



Use of Extra-label Drugs in Commercial Aquaculture

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ARTICLE INFO

Article history

Received: 28 Nov 2020

Accepted: 21 Jan 2021

Published: 30 Mar 2021

Keywords

Extra-label drugs,
Antibiotics,
Commercial aquaculture

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ABSTRACT

The present study focused on the use of extra-label drugs in commercial aquaculture. Data was collected through questionnaire interview with 30 drug retailers and 30 commercial aqua farmers in Mymensingh Sadar and Trishal upazila of Mymensingh district. All together 94 extra-label drugs of different groups were identified which included antibiotics, disinfectants, nutritional supplements, probiotics, gas remover and saline. Six groups of antibiotics having 10 different active compounds with 46 trade names were found in the drug retailer shops. These drugs were primarily prepared either for the use in veterinary or poultry but were found using indiscriminately in aquaculture. All these drugs were marketed by 18 companies in the study areas. It was observed that 83% drugs were not labeled for aquaculture purpose. Majority (77%) of the commercial aqua farmers used extra-label drugs in their farms and 73% of them never received any prescription from qualified personnel before use. Most of the farmers were unable to calculate appropriate doses and had no idea about risk, safety issue and toxicity reaction of using extra-label drugs. Farmers generally got suggestion from the drug retailer regarding application of drugs. The results also revealed that extra-label use of veterinary and poultry drugs in aquaculture is a common practice by commercial aqua farmers. Thus, the use of drugs in aquaculture should have a sufficient regulatory system in place. It is important to produce and use appropriate labeled drugs under a sufficient regulatory system for safe fish production in the aquaculture of Bangladesh.

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Introduction

Bangladesh has made a tremendous breakthrough in sustainable aquaculture through securing 56% contribution to the total fish production (DoF, 2018). The recent and rapid development has boosted Bangladesh to 5th in world aquaculture production (DoF, 2018). The shift of aquaculture towards the use of intensive culture systems during the last decades has led to several serious problems, particularly the misuse of extra-label veterinary medicines and chemicals used for the treatment of disease outbreaks, consequently raising concern with regard to the safety of aquaculture products (Baoprasertkul *et al.*, 2012).

A wide variety drugs, chemicals and biological have been using in different aquaculture activities for various purposes. Vast majority of the drugs are used for health management and treatment of fish diseases. Other major uses including water quality management, hatchery management and feed formulation. However, due to indiscriminate use of drugs, aqua farmers are not getting expected result. Also, antimicrobials used in

aquaculture cause negative impact on aquatic environment, contribute to the development of antimicrobial-resistance and the presence of residue in aquaculture products (WHO, 2006; Jaime *et al.*, 2012).

Extra label drug use describes the use of a drug in a manner for which it was not approved. It occurs when a drug approved for one species of animal is used in another animal, or when a drug is used to treat a condition for which it was not approved. Extra label use of veterinary or poultry drugs have now become a common practice in commercial aquaculture of Bangladesh. When an approved human or animal drug is used in a manner other than what is stated on the drug's label, then it is called an extra-label use, because the drug is used in a way that is "off the label" (FDA, 2020).

In most of the countries, government agencies exert some controlling actions on the use of drugs. In Bangladesh, the uses of drugs are rising tremendously and concern is now growing on the use of unapproved drugs in aquaculture. There are a number of reports on

Cite This Article

Jahan, F., Faruk, M.A.R., Azad, K.N. 2021. Use of Extra-label Drugs in Commercial Aquaculture. *Journal of Bangladesh Agricultural University*, 19(1): 160–167. <https://doi.org/10.5455/JBAU.14479>

the use of extra-label veterinary drugs in aquaculture in other countries (Breton, 2009; Yang and Zheng, 2007; Bravo, 2012; Zarza, 2012; Love et al., 2020). However, although few works have been carried out in Bangladesh on the use of aqua-drugs (Faruk et al., 2008; Ahmed et al., 2014; Ahmed et al., 2015; Hassan, 2016), but there is hardly any study conducted on the use of extra label drugs in aquaculture of the country. The objective of the present study was therefore to identify type, source and status of use of extra-label drugs in commercial aquaculture.

