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Article

Status of chemicals and aqua-drugs used for freshwater fish health management at Rangpur district of Bangladesh

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Abstract: In order to know the existing situation of different chemicals and aqua-drugs used for fish health management an investigation was conducted following a time frame of May, 2019 to October, 2019 at Rangpur district of Bangladesh. Data were collected from the randomly selected fish farmers, company representatives and chemical sellers through questionnaire interview, personal contact and Focus Group Discussion (FGD). Farmers were facing several water quality problems associated with different fish diseases. To overcome those obstacles they use variety of chemicals incluldling lime, salt, potassium permanganate, urea, TSP, phitkiri and copper sulphate. Farmers used different chemicals for various purposes like Aquapure, Biopond, Zeofresh, JV-zeolite, Zeorich, Megazeo plus, Geo-ren etc. for pond preparation and water quality management; Sumithion, Engreb, I-mec, Sanmarine etc. for eradication of unwanted species; Oxymax, Oxymore, Oxylife, Aci-ox, Oxyrich, Oxy-aqua, Oxyren etc. to increase oxygen concentration and Gasonil, Gastrap, Bioaqua-50, Gasonex, Metrix, Pondkleen etc. for reducing harmful gases in pond water. Used disinfectants like Timsen, Virex, Polgard+, , Micronil etc.; antibiotics include Renamycin, Eskamycin, Bactitab, Cotrim vet bolus, Chemycin, Aquamycin etc.; Aqua photo, Safegut, Biomax, Profs, Pond care etc. were the used probiotics where various growth promoters include Panvit aqua, Nutrigel, Aquazyme, Spa gelly, Charger gel etc. Some problems were reported regarding the use of chemicals such as their indiscriminate use, method of application, time of application and inappropriate doses.

Keywords: aquaculture; chemicals and aqua-drugs; fish health management; Rangpur

1. Introduction

Aquaculture is one of the fast growing food production divisions in the world. This sector has expanded, diversified, intensified and technologically advanced in Bangladesh over the last few decades (Shamsuzzaman and Biswas, 2012). The well-being of aquaculture can be maintained by good quality management practices.

In aquatic animal health management, there has been an increasing trend of using aqua-medicines and chemicals due to the expansion of aquaculture in Bangladesh (Hossain *et al.*, 2014). Farmers are using various types of compounds in fish health management and disease treatment such as growth promoters, antibiotics, disinfectants, probiotics and to develop water quality and to increase dissolved oxygen concentration (Alam and Rashid, 2014). In addition, chemicals and drugs can also play effective role in soil and water management, improvement of aquatic productivity, formulation of feed, reproduction of aquatic creatures, processing and value enhancement of the ultimate product (Subasinghe *et al*., 1996). In Bangladesh, approximately 400 different types of aqua-medicines are now produced and marketed by 100 pharmaceutical companies (Alam and Rashid, 2014). Presently lots of chemical industries and chemical sellers influence fish farmers to use these chemicals in their culture units, although most of the farmers have not adequate knowledge about the drug

stability and effectivity (Karim and Stellwagen, 1998; BFRI, 1999; Faruk *et al.*, 2004). This ignorance drives fish farmers to try several chemicals one by one based on their output. They use doses of any particular chemicals either from their own experience, from the instructions on the package of that product or by discussing with the chemical sellers or farmers. Therefore, the proper doses of these chemicals are repeatedly neglected that may eventually be a threat for aquaculture.

Considering the above facts, the present study was conducted in Rangpur district of Bangladesh with its purposes for identifying the diverse group of aqua drugs and chemicals used for aquatic health management, purposes of using, their active ingredients, recommended and applied dosages, price and sources.

