Original Research Article

A comprehensive scenario on application of aqua drugs and chemicals for the fish health management in fish hatcheries and farms of South-Eastern part, Bangladesh

ABSTRACT

Aims: The study was carried out to understand the current status of used drugs and chemicals in fish hatcheries and farms in Feni district, Bangladesh.

Methodology: Data were collected by pre-defined questionnaire interview, personal contact with farm and hatchery owners, and representatives of pharmaceutical companies by market survey.

Results: Twelve different groups of chemicals were being used for disease treatment and fish health management. Traditionally used chemicals were Lime, Salt, Potash (KMnO4) and Melathion. Although Malachite green hazardous to human health, it was widely used in hatcheries. Geotox, JV Zeolite, Amoxy fish, Megavit Aqua, Square aqua premix, Orgavit, Pure Oxy, Vitamin gel, O2-Marine etc. were widely used new chemicals. Renamycin was the most widely (36% farmer) used antibiotic followed by Oxysentin 20%, Orgamycin15% and Otetra vet power 50.

Conclusion: Nearly all farmers did not apply chemicals and drugs at proper doses because they thought the higher the doses applied the more and rapid will be the action. It was found that manufacturers and retailers of the products often neglected to provide farmers with necessary information regarding active ingredients and relevant instructions for safe and efficient use of aqua-drugs and chemicals. Recommended use of chemicals apparently brings good result but indiscriminate use of chemicals can be extremely detrimental to fish and our environment as well as to us and therefore, all of us should be aware of the proper use of chemicals.

Keywords: Aqua chemicals; aqua drugs; antibiotics; aquaculture; environmental concerns.

1. INTRODUCTION

Global food fish consumption significantly increased from 5.2 kg per capita in 1961 to 19.4 kg in 2017, at an average annual rate of 2.4% which was almost twice that of annual world population growth (1.6%) for the same period and higher than that the other animal protein foods such as meat, dairy, milk, etc., which rose by 2.1% per year and this is possible because of expanding fish production through aquaculture [1]. Aquaculture contributed 46% to the total global fish production and 52% to the total food fish used for human consumption worldwide in 2018 [1]. Aquaculture has already exemplified its vital role in global food security, with its production increasing by 7.5% per year since 1970 [1]. Nowadays, aquaculture is the fastest growing sector around the world and the significant source of protein because higher protein content is found in aquatic animal foods than terrestrial animal meats [2-3]. In 2018, Bangladesh was ranked fifth in aquaculture fish production

which produced almost 24 lakh tonnes fish that was 2.93% of the global aquaculture fish production [1]. Increasing population of Bangladesh translates to increasing demand for food which has been fulfilled by the intensification of agriculture and aquaculture [4]. Semi-intensive culture was practiced in most of the hatcheries and farms of Feni district. Semi-intensive fish culture has resulted in the massive use of chemotherapeutic agents in different aquaculture activities such as treatment of diseases, water quality management etc. Chemicals are an important term for intensified aquaculture which has been used in various forms for making aquaculture successful. In aquaculture, used chemicals can be classified by the purpose of use, the type of culture organisms, the life cycle stage for which they are used, the culture system and intensity of culture, and by the type of people who use them. A variety of chemicals are being used as sediment and water quality management product, fertilizers, anaesthetics, feed additives, hormone, growth promoter, disinfectants, antibiotics and antibacterial agents etc. Major benefits of chemical usage are - increase production efficiency, reduce the waste of other resources, increasing hatchery production and feeding efficiency, improve survival of fry and fingerlings to marketable size, reduce transport stress and to control pathogens, among many other applications.

Chemicals are used both prophylactically, at times of heightened risk of disease, and therapeutically, when an outbreak of disease occurs in the system. Farmers want to get maximum yield, but few would like to increase their cost of buying chemicals. The aggressive promotion of chemical products by salesmen has partly led to an increased use of drugs and chemicals without knowing their necessity, effective dose and usage. In Bangladesh, there have been limited data about the use of chemicals in hatcheries and fish farms in Feni district. So this survey is conducted to know the proper dose and purpose of chemicals used in aquaculture activities. Taking into consideration about disease problems and environmental chemotherapeutics, the study was conducted to make a list of chemicals, doses, sources and prices of those chemicals used in aquaculture in Feni district, Bangladesh.

