

Research Paper

Survey to determine current methods for handling and preservation of fresh fish in three Malawi cities

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A face-to-face survey with fish traders was conducted, in three selected Malawi city markets that included Lilongwe, Limbe and Blantyre, to determine existing methods used by fish traders to maintain fresh fish quality and preservation, identify existing knowledge gaps in issues related to fresh fish spoilage and preservation, and determine the fish traders' receptiveness to and perception of antimicrobial ingredients used to extend shelf life and quality of fish. Two major challenges experienced by the fish traders included lack of access to shelf life extension methods (33%) and low selling prices (27%). Fifty-five per cent of the traders used less than 500 g of ice per kg of fish for transportation and

storage of the fish. Responses by 54%, 22% and 16% of the fish traders for number of days before fish spoiled included 8 h, 1 day and 2 days, respectively. Approximately 94% of the respondents had no access to extension services, and 100% had no formal training in food safety, quality control, fish handling and basic personal hygiene. This study revealed the need for food safety programs and training for the fish traders in order to ensure safe and quality fresh fish.

Key Words: Fisheries, Malawi, Preservation Methods, Survey, Tilapia.

INTRODUCTION

Malawi is a landlocked country with a population of 15,906,483 people (Countryeconomy.com, 2014) and total area of 118,484 km², of which 20% (24,405 km²) is covered by water supporting over 800 species of fish (Food and Agriculture Organization, 2005). The largest water body in the country is Lake Malawi with an estimated surface area of 29,000 km² and a length of about 700 km. Other water bodies important for fishing activities include Lakes Malombe, Chilwa, Chiuta and six major rivers: Shire, Linthipe, Bua, Dwangwa, Rukuru and Songwe. These water bodies support fisheries resources which are of social and economic importance to the country (Food and Agriculture Organization, 2005; Government of Malawi and GTZ, 2007).

Fish provides over 60% of the dietary animal protein intake of Malawians and 40% of the total protein supply (Press Cooperation Limited, 2007). The existence of over 800 endemic fish species in Lake Malawi has also created ecotourism and an export trade for aquarium fish. The leading fishery in terms of commercial importance is the Chambo fishery, which consists of three *Oreochromis* species namely, *Oreochromis karongae*, *O. lidole*, and *O. squamipinnis*. Other commercially important fish species include *Haplochromis spp.*, *Engraulicypris sardella*, *Copadichromis spp.*, *Bargrus meridionalis* and *Clariid gariepinus* (Government of Malawi and GTZ, 2007). The *Oreochromis spp* are considered to be the most valuable. However, small fish are an important part

of the fisheries sector and represent a targeted segment for most fish consumers. So-called “trash fish” do not exist because every fish species has customers (Food and Agriculture Organization, 1993). Higher income consumers usually buy fresh *Oreochromis spp.*, from supermarkets and will only look for fish at produce markets if the fish is not available at the supermarkets. People with low incomes buy fish from the markets and choose the best fish on a given day at a price they can afford (Russell et al., 2008).

The fisheries sector directly employs about 50,000 fishermen and indirectly about 350,000 people who are involved in fish processing, fish marketing, net making, boat building and engine repair (Kanyerere et al., 2009). Fish is a source of income that generates beach price local revenue of 2.6 billion Malawi Kwachas (US \$24 million) annually. The contribution of fish to the Gross Domestic Product (GDP) was estimated at 4% (Food and Agriculture Organization, 2005), which is a significant contribution when compared to livestock which contributes 8% of the total GDP (Government of Malawi and GTZ, 2007).

Unfortunately, the demand and supply of this valuable food source for the Malawian people is hampered by poor and inadequate food safety and handling practices, which results in extremely short shelf life of not more than 48 ha after harvest (Ashie et al., 1996; Ghaly et al., 2010). Most fishing vessels consist of wooden boats, without freezing or chilling facilities to retard fish spoilage. In addition, the vessels are too small to carry ice on board which results in conditions that accelerate fish spoilage (Food and Agriculture Organization, 2005). There is also the danger that Malawian consumers eat fish that is spoiled and contains pathogenic bacteria.

The potential health risks associated with consumption of spoiled fish in conjunction with the high fish demand far from local fishing grounds necessitates the need for long-term preservation (Kanyerere et al., 2009). In order to improve the livelihoods of fishermen, processors and traders as well as upscale the role being played by the sector in developing countries, there is a need to reduce the fish losses incurred from fish spoilage. The most obvious means of increasing the supply of fish, even without increased landings, is by reducing post-harvest losses of what is presently caught (Russell et al., 2008). The post-harvest fish sector in the country is still under-developed. This results in losses estimated to be as high as 30% during some rainy seasons. Fish losses also result from inadequate processing and storage facilities and fish distribution problems due to inadequate means of transportation (Kanyerere et al., 2009).