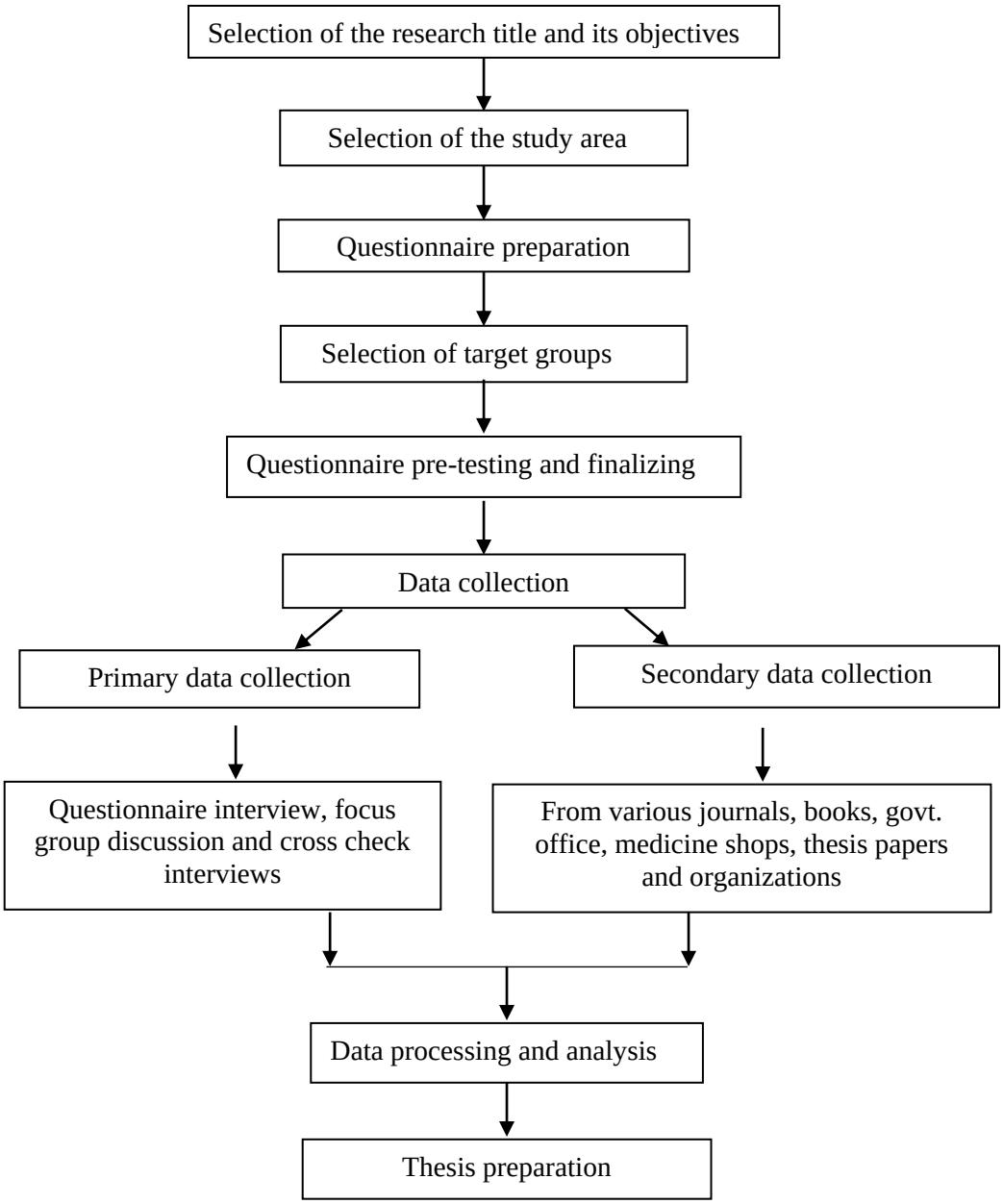
2. Materials and Methods

2.1. Study area and period

To investigate the status of chemicals and aqua-drugs used for freshwater fish health management Rangpur district was selected. Data collection period was from May, 2019 to October, 2019.

2.2. Flow chart of the research methodology

A clear and effective routine work was done to meet the objectives of the research work. The study was undertaken and completed according to the following order of methodology:



2.3. Preparation of questionnaire
Semi-structured questionnaires were made and field tested. To reach the objectives, necessary modifications were made based on the feedback. Questionnaires were prepared for data collection from the fish farmers, aqua-medicine producing companies and chemical sellers.

2.4. Target groups
Questionnaires were prepared for investigation and to achieve information. There were 100 fish farmers, 12 technical peoples of different drug producing companies and 17 chemical or drug shops were interviewed during the study period.

2.5. Data collection
Data was collected through questionnaire interview, personal contact, market surveys and Participatory Rural Appraisal (PRA) tool like Focus Group Discussion (FGD) with fish farmers, farm workers, medicine sellers and representative of different aqua-medicine producing companies in the selected area. Both the primary and secondary sources were utilized to collect data. Primary data were collected through simple interview with the respondents while carrying the survey. Secondary data helped to identify the problems and to confirm the primary data.

2.6. Analysis of data
The data were coded and inputted in a computer for further analysis. Data sheets were matched with questionnaires to confirm the exactness of data entered. MS Word and MS Excel have been used for processing and analysis, and presented in textual and tabular forms to meet the objectives.

