

Rapid Integrated Assessment of Nutrition and Health Risks Associated with Tilapia Value Chains in Egypt

Report prepared by

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Contents

List of tables.....	3
List of figures.....	4
Acknowledgments.....	7
Acronyms and definitions	8
Executive summary.....	9
1 Introduction.....	12
1.1 The project.....	12
2 Background.....	14
2.1 Overview of fish value chains in Egypt	14
2.2 Map of the fish value chain	15
2.3 Selection of hazards for biological sampling	17
3 Methods.....	17
3.1 Overview	17
3.2 Site selection	17
3.3 Surveys, participatory rural appraisals, focus groups discussions, and biological sample collection	18
3.3.1 Producers.....	18
3.3.2 Transporters	19
3.3.3 Retailers	19
3.3.4 Consumers.....	19
3.4 Laboratory analysis	19
3.5 Data management and analysis	20
4 Results.....	20
4.1 Description of respondents and study sites	20
4.2 Survey results	21
4.2.1 Producer survey	21
4.2.2 Transporter survey	24
4.2.3 Retailer survey	25
4.2.4 Fish fry shops survey	28
4.2.5 Consumer survey	29

4.3	Findings of the participatory rural appraisals (PRA) and focus group discussions (FGD)	42
4.3.1	Producer PRAs	42
4.3.2	Consumer PRAs	44
4.3.3	Focus group discussions with mothers with young children	46
4.4	Findings of laboratory analysis	47
4.4.1	Bacteriological analysis of fish samples from retail sale	47
4.4.2	Chemical analysis of tilapia samples from fish farms	47
5	General discussion and conclusions	48
5.1	Food and nutrition security: what is the role of tilapia in diets of producers and consumers?	48
5.2	Food and nutrition security: what is the relationship between fish farming and fish eating?	50
5.3	Food safety and nutritional issues: how do nutritional quality and food safety change along the value chain?	51
5.4	Food safety and nutritional issues: what are the trade-offs between food safety and nutrition?	54
5.5	Food safety and nutritional issues: are there trade-offs, synergies between feed and food?	55
5.6	How is tilapia value chain development (lengthening, complexity, adding value, processing, etc) likely to affect nutrition and food safety? What are trends and possible interventions and how could investments enhance consumption of nutrients and decrease risks?	56
5.7	Social and gender determinants: Who gets the nutritional benefits and bears the health risks of ASF? How do gender and poverty influence health and nutrition risks? How do cultural practices affect health and nutrition risks (consumption of raw food, withholding food during illness)?	57
5.8	Feedback on tools from enumerators	58
5.9	Conclusions and recommendations for risk management	58
6	Appendices	62
6.1	Appendix 1: Rapid integrated assessment protocol for Egypt	62
6.2	Appendix 2: Laboratory analysis protocol	62
6.3	Appendix 3: Participatory rural assessment and focus group discussion reports	62

List of tables

Table 1: Background data on Kafrelsheikh governorate	18
Table 2: Characteristics of the amount of farmed tilapia production in Kafrelsheikh, Egypt.	21
Table 3: Types and volumes of tilapia sold per day for different types of retailers in the Nile Delta, Egypt	25
Table 4: Characteristics of the amount of tilapia sold per day in fish fry shops in the Nile Delta, Egypt	28
Table 5: Characteristics of households interviewed in different communities in the Nile Delta, Egypt	30
Table 6: Taking decision for purchasing tilapia in the Nile Delta, Egypt	31
Table 7: Time (min) for transporting tilapia home and between arrivals until cooking.....	35
Table 8: Bacteriological characterisation of fresh tilapia samples collected from retail sale in the Nile Delta of Egypt	47
Table 9: Pesticides residues detected in farmed tilapia samples from Kafrelsheikh governorate, Egypt.....	48

List of figures

Figure 1: Framework for the rapid integrated assessment of food safety and nutrition (Häsler et. al, unpublished).....	13
Figure 2: Value chain of production and marketing of farmed fish in Egypt adapted from Macfadyen et al. (2011).....	14
Figure 3: Overview of fish value chains in Egypt (Source://www.slideshare.net/ILRI/update-on-fish-value-chain-development-in-egypt)	16
Figure 4: Study site for farmed tilapia production, Kafrelsheikh governorate, Egypt. Source: http://www.projecthorus.com/emf/Default.aspx?uc=UI/ViewDistrict&id=35	18
Figure 5: Producers' perceptions toward the safety and quality of their tilapia in Kafrelsheikh governorate, Egypt.....	23
Figure 6: Enumerators' observations of tilapia farms (biosecurity, workers and storage conditions) in Kafrelsheikh governorate, Egypt	23
Figure 7: Enumerators' observations of fish transporters and their equipment in Kafrelsheikh governorate, Egypt.....	25
Figure 8: Sources and frequency of farmed tilapia for retailers in the Nile Delta, Egypt	26
Figure 9: Frequency of cleaning crates and/or storage equipment by fish retailers in the Nile Delta, Egypt	26
Figure 10: Fish retailers' customers and frequency of selling fish in the Nile Delta, Egypt...	27
Figure 11: Enumerators' observations of fish retailers (facilities, workers/retailers conditions and storage conditions) in the Nile Delta, Egypt	27
Figure 12: Enumerators' observations for fish fry shops (facilities, workers/retailers conditions and storage conditions) in the Nile Delta, Egypt	29
Figure 13: Frequency of consumption of tilapia by adults (male/female) in the Nile Delta, Egypt. A: within the proximity of fish farming area, B: peri-urban area away from the fish production, C: rural area away from fish production site.	30
Figure 14: Characteristics for purchasing Tilapia considered by consumers in the fish-farming community	32
Figure 15: Characteristics for purchasing Tilapia considered by consumers in the peri-urban community	32
Figure 16: Characteristics for purchasing Tilapia considered by consumers in rural community	32
Figure 17: Characteristics of Tilapia purchased by consumers in different communities in the Nile Delta, Egypt. A: within the proximity of fish farming area, B: peri-urban area away from the fish production, C: rural area away from fish production site.	33

Figure 18: Sources for getting Tilapia by consumers in different communities in the Nile Delta, Egypt. A: within the proximity of fish farming area, B: peri-urban area away from the fish production, C: rural area away from fish production site.	34
Figure 19: Sources of purchasing tilapia by consumers in different communities in the Nile Delta, Egypt. A: within the proximity of fish farming area, B: peri-urban area away from the fish production, C: rural area away from fish production site.	34
Figure 20: Keeping tilapia at home between purchasing and cooking. A: within the proximity of fish farming area, B: peri-urban area away from the fish production, C: rural area away from fish production site.	36
Figure 21: Consumer behaviour with cooked tilapia leftover in the Nile Delta, Egypt. A: within the proximity of fish farming area, B: peri-urban area away from the fish production, C: rural area away from fish production site.	36
Figure 22: Knowledge, attitudes and practices of consumers in the fish-farming community	37
Figure 23: Knowledge, attitudes and practices of consumers in the peri-urban community...	38
Figure 24: Knowledge, attitudes and practices of consumers in the rural community.....	38
Figure 25: Health information for the two weeks prior to the interview in the fish-farming community	39
Figure 26: Health information for the two weeks prior to the interview in the peri-urban community	39
Figure 27: Health information for the two weeks prior to the interview in the rural community	40
Figure 28: Health information for the six months prior to the interview for the fish-farming community	40
Figure 29: Health information for the six months prior to the interview in the peri-urban community	41
Figure 30: Health information for the six months prior to the interview the rural community	41
Figure 31: The common preparation and consumption of fish reported by the PRA in Albendaria village (far from fish farming areas)	46
Figure 32: Tilapia harvesting (Photo by M. Eltholth).....	52
Figure 33: Sorting and grading of tilapia after harvesting at the farm (Photo by M. Eltholth)	52
Figure 34: Wholesale fish market in Kafrelsheikh (Photo by M. Eltholth).....	53
Figure 35: Transporting of tilapia (Photo by M. Eltholth).....	53
Figure 36: Fish shop in one of the retail markets (Photo by M. Eltholth)	54

Figure 37: Fish seller at the village market (Photo by M. Eltholth)54

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Acronyms and definitions

ACIAR	Australian Centre for International Agricultural Research
APC	Aerobic plate counts
ASF	Animal source food; refers to all animal and fish source foods including but not limited to milk, dairy products, meat, eggs, fish, offal, animal skin, blood
BMP	Best Management Practices
CAC	Codex Alimentarius Commission
EOS	Egyptian Organization for Standardization and Quality
Feddan	A unit of land used in Egypt, 1 Feddan=0.42 hectares=1.038 acres=4200m
FGD	Focus group discussion; a group of 6-10 people gathered together from similar backgrounds or experiences to discuss a specific topic of interest
Fish seller (fresh)	In this study, fresh fish sellers are any retailers selling whole fresh fish (with no processing or cooking); these include street vendors, market sellers, shops and supermarket
Fish seller (cooked)	In this study, cooked fish sellers are any retailers who prepare, cook or process fish; these include market sellers, fish fry shops, restaurants and caterers; if market sellers sell both cooked and fresh fish, they should be included as both fresh and cooked fish sellers
FTE	Full-time equivalent – is a unit that indicates the workload off an employed person
HACCP	Hazard Analysis Critical Control Point
HH	Household
ILRI	International Livestock Research Institute
Input supplier	Value chain actors providing inputs into production, such as feed suppliers and sources of animal health inputs
ISO	International Standards Organization
PRA	Participatory rural appraisal; uses methods that enable people to share, analyse and enhance their knowledge of livelihoods and conditions and to plan, act, monitor, evaluate and reflect on projects and programmes
Producer	Any individual or group producing farmed fish
Retailer	Any individual or group selling fresh or processed fish
RIA	Rapid integrated assessment of food safety and nutrition
Transporter	Any individual or group that transports fish (paid for transport but does not buy or sell fish)
Wholesaler	In this study, wholesalers are any retailers that sell fish in bulk

Executive summary

Animal source foods (ASF) provide important sources of energy, micro and macro nutrients but may constitute a risk of foodborne disease. Livestock and fish value chains support the livelihoods of millions of rural and urban poor, for whom such value chains can act as pathways out of poverty. Interventions to develop these value chains should explicitly consider impacts on food safety, nutrition and livelihoods. Egypt is the largest aquaculture producer in Africa and the 8th largest globally; in 2011 the aquaculture production was about 986,820 tonnes. The aquaculture sector makes a significant contribution to income, employment creation and food security. It is also growing rapidly: fish consumption in Egypt rose from 8.5 kg to 15.4 kg/person/year between 1996 and 2008. However, the available data that characterise production, marketing and consumption patterns of farmed tilapia are scarce. Also data for quality and safety of farmed tilapia are scarce.

This report presents outputs from an integrated assessment for the farmed tilapia value chain in one of the main farmed tilapia producing areas in Egypt. The aim of which was to characterise production, marketing, consumption patterns and to assess nutritional benefits and health hazards associated with farmed tilapia. Data collection toolkits were developed that includes participatory methods, structured questionnaires, observation checklists and biological sample collection. These tools were applied at the production, bulking (i.e. wholesale or collection points), processing, retail and consumption stages to explore the following key research questions:

1. Food safety

- What are the main hazards likely to be present in the ASF food value chain?
- What risks do these hazards pose to value chain actors?

2. Food and nutrition security

- What is the role of the ASF food in question in diets of poor farmers and consumers?
- What is the relationship between livestock keeping and livestock eating?

3. Combined food safety and nutritional issues

- How does nutritional quality and food safety change along the value chain?
- What are trade-offs between food safety and nutrition?
- Are there trade-offs, synergies, between feeds and foods?

- How do the different ASF VC compare in meeting nutrition and safety needs?
 - How is VC development likely to affect nutrition and food safety?
4. **Social and gender** determinants of health and nutrition
- Who gets the nutritional benefits and bears the health risks of ASF? How do gender roles and poverty influence health and nutrition risks?
 - How do cultural practices affecting health and nutrition risks?
5. Trends and possible **interventions**
- How could investments enhance consumption of nutrients and decrease risks?

The data collection tools were applied to collect data from farmed tilapia producers (100), transporters (32), retailers (100), fish fry shops (20) and consumers (300 households). Farmed tilapia samples from 100 farms were tested for chemical pollutants namely heavy metals (arsenic, lead, cadmium and mercury). Tilapia samples from 100 retailers were tested for Aerobic plate counts (APC), *E. coli*, *Listeria monocytogenes*, *Salmonella spp*, *Vibrio parahaemolyticus* and *Staphylococcus aureus*.

Results showed that, more than half of producers in the study area were small scale, having a farm size of 10 Feddan or less. The main water supply for almost all farms was agricultural drain water, potentially contaminated with chemical and biological hazards. The main production constraints were reported to be feed prices, water quality and availability, land rent, fuel and energy sources and environmental conditions. The farmed tilapia value chain was short with little value adding, almost all produced tilapia was transported to retail sale and sold to consumers as fresh apart from some processing as cleaning, grilling or frying. There was a lack of hygiene during transportation and marketing of farmed tilapia that could be potential sources for post-harvesting contamination. The availability and frequency of tilapia consumption were higher in fish-farming community than in other communities. In non-fish producing communities, tilapia may be available in the market once a week during the village market day.

Analysis of farmed tilapia samples for chemical pollutants (heavy metals and pesticides residues) revealed that, all tested elements were either non-detectable or within the maximum permissible limits (MPL) defined by the national and international organisations. The bacteriological analysis for tilapia samples collected from retail sale indicated that, the proportions of samples that exceeded the Egyptian MPL for fresh fish were 13.7%, 8%,

7.7%, 3.3%, 13% and 12.3% for APC, E. coli, L. monocytogenes, Salmonella spp., S. aureus and V. parahaemolyticus, respectively. However, the results for more than 64% of samples were within the MPL for all standards tested for. These findings indicated that there was a potential post-harvesting contamination of farmed tilapia.

In conclusion, tilapia is perceived as a highly nutritious ASF frequently consumed by a high proportion of the HH members in the study area at least once a week. Also a high proportion of respondents stated that they would consume more tilapia in the future. The main constraints to production were water quality and availability, fish feed prices and quality, availability of land and the rent, fuel and energy sources. Future studies for potential improvement of water quality, alternative non-conventional fish feed and other energy sources would increase production of tilapia and decrease production costs. The productivity of fish farms could be improved by improving feed quality, water quality, the use of new technologies and training fish farm workers in best management practices. Genetic studies for selecting cold and disease resistant tilapia strains are also recommended.

One of the main determinants of quality and safety of tilapia was post-harvest handling and potential contamination. Further studies are required to assess the impact of traditional fishing methods and slow suffocation of tilapia on the nutritional quality and safety. Potential investment by providing cold chains, supervising fish markets and implementing hazard analysis critical control points (HACCP) would improve the safety and quality of tilapia and reduce human health hazards.

Tilapia processing and value addition should be investigated as well in terms of profitability, nutrition and food safety of the final products. Also consumers' perceptions for purchasing processed and/or semi-processed tilapia should be assessed. The impacts of traditional processing and cooking methods of tilapia on the nutritional value, biological and chemical hazards should be assessed.

One of the important and urgent requirements is the development of a reliable database for fish farms in Egypt. Until now there is no database for fish farms and the production data for aquaculture in Egypt are estimated figures from the markets. Such a database would contribute to the development of a more regulated system and facilitate the implementation of mitigation measures.

1 Introduction

Malnutrition and disease are closely interlinked, affecting the overall health and nutritional status of individuals and populations. Although this relationship is recognised in nutritional frameworks, disease and nutrition intake are usually assessed in a disaggregated way, leading to policies which improve one aspect and impair the other. Disease control measures may impact on the availability of nutritious foods; similarly initiatives to increase production of nutritious foods may also increase risks of foodborne diseases.

Animal source foods (ASF) provide important sources of energy, micro and macro nutrients but may constitute a risk of foodborne disease. Livestock and fish value chains support the livelihoods of millions of rural and urban poor, for whom such value chains can act as pathways out of poverty (ILRI, 2011). Interventions to develop these value chains should explicitly consider impacts on food safety, nutrition and livelihoods.

In order to assess food safety risks while explicitly taking into account nutritional aspects, the aims of this project were to:

1. Develop methods and approaches for assessing ASF value chains in relation to nutrition and health and;
2. Apply these methods and approaches to value chains with high potential for pro-poor transformation. This case study focused on the tilapia value chain in Kafrelsheikh in the Nile Delta, Egypt.

Additionally, the information collected was used to identify research opportunities for improving nutrition and decreasing health risks in the value chains investigated.

1.1 The project

First a framework (Figure 1) was developed to combine value chain analysis with risk assessment, taking into account consumption and nutrition in the risk characterisation. Within this framework, the main outcomes of interest in relation to a specific food chain are:

1. Risks of foodborne disease in people
2. Nutritional contribution of the food product to people's diet

Through the food value chain, the foodborne hazards and nutrient contents of food products may either decrease or increase, thereby impacting the risk of foodborne disease and changing the nutrient content of the food produced. The activities and changes in the value chain also have impacts on the health and nutrition of consumers and value chain actors through for example fluctuations in availability and acceptability of the food product, decrease or increase in incomes or and coverage and quality of health services. Further, the framework proposes the use of economic and social science methods, in particular value chain analysis and participatory methods, to assess how economic, social and cultural factors impact on people's behaviour, attitude, and perception and how they relate to risky practices.

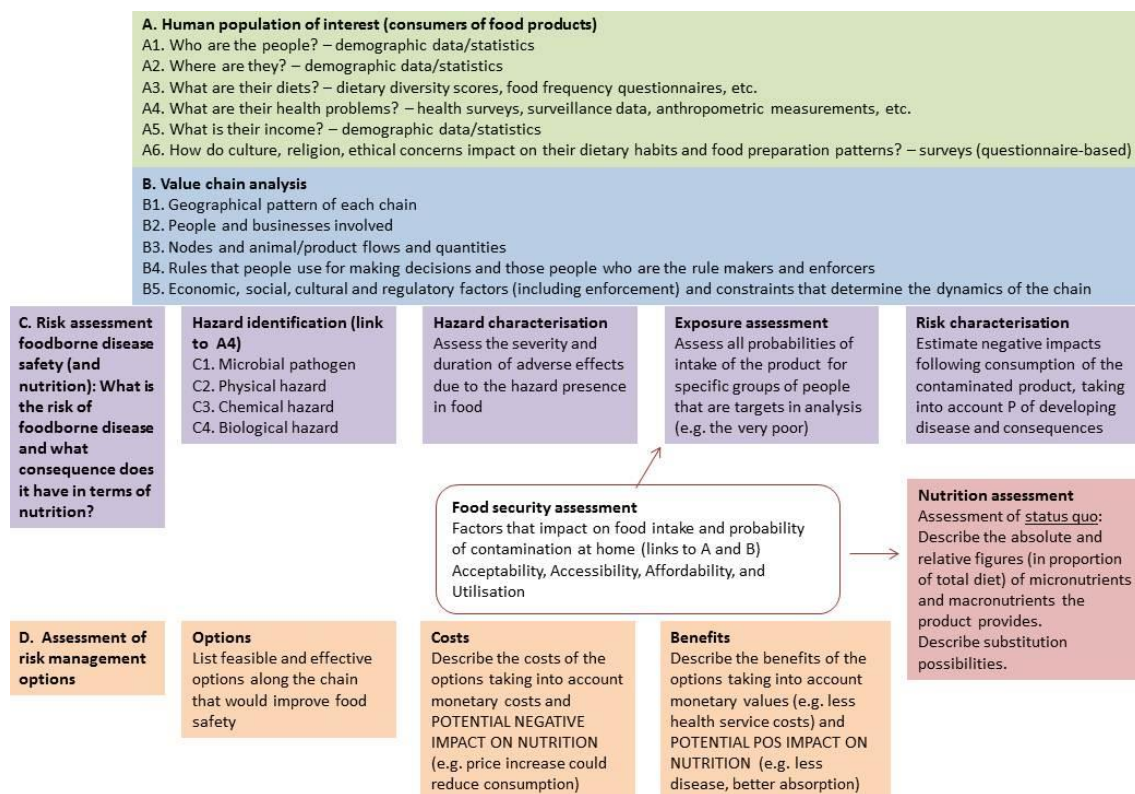


Figure 1: Framework for the rapid integrated assessment of food safety and nutrition (Häsler et. al, unpublished)

Based on this analytical framework, a generic data collection toolkit was developed that served as a basis for country specific data collection. It includes participatory methods, structured questionnaires, observation checklists and biological sample collection. This toolkit was modified for Egypt taking into account the value chain selected and country specific characteristics for inclusion in a field protocol (Appendix 1). These tools were applied at the production, bulking (i.e. wholesale or collection points), processing, retail and consumption stages to explore the following key research questions:

1. Food safety

- What are the main hazards likely to be present in the ASF food value chain?
- What risks do these hazards pose to value chain actors?

