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SEASONAL VARIATION OF WATER QUALITY PARAMETERS AND USES OF AQUA MEDICINES IN SHRIMP FARMING IN THE SOUTH-WEST REGION OF BANGLADESH

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Abstract

Shrimp farming is a fast-growing industry, considered one of the best export-earning products in the coastal communities of Bangladesh. In this study, we observed the seasonal variation of water quality parameters in shrimp farms, as well as assessed the uses and effectiveness of aqua medicines. Primary data were collected through face-to-face interviews with 42 shrimp farmers and 30 drug and chemical sellers. The temperature varied from ~30 ^{0}C (during summer) to 15 ^{0}C (during winter), respectively. Dissolved oxygen (DO) levels recorded ranged from 3.5 mg/L to 6.0 mg/L in the study period. The pH remained stable from autumn to the rainy season, within 6.5 to 8 in all sites. Ammonia and nitrite concentrations were higher during the winter season. However, these values were lower before and after the winter. Seven categories of aqua medicines from 38 pharmaceutical companies were found to be used by the farmers. The effectiveness of the drugs and chemicals used by farmers to prepare ponds for increased growth rate and as a disinfectant ranged from 60 to 80% on average. Farmers used these aqua drugs and chemicals haphazardly and appeared to have little knowledge, awareness, and concern about their proper use and effectiveness. To overcome these problems, an effective and functional regulatory framework is required to monitor shrimp farms from the existing government institutions or authorities.

Keywords: Water quality parameters, aqua medicines, effectiveness, coastal region, Bangladesh.

Introduction

Shrimp farming has expanded rapidly in the south-west coastal region of Bangladesh because of its huge demand in the international market (Ahmed and Diana, 2015). It has become an important part of the economic sector in terms of income generation, employment opportunities, and foreign exchange earnings (Afroz and Alam, 2013). More than 0.7 million people are directly or indirectly engaged in shrimp farming and its associated activities (Banks, 2003). The rapid development of shrimp farming in south-west Bangladesh has been likened to a 'blue revolution' (Islam, 2007). The term 'blue revolution', allegorically means the blooming of shrimp farming in the coastal areas (Deb, 1998). In the coastal regions of many tropical nations, shrimp farming is a prevalent pastime, and Bangladesh also provides ideal conditions for shrimp culture (Uddin et al., 2020). Early in the 1970s, Bangladesh began exporting shrimp to other countries, and today it boasts 36 different varieties of shrimp, a highly notable development (Uddin et al., 2020). The economic contributions of coastal aquaculture, notably the culture of black tiger shrimp (Penaeus monodon), to both rural and national economies have emerged as a significant source of export revenue and employment in Bangladesh's coastal regions (Sharker et al., 2014; Uddin et al., 2020). With the expansion of shrimp farming, farmers are increasingly facing problems with various diseases, and the use of drugs and chemicals for treatment is increasing. A wide variety of water and sediment treatment compounds, fertilizers, pesticides, disinfectants, antibiotics, feed additives, hormones, vaccines, and probiotics are used to treat and control diseases, improve soil and water quality, and increase productivity (Anwar et al., 2018; Ullah et al., 2020; Aktar et al., 2020; Alam and Haque, 2021; Kawsar et al., 2022).

A significant issue determining the industry's sustainability is the quality and quantity of water used for shrimp production (Kasnir et al., 2014; Ullah et al., 2020; Uddin et al., 2020). Disease outbreaks are influenced by the factors impacting shrimp survival and growth in the water and soil (Ferreira et al., 2011). Moreover, poor water quality affects management and raises stress levels in shrimp and other fishes, making them more vulnerable to infections (Ferreira et al., 2011; Uddin et al., 2020; Bhuyain et al., 2022).

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Chemicals or aqua drugs are one of the outside inputs needed for prolific fish production in aquaculture as well as in all food manufacturing industries. Therefore, more pesticides and antibiotics are used in aquaculture due to its intensification in Bangladesh (Shamsuzzaman and Biswas, 2012; Uddin et al., 2020). However, to promote natural aquatic productivity, chemicals and antibiotics are crucial parts of pond building, soil and water management, and aquatic animal health management (Shamsuzzaman and Biswas, 2012; Kawsar et al., 2022). As a result, the majority of farmers use these pesticides extensively without understanding their necessity, efficacy, recommended dosage, or mode of application due to their illiteracy on proper information gap, which is also known as the term 'informational barriers' (Sharker et al., 2014; Islam et al., 2016; Islam et al., 2020). Therefore, the bacteria that impact humans could become resistant to antibiotics due to these chemicals' toxicity, allergenicity, or carcinogenicity. Thus, the relevant authority can organize training sessions and workshops to increase public understanding of the use of aquatic chemicals and pharmaceuticals for transformative adaptations (Barman et al., 2021; Islam et al., 2021; Bhuyain et al., 2022).

