Field study on Cadmium pollution in water and Crustacean gill parasites in freshwater cultured *Tilapia zilli* fish

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Abstract: The aim of this study is to explain the relationship between Cadmium pollution in water and Crustacean gill parasites in freshwater cultured *Tilapia zilli* fish. A total of 375 adults cultured *Tilapia zilli* were studied the effect of water cadmium pollution on clinical examination and the prevalent seasonal crustacean gill parasitic infestations in the period 2009-2010. This investigation revealed the appearance of the parasites during spring, summer and autumn and their disappearance during winter. Clinical signs were pale skin, blood spots with cognation of gills, as well as post mortem lesions and isolation of infested parasites. *Ergasilus sp* and *Lamproglena sp* were decreased in gills with high concentration of cadmium. The present study was concluded that, there were inversely proportion relationship between cadmium concentration pollution in aquaculture and the prevalence of gill crustacean infestation during spring, summer and autumn seasons while infestation was disappeared during winter season. Also, there was a relationship between cadmium residues in *Tilapia zilli* gills and its concentration in the water, the obtained results showed that the cadmium concentration in the gills were higher than that in the water.

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1. Introduction

Over the last few decades; aquatic pollution is still a problem in many freshwater and marine environments as it causes negative effects for the health of the respective organisms (Farombi et al. 2007). Heavy metals are natural trace components of the aquatic environment, but their levels have increased due to domestic, industrial mining and agricultural activities (Kalay and Canli 2000). Aquatic organisms such as fish accumulate metals to concentrations many times higher than present in water (Olaifa et al. 2004 and Noor El Deen et al.2010). Permissible limits of cadmium are 0.05 ppm Egypt E.O.S.Q.C. (1993), but in environments impacted by man, concentrations can be several micrograms per liter or greater (Annune et al. 1994). They can take up metals concentrated at different levels in their different body organs. Target organs such as gills, have a tendency to accumulate heavy metals in high values by (Khaled 2004 and Yilmaz 2005). Cadmium may have toxic effects, altering physiological activities in gills and fish blood (Mona Zaki et al. 2010). The relationship of parasitism and pollution is not simple and in essence involves a double edged phenomenon in which parasitism may increase host susceptibility to toxic pollutants or pollutants may result in an increase or decrease in the prevalence of certain parasites. Pollutants may affect an intermediate or alternate hosts in parasite life cycle and on free-living life cycle stages of parasite invasion (Sindermann 1990). Pollution stress can influence the prevalence of parasites directly or indirectly,or the parasite infestation may decrease the host resistance to toxic pollutants (Khan and Thulin 1991) . *Ergasilus* sp which exposure to pollution considerably reduced in zone of pollution (Kuperman 1992). The prevalence of crustacean parasite infesting *Oreochromis niloticus* in Lower Egypt (Kafre El–Shiehk Governorate (1998-1999) fish farms were 30 % and the highest the prevalence was obtained during summer (56.6%.) and 44.8% in spring, while was 20.5 % in autumn and 0% in winter in (Noor El Deen 2000). The less polluted water can allow for or cause parasite proliferation,whilst higher level of contamination can have a negative effect on the survival of *Lamproglina clariae* (Avenant-Oldewage (2003). There is more awareness of the importance of studying fish parasites as one of the major obstacles in fish production. About 80% of fish diseases are parasitic especially for warm water fish (Eissa et al. 2000). This study was undertaken to investigate the correlation between cadmium concentration in water and the prevailing crustacean gill parasites in cultured *Tilapia zilli* which were collected from Kafr El sheikh governorate fish farms.Clinical picture, correlation between crustacean parasitic infestation and concentration of cadmium in

water and tissues of cultured *Tilapia zilli* are also considered.

2. Materials and methods

Fish:

A total number of 375 cultured adult *Tilapia zilli* fish were collected with average length of 15-20 cm and of body weight ranged from 85-100 gm and subjected to clinical examination for detection of the prevalent parasitic infestations during the different seasons over a period of a year (2009 - 2010).

Water samples

A total number of 27 water samples simultaneously with fish specimens and equally distributed through out the different seasons, were collected from the different fish ponds from Kafr El sheikh governorate (Lower Egypt).

Clinical Examination

Alive fish were clinically examined for general behaviors, changes in colour, respiratory manifestation, feeding and any clinical abnormalities of the gills according to the methods described by Noga (1996).

Parasitological examination

Crustaceans were refrigerated then fixed in 70% alcohol glycerin, passed through ascending grades of alcohol (70, 90,95% and absolute) then cleared in xylol, mounted in Canada balsam or by clearing in lacto phenol and mounted in glycerin gelatin according to (Lucky 1977) and identified according to Paperna (1996).

