The3rd International Conference Environmental Studies and Research Institute
"Natural Resources and Future Challenges"
23 - 25 February 2015

HYGIENIC ASSESSMENT OF WATER AND FISH QUALITY AND PERFORMANCE FEEDING ON FRESH OR FERMENTED CHICKEN MANURE

Fatma Abouelenien[1*]; Nagham Elsaidy[1]; Ghada A.K. Kirrella[2] and R.A. Mohamed[1]

[1]Department of Hygiene and Preventive Medicine, Faculty of Vet.Medicine, Kafrelsheikh University (33156), Egypt.

[2]Department of Food control, Faculty of Vet.Medicine, Kafrelsheikh University (33156), Egypt.

ABSTRACT

The aim of the present study is to provide an overview about the impact of feeding fish onchicken manure (CM) or fermented chicken manure (FCM) on thephysicochemical character of water and performance of fish, as well as public health hazards and risks associated with consuming such fish in regard to fish quality. Nile tilapia) *Orechromisniloticus* (as an experimental fish where stocked into 7 groups (G) with duplicate treatment. Each group received different mixture of CM or FCM with fish ration (FR), 0:100, 25:75, 50:50 and 100:0 (% CM or FCM: % FR .(Physico -chemical character of water and heavy metal load (Cu ,Pband Zn) of water and fish, as well as fish performance were measured and compared with control group received only fish ration (FR). Unionized ammonia (UIA) was significantly high (P (0.05 >at groups received FCM resulted in 100% mortality in such groups. Dissolved oxygen level (DO) was significantly low (P (0.05 >at both groups received CM and FCM compared with control group. While heavy metals load (zinc, copper, lead) at water samples showed no significant difference among the examined groups, however slight decrease were observed at groups received FCM. While in fish flesh zinc only was detected above permissible limits in all examined samples. Specific growth rate (SGR) percentage were lower at groups received CM and FCM .Results recommended that addition of CM as a feed for fish must be controlled carefully in regard to the amount added and method of application. 25% CM as a part of fish feed is quiet safe for adding according to the above result. In spite of FCM is less in heavy metals than CM, but its ammonia content is higher, so using FCM must be done with great care concerning the level of ammonia and DO.

Keywords: *water: fish quality and chicken manure*

INTRODUCTION

Fish is a major source of protein for the increasing world population especially in developing countries of Africa, Asia and South America (FAO, 2006a; Gabriel *et al.*, 2007) and the major solution to the dietary protein shortage in such countries is increased fish production) Nnaji*et al.*, 2009a,b). Therefore, the main aim of the Egyptian government is not only to increase the fish production from different resources, particularly from aquaculture, but also to improve the quality of fish product.To meet the growing demand for fish, aquaculture is experiencing a rapid development. Total aquaculture production in Egypt reached 705, 490tonnesin 2009 (GAFRD, 2010).

The need for low cost system for fish production that will meet the food needs of the rural and urban poor and at the same time maximize the utilization of resources becomes pertinent(Nnaji*et al.*, 2011).Inorganic fertilizer has been promoted as more desirable due to its lower loading rates (due to higher nutrient contents) and lower oxygen demand (Yamada, 1986; Coleman and Edwards, 1987). However, manure has often been demonstrated to increase fish yield beyond that expected from the addition of inorganic forms of N and P alone (Schroeder, 1978; Noriega-Curtis, 1979). Studies have shown that there is a significantly higher level of fish yield in ponds fertilized with chicken manure than in ponds fertilized with inorganic fertilizer alone (Diana *et al.*, 1990).Many farmers pile the dry manure on the pond dykes, where it is sprayed with water for a few days before it is washed into the ponds. This process increases the fermentation rate and reduces the time to achieve maximum primary production.

Poultry litter and animal wastes in general contain high concentrations of some trace elements (Jackson *et al.*, 2003;Nnaji*et al.*, (2011) reviewed that CM applied to fish ponds is a mean for possible transfer of heavy metals in to aquatic system. Likely health risks to human beings and fish from heavy metal contamination arising from the use of CM and spilled chicken feed in rearing of fish in integrated chicken –fish system especially when fish reared in such a system and consumed for long periods. They explained the effect of chicken manure on pond /water sediments. They concluded that the persistence and toxicity of heavy metals in man and aquatic organisms calls for the constant monitoring of the incidence of these metals in the environment. According toAlinnorandobiji (2010) the contamination of water bodies and aquatic animals by heavy metals have been a global problem and constant monitoring of the environment for heavy metal contamination is important. This concern is largely due to the persistence, toxicity ,bioaccumulativeand non-biodegradable nature of such metals) Azmatet al 2008; Bhattacharya et al., 2008). Fish consumption is an important avenue for pathogen and heavy metal exposure to man (MusaigerandD,Souz, 2008; Christopher *et al.*, 2009). Heavy metals concentration in the tissues of fish enter into human beings through food chain and due to their cumulative action causes potential health hazards sometimes even lethal (El-shehawiet al., 2007). Heavy metals like arsenic (As), zinc (Zn) and copper (Cu) are also added feed supplements to boost poultry production and when added above the required levels they may accumulated to high levels, in the animals which are also transferred to aquatic systems when manure used for aquaculture. Organicmanuringalso leads to severe depletion of dissolved oxygen, high biological andchemical oxygen demand and high ammonia levels (Boyd, 1982), leading to stress in cultured fish (Parker, 1986).