The researchers of this study believe that implementation of proper handling and food safety interventions would increase the shelf life of fresh fish in Malawi and reduce or eliminate the presence of spoilage and pathogenic bacteria. Prior to implementation of food safety practices, it was necessary to conduct a survey

amongst key personnel responsible for fish harvest and trading. The survey would identify the existing knowledge gaps in fresh fish processing and handling methods among Malawian fish traders and assist in the development of antimicrobial interventions to retard the growth of spoilage bacteria and reduce or eliminate pathogenic bacteria in the fish. The survey will be beneficial to the fish traders as well as the Malawian consumers.

MATERIALS AND METHODS

Three Malawi city markets, Lilongwe city market in Lilongwe, Blantyre city market in Blantyre and Limbe city market in Limbe, were selected as target sites for the survey. The fish traders in this study purchased their fish directly from the fishermen on the day that the fish arrived at the Lake Malawi pier, and sold it directly to marketers and consumers, which is the common trading practice in Malawi. Initially, questions were developed for inclusion in the survey based on the researcher’s knowledge of fisheries in Malawi and the time that the researcher spent observing the fish harvesting procedure in Malawi. Appropriate and pertinent questions were compiled in the survey and administered in a face-to-face interview (Ivy, 2014; statistical computation lab, 2003). The questionnaire was administered orally and the participants’ responses were recorded on the questionnaire. Eighteen questionnaires were administered with six questionnaires issued per city market. Respondents were randomly selected to participate voluntarily, and no compensation was given for their participation. Meeting times that were convenient for the fish traders were scheduled with each participant separately. Initially, the interview began with an introduction of the interviewer to assure the respondents that the interview was legitimate and the reviewer was qualified to conduct the interview. A total of 40 traders was contacted, but only 18 (45%) agreed to participate. Each questionnaire was assigned a number without reference to the company or person being interviewed in order to maintain anonymity. Immediately following the introduction, the participants were asked to respond to thirty questions that were pertinent to the Malawian fish traders.

Statistical analyses

The data were compiled and analyzed using the SPSS Program (IBM North America, 2011) to generate frequencies and percentages for the responses.

RESULTS AND DISCUSSION

The responses for each question from the three Malawi city markets that included Lilongwe, Limbe and Blantyre

Table 1. Preferred fish species and reason for their preference.

Preferred Species	Great taste preference (%)	High market value (%)	Cheap Producer Price (%)	Great taste preference and high market value (%)
<i>Oreochromis</i>	83.30	8.30	8.30	0.10
<i>Engraulicypris sardella</i>	0.00	50.00	50.00	0.00
<i>Rhamphochromi</i>	33.30	0.00	100.00	0.00
<i>Oreochromi, Engraulicypris sardella and Rhamphochrom</i>	33.30	0.00	0.00	66.70

Table 2. Types of customers preferred.

Customer Type	Percentage
Consumers	66.70
Consumers and other traders	16.70
Consumers and processors	5.60
All (consumers, other traders and processors)	11.00

were compared. The data from all markets were similar. Therefore, the data from all markets were combined and overall percentages were reported in this study. The similarities between the three markets were due primarily to the small sample size of 18 respondents. The small sample size experienced in this study was due primarily to difficulties during the solicitation of participants for the survey. General reluctance and unwillingness to participate were the main challenges encountered because of the following reasons given by the respondents:

- (a) Fear that the consequences of this survey might result in an increase in market charges by the Malawi Revenue Authority.
- (b) There were no meaningful benefits from previous surveys.
- (c) Fear of reprisals due to concerns that the survey was being conducted by the Malawi Bureau of Standards among potential respondents who do not follow proper selling procedures (i.e., selling of spoiled fish).
- (d) There was no economic incentive in the form of cash for their participation.

In addition, there was a lack of willingness of the respondents to answer questions 1 through 10. No responses were given to questions 18, and 26-28 because the question were not applicable to the respondents.

Survey Outcomes

The age categories of the participants were 23-27 years (28%), 30-39 years (50%), 40-45 years (16%) and 54 years (6%) (Partial response for Question 2). Three fish species that included *Oreochromis spp.* locally known as Chambo and Tilapia, *Engraulicypris sardella* locally

known as Usipa and *Rhamphochromis spp.* locally known as Mcheni, were reported as the most preferred species for sale by the fish traders (Table 1). Among the three species, 83% of the respondents preferred Tilapia (Chambo) for its "great taste", while all three species had an overall score of 33% for great taste preference. *Engraulicypris sardella* ranked high for cheap producer price (50%) and high market value (50%) (Table 1).

