JOURNAL OF VETERINARY AND APPLIED SCIENCES
2016 VOL. 6 (2): 37 - 46
Manuscript No. JVAS/2015/006; Received: 24/07/2015; Accepted: 10/06/2016
Published by: Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Nigeria

ASSESSMENT OF THE INFLUENCE OF POND TYPE, WATER SOURCE AND MANAGEMENT ON THE PREVALENCE OF FISH DISEASES IN ABUJA AND ENVIRON

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ABSTRACT

This study was carried out to evaluate the influence of pond type, water source and management practices on the prevalence of fish diseases in Abuja FCT and environ. A questionnaire was designed and validated by four experts. Cronbach alpha was used for the reliability test and an overall reliability coefficient of 0.87% was obtained. Stratified random sampling technique was used to select 60 fish farms out of the total of 271 fish farms, 5 each from the 12 Area Councils and Local Government Areas that made up the study area. A total of 120 medium-sized live fish suspected to be sick were selected from 20 farms. Sixty of them were clinically examined for bacterial infections, ecto- and endo-parasites, while the other 60 were used to isolate and identify bacteria from their skin. Forty five (75%) of the ponds studied were concrete type, 13 (21.7%) were earthen, 2 (3.3%) were tanks and 1 (1.7%) natural types. With regard to water source, 68.3% sourced water from boreholes, 18.3% from streams, 10.0% from taps and 3.3% from spring. Majority of the farms (66.7%) practiced monoculture and stocked Clarias species (71.1%) as the fish of choice. In terms of feed source, 83.3% used commercial feeds, 11.7% formulated feeds without a feed mill, while 5% had their own feed mills. Supplemental feeding was carried out in 78.3% of farms surveyed. Out of the 20 farms evaluated for diseases, ectoparasites (leeches and lice) were isolated and identified in 4 (20%); endoparasites (cestodes and nematodes) in 8 (40%), and bacteria were identified in 12 (60%) farms. The results of the study suggest that fish feed supplements of animal origin were the major sources of fish diseases in the study area. Therefore, fish farmers should be advised to process (by boiling) the animal wastes used as feed supplements to avoid the health problems emanating from them. In conclusion therefore, the results of this study suggest that nutritional management is the major culprit in fish diseases in Abuja and its environs as pond type and water sources did not appear to contribute significantly to the causes of fish diseases in the study area.

Keywords: Pond Type, Water Source, Management, Fish Diseases, Abuja, Nigeria

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ISSN: 2315 - 6856

INTRODUCTION

Food of animal origin provides high quality energy, protein and a variety of micro-nutrients for man. Thus, the Food and Agricultural Organization of the United Nations [1] reported that about 16% of man's energy and 34% of protein constitute total contribution of animal food products of the world food supplies. Meat is the major contributor, followed by milk, fish and egg [2]. Protein consumption by man varies from country to country depending on the level of development and availability of resources. McDonald *et al*. [2] further noted that about 55.5 g of animal protein is consumed per person per day in most developed countries which is above the world recommended average of 28 g. Protein consumption rate reached 34 g/person/day in Burundi, 11.4 g in Ghana but only 8.0 g in Nigeria against 35 g recommended for developing countries [3].

The Food and Agricultural Organization of the United Nations [1] highlighted that Nigeria rates least among the 47 countries evaluated for its animal protein consumption in sub-Saharan Africa. This is attributable to uncontrolled population growth, rapid urbanization and a widening gap between demand and supply of food for her teeming population [4]. By 2011, the population of Nigeria was estimated at about 167 million [Nigerian National Population Commission, 2011]. It has been suggested that fish farming could be a readily available means of providing animal protein for this population.

Fish is one of the few animal protein sources which have no serious socio-cultural constraints to its production and consumption. Indeed 40% of animal protein consumed in Nigeria comes from fish [5]. Aihonsu *et al.* [6] reported that traditionally, fish generally appears cheaper than meat and is a more effective source of animal protein to supplement proteins from plant sources in human diet. Protein from fish is known to contribute about 8.4% of total protein derived from ingested foods in Nigerian diets. Accordingly, the protein content of fish and fish products are higher than those of other similar food items such as beef and pork. Eyo [7] had earlier argued that fish meat is less tough and more digestible than other meat types.