2. MATERIAL AND METHODS

2.1 Study area

Feni (23.0186°N, 91.3966°E) is one of the coastal districts which are situated in the south-eastern part of Bangladesh (Fig. 1). It is bounded by Feni, Mahuri, Kuhuri, Silonia and Kalidas Pahalia rivers. Feni is the most known coastal district in Bangladesh because of having a thousand culture based ponds covering an area of 9686 acre with fish production of 7658 MT [5-6]. For this reason, 6 upazilas (Feni Sadar, Sonagazi, Daganbhuiyan, Parshuram, Chhagalnaiya and Fulgazi) of Feni district was selected for the present study.

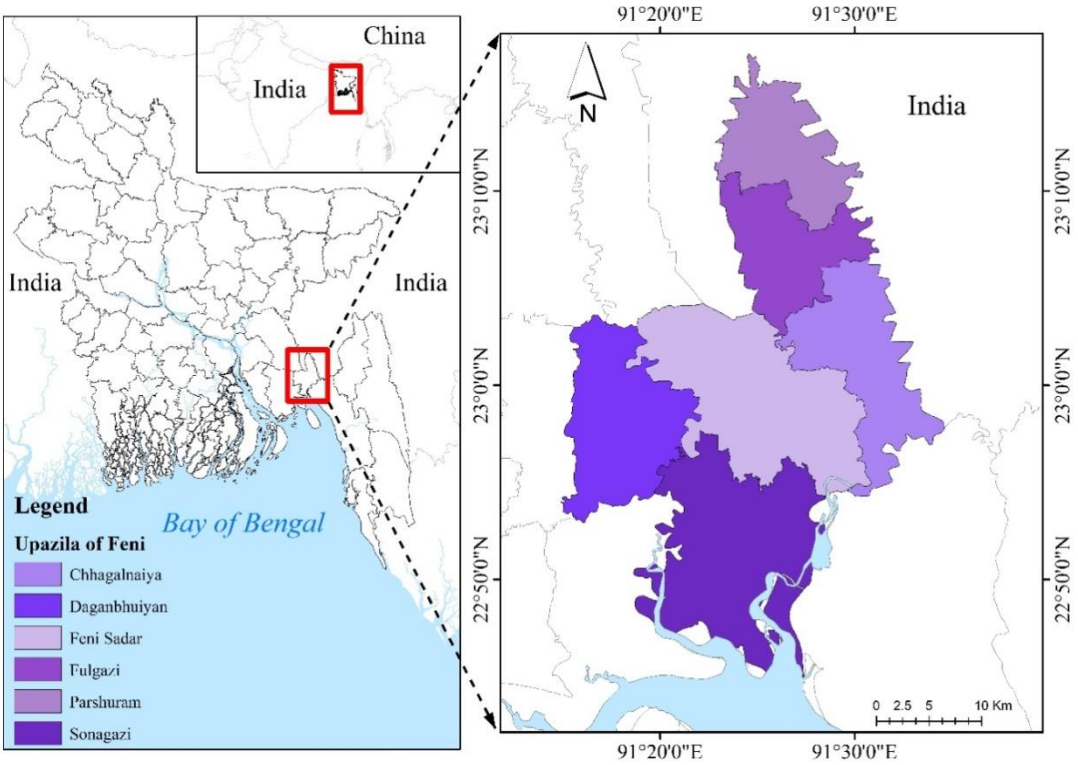

Fig. 1. Sampling points in Feni District, Bangladesh

2.2 Study duration and target groups

Present study was conducted in 6 upazilas of Feni, Bangladesh. As aquaculture activities in Feni is quite diversified, the present study was conducted including different target group to have an overall figure of the aqua-drugs and chemicals which are used in aquaculture purposes in this area. For these, a total of 50 fish farmers and 31 representatives of different pharmaceutical companies were interviewed during the study period. All the respondents were selected randomly.

