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INVESTIGATION OF THE EFFECT OF WATER QUALITY ON SEED PRODUCTION IN TWO TILAPIA HATCHERIES IN EGYPT

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ABSTRACT

A field study was conducted in two tilapia hatcheries, hatchery (A) located at El Fayoum Governorate and hatchery (B) located in Sharkeya Governorate, to investigate the effect of water quality on seed production. Eighty-four water samples were collected from the inlet, outlet, broodstock ponds, egg funnels and nursery ponds for determination of physico-chemical condition and microbial count of water used for incubating eggs and nursing frys. Fry and eggs samples were also examined for microbial loads. Results indicated that there was no significant difference between both hatcheries with respect to microbial of water samples, fry and eggs, although they were slightly higher in hatchery (B) than hatchery (A). Temperature (Temp.) and pH were not significantly different among water samples from both hatcheries. Dissolved oxygen (DO) and nitrite were significantly different for water samples used for incubating eggs between both hatcheries with means of (5.11 ± 0.305), (5.08 ± .44) mg/dl, respectively and (0.06 ± 0.03), (0.09 ± 0.06) mg/dl, respectively. DO and nitrite were also significantly different between both hatcheries for water used for rearing fry with means of (4.84 ± 0.24), (5.11 ± 0.47) mg/dl, respectively and (0.08 ± 0.05) and (0.11 ± 0.10) mg/dl, respectively. Ammonia showed significant different between both hatcheries for water samples used for incubating eggs with means of (0.23 ± 0.09) and (0.72 ± 0.35) mg/dl, respectively, on the other hand ammonia in water samples used for rearing fry were not significantly different between both hatcheries. The low level of difference in both microbiological and physical-chemical parameters between the two hatcheries leads to similar fertility percentage (95% and 96% for hatchery (B) and hatchery (A), respectively), hatchability percentage (90% and 91% for the hatchery (B) and hatchery (A), respectively) and mortality percentage (10% and 9% for hatchery (B) and hatchery (A), respectively). The better performance of hatchery (A) may be due to better sanitary measurements adopted.

Keywords:

Hatcheries- fry and eggs- water quality- microbial counts.

INTRODUCTION

Egyptian fishery production grew from 724,300 tons in 2000 to1.3 million tons in 2010 **(GAFRD, 2011)** primarily due to growth in aquaculture production which increased its share of total production from 47% in 2000 to 70% in 2010 **(GAFRD, 2011; Macfadyen *et al.*, 2012).** Aquaculture activities have become more sophisticated and diverse and are supported by the development and expansion of many tilapia hatcheries **(Saleh, 2007).** The Nile tilapia is the most commonly produced freshwater species. Development of tilapia seed production was the reason behind the sharp increase in aquaculture production in Egypt during the last decade. Seed production is carried out in commercial hatcheries or in farm-based hatchery units. The main activity of the commercial hatcheries is the production of fish seed (fry or fingerlings) and all its production are sold to grow-out farmers. Some fish farms may have smaller hatchery units sufficient to cover the requirements of fry and fingerlings; surplus production is sometimes sold to other farms. Most tilapia seed production comes from private hatcheries. Governmental hatcheries were originally designed to produce different species of carp. Tilapia seed production is a side activity in the nine governmental hatcheries which produce in total a production of 38.03 million fingerlings (3-5 g) per year **(GAFRD, 2005).** Seed production in mouth brooding tilapia largely depends on the culture system (pond, hapas in pond or tank) and the degree of intensification **(Little *et al.*, 1994).** The system applied in most industrial hatcheries (private or government) depends on indoor breeding tank systems. This system was developed to facilitate production of tilapia seed one or two months earlier than that produced in outdoor systems. The second most common system of tilapia seed production is the use of hapas in ponds. This system was introduced from Asia and developed locally to suit local conditions. A modification of this system is presently expanding in the country for early season fry production. In this system, hapas are fixed in smaller ponds (500-1000 m2) or concrete tanks inside a greenhouse **(Saleh, 2007).** Hatchery, nursery and early rearing systems offer an ideal environment for infection and disease outbreak, because such systems usually stress the host and favour the proliferation of virulent pathogens. In addition, the various components of the immune system (both innate and specific) are known to become structurally and functionally competent only after four to eight weeks post-hatching depending on the fish species. Bacterial infections are suggested to be a major cause of both egg losses and occurrence of deformed fish larvae, however these are not attributed to specific obligate pathogenic bacteria, but rather to proliferation