Of all the water quality parameters that affect fish, ammonia is the most important after oxygen, especially in intensive systems. Ammonia in aquatic systems exists in both ionized (NH4 ($^+$and un-ionized forms (NH3). The un-ionized form of ammonia present in effluent ponds and systems is toxic to aquatic life (Alabaster and Lloyd, 1980). Harmful effects of ammonia on aquatic organisms have been extensively studied (Adams *et al.*, 2001; Alabaster and Lloyd, 1980;Chen and Lin, 1995; Harris *et al.*, 1998; Noor-Hamid *et al.*, 1994; Rasmussen andKorsgaard (1996).Ammonia causes stress and damages gills and other tissues, even in small amounts. Fish exposed to low levels of ammonia overtime are more susceptible to bacterial infections and have poor growth. Acute toxicity of un-ionized ammonia affects the survival of all aquatic organisms, while long term exposure to un-ionized ammonia (UIA) induces chronic toxicity effects on growth, reproduction and longevity (Andersen and Buckley, 1998;Arauzo, 2003; Arauzoand Valladolid, 2003; Leung *et al.*,2011). Knud-Hansen *et al.* (1991) found through leaching experiments that about 40% of chicken manure (N) was released as either ammonia or nitrate-nitrite after 6 days' immersion in pond water. Nitrate, the end product of the nitrogen cycle, is considered to be harmless to fish in natural systems and ponds as it is used as a fertilizer by plants, including phytoplankton. In closed systems with little or no water exchange, however, nitrate will accumulate and may be harmful if higher than 250 mg/L. Acute and chronic effects of nitrate have been reported in several fresh water fish species (Camargo *et al.*, 2005; Hamlin, 2006 ;Kamstraand van derHeul (1998 ,and marine invertebrates (Camargo et al., 2005; Hirayama, 1974;Kuhn *et al.,* 2010; Romano andZeng, 2007).

To the best of author's knowledge most of previous studies concerned mainly with the benefits of using CM as cheap organic fertilizer for fish ponds. Therefore, the aim of the present study is to provide an idea about the impact of using CM on water and fish quality. Two types of chicken manure were used fresh (CM) and fermented underthermophiliccondition (55ºC), with the aim to compare the effect of this treatment on water and fish quality .physico-chemical character of pond water, heavy metal load as Cu ,Pb , and Zn of water and fish as well as fish performance were measured and compared with control groups receiving only fish ration (FR).

MATERIALS AND METHODS

This laboratory study was carried out for 60 days (from 1st September till 1st November, 2012) at laboratory of department of Hygiene and preventive medicine faculty of vet .Medicine , KafrelshiekhUniversity, Egypt .Nile tilapia) *Orechromisniloticus* ,(was used for this study

Fingerlings with mean average weight of 10g and 7 cm length was obtained from local fish farm (El-Reyad ,KafrEl-Shiekh ,Egypt). Fish were homogenous in size, body weight and apparently health. The fish were acclimatized for seven days before the experiment. They were fed on the same diet (fish ration composition is illustrated in table 2) used in this study. During this adaptation period, the dead and weak fish were eliminated daily .

Chicken manure (CM) and fermented chicken manure (FCM)

CM was obtained fromKaferelshikhUniversity chicken farm (cage layer system) was collected from deposits directly under chicken cages. Fermented CM (FCM) was prepared by placing CM in a set of 125 ml capacity anaerobic serum vials. The headspaces of in the bottles were purged with N_2gas, and the vials were sealed with rubber stoppers and crimped aluminum caps. These bottles were incubated anaerobically 55°C. Biogas produced was monitored every day. When gas production stopped, vials were opened; FCM produced was collected and kept under -20°C until used) Abouelenien*et al.,* 2009; 2010). Characteristics of CM and FCM were illustrated in Table 1.

Experimental design

Feeding regime was 3 % of body weight per day was employed throughout the trial. The amount of feed was calculated and readjusted after weekly weighing. The fish aquaria under experiment were divided into 7 groups (G), stocked into 14 aquaria (dimension, 40x50x100cm) at stocking rate of 14 fish per aquaria (60 L water /aquaria,). The fish aquaria were supplied with chlorine free tap water with continuous aeration, using an electric aquarium air pump)HaliBAO-Cx (8200 for 60 days with. Two set of manure feeding used, first set received CM as a feed with different ratios (ranged from 0-100%), the second set received FCM, with different ratios (0-100%), and control aquaria which received fish ration (FR), containing 27% crude protein (CP), Composition and chemical analyses of the experimental CM, FCM and FR are shown in table (1) and (2). 2 replicate for each treatment, water changes on daily basis. Detailed description of the groups was illustrated in Table3.

Sampling

Water sampling was done once every two weeks, with a total number of 4 water samples which done at fixed time(Jha*et al.,* 2004). Water samples were collected by inverting 250 glass bottle 30 cm below the pond water surface. All samples were transferred to the lab. Five Fish were sampled at the same time of water sampling with water sampling by harvested with net and put in polyethylene bag. Ten grams of muscle portion of fish along with skin were homogenized for 1 min. with 90 ml of saline (0.85%NaCl (in a stomacher .