3. Results
3.1. Water quality problems faced by the fish farmers
In the study area, the fish farmers reported various types of water quality problems in fish pond during culture period. These includes dissolve oxygen (DO) deficiency (95% of farmers), high ammonia (74%), algal bloom (37%), turbidity (28%), pH (19%) and poor phytoplankton (14%) (Table 1).

3.2. Diseases faced by the fish farmers
In the study area, various types of fish diseases were occurred mainly during the winter season. Fishes were affected by different types of fish diseases such as EUS (69.32% of farmers), tail and fin rot (59.09%), argulus (55.68%), gill rot (43.18%), dropsy (42.05%), exophthalmia (13.64%), CCVD (5.68%) (Table 2).

3.3. Some commonly used traditional chemicals
From the present study, it was found that Lime, Potassium permanganate, Salt, Phitkari, Copper sulphate, Urea and TSP were commonly used by the selected farmers. The list of those used chemicals, their applied doses, price and sources are shown in (Table 3).

3.4. Chemicals used to remove unwanted species
For the removal of unwanted species, the farmers used Engreb, Nigotox aqua, Rota plus, Sanmarine, Sumithion, Tea seed meal and I-mec. Different information regarding to those chemicals are given in (Table 4).

3.5. Chemicals used for pond preparation and water quality management
The fish farmers of the study area used some chemicals for pond preparation and water quality management such as Aquapure, Biopond, Zeofresh, JV-zeolite, Zeorich, and others are shown in Table 5.

3.6. Chemicals used to increase oxygen concentration
In the investigation area, some chemicals were used by fish farmers to increase oxygen concentration in their pond. These chemicals are listed below (Table 6) with their trade name, active ingredients, recommended dose, applied dose, price and source/manufacturer.

3.7. Aqua-medicines used to remove harmful gasses in the study area
Farmers of the Rangpur region used some aqua-medicines to remove harmful gasses from their culture unit. The trade name, active ingredients, recommended dose, applied dose, price and source/manufacturer of those aqua-medicines are given in Table 7.

3.8. Disinfectants used in the study area

The fish farmers of the study area used some disinfectants to keep their pond free from pathogens. These aqua-medicines are listed below with their trade name, active ingredients, recommended dose, applied dose, price and source/manufacturer (Table 8).

3.9. Antibiotics used against diseases in the study area

From the study, it was observed that antibiotics were used by the farmers against fish diseases at Rangpur district. The trade name, active ingredients, recommended dose, applied dose, price and source/manufacturer of those antibiotics are given in (Table 9).

3.10. Probiotics used in the study area

The selected fish farmers were also used various types of probiotics. The trade name, active ingredients, recommended dose, applied dose, price and source/manufacturer of some probiotics are shown in (Table 10).

3.11. Growth promoters used in the study area

Several growth promoters were used by the fish farmers of the Rangpur district. These growth promoters are given below (Table 11) with their trade name, active ingredients, recommended dose, applied dose, price and source/manufacturer.

3.12. Knowledge of aqua chemicals and drugs

In the study area, most of the farmers (76%) were known of the aqua-medicines from company representatives through the seminars arranged by the company personnel, while (58%) of the farmers acquired knowledge on aqua-medicines from discussion with chemical sellers, hatchery owners and other farmers. About 47% farmers obtain knowledge from government organizations (GOs) (Table 12).

3.13. Problems faced by the fish farmers in the study area

Several problems were faced by the fish farmers in the study area including diseases (88% of farmers), low quality of fish seed (63%), lack of technical knowledge (58%), lack of finance (55%), low price of the end product (46%), insufficient water in dry season (41%), price of feeds and chemicals (39%), flood/overflow (36%),lack of manpower (30%), problem of pond leasing (27%), theft of fish (21%) (Table 13).

Table 1. Water quality problems faced by the fish farmers in the study area.

Water quality problems	Prevalence (%)	Death (%)	Treatment	Number of farmers (n = 100)	% of farmers
DO deficiency	40-60	2-5	Exchange of water, sodium per-carbonate	95	95
Ammonia	20-40	2-10	Exchange of water, *Yucca schidigera* extract	74	74
Algal bloom	30-50	0-1	Withdrawal of bloom using straw rope, probiotics	37	37
Turbidity	30-50	0-2	Lime, zeolite	28	28
pH	20-40	4-10	Exchange of water, lime (when low), *Yucca schidigera* extract (when high)	19	19
Poor phytoplankton	20-30	0-1	Urea, TSP, zeolite	14	14

Table 2. Diseases faced by the fish farmers in the study area.