Materials and Methods

The study was carried out in Trishal and Mymensingh sadar upazila under Mymensingh district of Bangladesh for six from February to July 2017. Data were collected from 30 drug retailers and 30 commercial fish farmers through questionnaire interview. The major topic of questionnaire included types, constituents, sources, uses, price and label of drugs. In addition, idea about extra label use, receiving prescription, dose calculation ability and proper application methods were also included. Data were analyzed using descriptive statistics.

Results

Extra-label drugs

In this study, 94 extra label drugs were found in the drug shops which were used by the commercial aqua farmers. The drugs could be grouped as antibiotics, disinfectant, ammonia reducer, probiotics, nutritional supplements, saline and pesticides. All these drugs were provided by 18 companies. Drugs from ACI, Eon, Acme, Square, Renata, SK+F and Novartis were found prominently at drug shops. Group wise description of identified extra-label drugs are given below:

Antibiotics

Six groups of antibiotics having 10 different compounds with 46 trade names were found in drug shops. The groups included beta-lactams, macrolides, fluoroquinolones, tetracyclines, sulfonamides and quinolones. Major compound and trade names of extra-label antibiotics under different groups are summarized in Table1.

Seven various trade named antibiotics were found under the group of beta-lactams. The major constituent of this group was amoxicillin and their price varied from Tk. 110-270 per 100g. Major companies that provide these products included Acme, ACI, Navana, Square and Reneta (Table1). In poultry and veterinary, this broad spectrum antibiotic is used for preventing and treating different bacterial and mycoplasmic diseases. In dairy industry, they are effectively used against Mycoplasmosis, *Streptococcus* and *Staphylococcus*

infection. They are also found to retard growth against bacteria those are sensible to penicillin. In aquaculture, beta-lactams have been using against red mouth, septicemia infection and epizootic ulcerative syndrome in fish.

Under the group of macrolides, twelve various trade named antibiotics were found. Major constituents of this group were erythromycin, azithromycin and tylosin. Generally, macrolides antibiotics are used for the treatment of Mycoplasmosis, associated with secondary bacterial infections in poultry. They are also effective against bacteria those are responsible for respiratory and genetic disorder. In aquaculture, they have been using to control mortality associated with enteric septicemia in catfish and for the treatment of secondary bacterial infections. Ten trade named extra-label antibiotics of the group fluoroquinolones were found also identified in the drug shops. These were found effective against *Streptococcus* infection in tilapia and carps. Under the group of tetracycline, 11 different trade named antibiotics were found.

Major constituents were oxytetracycline, doxycycline and chlortetracycline. In poultry, they were generally used against Colibacillosis, Cholera, *Streptococcus* and *Staphylococcus* and also effective against bacterial infection like respiratory and genetic disorder, *Clostridium*, CRD, Mycoplasma and Enterytis infection. According to drug seller and information leaflet, these antibiotics were effective against fin rot, Edwardsiellosis, Columnaris and some other bacterial diseases found in freshwater fishes of Bangladesh. Moreover, five trade named sulfonamids with sulfadiazine and trimethoprim as their major active ingredients were also found in the shops. According to the package these extra label drugs could be useful in killing all kind of bacterial, viral and fungal infections. Finally, under the group of quinolones, one antibiotic, peflox vet was found. The price of this antibiotic was 140 Tk. per 100 ml. In aquaculture, it could be effective against Columnaris, Vibriosis and bacterial gill disease.

Disinfectants

Five different extra-label disinfectants were found in the surveyed shops which included virex, virocid, virusnip, povin vet and timsen. Mainly ACI, Novertis, Eon provided these disinfectants (Table 2).

Ammonia remover

Four ammonia removing substances were found in the drug shops (Table 3). There major constituents were glycocomponent, saponins, extract of Yucca and the price varied from 315-350 Tk. per 100 ml with different doses.