CM, FCM and FR were sampled with a rate of 100g, of each. Samples were transferred into a plastic bag and subjected to sample preparation according to APHA (1992; 1998).

Analytical methods

Water temperature, pH and dissolved oxygen were measured in situ with (a Yellow Springs dissolved oxygen (DO) meter Model 54A). Pond water pH was determined using aSuntexdigital meter Model Sp-5A. Temperature was recorded by a mercury thermometer .TOC was determined with a TOC analyzer (TOC-5000, Shimadzu .(TS, VS, TKN, NH3-N, and NO3-N were measured in accordance with the standard methods (APHA, 1998).

Digestion of water samples, 10ml of nitric acid was added to 50ml of each water sample and heated at 150ºC for 30mins. 5ml of nitric acid was then added to each tube and heated for 30minutes at 200ºC, to the mixture was added 2ml of hydrogen peroxide before further heating at 200ºC for 30minutes. The resulting solutions wereallowed to cool at room temperature and then the volume made up to 25ml with distilled water (AOAC, 1995).

Fish samples were analyzed by a modified procedure from the Association of Official Analytical Chemists (AOAC, 1995). For analysis of heavy metals in CM, FCM, and FR samples were prepared according to the technique described by AOAC official method 999.11. In prepared samples of water, fish muscles, CM, FCM, and FR,Lead) pb ,(Zinc) Zn (and Cupper (Cu (using Atomic Absorption Spectroscopy, (Model-analyst 200,PerkinElmer).

The weights of the fish were recorded at the beginning of the experiment and during harvest to the nearest 0.001 g. Dead fish were removed daily, and were not replaced during the course of the study. Differences between the number of fish stocked and the number of fish at harvest were used to calculate mortality percentage in each treatment. The specific growth rate (SGR) was calculated as: SGR= 100)]lnWt–lnW0)/t]; where W0 andWtare the initial and final weights of live fish (g) respectively, and) t) is the culture period in days (Ricker, 1975).

Statistical analysis

Data was presented as means ± SEM and analyzed by one-way ANOVA using Graph Pad™ prism 5. TheTukey'sMultiple Comparison Test was used as a post hoc test when appropriate (P>0.05 ,ANOVA). The significance level was set at P>0.05.

RESULTS AND DISCUSSION

Table (1), illustrated that the highest amount of TKN was found in CM (87 g-N kg-TS-1) and lowest in FR. Additionally highest amount of TAN was found in FCM (30 g-N kg-TS-1) from this result the amount of CM replaced FR was calculated .The crude protein content in FCM was lower than that in CM. Water temperature was between 24.22ºC and 25.02ºC during the 8 weeks. However, there was no difference in water temperature from one management regime to another on any particular sampling date (Table 4). The water pH in all the treatments was alkaline (Table 4) with the lowest value in control group (8.26), while the highest value was reported in G7 (8.47). Average values of total ammonia and un-ionized ammonia were illustrated in table 4 which significantly higher in G7 (100% FCM) P.0.05.>Highest unionized (15.49 mg/L) ammonia was found in water samples taken from G7 (100% FCM), and lowest value (4.17mg/L) was in G1 (control).However there was no difference in nitrate values between different groups (1.95 to 2.36 mg/L) (table 4). The values of dissolved oxygen were significantly higher (P (0.05>in G1 (control) treatment, than other treatments (Table4).

Metal concentrations) Pb ,Zn and Cu) in fish and water samples in different treatment groups are illustrated in table 5.The mean concentration ofPb ,Zn and Cu in water samples were ranged from 0.03 (G7) to 0.11 (G3), 0.79 (G7) to 1.26 (G2) and 0.09 to 0.23 mg/l respectively. Cu andPbwere not detected in fish muscle samples in any treatment; however Zn was detected in a range of 32.13 to 44.13 mg/g (Table 5).

The final body weight of the Nile tilapia under different treatments ranged from 8.85 to 16.38 g with significant difference between groups (Tab. 6). At harvest, maximum final weight was achieved in G2 (25% CM), and lowest in G4 (100% CM).The specific growth rate (SGR %/day) was ranged from 0.4 to 1.92 withhighest value in G2 and lowest in G4 (table 6). Survival of Nile tilapia among treatments was ranged from 0 in G7 (100% FCM) to 100% in G1 (control).

Evaluating the impact of introducing organic fertilizers (chicken manure) with or without supplementary feeding onphysico -chemical character of pond water, heavy metal load as Cu , Pb ,and Zn of water and fish, as well as fish performance were studied usingNile tilapia. CM contains high amount of organic nitrogen in the form of uric acid) Krylovaet al., 1997 ,(withthermophilicanaerobic fermentation ammonia was accumulated) Abouelenienet al., 2010; 2014 .(The amount of CM and FCM used in different groups was calculated on dry matter (DM) basis according to its crude protein content .Amount of crude protein measured in the current study either in CM (12.39) and FCM (9.68) was lower than that measured byRapatsaandMoyo (2013)who found 27.6% CP in CM (Table 1).

