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Effect of Pond Management on Prevalence of Intestinal Parasites in Nile Tilapia (*Oreochromis niloticus*) under Small Scale Fish Farming Systems in Morogoro, Tanzania

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Abstract

A cross-sectional study was conducted in small scale fish farming systems in Morogoro urban and rural area between December 2007 and February 2008 to determine the effect of pond management on prevalence of intestinal parasites in Nile Tilapia (*Oreochromis niloticus*). Water physicochemical parameters in fish ponds and the risk factors for intestinal parasites were determined. Information on pond type and cleanness, feeding and general pond management was also gathered through questionnaires and participant observations during the sample collection. One fifty three adult *O. niloticus* from 13 ponds were examined.

It was found that most ponds (69%) were small and of earthen type, 77% were clean and were using river water. Up to 92% of farmers changed pond water regularly and almost all farmers reported to use maize bran as the main feed for fish. Farmers used different types of animal manure to fertilize the ponds. The observed water physicochemical levels were within the normal range for fish water ponds as recommended by FAO. The prevalence of intestinal parasites was 16.3%. Specifically, 15% of fish had *Eimeria* oocysts while 1.3% had unidentified flukes. Prevalence of parasites was significantly higher ($P < 0.05$) in ponds located in rural (18.7%) than in urban areas (6.7%). Significantly ($P<0.05$) higher prevalence of parasites was observed in fish ponds using river water (18.8%) than in ponds using rain water (0%). Pond type was also a risk factor as there was a significantly ($P < 0.05$) higher parasite infection rates in earthen ponds (20.9%) than in fish reared in concrete ponds (4.7%). It is concluded that earthen fishponds, keeping fish in rural areas and using river water in ponds predisposes fish to intestinal parasites. Good water quality management and proper fish husbandry techniques will eliminate most parasitic infection and improve fish production.

Key words: Aquaculture, helminths, infection, rural areas, urban areas, water quality

Introduction

Aquaculture in Tanzania has a vast but yet untapped potential. Freshwater fish farming, in which small-scale farms practice both extensive and semi intensive fish farming dominate the industry (Lamtane 2008). In many parts of Tanzania, small fishponds with an average size of 150 m^2 are integrated with other agricultural activities such as gardening and animal production on small pieces of land. In 2005, Tanzania was estimated to have 14,100 freshwater fish ponds scattered across the mainland (FAO 2005). The distribution of fishponds in the country is determined by several factors such as, availability of water, suitable land for fish farming, awareness and motivation within the community on the economic potential in fish farming (FAO 2005).

Nile Tilapia, a member of the *Cichlids* family is one of the largest freshwater Tilapia found in most tropical waters (Thistleton 1986; Lamtane 2008). This is the most common artificially raised species of fish in Tanzania, because it can be easily managed by farmers, has indiscriminate appetite, highly prolific and is tolerant even to poor water quality (de Graaf 2004; FAO 2005).

Pond fish farming is faced by several constraints, among which are fish diseases (Hecht and Endemann 1998; Roberts 2001). Where studies have been conducted, helminths are reported as among the predominant group of parasites that significantly affect fish in most of the fishponds in Africa (Paperna 1996; Hecht and Endemann 1998). Helminths of importance to fish are in groups of cestodes, trematodes and nematodes (Paperna 1996). In addition, other parasites in particular protozoan such as coccidia are also common (Hecht and Endemann 1998). Fish parasites are of economic importance because they affect their productivity through mortalities, decreased growth rate, reduced efficiency in feed conversion ratio and lower the quality of the fish meat (Aiello and Mays 1998; Hecht and Endemann 1998). Among the predisposing factors of fish to parasitic infestations under aquaculture rearing systems includes age, poor nutrition, high stocking densities, poor water quality and poor culture facility.

Increasingly, fish farmers in Morogoro, Tanzania have been experiencing sub-optimal production performance in aquaculture. Although it is well known that intestinal parasites can cause significant production losses in aquaculture, and that it could be one of the reasons for production losses, there are no parasite studies that have been conducted in Tanzania. Since, management practices are highly diverse for the fish farmers in Morogoro, it is likely that parasite infections might differ between farms as a result of differences in pond management practices. The objective of the present study was to assess the effects of pond management practices on the prevalence of intestinal parasites in Nile Tilapia reared under the small scale fish farming system in Morogoro, Tanzania.