Disease	Clinical signs	Prevalence (%)	Death (%)	Number of farmers (n = 88)	% of farmers
EUS	Red spot and infection	30-50	5-20	61	69.32
Tail and fin rot	Reddish color, broken tail and fin	20-50	2-20	52	59.09
Argulus	Rubbing or flashing against solid, excess mucous	20-40	2-10	49	55.68
Gill rot	Gill swelled and discolored gradually	20-40	5-20	38	43.18
Dropsy	Swollen abdomen	10-30	2-15	37	42.05
Exophthalmia	Eye swollen	10-25	2-15	12	13.64
CCVD	Lesion on mouth, white spot in head and body, infected fish remain flat on surface	70-95	80-90	5	5.68

Table 3. List of commonly used chemicals.

Trade name	Applied dose	Price (TK.)	Source
Lime	Pond preparation:1 kg/dec (sandy bottom), 1-2 kg/dec (clay bottom) During culture: 200-250 g/dec	20-22/kg	Chemical seller
Potassium permanganate ($KMnO_4$)	0.5-2 g/dec	20/10g	Chemical seller
Salt (NaCl)	100-200 g/dec	18/kg	Chemical seller
Phitkari	8-10 g/dec	60-80/kg	Chemical seller
Copper sulphate [$CuSO_4$. $5H_2O$]	5-10 g/dec	200-220/kg	Chemical seller
Urea	200-300 g/dec (pond preparation), 100-150 g/dec (during culture)	16-17/kg	Chemical seller
TSP	100-200 g/dec (pond preparation), 50-100 g/dec (during culture)	22/kg	Chemical seller

Table 4. List of chemicals used to remove unwanted species.

Trade name	Active ingredients	Recommended dose	Applied dose	Price (TK.)	Source/ Manufacturer
Engreb	Cypermethrine 10 %	7 ml/dec	5-8 ml/dec	125/100ml	Eon Animal Health Ltd.
Nigotox aqua	Trichlorphon 40%	12-13 ml/dec	10-12 ml/dec	240/250ml	Chemist Laboratories Ltd.
Rota plus	Rotenone 9%	20-30g/dec/ft. water	20-25 g/dec/ft. water	480/kg	ACI Animal Health Ltd.
Sanmarine	Cypermethrine 10 E.C.	5-7 ml/dec	5-7 ml/dec	390/400ml	Macdonald BD.
Sumithion	Fanitrothion	4-5 ml/dec	4-6 ml/dec	162/100ml	Chemical seller
Tea seed meal	Seponin 15-16%	0.8-1 kg/dec/5 ft. water	1 kg/dec	4500/50kg	ACI Animal Health Ltd.
I-mec	Ivermectine	6 ml/dec (3ft. water)	5-6 ml/dec	265/100ml	Eon Animal Health Ltd.

Table 5. List of chemicals used for pond preparation and water quality management.

Trade name	Active ingredients	Recommended dose	Applied dose	Price (TK.)	Source/ Manufacturer
JV zeolite	Natural geolite	6-8 kg/33 dec	6.5-7 kg/33 dec (200g/dec)	565/10kg	Eon Animal Health Ltd.
Geo-prime	Natural green geolite 100%	200-250 g/dec	200 g/dec	500/10kg	SK+F Pharmaceuticals Ltd.
Zeorich	Natural geolite 100%	100-200 g/dec	100 g/dec	535/10kg	Opsonin Agrovet
Megazeo plus	SiO_2, $A1_2O_3$, Fe_2O_3, CaO, MgO, Na_2O,K_2O and Mn	200 g/dec/ month	200-250 g/dec	400/10kg	ACI Animal Health Ltd.
Aqua pure	Natural sodium alluminium silicate	10-16 kg/acre	10 kg/acre (100 g/dec)	580/5kg	Square Pharmaceuticals Ltd.
Biopond	Geolite and probiotic	2-3 kg/acre/15 days	2-2.5 kg/acre (20-25 g/dec)	1035/2kg	SK+F Pharmaceuticals Ltd.
Zeolite gold	SiO_3, MgO, CaOetc.	200-250 g/dec/ month	200 g/dec	530/10kg	Fish Tech BD Ltd.
Zeo fresh	SiO_2, $A1_2O_3$, Fe_2O_3 CaO, MgO, Na_2O, K_2O and Mn	10 kg/acre	10 kg/acre (100 g/dec)	420/10kg	Square Pharmaceuticals Ltd.
Geo-ren	Aluminum sodium silicate	20-25 kg/acre	20 kg/acre (200 g/dec)	650/10kg	Renata Animal Health
Acme zeolite	Aluminum sodium silicate	20-30 kg/acre	20 kg/acre (200 g/dec)	280/10 kg	ACME Laboratories

Table 6. List of chemicals used to increase oxygen concentration.