To our knowledge, a small number of studies have reported on the application of aqua medicines in shrimp farming in south-west Bangladesh, despite its enormous potential risks to human health and the environment. As a result, there is a dearth of knowledge about the current situation and effects of utilizing pesticides and antibiotics in the aquaculture sector, particularly in managing the health of aquatic animals, which warrants investigation. Based on this background, the present study was conducted to assess the seasonal variation of water quality parameters in shrimp farms in the south-west region of Bangladesh. Furthermore, this study also examines the use and effectiveness of several categories of aqua medicine in shrimp farming.

Materials and Methods

Study area

The study was conducted in shrimp farms and drug outlets of various Upazila of the Khulna region in Bangladesh. The sampling locations of coastal areas were Rupsha, Dacope, and Botiaghata Upazila in the Khulna district. These sites were chosen because there were several shrimp farms and farmers who practiced shrimp culture using aqua medicines and chemicals. However, there were several aqua drug dealers and pharmaceutical company representatives.

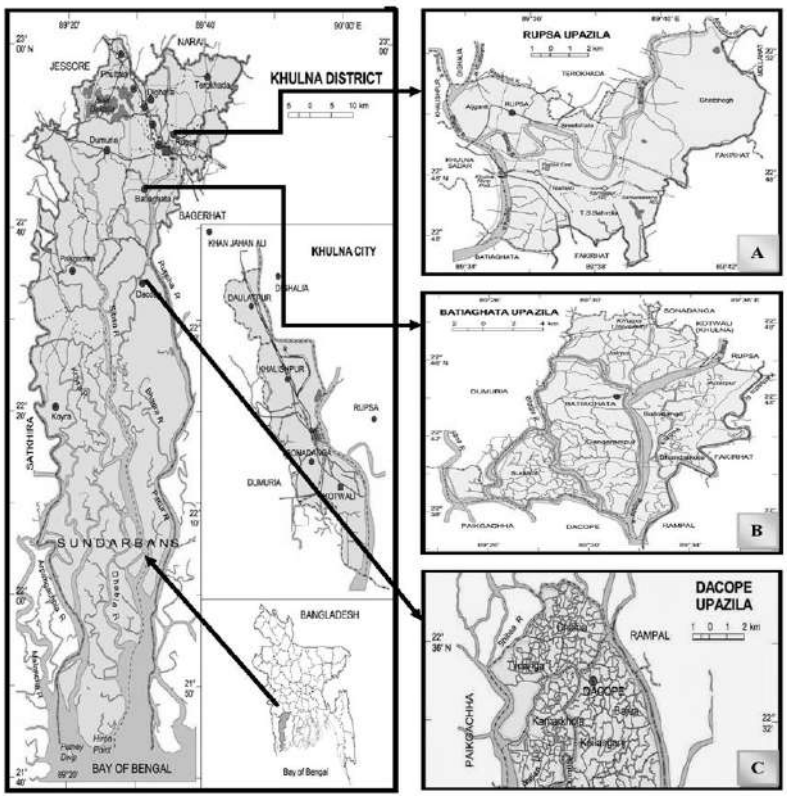

Figure. 1. Map of the study area indicated Rupsha, Botiaghata and Dacope Upazilla of Khulna districts. (Source:www.mapsofbangladesh.com & www.bdmaps.blogspot.com).

Assessment of water quality parameters

Water quality parameters like temperature (using a Celsius thermometer), dissolved oxygen, pH, ammonia, and nitrite were determined by Backpack Lab Marine Science Educational Test Kit (Model: HI3899BP). These analyses were carried out on the pond side at 15 days intervals during the study period between 10:00 and 12:00 AM.