opportunistic bacteria in the environment of intensive egg incubation. External fungal infection is also a problem in hatcheries during incubation of eggs.The fungus first establishes on dead and unfertilized eggs and gradually spread to healthy developing eggs destroying the entire batch of incubated eggs **(CV Mohan, 2007).** Aquatic ecosystem affected the organisms, as well as the chemical and physical characteristics of water **(Delince, 1992).** Fish is in direct contact with microflora in the environment and the opportunistic pathogens already present in the water may invade the host under stress and undesirable water quality conditions. It is therefore important to understand the microflora associated with fish culture environment, since the microflora of cultivated fish reflects its aqueous environment **(Erondu and Ayanwu, 2005).** Water quality in aquaculture fish ponds is controlled by a complex interplay of many factors. The amount of dissolved oxygen (DO) is controlled by factors such as photosynthesis, respiration by fish and microorganisms, air-water-exchange and oxygen input in the water flowing into the pond **(Gulliver and Stefan, 1984).** Managing the water used for aquaculture is one of the most essential components of managing an aquaculture system. It is essential to monitor the water quality frequently and remove waste constantly, particularly in an intensive system, as the TAN waste produced by fish is highly toxic. Ensuring that water quality is maintained at a premium reduces the risks associated with stress and disease **(Furey *et al.* 2006)**. The proposed study was conducted to investigate the effect of water quality on seed production and hatchery performance. Materials and methods study was conducted in two hatcheries: hatchery (A) and hatchery (B) at the period between June to August. Hatchery (A) was a tilapia hatchery located at Al-Fayoum Province and receiving water from agricultural drainage at Qaroun lake region. Water was exchanged every 4 hours daily but no filters were used. Hapas made of 1 mm mesh netting material of a 4× 7×1 m dimension for broodstock and about 3 x4 x1 m for fry. Hapas were fixed in earthen ponds, usually arranged in parallel rows covering most of the water area of the ponds and are kept about 0.25 m above the bottom. Broodstock were stocked at the rate of 80 females: 27 male per hapa while stocking density for frys was about (29000-30000) frys per hapa. Aerators were used to maintain DO levels and water quality analysis was performed monthly. A motor 7.5 horse power (220 volt) was used in the hatchery to reduce ammonia level and this also helps to maintain DO levels. Eggs were not disinfected but equipments were disinfected using common salt (150 g/ 7 liters) and same equipments were not used between different departments. The manager and workers were trained about sanitary measurements. Hatchery

(B) was a carp and tilapia hatchery that was located at Abbasa village, Abu-Hamed District, Sharkeya Governorate. Water was supplied from Gadoun canal, branched from Ismailia canal. Water was exchanged 4 times/ week and a gravel filter at the main water source were used. Brood stock were stocked in concrete ponds at the ratio of 120 females: 40 males per pound (3 x 20 x 1.5m), while fry were also stocked in concrete ponds (3 x 10 x 1m). Aerators were used to maintain DO levels and water quality analysis was performed once/ year. No disinfection for seed or equipment was done. Furthermore, the workers in that hatchery were not trained about sanitary measurements and used the same equipment between different departments. In both hatcheries, the crude protein content of tilapia feed is about 25- 30% for brood stock and about 30- 40 % for fry. Brood stocks were fed once per day at the morning in hatchery (A) and twice per day in hatchery (B) while fry in both hatcheries were fed 7 times per day at a rate of 18-20% from their weight. Fry of 9 to 11 mm in total length normally were treated with 17 a-methyl testosterone. The androgen compound was provided to fry in feed. The usual dose was 30 to 60 mg methyl testosterone/kg feed, and the feed is offered for 3 to 4 weeks. Fertility, hatchability and mortality rates were recorded for both hatcheries.

1. Water quality:

Water samples were collected biweekly between 8 am to 12 pm during the period from June to August 2016 to monitor the physical-chemical and microbial characteristics of water in hatchery (A) and hatchery (B). A total number of 84 water samples were taken. They were taken from inlets and outlets, from nursery ponds, bloodstock ponds and egg funnels. Water temp., and DO were measured in situ using a portable water- resistant DO meter with galvanic probe (HI 9147-Europe, Romania) while pH was measured in field using electrometric pH meter (pHep® HI 98107- Italy). Unionized ammonia (NH3) and nitrite- nitrogen (No2-N2) in examined water samples was determined by using standard methods as described by **A.P.H.A (1998).** Total bacterial count (T.B.C) and total fungal count were determined using spread plate technique described by **A.P.H.A (1998).**

2-Fry:

Fry of an average body weight (0.4 -1.5gm) were collected and transported alive in a large strong double plastic bags filled up to its 1/3 with original farm water, while the other 2/3 was filled with compressed oxygen by using oxygen pump from the farm then packed in a large ice box and surrounded by ice bags. In the lab, 5 fry were placed in sterile tissue culture test

tubes 50ml. capacity and homogenized using sterile sand, 10 ml. 8.5% sterile physiological saline and glass rods then tenfold serial dilutions were prepared for determination of total bacterial count and total fungal count.