Materials and methods

Study areas and sample collection

The study was conducted in Morogoro municipality and some selected areas in Mvomero district namely Mgeta and Turiani wards. The samples were collected from the purposively selected households with fish ponds and willingness of farmers to participate in the study. Participants' observation and structured questionnaires were administered to fish farmers in order to gather information on source of fries, fish feeding and feed type; use of manure and its type; pond type, water source, frequency of changing water and history of diseases and mortalities of fish. Stocking density, pond hygiene, disease history and medication were also recoded during the sample collection**.** Before the fish samples were collected; pond size and physicochemical water quality were assessed. Tape measure was used to measure the size of ponds. Water test kits (Tetra Gmbh, Germany) were used to measure parameters like carbon-dioxide, nitrate, hardness, alkalinity and ammonia. All the procedures for physicochemical water quality parameters analysis was done according to the manufacturer's instructions. Water pH was measured using a probe (Eco pond supply, USA) while water temperature was measured by using thermometer. For conveniences, fish ponds were arbitrary classified as small (25.3 to 300 m^2) and large (> 300 m^2). General examination of the fish ponds was further made to assess for cleanness, vegetations and any other factor which could accelerate diseases and parasitic infection in fish.

Fishing was done with 2 x 12 m seine nets of 6.5 mm mesh size and each fish was clinically examined for any abnormality. Thereafter, the fish were sacrificed by decapitation and pithing. The fish samples were put in a cool box with ice pack at 4°C and subsequently transported to the laboratory for analysis. Parasitological analysis was carried out within three to four hours from sampling time.

Laboratory sample processing and parasite identification

In the laboratory, the weight, total length, standard length, circumference and displacement volume of each fish was measured and recorded. Every fish was laid on a dissection plate on its right side with the abdomen directed towards the dissector. By using a pair of scissors, the body cavity was opened into two slits. The first cut run from the rectal opening up to the branchial cavity, the second cut through an arch from the anus up to the spine and further to the upper side of the branchial cavity. Organs and tissues were first examined in situ for any gross pathological abnormalities. The entire length of the gastrointestinal tract (GIT) was removed and placed in a black coloured tray, straightened and opened to empty the contents. About 100 ml of distilled water was added, gently shaken to wash out the intestines and examined for parasites using laboratory lamp aided with a magnifying lens. Any parasite observed was picked with a plastic forceps and placed in universal bottles with 15 mL of 70% alcohol and stored for identification.

The remained contents were washed several times by filtering through a stainless steel sieve (W.S. Tyler Incorp. Mentor, Ohio) with 212 µm pore size. After filtration, the mixture was transferred to a Petri dish for further examination of parasites under sterio microscope. Thereafter, the filtrates were centrifuged by using an ordinary centrifuge machine at relative centrifugation force of 425.6G for five minutes. The supernatant were discarded. One drop of the sediments was placed on a microscope glass slide with two drops of normal saline, smeared and glass cover slip was put on top. The content was examined for worm eggs, coccidian oocysts and adult parasites under light microscopy at times 10 and 40 magnifications. In addition, the intestinal mucosa was scooped with a glass slide at different locations and wet smears were prepared for parasite examination. Standard fish parasite identification keys were used during examination of the collected parasites (Soulsby 1982; Paperna 1996).

Each parasite in the 70% alcohol was mounted on a microscope glass slide where a drop of lactophenol was added and a cover slip was placed. The specimen was observed under stereo microscope (20x magnification) with a side lamp.

Results

A total of 13 freshwater fish ponds were surveyed and 153 fish samples were collected and analyzed for parasitic infection. Of these ponds; three were from urban (Morogoro municipality) and 10 ponds from rural areas (Mkindo and Mgeta). Results on pond type, size, location and management of fish pond are shown in Table 1. Most of the ponds were earthern type, small in size which used river water. Maize bran was the common fish feed and the ponds were mostly fertilized by cattle and poultry manure. One farmer reported the occurrence of gas bubble disease which caused massive mortality of fish in the pond.