There is no doubt that demand for fish in Nigeria is at very high rise against the short supply. In view of the rising human population and demand for scare but costly animal protein foods in Abuja area, fish farming is considered an appropriate means for bridging the gap between high demand and supply. Consequently, new and less experienced farmers are lured into fish farming in the area when they may not have adequate knowledge of the principles and management skills needed to sustain high productivity and efficient marketing of the product. One of the approaches for promoting satisfactory fish farming in the zone is to evaluate critical factors affecting production especially and methods needed to overcome arising constraints.

Many factors including diseases, fluctuating pasture quality and quantity, limited water availability, poor quality breeding stock and religious discrimination have been identified to impede the production, supply and consumption of animal protein food in Nigeria [8]. In a study at Morogoro, Tanzania on the Nile Tilapia [9], a significantly ($p<0.05$) higher prevalence of parasites were observed in fish ponds using river (18.8%) than rain water (0.0%). The authors [9] also noted that pond type was a risk factor in the prevalence of diseases as there was a significantly ($p<0.05$) higher parasite infection in earthen (20.9%) than concrete (4.7%) pond types.

Presently, there is dearth of information on the influence of pond type, water source and general management on the sources and prevalence of fish diseases in Abuja area of Nigeria. Consequently, this study was designed to evaluate the factors affecting location, pond type, water source, management practices, feeds and feeding as well as health status of fish in fish farms around Abuja.

MATERIALS AND METHODS

Selection of Farms and the Study Area

Stratified random sampling technique was employed to select 60 fish farms; five each from twelve Local Government Areas (LGA). The study area was made up of the 6 Area Councils in FCT (Abuja, Gwagwalada, Kuje, Bwari, Kwali, and Abaji; 4 LGAs (Karu, Keffi, Kokona and Nasarawa) in Nasarawa State and 2 LGAs (Suleija and Tarfa) in Niger State. Delineation and identification of the study farms lasted for 2 months.

Questionnaire Distribution for Data Collection

The study adopted a survey design. A questionnaire titled "Health and Management Practices in Fish Farms in Abuja Area, Nigeria'' was designed and validated. Cronbach alpha was used for the reliability test and an overall reliability coefficient of 0.87 was obtained. The questionnaire sought information on farm workers and data on establishment and factors affecting farm location, type of pond, source of water, personnel structure, management practices, feeds and feeding, common fish health problems and marketing strategies applied among fish farmers in Abuja FCT and its environ.

Sample Collection

On each visit to a fish farm, farm records (to identify the type, quality, quantity of feeds used as well as financial records of expenditure and income) and the common health problems of fish were assessed. Six fish with obvious symptoms of sickness such as low feed consumption, outright failure to eat, sluggishness, fish gathering together, leanness, fish rubbing their bodies against the walls of the pond, sores or lesions or bleeding areas on the body of fish, mortalities or dead fish floating on surface of the pond were randomly selected from the farm. Collected samples were properly labelled, divided into 2 groups (A and B) of three fish each and dispatched respectively to Microbiology and Parasitology laboratories at the Federal University of Agriculture, Makurdi for diagnosis. On the whole, a total of 120 medium-sized fish were selected from 20 farms. Half of them (n=60) were used for the detection of ecto- and endo-parasites, while the other half (n=60) were used for isolation and identification of bacteria that caused the diseases. Samples were collected from the edge of ponds with a deep net as described by Durborow [10]. These samples were transported to the laboratories in cool bore-hole water under ambient environmental temperature in a 50-litre plastic jerry can within 2 to 4 hours of collection.

Experimental Procedures

Two experimental studies were carried out as follows:-

Study 1: Collection and identification of ecto and/or endo-parasites among fish farms located in Abuja and environ.

Study 2: Identification of bacteria flora in fish farms within Abuja and environs.