Table 1. Summary of major group of antibiotics found in drug shops

Antibiotics group	Compounds	Trade Name
Beta- Lactams	Amoxicillin	Moxilin Vet, ACIMox, Navamox Vet, Moxillin Vet DS, Colimox, Mimox, Renamox
	Erythromycin	Ery Vet, EST Vet, Erazine Vet, Micronid, Enstrimb, Eraprim Vet, Erisen Vet
Macrolides	Azithromycin	Azi Vet, Azin Vet
	Tylosin	Tylo Doxi, Tylo Vet, Tidoxy
Fluroquinolones	Ciprofloxacin	Cipro Vet, Ciproflox, C-FLO, Cibro-Plus, Renaflox, Ciprocin Vet, Cipro A Vet, CFCIN Vet, Ciptec, Cirolin- 20
Tetracyclines	Oxytetracycline	Tetra Vet WSP, Renamycin, Oxy-D Vet, Doxy Oxy, Oxin, Bactilab, Teradox, Oxsentin
	Doxycycline	Oxy-D Vet, Doxy Oxy, Teradox
	Chlortetracycline	Captor, Eon CTC, Cotra Vet
Sulfonamides	Sulfadiazine	Eskatrim, S-trim vet, Renatatrim Vet, Ativet, Cotrim Vet
Quinolones	Pefloxacin	Pefloxe

Table 2. List of disinfectants found in drug shops

Trade Name	Constituents	Dose	Price (Tk/100 g)	Source
Virex	Peroxymsulphat, Sodium 50% and dichloroisocyanurate 5%	200 g/33 dec.	170	ACI Animal Health
Virocid	Didecyldimethyl ammonium chloride, Alkyldimethylbenzyl ammonium chloride, Alcohol: isopropanol	6ml/1 L water	180	ACI Animal Health
Virusnip	Potassium permanganet 50%, Sodium Dichloroisocyanet 5%, Eipients 45%	Arial spray at 5% dilution or 1 kg to 1300 L water	160	Novartis Animal Health
Povin vet	Povidon iodine USP 10%	2-3ml/L water	33	AV Agro Ltd.
Timsen	N-alkyl dimethyl benzyl ammonium chloride+stabilized urea	20g/40 m ² (for prevention) and 80 g/42 m ² (for treatment)	420	Eon Animal Health Products Ltd.

Table 3. List of ammonia remover found in shops

Trade Name	Constituents	Price (Tk/100 mL)	Source
Acp Yucca	Extract of <i>Yucca schiigera</i> that contains Saponin and Glycocomponent	315	ACP Agro Science Ltd.
Yuka	Extract of <i>Yucca schiigera</i> that contains Saponin and Glycocomponent	315	AV Agro Ltd.
Pond Kleen	Extract of <i>Yucca schiigera</i> that contains Saponin and Glycocomponent	350	ACI Animal Health
Ammocure	Extract of <i>Yucca schiigera</i> 500 mg	315	Acme Laboratories

Table 4. List of probiotics found in drug shops

Trade Name	Constituents	Price (Tk)	Source
FRAC12	Well balanced mixture of 1-monolaurin and essential oil	180/100 g	ACI Animal Health
Protexin	<i>Lactobacillus plantarum</i> , <i>L. bulgaricus</i> , <i>L.acidophilus</i> , <i>S.thermophilus</i> , <i>Candida pintolopesii</i>	325/500 mL	Novartis Animal Health
Protimin	Amino acids and minerals	460/500 mL	SK+ F

Table 5. List of saline found in drug shops

Trade Name	Constituents	Price (Tk/kg)	Source
Energy plus	DextrosenhydrusUSP98g+Ascorbic acid	320	ACI
Acilyte	Sodium bicarbonet, sodium chloride, potassium chloride,Dextrosenhydrus, Vit- A	140	ACI
Osmosaline	Electrolyte with Vit- A	160	Eon
Bloatstop vet	SemethiconUSP1g/100ml	80	Acme
Glucolyte	Electrolyte with sodium bicarbonet, sodium chloride, potassium chloride, Vit-A BP 2000 IU	110	Acme
Oralyte	Electrolyte with Vit- A	110	AV Agro

Probiotics

Probiotics of 3 different trade names like FRAC 12, protexin and protimin were found (Table 4). According to the information leaflet and drug retailer information, major constituents are well balanced mixture of 1-monolaurim and essential oils, amino acids and minerals. Major companies those provided these products were ACI, SK+F and Novartis.

Saline

A number of extra label saline were found with different trade names (Table 5). Their major constituents were dextrosenhydrus, ascorbic acid, sodium bicarbonet, sodium chloride, potassium chloride, dextrosenhydrus and vit- Aacitet. Doses of saline also varied during fry transportation. Major companies those provided these products were ACI, Eon, Acme and AV agro Ltd. In aquaculture, it is used for particularly for giving instant energy of fish fry during fry transportation.

Nutritional supplements

A great variety of nutritional supplements with various trade named were found. According to their constituents, nutritional supplements with vitamin premix are summarized in Table 6. About 17 trade names of such products were found in the drug shops.

