Science and Technology noted with concern the non acceptance of test results from laboratories in Malawi (SADCA 2006). This has been viewed as a serious hinderance to stimulate growth, especially in the agricultural and fish industries (SADCA 2006). Lack of information regarding fish quality from the Malawi Bureau of Standards suggest that the Bureau is not active as far as enforcing of fish quality standards is concerned in Malawi hence need for more effort.

The main fish processing methods used in Malawi are sun drying and smoking (Figure 4) and preservation facilities such as cold rooms and freezers are not available in many places expect for MALDECO Fisheries Limited (the only large scale fish processing company in Malawi)

(Commonwealth/GTZ 2007). This calls for efforts to correct the situation in view of the important role played by the fisheries sector in Malawi.

4.2 The need to intensify fish production from aquaculture: opportunities and challenges

The failure of government policies in protecting wild fish stocks from over fishing is a clear indication that restoring the over fished stocks to sustainable levels will be a long term achievement if at all possible. Intensification of aquaculture appears to be the best option to meet the ever growing demand for fish in Malawi. MALDECO pioneered the start of commercial aquaculture in Malawi with the construction of earthen ponds in 2003 but only started breeding the fish for re-stocking into the cages in the lake in 2005 (Figure 11) (Best of Malawi 2009).



Figure 11: MALDECO concrete tanks for breeding tilapia (L) and part of the cages on Lake Malawi (R) where the bred fish are stocked for production (johnhbradley.com undated)

Nevertheless, despite the potential (conducive climate, availability of local feed ingredients, high demand etc.) for expansion of the aquaculture industry in Malawi, some important areas need to be critically analysed such as culture practices, methods of harvesting the fish and production costs, and the type and quality of feeds. Fish raised in captivity, unlike those in the wild, are exposed to high levels of stress (Biswas *et al.* 2006) due to frequent handling and poor water quality and perhaps inappropriate feed and harvesting methods that compromise the quality of the flesh, shelf life and nutritional value of fish (Ruff *et al.* 2002).

4.3 Drying and smoking fish processing methods

Fish processing using sun drying and smoking, though less costly, result in losses of up to 30% (FAO 1992b) especially during the rainy season, which in Malawi is from November to March, when fish drying and smoking is difficult due to prolonged periods of cloud cover, high humidity (FAO 1992a) and continuous rains in some cases. A considerable amount of fish becomes spoiled due to rancidity, and microbial and insect attacks. However, the quality and nutritional value of dried and smoked fish is compromised if the fish is not stored properly. For example, water soluble vitamins found in fish may be lost due to heating which reduces the moisture (FAO 1992c). Processed fish sold locally fetches a low price (FAO 1992b), resulting in marginal profits to fish processors and traders.

4.4 Other challenges facing the fish processing industry in Malawi

Several challenges have been reported (FAO 1992b). Use of local packaging materials such as bamboo baskets compromises the quality of the fish during transportation. Market facilities also lack coolers and ice. The poor means of fish transportation ranging from use of push bicycles to unrefrigerated vehicles coupled with poor roads increases the rate of fish spoilage. Non-enforcement of fish quality standards by the Malawi Bureau of Standards combined with the high demand for fish results in another problem, that of maintaining and ensuring fish quality and safety for consumers in Malawi.

4.5 Fish and fish product imports into Malawi

Increased imports of both dried and fresh fish and fish products, including fish meal, into Malawi (INFOSA 2009, Commonwealth/GTZ 2007) make monitoring of the quality and safety urgent.

4.6 Role of the Aquaculture and Fisheries Science Department in fisheries training

Higher education training institutions such as universities play an important role in national and international development through research, training and outreach activities. Bunda College of Agriculture is a major trainer of professionals in Malawi such as policy makers and scientists, but there is a need to develop a comprehensive teaching package on fish quality and processing that can be used for both teaching and training staff in this field. Though this has not been clearly identified as a need in this work, its importance cannot be undermined.

Students from several countries in southern Africa supported by donor agencies such as the Icelandic International Development Agency (ICEIDA) (Asgeirsson *et al.* 2004) have been trained at Bunda College of Agriculture in Aquaculture and Fisheries to Diploma, Bachelors and Masters Degree levels. A regional PhD programme in Aquaculture and Fisheries Science is to commence in the department in 2009.

- Teaching staff

Generally, the problem of poorly or inadequately trained staff in the field of fish processing and quality management appears to be the root cause of the problems discussed above. The country lacks qualified personnel which are essential for a successful fish processing programme. The policy on fish processing and quality management as laid out by the Malawi Department of Fisheries (MPRSP 2005) is not exhaustive.