Investigating the water quality of experimental ponds is of great importance in regulating and following the suitability of their water for holding and rearing fish. For basic understanding of water quality in studied ponds, water temperature, dissolved oxygen, pH, nitrate and ammonia were determined and are given in Table (4). No significant difference in water temperature between different groups during the experiment. This result was the same as obtained by El-Ebiary (1998) andPriyadarshini*et al.* (2011).Farmanfarmaianand Moore (1979) reported that, aquatic organisms could put up with a wider range of temperatures, without sudden or severe fluctuations. Water temperature over 18 °C was best for warm water fish survival and growth and many species suffered and died below 12 °C (Nagel, 1979).The current temperature results were slightly lower than the optimal temperature for growth of tilapia that is 26-34°C (Saber et al., 2004 **.**(No significant difference in values of pH, which was in the alkaline range throughout the experiment (Table 4).This result could be attributed to the high level of ammonia in all groups received either CM or FCM, and indicating favorable conditions for biological production (Priyadarshini*et al.*, 2011andFallahi*et al.*, 2013). However, this range is still in the range that optimum for growth of tilapia (Ross, 2000).

Dissolved oxygen (DO) was highest in G1 that not received manure and lowest in G7 that received 100% FCM (Table 4). There is a significant difference betweencontrol groupand groups from G3-G7 but no significant difference between control group and G2 that received 25%CM. This findingcould be attributed to the addition of manure,which contains organisms that decompose the organic matter and thus consuming the DO leading to decrease in its concentration in water(Fallahi*et al.*, 2013). However, Tilapia is highly tolerant to low dissolved oxygen concentration(0.1 mg/l) (MagidandBabiker, 1975)and the optimum growth is obtained at concentrations greater than 3 mg/l (Ross, 2000).The measured DO was lower than that measured byRapatsaandMoyo (2013) ,who found the mean of DO in ponds received CM was 7.73 mg/l.

Ammonia is a killer when present in higher concentrations, and many unexplained production losses have likely been caused by ammonia (John and tucker, 2004). UIA was calculated from TAN through measuring of temperature and PH. UIA is more dangerous than ionized ammonia and in the present study pH was (≥8) which intensify the fraction of UIA

)Arauzoand Valladolid, 2003 and Leung et al., 2011). Un-ionized ammonia (UIA) was higher with groups received either FCM or CMcompared to control group which is significantly different (Table 4). Where, UIA reach up to 15.09 mg/l in G7 that received 100% FCM and this concentration resulted in 100% fish mortality because of ammonia toxicity. As ammonia is toxic to tilapia at concentrations of 2.5 and 7.1 mg/l as UIA, for blue and Nile tilapia respectively(Rednerand Stickney, 1979 and El-Sherif*et al.*, 2008) and depressed feed intake and growth at concentrations as low as 0.1 mg/l (El-Sherif*et al.*, 2008). Optimum concentrations are estimated to be below 0.05 mg/l (El-Sherif*et al.*, 2008). Exposure of fish to different high concentrations of ammonia and/or UIA are known to cause behavioral and physiological changes in fish and have several possible mechanisms oftoxicity (Evans *et al.*, 2006).Under the condition of this experiment, exposure of Nile tilapia to high concentration of ammonia and/or UIA was accompanied by decreased swimming activity. At first, the fish settled on the bottom of fish pond with very little movement. With the increase of ammonia concentration at (G6 and G7), the fish moved higher in the water column and reach the surface of fish pond with the highest level of ammonia and UIA (G7). For groups that received CM and FCM (Except 25% CM), fish showed dark discoloration of body and lethargy. This may be attributed to the respiratory difficulties originated from high ammonia and UIA and low DO (Israeli-Weinstein and Kimmel, 1998). The decreased activity of fish resulted in lowering of ammonia production and subsequently reduced its harmful effects. While, under higher concentration of UIA, fish became more lethargic and anorexic which leads to exhaustion, surface swimming and death (Randall andTsu ,2002).

There is no significance different in Nitrate concentration between different groups ($P<0.05$). This result was nearly the same obtained byPriyadarshini*et al.*,2011) (who studied the effect of using manure as a feed for fish.

According to the Environmental Protection Agency (EPA), lead, copper and zinc are some of the most common heavy metals inducing pollution) Ang, 2008).

With the aim to study the heavy metal impacts through feeding the fish on CM and the potential transfer of metals to human through consumption of fish flesh. Cu, Zn, andPbwere measured in CM, FCM, FR, water and fish muscle samples. The result of the present study showed that no significant difference between different groups and control group (P (0.05<in concentration of tested metals (Cu ,Pband Zn) (Table 5).

The Concentrations of lead) Pb (in water samples showed no significant difference between groups (P (0.05<with maximum concentration, of 0.11mg/l, in G3 which received 50% CM . While the lowest concentration was found in G7 (0.03 mg/l .(It seems that anaerobic fermentation of CM resulted in decreasing in the level ofPb .In addition, this value is less than that of control. The level ofPbin all groups does not exceed the maximum permissible limit MPL of EOS (1993**,**(which is 0.1mg/l (Table 5).The mean concentration of Zn in different groups was not significantly different (P ,(0.05<with highest in G2 and lowest in G7 with 100% FCM. Moreover, the mean of Zn in all groups was less than the maximum permissible limit recommended by EOS, (1993) which is 5mg/l) KebedeandWondium .(2004 For Cu, there was no significant difference between groups with highest in G1 and G3 (0.23 mg/l), and lowest in G5 (0.09mg/l), and the values of all groups are less than the MPL (Table 5). The values of Zn and Cu in CM is decreased afterthermophilicanaerobic digestion (Table 1), so it is expected that the water samples from groups received FCM have lower concentrations of these metals than others. This result wasin agreed with that obtained byVoća*et al.*, (2005).