2. Food and nutrition security

- What is the role of the ASF food in question in diets of poor farmers and consumers?
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 - How do cultural practices affecting health and nutrition risks?
- 5. Trends and possible interventions**
- How could investments enhance consumption of nutrients and decrease risks?

2 Background

2.1 Overview of fish value chains in Egypt

In 2009 the Egyptian aquaculture production was about 705,490 tonnes making Egypt by far the largest aquaculture producer in Africa and the 11th largest aquaculture producer globally. The aquaculture sector makes a significant contribution to income, employment creation and food security in the country, all of which are national priority areas given low per capita income levels, rising population, worsening food security indicators, and official unemployment levels which have remained at around 10% for the last ten years. A recent value chain analysis of the industry (Macfadyen, et al. 2011 and 2012) revealed that the farmed fish value-chain in Egypt is strongly based on the production of tilapia followed by mullet as the second most important species on private fish farms. Other species of fish such as carp and catfish are farmed in small quantities. The farmed fish production chain was found to be short without any processing, which implies no value addition, but there is also less scope for nutrient loss due to processing. Harvested farmed fish are commonly sold either fresh on ice (in summer months or if sales are made far away from farms), fresh without ice (in winter months and/or if sales are made close to farms), or alive (e.g. tilapia in water tanks supplied with oxygen). Post-harvest losses were estimated to be less than one percent, Figure 2.

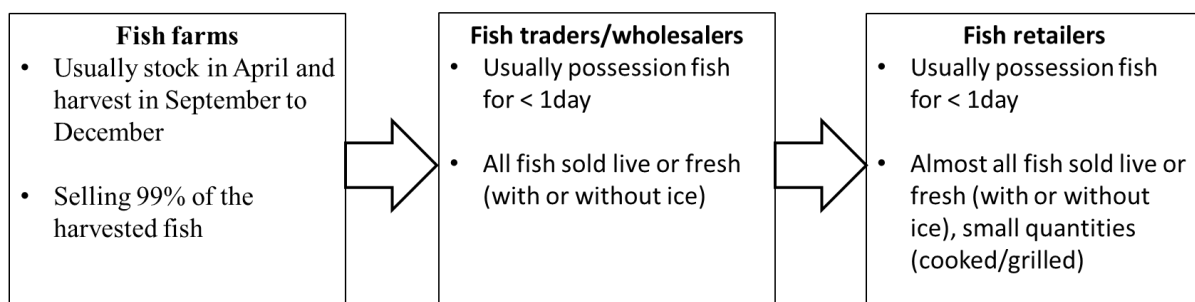


Figure 2: Value chain of production and marketing of farmed fish in Egypt adapted from Macfadyen et al. (2011)

The authors indicated factors that could cause poor performance of the sector, namely poor quality of fish fry; poor quality of water; poor practices with regards to feed management,

farm design and construction, fish health management, and stocking densities; consumer preference for wild fish and a distrust of processed products; and poor fish hygiene and handling practices throughout the value-chain.

2.2 Map of the fish value chain

Fish value chains in Egypt are relatively short. Figure 3 provides a description of the main actors and activities along the chain (Macfadyen, et al. 2011). Findings by Macfadyen et al (2011) are summarised in this section.

Production inputs in the form of seed (fry and fingerlings) and feed are supplied by fish hatcheries and feed retailers, respectively. Producers sell fish without any processing to wholesalers. Fish go from wholesalers to retailers then to consumers. Most fish farms produce a mix of species, but the majority (98%) of farmed fish sold are tilapia. The stocking densities are very variable and many farmers are using sub-optimal stocking strategies. Most farms make profits, with an average of 22% net profits as a percentage of sales. The highest production costs are feed (average 67%), fish fry (13%), labour (8%), sales commission (5%), fuel, electricity and/or power (3%). There are no data available on disease related costs or other problems. Land rents are the highest fixed costs, followed by repair and/or maintenance costs. Most farms have been in business for many years (average 18 years). The people employed on fish farms are almost all men; there are approximately 8.3 full time jobs per 100 tonnes of fish produced and there is some seasonal employment for mostly unskilled activities, such as stocking harvesting and weed clearance. The main production constraints reported are cost and quality of feed, water quality and availability, land availability, opportunities to own and security of tenure, feed management and reported disease outbreaks in fish. The banks were described to not be supportive of loans to aquaculture and many farmers obtain credit from feed mills or traders to cover cash flow requirements.

At wholesalers and traders, there are no processing activities, so the main activity is almost entirely distribution, typically by individuals working alone but employing small numbers of labourers to load and unload fish. Fish is transported in pickup trucks in plastic boxes (with or without ice); chilled or freezer trucks are not used. The main earning is from sales commission (3-6% based on sales of fish) and the magnitude of profit depends on whether farmers deliver the fish themselves or the wholesaler/traders collect fish from farms. The operational costs are labour, truck rental/ transport, ice and fuel/power. Fixed costs do not exceed 1% of sales and include: rents/leases, depreciation of buildings, fish boxes and vehicles, repairs. Employment is almost entirely for men, commonly full time, and most are employed in loading and unloading fish. This activity generates slightly less than one full-time equivalent (FTE) per 100 tonnes of fish sold.

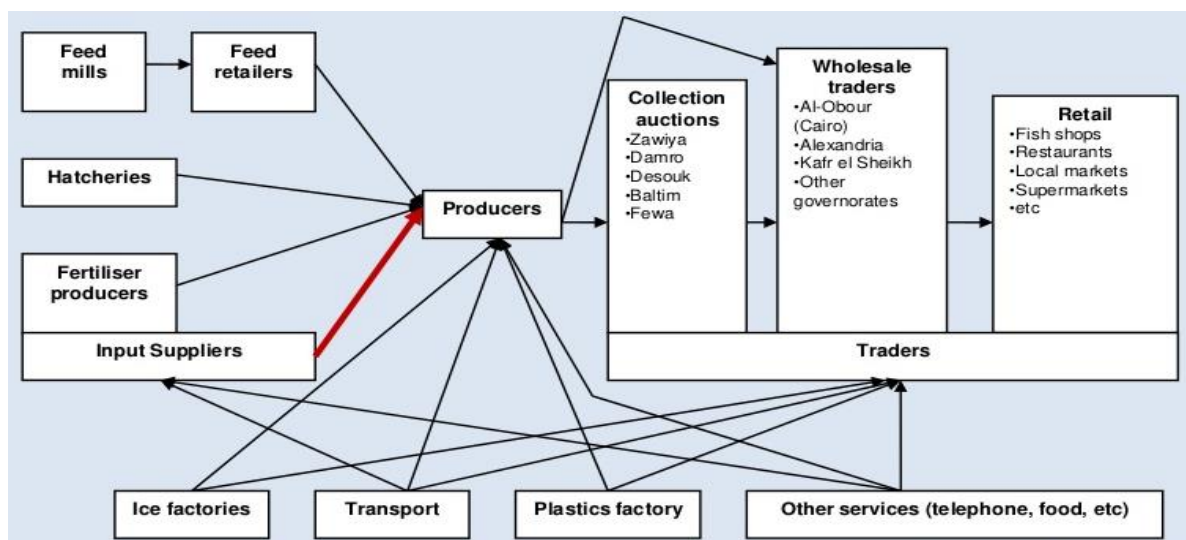


Figure 3: Overview of fish value chains in Egypt (Source://www.slideshare.net/ILRI/update-on-fish-value-chain-development-in-egypt)

Fish retailers are either informal street sellers or retail shops. Street sellers are usually individuals who purchase fish from wholesale markets or traders and set up a shop by the side of the road with minimal equipment such as a metal dish to display their fish and shade from the sun. Retail shops usually have fridges or freezers for storing fish if not sold the same day of purchase. They usually employ labour to clean and/or prepare the fish. They have higher operational and fixed costs than informal street traders, and may also employ people to sell fish on the street informally (poorer quality or different species). Some of them may engage in food service and/or restaurant businesses and use grills to cook fish. More women are employed in retailing than in fish farms or wholesalers and retailing creates 4.6 jobs (FTE) per 100 tonnes sold. The average net profit as percentage of sales in the VCA study was 6.8%. The constraints for retailers are weak prices, seasonal production leading to price fluctuations and oversupply of the market during harvesting periods. Also some consumers prefer meat and wild fish due to concerns over the quality of water used in fish farms.

Feeds are supplied to fish farms from feed mills of different sizes and using a range of processing methods. Feed processing is a rapidly evolving sector. There are around five international standard feed mills in Egypt producing sophisticated, extruded feeds and many other using simple pressure pelleting techniques to produce feeds of varying quality. Feed prices have increased in recent years which may provoke farmers to purchase lower quality feed despite the higher quality feeds having higher feed conversion efficiency.

There are 12 government fish hatcheries, 98 licensed private hatcheries and an estimated 500 unlicensed hatcheries. The main demand from farmers is for mono-sex tilapia fry, which apart from the start of the breeding season in April-May are usually in ready supply. The most common complaint is that fry are sold as mono-sex but the fish still reproduce, possibly because of inadequate, poor quality hormones or poor hatchery management practices.

2.3 Selection of hazards for biological sampling

Hazards identification was undertaken in collaboration with Safe Food Fair Food (SFFF)¹, based on available literature, expert opinion and standard food safety testing recommendations.

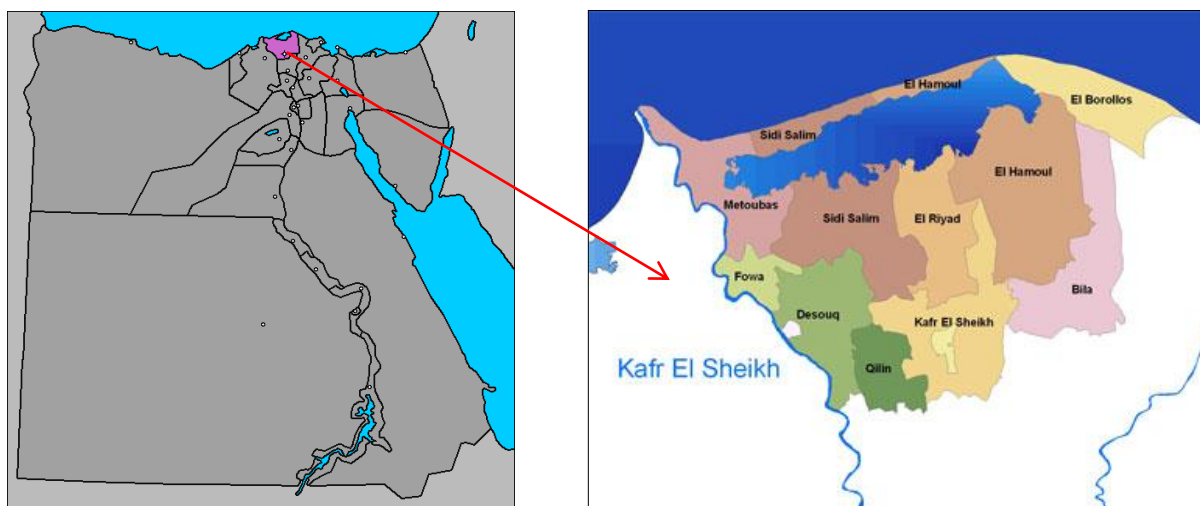
3 Methods

3.1 Overview

The rapid integrated assessment toolkit includes participatory rural appraisals (PRA), focus group discussions (FGD), structured questionnaires including observation checklists, and biological samples collection. These instruments were applied at the production, bulking (i.e. wholesale or collection points), retail and consumption stages as described in the next sections. All questionnaires were translated into Arabic language by the first author and independently reviewed by two other persons.

3.2 Site selection

In consultation with WorldFish and local collaborators at Kafrelsheikh University, it was decided to focus on the farmed tilapia (*Oreochromis niloticus*) value chain, the most commonly farmed species of fish in both Egypt and Africa (Macfadyen et al., 2011, FAO, 2012). As the main fish producing governorate, producing an estimated 55% of the farmed fish sold in Egypt, Kafrelsheikh Governorate² (Figure 4) was identified as the target study area (Macfadyen et al., 2011).



¹ A literature review of nutrition and foodborne hazards in Egypt is underway and will be available as an independent document at ILRI

² Governorates are the highest level of Egypt's five tier jurisdiction. There are 27 Governorates in Egypt

Figure 4: Study site for farmed tilapia production, Kafrelsheikh governorate, Egypt. Source:
<http://www.projecthorus.com/emf/Default.aspx?uc=UI/ViewDistrict&id=35>

Table 1 summarises key demographic and fish production data for Kafrelsheikh governorate. Importantly, 80% of the total fish produced in this governorate is tilapia (55% of the national production).

Table 1: Background data on Kafrelsheikh governorate

Variable	Value (% of national total)
Population ('000s)	2,875 (4%)
Unemployment ('000s)	72 (3%)
Area of pond production (fed)	143,727 (40%)
Total fish production from ponds (tonnes)	324,479 (55%)
Tilapia production from ponds (tonnes)	259,583
Mullet production from ponds (tonnes)	14,966
Carp production from ponds (tonnes)	42,383
Catfish production from ponds (tonnes)	7,547

Source: Adapted from Macfadyen et al. 2011.

3.3 Surveys, participatory rural appraisals, focus groups discussions, and biological sample collection

3.3.1 Producers

A sampling frame of fish farms in Kafrelsheikh governorate was compiled through government records of licensed fish farms and records of fines administered to farms without licenses. These lists (759 farms in total) were compiled and stratified into farms of different sizes: Less than 5 feddans (4200 m²), 5-10 feddans and over 10 feddans. The sample size was calculated using an expected prevalence of chemical contamination (50%), 95% confidence interval, +/- 10%, which resulted in a sample size of 97 farms. Excel randomiser was used to randomly select farms from each group in numbers proportional to the percentage of farms in each group. Contact details for each farm were obtained from government records, fish associations and fish feed factories. Visits were scheduled with either the farm owner, manager, or a worker who was authorised to talk to the enumerators. Upon visiting fish farms, interviews were conducted and biological samples were collected according to the instructions and protocol established (Appendix 1, rapid integrated assessment (RIA) protocol). In addition to questionnaires and biological samples from fish farms, four PRAs for producers were conducted (Appendix 1, RIA protocol). For each PRA, enumerators with support from local contacts such as veterinarians invited a group of 10-15 producers and key persons in the industry such as hatchery owners and fish feed traders to participate in the study. Participants were randomly selected from the list of the fish farms visited for the producer survey. Informal interviews with key individuals, focus groups or mixed groups are commonly used tools for generating data (Mercado, 2006).

3.3.2 Transporters

Interviews with 32 transporters moving tilapia to or from wholesale markets were conducted according to the instructions and protocol (Appendix 1, RIA protocol).

3.3.3 Retailers

Markets and retailers serving the study area were identified by tracing back from reported household sources of tilapia after conducting the household survey (see next section). Interviews were conducted and biological samples were collected from 20 wholesalers, 47 retailers and 23 street vendors according to the instructions and protocol (Appendix 1, RIA protocol).

3.3.4 Consumers

Target consumer groups were identified based on demographic characteristics and proximity to fish farming areas. Three case study areas were identified, namely:

- Rural village in Kafrelsheikh Governorate, Damro (close proximity to fish farming areas)
- Urban/peri-urban area in Gharbya Governorate, Kharseet (geographically removed from fish farming area)
- Rural village in Menoufia Governorate, Albendaria (geographically removed from fish farming area)

Each area consists of approximately 2000 households (HH). The sample size was calculated using an expected prevalence of consuming tilapia (50%), 95% confidence interval, +/- 10%, which resulted in a sample size of 92 HH. Households were numbered and from each area 100 households were selected by simple random sampling. Household surveys, PRAs and FGDs with mothers with children under 5 years age (Appendix 1, RIA protocol) were administered in each case study area.

3.4 Laboratory analysis

Tilapia samples were collected from 100 fish farms and from 100 retailers as described above. The collected samples were tested for the following:

- Organophosphorus (OP) and organochlorine (OC) pesticide residues;
- Heavy metals: mercury, cadmium, lead and arsenic;
- Aerobic plate counts;
- *E. coli*;
- *Listeria monocytogenes*;
- *Salmonella spp*;
- *Vibrio parahaemolyticus*; and
- *Staphylococcus aureus*.

Chemical analysis was performed on fish collected at farms, as fish were unlikely to be contaminated with chemicals between harvesting and sale. The chemical analysis was performed at Kafrelsheikh University Central Laboratory of Environmental Studies (KUCLES).

Due to funding limitations, microbiological analysis was only performed on fish samples collected at retail level, with testing and enumeration completed on a minimum of three samples from each retailer. The microbiological analysis was performed at the Central Diagnostic and Research Laboratory, Faculty of Veterinary Medicine Kafrelsheikh University (for a detailed protocol of the laboratory analysis, please see Appendix 2).

3.5 Data management and analysis

Data collected from different surveys were translated back to English language by the first author. Qualitative data from PRAs and FGDs were summarised. Quantitative data were entered into an electronic web-based database using Microsoft access. Data were then extracted into Microsoft excel for analysis. Descriptive statistical analyses were conducted to allow comparison between different study sites using Instat+ for Windows v.3.36 software.

4 Results

The aim of this study was to assess assessing tilapia value chains in relation to nutrition and health and to identify research opportunities for improving nutrition and decreasing health risks (e.g. new technologies, development of institutions, social and marketing innovations). In this section, the findings from the value chain analysis, participatory assessments, consumer surveys and biological sampling are synthesised; for detailed results of the focus group discussions and participatory assessments, please refer to Appendix 3.

4.1 Description of respondents and study sites

Kafrelsheikh governorate was identified as the target area for fish producers; 100 fish farms were identified and visited for the questionnaire interviews and biological sample collection. The total number of participants in the producers' PRAs ranged from 8 and 20, with no female participants. Structured questionnaire interviews were conducted with 32 fish transporters around the main wholesale market in Kafrelsheikh Governorate. The sites for the consumers' surveys were one village in Kafrelsheikh Governorate, Damro, (in close proximity to fish farming areas), one village in Menoufia Governorate, Albendaria (geographically far from the main fish farming area) and one urban/peri-urban area in Gharbya Governorate (Kharseet). For each site, 100 HH interviews were conducted plus one consumer PRA and one FGD with mothers with young children. The total number of participants in the consumer PRAs ranged from 14 to 17, with female participants dominating in all groups (proportion of women 64-86%). The number of women participating in the FGD ranged from 8 to 12. Retailers were traced back after consumer survey; 100 retailers were

identified and visited for the questionnaire interviews and biological sample collection. Twenty fish fry shops were also interviewed.