Data collection

Primary data were collected from different target groups to have an overall scenario of the aqua medicines use and their impact on overall shrimp culture practices like water quality, health condition, production, etc. Data were collected from July 2017 to June 2018 through face-to-face individual interviews using a structured questionnaire with shrimp farmers, local retailers of aqua-drugs and chemicals, and representatives of pharmaceutical companies. Individual interviews were done with the farmers through arbitrary personal contact. A total of 42 farmers (12 to 15 from every sampling area) were interviewed in these study areas. To know the uses and effectiveness of medicines, an individual interview was conducted with 30 drug and chemicals sellers (5 to 8 medicines sellers and traders in each area, and 5 representatives of pharmaceutical companies). Farmers were asked about the drugs they use as disinfectants, growth promoters, antibiotics, and for diseases in their ponds. They were also asked about the effectiveness of the drugs etc.

Data analysis

The collected data from the interviews were entered into a database using MS Excel software. The data were cleaned, edited, and cross-checked thoroughly before analysis. The data were processed and analyzed using the statistical software package SPSS (Statistical Package for Social Science) version 23 (IBM SPSS, Armonk, NY, USA). Finally, the analyzed data were presented in tabular forms and graphs.

Results & Discussion

Seasonal variation of water quality

Temperature, dissolved oxygen (DO), pH, ammonia, and nitrite of water were recorded from shrimp ponds of three Upazilla in different seasons. From the study area, the significantly ($P< 0.05$) highest temperature was recorded in the summer season, above 30 ^{0}C, and in the rainy season, the temperature was slightly decreased (Fig. 2). During autumn, the temperature was near about 30 ^{0}C, and then in the winter season, the lowest temperature was recorded at around 15 ^{0}C in the study area (Fig. 2). The decrease of temperature could be due to shorter winter photoperiod and less intense of heat than summer (Nirmal Kumar et al., 2008). Moreover, the lowest value of dissolved oxygen reported from Dacope than Rupsha and lastly Botiaghata ranged from 3.5 to 4.5 mg/L in the winter season (Fig. 3). In summer, the amount of dissolved oxygen reported from 4.5 mg/L to 6.0 mg/L and in the rainy season, it was recorded highest 5.5 mg/L and lowest 4.5 mg/L (Fig. 3). The actual amount of dissolved oxygen varies depending on the pressure, temperature, and salinity of the water (Omer, 2019). Dissolved oxygen (DO) plays an essential role in the survival of aquatic biology and it is an important indicator used to evaluate the degree of freshness of aquatic habitat (Agbaire and Obi, 2009). The water quality parameters deteriorated during the dry seasons in all freshwater sources (Döndüa et al., 2022). The recorded pH values remained stable from autumn to the rainy season within 6.5 to 8 in all study areas (Fig. 4). Kumar et al. (2011) found a similar result that ranged from 7.03 to 7.23, which is within the prescribed limit of 6.5-8.5.

Poor water quality was recorded during the winter in Dacope, where the amount of ammonia and nitrite peaked at about 0.8 mg/L and 0.4 mg/L, respectively (Fig. 5 and Fig. 6). In Botiaghata, the amount of ammonia was recorded at 0.2 at mg/L in the winter season, which was recorded at zero during the autumn and rainy season (Fig. 5). The nitrite level was recorded at around 0.1 mg/L (Fig.6). In Rupsha, the amount of ammonia recorded approximately 0.1 mg/L and zero mg/L during autumn and summer respectively. The nitrite value was recorded at zero mg/L in both the autumn and summer seasons (Fig. 5 and Fig. 6). The fact that algae absorb very little ammonia, but the supply of ammonia remains constant during the winter is one of the primary causes of rising ammonia and nitrite levels. Eutrophication may result from high nitrogen or nitrogenous product levels (Hasan et al., 2009). Therefore, it is essential to keep it within the desired range. The organisms to be farmed determine the necessary water quality, which consists of interrelated elements. For culture organisms to survive and grow as optimally as possible, adequate water quality must be maintained (Islam et al., 2016, Barman et al., 2021). Most people agree that improved health management of aquatic creatures and the aquatic environment is ensured by a proper range of water quality measures (Islam et al., 2015). Disease outbreaks may be linked to the water quality indicators of total hardness, total alkalinity, pH, temperature swings, dissolved oxygen, and ammonia (Anwar et al., 2018; Barman et al., 2021).

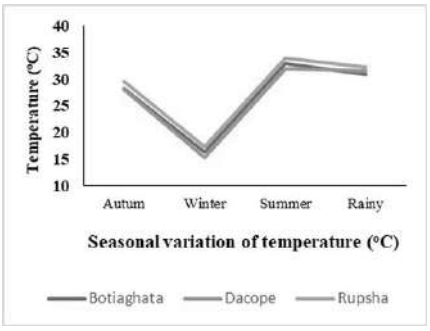

Figure. 2. Seasonal variation of temperature.