2.3 Preparation and validation of questionnaire

The questionnaire was developed by existing a vigorous literature review and a bench of professional specialized researchers as well as personal proficiencies [7]. To recheck the design and validation of questionnaire a pilot study was conducted in Noakhali district with similar settings of farm and hatchery owners, and representatives of pharmaceutical companies. About 20 fish farmers and 10 representatives of different pharmaceutical companies were interviewed during piloting. According to the pilot study, the questionnaire was redeveloped and framed in a consistent way to collect the field data. One of the most integral parts of the survey study is direct observations which help to ensure gathering of data on definite manner [8].

Through visiting the hatcheries or farms, several factors were considered with importance and included into the questionnaire such as uses and purpose of aqua-chemicals or toxicants, difference in methods (traditional and modern) of application, effectiveness as well as side-effect of chemicals or drugs, diversity in applied dose and ban on chemicals or

toxicants by the government, local availability and price of the chemicals, popularity of specific chemicals or drugs in study areas and consideration the environmental risk [9].

2.4 Data Collection

The data were collected from the farmers and owners of fish hatcheries and fish farms, the representatives of different pharmaceuticals companies through questionnaire interview, personal contact, market surveys and Participatory Rural Appraisal (PRA) tool like Focus Group Discussion (FGD) in the study area. Additionally, some more information were collected from different national and regional literature and publications, use of drugs and aquatic chemicals from the survey section of Department of Fisheries (DoF) as well as district Fisheries Office of Feni, Bangladesh, quarterly and annual reports available from different pharmaceuticals companies, fish farms and hatcheries etc.

2.5 Data analysis

The collected data were scrutinized and sorted carefully and then analyzed using tabular and descriptive statistical techniques. The figures and associated tables were prepared in conformity to the objective of the study.

3. RESULTS AND DISCUSSION

About 12 different groups of chemicals and aqua-drugs were used by the farmers in the present investigation. These chemicals and drugs are used mainly for increasing hatchery production and feeding efficiency, improving survival of fry and fingerlings, increasing growth rate and fecundity, reducing mortality rate, preventing infection etc. [9]. Using of these chemicals is increasing with the improving of level of farming systems (extensive, improved extensive, semi-intensive and intensive). The very commonly used products were pond preparations chemicals, fertilizers, disinfectants, oxidizing agents and antibiotics as well as different kinds of miscellaneous chemicals. Our outcomes suggested that chemicals groups of present study was higher than the Patuakhali and Bogura district of Bangladesh and lower than the Noakhali region of Bangladesh and in intensive shrimp farms in the Philippines [9-11].

3.1 Chemicals used for pond preparation

A total of 11 types of chemicals were used for pond preparation associated with water and sediment treatment in the present study to regulate water quality, generate fertility in ponds, removal of harmful toxic compounds and bad odors to ensure healthy and favorable environment for aquatic organisms (Table 1). The most commonly used chemical for pond preparation in carp culture was lime because of its lower price and local availability. While comparing with other studies conducted, lime was found to contribute the major portion for maintaining soil and water quality in the pond preparation stage [12-14].

Moreover, 60% farmers used lime, 20% used salt, 12% potash and 8% used melathion as a traditional chemicals to improve soil and water quality as well as fish health management (Fig. 2) which is quite similar to the findings of Faruk et al. [15] in Mymensingh district of Bangladesh. Additionally, Megavit Aqua, Vitamix F, Aqua Premium, Square aqua premix, Orgavit, Pure Oxy Amoxy fish, Zeolite gold granular were the most widely used new chemicals among farmers of Feni district (Fig. 3).

Table 1. List of Chemicals used as pond preparation, fertilizer, disinfectants and oxidizing agents with their doses and sources in Feni district, Bangladesh.

Trade Name	Chemical Formula	Dose	Sources	Price (BDT/kg)
Pond preparation				
Lime	CaO, $Ca(OH)_2$	500-2,000 kg/ha (Pond preparation); 20-300 kg/ha (Rearing phase); 50-300 kg/ha (Disease control).	Chemical seller	12/kg
Agricultural lime	$CaCO_3$	200-8,000 kg/ha (Pond preparation); 10-500 kg/ha (Rearing phase); 100-300 kg/ha (Disease control).	Chemical seller	8-15/kg
Zeolite	SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, Na_2O	20-30 kg/acre	National Agricare Imp. Exp Ltd	55/kg
Ammonil	Yucca plant extract	100-200 g/100dec/month (Rearing phase)	Novartis	Unknown
Aqua Zeolite	SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, Na_2O	20-25 kg/100 dec (Pond preparation); 10-20 kg/100dec/month (Rearing phase).	Meridian Agro Industries Ltd	Unknown