4.2 Survey results

4.2.1 Producer survey

One hundred producers were interviewed. The interviews were conducted with owners (69%), workers (30%) and managers (1%). All of them were male and the mean age was 40 years old (min 17, max 70, standard deviation, SD, 12.41). About 50% of respondents were non-educated, 40% had a secondary school and 4% a university education. The mean land area of fish farms was 14.57 feddan (min 1.5, max 85, SD14.96). About 60%, 30% and 10% of respondents had fish farms with land areas of 10 feddan or less, >10 and <30 feddan and >30 feddan, respectively. Almost all producers (94%) reported one production cycle per year while a few had two production cycles per year. The mean amount of total tilapia production (different grades) was 3.2 tonnes/feddan/cycle (min 1.4, max 6, SD 0.84), Table 2.

Table 2: Characteristics of the amount of farmed tilapia production in Kafrelsheikh, Egypt

Amount of production (tonne/feddan/cycle)	Grade I*	Grade II**	Grade III***
Minimum	0.5	0.2	0.1
Maximum	4	2	2
Mean	1.65	0.86	0.69
SD	0.64	0.43	0.35

*Grade I less than 3 fish/kg, **Grade II from 3 to 5 fish/kg and ***Grade III >5 fish/kg

All respondents stated that there was no inspection or supervision for the production process from either the government or the private sector. Thirteen percent of producers used fertilizers in their fish farms during off-season before fish cultivation. They usually use super phosphate, urea and/or lime once or twice a year. Only 4% of producers have agricultural land nearby their fish farms. They commonly use fertilizers such as super phosphate and urea and sometimes pesticides such as malathione for agricultural activities in the nearby land.

Almost all (94%) producers use branded fish feed. The mean quantity used is 5 tonnes/feddan/cycle (min 2, max 10, SD 1.92). Other than branded fish feed, 60% of producers use poultry manure, 15% use rice or wheat wastes, 7% use other crop wastes, 5% use home-made feed and 4% use unbranded fish feed. A small proportion of respondents (5%) stated that they sometimes use other wastes such as bakery wastes and expired pasta. Only 5% treat poultry manure before using it by adding some feed additives and/or fermentation with the aim of improving its nutritive value. More than 60% of producers store fish feed for a short period of time (from 2 to 30 days) and all farms use hand feeding to distribute fish feed in the ponds.

The main water supply for most fish farms (77%) is agriculture drainage canals, which contain water that has been used for agricultural activities. A few producers use water from clean agricultural irrigation canals that has not been used yet and very few use ground water. More than 95% of producers said that they exchange water in their fish ponds on a daily basis. Most producers believe that good quality water should be clear, not turbid or greenish in colour. More than 90% of producers do not test water; however, a few producers test water when there is a health problem in fish such as high mortality rate with unknown cause. Water testing is usually carried out by their veterinarian and most often for ammonia and other chemical pollutants. Tests are generally conducted in private laboratories.

About 30% of producers use treatments; 66.7% use antibiotics, 16.7% use growth promoters, 13.3% use probiotics, and 3.3% use potassium permanganate. Of those who use medication, 73.3% buy them from private veterinarians, 20% from pharmacies, and 6.7% from local shops. About 30% of producers have their own fish hatcheries while the rest buy their stock from private hatcheries. Almost all fish farms (97%) have other fish farms nearby or adjacent to their site. Other than fish, 70% of producers keep cattle, buffalo, sheep, goat, donkeys, poultry and/or dogs.

The time of harvesting depends mainly on the working hours of the wholesale market which range from 6 AM to 2 PM. However, 21% of producers stated that they harvest their fish at night and/or early morning. Most respondents (90%) do not mix fish from different ponds during harvesting. To maintain quality, 68% of producers said they discard dead fish during sorting and grading at the farm before transportation. They believe that dead fish will affect the quality of the rest of fish and will not be sold. All producers sell their fish through the wholesale market, while 9% said they also sell to traders/transporters and 6% sell to retailers but no one said they sell fish directly to consumers. According to producers, fish is usually transported from farms through to retailers in plastic boxes with ice (66%), refrigerated trucks (24%) or in plastic drums equipped with an oxygen supply for live fish (6%). The mean transportation time from farm to the wholesale market is 1.38 hours (min 1, max 3, SD 0.68).

Producers' perceptions regarding the safety and quality of their tilapia are summarised in Figure 5. Most of respondents (80%) strongly disagreed with the statement that they know who ends up eating their fish, 35% strongly agreed that treatments given to fish may affect human consumers, 50% strongly agreed that buyers will not buy their fish if the quality is not high, and 63% strongly agreed that they always find someone to buy fish.

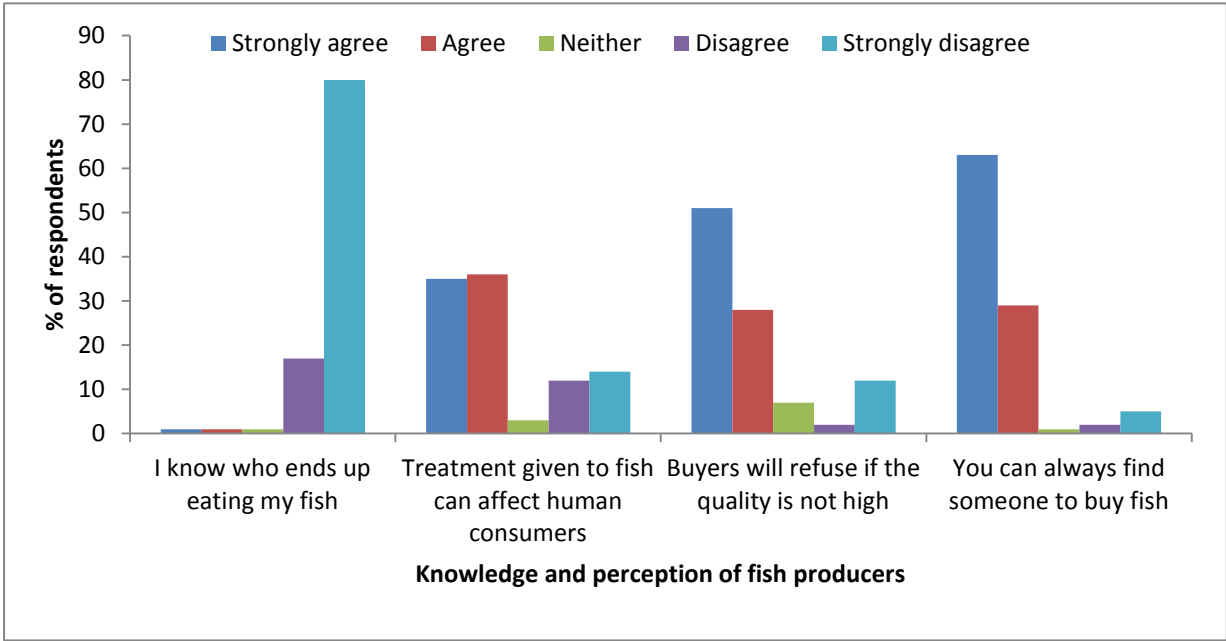


Figure 5: Producers' perceptions toward the safety and quality of their tilapia in Kafrelsheikh governorate, Egypt

Observational data for fish farms' biosecurity, workers conditions and storage conditions are summarised in Figure 6. Noticeably, 55% of farms had domestic animals and there was no filtration of water in almost all fish farms. In more than 90% of farms, ponds were interconnected, there was a feed store and there were signs of rodents.

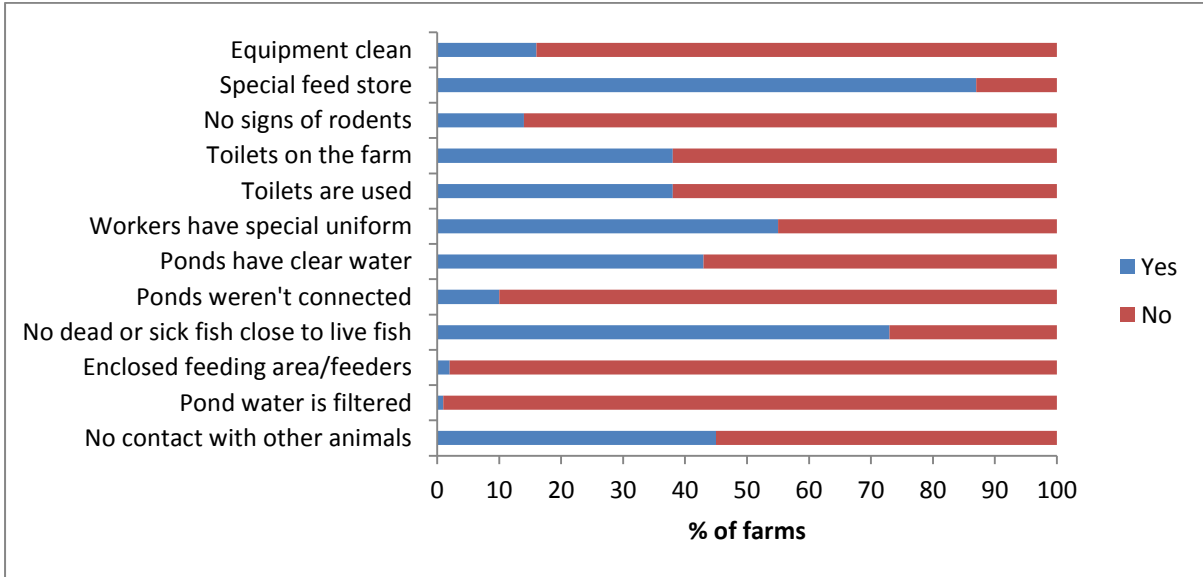


Figure 6: Enumerators' observations of tilapia farms (biosecurity, workers and storage conditions) in Kafrelsheikh governorate, Egypt

4.2.2 Transporter survey

Thirty-two fish transporters around the wholesale fish market in Kafrelsheikh were interviewed. All were male, with a mean age of 38 years (min 22, max 60, SD11). The education level of transporters varied from non-educated (21%), primary school (21%), middle school (15.6%) to secondary school (40.6%). The mean amount of fish transported per load was about 3 tonnes (min 1, max 13, SD 2.62). The mean number of loads per day was 1.3 (min 1, max 3, SD 0.55). Transporters said they work from four to seven days per week and more than 70% of them transported fish all through the year. Only one transporter stated that there was an inspection of the fish by the Ministry of Health during transportation. However, there was no feedback to the transporter. None of the transporters have a fish farm and more than 80% usually transport fish from fish farms to the wholesale market. They transport fish from the surrounding districts to the wholesale market in Kafrelsheikh and then to different markets outside Kafrelsheikh such as Tanta, Cairo, Alexandria and Upper Egypt.

About 90% of transporters said they did not know if the fish supplier had a licence or not. About 37% of transporters say they check the quality of fish before transporting for type, size, colour and odour. According to transporters, fish is usually transported in plastic boxes of 20 to 25 kg capacity with ice (62.5%) or in water tanks with oxygen supply for live fish (37.5%). Fish transporters either clean crates daily (68%), weekly (15.6%), or infrequently (15.5%). About 56% of transporters said they use disinfectants for cleaning crates and equipment. Most transporters (75%) said they usually do not mix fish from different farms in the same load. The mean transportation time of fish from farms to the final destination was estimated at 3.6 hours (min 1, max 24, SD4.33). Transporters usually transport fish from farms to traders/wholesalers (75%), retailers (22%) and/or restaurants (3%).

Interviewers' observations for fish transporters are summarised in Figure 7. Most respondents (87.5%) had clean clothing and shoes, 75% were using plastic containers, and more than 70% had clean storage equipment. None of transporters had visible signs of communicable diseases.

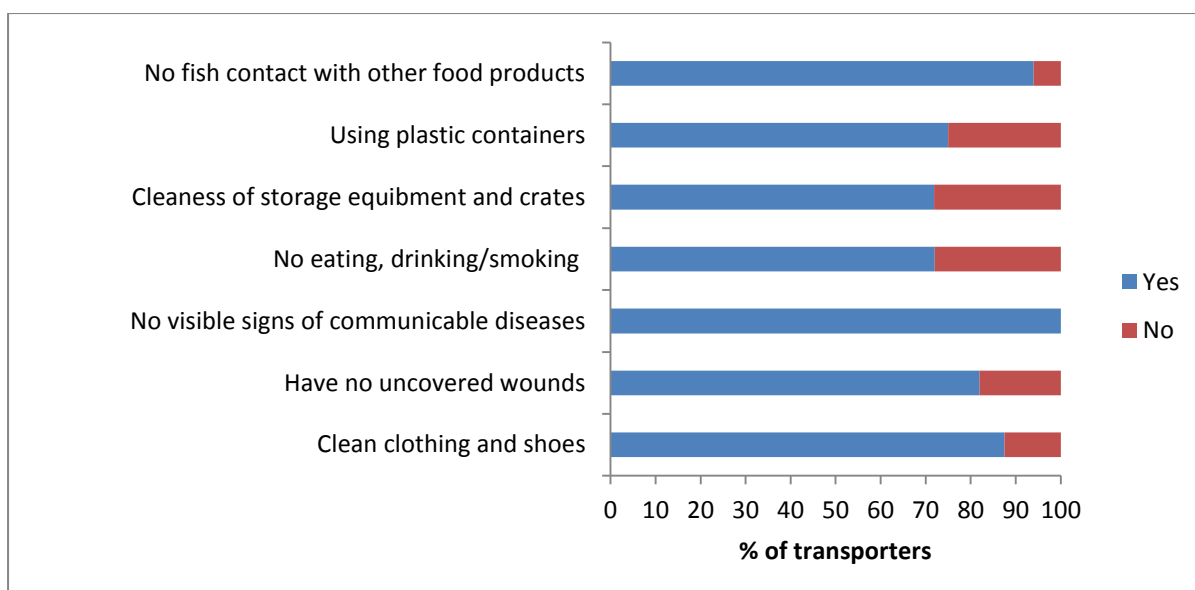


Figure 7: Enumerators' observations of fish transporters and their equipment in Kafrelsheikh governorate, Egypt

4.2.3 Retailer survey

Of the 100 retailers interviewed (20 wholesalers, 47 retailers and 23 street vendors), 62% were men and 38% were women. Eighty-five percent were owners of the retailing business and 15% were workers. The mean age was 38 years (min 18, max 60, SD 9.58). The level of education was 40% non-educated, 23% secondary or high school, 18% middle school, 11% with primary education, and 8% university education. The types and volumes of fish sold per day varied according to the type of retailer (Table 3).

Table 3: Types and volumes of tilapia sold per day for different types of retailers in the Nile Delta, Egypt

Type of business	Mean weight (kg) of fish sold per day			
	Grade I*	Grade II**	Grade III***	Total amount
Wholesalers	1500	1650	1300	4450
Market sellers	44.17	50.98	46.97	142.12
Street Vendors	18.33	41.96	43.96	104.25

*Grade I less than 3 fish/kg, **Grade II from 3to 5 fish/kg and ***Grade III >5 fish/kg

Only one respondent said there is inspection for the quality of fish by an official veterinarian who usually takes samples, but there is no feedback to the retailer. Most retailers get fish from the wholesale market in Kafrelsheikh while a few retailers said they sometimes have fish from their own farms and/or other farms (Figure 8). More than 70% of retailers said they do not know if their fish supplier has a licence or not. A high proportion of retailers (62%) said they check the quality of fish before buying by examining the general appearance of fish; colour, odour, empty stomach and thickness of back muscles.

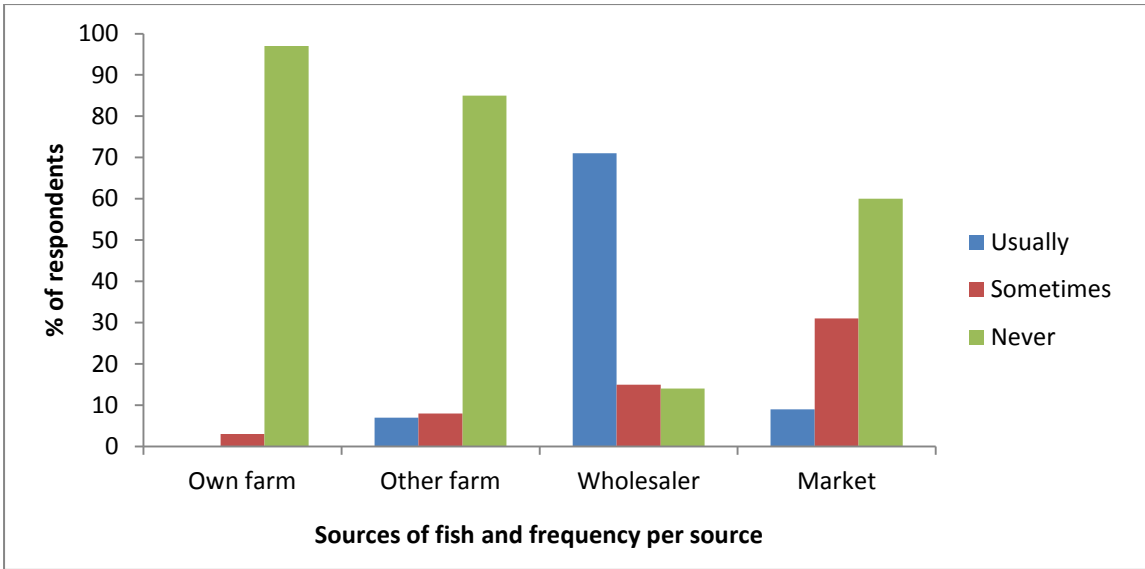


Figure 8: Sources and frequency of farmed tilapia for retailers in the Nile Delta, Egypt

According to retailers, fish is usually transported from the source to the final destination in plastic boxes with ice (87%), without ice (11%) or in water tanks with oxygen supply (2%) for live fish. The majority of the retailers (80%) clean their crates and other storage equipment on a daily basis. However, only 9% use disinfectants (Figure 9).

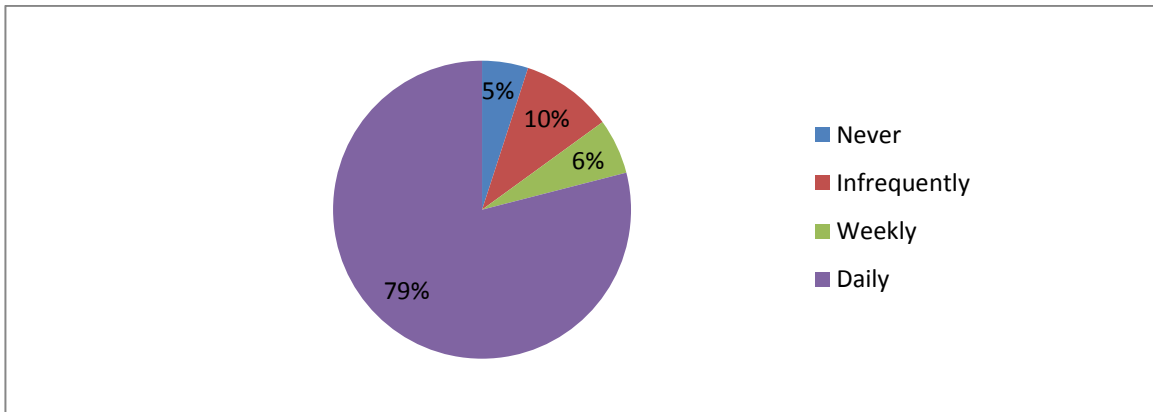


Figure 9: Frequency of cleaning crates and/or storage equipment by fish retailers in the Nile Delta, Egypt

Most retailers (87%) sell fish directly to consumers (Figure 10). About 30% of retailers cook fish for their costumers, either by grilling and/or frying. Interviewers’ observations for retailers are summarised in Figure 11. About 50% of retailers had a permanent structure, a source of electricity, access to running water, a concrete floor, separate rubbish bins and clean clothes. More than 50% used plastic storage containers.