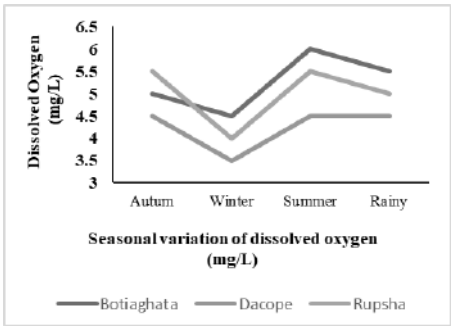

Figure 3. Seasonal variation of dissolved oxygen.

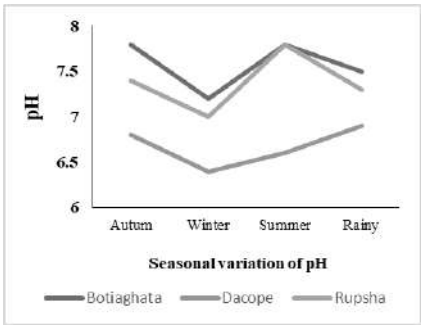

Figure 4. Seasonal variation of pH value.

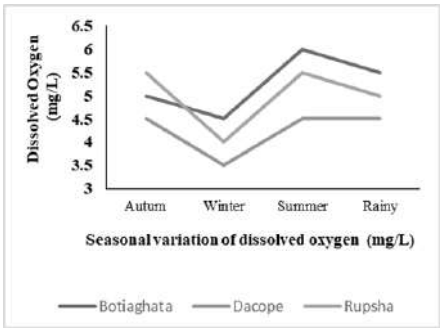

Figure 5. Seasonal variation of ammonia.

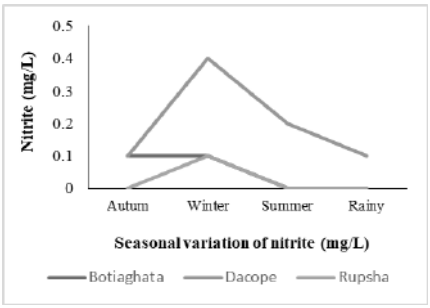

Figure 6. Seasonal variation of nitrite.

Major pharmaceutical companies in the Khulna region

In the Khulna region, 38 pharmaceutical companies supplied different aqua-drugs and chemicals in the study areas. Maximum products were supplied by ACI Animal Health Ltd., First Care Agro Ltd., Fishtech (Bd.) Ltd., Advance Agrotech (Bd) Ltd., Al Madina Pharmaceuticals Ltd, Square Pharmaceuticals Ltd. Organic Pharmaceuticals Ltd., and the minimum products were supplied by Agro Care, Khulna., Century Agro Ltd., Agrosia Corporation, Khulna., Pals Agrovet., Sp Vet Care Ltd., Biswas Agrovet Ltd., and Fish world Ltd. (Table 1). In the Lakhsmipur district, 22 companies were supplied with different drugs and chemicals, and ten companies provided about 79% of the total products (Paul *et al*., 2021). The study showed that these were Fish tech (BD) Ltd. (23%), Novartis Animal Health Ltd. (15%), ACI Livestock and Fisheries (7%), Renata Ltd. (5%), Eon Animal Health products Ltd. (5%), Acme Pharmaceuticals Ltd. (5%), Square Pharmaceuticals Ltd. (5%), Opsonin Pharma Ltd. (4%), Sigma Agro-vat Ltd. (5%), Fish Care Pharmaceuticals Ltd. (5%) and the remaining 21% were supplied by the other 12 companies including local nonbrand companies. A list of pharmaceutical company name and their products are mentioned in details in Table 1.

