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Nitrogen and Phosphorus budget for Nile tilapia hatchery

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Abstract

Tilapia hatcheries if not well managed, it can cause environmental damage. The present study was designed to quantify the impacts generated by Nile tilapia hatcheries, through applying environmental indicators, which is necessary for tilapia hatcheries sustainable development. Three culture trials, each of 15 days, have been carried out to determine environmental indicators: the nitrogen and phosphorus flux and nutrient mass balance based on inputs from feed and losses in fish harvest, nutrients load in the effluent water, and fish bio-solid wastes (sludge). In each, three cement ponds were assigned to determine the nutrients input and loss for 15 days intervals, fry production cycle. The results showed that every 1 Kg feed of 35% protein produce 420 g sludge, of which 262 gm fish excretion. Uneaten feed was found to represent 15.8-20% of the introduced feed and produce 37.6 - 43.2 % of sludge. Fish retained at least 25.8 ± 3.91 % and 2.74 ± 0.37 % of the input feed nitrogen and phosphorus, respectively. While the sludge contained 11.3 ± 0.78 % and 32.62 ± 14.46 of the feed nitrogen and phosphorus, respectively. Effluent water contained 43.64 ± 6.45 % and 50.22 ± 16.63 % of feed nitrogen and phosphorus, respectively, distributed in three main fractions: particulate form; dissolved organic and dissolved inorganic forms. The feed nitrogen recovery in the present study was 80. 57%, while the phosphorus recovery reached 85.58% of the feed phosphorus content. Fry production is discussed in response to the feed protein content and feeding rate.

Keywords: Nile tilapia-hatchery, *Oreochromis niloticus*, Nitrogen and Phosphorus dynamics, nutrient budgets, fry production.

INTRODUCTION

Aquaculture as any aquaculture production activity, if not well managed, it can cause environmental damage (Gorlach-Lira *et al*., 2013; FAO, 2014). Nutrients load and suspended solids in aquaculture effluent can cause eutrophication (Cho *et al*., 1991; Ozbay *et al*., 2014), oxygen depletion (Wu *et al*., 1994) and algae blooms problems in the surrounding aquatic environments. Moreover, releasing aquaculture effluent of poor quality may have a significant impact on the aquatic organisms in the receiving water bodies (Piedrahita, 2003; Stephens and Farris, 2004). The amount of these pollutants in the effluent depends on a wide range of factors. Their environmental impact can be decreased either by improved farm management, or by physical and/or biological treatment of the effluent. To reduce the nutrient loss; adequately protect surface water quality from the potential negative impact of aquaculture effluent; maintain health and welfare of the fish; achieve high growth and reproduction performance and to increase the efficiency of water use, it is essential to estimate waste production, including the quantity of total solids, phosphorus and nitrogen flux **(**Westers 1995; Lin and Diana 1996). In this context, several studies documented nitrogen dynamics in aquaculture target systems to ensure and improve the stability and longevity of aquaculture, (Daniels and Boyd, 1989; Acosta-Nassar *et al*., 1994; Boyd, 1997). However, scarce studies determine nitrogen and phosphorus budget in tilapia hatcheries, within cement ponds, although it is important for tilapia performance and fry production as well as for their hatcheries sustainability. The good management of tilapia hatcheries is mainly grounded on considering the sustainable development factors. Therefore, the input and output must be taken into consideration and the obtained results must be properly evaluated, especially those influence the aquatic environment.

On the other hand, several studies showed that the fish sludge accumulating during fish growing is rich in organic matter, nitrogen and phosphorus (Funge-Smith and Briggs 1994; Hopkins *et al*., 1994; Jamu and Piedrahita 2001, Boyd *et al*., 2002). Fish bio-solid wastes (Sludge) accumulation is undesirable as it can negatively impact fish yields due to unpredictable release of toxic elements such as hydrogen sulfides and nitrites. High organic matter deposition is concomitant with a high oxygen demand and lead to oxygen depletion (Boyd and Tucker 1995). Funge-Smith and Briggs (1994) and Lin (2003) reported that although the fish bio-solid wastes are a waste of valuable nutrients, nevertheless, its direct disposal to natural systems possesses an environmental threat.

A deeper understanding of the interaction between nutrient inputs (feed), nutrient retention (growth) and outputs (soluble and particulate waste) will help address the sustainability of land-based aquaculture production systems (Orellana *et al*., 2013). Good practice in the management of water resources aims to diminish the cost of water, reducing consumption and maximizing the reuse or recycling of supply water, while returning it to the natural waters with acceptable physicochemical and biological characteristics and, hence, avoiding negative impacts on ecosystems.

So the present study aimed to utilize the environmental indicators as a quantitative tool to evaluate and discuss the nitrogen and phosphorus flux from the hatcheries of Nile tilapia (*Oreochromis niloticus* Linnaeus, 1758) in cement ponds and subsequently understand nitrogen and phosphorus dynamics in tilapia hatcheries ponds and characterize their environmental impact. So the effective management practices can be recommended to minimize tilapia hatcheries environmental impacts and define the most effective means to treat and reuse the Nile tilapia (*Oreochromis niloticus* Linnaeus, 1758) hatcheries effluents and bio-solid wastes.