Figure 10: Fish retailers' customers and frequency of selling fish in the Nile Delta, Egypt

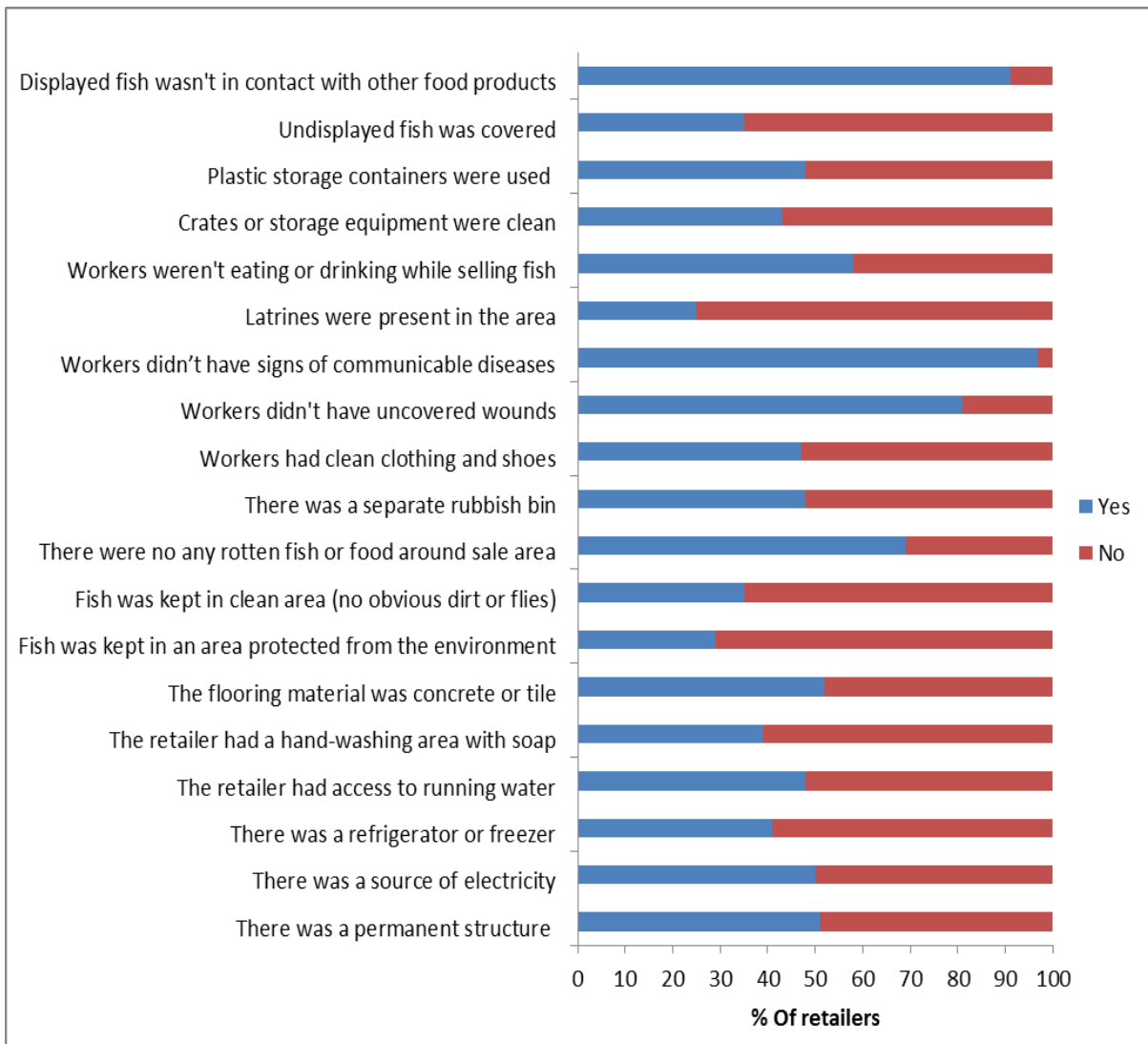


Figure 11: Enumerators' observations of fish retailers (facilities, workers/retailers conditions and storage conditions) in the Nile Delta, Egypt

4.2.4 Fish fry shops survey

Twenty Fish fry shops (fish sellers who prepare, cook or process fish) were visited and 15 owners and 5 workers were interviewed. The respondents were 7 females and 13 males and the mean age was 36 years (min 19, max 50, SD 7.03). More than 50% of respondents were non-educated, 40% had a secondary school, and 5% had a middle school education. Characteristics of the amount of tilapia sold per day are summarised in Table 4. The mean volume of tilapia sold/day was 47 kg (min 25, max 120, SD 22.10).

Table 4: Characteristics of the amount of tilapia sold per day in fish fry shops in the Nile Delta, Egypt

Amount of tilapia (Kg/day)	Grade I*	Grade II**	Grade III***	Total amount
Minimum	10	10	5	25
Maximum	30	50	40	120
Mean	13.75	19.15	14.10	47
SD	4.98	10.42	9.59	21.5

*Grade I less than 3 fish/kg, **Grade II from 3 to 5 fish/kg and ***Grade III >5 fish/kg

All respondents stated that there is no inspection of their fish and they usually buy fish from wholesale markets mainly from Kafrelsheikh, Tanta, Balteem and Kafrelzyat. They did not know if the supplier has a licence or not. About one third of respondents said they check the quality of fish (colour, odour, and size) before buying. Forty per cent transported fish in refrigerated trucks and 65% keep fish on ice during transportation. All said they clean crates and storage equipment daily and 85% said they use disinfectants. The mean transportation time from source to the fry shops is about 3.5 hours (min 1, max 5, SD 0.94). Fish is usually kept on ice during the day (75% of respondents) and sold in the same day, the rest is kept overnight in refrigerators (80% of respondents). All respondents said they clean surfaces where fish is placed once a day using tap water (90%) or water tanks (10%). Most respondents (80%) use bar soap, detergents (20%) and disinfectants (65%) for cleaning surfaces. All respondents stated that they always sell fish directly to end consumers. In fry shops, tilapia is prepared either by frying for 10 to 25 minutes or grilling for 15 to 20 minutes. Most fry shops (90%) had a hand washing area; 40% of respondents said they wash hands after using the toilet, and 60% said they wash their hands regularly during the day. More than 50% of respondents do not use the same knives and boards when preparing different foods at the same time. Tap water is usually used for cleaning surfaces and utensils and sometimes detergents.

Interviewers' observations for fish fry shops are summarised in Figure 12. About 90% had a permanent structure, a source of electricity, access to running water and separate rubbish bins. Almost all fish fry shops had a hand washing area, clean clothes and clean equipment. None of the workers had any visible signs of communicable diseases or uncovered wounds.

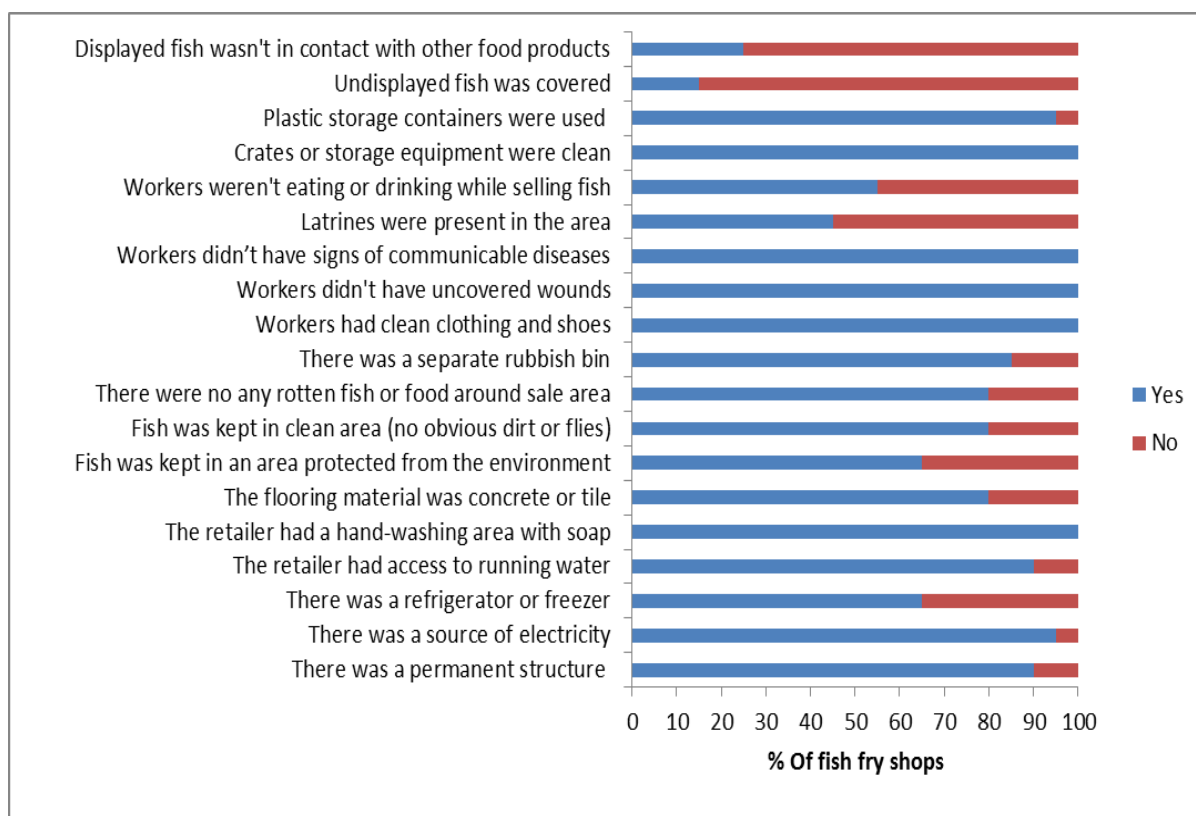


Figure 12: Enumerators' observations for fish fry shops (facilities, workers/retailers conditions and storage conditions) in the Nile Delta, Egypt

4.2.5 Consumer survey

Three hundred households were visited in three different locations (100 each) according to the demographic characteristics and proximity to fish farming areas. The characteristics of these HHs are summarised in Table 5. The results show that in all communities most were male-headed households. The mean age of the head of the HH was 45.8, 40.74 and 47.66 years, and the mean number of inhabitants per HH was 5, 4.11 and 4.21 in fish-farming, peri-urban and rural communities, respectively.

Most of HHs (79%) in the fish-farming community were involved in the process of fish farming and production throughout the year, either by having a fish farm, trading in fish or fish feed, working in fish markets or by working in any of the fields related to fish production. Working in fish farms and/or other related activities such as trading of fish and/or fish feed, represented the only income source, major income source, and same importance as other income sources for 63.29%, 25.35% and 10.13% of the HH involved in fish production, respectively. In contrast, in the non-producing communities only 1% of HHs were found to be involved in fish industry and income from the fish value chain did not represent the only or major source of HH income in any of the HHs.

Table 5: Characteristics of households interviewed in different communities in the Nile Delta, Egypt

Characteristics of the HH		Community		
		A*	B**	C***
Gender (%)	Male	86	92	91
	Female	14	8	9
Age/Year	Min	24	23	25
	Max	77	90	70
	Mean	45.8	40.74	47.66
	SD	11.2	12.51	10
Number of inhabitants/HH	Min	2	1	1
	Max	21	9	7
	Mean	5	4.11	4.21
	SD	2.26	1.41	1.18

* A, within the proximity of fish farming area, ** B, peri-urban area away from the fish production, *** C, rural area away from fish production site.

The frequency of consumption of tilapia is illustrated in Figure 13. The results show that 75%, 19% and 8% of households consumed tilapia twice per week in fish-farming, peri-urban and rural communities, respectively.

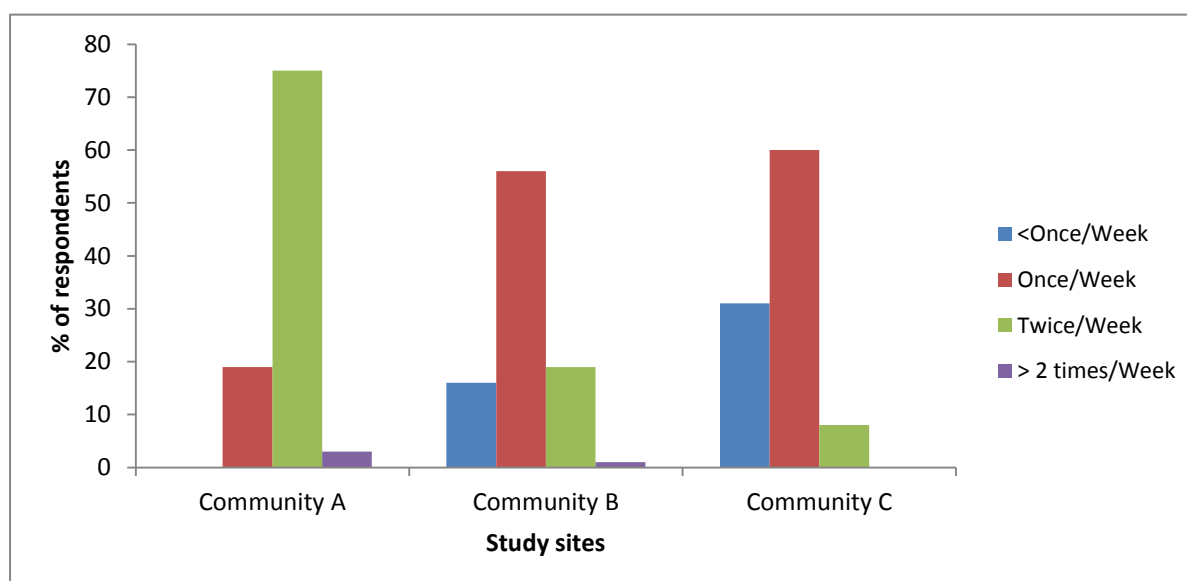


Figure 13: Frequency of consumption of tilapia by adults (male/female) in the Nile Delta, Egypt. A: within the proximity of fish farming area, B: peri-urban area away from the fish production, C: rural area away from fish production site.

Tilapia was replaced by other fish species or frozen imported fish by 49%, 85% and 94% of the respondents in fish-farming, peri-urban and rural communities, respectively. The reasons for replacement were the lack of availability of tilapia in the market, the high price of tilapia

compared with other types, especially imported frozen fish, and sometimes consumer preference. Some consumers stated other reasons such as their financial inability to buy and/or the low quality of the available tilapia. Other substitute animal source foods to tilapia included chicken, meat, offal or eggs. Respondents said the decision to buy tilapia was mainly a joint decision in the fish-farming community and a decision made by the wife in peri-urban and rural communities, Table 6.

Table 6: Taking decision for purchasing tilapia in the Nile Delta, Egypt

Who takes the decision to buy tilapia in the HH?	Community (%)		
	A*	B**	C***
Joint decision	50	24	40
Head of the HH	28	3	11
Wife	22	74	48

* A, within the proximity of fish farming area, ** B, peri-urban area away from the fish production, *** C, rural area away from fish production site.

Characteristics considered by consumers when buying tilapia are illustrated in Figures 14, 15, 16 for fish-farming, peri-urban and rural communities, respectively. The degree of cleanness of the source was considered very important by 99%, 93% and 72% of the consumers in peri-urban, rural and fish-farming communities, respectively. Access to supplies of tilapia was considered important by 28%, 30% and 75% of consumers in fish-farming, peri-urban and rural communities, respectively. For the fish-farming community, cleanness, trust in sellers, storage time and prices were considered very important criteria for purchasing tilapia. For the peri-urban community, cleanness, storage time, accessibility and regular availability were considered very important criteria for purchasing tilapia. For the rural community, cleanness, trust in sellers, credit and relation with the supplier were considered very important criteria for purchasing.

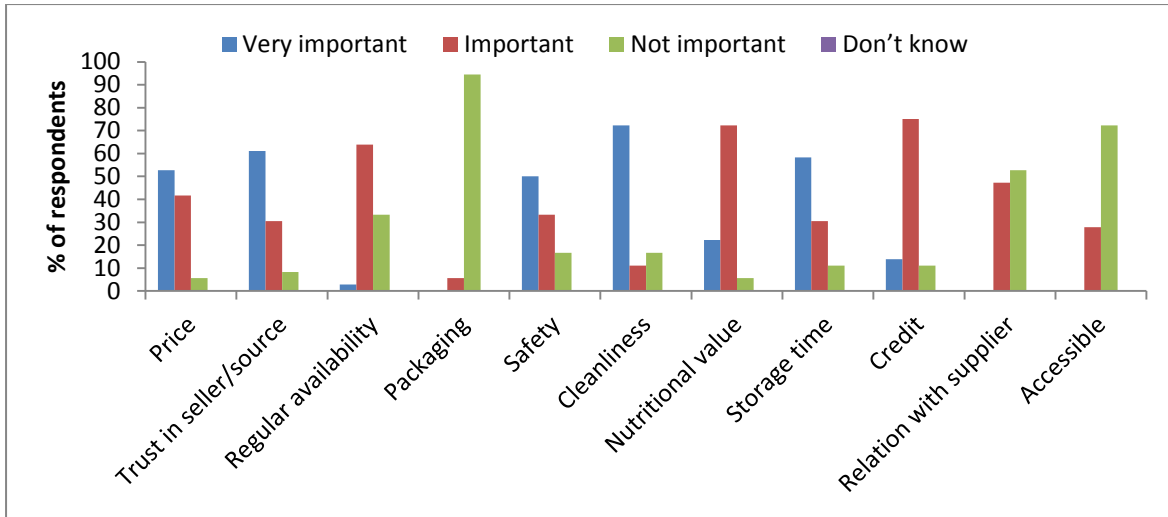


Figure 14: Characteristics for purchasing Tilapia considered by consumers in the fish-farming community

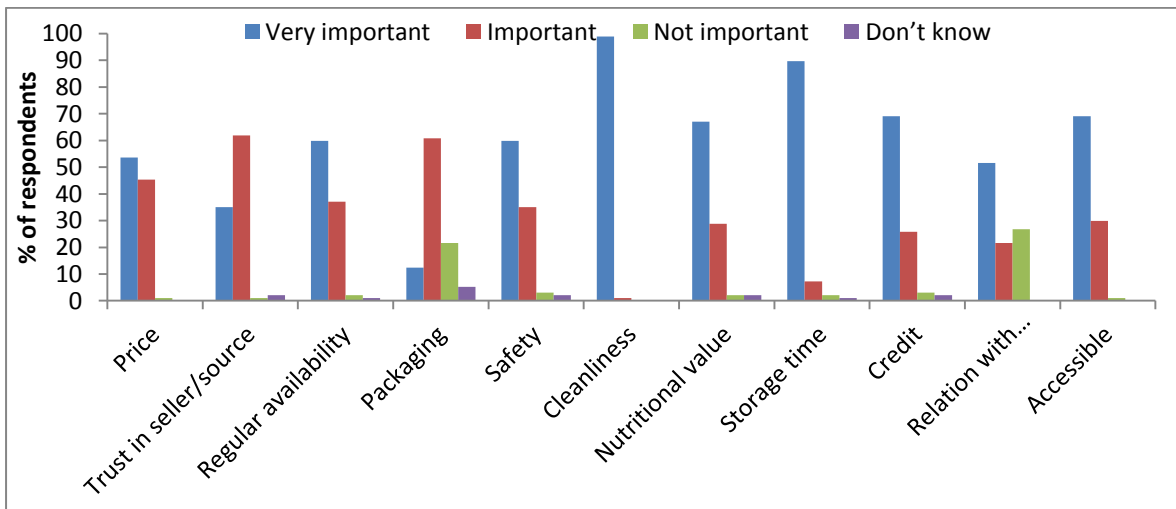


Figure 15: Characteristics for purchasing Tilapia considered by consumers in the peri-urban community

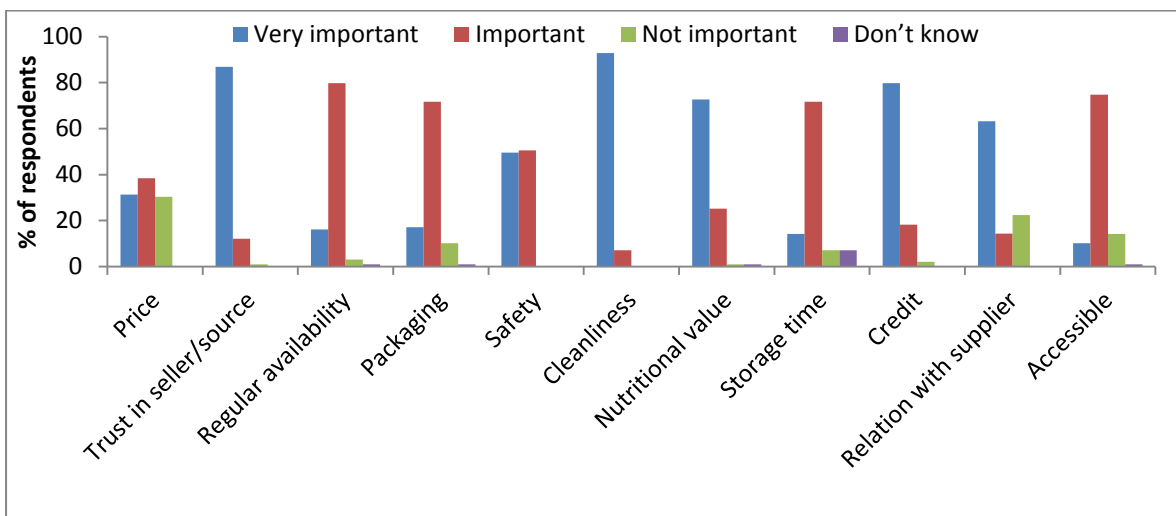


Figure 16: Characteristics for purchasing Tilapia considered by consumers in rural community

In the fish-farming community almost all consumers purchase tilapia grade II and 50 % purchase tilapia grade I. In the peri-urban community 88% of consumers purchase tilapia grade 1 while in the rural community 73% of consumers buy tilapia grade II (Figure 17).