Other micronutrients

The component of calcium, zinc and phosphorus supplements were listed from drug shops (Table 7). In aquaculture, they are used for prevention and treatment of deficiency of calcium, phosphorus and vitamin D₃. It also helps for sexual maturity and bone development of fish. Moreover, information provided in the label indicates that it enhances neurological system and hormonal production and reduces fat deposition in fish.

Pesticides

Extra label pesticides including sumithion, energy and rise 10 EC were available in the drug shops (Table 8). Major companies that provided these pesticides were Eon and Setu Corporation Ltd. In agriculture, pesticides are used to prevent or control of pest. In aquaculture, they are used to control noxious organisms like *Hash poka* in the pond. Sumithion is used particularly to control *Argulus* sp. in fish pond.

Selling percentages of extra-label drugs by drug retailers

Extra label antibiotics (48.93%) were the most sold drugs by the retailers in the study areas followed by disinfectant (5.32%), ammonia remover (4.26%), probiotics (3.19%), saline (6.38%), nutritional supplements (26.59%) and pesticides (3.19%) (Fig. 1).

Labeling of the packet and information leaflet

Most of the packet and information leaflet were not well labeled for use in aquaculture. Most information provided on the labels focused either use in veterinary or poultry. About 83% drugs were unlabeled for aquaculture having no information for use in fish though they were found to be used by commercial fish farmers and only 7% were well labeled and about 10% had little labeling (Fig. 2).

Extra-label drugs used by commercial fish farmers

All the 30 interviewed commercial fish farmers practiced polyculture system for growing fish. Major cultured species were Pangus (*Pangasianodon hypophthalmus*), Tilapia (*Oreochromis niloticus*), Shing (*Heteropneustes fossilis*), Pabda (*Ompok pabo*) and Gulsha (*Mystus cavasius*). In addition, they add some carps like Rui (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhinus cirrhosus*), Silver carp (*Hypophthalmichthys molitrix*) and Carpio (*Cyprinus carpio*) with their major species.

Most frequently used extra-label drugs by the farmers

Majority (77%) of the commercial fish farmers used a number of extra-label drugs in their farms. They used these drugs because of the availability and effectiveness in their culture system. Most frequently used extra-label drugs by farmers were antibiotic (66.66%), nutritional supplement (50%) and disinfectant (40%) followed by saline (26.66%), ammonia remover (23.33%), probiotics (10%) and pesticides (6.66%) (Fig. 3). Individually, Renamycin and Timsen were the mostly used drugs by the farmers followed by Pondkleen, Acmezyme and Oralyte.

Misuse of drugs

It was found that about 73% farmers used drugs without having any prescription from any qualified person while 27% accepted counseling sometimes in case of disease problem or any other environmental problems of their farms. Farmers usually received prescription from different sources including technical personnel of drug company and upazila fisheries officers. Farmers were questioned about whether they could calculate the amount of drugs needed before use and it was found that 87% farmers were unable to calculate whereas 13% farmers were quite able to calculate the dose. Using over dose and dosage of drugs was found as very common phenomena in commercial fish farming. Most of the time, farmers practiced over dose intentionally without following any guidelines. It was noticed that overall 90% farmers did not maintain the guideline of applying dose and dosages while 10% did that practice. Majority (88%) of farmers mentioned that they had no idea about risk, safety issue and toxicity reaction of using these drugs

and only 7% farmers had little idea about it. When farmers became unable to use any drugs, they took suggestions from drug sellers and it was reported that most (60%) of the farmers took suggestion from the drug retailers although literally they had no right to suggest. About 72% farmers of Mymensingh Sadar received suggestion from drug sellers and 45% in Trishal did the same.