Trade name	Active ingredients	Recommended dose	Applied dose	Price (TK.)	Source/ Manufacturer
Aci-Ox	Sodium per carbonate $2Na_2CO_3.3H_2O_2$	Normal: 3-4 g/dec Extreme: 5-7g/dec	7-8 g/dec	510/kg	ACI Animal Health Ltd.
Oxy-A	Sodium percarbonate	3-4 g/dec	4-5 g/dec	550/kg	ACME Laboratories Ltd.
Oxy-aqua	Sodium percarbonate	2.5-5 g/ dec	4-5 g/dec	690/kg	Navana Animal Health
Oxyflox	Sodium percarbonate	Normal: 3-4 g/ dec Extreme: 5-6 g/dec	5-6 g/dec	500/kg	Chemist Laboratories Ltd.
Oxy gold	Sodium percarbonate	2.5-5 g/ dec	4-6 g/dec	635/kg	Fish Tech Ltd.
Oxyrich Tab	Sustained release O_2 12%	5-12 tab/ dec	5-10 tab/dec	650/kg	Opsonin Agrovet
Oxymax	Sodium percarbonate	Normal: 2.5-3 g/dec Extreme: 5-10 g/dec	4-10 g/dec	700/kg	Eon Animal Health
Oxylife	Oxygen precursors, Probiotics	4-5 g/dec	4-6 g/dec	650/kg	Square Pharmaceuticals Ltd.
Oxymore	Sodium carbonate per-oxihydrate 90%	Normal: 2-5 g/dec Extreme: 7-10 g/dec	4-10 g/dec	740/kg	SK+F Pharmaceuticals Ltd.
Oxyren	Sodium percarbonate	2-3 g/ dec	4-5 g/dec	650/kg	Renata Pharmaceuticals Ltd.

Table 7. List of aqua-medicine used to remove harmful gasses in the study area.

Trade name	Active ingredients	Recommended dose	Applied dose	Price (TK.)	Source/ Manufacturer
Bio-Aqua-50	Yucca plant extract, Saponin components	3-4 ml/dec	3-4 ml/dec	298/100ml	Eon Animal Health Products Ltd.
Gasonex (+)	*Pseudomonas* sp., *Bacillus subtilis*, *Nitrococcus* sp.	200-400 g/acre	300-400 g/acre (3-4 g/dec)	445/100g	Fishtech BD Ltd.
Gastrap	Enzyme and probiotics	200 g/acre/3-6 feet water	200-400 g/acre (2-4 g/dec)	326/100g	Square Pharmaceuticals Ltd.
Yucca gold	*Yucca schidigera* extract	100 ml/33 dec	100-132 ml/33 dec (3-4ml/dec)	1850/500ml	ACI Animal Health Ltd.
Gasonil	Yucca plant extract, Saponin cmponents, Glyco components	150-200 g/acre	300-400 g/acre (3-4 g/dec)	495/250g	SK+F Pharmaceuticals Ltd.
Metrix	Al_2O_3, CaO, SiO_2, Feroso ferric oxide	6-10 kg/acre	5-6 kg/acre (50-60 g/dec)	767/5kg	Eon Pharmaceuticals Ltd.
Pondkleen	*Yucca schidigera* plant extract	100 ml/33dec	100-132 ml/33 dec (3-4ml/dec)	1500/500ml	ACI Animal Health Ltd.
Ammo check	Extract of *Yucca schidigera*	3-4 ml/dec/3-5 ft. water	3-6 ml/dec	250/100ml	Navana Animal Health
Yuka	*Yucca schidigera* extract	2-3ml/dec/3-4 ft. water	2-5 ml/dec	315/100ml	Opsonin Agrovet

Table 8. List of chemicals or aqua-drugs used as disinfectants.