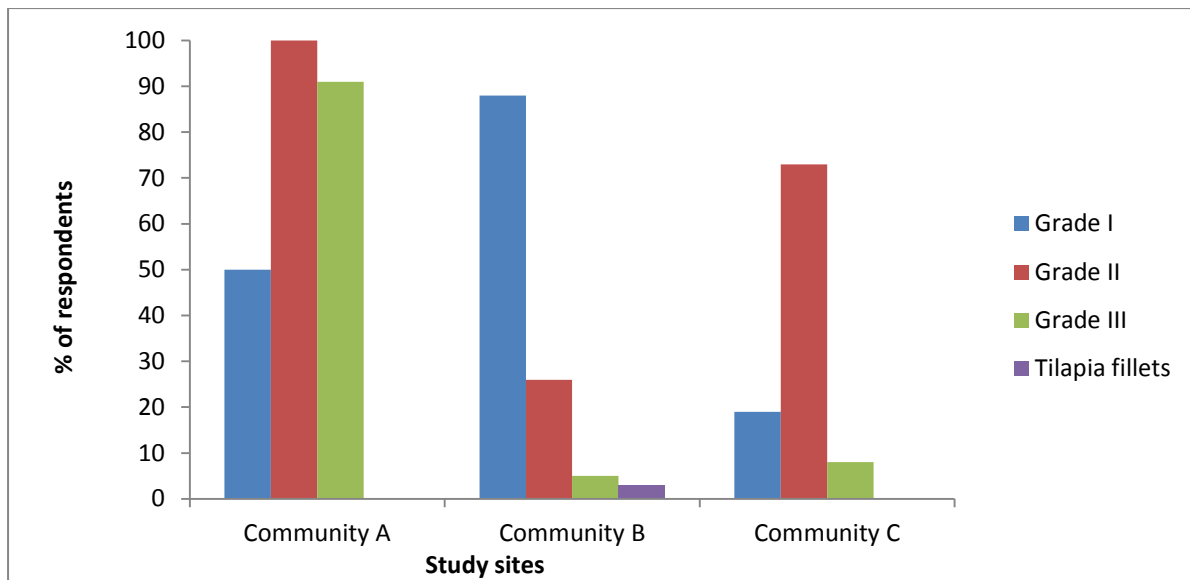


Figure 17: Characteristics of Tilapia purchased by consumers in different communities in the Nile Delta, Egypt. A: within the proximity of fish farming area, B: peri-urban area away from the fish production, C: rural area away from fish production site.

The only source of tilapia for consumers in peri-urban and rural communities was by purchasing. However, in the fish-farming community consumers could get tilapia by purchasing, or from their own farms, or gifted from the work place and/or as a gift from others (Figure 18). In all communities, almost all consumers purchased tilapia from retail markets (Figure 19) and stated that tilapia was always packaged in plastic bags unless it was prepared by the seller in which case it was packed in aluminium foil.

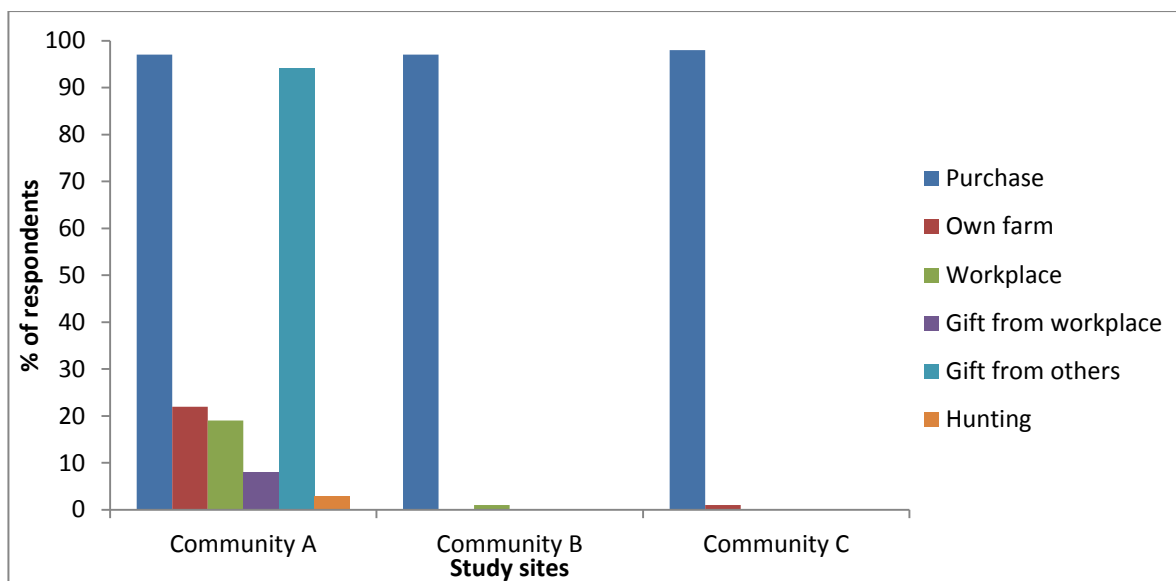


Figure 18: Sources for getting Tilapia by consumers in different communities in the Nile Delta, Egypt. A: within the proximity of fish farming area, B: peri-urban area away from the fish production, C: rural area away from fish production site.

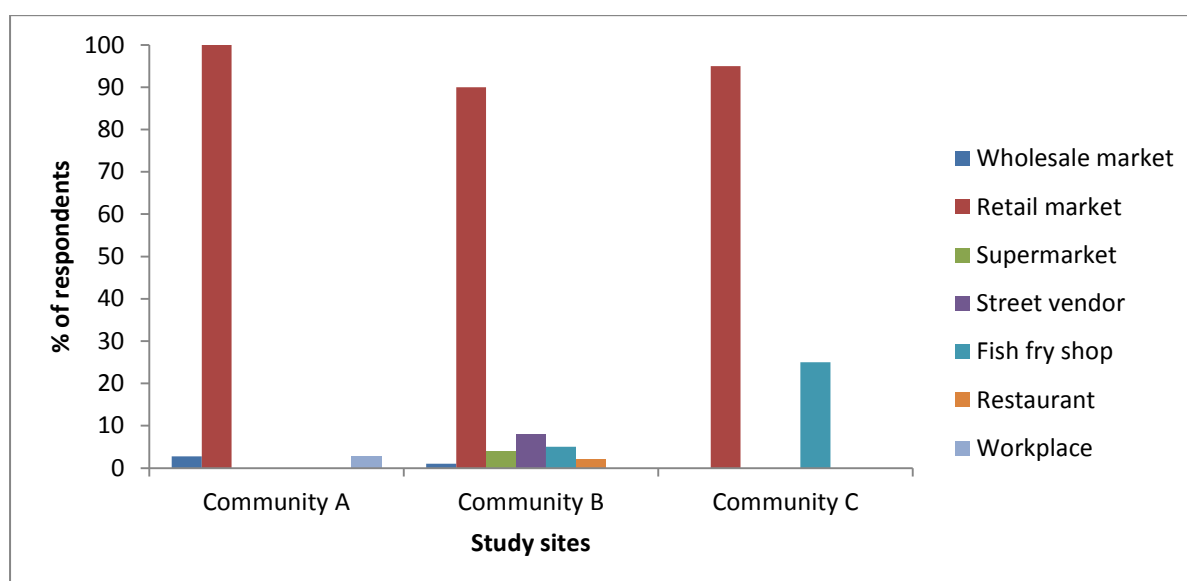


Figure 19: Sources of purchasing tilapia by consumers in different communities in the Nile Delta, Egypt. A: within the proximity of fish farming area, B: peri-urban area away from the fish production, C: rural area away from fish production site.

The mean time for transporting tilapia home from the place of purchase was estimated at 15, 46 and 54 minutes for fish-farming, peri-urban and rural communities, respectively. The mean time that tilapia was kept at home before cooking was about 0.5, 1 and 1.5 hours for the fish-farming, peri-urban and rural communities, respectively (Table 7). During this period tilapia is mainly kept at room temperature in fish-farming community and refrigerated or on

ice in peri-urban and rural communities (Figure 20). In all communities, tilapia was usually cooked on the day of purchase, otherwise it was stored in freezers.

Table 7: Time (min) for transporting tilapia home and between arrivals until cooking

		Community		
		A*	B**	C***
To transport tilapia home	Min	5	10	5
	Max	30	180	240
	Mean	14.34	46.13	54.04
	SD	7.61	39.15	37.09
Keeping at home before cooking	Min	5	15	15
	Max	180	720	360
	Mean	33.95	55.21	96.42
	SD	33.30	80.06	70.24

* A, within the proximity of fish farming area, ** B, peri-urban area away from the fish production, *** C, rural area away from fish production site.

The most commonly used methods for cooking tilapia stated by all respondents were frying and grilling. Frying time ranged from 10 to 25 minutes and grilling time was about 30 minutes. Some other methods are used for cooking tilapia such as by dressing with onions, spices and tomato sauce with and/or without other vegetables and cooking in the oven for 30 to 40 minutes. This method (called “Samak singary”) is frequently used for preparing fish, especially in the fish-farming community. More than 90% of consumers consume tilapia with fresh salads. Leftover cooked tilapia is eaten after reheating by most consumers (86%) in the fish-farming community and eaten cold by 70% of consumers in rural community. No one in the three communities used leftover tilapia as compost (Figure 21).

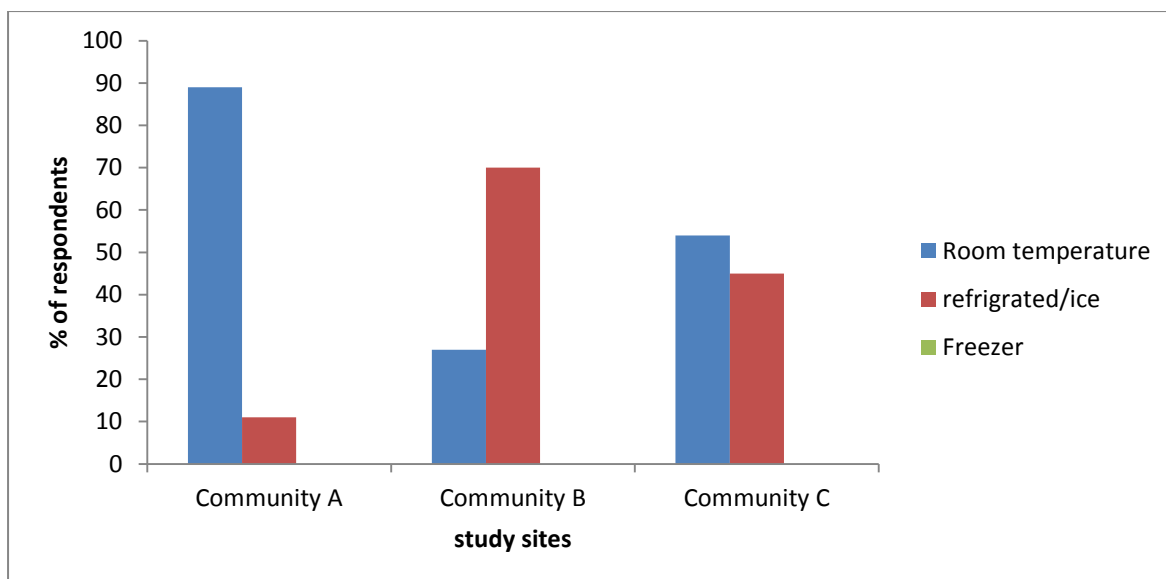


Figure 20: Keeping tilapia at home between purchasing and cooking. A: within the proximity of fish farming area, B: peri-urban area away from the fish production, C: rural area away from fish production site.

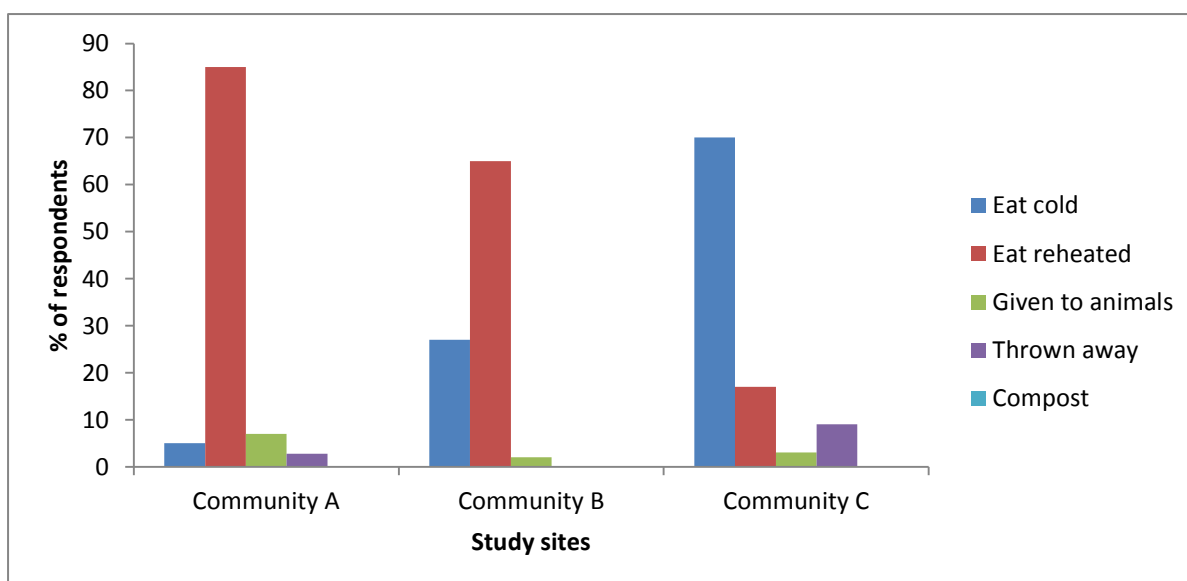


Figure 21: Consumer behaviour with cooked tilapia leftover in the Nile Delta, Egypt. A: within the proximity of fish farming area, B: peri-urban area away from the fish production, C: rural area away from fish production site.

It was noticed by enumerators in all study sites that more than 95% of households have a hand-washing area with soap in the kitchen. Eighty per cent, 72% and 88% of respondents in fish-farming, peri-urban and rural communities, respectively, said they use the same knives and boards when preparing tilapia and other foods at the same time. However, some respondents stated that they wash knives and boards before re-using.

Knowledge, attitudes and practices of consumers are summarised in Figures 22, 23 and 24 for fish-farming, peri-urban and rural communities, respectively. Almost all respondents in the three communities agreed that eating tilapia is good for health, tilapia is a highly nutritious food and tilapia safety can be judged by sight and taste. High proportions of respondents especially in peri-urban and rural communities said they would eat more tilapia in the future. More than 90% of respondents in peri-urban and rural communities believe that the quality of wild caught tilapia is better than the farmed fish; on the other hand, more than 80% of respondents in fish-farming community disagreed. About 70% of respondents in peri-urban and rural communities said they would buy more tilapia if it was cheaper but the quality was the same.