Geotox	SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, Na_2O	20-25 kg/100 dec (Before fish stocking); 10-20 kg/100 dec (After fish stocking) for 3-6 feet depth.	Novarties	58/kg
Mega Zeo	SiO_2,Al_2O_3, Fe_2O_3CaO, MgO, Mn, Na_2O, K_2O	25 kg/100 dec/3-6 feet depth.	ACI	48/kg
JV Zeolite	SiO_2, Al_2O_3, Fe_2O_3 CaO, MgO, Na_2O, k_2O_7	1 kg/33 dec	Eon Animal health Products Ltd.	52/kg
Bio-Tuff	SiO_2, Al_2O_3, Fe_2O_3 CaO, MgO, Na_2O, K_2O, TiO_2	15-20 kg/100 dec	Organic Pharmaceuticals Ltd.	55/kg
Fish Calipus powder	Unknown	400 g/33dec	Aquaculture International BD	75/400g
Zeolite gold granular	SiO_2, Al_2O_3,Fe_2O_3 CaO, MgO, Na_2O	Unknown	Fishtech (BD) Ltd.	42/kg
Fertilizer				
TSP	$Ca(H_2PO_4)_2.H_2O$	80 kg/ha/month	Chemical seller	22/Kg

16-20-0 (Mono-Ammonium Phosphate)	$NH_4H_2PO_4$	4-100 kg/ha (Pond preparation); 150-300 kg/ha (Rearing phase)	Chemical seller	Unknown
14-14-14 (NPK, complete fertilizer)		7.5-15 kg/ha (Pond preparation); 3 kg/ha (Rearing phase)	Chemical seller	30/kg
46-0-0 (Urea)	CH_4N_2O	5-120 kg/ha (Pond preparation); 3.2-5 kg/ha (Rearing phase)	Chemical seller	12/kg
Chicken manure	-	100-3,000 kg/ha (Pond preparation)	Chemical seller	Unknown
Cow manure	-	100-500 kg/ha (Pond preparation)	Chemical seller	Unknown
Disinfectants				
Bleaching	Chlorine	20-50 ppm (Pond preparation); 10-30 ppm (Egg disinfection); 1-2 ppm (Bath treatment)	Chemical seller	
Formalin	Formaldehyde 40%	25 ppm	Chemical seller	
Timsen	n-alkyl dimethyl benzyl ammonium chloride+	20 g/33 dec (Disease prevention purpose); 80 g/33dec (Disease treatment)	Eon Animal Health Products Ltd.	

	stabilized urea			
EDTA	Sodium thio-sulfate	0.1-1 ppm	Chemical seller	
Emsen	n-alkyl dimethyl benzyl ammonium chloride+ stabilized urea	80 g/33dec	Eskayef Bangladesh Ltd.	
Sodium hypochlorite	NaCl	1-2%, 20 min	Chemical seller	
Quick lime	CaO	380g/m^2 to dry Pond bed	Chemical seller	
Sodium hydroxide	NaOH	1-2%	Chemical seller	
Quaternary NH4+	Unknown	600 ppm	Chemical seller	
Argulex	Unknown	400 ml/33 dec	Eon Animal Health Products Ltd.	
Diletix	Unknown	20-30 ml/acre	Unknown	
Oxidizing agents				
Oxy plus	Na_2O_2+AlOH Na_2O_2-90%	500 g/acre	Navana Animal Health	530/kg
Oxy more	Sodium carbonate peroxyhydrate	250-500 g/acre	Eskayef Bangladesh Ltd.	500/kg
Bio- Ox	Sodium	2.5-5.0 g/acre; 5-8 g/acre	ACI Animal Health	510/kg

	carbonate, H_2O_2	(In case of high deficiency).		
Aqua-oxygen	Sodium per carbonate	250-350g/acre	Meridian agro Industries Ltd	610/kg
Oxyflow	H_2O_2 10%	250-350 g/acre; 500 gm/acre (In case of high deficiency).	Novartis Pharmaceuticals Ltd.	600/kg
Pure Oxy	Unknown	Unknown	Al-Madina Pharmaceuticals	650/kg
Oxy max	H_2O_2 10%	250-500gm/acre (1 m deep water body)	Eon Animal health Products Ltd.	600/kg
Quick Oxygen	Sodium per carbonate + free Oxygen	250-350 g/acre; 500 g/acre (In case of high deficiency)	Organic Pharmaceuticals Ltd.	615/kg
O_2-Marine	H_2O_2 10%	33-40 Tablets/33 dec	Organic Pharmaceuticals Ltd.	535/kg