MATERIALS and METHODS

The present study was designed to determine the nitrogen and phosphorus budget, nutrients mass balance and characterize the effluent and sludge of Nile tilapia brood-stock's cement ponds, in the Central Laboratory for Aquaculture Research (CLAR) hatchery, Abbassa, Abuo-Hammad, Shrakia governor.

During three successive culture trials on 23rd May 2017 through 7thJuly 2017, each of 15 days, the input of nutrients via feed only and nutrients loss in fish biomass, nutrients settled in sludge, nutrients load in the effluents and the nutrients mass balance, are the environmental indicators that have been determined in this study.

To achieve that goal three cement ponds with dimension of 2.80 × 8.1× 1.5 m were assigned for the environmental indicators determination in each culture trial and filled with water at 50 cm high, with a working volume of 11340L, and stocked with 60 Nile tilapia fish with an average weight of 160 ± 2 gm, at sex ratio of 3 female:1 male. The daily feeding rate was adjusted at 1.2 % of the total fish biomass, introduced twice daily at 9:00 and 15:00 using feed of 5.53 % nitrogen (35% crude protein) and 0.191 % phosphorus contents.

In order to a chive the objectives of the study, the amount of water in the ponds were used during the study period without replacement except for compensation for the loss of evaporation.

Nutrient budgets and mass balance

The considered nutrient gains source was feed while considered nutrient losses were the gain weight of harvested fish, drainage water and collected tanks sediment (sludge).

To estimate total nutrient gains from feed, feed proximate analyses were made for total nitrogen as well as total phosphorus contents.

To estimate nutrient contribution of affluent water, water samples were collected from the inlet pipe during ponds filling and evaporation compensation and their nitrogen and phosphorus contents were determined. To calculate the nutrient contribution from feed in the ponds water (Nutrients Mass Balance, NMB), the nutrient load in affluent water (L_A) was subtracted from the effluent nutrient load (L_E) at the end of each culture trials (15days), according to the following Equation ((Boyd and Queiroz, 2001; Boyd *et al*., 2007; Osti *et al*., 2018) :

$NMB = L_E - L_A$

Where: NMB = nutrients mass balance loads of (TP and TN)

L_E = the considered variable load in the effluent of the ponds

L_A = the considered variable load in the affluent of the ponds

Also, different forms of nitrogen and phosphorus in affluent (at the beginning of each culture trial) and effluent water (at the end of each culture trail) were measured to determine the feed contribution in nitrogen and phosphorus forms in water.

For considered losses in sludge, sediments from each pond were collected during fry harvest and its TN and TP were determined. Final fish samples, at the end of spawning season, were collected and their TN and TP were determined and multiply in weight gain at the end of each culture trial, to measure N and P loose in fish biomass.

Sludge of different sources determination:

Affluent water: The volume of water added to ponds was estimated by monitoring water levels in each fish pond. Gradual signs (100 cm high) were marked on the cement ponds walls to monitor changes in ponds water depth and volume. The total suspended solids were determined according to APHA (1998). The amount of solids was calculated (11.7 mg/l which means 132 g of sediment/ tank of 11340L per 15 days).

Feed: Commercial feed (35% crude protein) was used throughout the experiment and the quantity of feed inputs into the fish ponds were introduce twice daily (9:00 and 15:00) and recorded daily then quantified at the end of the each culture trial (15 days) and the feed contribution to sediment accumulation was estimated based on assumption that every 1Kg feed produce about 412 gm sediment (**Muendo *et al*., 2014**), and 15% of the offered feed is not eaten (**Boyd 1995; Boyd and Tucker, 1995**).

Chemical analysis:

Total nitrogen in sludge, fish and feed was analyzed by the Kjeldahl method (AOAC 1990). The total phosphorus content in sludge; fish and feed was determined by using dry ash method (Tavares and Boyd, 2003) for digestion then phosphorus was colorimetrically estimated using the vanadomolybdate method (APHA, 1985).

Affluent and effluent water samples were collected at the beginning and ending of each culture trial, respectively, from each pond for analysis and determination of : total solids (TSS), NH_4;NO_2;NO_3,total nitrogen of sample before filtration (TN); Total dissolved nitrogen(TDN) of sample after filtration; total phosphorus of sample before filtration (TP); total dissolved phosphorus (TDP) of sample after filtration and orthophosphate (OP) according to the analytical methods of AOAC (1990).

The total nitrogen and total phosphorus were determined according to (Gross and Boyd 1998) and (Boyd 1979) for the nitrogen determination and ascorbic acid method (Boyd and Tucker 1992) for the phosphorus.

Particulate nitrogen (Part.N); particulate phosphorus (Part. P); dissolved organic nitrogen (DON); and dissolved organic phosphate (DOP) were calculated.