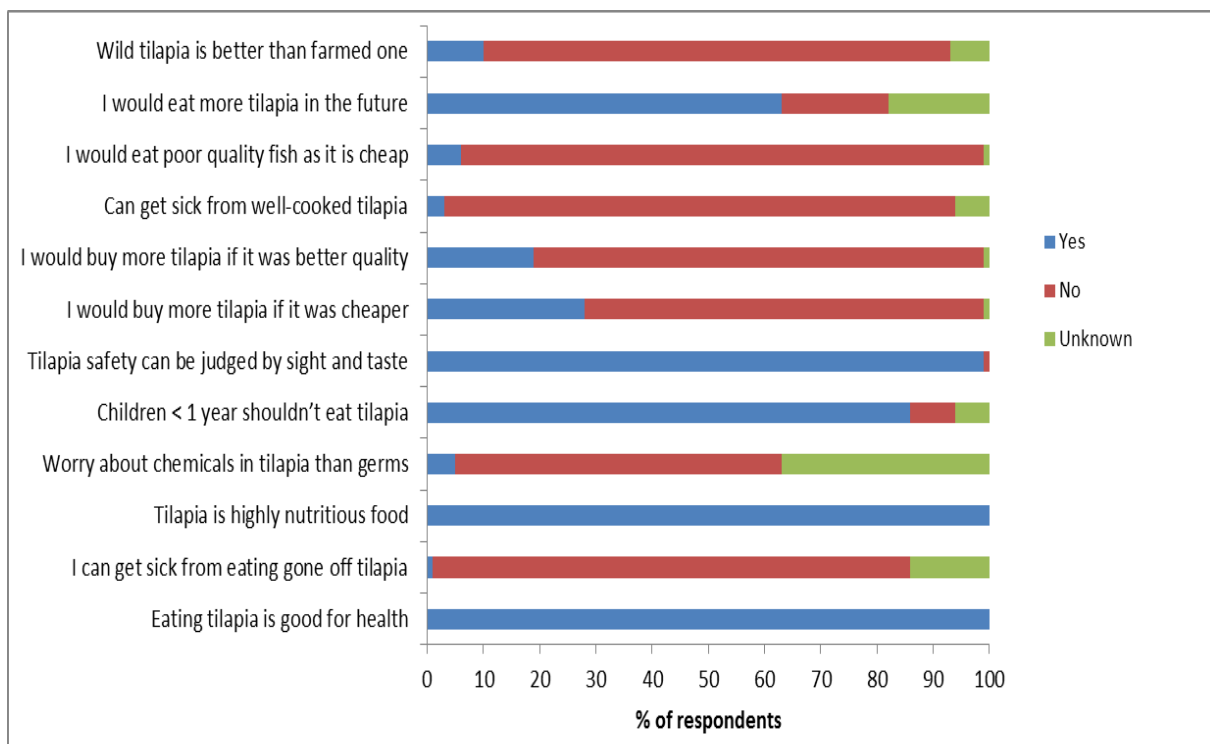


Figure 22: Knowledge, attitudes and practices of consumers in the fish-farming community

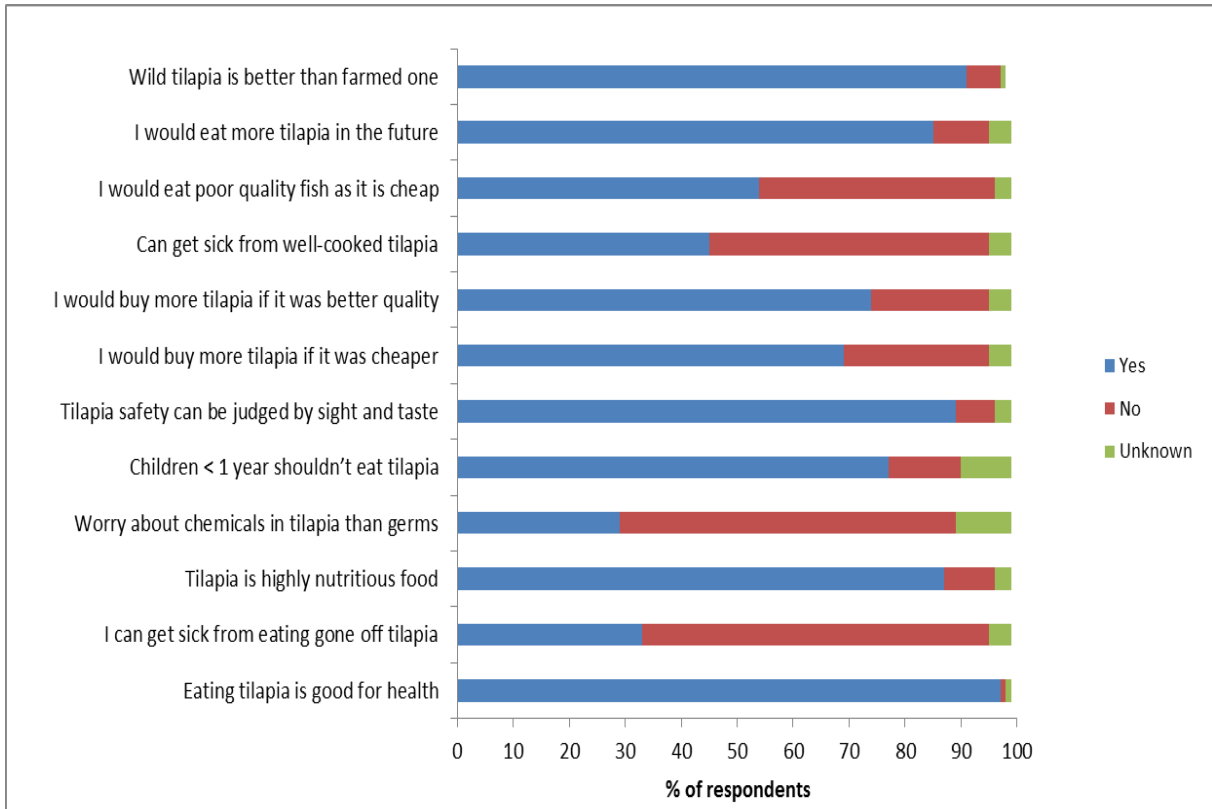


Figure 23: Knowledge, attitudes and practices of consumers in the peri-urban community

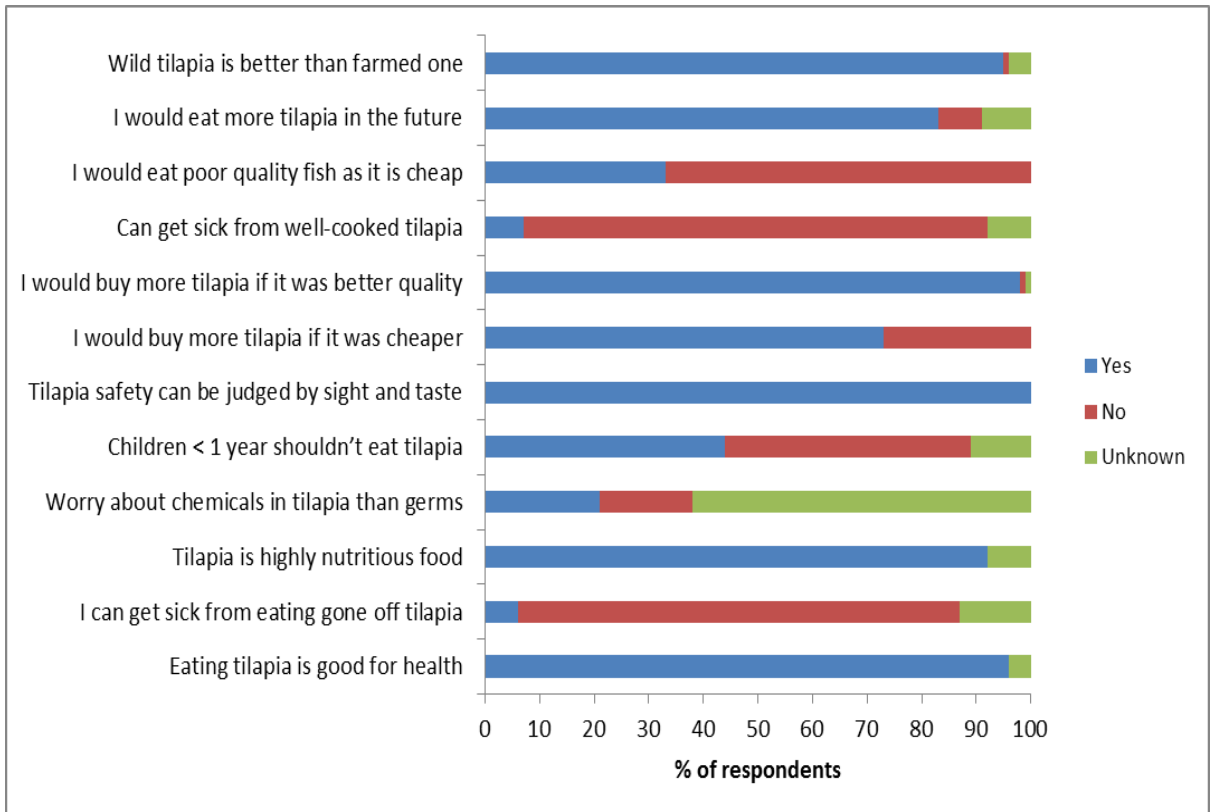


Figure 24: Knowledge, attitudes and practices of consumers in the rural community

Health information for the two weeks prior to the interview for the HH members is illustrated in Figures 25, 26 and 27 for fish-farming, peri-urban and rural communities, respectively. Fever and gastrointestinal illness such as diarrhoea, vomiting and stomach pain were predominant symptoms among children from 0 to 2 years old, especially in the fish-farming community. Headache was recorded in 40% and 18% of households for women in peri-urban and rural communities, respectively.

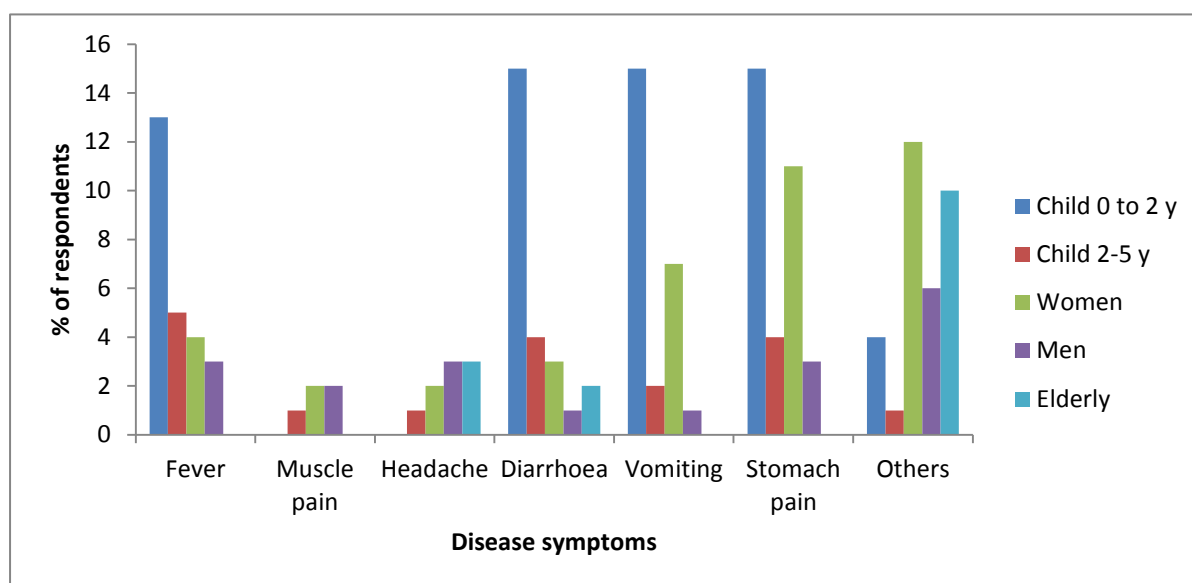


Figure 25: Health information for the two weeks prior to the interview in the fish-farming community

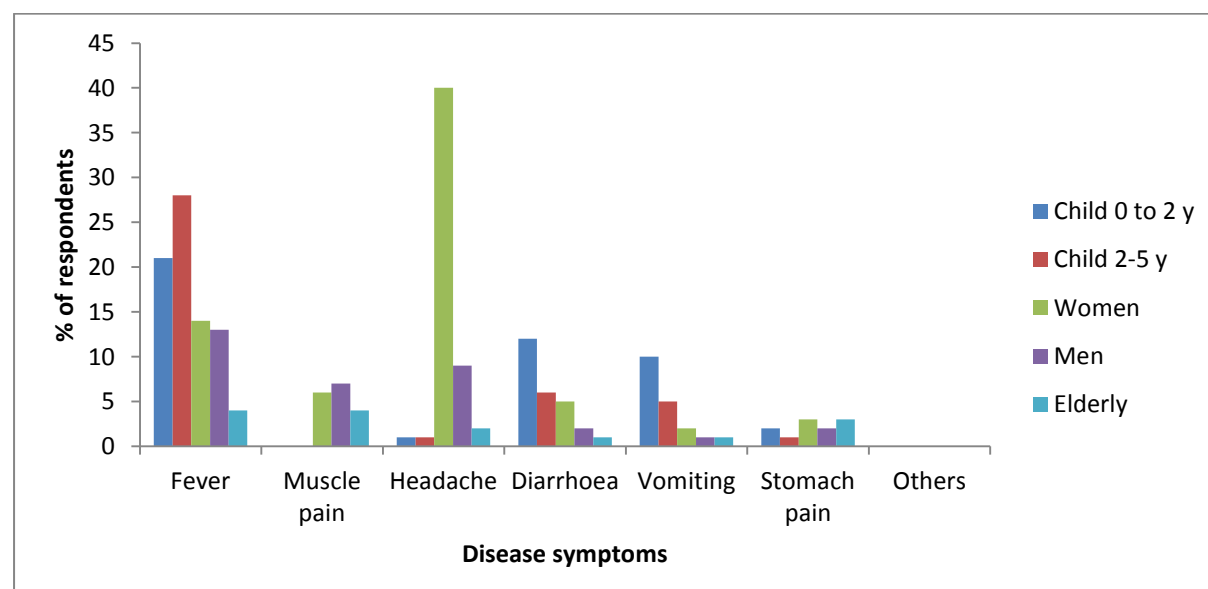


Figure 26: Health information for the two weeks prior to the interview in the peri-urban community

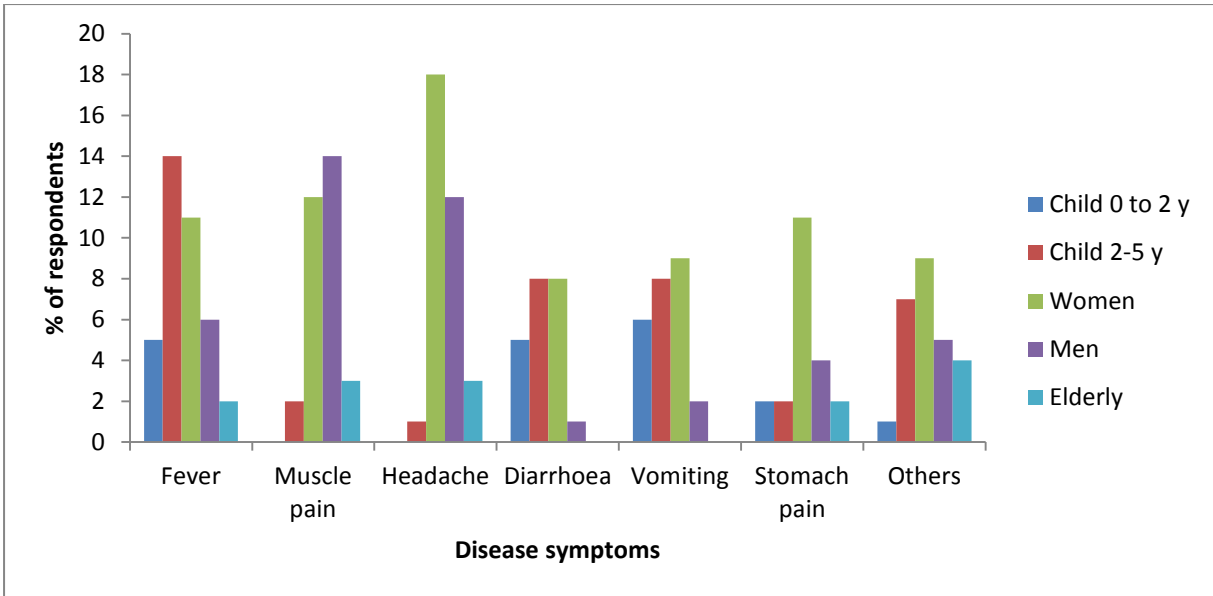


Figure 27: Health information for the two weeks prior to the interview in the rural community

Health information for six months prior to interviews for the household members are illustrated in Figures 28, 29 and 30 for fish-farming, peri-urban and rural communities, respectively. It is clear that the most frequently occurring symptoms were headache and stomach pain in men and women, especially in the rural community.

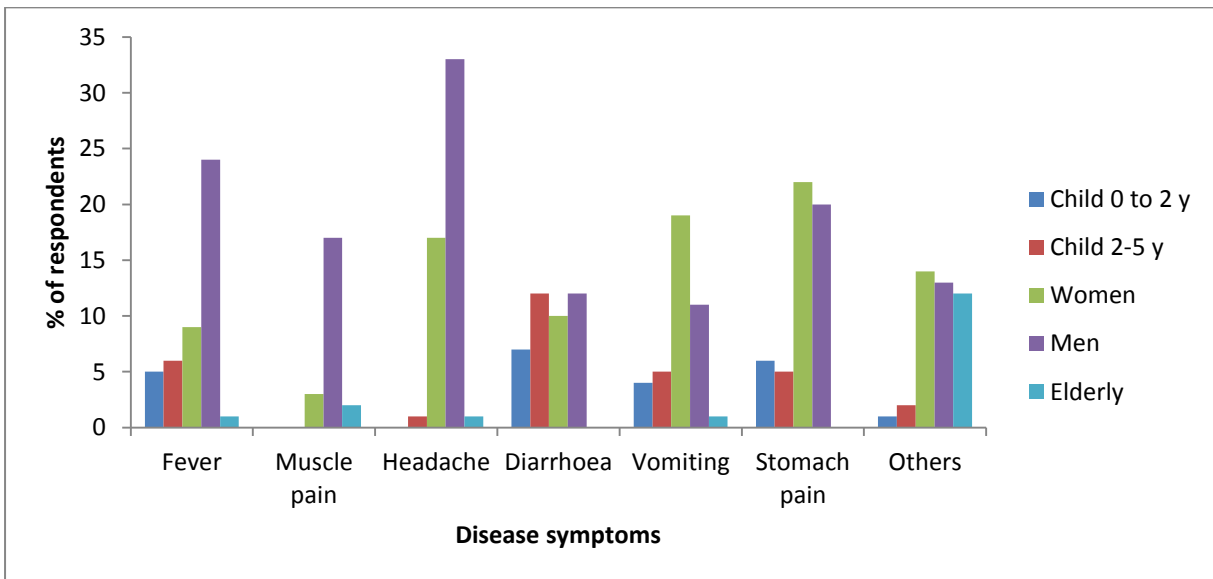


Figure 28: Health information for the six months prior to the interview for the fish-farming community

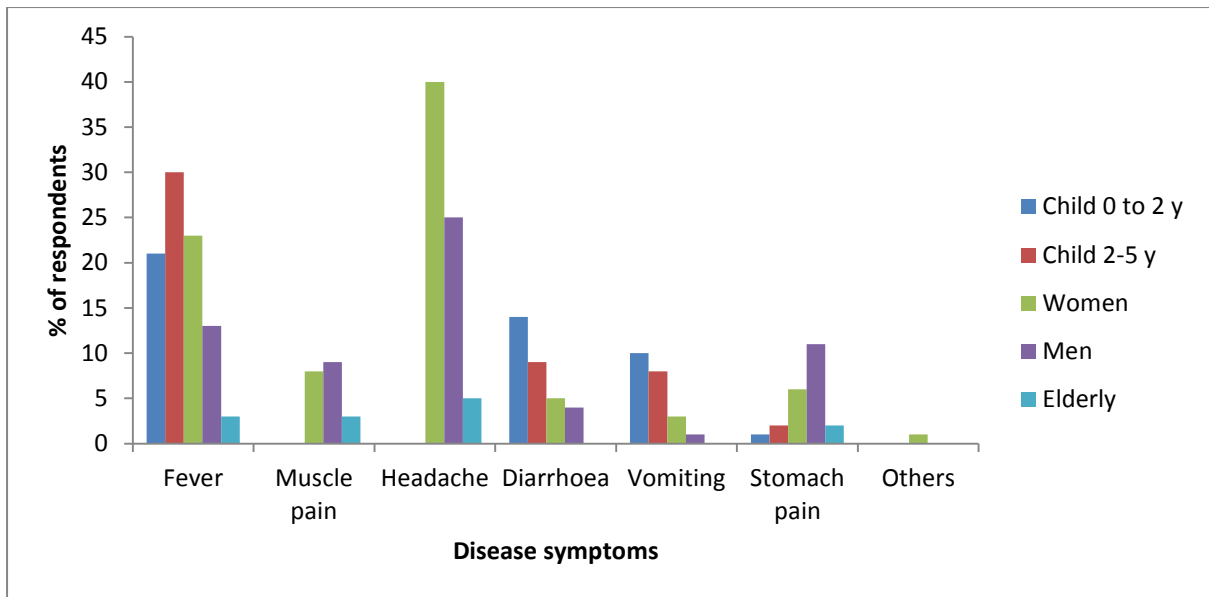


Figure 29: Health information for the six months prior to the interview in the peri-urban community

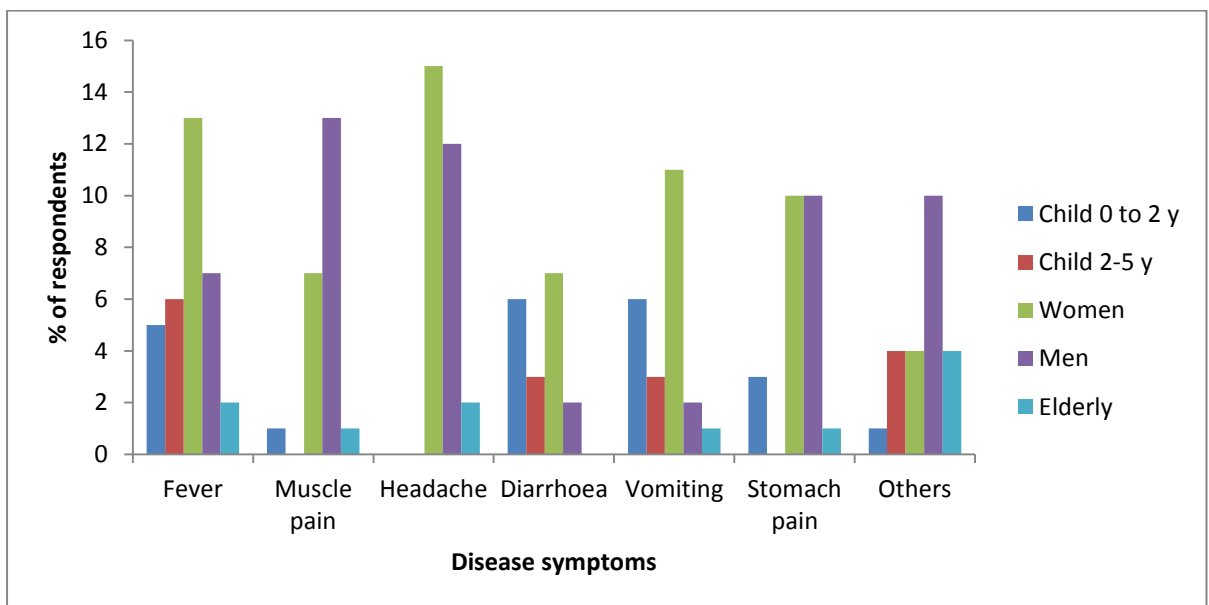


Figure 30: Health information for the six months prior to the interview the rural community

4.3 Findings of the participatory rural appraisals (PRA) and focus group discussions (FGD)

4.3.1 Producer PRAs

4.3.1.1 Fish production cycle and consumption

Producers in the four PRAs explained that the fish production cycle usually starts from March/early April. Farmers start with either fingerlings or newly hatched tilapia from hatcheries (private or commercial). Also farmers who have small size tilapia (non marketable weight) carried over from the previous season start feeding them. They continue feeding and fishing until end of October/early November. From late November/early December until end of February/early March, there is a decrease in fish production as tilapia stop feeding during winter. About 70% of producers have one production cycle per year and 30% or less may have three cycles over a period of two years. Fish consumption usually increases around Easter (April) and summer vacations (June to September) and during the month of Ramadan. Fish consumption is low around the Eid al-Adha holiday, due to increased availability of meat from sacrifices.