Table 6. List of vitamin premix found in drug shops

Trade Name	Constituents	Price (Tk)	Source
Nutri-egg	Vitamins-Vitamin A, B1, B2, B6, B12 and D; Minerals-Sodium, Potassium, Calcium, Iron, Magnesium and Sulphur	130/100 g	ACI Animal Health
Vital B+C	Vitamin A, B1, B2, B6, B12 and C, Nicotinamide, Biotin, Folic acid, More than 60 minerals, trace and oligo-elements	212/500 g	Navana Pharmaceuticals Ltd
Megavit -WS	Vitamin A, B1, B2, B6, B12 and C, Nicotinamide, Biotin, Folic acid	190/50 g	Novartis Pharmaceuticals Ltd
Rena- WS	Vitamin A, B1, B2, B6, B12 and C, Biotin Folic acid	235/kg	Renata Pharmaceuticals
Thiavin	Vitamin B1 and B2 premix	80/100 g	F n F Pharmaceuticals Ltd
Immunizer	More than 60 minerals, trace and oligo-elements	1100/250 mL	Nexus Com. Ltd.
E-Vet Plus	Vitamin E and Selenium supplement	180/100 mL	Acme Laboratories
Vitex-ES	vitamin E with Selenium premix	150/100 g	Eon Animal Health
Eskavit- E	Vitamin E acetate	124/100 mL	SK+ F
Eskavit A, D, E	Vitamin E acetate	124/100 mL	SK+ F
GlucoseC	Glucose+Vitamin C	200/500 g	Navana
Glucovet	Vitamin C Premix	120/500 g	Acme Laboratories
Megavit C Plus	Vitamin C Premix and mineral	100/100 g	Acme Laboratories
Vitamix C-Vet	Vitamin C Premix	800/1 kg	Acme Laboratories
Rena- C	Vitamin C Premix	1725/kg	Renata
Vitex-C	Vitamin C Premix	150/100 g	Eon Animal Health
Vitex-BC	Premix of vitamin B complex and vitamin C	240/500 g	Eon Animal Health
BC mixB+C	Premix of vitamin B complex and vitamin C	320/1 kg	AV agro Ltd.

Table 7. List of calcium, zinc and phosphorus found in drug shops

Trade Name	Constituents	Dose	Price (Tk)	Source
Calplex	Calcium, Phosphorus and Vitamin D3	2.5 mL/L of drinking water	69/100 mL	Square Pharmaceuticals Ltd.
DCP Plus	Calcium, Phosphorus	1 kg/100 kg of feed	52/500 g	AV Agro Ltd.
FRA AC 34	Calcium, Phosphorus	1-2 mL/L of drinking water	700/500 mL	ACI Animal Health
CP Vet	Calcium, Phosphorus and Vitamin B12, Vitamin C, Vitamin D3 and Citric acid	1 g/L of drinking water 3-5 days	180/L	Acme Laboratories Ltd.
Xinc-Care	Zinc sulphate	1-2 mL/L of drinking water	120/L	SK+ F

Table 8. List of pesticides found in drug shops

Trade Name	Constituents	Dose	Price (Tk)	Source
Rise 10 EC	Each liter contains 100g cypermethrin	200 mL/acre	133/100 mL	Eon
Energy	Each Kg contains 800g Sulphur	700 g/acre	130/500 g	Eon
Sumithion	Organo Phosphorus	10 L/5 dec	155/100 mL	Setu Corporation