Calculations:

Total nutrient (Nitrogen / Phosphorus) Input per pond (TN_I) =Total amount of applied feed (kg) × average of dry matter fraction × average of nutrient (nitrogen/Phosphorus) content in dry feed (Kg) by Kg of feed

Nutrient loss in fish biomass was calculated as following equation

$N_B = P \times DM \times N_{DM}$

Where: NB = converted nutrient in fish biomass (kg of TP or TN), P = fish gain weight (kg) at the end of each culture trial, DM = amount of dry matter by kilogram of fish (kg), N_{DM} = amount of nutrient (TP or TN) by kilogram of dry matter of fish (kg) (Boyd and Queiroz, 2001; Boyd *et al*., 2007).

According to Thoman *et al*., (2001) the following equations have been used to determine different fractions of nutrients in water.

Particulate nitrogen = total nitrogen (TN) before sample filtration – TDN after sample filtration

Dissolved inorganic nitrogen (DIN) = NH_4 +NO_2 + NO_3 mg/L

Dissolved organic nitrogen (DON) = TDN after sample filtration – DIN

Particulate phosphorus = total phosphorus (TP) before sample filtration – TDP after sample filtration

Dissolved organic phosphorus (DOP) = TDP after sample filtration - Orthophosphate

%Total nutrients (Nitrogen/Phosphorus) Recovery (TNR; per tank) =%Nutrient (N/P) Fish) + %Nutrient in sludge +% inorganic fraction of nutrient (DIN/OP) in water +% organic Nutrient (DON/DOP) in water + particulate nutrients (Part.N/Part. P) in water.

RESULTS and DISCUSSION

Fish growth:

At the beginning of the experiment, 23rd May of 2017, the average weight of fish in the ponds was 160± 2 g. At the end of the experiment, 7th July of 2017, the average fish weight was 173.5±3.5 g. The feed intake was of 5.55 kg/45days and the feeding rate was adjusted at 1.2 % of the total fish biomass.

TSS:

TSS in affluent water was found to be 11.7 mg/liter and produced about132 gm sediment/pond of 11340L working volume, which represents about12.8-15.2% of the total produced sludge at the end of the culture trial. According to the literatures, every Kg feed produces about 412 gm sludge of which less than 10% attributed to the affluent water (Muendo *et al*., 2014).

The TSS as a result of feeding was determined before a meal and after 3 and 6 h of the meal, in the present work. Uneaten feed was found to represent 15.8-20% of the introduced feed and produce 37.6 - 43.2 % of sludge result of feed and the rest of feed's sludge was a result of fish excretion. So, 1Kg of the applied feed produced 262 gm fish solid excretion and about 420 gm sludge/1kg feed. Similarly, Boyd (1995); Boyd and Tucker (1995) estimated the uneaten feed to be 15% of the introduced feed. Also, in the present study, the estimated fish excretion (31.1-32.7% of the ingested feed) is closer to the 30% of the ingested feed reported by Porter *et al*., (1987). In general, in fish that masticate pellets, such as tilapia or tambaqui (*Colossoma macropomum* (Cuvier 1818)), uneaten feed was found to range between 10% and 30% of the applied feed (Van Der Meer et al. 1997). While, species that swallow the pellet such as European eel or African catfish (*Clarias gariepinus* (Burchell 1822)), have feed losses varies between 1 and 10% (Heinsbroek et al. 1989).Our results are also similar to those reported by Summerfelt *et al*., (2001) who calculated that every kilogram of fed feed emits 0.43 kg of suspended solids, additional 9% suspended solids of feed emerge from activity of heterotrophic organisms and another 0.09% – due to activity of nitrification bacteria. Mongirdas *et al.,* (2017) reported that it is unreal to expect less than 200 g of sediment in real growing conditions, and values higher than 450 g does not appear as well, because that would suggest uneconomical use of feed and would extremely increase the first cost of fish production.

Fish bio-solid wastes (Sludge) accumulation is undesirable as it can negatively impact fish yields due to unpredictable release of toxic elements such as hydrogen sulfides and nitrites. High organic matter deposition is concomitant with a high oxygen demand and lead to oxygen depletion (Boyd and Tucker 1995). Funge-Smith (1994); Smith (1996) and Lin (2003) reported that although the fish bio-solid wastes are a waste of valuable nutrients, nevertheless, its disposal to natural systems possesses an environmental threat. Therefore it is necessary to search for a suitable treatment before using it, i.e., vermicomposting (Kouba *et al*., 2018).

Nitrogen budget:

The affluent water contribution in nitrogen and phosphorus budget was calculated and deducted from different fractions of nitrogen and phosphorus data, so the feed became the only measured nutrients source as shown in tables of nitrogen and phosphorus (Tables 1&2).