4.3.1.2 Entry, exit, morbidity and mortality

Seventy to ninety percent of fish producers start the production cycle with fingerlings (10-15 g body weight) and about 10 to 30% start with newly hatched fish (1-2 g body weight). The number of tilapia fingerlings stocked per feddan is usually around 10,000. Some farmers operate polyculture systems and stock 2,000 to 5,000 mullet fingerlings per feddan and/or other fish species in the same pond beside tilapia. About 70 to 80% of producers said they have their own fish hatcheries. The estimated mortality rate is about 10 to 15 % due to different causes. Harvested fish is sold without any value addition at the wholesale market.

4.3.1.3 Fish production constraints

Producers mentioned the following constraints:

1. The most important constraint is feed price. Farmers complain that feed prices are continuously increasing, while fish prices are stable and sometimes decrease due to the large quantities of production.
2. Marketing is also a fish production constraint. The media can play a negative role by announcing from time to time that farmed tilapia is contaminated and may contain public health hazards. This increases consumers' concerns about farmed tilapia and makes them prefer wild tilapia and/or frozen imported other fish species with a perception that they are safer than farmed fish. Also there is no control on imported frozen fish that enters the markets and is sold as if it is fresh fish with low prices. Farmers see imported fish as competition for their products, in particular as they say there are no specific regulations, guidelines and criteria for imported fish.

3. The third ranking constraint was fish disease, especially in winter when there can be a high mortality rate after very cold nights. Producers said they were not aware of specific fish diseases apart from some non-specific symptoms after fish exposure to stress.
4. Water sources and quality were also considered to be fish production constraints in the area. By law, fish farms are only allowed to use water from agricultural drainage canals and lakes which can be heavily polluted with fertilizers and pesticide residues. Also the water flow depends on agricultural activities so it varies through the year. In farms close to the coastal zone at some times of the year the water level in the drainage canals can become lower than the sea allowing high salinity water to enter the fish farms.
5. For farmers who rent land from the government, increasing yearly rents was voiced as another constraint. Together with increasing feed prices, fish farmers can end up with little or no profit.
6. Especially during winter season, environmental conditions, such as heavy rainfall, can make it impossible to access fish farms. Farmers said they would like government to pave the main roads in the area.
7. Fish farmers said that they would like an authority to provide high quality hormones used for the production of mono-sex tilapia at reasonable prices as they are sometimes adulterated.
8. Farmers suggested that lack of knowledge and awareness of producers with new fish farming methods and the best management practices can be a constraint. They suggest that training programs should be implemented by government fish authorities in the region and/or by the university.
9. Producers also expressed concerns about fuel shortages and the high price of fuel, particularly in the last two years for their tractors, water pumps and other vehicles. They suggested looking for alternative sources of energy such as electricity and/or solar energy.

4.3.1.4 Producers' perception of fish quality and safety

Fish size, weight, fattiness, gill colour, odour and firmness were considered as indicators for the fish quality and safety. Producers said they are very concerned about the quality and safety of the fish for the sake of their profitability and income as they said they receive higher prices for higher quality and safer fish.

From the producers' point of view, the main factors affecting the quality of the fish are water quality, source (locality) and the frequency of water changes. When the water quality is bad, the food conversion ratio (FCR) is poor and there is stress on fish. Feeding is another factor affecting fish quality, especially the protein concentration which should not be less than 25%.

Farmers thought that diseases do not affect fish quality, as the diseased fish or those with lesions are removed from the pond and do not affect the risks for future batches.

Producers said that the weather affects the quantity of fish harvested more than the quality. Production in the winter season, results in weaker fish and the quantity will be affected. However they said that consumers like to purchase fish from the market during hot weather but the hot weather can affect the quality of fish because they have large amounts of feed in the stomach so the quality of fish harvested in cold weather may be better.

In order to improve fish quality, producers would like to change the current legislation and be allowed to have access to clean irrigation water for their fish farms. However, they frequently change the water and in some areas ground water is used to keep the quality and improve production. At harvesting time, they stop feeding before harvesting to have fish with empty stomach, fishing at night or early morning, add ice to fish boxes and transport to the wholesale market as soon as possible.

4.3.2 Consumer PRAs

Consumer PRAs were conducted in the same three villages that were surveyed, namely Damro (in close proximity to fish farming areas), Albendaria, (geographically far from fish farming areas) and Tanta (Kharseet).

4.3.2.1 Availability and accessibility of ASF

Generally, ASFs such as milk, dairy products, meat, poultry and fish are available in the 3 sites around the year. However fish is more available and accessible in study site I in the vicinity of fish farms compared to the other 2 sites. Moreover in the peri-urban site, fish is available and easily bought from the nearby city compared to the rural area which depends mainly on fish sellers at the village market once a week. In both the rural and peri-urban areas, about 90% of HHs keep cattle (cows/buffaloes). Milk produced from these animals is usually for home consumption either as fresh milk and/or for processing of homemade cheeses after cream removal. Cream can be consumed as such or further processed into butter and/or ghee. The excess (after HH consumption needs) milk, cheese, cream, butter and/or gee are sold. The same applies for poultry with more than 90% of HH keeping different species (chicken, ducks, geese, pigeon and turkey) usually in small numbers. Poultry and poultry products such as eggs are usually for the HH consumption, gifts, weddings and funerals. (Full details in appendix 3: Reports for the PRAs)

4.3.2.2 Fish quality and safety

Consumers in all three study sites said they were aware of quality attributes. However, the ranking was different from one site to another and the presence or absence of some attributes was also different, depending on the distance, time and method of transporting and keeping of fish from production sites to retailers, then to consumers. Consumers in the 4 PRAs agreed that smell, colour of fish and gills, firmness and degree of detached scales are the main attributes for fish quality. Consumers said they did not buy fish with changes in these

attributes, even if there are no other choices. However, consumers in the first study site (fish production area) stated that they rarely see these changes as the time between fish harvesting and selling is very short.

4.3.2.3 Fish preparation and consumption

In the three study sites, tilapia is usually bought either from retailers in the village market (during the market day), fish shops in the village or in the nearby city. Most consumers asked the seller to clean, and eviscerate fish before taking it home for preparation. Also a high proportion of consumers said they asked the seller to cook the fish for them, either by frying or grilling. There was no typical schedule for fish preparation and consumption. However, the following is a general example from a site far from fish production area (Figure 31):

- Fish is either bought from the village market, which is usually held once a week, from fish shops within the village and/or from fish sellers in the nearby city market (Tala and/or Tanta).
- Fish is usually bought fresh.
- After purchasing fish, most consumers usually ask sellers to clean and eviscerate it, although a few consumers take the fish home and prepare it themselves.
- Many consumers ask the sellers to cook fish for them either by frying or grilling and take it home ready for consumption.
- Consumers who purchase raw fish either cook it for consumption on the same day or keep it in a freezer for future consumption.
- The time between fish purchasing and arrival at home, depends on the source of fish: if it is from local sellers at the village it takes from 15 to 30 minutes, but if it is from sellers in the nearby city market it may be more than one hour.
- The time of purchasing fish during the day also depends on the source of fish: if it is from the village market it is usually early in the morning but if it is from the nearby city market it could be from early morning to 3 or 4 pm.
- Women usually decide what to cook and when.

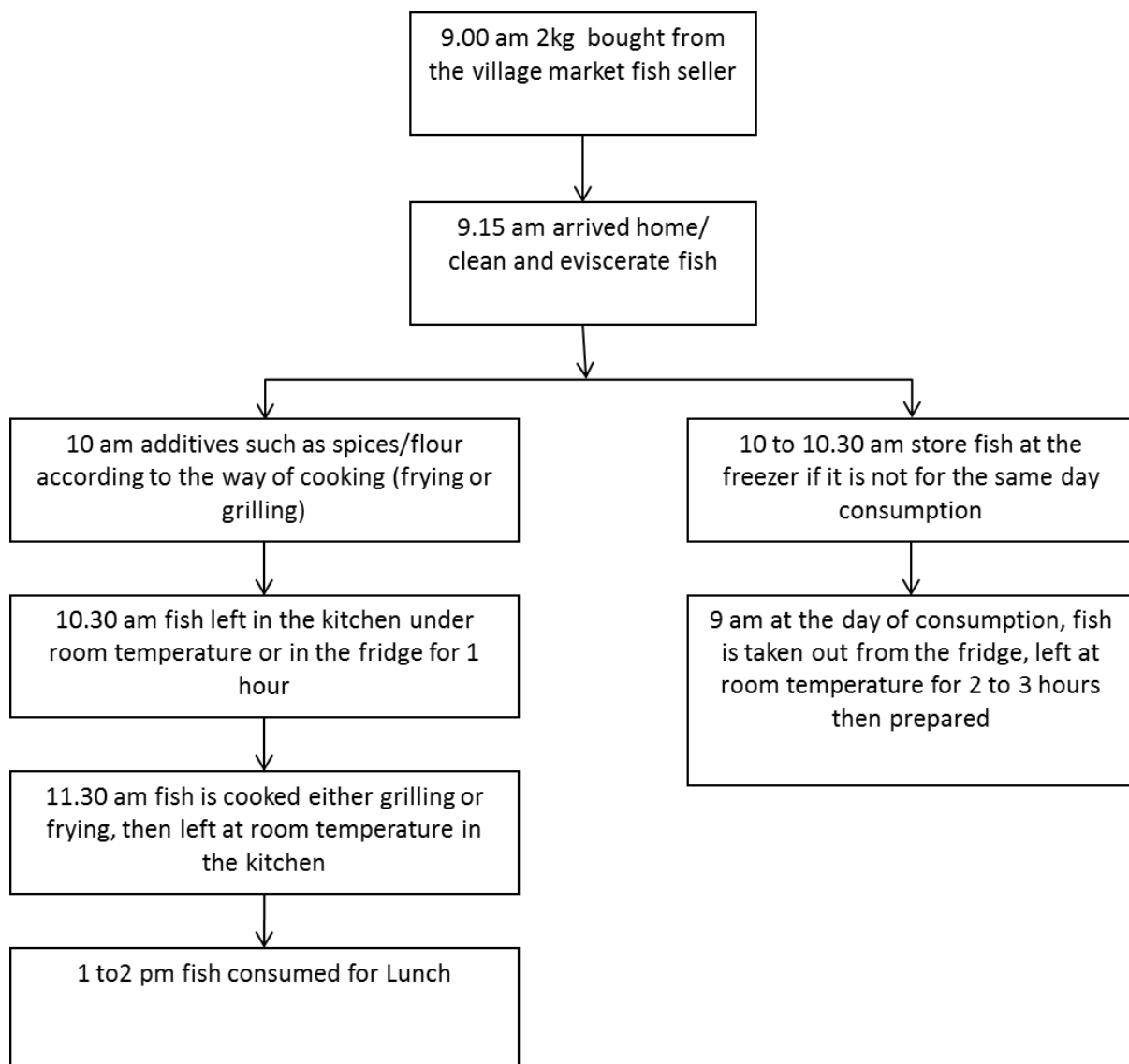


Figure 31: The common preparation and consumption of fish reported by the PRA in Albendaria village (far from fish farming areas)

4.3.3 Focus group discussions with mothers with young children

Focus group discussions with mothers with young children were conducted at the same study sites where the consumer survey was conducted at the health care centres during child vaccination days. Mothers in the three sites agreed that they usually start to introduce solid food to their infants at the age of 4 to 6 months. They begin with milk, yoghurt and/or egg yolk (boiled/fried) in small amounts. At the age of one year, they start to introduce meat, poultry and fish to the diet of children. The main and sometimes the only source of milk and dairy products particularly in rural areas is the milk produced by their own livestock, mainly cattle and buffalo. Therefore, the pattern of consumption of milk and dairy products mainly depends on its availability in the HH so when animals are dried off during the late gestation

period, there is no milk. Milk is usually consumed after boiling; however, dairy products such as home-made cheese are not exposed to sufficient temperature for killing pathogenic agents. Fish is usually consumed grilled or fried.

4.4 Findings of laboratory analysis

4.4.1 Bacteriological analysis of fish samples from retail sale

In total, 100 tilapia samples (three fish in each sample) were collected from 100 retailers during March to May 2012. Samples were bacteriologically analysed for total aerobic plate count, *E. coli*, *Listeria monocytogenes*, *Salmonella spp.*, *Staphylococcus aureus* and *Vibrio parahaemolyticus*. The results are summarised in Table 8. The prevalence of *E. coli*, *Listeria monocytogenes*, *Salmonella spp.*, *Staphylococcus aureus* and *Vibrio parahaemolyticus* were 8%, 7.7%, 3.3%, 13% and 12.3%, respectively. However, more than 64% of samples were compiled with all standards tested for. According to the Egyptian standards for fresh retail fish, the total aerobic count, *E. coli* and *Staphylococcus aureus* should not exceed 10^5 , 10^2 and 10^3 /gm of fish muscles, respectively. Fresh retail fish should be free from *Listeria monocytogenes*, *Salmonella spp.* and *Vibrio parahaemolyticus*.

Table 8: Bacteriological characterisation of fresh tilapia samples collected from retail sale in the Nile Delta of Egypt

Foodborne pathogens	Bacterial count		Egyptian standard	Samples > standards (%)	Egyptian
	Mean	SD			
Total aerobic count (10^5 cfu/g)	6.2	3.80	$1*10^6$		13.7
<i>E. coli</i> (10^3 cfu/g)	0.73	0.54	100		8.0
<i>L. monocytogenes</i> **	NA	NA	0.0		7.7
<i>Salmonella spp.</i> **	NA	NA	0.0		3.3
<i>S. aureus</i> (10^3 cfu/g)	1.17	1.03	1000		13.0
<i>V. parahaemolyticus</i> (10^3 cfu/g)	0.89	0.91	0.0		12.3

* Adapted from EOS (Egyptian Organization for Standardization and Quality) (2005), ** The count for *L. monocytogenes* and *Salmonella spp.* Was not presented as enrichment steps were used.

4.4.2 Chemical analysis of tilapia samples from fish farms

The analysis for pesticide residues detected six pesticides, namely Aldrin, Dieldrin, Endrin, Heptachlor, Heptachlor-Epoxide (beta) and Lindane. The mean concentrations were 19.18, 16.78, 2.37, 2.67, 1.29 and 3.04 ppb, respectively (Table 9). All results were well within the permissible limits according to Codex Alimentarius Commission (CAC) (2009). Other pesticides residues and PCB were not detected. For heavy metals mercury was detected with a mean concentration of 0.07 ppm which is lower than the MPL (0.50 ppm) stated by

Egyptian Organization for Standardization and Quality (EOS 2010). The level of arsenic, lead and cadmium was under the detection limit.

Table 9: Pesticides residues detected in farmed tilapia samples from Kafrelsheikh governorate, Egypt

Concentration (ppb [*])	Pesticides					
	Aldrin	Dieldrin	Endrin	Heptachlor	Heptachlor- Epoxide(beta)	Lindane
Minimum	7.48	9.2	0.34	0.8	0.34	1.2
Maximum	35.42	33.6	12.4	6.96	2.91	5.9
Mean	19.18	16.78	2.37	2.68	1.29	3.04
Standard deviation	7.64	6.18	2.69	1.48	0.56	1.33
MPL ^{**}	300	300		200	200	200

*ppb=part per billion, **MPL= Maximum permissible limits, (CAC, 2009) adapted from (Yahia and Elsharkawy, 2014)

5 General discussion and conclusions

In this section, the findings from the value chain analysis, situational analysis, participatory assessments, consumer surveys and biological sampling are drawn together to discuss key research questions posed by the funding body.

5.1 Food and nutrition security: what is the role of tilapia in diets of producers and consumers?

Animal-source foods are considered an important component of a nutritious and balanced diet. Tilapia is a mild white fish that is low-fat and low in calories, rich in protein, vitamins and minerals such as vitamin B₁₂ and potassium (Roos et al., 2003, Mogensen, 2001). A four-ounce portion of tilapia provides about 30 grams of protein, 2.1 micrograms of vitamin B₁₂, and about 450 milligrams of potassium. Fresh water aquatic animals are good sources of important nutrients, such as calcium and vitamin D that are essential for growth and development (Roos et al., 2003, Mogensen, 2001). They are also good sources of essential fatty acids, particularly of 22:6n-3 and 20:4n-6, which are important for normal neurodevelopment and visual function in pre-term infant nutrition. Their muscle tissues also contain substantial levels of other fatty acids of the n-3 series, such as 20:5n-3 and 18:3n-3 people (Karapanagiotidis et al., 2010, Roos et al., 2003, Mogensen, 2001). They can contribute to the requirement for essential fatty acids, particularly of n-3, that are absent in other food sources commonly available to these people (Karapanagiotidis et al., 2010, Roos et al., 2003, Mogensen, 2001). The importance of omega-3 polyunsaturated fatty acids (n-3 PUFA), particularly docosahexaenoic acid (DHA, 22:6n-3) and eicosapentaenoic acid (EPA, 20:5n-3), in human nutrition has become widely recognized (Simopoulos, 1999, Connor, 2000). It was found that consumption of fish oils containing n-3 PUFA reduces the biochemical factors associated with cardiovascular disease, diabetes, rheumatoid arthritis and

cancer, besides acting directly on the growth process and human development (Nettleton, 1995).