The traders' buyers included primarily other traders, consumers and processors. Most of the respondents (67%) declared that consumers were their preferred customers followed by other traders (17%) and consumers and processors (11%) (Table 2). The results indicated that consumers are the preferred customers. The condition of fish at the time of sale can have a direct impact on the sales. It was evident that there was a general lack of consumer awareness of fish quality standards, because consumers buy fish regardless of the condition of the fish from a quality and safety point of view. In addition, consumers were preferred by most traders because most consumers can only afford to buy fish at a reduced price or cheaper price when fish shows signs of spoilage.

Traders from the Blantyre City markets sourced fish from Mangochi while traders from Lilongwe city markets sourced fish from Salima due to the proximity of these areas to the city markets (Table 3). Since two city markets were sampled in Blantyre and one city market was sampled in Lilongwe, the majority of the respondents for this survey came from the Blantyre city markets and they bought their fish from Mangochi. All the interviewed respondents reported public transport as the means of transport from the pier to the city (Table 3). For long distance transportation, most fish traders hitch a ride or travel by public transport, mainly buses, trucks and pickup trucks. For short distance, some own bicycles (7%), motor cycles (1%) or pick-up trucks (2%). Traders without transport are able to hire bicycles and helpers to

Table 3. Fresh Fish Suppliers and Transportation .

Parameters	Response	Percentage
Fresh fish suppliers	Mangochi	67.00
	Salima	33.00
Mode of transportation	Public transport	100.00
	Own vehicle	0.00
Average number of hours it takes to travel from the beach to the city market	3	33.00
	4	67.00

Table 4. Fresh fish storage and handling.

Parameters	Response	Percentage
Methods used to retard fresh fish spoilage	Ice in coolers	61.00
	Preservatives	6.00
	Ice and gutting	27.00
	Ice and rinsing in clean water.	6.00
	Nothing	0.00
The reason why no method is used to retard fish spoilage	No response	0.00
Containers used to carry fresh fish during transportation	Cooler boxes	11.00
	Bamboo baskets	61.00
	Coolers and bamboo baskets	22.00
	Bamboo baskets, pails and sacks	6.00
	All	0.00
Methods for accessing ice	Buy from sellers	100.00
	Buy from city market ice plant	0.00
	Own ice maker	0.00
The quantities of ice used per 1 kg of fish	100 grams	5.00
	200 grams	17.00
	250 grams	11.00
	300 grams	11.00
	350 grams	11.00
	400 grams	28.00
	500 grams	11.00
600 grams	6.00	
Days/hours for fish to spoil using fishermen preservation method	1 day	22.00
	2 days	16.00
	3 days	11.00
	3 hours	6.00
	4 hours	17.00
	6 hours	17.00
	8 hours	11.00

transport the fish, usually in sacks, baskets or cartons, from the beach to the main road (Food and Agriculture Organization, 1993). The average time of travel to the city markets ranged from 3 to 4 h, with 67 and 33% indicating that 4 and 3 h are needed, respectively (Table 3).

In order to avoid or retard fresh fish spoilage, 61% of the respondents use ice in coolers, 6% rinsed fish in clean water, while others (5.6 %) gutted the fish or used other methods such as sun-drying (Table 4). A high percentage of respondents (44%) reported that they

reduced the selling price when fish shows signs of spoilage. Approximately 17% of the respondents reported that they would sell fish showing signs of spoilage to traders and 6% would resell to further processing operations. Major challenges experienced by the fish traders were lack of access to fresh fish shelf life extension methods and lack of knowledge of preservatives used to retard spoilage in fresh fish (Table 4).

Sixty-one percent of respondents used bamboo

Table 4. Contd.

Parameters	Response	Percentage
Means used by fishermen to determine when fish begins to spoil	Bad smell only	5.60
	Sunken eyes only	0.00
	Gill color only	0.00
	Fish scales falling off only	5.60
	Muscle tenderness only	5.60
Methods used by fishermen when fish show signs of spoilage	Reduce price	44.20
	Sun drying	5.60
	Smoking	0.00
	Resale to other processors	16.70
	Frying	5.60

Baskets as containers for carrying fresh fish during transportation, 22% used both cooler boxes and bamboo baskets, and 11% used only cooler boxes (Table 4). These local packaging materials compromise the shelf life of fresh fish during transportation. The survey revealed that sun drying and smoking methods are preferred by the fish traders when fish begin to show signs of deterioration, in order to mask the obvious signs of spoilage from consumers.