The data of the nitrogen budget is shown in Table (1), nitrogen added in feed; nitrogen retained in fish; nitrogen lost in sludge as well as different nitrogen fractions lost in drainage water. Based on the proposed indicators by Boyd and Queiroz (2001) and Boyd *et al.* (2007) for nutrients, fish retained at least 25.8 % of the input feed nitrogen as the results showed (Table 1). The present study results are superior over the results reported by Avnimelech (1999) who found only 23% of the feed protein was recovered by the hybrids tilapia fish stocked in 50 m^2 ponds at a density of 80 fish /m^2 and fed 30 % protein diet. Similar results registered by Boyd *et al.* (2007) who estimated that 23% of TN introduced in the fishponds as feed were converted in tilapia biomass. Far lower retention percent reported by Lin *et al.*, (1996) 15.45-20.04% N from the total inputs, for tilapia fish in fertilized earthen ponds. The present work results are in consistence with Avnimelech, (2006) and Osti *et al*., (2018) who found that 26% - 30% of the offered feed's nutrients are assimilated for fish biomass growing. Also our results are consistent with Boyd, (1985); Muthuwani and Lin, (1996) who reported that fish in a pond assimilate only about 25% of the nitrogen added in the feed and the rest is excreted as NH_4 or as organic N in feces or feed residue. Nevertheless, Wang *et al.* (2012) have found 38% of TN which entered the system in the form of feed is reversed into fish biomass and the remaining 62% were released to the environment.

Several studies showed that the fish sludge accumulating during fish growing is rich in organic matter, nitrogen and phosphorus (Funge-Smith and Briggs 1994; Hopkins *et al*., 1994; Jamu and Piedrahita 2001, Boyd *et al*., 2002). However, in the present study we found that sludge contain less nutrient than water, this can be attributed to the very short period of the fry collection, every 15 days, compared to the fish growing season, that may last for 4 months, that did not provide enough time for solid settlement. Muendo *et al*. (2005) reported that in tilapia ponds in the Nile delta, never drained, the concentration of nitrogen in the seepage water is 6.5 times higher than in water 2–10 cm above the sediment. As the results showed (Table 1), the sludge contained 11.3 ± 0.78 % of the feed nitrogen, as a total of fish excretion and uneaten feed settled at the tank bottom. Nitrogen content in fish feces was reported to vary from 10 to 40% depending on nitrogen content of fish feed and fish species (Lupatsch and Kissil, 1998; Schneider *et al*., 2004; van Rijn, 2013).

Water Total nitrogen in the present study was 4 ± 0.68 mg/L that represented 43.64 ± 6.45% of the feed nitrogen content distributed in three main fractions: particulate N; dissolved organic N and dissolved inorganic N. Osti *et al.*, (2018) and Boyd and Queiroz (2001) reported that 16% TN which entered the system in the form of feed were exported by effluent.

Water particulate nitrogen represented 13.29 ± 7.27% of feed nitrogen, while total dissolved nitrogen was 30.35 ± 8.68 % of feed nitrogen. Dissolved inorganic nitrogen was determined to be 10.78 % of feed nitrogen, while dissolved organic nitrogen was 19.57 ± 4.31 % of feed nitrogen. Similarly, Cripps and Bergheim (2000) reported that particulate wastes commonly contain 7-32% of the total nitrogen (TN) and the remainder is in the dissolved fraction in wastewater. Mongirdas *et al*., (2017) reported that nitrogen from protein, used up during fish vital processes is emitted through gill – 60–90 % – as ammonia and 9–27 % as urea. However, dissolved organic nitrogen (DON) in the present study was higher than dissolved inorganic nitrogen (DIN) and that can be attributed for two reasons: organic form of nitrogen as well as phosphorus needs time (i.e. more than 4 weeks, Summerfelt and Vinci 2003) for mineralization through the microbial activity and the inorganic nitrogen fraction is consumed by the phytoplankton over short time scale. Muendo *et al*., (2014) also reported that the organic forms of nutrients will become available after some time through microbial activity. On the other hand, Thoman (2001) determined that nitrogen loss via denitrification process reach 9 – 21% of the total nitrogen input in recirculating systems. While, Daniels and Boyd (1989) estimated that 50% of the nitrogen entering via the feed was lost through the combined effects of denitrification and ammonia volatilization in polyethylene-lined, brackishwater ponds. Acosta-Nassar *et al*. (1994) estimated that only 1% of the total nitrogen was lost through denitrification in a semi-intensive freshwater fish culture pond. The feed nitrogen recovery in the present study was 80.57%. Thoman *et al*., (2001) reported average total nitrogen recovery ranged from 91.4 to 79.3%.

The unaccounted part of nitrogen loss can be attributed to ammonia volatilization and denitrification processes; however we could not measure these processes due to a lack of facilities. Daniels and Boyd (1989) estimated that 50% of the nitrogen entering via the feed was lost through the combined effects of denitrification and ammonia volatilization in polyethylene-lined, brackishwater ponds. Lin *et al*., (1996) reported the unaccounted loss of N between 70.66-78.01% of the total inputs, and the losses of N in discharged water ranged from 7.19-10.81% of the total inputs, and attributed the large amount of unaccounted nitrogen to losses through denitrification process in the sediment. Nevertheless, ammonia loss by volatilization is considered to be insignificant in aquaculture systems those with low concentration of NH_3, where ammonia volatilization rate correlates with NH_3 concentration (Zimmo *et al*., 2004).