The result of fish muscle examination showed that, only Zn was detected with highest level in G4 (44.13 mg/kg), and lowest in G1 (control), however no significant difference between groups. The level of Zn in fish muscles was lower than the MPL (EOS, 1993), except for G4 which was higher than the MPL (Table 5). Zinc in aquatic environment is a potential toxicant to fish) Everall*et al.,* 1989) which causes disturbances of acid-base and ion regulation, disruption of gill tissue and hypoxia(Hogstrand*et al.,*1994) .(SenthilMurugan*et al.* (2008) reported that zinc load in fish muscle was low as compared to other organs.

There were significant difference (P>0.05)at the average of feed intake and final body weight between control and different groups received fresh and fermented CM (Table 5). Highest FI and final body weight were recorded in G2 that received 25 % CM while the lowest one in G4 which received 100% CM. This result could be explained on the basis of better water quality of water in this group as lower ammonia content was observed. Feeding andmanuring , individually and in combination, improved the growth of fish significantly (P (0.05>in all groups (Table 5).

Highest Specific growth rate (SGR %) was observed in G2 whish received 25% CM and the lowest was in G4 that received 100% CM. The average SGR percentage was higher than that obtained by El-Ebiary (1998) who obtained 1.05% SGR for tilapia reared on poultry manure as a fertilizer. Survival rate was highest in control group followed by G2 and lowest was in G7 which received 100% FCM which showed 100% mortality which may attributed to sudden elevation of ammonia level by addition of FCM .As FCM contain higher amount of ammonia than non-fermented) Abouelenien*et al.,* 2010), which caused fish toxicity and death .

CONCLUSION

Ammonia toxicity is the main problem appeared to limit the portion of chicken manure applied to fish aquaculture. UIA concentration was higher than 6 mg/l in all groups received CM or FCM with higher values in Groups received FCM. Fish group that received100% FCM showed 100% mortality caused by ammonia toxicity. The practice which done by fish farmer which leads to fermentation of CM before applying it to the fish pond cause increase in UIA of CM. Groups which received25% CM showed better performance of fish and water quality. Fermentation of CM lowers its heavy metal content and consequently decreasing its concentration in water samples. No significant difference found between groups concerning the measured metals) Pb ,Zn, and Cu), while their concentration were less than the MPL reported byEOS (1993). Zn was the only mineral detected in fish muscle, reaching its highest concentration in G4, which received 100% CM. From the above results, it is recommended that addition of CM as a fertilizer or feed for fish pond should be controlled carefully concerning the amount added and method of application. Adding of 25% CM as a part of fish feed is quiet safe according to the above result. In spite of FCM is bacteriologically safer than CM and contain more available nitrogen, less heavy metals, but its ammonia content is higher. Therefore, using of FCM should be done with great care to level of ammonia and DO .

REFERENCES

Abouelenien, F., Kitamura Y.,Nishio N. and Nakashimada, Y. (2009). Dry anaerobic ammonia-methane production from chicken manure .ApplMicrobiolBiotechnol .764-757 :82 ;

AbouelenienF, Fujiwara W ,NambaY ,KossevaM ,NishioN ,NakashimadaY. 2010 Improved methane fermentation of chicken manure via ammonia removal by biogasrecycle . BioresourTechnol.6373–6368 :101 ;

AbouelenienF ,NambaY ,KossevaM ,NishioN ,NakashimadaY .2014 .Enhancement of methane production from co-digestion of chicken manure with agricultural wastes . BioresourceTechnology 159; 80–87

Adams, M.B., Powell, M.D., Purser, G.J., 2001 .Effect of acute and chronic ammonia and nitrite exposure on oxygen consumption and growth of juvenile big bellied seahorse .Journal of Fish Biology 58, 848–860.

Alabaster, J.S., Lloyd, R., 1980 .Water Quality Criteria for Freshwater Fish .Butterworths , London.

AlinnorI. J. and I. A .Obiji .(2010) Assessment of trace metal composition in fish samples fromNworieRiver .Pakistan J .Nutr2010 :85-81 :(1) 9 .

Andersen, H.B., Buckley, J.A., 1998 .Acute toxicity of ammonia toCeriodaphniadubiaand a procedure to improve control survival .Bulletin of Environmental Contamination and Toxicology 61: 116–122.

Ang ,H.H. (2008): Lead contamination in Eugeniadyerianaherbal preparations from different commercial sources in Malaysia, Food Chem .Toxicol.1975–1969 (2008) 46 .

APHA (1992 .(Standard Methods for the Examination of Water and Wastewater, 18th edition . American Public Health Association, Washington, D.C.

APHA (1998 .(Standard Methods for the Examination of Water and Wastewater, 20th edition . American Public Health Association, Washington, D.C.

Arauzo ,M., 2003 .Harmful effects of un-ionisedammonia on the zooplankton community in a deep waste treatment pond .Water Research 37: 1048–1054.