As a relatively new department at Bunda College of Agriculture (about 10 years old) (AQFSD 2006), the Aquaculture and Fisheries Department still has a shortage of teaching staff. The fish processing and quality management course was taught by staff from the Animal Science Department (a sister department) until 2005 when additional staff members were recruited to teach the course. However, the background of the new staff members in fish processing and quality management was weak and they needed further training. It is to that effect that the Department endorsed Mr. F. Kapute (BSc Agr., MSc. AQFS) to pursue the six-month United Nations University Fisheries Training Programme (UNU-FTP) in Iceland to improve his knowledge and skills in the area of fish processing and quality management.

- Teaching materials

In addition to capacity building of teaching staff, there is also a need to analyse and assess the teaching materials available in the department that can be used for effective teaching of fish processing and quality management. From the results and the general analysis it was apparent that both the department and Malawi in general have but a limited capacity (infrastructure) to promote fresh fish processing. It is therefore suggested that particular attention be paid to the improvement of processing through drying and smoking.

4.7 Development of a fish processing handbook from the reviewed curriculum

The area of fish processing and quality management has not been emphasised in the teaching curriculum chiefly due to lack of qualified teaching staff. Therefore, only basics in fish quality and processing have been taught by staff from the Department of Animal Science within the college. The course has been taught from standard text books, but without adapting them to reflect conditions in Malawi. The old syllabus (Table 1) that has been used for the past years lacked important areas as far as fish processing and quality management were concerned. That is why the department decided to carry out a curriculum review to accommodate new aspects. Added to the new syllabus (Table 1) is HACCP, traceability and value adding to mention only the major ones. The analysis showed that the revised curriculum for the teaching of fish processing and quality management is more comprehensive than the old one because it better reflects international developments in fish processing and quality management which are not present in the old curriculum. Secondly, preparation of the detailed lesson plan and materials reflect the situation in Malawi. The challenge now was to develop a complete and comprehensive teaching document out of the recommended topics. The major output therefore for this project was the development of a handbook to be used for teaching in fish processing and quality management in the Department of Aquaculture and Fisheries Science.

- The process of writing the teaching handbook

Most of the effort in this project was concentrated on the writing/preparation of the handbook. Several methodologies were followed starting with an extensive and comprehensive literature search (information gathering). Using the revised topics for the syllabus, relevant information was collected from internet searches, lecture notes, books, journal articles, government/FAO documents including anonymous documents such as reports and pamphlets. The material was then organised into sections for a clear and systematic flow of the information.

The new (reviewed) fish processing and quality management syllabus (Table 1) was used as a guide (sketch) in writing the handbook, i.e. detailed information was sourced for each and every topic. Included as part of the handbook were the relevant practicals which were organised depending on the available teaching materials in the Department of Aquaculture and Fisheries Science.

5 CONCLUSIONS AND RECOMMENDATIONS

Development of the fisheries industry and fish processing, in particular in Malawi calls for collaborative efforts. However, as expressed earlier, fish processing can only be viable and sustainable if there is enough production of fish available for processing. This would, however, require a steady and considerable increase in the supply of raw materials. The starting point is therefore to focus on the improvement of fish production either from capture fisheries, aquaculture or both. This is the challenge at hand faced by Malawi. Indeed, an effort to increase fish production through aquaculture which is one of the government's main priorities needs to be critically scrutinised. There is more handling of cultured fish and hence the improvement of fish production through aquaculture increases the need for knowledge and skills in fish handling and processing to assure a prolonged shelf life of the harvested fish. Nutritional value, quality management and consumer safety of the harvested fish should be given undivided attention.

Malawi, as a country that imports more fish than it exports, needs a vibrant and strong fish safety and quality inspection unit. Reports that the quality of most of the fresh fish imported into the country such as the horse mackerel is greatly compromised with poor handling such as temperature abuse and general hygiene should be a clear wake-up call (FAO 1992b). Enforcement of fish quality and safety standards in Malawi should therefore be viewed on a wider scale other than in retail fish selling points only. Thorough and constant inspection should include all fish imports. This calls for the empowerment of the fish inspection unit in the Department of Fisheries as well as the quality regulatory bodies in Malawi such as the Malawi Bureau of Standards to conduct fish quality and safety management checks. Implementation of HACCP and traceability requirements will be essential.