Table (1): Nitrogen budget, input and excreted fractions in Nile tilapia brood stock concrete ponds.

Parameter	Feed N input	Nitrogen retained in Fish	Nitrogen in sludge	Water Nitrogen						
Unit				TN	TDN	Part. N	DO N	NH_4	NO_2	NO_3
(mg/L)				4.00 ± 0.68	2.76 ± 0.77	1.24 ± 0.73	1.78 ± 0.39	0.20 ± 0.1	0.13 ± 0.06	0.65 ± 0.39
g/pond	103.60± 4.73	26.59± 2.64	11.53 ± 1.18	45.34 ± 7.73	31.32 ± 8.7	14.02 ± 8.27	20.24 ± 4.37	2.26 ± 1.16	1.44 ± 0.73	7.39 ± 4.44
% of feed N		25.8 ± 3.91	11.13 ± 0.78	43.64 ± 6.45	30.35 ± 8.68	13.29 ± 7.27	19.57 ± 4.31	2.20 ± 1.16	1.37 ± 0.65	7.21 ± 4.34

TN = Total nitrogen; TDN = Total dissolved nitrogen, Part.N = particulate nitrogen; DON = Dissolved organic nitrogen. Each value is an average of 9 replicate± standard deviation.

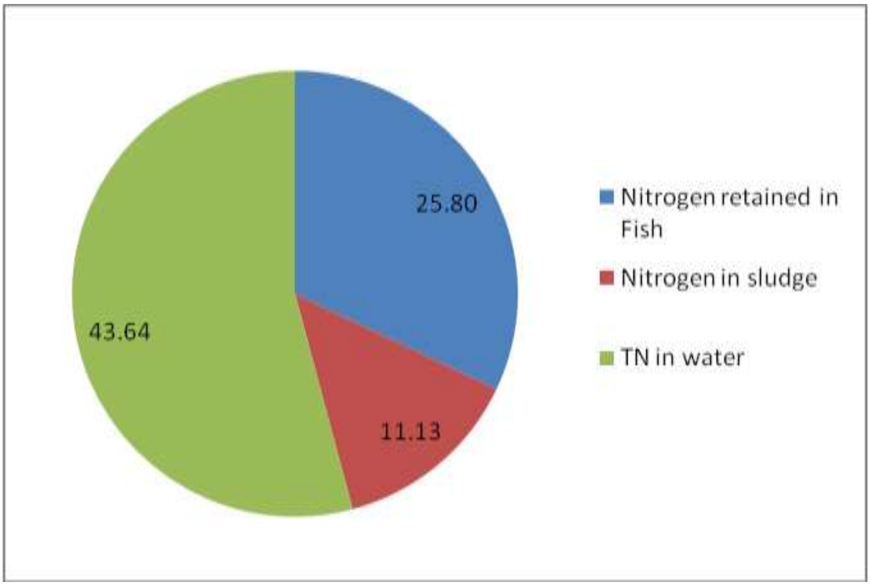

Fig (1) Nitrogen budget in Nile tilapia brood stock concrete ponds

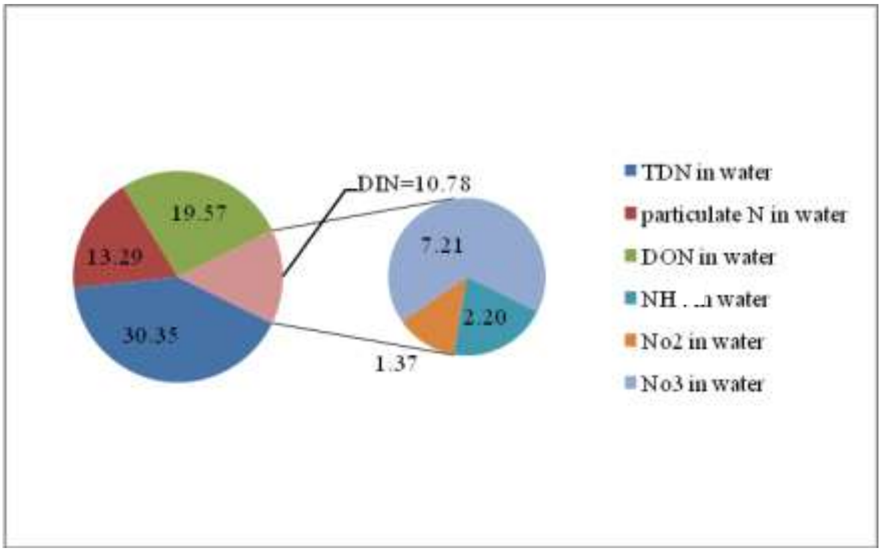

Fig (2) Nitrogen fractions in water in Nile tilapia brood stock concrete tanks, TDN= total dissolved nitrogen, DON= dissolved organic nitrogen, DIN= dissolved inorganic nitrogen.