Estimation of cadmium in Tilapia zilli gills

Each 0.5gm of different gill fish samples were well digested using Conc, H2sO4 according to the method outlined by Cottenie (1980).

Statistical analysis

The results of prevalance performances were statistically analyzed using analysis of variance procedure in SAS (Duncan 1955).

3. Results

Clinical picture

The first sign observed in *Tilapia zilli* exposed to cadmium pollution was swam rapidly in circles manner of the affected fish in which the fishes aggregate in groups around the water inlet. Most of these fishes showed dark discolourtion of the skin, emaciation, loss of appetite and eventually loss of escape reflex. The gills appeared pale in colour with numerous noduler like as white to yellowish colouration and appear as V or inverted V-shaped of the egg sacs on the attached gills in some examined fish during post mortem examination.

Parasitological examination

The microscopical examination the white nodule appear as V or inverted V-shaped of the egg sacs on the attached gills revealed as ergasillid female copepods (Figure1). Also, other parasites appears as cylindrical consists of three distinctive parts, cephalothorax that is oval and externally unsegmented are present revealed as Lamproglid female attached firmly to gill filament by the aid of two powerful claws alone (Figure2). While in few tilapia fish both infestations (Figure3).

Cadmium residues in water fish farms and Tilapia zilli gill tissues

As shown in Table 1 , the mean concentration of cadmium in water of *Tilapia zilli* farms were 0.02± 0.009, 0.02± 0.002 and 0.02± 0.009 ppm in location 1, 2 and 3 respectively during winter season and the mean concentration of cadmium in water of tilapia farms were 0.05± 0.003, 0.03± 0.001 and 0.02± 0.003 ppm in location 1, 2 and 3 respectively in autumn season while the mean concentration of cadmium in water of *Tilapia zilli* farms were 0.07± 0.005, 0.04± 0.003 and 0.03± 0.007 ppm in location 1, 2 and 3 respectively in spring season and the mean concentration of cadmium in water of *Tilapia zilli* farms were 0.04 ± 0.009,0.03± 0.002 and 0.04± 0.009 ppm in location 1, 2 and 3 respectively in summer season.

Table 2, showed that the mean concentrations of cadmium in gills of *Tilapia zilli* were 0.19±0.002, 0.72±0.002 and 0.99±0.004 in location 1, 2 and 3 respectively in spring season and the mean concentration of cadmium in gills were 0.12±0.002,0.63±0.002 and 0.85±0.004 ppm in location 1, 2 and 3 respectively in summer season. While the mean concentration of cadmium in gills of *Tilapia zilli* were 0.11±0.004, 0.53±0.004 and 0.65±0.004 ppm in location 1, 2 and 3 respectively in autumn season and the mean concentration of cadmium in gills were 0.08±0.003, 0.35±0.004 and 0.45±0.002 ppm in location 1, 2 and 3 respectively in winter season. Cadmium residues were significantly increased in gills of *Tilapia zilli* than water fish farms. Also, the crustacean gill infestation increased parallel to increase cadmium pollution in examined water and gills of *Tilapia zilli* was observed. On opposite no infestation in winter season was observed.

Table 1: Cadmium concentration in water of *Tilapia zilli* farms (three localities) in summer, spring and autumn seasons was done.

Metal	Areas	In summer water samples (mg/L)			In spring water samples (mg/L)			In autumn water samples (mg/L)			In winter water samples (mg/L)		
		Min.	Max.	Mean ± SE	Min.	Max.	Mean ± SE	Min.	Max.	Mean ± SE	Min.	Max.	Mean ± SE
Cadmium	1	0.001	0.082	0.05± 0.03	0.003	0.058	0.07 ± 0.005	0.001	0.082	0.04± 0.009	0.001	0.042	0.02± 0.009
	2	0.001	0.062	0.03±0.01	0.002	0.042	0.04 ± 0.003	0.001	0.062	0.03± 0.002	0.002	0.037	0.02± 0.002
	3	0.001	0.042	0.02± 0.003	0.001	0.072	0.03± 0.007	0.001	0.082	0.04± 0.009	0.001	0.082	0.02± 0.009
Total average		0.0013	0.07	0.03±0.01	0.002	0.052	0.03 ±0.51	0.001	0.072	0.07 ±0.51	0.001	0.072	0.02± 0.007

Means within the same column of different letters are significantly different at ($P < 0.05$).

Table 2: Residue of Cadmium and the prevalence of crustacean gill *Tilapia zilli* fishes parasites at different seasons.