Study 1: Examination for ecto and/or endo-parasites among fish farms located in Abuja and environ

Sixty whole fish samples were used in this study (Group A). The gills of the fish collected for diagnosis were examined according to the method of Emere and Egbe [11] as follows: The operculum of the gill was cut open with a clean scissor to expose the arches. With a hand lens the arches were examined for ecto-parasites. A glass pipette with blunt tip was placed on the arches and aspirated. The content of the pipette was placed on a Petri-dish containing normal saline solution and examined under a dissecting microscope for proper identification of ecto-parasites. The fish sample was further dissected to expose the gastrointestinal tract and the intestine was removed and placed whole on a glass and slit open longitudinally with dissecting needles. The contents were washed into a Petri-dish containing normal saline solution and examined under a dissecting microscope for endo-parasites. Isolated parasites were identified by matching method as described by Pouder *et al*. [12].

Study 2: Identification of bacteria in fish farms within Abuja and environ.

Total Viable Count of Bacteria using the Pour Plate Method

Skin scrapings from 60 fish (Group B) were used for bacterial counts using the pour plate method. For each sample, bacteria were cultured, counted and properly identified using the method described by Eyo [7] and modified by Baird-Parker [13]. To determine this, a known volume of skin extract was serially diluted, with the homogenate of each dilution evenly spread on Nutrient agar plate. In this regard, 7g of nutrient agar powder was weighed out using electronic balance, dissolved in 250 ml of distilled water in a conical flask, covered with cotton wool and aluminium foil and vigorously agitated to dissolve content. Thereafter, it was autoclaved at 121^{o}C for 15 minutes. The skin extract was done by using paired forceps to raise the skin carefully, free from the muscle and cut off aseptically with a pair of scissors. The skin cuts were placed on an electronic balance to weigh out 5g. The extract was homogenized for 2 minutes in 50 ml of distilled water. Nine millilitres of distilled water was put into each of 5 culture tubes. They were sterilized by autoclaving at 121^{o}C for 15 minutes and allowed to cool to 45^{o}C. One millilitre of the homogenate solution was transferred into the first culture tube (A) and vigorously agitated, then serially diluted into four other tubes (B-E). These serial diluents were coded 10-1 to 10-5 respectively. Five Petri dishes were arranged and coded 10-1 to 10-5 accordingly and 0.1 ml of the diluents was dispensed into the first Petri dish coded 10-1 and this was repeated for the 10-2 to 10-5 dishes. The cooled Nutrient agar at 45^{o}C was then poured into respective Petri dishes containing the diluents and mixed properly. The Petri dishes were incubated at 37^{o}C for 48 hours to allow for formation of bacterial colonies from the extract. Using a colony counter (Bran Scientific and Instrument Company, England), all samples were counted and recorded as colony forming unit per gram (cfu/g). The diluent was multiplied with the dilution factor to get the cfu/g.

Identification of Coliform Bacteria

Another 5 g of the skin extract was diluted with 50 ml of distilled water, homogenized in a blender for 60 seconds. Ten grams of MacConkey broth was prepared as a single strength and another 20 g of MacConkey broth was prepared as double strength. Each was dissolved separately in 250 ml of distilled water, dispensed into 15 culture tubes divided into three groups of 10 ml, 1ml and 0.1ml respectively. A durham tube was inserted into each of the culture tubes and sterilized in autoclave at 121^{o}C for 15 minutes. Ten millilitres, 1 ml and 0.1 ml, of the homogenate solution were added to the corresponding 10 ml, 1 ml and 0.1 ml of the culture tubes containing MacConkey broth. Five tubes were used for the double strength of 10 ml and the other 10 tubes were used for the single strength of 1 ml and 0.1 ml. These were incubated at 37^{o}C for 24 to 48 hours. A change of colour of the culture tube from purple to light-yellow with gas trapped inside the durham tube was considered positive for coliform bacteria. Data on all the culture tubes were collected and collated for analysis.

Identification of Bacteria through Gram's Stain

The bacterial colony was picked with a loop, mixed with a drop of clean water on a slide, evenly spread over an area of 1.5 cm diameter and allowed to air-dry. Thereafter, it was heat fixed by passing the slide through a flame 3 times, flooded with 0.5% crystal violet for 30 seconds, drained and flooded again for 30 seconds with Lugol's iodine. The slide was then decolorized with absolute alcohol for 10 seconds and washed with water. It was again stained for 30 seconds with1.10 carbol fuchsin, washed with water, blotted gently and allowed to air-dry completely. The slide was examined under oil immersion microscopy. Gram-positive organisms stained violet-blue while Gram-negative ones were pink-red.