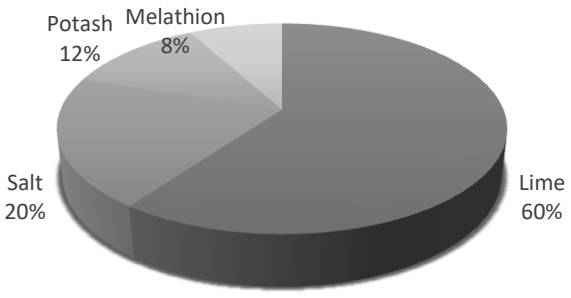

Fig. 2. Widely used traditional chemicals in Feni district for soil and water treatment.

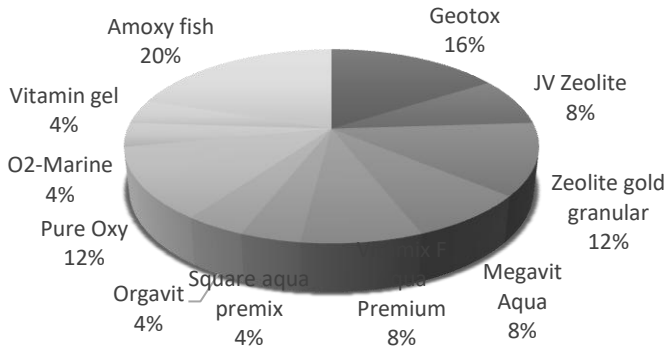

Fig. 3. Widely used new chemicals in Feni district for soil and water treatment.

3.2 Chemicals used as fertilizers

In the study area, most of the farmers used inorganic fertilizers such as TSP, Mono-ammonium phosphate, NPK and urea although organic fertilizers such as chicken manure and cow manure were also used during pond preparation and the culture period to enhance production of natural foods in the ponds (Table 1). Meanwhile, the finding of our study was supported by some other studies conducted throughout Bangladesh [9,14-15]. However, organic manure has drawn the attention of environmental concerns because excessive use of these may increase the risk of bacterial propagation in the culture system [16]. Additionally, different types of antibiotics which are used in poultry industries have some residues in poultry manure which can cause antimicrobial resistance among the farmed fish and shellfish [17]. Fertilizers pose minimal risk to food safety in aquaculture, when used appropriately, any misuse could constitute hazard in aquaculture products [18].

3.3 Chemicals used as disinfectants

In the present survey area, 11 types of disinfectants such as formalin, timsen, EDTA, emsen, bleaching powder, sodium hypochlorite etc. were used both in hatchery and grow-out systems for disinfecting all equipment's and fish throughout the production cycle to maintain hygiene, treat disease and prevent some bacterial and fungal infection (Table 1). Our findings were supported by some authors who have more or less similar results [10, 13, 19].

Generally, formalin is used not only to destroy different types of filamentous bacteria in grow-out ponds and hatcheries, but also to reduce fungal and ectoparasitic infections of protozoans and trematodes in farm productions [20]. Formalin is a potential carcinogen agent which is harmful to many phytoplankton and crustaceans at the concentrations required to treat bacterial infestations and also causes eye irritation and inhalation in fish [21]. Sodium hypochlorite is very toxic to fish and corrosive to metal. But water containing these disinfectants agents should be treated before discharging it into receiving waters for its moderate to high toxic behavior.