Season and samples location	Autumn, 125 *Tilapia zilli* fish				Summer,125 *Tilapia zilli* fish				Spring,125 *Tilapia zilli* fish				Winter,125 *Tilapia zilli* fish			
	Cd in gills (mg/kg dry wt.)	No of parasites			Cd in gills(mg/kg	No of parasites			Cd in gills	No of parasites			Cd in gills(mg/kg	No		
		E	L	E&L		E	L	E&L		E	L	E&L		E	L	E&L
1	0.11±0.004	27	13	3	0.12±0.004	18	9	3	0.19±0.002	12	6	2	0.08±0.003	0	0	0
2	0.53±0.004	25	10	3	0.63±0.007	17	7	2	0.72±0.002	8	4	0	0.35±0.004	0	0	0
3	0.65±0.004	23	7	3	0.85±0.003	10	5	1	0.99±0.004	4	2	1	0.45±0.002	0	0	0
Total	0.43±0.004	25	10	3	0.53±0.0038	15	7	2	0.63±0.006	8	3	1	0.33±0.004	0	0	0
%		20	9.5	2.4		12	5.3	1.7		6	2.5	1.3		0	0	0

Cd: Cadmium E: *Ergasilus* L: *Lamproglena* $Chi^2 = 17.53$ * = Significant at ($P < 0.05$). (The number of infested fish differ significantly among localities

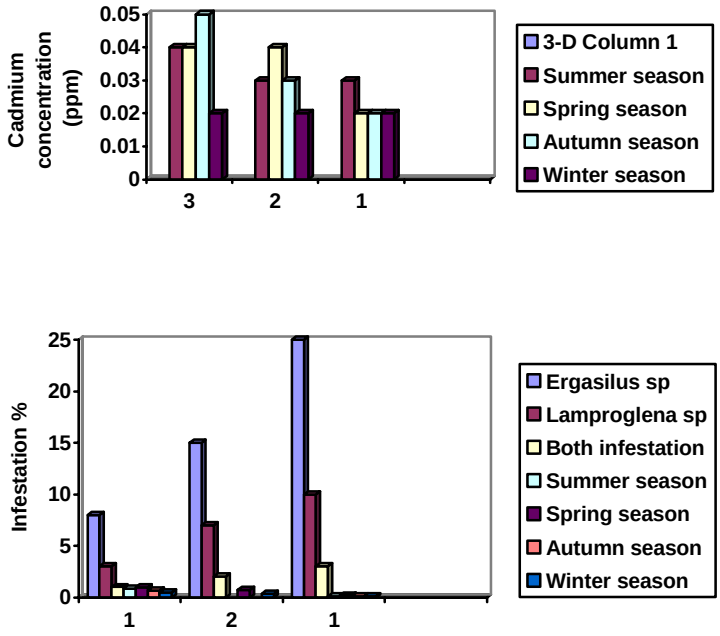

Figure 1: Showing *Tilapia zilli* was suffering from cognation and white dot (*Ergasilus* sp.) on gills.

Figure 2: Showing *Tilapia zilli* was suffering from paleness and white dot (*Lamproglena* sp.) on gills.

Figure 3: Showing *Tilapia zilli* with mixed infestation with *Ergasilus* and *Lambroglena* sp. on gills.

4. Discussion

The fish farms in Egypt are probably polluted by Cd pollutant mainly through drainage system of irrigation water which is designed to flow directly to the fish farms and from by products of industry (Eissa et al. 2011). The relationship of parasitism and pollution was not simple and the parasitization might result in an increase or decrease in the prevalence of Ergasilus and Lamproglina sp among Tilapia zilli . Regarding to clinical signs of infested Tilapia zilli and exposed to natural Cd showed that respiratory distress and slimy pale skin. These may be attributed to prolonged exposed to Cd who affect on osmoregulation. These results were in agreement with (Allen,1994).

Concerning, the postmortem of examined Tilapia zilli and infested with Ergasilus sp and Lamproglena sp, there were increase of mucus producing cells in the gills and presence of white dots. These results may be attributed to harmful effect of parasites. These results agree with those recorded by Rani and Ramamurthi 1987 and Eissa 2004 who found that the postmortem examination of gills of tilapia sp revealed pale gill appearance with white dots.

Dealing with parasitological examination of Tilapia zilli naturally exposed to Cd, infested with Ergasilus sp revealed that the Ergasilus appear as V or inverted V-shaped of the egg sacs on the attached gills. The results were coincided with those recorded by Eissa et al 2010. Also, Lamproglina sp parasite was appeared as cylindrical consists of three distinctive parts, cephalothorax that is oval and externally unsegmented are present revealed as Lamproglid female attached firmly to gill filament by the aid of two powerful claws alone . The results were coincided with those recorded by Eissa 2004.The results obtained from Tilapia zilli natural exposed to Cd in water of tilapia farms ,it was slightly increased gradually from winter season (0.02± 0.007 ppm) and (0.03± 0.001ppm) in autumn season to (0.03± 0.005ppm) in summer season and (0.04± 0.005ppm) in spring season and the prevalence of infestation was decreased gradually from autumn season (20, 9.5 and 2.4 % of Ergasilus sp., Lamproglena sp. and mixed infestation respectively) and (12, 5.3 and 1.7 % of Ergasilus sp., Lamproglena sp. and mixed infestation respectively) in summer season to (6, 2.5 and 1.3 % of Ergasilus sp., Lamproglena sp. and mixed infestation respectively) in spring season. While, the parasitic infestations in winter