Phosphorus budget:

In freshwater bodies, phosphorus is the main limiting factor for development of flora. Unused feed phosphorus in aquaculture, make its way to environment and encourages eutrophication (Mongirdas *et al*., 2017). In the present study results showed that fish retained at least 2.74 ± 0.37 % of the feed phosphorus content. The assimilation of phosphorus, for different species of fish, depends on the composition of feed. Beveridge (1984) reported that Tilapia assimilates only 65% of phosphorus in fishmeal compared to salmon, and carp practically does not assimilate it at all – it requires phosphorus from plant-based ingredients. A higher percent 10.02-15.10% P from the total P inputs was reported to be retained in tilapia fish by Lin *et al*., (1996) in fertilized earthen ponds. Wang *et al*. (2012), have found that 30% TP which entered the system in the form of feed were reversed into fish biomass.

The un-dissolved fraction of phosphorus, in the present study, was determined to be more than 37% of feed phosphorus (32.62 ± 14.46% in sludge and 5.35±3.86% of the total feed phosphorus as particulate P in water). Cripps and Bergheim, (2000) also reported that the main part of feed phosphorus, 30%–84% of the total phosphorus (TP), is in un-dissolved fraction, i.e. is not assimilated. At a feed conversion ratio of 1.0 kg feed kg^{-1} gain, the estimated discharges from juvenile salmonids in terms of g (P) kg^{-1} fish gain 7.5 g P (80%–90% solid-bound) (Cripps, Bergheim, 2000). Foy and Rosell (1991); Kelly *et al*., (1994) showed that the proportion of nutrients in the particulate fraction increased with temperature. Shrestha and Lin, (1996) reported that sedimentation is generally considered a main mechanism for P loss in ponds because mud are known to have a strong affinity for phosphorus. Phosphorus and organic matter are released largely as particulate matter (Piedrahita, 2003), which is matching with the present work founds, more than 37 % of feed P in un-dissolved form. In general several studies have reported that in fish ponds with age of 1-30 years the total phosphorus concentrations in sediment ranging from 0.334 to 1.73 g/kg while the available phosphorus concentrations ranged 0.005 to 0.022 g / kg (Wahab *et al*., 1984, , Ming-Kui and Li-ping 2006, Wudtisin and Boyd 2006).

The water in tilapia brood-stock tanks contained 50.22 ± 16.63 % of the feed phosphorus content distributed in three main fractions: particulate phosphorus (5.35 ± 3.86 % of feed phosphorus content); dissolved organic phosphorus (16.47 ± 7.69% of the feed phosphorus content) and dissolved inorganic phosphorus (28.41 ± 10.65 % of the feed phosphorus content). The phosphorus recovery in the present study reached 85.58% of the feed phosphorus content. Lin *et al*., (1996) reported the losses of P in discharged water ranged from 2.00-3.84% of the total inputs, and the unaccounted loss of P between 81.88-87.25% of the total P inputs.

Muendo *et al*. (2005) reported that in tilapia ponds in the Nile delta, never drained, the concentration of phosphorus in the seepage water is 21 times more concentrated than pond water. Osti *et al*., (2018) and Boyd and Queiroz (2001) reported that 11% TP which entered the system in the form of feed were exported by effluent. However, Wang *et al*. (2012), have found that 70% TP which entered the system in the form of feed were released to the environment, which is matching with the present study founds, where more than 82% of the total P input was exported to the environment in dissolved form in water and settled form in sludge.

Table (2): Phosphorus budget, input and excreted fractions in Nile tilapia brood stock concrete ponds.

Parameter	Feed P input	Phosphorus retained in Fish	Phosphorus in sludge	Water Phosphorus				
Unit				TP	TDP	Part. P	DOP	OP
(mg/L)				0.16 ± 0.05	0.14 ± 0.05	0.02 ± 0.01	0.05 ± 0.02	0.09 ± 0.03
g/pond	3.53 ±0.16	0.10 ± 0.01	1.16 ± 0.51	1.77 ± 0.56	1.58 ±0.53	0.18 ±0.13	0.58 ±0.27	1.00 ± 0.38
% of feed P		2.74 ± 0.37	32.62 ± 14.46	50.22 ±16.63	44.87 ±15.2	5.35 ±3.86	16.47 ±7.69	28.41 ±10.65

TP = total phosphorus; TDP = total dissolved phosphorus; Part.P= particulate phosphorus; DOP= dissolved organic phosphorus; OP = ortho phosphste. Each value is an average of 9 replicate± standard deviation.