3.4 Chemicals used as oxidizing agent

About 9 types of Oxidizing agents were used in the present study area to improve O2 concentration, maintain biological oxygen demand (BOD) as well as chemical oxygen demand (COD) into the fish ponds, remove hardness associated with poisonous gases and prevent diseases in fish (Table 1). These results are quite similar to previous studies

conducted in different region of Bangladesh [12,19,22]. Alam and Rashid [23] stated that several types of aqua chemicals which used as oxidizing agents increase growth and survival rate of finfish and shellfish. Different types of traditional methods such as swimming, sprinkling water surface by bamboo, use aerator etc. used by the local farmers to increase the oxygen concentration into the farm water.

3.5 Chemicals used as antibacterial agents

In this investigation, about 8 branded antibiotics were used as a prophylactic agents occurred in the most frequently and severely in semi-intensive culture systems mainly during the bacterial disease (Table 2). The widely used antibiotics for the treatment of fish diseases in Feni district were Oxysentin 20%, Renamycin, Otetra vet power and Orgamycine 15%. Our findings were consistent with the findings of [12,15, 24, 25].

Lalumera et al. [26] stated that about 75% of the antibiotics which are administered in feed enter the environment via excretions of targeted species and leaching from uneaten or undigested feed. But excessive and improper use of antibiotics contributes the development of resistant strains of bacteria which are leading threat of aquaculture nowadays [27]. Banned antibacterial agents such as Nitrofuran which is a curse for our 'WHITE GOLD' industry and Chloramphenicol were not used by the farmers of Feni district.

Table 2. List of Drugs used as Antibiotics with their source and dose in Feni district, Bangladesh.

Trade name	Compound	Dose	Source	Price (BDT)
Renamycin	Oxytetracycline	28-42 g/100 kg feed/10 days.	Renata Pharmaceutics Ltd	85/100g
Ranamox	Amoxicillin, Trihydrate	28-40 g/100 kg feed /10 days	Renata Pharmaceuticals Ltd	145/100g
Amoxy fish	Amoxicillin Trihydrate bp 98%	1-1.5kg/MT (For prevention); 2-3kg/MT of feed (for treatment)	Fish tech (BD) Ltd	1090/50g
Otetra vet power 50	Oxytetracycline	Mixed with feed; 11-16 g/100 kg body wt.	Square Pharmaceuticals	160/100g

Acimox(vet) Powder	Amoxiciline (Trihydrate)	1 g/1 kg feed	ACI Animal Health	78/100g
Oxysentin 20%	Oxytetracline HCl BP	100-200 g/100 kg feed/5-7days	Novartis Pharmaceuticals	700/kg
Orgamycin 15 %	Oxytracycline HCl BP (WSP)	60 g/100 kg feed /10days (For prevention); 120-240 g/100 kg feed/5-7 days (for treatment)	Organic Pharmaceuticals Ltd.	70/100g
Chlorsteclin	Chlortetracyclie	1g/kg feed (For prevention); 3g/kg feed (for treatment)	Novartis Pharmaceuticals	Unknown

3.6 Chemicals used for diseases treatment

Different types of therapeutic agents such as lime, formalin, salt, potash, malachite green, timsen etc. were commonly used for preventing of fish diseases and eradication of external parasites as well as fungal diseases in the aquaculture farms of Feni district. Among them, malachite green commonly used as therapeutic agent, although its use is not permitted in the developed countries and some Southeast Asian countries (e.g., Thailand) due to human health concerns relating to its role as a respiratory enzyme poison [28]. The present investigation was close to some previous studies where Potassium permanganate, lime, formalin, Salt, Methylene Blue, Malachite Green, Melathion, bleaching Powder and Timsen were used as diseases preventing agents in aquaculture [29-30].. According to Smith [31], it is very crucial to use appropriate amount of chemicals or drugs against disease and to maintain good health of fish right amount of drugs or chemicals should be applied to the culture systems.

3.7 Chemicals used as growth promoter

Different chemicals were used by the farmers as growth promoter to increase production and growth rate of fish, improve food conversion ratio (FCR), and immune capacity as well as reduce mortality rate in the study area. Among them Megavit Aqua, Aqua Boost, Cevit aqua, Vitamin gel, Rapid growth and Square aqua premix were readily available and widely used in Feni district. Due to high price of these chemicals, small scale farmers were used some native ingredients such as mastered oil cake, soyabean meal, rice or wheat bran, kitchen wastages and locally available fish meal in the present study area. Our findings are consistent with the findings of [15, 22] in Mymenshigh and Noakhali region of Bangladesh.