Table 1. Type, size, location and management of fish pod

Factor	Category	Number (n)	Percentage (%)
Pond type	Concrete tank	4	30.8
	Earthern	9	69.2
Pond size	Large (> 300 m^2)	4	30.8
	Small (25.3 - 300 m^2)	9	69.2
Pond location	Urban	3	23.1
	Rural	10	76.9
Water source	Surface water	3	23.1
	River water	10	76.9
Pond cleanness	Clean	10	76.9
	Dirty	3	23.1
Frequency of changing pond water	No change	1	7.7
	3 weeks -6 months	8	61.5
	7 months-1.5 year	4	30.8
Disease occurrence	Yes	1	7.6
	No	12	92.4
Fish feed	Maize bran	5	38.5
	Maize bran and fishmeal	2	15.4
	Maize bran, reen leaves and table remains	6	46.1
Type of manure	Cattle	6	46.2
	Poultry	6	46.2
	Goat	3	15.4
	Pig	4	30.8

Most of the physicochemical water parameters recorded during the study (Table 2) were within the recommended standard range for the freshwater fish ponds.

Table 2. Means and standard deviation of physicochemical water parameters

Water quality parameter	Mean	Standard deviation
Temperature (°C)	26	3.1
pH	6.8	0.8
Nitrate (ppm)	0.2	0
Ammonia (ppm)	1.0	0
Carbon dioxide (ppm)	10.4	4.5
Alkalinity (ppm)	78.7	34.1
Hardness (ppm)	76.6	24.1

Legend: ppm = parts per million

Fish measurements showed that standard length ranged from 8 cm to 23 cm (mean 11.6±2.6 cm) while the weight ranged from 12 g to 378 g (mean = 57.3±46.4 g). The fish circumference ranged from 7 cm to 1110 cm (mean circumference = 18±88.9 cm).

Results on fish intestinal parasites showed that of the 153 fish examined, 25 (16.3%) were infected. Coccidian oocysts mostly *Eimeria* sp. were detected in 23 (15%) fish while unidentified white worms fluke like were found in 2 (1.3%) fish samples. The risk ratios for parasite infestations are shown in Table 3. A significantly ($P < 0.05$) higher frequency of parasites was found in fish from rural areas (18.7%) than fish from urban areas (6.7%). Significantly ($P<0.05$) there was also higher frequency of parasitic infestations observed in fish ponds using surface water (18.8%) than in ponds using rain water (0%). Furthermore, the results show that there was higher parasitic infection in fish from earthern ponds (20.9%). It was further found that a large number of different phytoplankton species were identified in the fish intestines. The phytoplankton included green algae, golden algae, blue green algae (cyanobacteria) and diatoms.

Table 3. Association of risk factor and parasite status in fish

Risk factor	Category	Number of fish (n)	Number infected (%)	Statistical significance
Pond size	Large	47	9 (19.1)	P = 0.39
	Small	106	16 (15.1)	
Fish source	Urban	30	2 (6.7)	P = 0.004*
	Rural	123	23 (18.7)	
Water source	Surface	133	25 (18.8)	P = 0.03*
	Rain	20	0 (0)	
Pond type	Earthen	110	23 (20.9)	P = 0.014*
	Concrete	43	2 (4.7)	

*Legend: P = Levels of statistical significance, % = Percentage, * = significantly different P < 0.05*

Discussion

Findings from this study demonstrate that a relatively higher percent (16.3%) of fish reared under small scale fish pond farms in Morogoro were infected with intestinal parasites. In particular, earthen ponds which used river water in rural areas had the highest infection rate. Several scholars reported a number of intestinal parasites including coccidian and helminths in fish under artificial rearing system (Paperna 1996; Hecht and Endemann 1998; Kirjuśina and Vismanis 2007). A higher number of fish was found to be affected by *Eimeria* coccidia. Biologically, these parasites develop intracytoplasmically in epithelial mucosa cells of the intestines where they cause a serious damage especially in the fries which may lead to stunted growth and sometimes mortality (Landsberg and Paperna 1987). Since coccidiosis in fish usually manifests itself as a chronic infection, mortality is gradual and is overlooked in most farms. However, the results of the current study recorded *Eimeria* coccidia infection in adult fish which had not caused severe lesions in the intestines and there was no history of fish mortality in the study ponds. This may be explained by the fact that Tilapia sp. are resistant fish and they do not frequently succumb to disease endemics and have a remarkable power of recovery from infections (Kirjuśina and Vismanis 2007). Therefore this could account for the low infection rates recorded during this study with regardless of poor management to some of the ponds.