Category of aqua-drugs and chemicals used in the study areas

During the present research, seven categories of aqua-drugs and chemicals used by the farmers were recorded in the aqua-drugs shops. In the coastal aquaculture of the Khulna region, the chemicals used by farmers were categorized as pond preparation, water quality maintenance, oxygen suppliers, gas removal, growth promoters, disinfectants, antibiotics, and disease treatment. In Bangladesh, aqua-drugs are used to improve water quality and dissolved oxygen

levels as disinfectants, antibiotics, growth promoters, probiotics, and insecticides in the culture system. Seven categories of aqua medicines and chemicals were used by small fish farmers, commercial fish farmers, and hatchery owners in Shatkhira District (Alam and Rashid, 2014). Eight different categories of aqua-drugs and chemicals were used in shrimp farming activities in the coastal belt of Bangladesh as oxygen suppliers, disinfectants, growth promoters, antibiotics, pond preparatory, gas removal, insect killers, etc, and microbe killers (Ahmed et al., 2015). Six categories of aqua-drugs and chemicals were found to be used by fish farmers and hatchery owners for water quality management, disinfectants, disease treatment, antibiotics, and growth promoters (Sharker et al., 2014, Anwar et al., 2018).

Drugs used in pond preparation and water quality management

Different aqua-medicines were used during pond preparation and water quality improvement of fish ponds. For water quality management Acme's Zeolite, Agricultural lime, Bio-tuff, JV Zeolite, Lime, Urea, Zeolite plus, Aquazet, Benzo, Geotox, and Zeocare were used. Pondkleen, Pathonil, Fishcare Gold, Vita-Plankton, Plankton Grow, Megazeo Plus, Acme's Zeolite, Ukasol, Nordcap Fish Gold, and Ammocure vet, were available for water quality management (Ullah et al., 2020).

Use of disinfectants

Bleaching, Timsen, BKC (Benzal Konium Chloride), Emsen, Lime, and Formalin were used as disinfectants in the south-west coastal areas. Formalin is also used to control protozoan disease. BKC was recorded as controlling the bacterial disease. The list of disinfectants with their category and trade names are mentioned in Table 1. Formalin, bleaching, and EDTA (Ethylenediaminetetraacetic acid) were used as disinfectants. Among them, formalin was the most widely (43% of farmers) used disinfectant found by Chowdhury et al. (2015) and Rahman et al. (2019).

Use of oxygen suppliers

Several chemicals with very similar names were readily available in the aqua-drug shops of the study areas. Oxidizing agent hydrogen peroxide was the major active ingredient of such chemicals. Some drugs were also used to remove hardness and poisonous gases, i.e., Oxy Plus and Quick oxygen. Oxymax, Aci-Ox, Oxy-A, Oxycon, M: H-10, Oxymore, and Oxy gold were available as an oxygen supplier (Ullah et al., 2020). However, sometimes the supply chain depends on the demands of the customer choice (Barman et al., 2014).

Use of growth promoters

Several aqua-medicines were found in the aqua-medicine company and used as growth promoters as well as to increase production. Megavit Aqua, Aqua Boost, Aquamin, Acimix Super-fish, Aqua- C, Cevit-Aqua, Square Aquamix, Panvit-Aqua, Cp-Vet WSP, E-Vet Plus, Vitamix F-Aqua, Rena-WS, Rena C, Rena Fish, Vitax-C, Vitax-ES, Charger Gel, and Bio-Permix (gold) were used as a growth promoter.

Use of antibiotics

Renamycin, Bactitab, Chlorsteclin, Cotrim-Vet, Orgacycline-15%, Oxysentin 20%, and Sulfatrim are antibiotics with different trade names were found in the aqua drugs shops as well as used by the shrimp farmers. The active ingredients of such antibiotics are mainly Oxytetracycline, Chloro-tetracyclin, Amoxicillin, Co-trimoxa zole, Sulphadiazine, and Sulpha methoxazole. All of these antibiotics are effective against bacterial diseases.

Chemicals in disease treatment

Apart from antibiotics, only a handful of traditional chemicals were available in the shops to treat shrimp diseases (Anwar et al., 2018; Kawsar et al., 2022). Farmers use these chemicals to treat various shrimp diseases with different doses. Potash, lime, Formalin, Salt, Methylene Blue, Malachite Green, Malathion, and Timsen were used for disease treatments. Malathion, Dipterex, Malachite green, Formalin, Salt, and Methylene blue are useful for the eradication of external parasites as well as fungal diseases. Lime is also used for common fish diseases. Timsen is used for the treatment of various diseases and as a disinfectant.

Table 1. Aqua drugs producing companies and their products in the study areas.