Trade name	Active ingredients	Recommended dose	Applied dose	Price (TK.)	Source/ Manufacturer
Timsen	N-alkyl dimethyl benzyl ammonium chloride-40%	20g/33dec (for prevention) 80g/33dec. (for treatment)	1-2 g/dec	111/20g	Eon Animal Health Products Ltd.
Aquakleen	Tetra-desail Tri-methyl Ammonium bromide, BKC, Amaino nitrate	0.5-1 liter/acre	o.8-1 liter/acre	460/1 liter	Square Pharmaceuticals Ltd.
Pond safe	Alkyl-dimethyl benzyl-ammonium Chloride Solution 80% Inert Ingredients 20%	600-800 ml/acre	6-7 ml/dec	1035/500ml	Fish Tech BD Ltd.
Virex	Potassium per-oxi monosulphate 50%	100 g/33dec	100-132g/33 dec (3-4 g/dec)	170/100g	ACI Animal Health Ltd.
Polgard plus	3-methyl and 4 methyl two chain brominated compound	500 ml/acre	500-600 ml/acre (5-6 ml/dec)	460/250 ml	Fishtech Ltd.
Bleaching powder	Calcium hypochlorite	50 g/dec	50 g/dec	90-100/kg	Chemical seller
Biokleen aqua	n-alkyl dimethyl benzyl ammonium chloride 40%+ stabilized urea 60%	1-2 g/dec	1-2 g/dec	180/30g	Chemist Pharmaceuticals Ltd.
Sansure	Benzylchonium chloride 80%	150-200ml/33dec	165-198 ml /33dec (5-6 ml/dec)	285/100ml	Opsonin Agrovet
Micronil	Benzylchonium chloride 80%	1-2 liter/acre	1-1.2 liter/acre (10-12 ml/dec)	300/100 ml	SK+F Pharmaceuticals Ltd.

Table 9. List of antibiotics used against diseases.

Trade name	Active ingredients	Recommended dose	Applied dose	Price (TK.)	Source/ Manufacturer
Renamycin	Oxytetracycline	2-4 g/4-5kg feed, 10days	1-2 g/kg feed/week	80/100g	Renata Pharmaceuticals Ltd
Bactitab	Oxytetracycline 20%	1-2 g/kg feed/week	1-5 g/kg feed/ week	82/100g	ACI Animal Health Ltd.
Eskamycin	Oxytetracycline 50%	1-2 g/kg feed	1-4g/kg feed	180/100g	SK+F Pharmaceuticals Ltd.
Chemycin	Oxytetracline HCl BP	0.3-1 g/kg feed, 5-7 days	1-2g/kg feed	700/kg	Chemist Laboratories Ltd.
Aquamycin	Chlortetracycline	1-2 g/kg feed, 5 days' interval	1-3 g/kg feed	700-800/kg	Fishtech BD. Ltd.
Oxy-D Vet	Oxytetracycline 20% + Doxycycline 10%	1 g/kg feed daily	1-2 g/kg feed	175/100g	Eon Animal Health Products Ltd.
Cotrim vet bolus	Sulphamethoxa-zole + Trimethoprim	1-2 g/kg feed/week	1-4 g/kg feed	89/20 bolus	Square Pharmaceuticals Ltd.
Oxin WS	Oxytetracycline 20%	1-2 g/ kg feed	1-2 g/kg feed	745/kg	Navana Animal Health
Otetra vet power 50	Oxytetracycline	2-3 g/kg feed/week	1-3 g/kg feed	195/100g	Square Pharmaceuticals Ltd.
Urocot	Erythromycin	2-4 g/kg feed	1-5 g/kg feed	100/100g	Opsonin Agrovet

Table 10. List of probiotics used in the study area.

Trade name	Active ingredients	Recommended dose	Applied dose	Price (TK.)	Source/ Manufacturer
Aqua photo	*Bacillus subtilis* and *Rhodoseudomonas* sp.	60 –70 ml/ dec	50-60 ml/dec	579/1 liter	ACI animal health
Safegut	Probiotics, vitamin and enzyme	1 g/Kg feed	1-2 g/kg feed	300/250g	SK+F Pharmaceuticals Ltd.
Aqua magic plus	*Azotabactor chorococcum, Bacillus subtillis, Candida utilis*	5-8 kg/acre	5-6 kg/acre (50-60 g/dec)	750/5kg	Fishtech Ltd.
Ecorich	Probiotics, mineral, geolite	1-1.5 kg/33dec	1.3-1.6 kg/33 dec (40-50 g/dec)	800/5kg	Opsonin Agrovet
Biomax	Probiotics and nutrients	4-5 kg/acre/3 ft. water	5 kg/acre (50 g/dec)	410/kg	Square pharmaceuticals Ltd.
Profs	*Bacillus* sp. and *Pedicoccus* sp.	50-70 gm/33 dec	2-3 g/dec	660/100g	Eon Animal Health Ltd.
Pond guard	*Bacillus* sp., *Nitromonus* sp., *Nitrobacter* sp.	10-12 kg/acre	10 kg/acre (100 g/dec)	800/5kg	ACI Animal Health Ltd.
Pond care	Probiotics	50 g/acre	50-100 g/acre	495/50g	SK+F Pharmaceuticals Ltd.