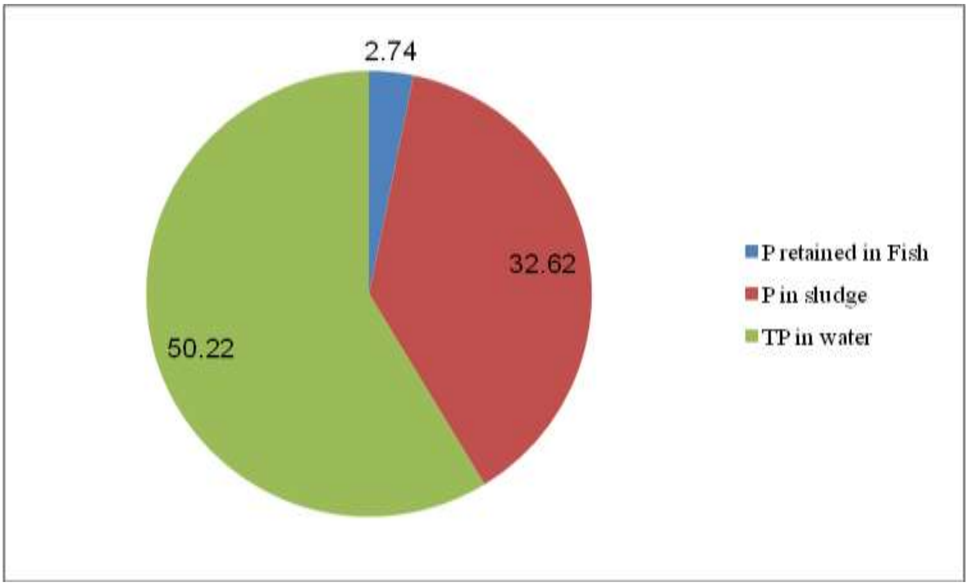

Fig (3) Phosphorus budget in Nile tilapia brood stock concrete ponds

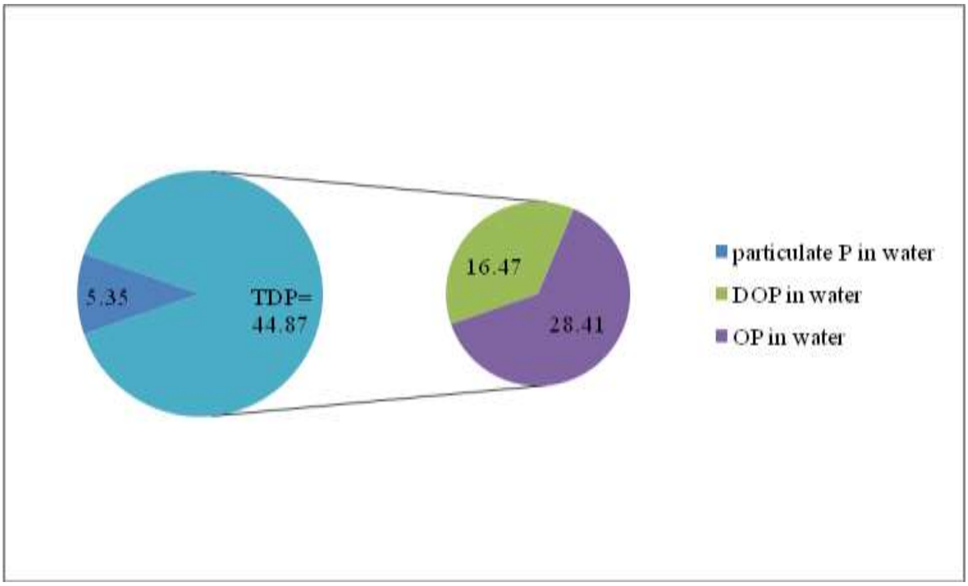

Fig (4) Phosphorus frictions in waster in Nile tilapia brood stock concrete tanks, TDP = total dissolved phosphorus, DOP= dissolved organic phosphorus, OP= ortho-phosphate.

Organic phosphorus fraction was found, in the present work, to represent about16.47 ± 7.69% of the total phosphorus input as feed. Similarly, several studies reported organic phosphorus to form 23-60% of the total phosphorus (Rath 2000, Boyd *et al.*, 2006, Ming-Kui and Li-ping 2006).

Table (3) fry production in brood-stock cement tanks of Tilapia Hatchery

Trials	R1		R2		R3	
	No.fry/female	No.fry/pond	No.fry/female	No.fry/pond	No.fry/female	No.fry/pond
Trial 1	390	17550	410	18450	400	18000
Trial 2	405	18225	420	18900	430	19350
Trial 3	440	19800	455	20475	435	19575
Aver ± SD	411.7± 25.7	18525± 1154.6	428.3± 23.6	19275± 1063.3	421.7± 18.9	18975±851.8

In the present study the applied feed contains 5.53% N (35 % protein). According to Hassouna *et al.*, (2002) who stated that the reproductive performance significantly improve by increasing crude protein (CP) level in the commercial diets and that from the economic and production points of view, the 35% diet seems more suitable and efficient than other tested higher or lower levels .

In the present work the feeding ration was calculated to be 1.2% of the total fish biomass. Also, Santiago, (1985) better reproduction activity was reached when Tilapia breeders were fed with pelleted supplemental diets containing 20 or 40% crude protein at a daily feeding rate of 1% of fish biomass for 24 weeks in cages and tanks. However, Abou-Zied and Ali (2007) found that brood-stock feeding rate at low (less than 1% of the total fish biomass) level was more effective in increasing fry production than higher levels. This may suggest that at lower feeding rate the uneaten feed would be less than that has been determined in the present study.

