Article

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

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Received: 18 May 2020/Accepted: 28 June 2020/ Published: 30 June 2020

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 including 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, Imec, 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 (KMnO₄) 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 [CuSO₄·5H₂O] 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 E.C. | 10 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 | 4-6 ml/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% SiO₂, Al₂O₃, Fe₂O₃, CaO, MgO, Na₂O, K₂O and Mn | 100-200 g/dec    | 100 g/dec                  | 535/10kg    | Opsonin Agrovet           |
| Megazeo plus  |                                                        | 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. |
| Zeorich gold  | SiO₂, MgO, CaOetc.                                      | 200-250 g/dec/ month | 200 g/dec                  | 530/10kg    | Fish Tech BD Ltd.         |
| Zeo fresh     | SiO₂, Al₂O₃, Fe₂O₃, CaO, MgO, Na₂O, K₂O and Mn          | 10 kg/acre       | 10 kg/acre (100 g/dec)     | 420/10kg    | Square Pharmaceuticals Ltd.|
| Geo-ren       | Aluminum sodium alluminium silicate                     | 20-25 kg/acre    | 20 kg/acre (200 g/dec)     | 650/10kg    | Renata Animal Health      |
| Acme zeolite  | Aluminum sodium alluminium 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 2Na₂CO₃·3H₂O₂                        | 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 12% | Sustained release O₂ 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 | 445/100g    | Fishtech BD Ltd.                     |
| Gastrap       | Enzyme and probiotics                                   | 200 g/acre/3-6 feet water | 200-400 g/acre (3-4 g/dec) | 326/100g | Square Pharmaceuticals Ltd.          |
| Yucca gold    | *Yucca schidigera* extract                             | 100 ml/33 dec    | 100-132 ml/33 dec (3-4 ml/dec) | 1850/500ml | ACI Animal Health Ltd.               |
| Gasonil       | Yucca plant extract, Saponin components, Glyco components | 150-200 g/acre  | 300-400 g/acre (3-4 g/dec) | 495/250g | SK+F Pharmaceuticals Ltd.           |
| Metrix        | *Al₂O₃*, *CaO*, *SiO₂*, 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 (3-4 ml/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                             | 2-3 ml/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) | 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 | 0.8-1 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      | 100-132 g/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) | 460/250ml | 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 SK+F Pharmaceuticals Ltd. |
| Micronil      | Benzylchonium chloride 80%                            | 1-2 liter/acre   | 1-1.2 liter/acre (10-12 ml/dec) | 300/100 ml | Opsonin Agrovet 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, 10 days | 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       | Oxytetracyline HCl BP    | 0.3-1 g/kg feed, 5-7 days | 1-2g/kg feed | 700/kg | Chemist Laboratories Ltd.         |
| Chemycin       | 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 | Navaan Animal Health Laboratories |
| 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 | *Azotabacter chororococcus*, *Bacillus subtilis*, *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., *Nitromonous* 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, D₃, B₁, B₂, B₆, 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                   |
| Nutrigel            | Vitamin, mineral, probiotic                     | 5-10 ml/kg feed  | 5-6 ml/kg feed        | 650/1 liter       | Agrovet                   |
| Vitamix- F          | Vitamin, minerals, amino acid                   | 2.5 kg/ton feed  | 1-2 kg/ton feed       | 330/kg            | ACME Laboratories         |
| aqua premium        |                                                 | 0.5-1 g/kg feed  | 1 g/kg feed           | 1000/500g         | SK+F Pharmaceuticals Ltd. |
| 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, B₁, B₂, B₆, B₁₂, C, D₃, E, K, Cu, Mn, Fe, Co, I, Ca, CO₃etc. | 1 kg/ton feed | 1-2 g/kg feed         | 300/Kg            | Renata Pharmaceuticals Ltd.|
| Chemovit Aqua       | Vit-A, B, C, D₃, 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, Oxirich Tab, Oxygold, Oxy-aqua, Oxy-A, Oxyflox and Oxynren 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, Ammon 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, chlorotetracycline, 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 chlorotetracycline 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.

Acknowledgements
The authors would like to express their sincere appreciation to Institute of Research and Training (IRT) for funding this research.
Conflict of interest
None to declare.

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