season were absence result to sharp decrease of temperature which effect on crustacean parasites life cycle. These results revealed that were correlation between the prevalence of crustacean gill infestation and cadmium pollution was inversely. These results revealed that there were inversely proportion between cadmium concentration and prevalence of infestation where the number of *Ergasilus* sp. and *Lamproglena* sp decreased with increased cadmium concentration. The increase cadmium pollution and decrease of infestation in spring and summer season may be attributed to industrial and agriculture activity. These results were agreement with that reported with (Rehab 2004) who revealed that inversely proportion between cadmium concentration and parasitic infestation. These results in agreement with that recorded by (Kuperman, 1992) who found that the number of highly sensitive ectoparasites of *Abramis brama*, *Ergasilus* sp (Crustaceans) reduced in Rybbinsk reservoir (Volga basin) polluted with heavy metals.

Regarding the results of cadmium concentration in gills of examined *Tilapia zilli* was decreased gradually from winter season (0.33±0.0004 ppm) and autumn season (0.43±0.004 ppm) to (0.53±0.003ppm) in spring season and (0.63±0.006 ppm) in summer season. These concentrations were increased in spring and summer than autumn and winter season may be attributed to direct contact of examined fish to polluted water. The recorded results of cadmium concentrations in fish were higher than the permissible limits intended by FAO/WHO (1992) (0.05 ppm) and Egyptian Organization for Standardization and Quality Control "E.O.S.Q.C" (1993) (0.1 mg /1). These results was nearly agreement with those reported by Celik and Oehlenschlager (2007) who recorded Cd concentration with levels varied from 0.1 to 0.8 ppm. The high levels of Cd in gills may be attributed to direct contact to polluted water fish farms. The result was revealed that inverted correlation between cadmium concentration and prevalence of crustacean gill parasites in different seasons and the infestation decrease gradually with increase of cadmium concentration, these results attributed to the harmful effect of cadmium on crustacean gill parasites. These results revealed that inversely proportion between cadmium concentration and crustacean gill parasites. From the point of view, one could attribute the result of effect of cadmium on crustacean gill parasites. These results in agreement that reported with (Sinderman 1990) who recoded that the relation of parasitism and pollution was not simple and the parasitisation might result in an increase or decrease in the prevalence of certain parasites and the effects of pollution on parasites may be positive or negative i.e. pollution may increase parasitism and on the other hand it may be fatal for certain parasite species leading to a decrease in parasitism. The effects of simultaneously occurring parasites and pollutants can be additive, synergistic or antagonistic and that they can not be predicted easily. These results obtained from crustaceans gill parasites of *Ergasilus sp* and *Lamproglena sp* infested *Tilapia zilli* were decreased gradually with cadmium concentration above the permissible limit in water and exposure time. These were attributed to the parasites with direct life cycles are normally ectoparasites. These results were agreement with that recorded by Khan and Thulin (1991) who recorded that ectoparasites directly exposed to water may be more sensitive to contamination, thereby reducing there survival and reproductive rates. Also,(Kuperman,1991) who reported that the abundance of crustacean parasites changes under different environmental conditions and decrease considerably in polluted areas. Avenant-oldewage(2003) who suggested the less polluted water can allow for or cause parasite proliferation , whilst higher level of contamination can have negative effect on the survival of *Lamproglena clariae*.

The results of seasonal prevalence of cultured investigated fish revealed that the highest percentage of infestation was in summer followed by spring and the lowest in autumn while no infestation in winter due to these crustacean parasites disappear at low temperature. On the other hand, cadmium concentration in gills of examined fish was the lowest in winter season and the crustacean gill parasites were absent. These may be attributed to absence of crustacean parasites with low temperature under 18C. These results were agreement with that recorded by Bruton (1979) who recorded that the suitable environmental condation for spawning, which usually takes place at water temperatures above 18 °C.

The present study was concluded that, there were inversely proportion relationship between cadmium concentration pollution in aquaculture and the prevalence of gill crustacean infestation during spring, summer and autumn seasons while infestation was disappeared during winter season. Also, there was a relationship between cadmium residues in *Tilapia zilli* gills and its concentration in the water, the obtained results showed that the cadmium concentration in the gills were higher than that in the water.

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