Currently, the use of ice for fresh fish is limited and no chemical additives or preservatives have been documented for use on fresh fish in Malawi (Hara and Mkoka, 1993). Limited ice is available for the fish traders. Ice is used primarily by middle men who transport fish from the main fishing grounds to the markets. Ice blocks are placed in between layers of fish in bamboo baskets, aluminum tins or cooler boxes. However, due to limited access to electricity, the use of ice is limited. Maldeco Fisheries Limited is the only company that has shore-based facilities, ice plants and chill storage facilities with a fish marketing and distribution network throughout Malawi. The company supplies fish to both rural and urban markets (Government of Malawi and GTZ, 2007). One hundred per cent of the fish traders reported that they must buy ice from private ice merchants (Table 4). Eighty-three percent of the respondents used less than 500 g of ice per kilogram of fish as compared to 17% of the respondents who used 500 g (11%) and 600 g (6.0%) of ice per kg of fish (Table 4).

With regard to the length of time it takes for fish to spoil under the fish traders' preservation methods, (22, 17, 11 and 51)% of the respondents declared that fish spoils after 24, 48, 72, and 3-8 h, respectively (Table 4). As temperature decreases, the microbiota of the product changes and at 0–2°C, the spoilage microflora will reach approximately 10^8 – 10^9 cfu/g after 2–4 weeks. Temperature is the most important factor influencing the shelf life of fresh finfish. Shelf life of iced cod is approximately 14–16 days (Jorgensen et al., 1988),

whereas increasing the temperature to 5°C shortens the shelf life to 6–7 days (Gram, 2009). Twenty-two percent of the respondents described signs of fish spoilage as bad smell, fish scales falling off and muscle tenderness, 11% reported spoilage as bad smell, sunken eyes, gill discoloration and presence of flies, and 22% described spoilage as bad smell, sunken eyes and gill discoloration (Table 4).

To decrease spoilage of fresh fish and hamper the profitability of their businesses, 44% of the respondents cited the reduction of selling prices as the best action to avoid losses. Seventeen percent of the respondents suggested re-sale of fish to other processors as the best action when fish begins to show signs of spoilage, and 6% of the respondents mentioned further processing of fish by frying or sun drying as the best actions taken when fish starts showing signs of spoilage (Table 4).

In regards to extension services and training, 94% of the respondents had no access to any extension services and training (Table 5). The 6% who were aware of training programs, never participated (Table 5). The "0" responses to questions 28 and 29 reflected the fact that there were no extension services or training offered by nongovernment organizations (NGO), governmental agencies, and other regulatory agencies in Malawi (Table 5).

The two major challenges experienced by the fish traders (Table 5) were lack of preservation knowledge for reducing spoilage in the fresh fish (33%), and low selling prices (27%). Equal concern was expressed for quick spoilage (17%), and lack of fish at Lake Malawi (17%). The least concern that faced the fish traders was transportation of fish (6%). The Guardian Development Network (2013) reported that a significant decrease in fish stock was directly related to rapid decreases in Lake Malawi's water levels. This observation suggests the importance and immediate need of antimicrobial intervention methods to retard the growth of spoilage and pathogenic bacteria in the current Malawi fish supply.

Table 5. Extension Services and training.

Parameters	Response	Percentage
Percentage of fishermen with access to extension services	Yes	6.0
	No	94.0
The type of extension service that fishermen (6% with 'Yes" response) access	No response	0
Extension services providers	No response	0
How often do you access the extension services?	No response	0
The extent to which fishermen have formal training	Food safety	0
	Quality control	0
	Fish handling	0
	Basic personal hygiene	0
The main challenge in the fresh fish business	Lack of fish at the lake	17.0
	Transportation problems	6.0
	Lack of preservation knowledge	33.0
	Low selling prices	27.0
	Quick spoilage	17.0

CONCLUSIONS

Although the findings in this study are based on a small sample size, the respondents were very reputable individuals in the fisheries industry, and realized the importance of participation in this survey. This study will have significant impact on fisheries in developing, as well as developed countries in regards to enhancing their food safety systems and practices in the fish industry. The findings in this study revealed that there is a general lack of standard fish quality preservation methods used by fish traders in the Malawi city markets. It was also revealed that there is a significant knowledge gap among the fish traders in basic handling and preservation methods for fresh fish. These factors coupled with poor facilities and technologies for fresh fish quality preservation or lack of access to existing facilities and technologies have resulted in an extremely high fish spoilage rate in Malawi. The results of this study can be used to develop a comprehensive food safety program and antimicrobial interventions that will result in reduction of bacteria on fresh fish and extended shelf life. This will result in increased profits for the fish traders and a safe, wholesome and quality fresh product for the consumers. All fish traders that were interviewed in this study expressed a desire for preservation methods that would assist in prolonging the shelf life of their fish. They also emphasized that the preservation methods must not alter the color, flavor and odor of the fish.

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