3.8 Chemicals used as pesticides

In the study area, Nicotine (tobacco dust), Rotenone and Saponin were used to control unwanted organisms entering the system within the inflow water, to treat fungal and parasitic infections, to kill different types of predator fish when it is not possible to drain out the pond completely. Among them, Rotenone is applied to kill predatory fish in aquaculture systems which usually decrease the zooplankton concentration in the pond [32]. Besides, Organophosphates such as Dichlorvos was used to control ectoparasitic infections, Trichlorfon for monogeneans infection, Dipterex and Malathion for ectoparasitic infection in freshwater aquaculture system. In addition, Organophosphates were widely used pesticides in study area. Due to the high neurotoxicity of organophosphates, potential effects on the health of fish farm workers are also to be concerned by the farm or hatchery owner [33]. Sumithion and Dipterex are used by the farmers of greater Noakhali region to control the insects into their farm [9].

3.9 Chemicals used as herbicides/algaecides

In the present study area, two types of herbicides were used to control unwanted algae, bloom forming organisms and various types of submerged plants or weeds into the culture system. Anhydrous ammonia was used at the rate of 12 ppm to eradicate dense growths of submerged weeds such as Hydrilla sp. and Najas sp. Copper was widely used at the rate of 2 ppm during pond preparation and at the rate of 2 kg/ha/day during rearing phase to control weed growth in aquaculture. The excessive use of copper substances in aquaculture systems may cause serious health issues in human because they are bio-accumulated into human food web through ingestion of cultured species [34].

3.10 Chemicals used as feed additives

In this study area, different types of antioxidant, feed preservative and vitamin were used as feed additives. Farmers of the investigated area were used Butylated hydroxyanisole, Butylated hydroxytoluene, Vitamin C and Vitamin E to preserve feed, to enhance disease resistance and to prevent deficiency syndromes in fish due to their antioxidant properties. Rico et al. [14] reviewed that most of the farmers frequently apply specific local herbs and garlic to increase the immunological status of the cultured species in China and Vietnam. Anderson [35] reported that these feed additives are highly digestible than the other feed stuffs (e. g antibiotics) without having any environmental risk.

3.11 Chemicals used as anaesthetics

Different types of anaesthetics like Carbon dioxide and Quinaldine were commonly used in the present study area to assist immobilisation of brood animals during egg and milt stripping during marketing and transportation for reducing stress. These anaesthetics are not expected to results in serious environmental hazards because of their biodegradable nature as well as lower amount of administration among the cultured organisms.

3.12 Chemicals used as hormones

In the aquaculture industry, carp fresh pituitary glands, dried pituitary extract and purified human chorionic gonadotropin (HCG) play an important role to control or induce ovulation for total control of life cycles in many species. In this investigation, 17α-methyltestosterone was widely used as an androgenic agent in masculinization of tilapia and the similar findings was also found by [14].

3.13 Chemical producing pharmaceutical companies

As aquaculture has flourished in Bangladesh, several numbers of pharmaceutical companies have been arisen to help the marginal to large scale farmers through their versatile chemicals substances. In the present study, about 14 companies were found either producing or marketing products targeting aquaculture. Among them, more than 85 % of the products were produced by seven companies like Organic Pharmaceuticals Ltd. (16%) followed by Square pharmaceuticals (10%), Novartis Animal Health Ltd. (23%), Eon animal Health Product Ltd. (13%), ACI Animal Health Ltd. (13%), ACMI Ltd (6%), and Renata Pharmaceuticals Ltd. (6%) and rest 13% were supplied by other seven companies respectively (Fig. 4). In Mymensingh district, among the 33 companies more than 50 % of the products were produced by seven companies like Organic Pharmaceuticals Ltd. (11.32%), followed by Rals Agro Ltd. (9.43%), Novartis Animal Health Ltd. (5.66%), Eon animal Health Product Ltd. (7.55%), ACI Animal Health Ltd. (11.32%), CP Aquaculture (5.66%), Square Pharmaceuticals Ltd. (5.66%) which is quite similar to the present investigation [15].