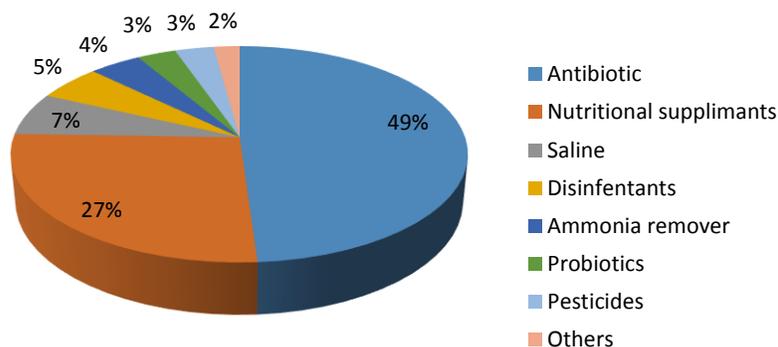


Figure 1. Percentages of selling extra-label drugs

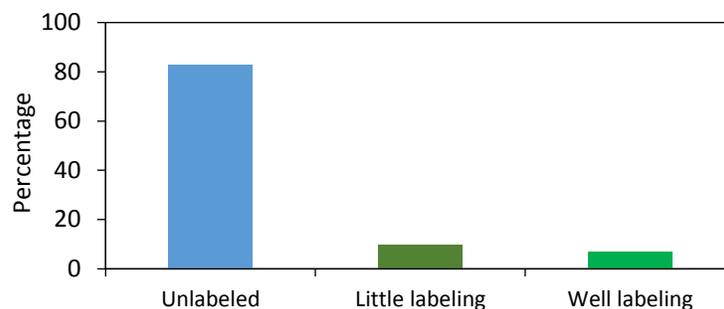


Figure 2. Labeling (%) on the drugs packets and information leaflet

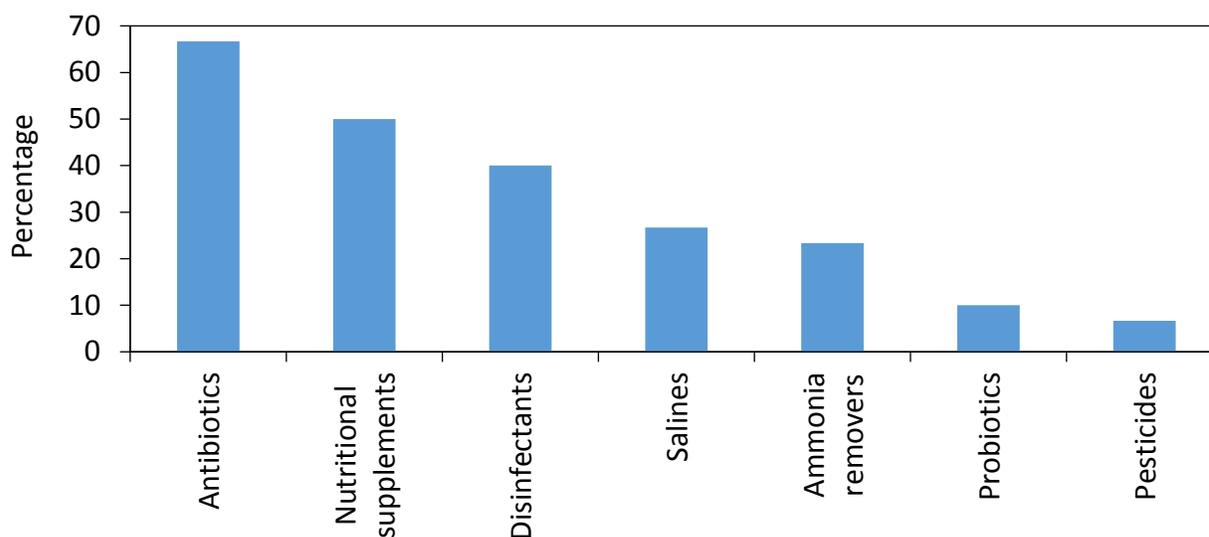


Figure 3. Frequently used extra-label drugs by fish farmers

Discussion

Aquaculture activities in Bangladesh are being influenced by huge number of drugs and chemicals. The present study was conducted in Trishal and Sadar upazillas of Mymensingh district to know the present status of use of extra-label drugs in commercial aquaculture. It was found that a wide range of extra label drugs were marketed by various companies for use in aquaculture. Most of the drugs were seen to use mainly for disease treatment, disinfecting aquaculture facilities, as nutrient supplements, during pond preparation and water management and as probiotics. Fish health management and disease treatment were the major areas where farmers were seen to use a lot of such extra label-drugs.

Only few approved and conditionally approved drugs are available to use in aquaculture. Therefore, a number of extra-label drugs are allowed to apply in fish under specified conditions with the supervision of a qualified veterinarian (FDA, 2020). It is evident that extra-label drugs have commonly been using in different countries in

different aquaculture systems (Zarza, 2012; Baoprasertkul *et al.*, 2012). The primary benefit of the use of extra label veterinary drugs in aquaculture is that their prudent and responsible use supports the development of intensive, industrial-scale food production systems. In addition, they are indispensable for the treatment of epizootic disease outbreaks having the potential to cause mass mortalities, the failure of individual aquaculture enterprises and the occasional collapse of entire industries (FAO, 2019).