The frequency of tilapia consumption by consumers at the vicinity of tilapia producing areas was higher than in other communities. This may be due to various reasons; for example having several alternatives for getting tilapia (e.g. purchasing, get from workplace, gift) and lower prices of tilapia compared to non-producing areas. Contrary to that, in non-fish producing areas, the only source of tilapia or any other type of fish was by purchasing. These results were consistent with findings in other countries such as Nigeria where the consumption of fish was significantly higher in fishing than in non-fishing households (Gomna and Rana, 2007, Gomna, 2011). Also in China and Bangladesh, the consumption of fish was found to be significantly higher in households in fish producing areas compared with both non-producers and the national average consumption (Dey et al., 2000). The replacement of tilapia with other types of fish, especially imported frozen fish, was found higher in non-producing areas in this study. This was due to the lack of availability of tilapia in the market (usually once a week), low quality, the high prices of tilapia compared with other types, and sometimes consumers' preference. Financial inability to buy tilapia was mentioned as another reason. The low quality of tilapia in non-producing areas may result from improper and/or unhygienic conditions during transportation and storage of tilapia from the production area to the consumers. The results showed that it may take 24 hours or more for tilapia to reach consumers in non-producing areas taking into account the transportation time from farm to the wholesale, then to retailers, then to local retailers and/or street vendors. During this time, tilapia was not frozen but mostly transported chilled with limited amounts of ice. Because there is commonly no monitoring of temperatures, it may be that transport temperatures of fish drop below recommended levels. The frequency of consumption of tilapia was higher in the peri-urban area than in the rural area as consumers in the peri-urban area can easily get tilapia from nearby city markets, usually have high income and different dietary habits. Tilapia may also be more affordable in peri-urban areas than in rural areas as there were higher proportions of salaried employees and consequently high purchasing power. It was also noticeable that tilapia grade I and II were more available and frequently consumed in non-producing communities. This means that higher grades of tilapia tended to be transported to non-producing areas and lower grade tilapia grade consumed locally. This may be due to higher prices for grade I and II tilapia in markets in non-producing areas.

Consumers assess signs of good quality tilapia using sensory checks; for most of them cleanness of the source was the single most important criteria for purchasing tilapia. However, as discussed before, sensory checks alone may give a false indication about the quality and safety of tilapia. There may be potential food safety risks due to contamination and/or cross-contamination at home as high proportions of consumers used to keep fish at room temperature and many consumers reported using the same knives for fish and other foods. Many consumers thought that wild tilapia is better than farmed one, especially in non-producing communities. This indicates some degree of mistrust in professional production and concerns about the quality of farmed tilapia. Most consumers in non-producing areas

would buy more tilapia if it was better quality. This illustrates the impact unhygienic transporting and storage conditions and the resulting spoilage may have on consumers demand. The results also indicated that the demand for tilapia is increasing with more than 80% of households particular in non-producing areas would like to consume more tilapia in the future.

Generally, the annual per capita consumption of fish in Egypt increased considerably from 7.98 kg/capita/year in 1990 to 15.55 kg/capita/year in 2005 (Alboghdady and Alashry, 2010). This may be due to the influence of the increased amount of aquaculture production in the last decades as it was discussed in the introduction of this document. Other causes could be due to diseases in other sources of animal protein such as cattle and poultry. The impact of Foot and Mouth Disease outbreaks in 2011 and 2012 on cattle and beef production was severe and led to the increase of beef prices. Higher beef prices and consumer fears of contracting FMD adversely influenced beef consumption (The average per capita consumption of red meat is estimated at 8.66 kg/year) and consequently shifted toward other ASF such as poultry and fish (Hamza and Beillard, 2012). Fish prices are cheaper compared with prices of meat and poultry. It was noticed that there were accelerated changes in the food habits of Egyptians either regarding types of food and/or cooking methods; however, fish grilling and/or frying remain common used methods (Hassan-Wassef, 2004).

5.2 Food and nutrition security: what is the relationship between fish farming and fish eating?

Our results show that about 80% of HHs in the vicinity of fish producing areas are involved in fish farming and/or other related activities such as trading of fish, fish feed industry, working in fish markets or transporting fish. Women are not involved in fish farming and/or transportation but 38% of fish retailers were female. Most consumers in this area consume tilapia at least twice per week in addition to other types of fish. Also, they can get tilapia via their own farms, or by purchasing, or from their workplace and/or as gifts. On the other hand, in non-fish producing areas, none of the consumers had their own fish farm and only 1% were involved in fish related activities, such as working in a restaurant serving fish in the nearby city. Consequently, the only source of tilapia or any other type of fish was by purchasing. The frequency of consumption of tilapia was found to be higher in the peri-urban area than in rural area as consumers in the peri-urban area can easily get tilapia from nearby city markets. The percentage of employees in fish in both peri-urban and rural non-fish producing communities was only 1%.

For other animal source foods such as milk, dairy products, poultry and eggs the frequency of consumption varies according to the productivity of HH cattle and poultry. Most of the HHs in the Nile Delta of Egypt rear cattle and poultry mainly for home consumption of products. Relatively small proportions buy poultry, eggs, milk and/or dairy products. Meat is usually bought fresh from local butcher shops. Frozen imported meats are usually bought from supermarkets at lower prices than fresh meat.

5.3 Food safety and nutritional issues: how do nutritional quality and food safety change along the value chain?

One of the main constraints pointed out during the producer PRAs was concerns over tilapia quality because of the lack of availability of clean water, as almost all farms in Kafrelsheikh use water from agricultural drainage canals. To promote the quality and safety of tilapia, producers frequently change water in ponds and discard dead tilapia and those with visible lesions during sorting and grading process. About 60% of producers use poultry manure as fertilizers and only a small proportion treat poultry manure before its use. Poultry manure may be a source of contamination. Results from producers, transporters, retailers and consumers surveys indicate that tilapia is potentially exposed to post harvest contamination along the chain. Unhygienic handling of tilapia was observed during harvesting, transporting to the wholesale, storage at the wholesale, transporting from wholesale to retailers, storage on retail, selling to consumers, transporting and storage at home before cooking. Examples of unhygienic conditions and potential points of contamination are illustrated in Figures 32 to 37.

- The commonly used method of harvesting is by draining water from ponds then catching tilapia in very turbid and low quality water (Figure 32). Feed deprivation prior to catching, removal from water, handling, grading and transportation act as stressors for tilapia, as temperature, dissolved oxygen, pH, carbon dioxide, ammonia, and the salt balance of the fish's blood may be changed during this period (Ashley, 2007, Conte, 2004). All of these factors may affect the nutritional quality and safety of tilapia and needs more investigation. The impacts of slow suffocation of tilapia on the nutritional quality and safety need to be investigated. In Figure 33, crates are shown to be thrown on the ground and in mud so even if they have been cleaned earlier there is a potential risk of contamination at the farm level.
- About 15% of transporters clean crates weekly, 15% infrequently and about half do not use disinfectants for cleaning crates/equipment. The observed level of hygiene at the whole sale market and of transporting utensils was not optimum, Figure 34 and 35. Only 9% of retailers use disinfectants for cleaning crates/equipment. The observed level of hygiene in fish shops was not at the optimum, Figure 36 and tilapia was exposed to the environmental conditions and there was no ice, Figure 37. Therefore contamination is likely to happen during transporting and/or storage on retail via unclean equipment and handling practices. Multiplication of microbial pathogens is also likely as there are no effective cold chains for preserving the quality of fish from harvest until reaching the consumers. The lack of hygiene, market regulations and/or application of regulations increases the risk of contamination of fish and of lowering the nutritional quality. At the consumer level, the time from buying to cooking may act as a potential factor for contamination of tilapia and/or multiplication of pathogens given that a considerable proportion of consumers keep tilapia at the room temperature during that period.



Figure 32: Tilapia harvesting (Photo by M. Eltholth)



Figure 33: Sorting and grading of tilapia after harvesting at the farm (Photo by M. Eltholth)

Results from microbiological examination of tilapia sampled from retail sale indicate that there is high contamination of samples with *E. coli*, *Listeria monocytogenes*, *Salmonella*, *Staphylococcus aureus* and *Vibrio parahaemolyticus*. Further studies are required to attribute the sources of contamination and identify critical control points. Processing of tilapia either by grilling or frying may decrease food safety risks for heat sensitive microbial pathogens, but may not have an impact on most chemicals if the fish was contaminated. The impact of

traditional cooking processes of tilapia in the study area on the nutritional quality and safety need to be assessed.



Figure 34: Wholesale fish market in Kafrelsheikh (Photo by M. Eltholth)



Figure 35: Transporting of tilapia (Photo by M. Eltholth)



Figure 36: Fish shop in one of the retail markets (Photo by M. Eltholth)



Figure 37: Fish seller at the village market (Photo by M. Eltholth)

5.4 Food safety and nutritional issues: what are the trade-offs between food safety and nutrition?

Producers, retailers and consumers indicated that quality attributes of tilapia (colour, gill colour, smell, detached scales and firmness) are very important and are taken into account when buying tilapia for consumption. Producers and consumers agreed that these quality attributes are indicators for nutritional quality and safety of tilapia. They also agreed that they

would not usually purchase tilapia displaying poor quality attributes even if there was no other option. Results from the consumer survey indicate that for more than 90% of consumers, cleanness of the source is the single most important criteria for purchasing tilapia. Almost all consumers believed that tilapia safety can be judged by sight and taste, i.e. there was limited awareness of foodborne hazards that do not cause spoilage. More than 80% of consumers in non-tilapia producing areas would buy more tilapia if it was better quality. This illustrates the impact unhygienic transporting and storage conditions and the resulting spoilage may have on consumer demand and intake of a highly nutritious food.

5.5 Food safety and nutritional issues: are there trade-offs, synergies between feed and food?

One of the main constraints pointed out during the producer PRAs for tilapia production is the availability of clean water, as almost all farms in Kafrelsheikh use water from agricultural drainage canals. Producers would like to change the legislation and use clean irrigation water, however this would be competing with the production of other crops unless used fish farm water could be directed back into the irrigation system. Fish feed availability, quality and prices are big constraints for tilapia production. The high price of fish feed and lack of cash sometimes forces producers to use low quality feed which may affect the quality and quantity of production while a small proportion use materials such as wheat flour mill, rice mill wastes, bakery wastes and out of date pasta for feeding tilapia. The growing demand for fish feed could compete with the concentrate feeds for other livestock such as poultry and cattle, as they are made from similar ingredients. Although many of the materials are imported, locally grown materials use the same resources for production, in particular land and water. About 40% of producers said they use poultry manure to fertilize their ponds which may influence the consumption of ASF in people's diets and their nutritional and food safety benefits and risks. An in depth analysis of such relationships remains open to further research; they could for example be investigated using a food systems model. Tilapia producers are looking for alternative and non-conventional feeds and would like the government to help by establishing new fish feed factories and/or giving them loans to buy feed and pay back after harvesting. Low quality water and feed sources potentially affect the quality and quantity of production and increase the risk of hazards in tilapia. The use of agricultural waste water for fish farms is a potential source of pollution with heavy metals and pesticide residues. These pollutants may affect the growth and production of tilapia.

Another production constraint is the high value of the annual rent for land belonging to the government. Producers would like the rent to be lower to decrease production costs. High feed land rental prices increase production costs leading to high retail prices for tilapia and consequently low consumption. As frequently mentioned in the PRAs for producers and consumers, the price of frozen imported fish is lower than that of tilapia which attracts consumers.

Some producers reported the use of waste food such as out of date pasta especially before tilapia harvesting to increase tilapia body weight. The impacts of this practice on growth

performance, body composition of tilapia, quality and potential risks for human health are unknown. In one of the producer PRAs, participants stated that they buy small size tilapia and use it as a substitute for fish meal after grinding. They are assuming that it is cheaper than fish meal however it contains 75% humidity so it is not cheaper. This practice could risk the transmission of fish diseases between farms as there is no heat treatment for this feed. Also it is not economically efficient.

5.6 How is tilapia value chain development (lengthening, complexity, adding value, processing, etc) likely to affect nutrition and food safety? What are trends and possible interventions and how could investments enhance consumption of nutrients and decrease risks?

Most producers usually start producing tilapia in April by stocking fingerlings or newly hatched fry and harvesting in September to December. About 70% of producers have their own hatcheries. High demand for tilapia is usually expected around Easter and Ramadan. The production chain has limited value addition, i.e. tilapia is usually sold fresh and some retailers cook the fish for immediate consumption (e.g. grilling and/or frying). Tilapia is transported as soon as possible after harvesting to the wholesale market then distributed to retailers and consumers. There is a potential post-harvest contamination due to unhygienic handling and the lack of cold chain along production, transporting and marketing. Consumers living in the vicinity of tilapia farms can easily get tilapia at any time however those living at the end of the chain cannot frequently buy fresh tilapia as discussed before.

Other than water quality, land rent and fish feed prices discussed above, producers reported a lack of energy sources such as electricity and fuel for their farms, unpaved roads which make transport very difficult especially during winter. Other production constraints mentioned were inefficient and/or adulterated hormones for mono-sexing and marketing problems for their products, namely the lack of export possibilities and competition from imported tilapia. Production of tilapia in sub-optimal water conditions, lack of best management practices (BMPs) for production conditions, lack of hazard analysis critical control point (HACCP) and International Standards Organization (ISO) approved processing plants, lack of value added capabilities (freezing, breeding, packaging, etc.), and lack of by-product industries were described as constraints for exportation of tilapia (Fitzsimmons 2008).

Potential interventions and investments could be targeted at different points along the production chain. At the farm level, intervention could be via changing the irrigation law in Egypt which would allow the use of clean irrigation water for fish farming and effluent water from the fish farms could be used for irrigation. However for fish farms in Kafrelsheikh this is not possible as they are situated downstream from agricultural activities and it would be very difficult to re-route their water into agricultural zones. Another option would be to improve the water quality; potential ways to do this at reasonable cost should be explored. To overcome feed constraints, producers suggested that the government either establish new feed factories or give them loans to buy feed and pay back after harvesting. Alternative sources of

energy and non-conventional feed sources should be investigated. Lack of knowledge and training is another production constraint which was brought up during the PRAs and survey for producers. Efforts are ongoing to address these constraints: WorldFish is implementing a fish farming development project which includes best management practice training for fish farmers in five governorates, including Kafrelsheikh. While efforts to develop cold and disease resistant tilapia have been slow to yield results, a faster growing strain of tilapia now being released to Egyptian fish farmers by WorldFish should result in shorter growing periods and give farmers more flexibility in production (Personal communication Malcom Dickson).

There should be an intervention for reducing risks of post-harvesting contamination with food-borne pathogens by providing cold chains and BMP training for transporters and retailers along the chain. Almost all producers, transporters and retailers stated that there is no inspection of their business. Therefore, potential options to explore to improve quality and safety of tilapia would be implementation and enforcement of minimal standards (public or industry standards), implementation of HACCP system for production and marketing of fish, and/or establishment of quality labeling systems.

Consumers are aware of the signs of good quality fish, but many believe that wild tilapia is better than farmed. Producers blame the media who they say often report that farmed fish is contaminated with hormones and other hazards. A potential intervention here is educational campaigns targeted at consumers regarding safety of farmed tilapia compared to wild tilapia.

5.7 Social and gender determinants: Who gets the nutritional benefits and bears the health risks of ASF? How do gender and poverty influence health and nutrition risks? How do cultural practices affect health and nutrition risks (consumption of raw food, withholding food during illness)?

Tilapia, other fish species and other ASF are frequently consumed by people in the study area and given to children. Results from the consumer survey, FGDs with mothers and PRAs with consumers indicate that children start eating milk and dairy products from 4 to 6 months of age. Mothers believe that feeding children these ASFs will give them a balanced diet, rapid growth, a good source of minerals such as calcium and a good source of energy. At the age of 12 months they start consuming other ASFs such as meat, poultry and fish. It seems that there is no gender discrimination but the amount of ASFs may be different with age; as an example an adult person may eat 1 or 2 tilapia per meal but a child under 5 may eat only a half.

Mothers reported that in a few cases children may not consume some ASFs due to allergic reaction such as skin rashes, or due to vomiting and/or diarrhoea upon milk consumption. Some mothers complain that their children refuse to eat fish due to a history of choking on fish bones.

There are no restrictions for any of the ASFs in all study areas apart from pork and its products as almost all HHs are Muslims. About 90% of HHs in rural areas keep cattle and

poultry and almost all production is for home consumption. The main limiting factor for the consumption of milk, dairy products, poultry and eggs is the productivity of HH cattle and poultry as most HHs depend on their own production. Another limiting factor for these ASF products is the prices.

5.8 Feedback on tools from enumerators

For the producers' survey, approaching fish farms was very difficult as there is no accurate database for fish farms and in most cases the address was the owner's home address and not the farm. It was more difficult during rainy days especially with muddy roads. In many cases, fish farm owners were reluctant to disclose information about their production as the land size and the amount of fish production per cycle unless they were guaranteed that the enumerator will not disclose this information to the authorities and it is for research purpose only. Producers were also curious about the benefits from this research and the feedback and they kept asking for the results of the analysis from the biological samples. Although enumerators reported that the PRAs were long and boring, producers attending the PRAs were happy as they found it quite useful for discussing their production constraints and to listen to potential suggestions for overcoming these constraints from experts at the end of the meeting.

Transporters and retailers were afraid to give information about their business as they said income tax is increasing annually. They were also asking about the benefits to them from this type of research. Apart from that, enumerators reported that the tools were fine, worked well and the response rate was almost 100%.

For the consumers' survey, enumerators reported that the household questionnaire was too long and frustrating with many repeated questions for the food consumption. However participants in the PRAs and FGDs for mothers with young children enjoyed the meetings and their feedback was very positive. The PRAs and FGDs were organised so that by the end of the meetings, there was a lecture and an open discussion about general aspects of food hygiene and the safety of animal source foods.

5.9 Conclusions and recommendations for risk management

Tilapia is perceived as a highly nutritious ASF frequently consumed by a high proportion of the HH members in the study area at least once a week. Also a high proportion of respondents stated that they would consume more tilapia in the future. The main constraints to production are water quality and availability, fish feed prices and quality, availability of land and the rent, fuel and energy sources. Future studies for potential improvement of water quality, alternative non-conventional fish feed and other energy sources would increase production of tilapia and decrease production costs. The productivity of fish farms could be improved by improving feed quality, water quality, the use of new technologies and training fish farm workers in best management practices. Genetic studies for selecting cold and disease resistant tilapia strains are also recommended.

One of the main determinants of quality and safety of tilapia is post-harvest handling and potential contamination. Further studies are required to assess the impact of traditional fishing methods and slow suffocation of tilapia on the nutritional quality and safety. Potential investment by providing cold chains, supervising fish markets and implementing HACCP would improve the safety and quality of tilapia and reduce human health hazards.

Tilapia processing and value addition should be investigated as well in terms of profitability, nutrition and food safety of the final products. Also consumers' perceptions for purchasing processed and/or semi-processed tilapia should be assessed.

The impacts of traditional processing and cooking methods of tilapia on the nutritional value, biological and chemical hazards should be assessed.

One of the important and urgent requirements is the development of a sound and reliable database for fish farms in Egypt. Until now there is no database for fish farms and the production data for aquaculture in Egypt are estimated figures from the markets. Such a database would contribute to the development of a more regulated system and facilitate the implementation of mitigation measures.

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6 Appendices

6.1 Appendix 1: Rapid integrated assessment protocol for Egypt



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2003 Document

6.2 Appendix 2: Laboratory analysis protocol



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6.3 Appendix 3: Participatory rural assessment and focus group discussion reports



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