Arauzo ,M., Valladolid, M., 2003 .Short-term harmful effects ofunionisedammonia on naturalpopulationsofMoinamicruraandBrachionusrubensin adeepwastetreatmentpond.WaterResearch 37: 2547–2554.

AzmatR, Aziz F, andYousif ,M, 2008 .Monitoring the effect of water pollution on fourbioindicatorsof aquatic resources of Sindh Pakistan .Res. J. Environ. Sci., 2:465-473

Bhattacharya, A.K., S.N .MandalandS.K.Das .2008 ,Heavy metals accumulation in water, sediment and tissues of different edible fishes in upper stretch ofGangeticWest Bengal . TrendsAppliedSci. Res .68-3:61,.

Boyd CE. 1982. Water Quality Management in Pond Fish Culture [M]. Amsterdam: Elsevier Scientific Publishing Company, BV.

Camargo, J.A., Alonso, A., Salamanca, A .2005 ,.Nitrate toxicity to aquatic animals: a review with new data for freshwater invertebrates. Chemosphere 58, 1255–1267.

Chen, J.-C., Lin, C.-Y., 1995 .Responses of oxygen consumption, Ammonia–N excretion and Urea–N excretion ofPenaeuschinensisexposed to ambient ammonia at different salinity and pH levels. Aquaculture 136, 243–255

Christopher AE, Vincent O, Grace I., Rebecca E, and Joseph E, 2009 .Distribution of heavy metals in bones, gills, livers and muscles of (Tilapia (OreochromisniloticusfromHenshawTown Beach market inCalabarNigeriaPak.J.Nutr ;8 ,. .1211-1209

Coleman, J.A., and Edwards ,P. 1987 .Feeding pathways and environmental constraints in waste-fed aquaculture: balance and optimization .Pages 240-281 in P.J.W .Moriarityand

R.S.V .Pullin ,editors .Detritus and microbial ecology in aquaculture .International Center for Living Aquatic Resources Management, Manila, Philippines

Diana, J.S., C.K. Lin, T .Bhukaswan ,V .Sirsuwanatach ,and B.J .Buurma .1990 .Thailand: Cycle II of the Global Experiment. Pond Dynamics/Aquaculture Collaborative Research Data Reports 2(2 .(Oregon State University, Corvallis, Oregon.

EOS, 1993.Egyptian standard, maximum levels for heavy metal concentrations in food . ES2360-1993, UDC.546.19:815:EOS ,Egypt.

Edward JB ,.IdowuEO ,.OsoJA andIbidapoOR (2013), determination of heavy metal concentration in fish samples sediment and water fromOdo-Ayo river in Ado-Ekiti ,Ekiti -state, Nigeria, int. J. of Environmental monitoring and analysis 1 (1); 27-33

El-Ebiary ,EH .1998 .The use of organic manures inpolyculturesystem for Tilapia, mullet and Carp .Egypt. J .Aquat.Biol .andfish; 2(3): 133-147.

El-Sayed ,A-F.M. 2007 .Analysis of feeds and fertilizers for sustainable aquaculture development in Egypt .In M.R .Hasan ,T. Hecht, S.S. De Silva&A.G.J .Tacon ,eds. Study and Analysis of Feeds and Fertilizers for Sustainable Aquaculture Development, pp. 401-422 .FAO Fisheries Technical Paper .No. 497 .Rome, FAO 510 .pp.

El-ShehawiAM ,Ali FK ,SeehyMA. Estimation of water pollution by genetic biomarkers in tilapia and catfish species shows species-site interaction. Afr. J.

Biotechnology; 2007.6-840:(6)

El-Sherif ,M. S., and A. M. EL-Feky .2008 .Effect of ammonia on Nile Tilapia) *O .niloticus* (performance and some hematological and histological measures .Eighth International Symposium on Tilapia in Aquaculture .Cairo, Egypt

Emerson, K., Russo, R.C., Lund, R.E., Thurston, R.V., 1975. Aqueous ammoniaequilibrium calculations: effect of pH and temperature .Journal of the Fisheries Research Board of Canada 32, 2379–2383.

Evans, J. J ,.Pasnik ,D. J., Brill, G. C& ,.Klesius ,P. H. (2006). Un-ionized ammonia exposure in Nile tilapia: toxicity, stress response, and susceptibility to Streptococcusagalactiae .North American Journal of Aquaculture, 68(1), 23-33.

Everall ,N.C., MacFarlane, N.A.A. and Sedgwick, R.W. 1989 .The interactions of water hardness and pH with the acute toxicity of zinc to the brown trout ,*Salmotrutta*L .J. Fish. Biol., 35: 27−36.

FallahiM,.AmiriA ,ArshadN ,MoradiM ,DaghighRoohiJ. 2013 Culture of Chinese carps using anaerobic fermented cow manure (Slurry) and comparison of survival and growth factors versus traditional culture Iranian Journal of Fisheries Sciences12 (1.(

FAO2006 .a. Report of the expert consultation on Global Forest Resources Assessment:

Towards FRA 2010, 12–16 June 2006 ,Kotka ,Finland .Rome, Italy. (Also available

athttp://www.fao.org/forestry/11187-1-0.pdf.(

Farmanfarmaian ,A. and Moore, R. 1979 .Diseasonalthermalaquaculture Effectof temperature and dissolved oxygen on survival and growth ofMacrobrachiumrosenbergii .In: Power Plant Waste Heat Utilization in Aquaculture. Final Report, March, 1980. NSF/RANN (ASRA/PFRA.(

General Authority for Fish Resources Development (GAFRD .2010 .(Statistics of fish productionof year 2009. Cairo, Egypt, GAFRD, Ministry of Agriculture and Land Reclamation 104 .pp.