Sl. No.	Aqua drugs producing Companies	Products
01	Acme Laboratories Ltd.	Miracle Lime, Vitamix F Aqua, Premium premix, Aqua WSP Acme's zeolite Pellete, Oxy A Granule
02	ACI Animal Health Ltd.	Aqua lime, Aqua cal, Ariake 3, Aci-Ox, Aqua photo aqua bond, Aquamin, Acimix super fish, Pond toss, Bio-Plus, Benthod, C Aqua, Fish Gel, Liquavit aqua, Megazeo Gold, No Algae, Plankton Grow, Shrimp Shield
03	Al Madina Pharmaceuticals Ltd.	Amcom Fish Premix, Hyvit Aqua WS Powder, Pure- Oxy Powder/Tablet, Madina Zeo
04	Annexvet (Pvt.) Ltd.	Zeonex and Diginix Aqua
05	Galaxy Pharma Agrovet Ltd.	Garlicin Powder, Bac Liquid, CAL-4 Vit
06	Avon Animal Health Ltd.	Bis Zeolite, Supure Zeolite, Bac super mix, Fish Oxy Tablet, and Oxygen plus
07	Vpco Ltd.	Marinavit, Colistin, AQ Grow–L, AQ Grow-P, Aqumin.
08	Advance Agrotech (Bd) Ltd.	Biotics, Live food, Aquaxide plus, Virokill aqua, Oxy Sos, Vita prime, Feed nutrisol, Butamin, Multi grow, Vitamin C-Sol, Ecozyme, Growth Gel, Paratics, Radar and Shrimp pro AP
09	A Plus Animal Health Ltd	Aqua booster plus, Mega plus, Biolite Plus and Aquamin
10	Advance Bio-products Ltd	Advance Vitamix, Bio-Oxy, Advance zeo plus, Fish Grow
11	Biswas Agrovet Ltd.	Alpha zeolite
12	Bristol Pharma Ltd.	pH fixer, Super Biotic, Super PS, Shrimp Safe Powder and Aqua-z Gold
13	Agro Care Khulna	Bio-Jib, Oxygrow, Mega veet
14	CP Aquaculture	AquaMax, C-150, Mutagen, pH fixer, Super Biotic, Super PS and Zymetine
15	Agrosia Corporation, Khulna	Bactacid, Agro veet, Aqua zeo,Protacide
16	Eon Animal Health Product Ltd.	JV Zeolite, Bio Aqua, Timsen, Efinol, Oxymax, Aqua savor and Fibosole
17	Fish World Ltd.	Geo top and Aqua Cleaner plus
18	Fishtech (Bd.) Ltd.	Geolite Gold, Aqua Magic plus, Gasonex Plus, Gallguard, BactoGrow, Pond Health, Oxy Gold, Blue Mix, Pond Cure and Seaweed.
19	First Care Agro Ltd.	Oxy Well, Gas Check Plus, Zeo First, Well Bloom, Provit Gell, Chlorwell, Well Guard, Bactisal-80, Zeo Magic Super, First Oxy, Uni-Ecosense, Uni-Hatch and First grow
20	Bagdat Fish & Poultry feed product	Aquazet, Omicide and Machalemen
21	Biplob Agrovet Ltd	Fish Curepas, CureOx
22	Future Animal Health Ltd	Aqua 4, Bio Plus, Bioliquire, Nature's Gift Liquid Gold
23	National Agricare Ltd.	Zeolite, Biopond
24	Nature Care	Zeocare, Lenocide, O-Plus and Nature Care GP
25	Navana Animal Health	Pond life, Oxy plus and Oxin WS
26	Novartis Pharmaceuticals	Geotox, Oxyflow, Oxysentin 20 %, Chlorsteclin, Aquaboost, Classic Aqua-Z Plus Powder and Ammonil
27	Nutria Health Ltd.	Nutra-P Mixer, Aqua-Z powder and Oxy Top