Identification of Bacteria through Indole, Methyl red, Vogues Proskan and Citrate utilization tests (IMVIC)

Biochemical tests including indole test, methyl red test, Vogues Proskau test, citrate utilization test, catalase test and coagulase test were conducted using standard procedures to isolate and identify bacteria species during the study [14].

Data Analysis
All data collected were subjected to descriptive statistical analysis according to Udom [15].

RESULTS
The results from this study identified 4 main factors prompting location of fish farms in Abuja and environs. These were the availability of land (68.3%) and water (16.7%), demand for fish (11.7%) and security (3.3%) (Table 1).

Table 1: Factors influencing the location of fish farms in Abuja and environs.

Factor	Number (%) of respondents			
	Abuja (n=30)	**Nassarawa (n=20)**	**Niger (n=10)**	**Total (n=60)**
Availability of land	22 (73.3)	14 (70.0)	5 (50.0)	41 (68.3)
Availability of water	4 (13.3)	4 (15.0)	3 (30.0)	10 (16.7)
Demand for fish	3 (10.0)	2 (10.0)	2 (20)	7 (11.7)
Security	1 (3.3)	1 (3.3)	0	2 (3.3)

The personnel structure of the fish farms in the study area showed that the average number of workers in a farm was 3 and that each farm had an employee designated as Farm Manager (Table 2). There were more male (88.3%) than female (11.3%.) Farm Managers. Majority (86.7 %) of the managers were resident on the farms while a few (13.3%) resided off the farm. Only 2 (3.3 of the farms in the FCT employed trained fish officers as Farm Managers but a vast majority (80%) of the Farm Managers were employees trained on the job. Farm Managers in farms located within the FCT received far higher emolument than those in Nassarawa and Niger States.

Table 2: Personnel structure and emolument of fish farm workers in Abuja and environs.

Variables		Abuja (n=30)	Nassarawa (n=20)	Niger (n=10)	Total (n=60)
Personnel	Total number	103	57	25	185
Manager's sex	Male	29 (96.7)*	16 (80)	8(80)	52 (88.3)
	Female	1 (3.3)	4 (20)	2 (20)	7 (117)
Manager's training	Job trained	2 (6.7)	0 (0)	0 (0)	2 (3.3)
	Trained on job	28 (93.3)	20 (100)	10 (100)	48 (80)
Manager's residence	On farm	28 (93.3)	17 (85)	7 (70)	52 (86.7)
	Off farm	2 (6.7)	3 (15)	3 (30)	8 (13.3)
Manager's emolument	Annual	268,666**	145,000	190,000	214,333
	Monthly	22,388	12,083	15,833	17,861

*Percentages; **Naira

Survey results of the source of water, type of pond and management systems in the study area indicated that concrete type of fish ponds were most numerous (75%) followed respectively by earthen (21.7%), tank (3.3%) and natural (1.7%) type ponds (Table 3). Similarly, a greater percentage of the farms (68.3%) sourced water from boreholes compared to 18.3% from streams, 10.0% from taps and 3.3% from spring/streams. A greater number of farms in the FCT sourced their water from boreholes and taps

compared to those in Nasarawa and Niger States who used predominantly water from boreholes and streams.

Most farmers (66.7%) practiced monoculture and *Clarias* was the major species of fish kept in the farms. Mosquito nets (28.3%), security men (26.7%) and dogs (23.3%) were major security measures adopted by the farms.

Table 2: Personnel structure and emolument of fish farm workers in Abuja and environs.

Variables		Abuja (n=30)	Nassarawa (n=20)	Niger (n=10)	Total (n=60)
Sex	Male	29 (96.7)	16 (80)	8(80)	52 (88.3)
	Female	1 (3.3)	4 (20)	2 (20)	7 (117)
Farm Head training	Job trained	2 (6.7)	0 (0)	0 (0)	2 (3.3)
	Trained on job	20 (66.7)	13 (65)	8 (80)	41 (68.3)
	Trained off job	8 (26.7)	7 (23.3)	2 (20)	17 (28.3)
Residence of Manager	On farm	28 (93.3)	17 (85)	7 (70)	52 (86.7)
	Off farm	2 (6.7)	3 (15)	3 (30)	8 (13.3)
Personnel	Number	103	57	25	185
	Trained on job	103	57	25	185
Emolument (₦)		8,060,000	2,900,000	1,900,000	12,860,000

Table 3: Distribution of respondents according to water source, pond type, production system and security in fish farms in Abuja and environs.