Table 11. List of growth promoters used in the study area.

Trade name	Active ingredients	Recommended dose	Applied dose	Price (TK.)	Source/ Manufacturer
Panvit aqua	Vit- A, D_3, B_1, B_2, B_6, Ascorbic acid	5-10 ml/kg feed	5-6 ml/kg feed	125/100ml	Square Pharmaceuticals Ltd.
GPA	Multi stain probiotics, enzymes	0.5-1 g/kg feed	1 g/kg feed	1000/500g	Opsonin Agrovet
Nutrigel	Vitamin, mineral, probiotic	5-10 ml/kg feed	5-6 ml/kg feed	650/1 liter	SK+F Pharmaceuticals Ltd.
Vitamix- F aqua premium	Vitamin, minerals, amino acid	2.5 kg/ton feed	1-2 kg/ton feed (1-2 g/kg)	330/kg	ACME Laboratories
Spa gelly	Omega-3 fatty acid	10-15 ml/kg feed	10-12 ml/kg feed	580 / 1 liter	Eon Pharmaceuticals Ltd.
Charger gel	1-3 D glucan, polysaccharides, Betain, β-glucans	2-4 g/kg feed	2-4 g/kg feed	1060/kg	Fishtech Ltd.
Aci super-fish	Vitamin, Mineral, amino acids	1-2.5 kg/ton feed	2-3 g/kg feed	550/2.5 kg	ACI Animal Health Ltd.
Rena Fish	Vit-A, B_1, B_2, B_6, B_{12}, C, D_3, E, K, Cu, Mn, Fe, Co, I, Ca_2CO_3etc.	1 kg/ton feed	1-2 g/kg feed	300/Kg	Renata Pharmaceuticals Ltd.
Chemovit Aqua	Vit-A, B, C, D_3, E, K, Cu, Mn, Fe, Co etc.	2 g/kg feed	1-2 g/kg feed	430/kg	Chemist Laboratories Ltd.
Aquazyme	Sodium sulphate, polyvinyl alcohol, starch, selenium, magnesium, silicate	0.5-1 g/kg feed	1-2 g/kg feed	335/500g	Eon Animal Health Products Ltd.

Table 12. Knowledge of aqua chemicals and drugs.

Source of knowledge	Number of farmers (n=100)	% of farmers
Company representatives	76	76
Discussion (chemical sellers, hatchery owners, other farmers)	58	58
Government Organization (GO)	47	47

Table 13. Problems faced by the fish farmers in the study area.

Problems	Number of farmers (n = 100)	% of farmers
Diseases	88	88
Low quality of fish seed	63	63
Lack of technical knowledge	58	58
Lack of finance	55	55
Low price of the end product	46	46
Insufficient water in dry season	41	41
Price of feeds and chemicals	39	39
Flood/overflow	36	36
Lack of manpower	30	30
Problem of pond leasing	27	27
Theft of fish	21	21

4. Discussion

Various types of chemicals and aqua-drugs have become a noteworthy part of successful aquaculture production (Rahman *et al.*, 2017). From the present study, it was observed that fish farmers used different types of commercial chemicals and aqua-drugs which were broadly categorized as chemicals used for removal of unwanted species, for pond preparation and water quality management, to increase dissolve oxygen concentration, to reduce harmful gasses, as disinfectants, antibiotics, growth promoters and probiotics against diseases.

The present study revealed that Lime, Potassium permanganate, Salt, Phitkari, Copper sulphate, Urea and TSP were commonly used by the selected fish farmers as traditional chemicals. These are used for pond preparation, to increase primary productivity, maintain good water quality which is more likely to the findings of Uddin *et al*. (2017) in Sylhet district and Ali (2008). To eradicate undesirable species farmers of Rangpur region used various chemicals such as Sumithion, Engreb, I-mec, Sanmarine, Rota plus, Tea seed meal and Nigotox aqua which is more or less similar to the findings of Anwar *et al*. (2018) and Rahman *et al*. (2015) In the study area Aquapure, Biopond, Zeofresh, JV-zeolite, Zeorich, Geo-prime, Megazeo plus, Zeolite gold, Geo-ren and Acme zeolite were used for pond preparation and water quality management by the selected fish farmers which is analogous to the study of Rahman *et al.* (2015).