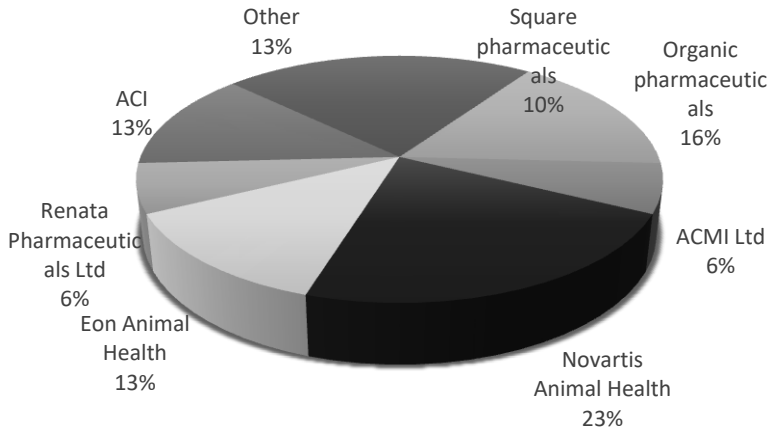

Fig. 4. Supply of Aquatic Chemicals products producing by different pharmaceutical companies in Feni district, Bangladesh.

3.14 Cost Contribution of the Products

In aquaculture, the amounts spent for fertilizers and chemicals are generally very low in the extensive farming systems. It appeared that the cost of fertilizers and the chemicals contributed less than 5% of the total cost. Three main pillar of aquaculture are feed seed and management. In present study, the majority cost of farming was the cost of fry followed by second highest cost was lease rent and the third was labour. The cost of labour was cheap in prior days but now-a day's various types of working facilities (such as textile factories, other mill and industries) provide them extra amount of wage than a day labour. The total production costs were relatively lower for the extensive farming than for semi- intensive farming. Moreover, liming and fertilizer costs for the hatcheries and farms accounted for 1% and 3.3% of total costs respectively. In contrast to the cost of fertilizers; chemicals were used mainly in the treatment and prophylaxis of disease problems, which constitute the largest single cause of economic losses.

3.15 Effect of prophylactic use of chemicals

Farmers of Feni district generally do not follow the recommended dose of aqua-drugs and chemicals during aquaculture activities. This picture is more or less similar to throughout Bangladesh. In case of insect killing, many fish farmers use higher dose than the prescribed

dose. This may cause serious biodiversity loss of aquatic organisms and creates an inequality in the aquatic as well as territorial ecosystems. Meanwhile, the prophylactic use of antibiotics by fish farmers which have been done to prevent the outbreak of infection as opposed to their use as a response to infection, is a particularly important contributor to the development of resistance strains of bacteria [36]. The environmental implications of the emergence of resistant strains of bacterial pathogens are twofold. Firstly, it makes infections more difficult to treat, thus endangering the viability of the farming process. Secondly, there are implications for human health. Waters receiving aquaculture discharges, and therefore containing antibiotic residues, may also receive domestic waste [37]. Thus, human pathogens are exposed to antibiotic used in aquaculture operations and which may also be used in human medicine-chloramphenicol is a notable example. It is possible that these pathogens may develop resistance to some of the important drugs used in treating human illness.

In the context of the use of chemicals in aquaculture, the FAO Code of Conduct stipulates some code for Human health and environmental concerns. The Code of Conduct recommended the safe, effective and minimal use of therapeutants, hormones and drugs, antibiotics and other disease control chemicals in fish farm for fish health management. It also recommended regulating the use of chemical inputs in aquaculture which are hazardous to human health and the environment.

4. CONCLUSION

Prophylactically using of chemicals and using of banned chemicals are harmful for aquaculture. The best practice for aquaculture is the less use of chemicals and uses the alternatives of chemicals such as probiotics, bioremediation, immunostimulants and vaccines. Problems in the use of chemicals in aquaculture (e.g., product quality, pattern of usage etc.) could be corrected or avoided by enhanced management, formulation and implementation of legislation and training of farmers. Regulations should not only control drug production and sales, but also the management of products and their handling and usage. The key point is to set up strict management of chemicals, establish standards, and license production so that unsuitable drugs can be banned from the market.

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