Variables	**Number (%) of respondents**			
	Abuja	**Nassarawa**	**Niger**	**Total**
Water source				
Bore-hole/well	21 (70)	15 (75)	5 (50)	41 (68.3)
Stream/river	3 (10)	4 (20)	4 (40)	11 (18.3)
Tap water	5 (16.6)	1 (5)	0 (0)	6 (10)
Spring water	1 (3.3)	0 (0)	1 (10)	2 (3.3)
Pond type				
Concrete/homestead	23 (76.7)	15 (75)	7 (70)	45 (75)
Earthen	5 (16.7)	5 (25)	3 (30)	13 (21.7)
Tank	2 (6.7)	0 (0)	0 (0)	2 (3.3)
Natural pond	1 (3.3)	0 (0)	0 (0)	1 (1.7)
Production system				
Monoculture	19 (63.3)	14 (70)	7 (70)	40 (66.7)
Poly-culture	11 (36.7)	6 (30)	3 (30)	20 (33.3)
Security device in use				
Mosquito netting	14 (46.7)	3 (15)	0 (0)	17 (28.3)
Security men	2 (6.7)	10 (50)	4 (40)	16 (26.7)
Security dogs	3 (10)	5 (25)	6 (60)	14 (23.3)
Bamboo tree fence	11 (36.7)	2 (10)	0 (0)	13 (21.7)

Majority of the farms within the study area (83.3%) used commercial feeds while some of them formulated their own feed with (5%) or without (11.7%) having a feed mill installed in their farms (Table 4). The major ingredients used in formulating local feeds were maize, ground nut cakes, millet, sorghum, dried fish and premixes. Feeding regimen were twice daily. Supplementary feeding in the form of dried trash fish, fly larvae grown on animal wastes, fresh cow dung, dried poultry wastes, wastes from fruits and vegetables and multivitamin supplements was carried out in 78.3% of farms.

Marketing strategies mostly adopted included the sale of live fish on farm based on demand and attainment of fish table size (1.8 to 2.5kg live weight). Farmers complained of exploitation by middle men who constituted the major purchasers. From the farm records and personal interviews, it was observed that fish farms minimally sought the assistance of veterinarians and other livestock experts in managing their farms and this may have contributed to their poor management/performance. From the questionnaires, the major constraints militating against fish farming business in the study area were finance, (70%), high cost of feeds (50%) and poor skills on the part of farmers (21.7%).

Out of the 20 farms screened for parasites, 12 (60%) had parasite infections which included the nematodes *Capillaria* and *Datylogyrus* species in 2 (10%) and 1 (0.5%) farms respectively; the cestode *Carylogyrus* species in 4 (20%) farms; the leech *Piscicola* species in 3 (15%) farms and the lice Argulus species in 1 (0.5%) farm (Table 5). A case of nematode infection that could not be identified was encountered in 1 (0.5%) farm. No cases of mixed infections were recorded in any farm during the investigation. All the nematodes and cestodes were recovered from the intestine while the leech and lice were recovered from the gill.

Table 4: Feeds and feeding management in fish farms in Abuja and environs.

Feeds/Feeding	Number (%) of respondents Abuja	Nassarawa	Niger	Total
Have feed mills	2 (6.7)	1 (5)	0 (0)	3 (5)
Have no feed mill	3 (10)	2 (10)	2 (20)	7 (11.7)
Commercial feeds	25 (83.3)	17 (85)	8 (80)	50 (83.3)
Supplementary feeds	23 (76.7)	17 (85)	7 (70)	47 (78.3)

Table 5. Parasite infections recorded among the 20 fish farms investigated in Abuja and its environs

Parasites Recovered		Predilection site	No. (%) Farms affected
Nematodes	*Capillaria* species	Intestine	2 (10)
	Datylogyrus species	Intestine	1 (0.5)
	Unidentified	Intestine	1 (0.5)
Cestodes	Carylogyrus species	Intestine	4 (20)
Leech	*Piscicola* species	Gill	3 (15)
Lice	*Argulus* species	Gill	1 0.5)

Results of the biochemical tests for identifying bacteria isolated from fish samples in the study area are shown in Table 6. The total viable count of bacteria ranged from $3.0x10^3$ to $5.8x10^{3.}$ Two bacteria genera; a gram negative and gram positive were isolated from 13 (65%) of the 20 farms screened and these included *Escherichia* species from 12 (60%) farms and *Staphylococcus* species from 1 (15%) farm. The

results further showed that concrete ponds generally harboured more parasitic and bacterial infections than earthen type ponds (Table 6).