28	Organic Pharmaceuticals Ltd.	Green Zeolite, Bio-Tuff, Water Clear, O2-Marine, Quick Oxygen, Orgamycin 15 %, Orgacycline 15 %, Orgavit aqua, Aqua Gold, Eco Marine and Ecomax
29	Penta Agrovet Ltd.	Pathocide, Oxy-plus, Zeolite Plus and Growmax
30	Rals Agro Ltd.	Pontox Plus, Microdine Iodine 20 %, Oxysun, Fish Cure, Fish Vita Plus, Grow Fast and Procon-PS
31	Renata Pharmaceuticals Ltd.	Aquastar grow-out powder, Pond Zyme, Renamycin and Renamox
32	Riams Bangladesh Ltd.	Fish Care Powder, Aquagel, Aquafox.
33	Eskayef Bangladesh Ltd.	Pondcare,Gasonil, Bottom clenner, Well Zeolite, Emsen and Oxy More
34	SP Vet Care Limited	Fish Safe, Zeopel
35	Square Pharmaceuticals Ltd.	Contrim Vet Bolus, Otetra Vet Powder, Sulfatrim, Cevit Ver, Vitamin Premix, Gas Trap, Oxy Life, Penamin, Aqua Clean, Panvit Aqua and Square Aqua Mix
36	Syngenta	Ukasol-Aqua, Bennot Gel, Albez and Super vit.
37	Pals Agrovet	Fish Care Tablet
38	Janata Traders	Oxygen mix, Major Zeolite, Pond purifier and Golden Bac

Percentage of aqua-drugs and chemicals used in the study areas

The farmers of the Botiaghata region used 85%, 15%, 30%, 65%, 35%, 55%, and 40% of drugs for pond preparation, gas removal, oxygen supplier, growth promoter, antibiotics, disinfectants, and disease treatment of shrimp, respectively. Farmers of the Rupsha region used 80%, 20%, 32%, 55%, 40%, 50%, and 42% of chemicals during pond preparation, gas removal, oxygen supplier, growth promoter, antibiotics, disinfectants, and disease treatment of shrimp, respectively. Whereas, in the Dacope region, farmers used 75%, 30%, 40%, 60%, 35%, 45%, and 45% chemicals during pond preparation, gas removal, oxygen supplier, growth promoter, antibiotics, disinfectants, and disease treatment, respectively. The percentage of aqua-drugs and chemicals used in the study areas is shown in Fig. 7, similar to Anwar et al. (2018).

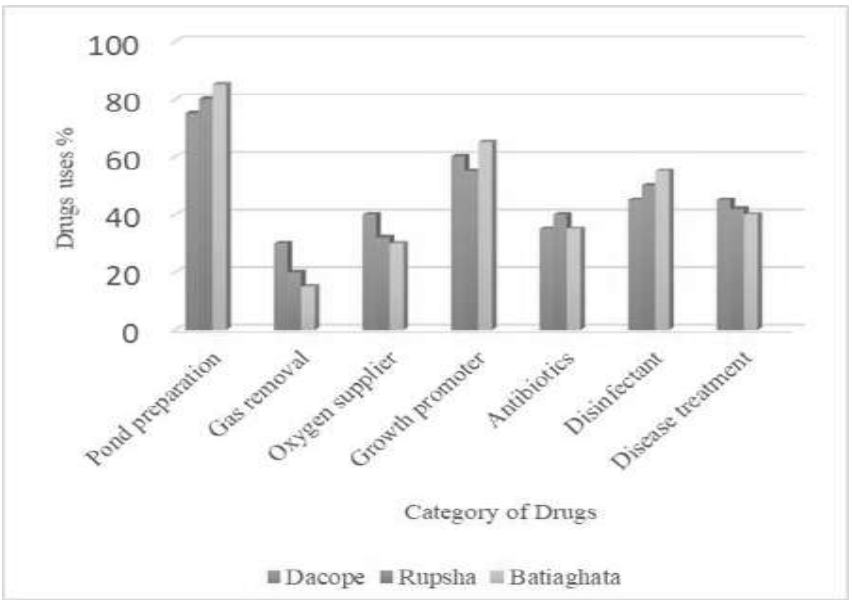

Fig: 7. Percentage of aqua-drugs and chemicals used in the south-west coastal areas.

Impact of aqua-drugs and chemicals at Dacope Upazila

The farmers of Dacope Upazilla used both traditional and new chemicals. Commonly used chemicals for pond management were Acme's Zeolite, Aqua-4, lime, Aqua Cal, Aqua Lime, and urea, with favorable effects ranging from 62 to 72%, 75 to 80%, 68 to 75%, 90 to 95%, and 85 to 95%, respectively. Farmers also employed oxygen sources,

including Fast Oxy, Oxy-flow, Oxy well, and Cure Ox, with Oxy Well-being the most effective (90%). Acme's Zeolite, Bio-tuff, Zeolite plus, O2 marine, Oxy-flow, Oxymax lime, and urea for pond management and oxygen supply have a positive impact on an average of 80-85% in Dacope (Hasan, 2014). Aquamin, Alpha Zeolite, and Aqua savor all exhibited a 70%, 60%, and 68% favorable effect on shrimp growth, respectively. Farmers used four different disinfectants during the culture period: BKC, Bleaching powder, Emsen, and Timsen. These disinfectants had good effects on microbial annihilation and disease recovery of 80%, 95%, 90%, and 90%, respectively. The most often prescribed antibiotics were Colistin and Bactitab.