In the present study, 6 groups of antibiotics with 46 different trade names were recorded in the drug shops of the study areas. Fish farmers usually bought these antibiotics from drug shops without any prescription by qualified person. Among the antibiotics, the following active compounds were found which included tetracyclines (oxytetracycline), amoxicillin, erythromycin, ciprofloxacin, sulfadiazine and chlortetracycline. The occasional uses of tylocin, azithromycin, pefloxacin, enrofloxacin etc were also reported. Antibiotics like oxytetracycline and

sulfonamides (sulfadiazine and trimethoprim) had been used widely to treat several diseases such as Vibriosis and ulcerative diseases in aquaculture (Nogueira-Lima *et al.*, 2006), although other broad spectrum antibiotics such as oxolinic acid and flumequine were also used (Sapkota *et al.*, 2008). Yang and Zheng (2007) reported that the extra-label veterinary medicines in China were classified by their functions and ingredients. Five different kinds of veterinary medicine were reported to be used in aquaculture which included disinfectants, antiparasitics, water-quality treatments, antimicrobial agents and herbal treatments. Bravo (2012) also informed the use of extra label veterinary medicines at the beginning of the salmon industry to control *Piscirickettsia salmonis* in Chile.

Antibacterial substances are utilized in aquaculture production to combat bacterial diseases. They are mainly applied through medicated feed and enter the environment as a result of leaching from feces and uneaten treated feed (Lalumera *et al.*, 2004). Among the chemicals used in aquaculture, special oversight should be given to veterinary drugs used to prevent and treat bacterial diseases. Only three fish grade antibiotics including oxytetracycline, sulfadimethoxine and sulfamerazine are approved by the FDA to use in aquaculture (FDA, 2020). In the present study, almost all the identified antibiotics were made for use in poultry and veterinary but were being used indiscriminately in aquaculture for disease treatment of fish. These antibiotics were not approved by appropriate authority to use in aquaculture. In recent study, Hassan (2016) also found some poultry and veterinary drugs used immensely at the farm level to produce fish.

Hazards due to the use of unapproved or banned antibiotics differ depending on the type of antibiotic, dose level, national regulations and there are no harmonised regulations yet to deal properly with this situation at an international level. Unapproved antibiotics or extra-label uses of antibiotics were used in two main situations which included extra label use of an approved antibiotic in aquaculture and extra-label use of an antibiotic not specifically approved for use in aquaculture (Subasinghe, 2009). Use of unapproved extra-label drugs in commercial fish farming can create potential human health hazard. These substances may be toxic, allergenic and carcinogenic. Presence of drug residue because of drug abuse in fish products may create negative impact on export business and even products may be rejected by the foreign buyers. Also, farmers are to pay additional money for the extra drugs and they lose financially. Okocha *et al.*, 2018; Beyene, 2016).

According to the Aqua Medicinal Products (AMPs) guideline of the Department of Fisheries, certain information of the name of drugs, amount of purchased drugs, name and address of drug retailer, date of drug application, amount of applied drugs, harvesting date after drug application, batch number, expired date, followed withdrawal period, description of aquatic animal have to be recorded during drug application (DoF, 2015). Also, records have to be stored for two years. Record keeping activity of farmers and retailers were found very poor. The present study also revealed a lack of information regarding the leaflets of particular drugs with dose, dosage, withdrawal period and method of application. Consequently, most of the farmers were found to be unable to calculate proper dose and dosages before using and hence, drug abuse happened. Even in some instances, there were wrong information on the leaflet like the disease mentioned there might not exist in Bangladesh aquaculture at all.

As per the guideline, it is mandatory to receive prescription from the authorized person before using antibiotics and other drugs. Majority of commercial farmers used drugs without receiving any prescription from qualified personnel. There was a lack of qualified personnel, providing prescription, in Bangladesh as well as in the study area. As a result, majority of the farmers could not receive proper prescription and they used to use drugs indiscriminately and thus drug abuse happened regularly.

Conclusion

The practice of using drugs and chemicals in aquaculture operations in Bangladesh are not fully regulated and controlled by competent authorities. Hence, the extra-label use of veterinary and poultry drugs in aquaculture is a common practice of commercial fish farmers. The uncontrolled and indiscriminate use of drugs in aquaculture may lead to the emergence of antimicrobial resistant organisms, loses of aquatic ecosystem and make negative impact on human health. Thus, the use of drugs in aquaculture should have a sufficient regulatory system in place. It is also important to produce and use appropriate labeled drugs in aquaculture for safe fish production. Further in-depth research is needed to understand the impact of extra-label drug on fish, aquatic ecosystem and human health.

Acknowledgement

The authors would like to acknowledge University Grants Commission (UGC) of Bangladesh for providing financial supports of the research and Bangladesh Agricultural University Research System (BAURES) for the overall management of the project.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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