Table 6: Pond type and disease prevalence in the study area

Pond type	No.)	Parasites group		Bacteria species	
		Ectoparasite	Endoparasite	*Escherichia*	*Staphylococus*
Earthen	(8)	1 (12.5)	2 (25)	6 (75)	6 (75)
Concrete	(12)	3 (25)	6 (50)	6 (50)	7 (58.3)
Total	(20)	4 (20)	8 (40)	12 (60)	13 (65)

DISCUSSION

The present study which evaluated the influence of pond type, water source and management practices on the prevalence of fish diseases was carried out in fish farms located at Abuja Federal Capital Territory, parts of Niger and Nasarawa States of Nigeria indicated that the main factors that determined location of fish farms in these areas included the availability of land, water and demand for fish. These findings agree with earlier report of Kudi *et a*l. [16] who observed that the most critical factors affecting fish production in Chikun and Kaduna South Local Government Areas of Kaduna State in order of importance were land, water and labour. However, it was noted that in even with the escalating population in the FCT, labour did not pose a problem in the study area. The finding that more men than women participated in fish farming in the study area was not surprising since similar observations were made by Kudi *et a*l. [16] in Kaduna State.

It was observed that majority (60%) of the fish farms studied used concrete than earthen ponds and with water supplied mainly from bore holes probably because of the urban nature of the study area, where physical space availability is considered a luxury to farmers possibly due to high cost. In this case, a closed recirculation of water system (RWS) with a bore-hole appears to be a much better source of water, as it could be constructed in-doors. It is possible that this system may have helped to minimize the contribution of water source to the prevalence of diseases in the study area.

adoption of monoculture as the main system of farming and *Clarias* as fish species of choice in the present study agrees with the findings of Fagbenro *et al.* [17] that of the over 30,000 metric tonnes of various freshwater fish species raised from cultures in Nigeria in the year 2000, catfish were more abundant only next to tilapias. Furthermore, Oresegun *et al*. [18] confirmed that of the several fish species available for culture, *Clarais gariepinus* was the fish that met the rigorous conditions of hardiness, tolerance to poor water quality, fast growth and relative disease resistance. Other farmers [19,20] who preferred polyculture did so mainly in areas away from highly populated city centres where there is sufficient land for earthen ponds.

Security services in most farms in the study area were provided by security man and dogs while mosquito nets were used to ward off predators. This is in agreement with Okaeme [21] who noted that in severe cases of predation, both mechanical and human efforts were employed.

Our findings showed that feeds and feeding management varied greatly in the farms investigated with most of the farms using imported commercial feeds that are usually costly. This is reminiscent of the work of Oresegun *et al*. [18] who reported the relative acceptability of commercial diet by catfish.

The parasites and bacteria recovered during the study suggested that they may pose serious health challenge to fish farming in the study area. It is possible that most of the parasites recovered in this study may have come from feed supplements especially those of animal waste origin. In earlier studies, Amlacher [22] recovered 32 different species of intestinal nematodes in fish while Ibiwoye *et al*. [23] observed that some freshwater fish species in Nigeria are rich in parasitic fauna. According to Okaeme [21], for successful fish farming, disease control must be an integral part of production because diseases may lead to loss of appetite, weight loss, reduced utilization of available resources, deformities, death and overall poor economic return in any production enterprise.

There was absence of organized fish marketing system which may have resulted in most of the farmers indiscriminately selling live fish on-farms. Quite often, these farmers sell to middle men who exploit the fish production business to the detriment of the producers.

Conclusion

From the findings of this study, fish feed supplements especially animal wastes were the major sources of fish diseases in the study area.

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