The general status of fish parasite infection was significantly higher in samples taken from rural areas as compared to those from urban areas. Poor fish environment, poor pond management, malnutrition and other stress factors have been reported to accelerate coccidia and other parasitic infection which may lead to clinical disease (Paperna 1996). Most of these factors were observed in fish ponds surveyed in rural areas during the current study. This could be the reason for a higher parasitic infection in particular *Eimeria* coccidia in fish from rural areas which were raised on earthen ponds with relatively poor management. Poor sources of fingerings and lack of extension services on fish farming may have direct impacts to fish health. Additionally, fish farming in rural areas is always integrated with poultry production and this might have contributed to the parasitic infection which some species may cross infect between fish and domestic poultry (Maar et al 1974; Aiello and Mays 1998).

The study has further shown that there was high rate of infection in fish from earthen fish ponds compared to reared in concrete ponds. This might have occurred due to the fact that earthen ponds were excessively silted that might had provided favourable environment for benthic microinvertebrates in the inshore area of water (littoral and profundal zones) to develop and become the sources of parasites for the fish (Paperna 1996; Kirjuśina and Vismanis 2007).

In addition, the results show that most of the ponds were small in size (ranging from 25.3 to 300 m^2 in size). This is because aquaculture seems to be informal to many farmers in Tanzania and people practice subsistence fish farming as source of supplementary household income and for home consumption. We observed that the fish were mostly fed on maize bran and sometimes greens and table remains which may have poor nutritional contents. Most of the fish examined were small in size which probably were stunted due to poor nutrition.

It was further observed that most of the ponds were fertilized by using cattle and poultry manure. Manure and fertilizers are used in fish ponds to encourage the growth of phytoplankton which make up fish food. In addition, phytoplankton growth enhances availability of dissolved oxygen. However excessive nutrient loading can result to overpopulation of phytoplankton, especially cyanobacteria and green algae which may lead to excessive production of oxygen which may cause gas bubble disease (Roberts 2001). This disease was once reported in one of the ponds surveyed in this study. However, overgrowth of cyanobacteria in fish ponds may also be detrimental to fish. Besides forming colonies that may be unpalatable to fish, cyanobacteria are capable of producing cyanobacterial toxins (cyanotoxins) which are toxic to fish (Malbrouck and Kestemont 2006). Cyanobacteria species like *Microcystis, Anabaena, Oscillatoria* and *Nostoc* are potential producers of heptapeptides-microcystin which affects liver of fish leading to mortality (Semyalo et al 2010). Fish intestinal contents examined during the current study were found to have a large number of different phytoplankton species including cyanobacteria. Therefore, this may present a risk of poisoning to fish.
The study further found that water used in fish ponds was sourced from rivers, municipal water, ground water, rain water and water from dams and lakes. However; the study shows that river water was used by most of the farmers. This might be due to the fact that Morogoro has many rivers and most of the ponds are located nearby rivers, so it was easier for the farmers to trap water from the rivers. However, river water may be sources of infections to fish ponds as water run off from faecal contaminated upland areas accumulates in rivers and in turn drains to ponds.

From the observations of this study, it is concluded that earthen fishponds, keeping fish in rural environment and using surface water for ponds predisposes fish to intestinal parasitic infections. Most fish health problems occur because of environmental problems: poor water quality, crowding, dietary deficiencies, or "stress". The best cure for any fish health problem is prevention. Good water quality management and proper fish husbandry techniques will eliminate most parasites described here. However, since concrete may be expensive over earthern ponds, farmers may be encouraged to regularly apply antiparasitic agents as control measures. The fact that Tanzania is a big country more studies are required to verify the magnitude of the parasites problem in fish under aquaculture farming.

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Go to top