It is apparent from these recommendations that lack of institutional capacity is one of the major limitations to effective development in fish production and consequently fish processing and quality management in Malawi. This is where the need for capacity building comes in and hence the important role played by the Department of Aquaculture and Fisheries Science at Bunda College of Agriculture. The Department of Aquaculture and Fisheries Science should be in a position to provide solutions to some of the problems facing the Malawi fisheries and fish processing through student and staff research and extension outreaches. Emulation of activities by MATIS (Iceland) such as carrying out research in feeds, sensory evaluation etc. then later transferring that information to the public would be of paramount importance. Bunda College (Aquaculture and Fisheries Science Department) as a training institution has to provide information regarding fish production, processing, safety and quality management. For the department to fully qualify for that challenge, necessary requirements have to be met. The development of the handbook is such a milestone that will go a long way in the improvement of the teaching of fish processing and quality management in the Department of Aquaculture and Fisheries Science.

The handbook should, apart from being used as a teaching material for students, contain practical sections that can be applied in general fish quality management such as quality assessment techniques, traceability, HACCP etc. The Malawi Department of Fisheries staff and other fish quality assessment institutions such as the Malawi Bureau of Standards can use the handbook as a guide to fresh fish inspection and assessment.

The department can and should play a pivotal role in the area of training and sensitisation of the public. In issues regarding increased aquaculture production, it is indispensable that

parallel to such efforts by government and the private sector, in Malawi, the Aquaculture and Fisheries Science Department should take an active and leading role in training fisheries technical staff, farmers and the general public on best ways of maintaining (preserving) the quality and nutritional value of the fish whilst increasing production through aquaculture. This would include long term capital investments such as building/developing fish cooling systems, refrigerated fish transportation vehicles. Currently, it is only the MALDECO Fishing and Aquaculture Company that has these facilities though inadequate.

Regarding fish imports into Malawi, the Aquaculture and Fisheries Science Department could carry out fish quality assessment through staff and student research projects on imported fish in cooperation with the Malawi Bureau of Standards. It is apparent that a lot needs to be done to improve the quality and safety of fish sold from most retail outlets (personal observation). This is an area that has received little attention probably due to the fact that the demand for fish is high and the buyers are not quality conscious.

It is also anticipated that the training of teaching staff from the department at the UNU-FTP will together with the prepared handbook to improve the teaching in fish processing and quality management in the Aquaculture and Fisheries Science Department and in Malawi in general.

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APPENDICES

Appendix 1: Revised Fish processing syllabus for the Aquaculture and Fisheries Science Department

University of Malawi
BUNDA COLLEGE OF AGRICULTURE

COURSE OUTLINE

- | | | | |
|--|--|--|-----|
| 1. <u>PROGRAMME</u> | : | BSc in Aquaculture and Fisheries Science | |
| 2. <u>COURSE TITLE</u> | : | Fish Processing Technology | |
| 3. <u>COURSE CODE</u> | : | AQF 412 | |
| 4. <u>YEAR</u> | : | 4 | |
| 5. <u>PRESENTED TO</u> | : | Faculty of Environmental Sciences | |
| 6. <u>PRESENTED BY</u> | : | Aquaculture & Fisheries Science Department | |
| 7. <u>NO. OF LECTURES/WEEK</u> | : | 1 x 1 hr (Sem. 1) | |
| 8. <u>NO. OF TUTORIALS/ PRACTICALS/WEEK</u> | : | 1 x 3 hrs (Sem. 1) | |
| 9. <u>METHODS OF ASSESSMENT</u> | : | Course work | 40% |
| | : | End of course exam | 60% |
| 10. <u>AIM OF THE STUDY</u> | To provide students with knowledge of the technology used in fish handling, processing and preservation of fish. | | |

11. COURSE OBJECTIVES

After completion of the course, students should be able to:

- (a) Process fish into different end-products
- (b) Add value to fish and fish products
- (c) Preserve fish to minimize post harvest losses

12. TOPICS OF STUDY

LECTURES

- Fish muscle biology
- Fish microbiology
- Fish handling
- Quality Control
- Fish Processing
- Value adding
- Principles of fish preservation
- Methods of Fish Preservation
- Pests and Pest Control
- Traceability of fish products
- International and national quality standards (ISO)
 - Hazard analysis and critical control points (HACCP)

PRACTICALS

- Design and operate smoking kilns
- Fish handling
- Fish processing methods
- Preservation methods
- Field visits to fish landing sites
- Fish quality tests (organoleptic tests etc)

13. PRESCRIBED TEXT

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