Gui,Y ,.Z. Wang, Y. Chen, W .Zhengand F. Li. 1989 .Use of fluctuating temperature to promote growth of Tilapianilotica .Journal of Fisheries of China .331 – 326 : 13 .

Gabriel U.U. O.AAkinrotimi ,D.O .Bekibele ,D.N .Onunkwoand P.E .Anyanwu ,(2007) , Locally produced fish feed, potentials foracquaculturedevelopment in sub-Saharan African Journal of Agricultural Research Vol. 297, pp. 287-295.

Hamlin, 2006 .Nitrate toxicity in Siberian sturgeon) Acipenserbaeri .(Aquaculture 253: 688–693.

Harris, J.O., Maguire, G.B., Edwards, S ,.Hindrum ,S.M., 1998 .Effect of ammonia on the growth rate and oxygen consumption of juvenile greenlipabalone ,HaliotislaevigataDonovan . Aquaculture 160: 259–272.

Hirayama, K., 1974. Water control by filtration in closed culture systems. Aquaculture .385–369 ,4

Hogstrand ,C., Wilson, R.W ,.Polgar ,D. and Wood, C.M. 1994 .Effects of zinc on the kinetics ofbranchialcalcium uptake in freshwater rainbow trout during adaptation to waterborne zinc . J. Exp. Biol., 186: 55−73.

Israeli-Weinstein, D., and E. Kimmel .1998 .Behavioralresponse of carp) Cyprinuscarpio (to ammonia stress. Aquaculture 165:81–93.

Jackson, B.P ,.Bertsch ,P.M., Cabrera, M.L ,.Camberato ,J.J., Seaman, J.C., Wood, C.W., 2003 . Trace element speciation in poultry litter. J. Environ. Qual. 32, 535–540.

Jha ,P ;.Sarkar ,K. and Barat, S. (2004). Effect of different application rates of cow dung and poultry excreta on water quality and growth of ornamental carp ,Cyprinuscarpiovr .koi ,in concrete tanks [J. Turkish Journal of Fisheries and AquaticSciences, 4: 17-22.

John A. Hargreaves and Craig S. Tucker (2004) Managing Ammonia in Fish Ponds, SRACPublication No. 4603, http://www2.ca.uky.edu/wkrec/ManagingAmmonia.pdf

JordieJ.C .Nettena ,Tjissevan derHeidebandAlfonsJ.P .Smoldersb (2013) Interactive effects of pH, temperature and light during ammonia toxicity events in Elodea Canadensis Chemistry and Ecology, Chemistry and Ecology458-29:448 .

Kamstra ,A., van derHeul ,J.W., 1998. The effect ofdenitrificationon feed intake and feed conversion of European eel AnguillaanguillaL. In :Grizel ,H ,.Kestermont ,P. (Eds.), Aquaculture and Water: Fish Culture, Shellfish Culture and Water Usage, European Aquaculture Society Special Publication no. 26, Oostende, Belgium, pp. 128–129.

Kebeda,A .and T.Wondimu,2004, Distribution of trace elements in muscle and organs of tilapia , OreochromisNiloticus ,from lakesAwassaandziway ,Ethiopian. Bull. Chem. Soc. Ethiopia, 18:119-130 .

Knud-Hansen C.F., McNabb C.O& .BattersonT.R. (1991) Application of limnology for efficient nutrient utilization in tropical pond aquaculture . VerhandlungenInternationaleVereinigungfurTheoretischeundAngewandteLimnologie :24 .2543-2541

Krylova ,N. I ,.Khabiboulline ,R. E ,.Naumova ,R. P., Nagel, M. A :(1997).The influence of ammonium and methods for removal during the anaerobic treatment of poultry manure, J. Chem. Tech .Biotechnol.105–99 :70 .

Kuhn, D.D., Smith, S.A., Boardman, G.D., Angier, M.W., Marsh, L., Flick Jr., G.J., 2010 . Chronic toxicity of nitrate to Pacific white shrimp ,Litopenaeusvannamei :impacts on survival, growth, antennae length, and pathology. Aquaculture 309, 109–114.

Leung J, Kumar M ,GlatzP, Kind K (2011) Impacts of un-ionized ammonia in digested piggery effluent on reproductive performance and longevity of DaphniacarinataandMoinaaustraliensisAquaculture406–401 :310

Magid ,A and MMBabiker .1975 ,Oxygen consumption and respiratory behavior of three Nile fishes .Hydrobiologia .367-46:359 .

Maldonado-MontielTDNJ ,Rodrı´guez-Canche ´LG,Miguel A .Olvera-Novoa .(2003) Evaluation ofArtemiabiomass production in SanCrisanto ,Yucata´n ,Me´xico ,with theuseofpoultry manure as organic fertilizer .Aquaculture 219: 573–584

MusaigerAO and D'Souza R (2008:(ChemicalComposition of Raw Fish Consumed in Bahrain. Pak JBiolSci.11:161-55 ,

Nagel, L .(1979) .Aquaculture in the third world .J. ofAnim.Res .And develop.77 :9 .