Impact of aqua-drugs and chemicals at Botiaghata Upazila

Farmers used chemicals in Botiaghata Upazila to prepare ponds and better shrimp production. Shrimp growth and output were found to be positively impacted by Acimix super fish, Marina vet, Cebit vet, and Amcon Fish Premix, respectively, to the extents of 65%, 80%, 85%, and 70%. On gas removal, Acmes Zeolite, Alpha Zeolite, Aci super mix, and Zeolite all demonstrated favorable effects of 70%, 60%, 75%, and 80%, respectively. Farmers used Oxy Plus, Quick oxygen, and Pure Oxygen with favorable benefits of 80%, 70%, and 85%, correspondingly boosting the amount of oxygen when the amount of dissolved oxygen (DO) in a pond abruptly reduced. Farmers utilized antibiotics including Oxytetracycline, Renamox, and Renamicin to prevent infections, although they only had a 55–60% average influence on disease recovery. It was found that for shrimp growth, gas removal, dissolving oxygen, antibiotics, and disease treatment, farmers used various types of drugs and chemicals, which had an average effectiveness of 70%, 65%, 75%, 90%, and 60% respectively (Hasan, 2014).

Impact of aqua-drugs and chemicals at Rupsha Upazila

The average effect of growth enhancers like Civet vet, Megavit aqua, and Aquaboost, which some farmers used, was between 70 and 80% on shrimp growth. It was noted that farmers used four different types of oxygen providers, including Oxyflow, Oxymax, O2 marine, and Bio-ox, with Oxyflow having the largest positive impact (75% increase in DO). Farmers used three antibiotics: amoxicillin, olgacycline, and oxytetracycline. Oxytetracycline has the highest yield of 90% against pathogens and has improved shrimp resistance. Farmers employed Aquazet, Bottom Cleaner, Bio Tuff, and Advance Zeo Plus to get the gas out of the pond's bottom. These positive effects were 65%, 70%, 55%, and 75%, respectively. Farmers used disinfectants such as Emsen, Lime, and Timsen. These disinfectants had a positive effect of 90%, 75%, and 80%, respectively. According to (Hasan, 2014), development stimulants such as Civet vet, Megavit aqua, Aqua boost, Oxyflow, Oxymax, Amoxicillin, Orgacycline, Emsen, lime, and Timsen, which had an average influence of 70–80% on shrimp growth, 75–80% on oxygen supply, 70–80% for antibiotics, and 90% for disease treatment. Aqua medicines are mainly used to improve water quality and enhance pond productivity (Khan et al., 2011).

Conclusion and a way forward

The aqua drugs and chemicals are mainly used to control fish diseases, improve soil and water quality, and increase pond productivity. Thirty-eight pharmaceutical companies supplied seven categories of aqua-drugs and chemicals in the study areas. The effects of aqua drugs and chemicals on shrimp production were highly susceptible. However, during the field observation, some problems with the use of aqua chemicals, including farmers' lack of knowledge about the doses of drugs, residual periods, and some adverse effects on shrimp and human health, were found. The use of aquatic drugs is increasing day by day. So, it is essential to ensure proper utilization and usage. To overcome the adverse pathologies in shrimp organs, the use of aqua-drugs and chemicals in ponds should be minimized. This study has a few suggestions to minimize these problems:

• This study found that the farmers do not have any clear idea about the proper uses of aqua-drugs and chemicals. The Farmers need to be more trained in order to ensure the proper use of aqua-drugs and chemicals. This study suggests arranging farmers' training on the appropriate applications, methods, and proper dosage of aqua-drugs.

• In this study, poor water quality was observed during the winter season. So, aqua drugs should not be used frequently during that time.

• Policymakers, researchers, and scientists should work together to reduce the adverse effects of aqua drugs and grow awareness among the farmers to minimize the use of aqua drugs. Policymakers can encourage farmers to practice prevention techniques rather than cures.

The present study's results will help further research on aqua-drugs, a market analysis of different drug companies, and taking precautionary steps against aqua-drug use.

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