Typically, successful fish culture depends on careful management of oxygen concentration in the culture ponds. In the current study Oxymax, Oxymore, Oxylife, Aci-ox, Oxyrich Tab, Oxygold, Oxy-aqua, Oxy-A, Oxyflox and Oxyren were used by the selected fish farmers to increase oxygen concentration. In line with the present study, earlier research findings revealed that ACI-OX 28%, oxymax 22%, oxy more 11%, oxy flow 22% were used for oxygenation into water in Comilla region (Rahman *et al.*, 2017); Oxyflow, Oxymax, Bio-Ox, Oxy-A and Oxy Gold were used to increase dissolved oxygen in aquaculture ponds (Monsur, 2012). Selected fish farmers in Rangpur region used Gasonil, Gastrap, Bio aqua-50, Gasonex, Metrix, Yucca gold,Pondkleen, Ammo check and Yuka etc. to remove harmful gases. And the findings can be correlated with the previous study done in the north-eastern region in Bangladesh by Rahman *et al.* (2015).

In the study area, diverse types of fish diseases such as tail and fin rot, Epizootic Ulcerative Syndrome (EUS), dropsy, exophthalmia, gill rot, argulosis and Chhanel Catfish Virus Disease (CCVD) were observed. Similar conditions were also reported by the various authors in previous studies in aquaculture of Bangladesh (DoF, 2002; Faruk *et al.*, 2004). Farmers of the investigated areas used several chemicals as disinfectants to maintain hygiene and in some cases to prevent/treat a wide variety of viral, bacterial and fungal infection. Timsen, Virex, Polgard plus, Bleaching powder,Aquakleen, Pond Safe, Biokleen Aqua, Sansure and Micronil were used by the farmers of the study area as disinfectants which is comparable to the findings of Anwar *et al.* (2018) in Jamalpur sadar upazilla of Bangladesh. In Rangpur region various types of antibiotics are used for disease treatment by the fish farmers like Renamycin, Eskamycin, Bactitab, Cotrim vet bolus, Chemycin, Aquamycin, Oxy-D Vet, Oxin WS, Otetra vet power-50 and Urocot. The active ingredients of such antibiotics were mainly oxytetracyclin, chlortetracycline, erythromycin, sulphamethoxazole, trimethoprim. It was noticed that antibiotics were used extensively without ensuing the recommended doses. Rahman *et al.* (2017) mentioned that oxytetracycline 44%, cotrim-vet 17%, amoxicillin 28% and chlortetracycline 11% were used as antibiotics for disease treatment in Comilla regions which is more or less similar to the findings of Chowdhury *et al.* (2012) and Sharker *et al.* (2014).

In the study area different types of probiotics including Pond care, Profs, Biomax, Aqua photo, Safegut, Aqua Magic plus, Ecorich and Pond guard were used by the selected fish farmers which is well supported by Rahman *et al.* (2017) in Comilla region and Alam and Rashid (2014) in Shatkhira district. Commercial farmers have a tendency to get their end product as soon as possible. Aquazyme, Panvit aqua, Nutrigel, Charger gel, GPA, Vitamix- F aqua premium, Spa gelly, Aci super-fish, Rena fish and Chemovit Aqua were applied by the selected fish farmers in Rangpur district as growth promoters as in Jamalpur sadar upazilla (Anwar *et al*., 2018) and Shatkhira district (Alam and Rashid, 2014).

There is no doubt that chemicals are useful. It was found that most of the farmers used chemicals indiscriminately without knowing their mode of action, doses and appropriate procedures of application. Aqua drugs should not be used, if these are hazardous to the surrounding environment. Pharmaceutical companies should conduct more research works to reduce the harmful effect of aqua medicines on aquaculture.

5. Conclusions

After completion of the present investigation it is somehow clear that the farmers of Rangpur region are using various chemicals and aqua drugs sometimes without having proper knowledge about the doses and method of application. Unfortunately, little care has been paid on the documentation of those aqua-medicines. As a result, there is a lack of information regarding the impact of those aqua-medicines. Basically, appropriate chemicals with proper doses can minimize the adverse effects of those chemicals in aquaculture but negligence can become a threat for the future.

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Conflict of interest
None to declare.

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