3-Eggs:

Tilapia eggs were collected twice biweekly between 8 am to 12 pm during the period from June to August (season of tilapia production) from ten egg funnels in hatchery A and from nine brood stock ponds in hatchery B. They were collected in sterile cups then packed in a large ice box and surrounded by ice bags for total bacterial and fungal count determination. 1gm of egg sample were rinsed and homogenized in Peugeot (screw cap) vials containing 1ml. of sterile normal saline (8.5g sodium chloride in 1000 ml. distilled water) according to **Jantrakajorn and Wongtavatchai (2015)** then ten-fold serial dilutions were prepared for determination of total bacterial count and total fungal count.

4-Statistical analysis:

Data gathered for the study was statistically analyzed using SPSS (Statistical package of social science), a computer program of biostatistics **(Hollander and Douglas, 1973)** for calculation of mean and SD (Standard deviation) and the degree of significance ($P \leq 0.5$) of the obtained results was determined.

RESULTS AND DISCUSSION

Table (1): Mean (±SD) physical-chemical values and microbial count of water in hatcheries A and B

	Hatchery A				Hatchery B			
	Inlet	**Outlet**	**Fry**	**Eggs**	**Inlet**	**Outlet**	**Fry**	**Eggs**
Temp.	28.75 (±.35)	28.90 (±.28)	31.44 (± .62)	27.14 (±6.78)	28.85 (±.21)	28.80 (±0.39)	28.93 (±0.40)	29.89 (±0.57)
DO	4.56 (±0.23)	4.24 (± 0.37)	4.84 (±0.24)**	5.11 (±0.305)**	4.47 (±0.19)	4.26 (±0.07)	5.11 (±0.47)**	5.08 (±0.44)**
pH	7.95 (±0.02)	7.97 (±0.02)	8.09 (±0.36)	7.61 (±0.25)	7.91 (±0.07)	8.05 (±0.12)	7.71 (±0.27)	7.71 (±0.25)
Ammonia	0.84 (±0.15)**	1.82 (±0.01)**	0.67 (±0.39)	0.23 (±0.09)**	1.93 (±0.01)**	3.56 (±0.15)**	0.83 (±0.46)	0.72 (±0.35)**
No_2	0.13 (±0.001)	0.13 (±0.01)	0.08 (±0.05)**	0.06 (±0.03)**	0.17 (±0.072)	0.24 (±0.01)	0.11 (±0.10)**	0.09 (±0.06)**
T.B.C	10.79 (±0.80)**	10.82 (±0.80)**	8.5 (±1.53)	8.6 (±1.51)	11.35 (±0.01)**	11.39 (±0.01)**	8.6 (±1.46)	8.7 (±1.53)
T.F.C	8.72 (± 1.4)	8.8 (±1.49)	5.98 (±1.26)	5.5 (±1.15)	8.85 (±1.53)	8.9 (±1.53)	6.03 (±1.27)	5.8 (±1.39)

**** The mean difference is significant at the .05 level.**

Table (2): Mean (± SD) Microbial counts (T.B.C & T.F.C) for fry, eggs and water (environment)

	Hatchery A				Hatchery B			
	Fry	**Water**	**Eggs**	**Water**	**Fry**	**Water**	**Eggs**	**Water**
T.B.C	**8.8 (±1.42)**	**8.5 (±1.53)**	**5.8 (±1.46)**	**8.6 (±1.51)**	**8.9 (±1.44)**	**8.6 (±1.46)**	**6.1 (±1.46)**	**8.7 (±1.53)**
T.F.C	**6.01 (±1.44)**	**6.03 (±1.27)**	**5.4 (±1.43)**	**5.5 (±1.15)**	**6.3 (±1.32)**	**5.98 (±1.26)**	**6.1 (±1.48)**	**5.8 (±1.39)**

Table (3): Fertility, hatchability and mortality rates

	Hatchery A	**Hatchery B**
Fertility %	**96%**	**95%**
Hatchability %	**91%**	**90%**
Mortality %	**9%**	**10%**

1) Water quality:

Table (1) summarizes the water quality condition in hatchery (A) and hatchery (B). It can be noticed from results that temperature recorded (27.14 -31.44) °C in hatchery (A) and (28.80 - 28.89) °C in hatchery (B), pH (7.61 - 8.09) in hatchery (A) and (7.71 - 8.05) in hatchery (B), DO (4.24 - 5.11) mg/dl in hatchery (A) and (4.26 - 5.11)mg/dl in hatchery (B), and nitrite (0.06 - 0.13)mg/dl in hatchery (A) and (0.09 - 0.24)mg/dl. Temperature, pH, DO and nitrite in water of both hatcheries showed similar ranges and were within the limits recommended for production **(Boyd, 2012).** The pH obtained in this study was similar to that of **Ntengwe and Edema (2008)** who observed that appropriate pH for increased fish production is 6 - 9. Similar results of D.O were also reported by **Onome and Ebinimi (2010)** who recorded higher dissolved oxygen of 4.34-mg/l. **Alim (2005)** recorded nitrite concentration ranging from 0.00 to1.021 mg/l that was more or less similar to the findings of present study. No significant differences were found between both hatcheries regarding temp., pH, however, a significant difference was found for DO and nitrites between hatcheries (A) and (B) where hatchery (A) recorded slightly lower values for DO and nitrite than hatchery (B) (Table 1). A significant difference was also recorded for ammonia in water used for fry where it recorded 0.83 (±0.46) mg/dl in hatchery (B) that used concrete nursery ponds for keeping fry

and 0.67(±0.39) mg/dl in hatchery (A) that kept their fry in hapas. These results were similar to that reported by **Rahman (2005) and Asaduzzaman *et al.* (2006)** who recorded ammonia value ranged from 0.01 to 0.82 and 0.203 to 0.569 mg /l, respectively. Nevertheless, ammonia levels in all ponds, hapas, egg funnels as well as inlet of in hatchery (A) 0.84 (± 0.15) mg/dl and hatchery (B) 1.93 (± 0.01) mg/dl was above the permissible level of 0.2mg/l recommended for aquaculture **(Njoku *et al.* 2015).** These results indicate that water supplying both hatcheries is moslty polluted water furthermore, the gravel filter used in hatchery (B) is not efficient enough to reduce the ammonia level while motor used in hatchery (A) is efficient to reduce the ammonia level.

2) Microbial counts:

Table (1) shows microbial counts in water used for keeping fry and incubating eggs were slightly lower in hatchery (A) recording (8.5-8.6), (5.5-5.98) log cfu ml $^{-1}$ for T.B.C and T.F.C, respectively while hatchery (B) recorded (8.6 -8.7), (5.8-6.03) log cfu ml $^{-1}$. NO significant differences were found between both hatcheries in water, however, a significant difference was recorded between inlets of both hatcheries, 10.79 (±0.80), 11.35 (±0.01) log cfu ml $^{-1}$, respectively, indicating that water supply for hatchery (B) was more polluted than hatchery (A). These results were more than the values recorded by **Ntengwe and Edema (2008)** in the order of 6 log CFU mL-1 from fish culture pond water. Table (2) illustrates microbial counts (T.B.C and T.F.C) for eggs, fry and water in hatchery (A) and hatchery (B). Total bacterial count and Total fungal count for fry and eggs were slightly lower in hatchery (A) (5.8 - 8.8), (5.4 6.01) log cfu ml $^{-1}$ respectively than hatchery (B) (6.1-8.9), (6.1-6.3) log cfu ml $^{-1}$ respectively. Total bacterial count for eggs was lower than that of fry and water in both hatcheries. This may due to that bacterium usually inhabit only a small area of egg surfaces (1 to 7.5%) **(Trust 1972, Sauter *et al.* 1987).** There was no significant difference in total fungal count for fry, eggs and water between both hatcheries. Bacterial counts affect the developing embryos through the excretion of enzymes and toxins, but above all they limit the amount of oxygen reaching embryos **(Trust 1972, Sauter *et al.* 1987),** while fungal spores develop on the surface of dead eggs, but they cannot attack live embryos. However, hyphae relocating from dead to nearby live eggs also quickly result in mortality **(Meyer, 1991)**. This was reflected on the hatchability and mortality percentages of both hatcheries which recorded 91%, 9% for hatchery (A) and 90 %, 10 % for hatchery (B) (Table 3). There were no significant differences between both hatcheries regarding fertility; hatchability and mortality

rates in this study may be due to low level of differences in both microbiological and physical-chemical parameters between the two hatcheries.

CONCLUSION

It was concluded from the present study that water supplying both hatcheries was exposed to pollution; furthermore, the gravel filter used in hatchery (B) was not efficient enough to reduce the ammonia level. The better performance of hatchery (A) may be due to better sanitary measurements adopted.

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