Nnaji ,J.C., C.T .Madu ,V.O .Omeje ,J.O .Ogunseyeand J .Isah2009 ,a .An integrated chicken-fish system in concrete ponds .Proceedings of the 24th Conference of Fisheries society of Nigerian (FISON .(Oct. 25-28 ,Akure ,pp.54-51 :

Nnaji ,J.C., F.C .Okoye ,C.T .Madu ,V.O .Omeje ,C .Wonah ,Nuhu ,M. and J .Isah2009 ,b . Optimum temperature and transportation density for tilapia) Oreochromisniloticus (broodstockin the semi-arid zone of Nigeria .J .Aquat .Sci., 24: 21-24.

Nnaji ,J.C ;.Uzairu ,A ,.GimbaC., andKagbuJ A (2011 .(Heavy Metals in integrated chicken-fish farming .Journal of applied science.2099-2092 :11 .

Noor-Hamid, S., Fortes, R.D ,.Parado-Estepa ,F., 1994 .Effect of pH and ammoniaon survival and growth of the early larval stages ofPenaeusmonodon ,Fabricius .Aquaculture 125: 67–72.

Noriega-Curtis, 1979 Primary productivity and related fish yield in intenselymanuredfish ponds . Aquaculture .344-17:335 .

Olajire ,A.A. andImeokparia ,F.E. (2000): A Survey of the water quality of theOsunriver ;metal monitoring and geochemistry. Bulletin of the Chemical Society of Ethiopia, 14: 91 – 108.

Parker NC .1986 .Stress and its implications in cultured fishes [A]. In :GrimaldiE, Rosenthal H. Trends and Problems inAquaculturalDevelopment – Proceedings of the Second International Conference onAquafarming – Aquaculture 84 [M]. Verona :Fieredi Verona, 167-177.

PrithwirajJha ,SudipBarat ,ChittaR .Nayak ,2008 .Fish Production, Water Quality and Bacteriological Parameters of Koi Carp Ponds Under Live-food and Manure Based Management Regimes .Zoological Research， 29(2) 165173—

PriyadarshiniM ,ManisseryJ.K ,.GangadharaB.Keshavanath ,P (2011) Influence of Feed, Manure and Their Combination on the Growth ofCyprinuscarpio) L (.Fry andFingerlingsTurk .J. Fish .Aquat .Sci. 11: 577-586

Randall, D. J., and T. K. N .Tsui .2002 .Ammonia toxicity in fish. Marine Pollution Bulletin 45:17–23.

Rapatsa ,M.M ,Moyo ,N.A.G (2013(Performanceevaluation of chicken, cow and pig manure intheproductionof natural fish food inaquadamsstocked withOreochromismossambicus . Physics and Chemistry of the Earth 66: 68–74

Rasmussen, R.S ,.Korsgaard ,B., 1996 .The effect of external ammonia on growth and food utilization of juvenile turbot ,Scophthalmusmaximus .Journal ofExperimental Marine Biology and Ecology 205, 35–48.

Redner ,B. D., and R. R. Stickney .1979 .Acclimation to ammonia by Tilapiaaurea .Trans. Am. Fish. Soc. 108: 383–388.

Ricker WE .1975 .Computation and interpretation of biological statisticsoffishpopulations [J]. Bulletin of the Fisheries Research BoardofCanada382-1 :191 ,

Romano, N ,.Zeng ,C., 2007. Effects of potassium on nitrate mediated alterations of osmoregulation in marine crabs. Aquatic Toxicology 85, 202–208.

Ross, P. S. (2000) Marine mammals as sentinels in ecological risk assessment .Human and Ecological Risk Assessment, 6 (1): 29-46.

Saber, A. El-Shafai ,A .FatmaEl-Gohary ,A.N .Fayza ,N. Peter Van Der Steen and J.G .Huub , .2004Chronic ammonia toxicity to duckweed-fed tilapia (O .niloticus.(Aquaculture, 232: 117–127

Schroeder, D.: Structure and weathering of potassium-containing minerals. Potassium

Research - Review and Trends .Proc. 1thCongress Int. Potash Inst., Berne (1978(

SenthilMurugan1, S ,Karuppasamy,R ,Poongodi1,RPuvaneswari ,S. (2008) Bioaccumulation Pattern of Zinc in Freshwater FishChannapunctatus) Bloch.) After ChronicExposure.TurkishJournal of Fisheries and Aquatic Sciences 8: 55-59

Voća ,N ,Krička ,T .Ćosi ,ćT .Rupić ,V .Juki ,ćŽ .KalamburaS.(2005(Digested residue as a fertilizer after themesophilicprocess of anaerobic digestion Plant Soil Environ., 51, 2005 (6): 262–266.

Yamada, R. 1986. Pond production systems: fertilization practices in warm water fish ponds . Pages 97-110*in*J.E .Lannan ,R O .Smitherman ,and G .Tchobanoglous ,editors .Principles and practices of pond aquaculture .Oregon State University Press ,Corvallis, Oregon.