CONCLUSIONS

The present work is based on monitoring of changes in the distribution of nitrogen N and phosphorus P in water, suspended matter and fish in a pond experiment, where applied feed was the only considered nutrient source. The objective of this work were to get data on the nutrients fate in the tilapia hatchery ponds system, and understanding the nitrogen and phosphorus fractions dynamics in order to define the most suitable and effective treatment practice for the effluent and sludge before reuse them.

In the present study, at a feeding rate of 1.2 % of the total fish biomass, it was found that the average net uptake of N and P 25.8 ± 3.91 % and 2.74

± 0.37 % of the input feed N and P contents. This is a significant contribution to fish feeding in such systems. On the other hand the uneaten feed was found to represent 15.8-20% of the introduced feed and produce 37.6 - 43.2 % of sludge, this percent may be reduced by reducing the feeding rate, although the uneaten feed percent is responding to the fish species too.

The net uptake (fish retention), though an important parameter, is just a part of the processes involved. Part of the nitrogen and phosphorus taken up by fish is excreted. The present study elucidated that while the sludge contained 11.3 ± 0.78 % and 32.62 ± 14.46 of the feed nitrogen and phosphorus, respectively. Effluent water contained 43.64 ± 6.45 % and 50.22 ± 16.63 % of feed nitrogen and phosphorus, respectively, distributed in three main fractions: particulate form; dissolved organic and dissolved inorganic forms. This information is of utmost importance to plan the wastewater treatment in order to reduce the water use, as well as in deciding how to utilize the produced sludge efficiently. Therefore the present study‘s results are of great economic and environment gains for aquaculture sustainable development.

The monitoring nutrients changes in the aquatic environment (dissolved and particulate) approach achieved a nitrogen recovery (80. 57%) and phosphorus recovery (85.58%). However, we did not consider other processes that may affect the nitrogen balance, i.e. nitrification and dentrification. A complicated isotopic technique of tagged nitrogen ^{15}N is needed for more details.

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الصور المختلفة للنيتروجين والفسفور فى احواض مفرخات اسماك البلطى النيلى

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تعتمد الإدارة الجيدة لمفرخات اسماك البلطى على الأخذ بعين الإعتبار التنمية المستدامة لتلك المفرخات وتاثيراتها على العوامل المحيطة بها. فتفريخ البلطي كأي نشاط لإنتاج الاسماك ، إذا لم تتم إدارته بشكل جيد ، فقد يتسبب في أضرار بيئية. ولهذا ، تم تصميم هذه الدراسة لتقدير التأثيرات الناتجة عن تفريخ البلطي النيلي ، من خلال تطبيق المؤشرات البيئية ، وهو أمر ضروري لتطويرواستدامة تفريخ البلطي. تم إجراء ثلاث تجارب استزراع ، كل منها ١٥ يومًا ، لتقدير المؤشرات البيئية: تدفق النيتروجين والفوسفور وتوازن العناصر بناءً على المدخلات من الأعلاف والفقد منها في حصاد الأسماك ، والمنصرف من العناصر الغذائية في مياه الصرف ، والمخلفات الصلبة للأسماك (الحمأة الناتجة). في كل من تجارب الاستزراع ، تم تعيين ثلاثة أحواض اسمنتية لتحديد مدخلات وفقدان المغذيات لمدة ١٥ يومًا ، وهي دورة إنتاج الزريعة. أظهرت النتائج أن كل ١ كيلو جرام من العلف (بروتين ٣٥٪) ينتج ٤٢٠ حمأة ، منها ٢٦٢ جم من إفراز الأسماك. تم تقدير العلف غير المأكول ليمثل ١٥,٨-٢٠ ٪ من العلف المقدم وينتج ٣٧,٦ - ٤٣,٢ ٪ من الحمأة. احتفظت الأسماك بما لا يقل عن ٢٥,٨ ± ٣,٩١ ٪ و ٢,٧٤ ± ٠,٣٧ ٪ من النيتروجين والفوسفورفي العلف ، على التوالي. بينما احتوت الحمأة على ١١,٣ ± ٠,٧٨٪ و ٣٢,٦٢ ± ١٤,٤٦ من نيتروجين والفوسفور في العلف ، على التوالي. احتوت مياه الفضلات على ٤٣,٦٤ ± ٦,٤٥٪ و ٥٠,٢٢ ± ١٦,٦٣٪ من النيتروجين والفوسفور في العلف ، على التوالي ، موزعة على ثلاثة أجزاء رئيسية: رواسب الغير ذائبة ؛ الجزيئات عضوية وغير عضوية الذائبة. كان الاسترداد النيتروجيني في الدراسة الحالية ٨٠. ٥٧ ٪ ، في حين أن الاسترداد للفوسفور بلغ ٨٥,٥٨ ٪ من محتوى الفوسفور للأعلاف المقدمة. تمت مناقشة إنتاج الزريعة في ضوء المحتوى البروتيني للعلف ومعدل التغذية وكذلك جودة المياه.