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Quantification of antibiotics applied in aquaculture in Mymensingh district

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Abstract. The present study was carried out to estimate the amount of antibiotics used in aquaculture activities in Mymensingh district. Data were collected from different pharmaceutical companies, drug retailers and fish farmers through questionnaire interview from July to December 2022. Seven groups of antibiotics having 25 different active ingredients with 82 trade names were found to provide by 12 different pharmaceutical companies. The groups of antibiotics included β-lactams, macrolides, sulfonamides, aminoglycosides, tetracycline, metronidazole, and fluoroquinolones. It was estimated that total 20.28 tons of solid and 23.96 tons of liquid antibiotics were sold during July 2021 to June 2022 for use in aquaculture with a total price of about Tk. 8.75 crore. Among the active ingredients of antibiotics, oxytetracycline in solid form has been sold at the highest amount of around 7.57 tons followed by erythromycin, doxycycline, amoxicillin, chlortetracycline, levofloxacin, neomycin, gentamicin, sulpha drugs, and ciprofloxacin. Of the total antibiotics sold during the mentioned year in year, 72% were used for terrestrial animal health and 28% were used for aquaculture. It was noticed that aqua farmers spent around 34% only for buying antibiotics and 66% for other medicines. The present study quantified the amount of antibiotics used only in Mymensingh district and to have a clear picture of the total amount of antibiotics used in aquaculture in Bangladesh, a comprehensive study needs to be conducted in all districts of the country.
Keywords: Antibiotic, Aquaculture, Active ingredient, Trade name

Introduction

Antibiotics have been used for inhibiting the growth or multiplication of a wide range of bacteria in human and veterinary medicine since the discovery of penicillin by Alexander Fleming in 1929 (Prescott 1997). The current intensification of aquaculture has led to the promotion of conditions that favor the development of infection and disease-related problems. Consequently, antibiotics are being employed prophylactically and therapeutically to manage these diseases as well as to enhance growth promotion (Okocha *et al.* 2018). The global antimicrobial use in food animals including aquaculture is increasing tremendously, estimated at 63,151 tons in 2010, and projected to rise by 67% in 2030 (Van Boeckel *et al.* 2015). A large variation in antibiotic use has been reported within the countries. For example, while Norway uses 1 g per ton of salmon produced, Vietnam requires 700 g per ton of shrimp (Smith 2008).

Antibiotics, however, have not always been used responsibly in aquaculture (FAO/WHO 2003). Irrational and inappropriate use of antibiotics in aquaculture can contribute to the development of antibiotic resistance. Moreover, their unregulated use could pose human health and food safety concerns that remain largely unaddressed in most developing nations of the world including Bangladesh. The presence of antibiotic residues in aquaculture products could result in the development of bacterial resistance and toxicity to consumers that can lead to death (Okocha *et al.* 2018). A number of reports have raised legitimate public concerns about the safety and abuse of antibacterial drugs in aquaculture (Alderman and Hastings 1998, Goldburg *et al.* 2001). The current increasing trend of aquaculture production in Bangladesh has also been associated with the corresponding increasing use of varieties of antibiotics. Vast majority of such compounds are

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being used indiscriminately particularly for fish disease treatment and health management (Faruk *et al.* 2008). The amount of antibiotics used in aquaculture of Bangladesh is not documented yet. As a consequence, there is every chance of drug abuse by different stakeholders. Considering the significant contribution of aquaculture production in Bangladesh, the present study was conducted to determine the amount of antibiotics used in aquaculture activities in Mymensingh district.

Materials and Methods

Data were collected from 12 depot manager of different pharmaceutical companies, 15 drug retailers and 30 fish farmers of Trishal, Muktagasa and Sadarupazla of Mymensingh district through questionnaire interview from July to December 2022. The areas were selected based on the intensity of commercial fish farms and the availability of pharmaceutical companies and drug retailers. A set of preliminary questionnaire was prepared for interview focusing mainly on name of antibiotics, groups, active ingredients, sources, price, amount of antibiotics sold by the companies and the amount used by farmers in a year. General farming information, culture strategy, types of farms and storage conditions were also included in the interview schedule. The preliminary questionnaire was tested at the field level and then the final set questionnaire was developed. The data were tabulated in the computer and raw data were entered in spread sheet of the Microsoft Office Excel program to analyze data.

Results

Antibiotic groups: Seven groups of antibiotics having 25 different compounds with 82 trade names were found to provide by 12 pharmaceutical companies to use in aquaculture in Mymensingh district. The groups included β-lactams, macrolides, fluoroquinolone, tetracyclines, metronidazole, sulfonamides, and aminoglycosides. The major active ingredients of such antibiotics were amoxicillin, erythromycin, levofloxacin, ciprofloxacin, oxytetracycline, doxycycline, chlortetracycline, sulfadiazine and enrofloxacin (Table I).

Table I. Summary of major group of antibiotics found in pharmaceutical companies

Group of antibiotic	Active ingredients	Trade Name
β- Lactams	Amoxicillin	Renamox, Navamox Vet, Acimox Vet, Moxacil-Vet, Moxilin Vet, Hicomox
Macrolides	Erythromycin	Micronid, EST-Vet, Erocot, Erazine Vet, Eraprim Vet, Set-3 Powder Eryvet (Powder), Turbonid Vet, Erotrim Plus Vet, Erisen-Vet,
	Tilmicosin	Tilmisin, Tilcon Vet, G.C. Greentil Liquid
Fluoroquinolones	Enrofloxacin	Enrocin, ENRO-10, Enroflox, Enrovet, Enrex Vet, Enflox-Vet, G-Enro (Vet), Alenro-Vet
	Ciprofloxacin	Cipronaf, Renaflox, CiproVet, C-Flo Vet, CIPRO-A VET, Al-Cipro, AcivetCipro, BeuFlox Vet, Ciprocin-Vet, Ciproflox Vet,

	Levofloxacin	XacQuin Vet, Aci-Levo, Levomax, Levoxin, Levobac Vet, Leovet
	Flumequine	Renaquine, Flumequine
	Pefloxacin	Pexacin
Tetracycline	Oxytetracycline	Oxy Naaf, OTC Vet Powder, Renamycin, Tetravet-LA, Eskamycin 50, Etracin, Ovet, Bactitab, Otetra-Vet, Vetomycin
	Doxycycline	Doxivet, D-Vet, Doxacil-Vet, DOXY-A VET (Powder), Tylo-Doxi Plus,
	Chlortetracycline	Captor, Aci-CTC, Eon-CTC Active, Al- CTC, Maxtor Vet, Cotra-Vet, CTC, Eska- CTC
Sulfonamides	Sulphamethoxazole	Naftrizol, Trisulfa sol. 20
	Sulfadiazine	Ativet, Sulpha-3, Eryvet, Cotrim-Vet,
Metronidazole	Metronidazole	Acimetro- vet, Renamet Bolus, Dirovet Powder
Aminoglycosides	Neomycin	Neoren, NS-Vet, Neosulcin, Nimocin Vet
	Gentamicin	Gentaren, Genta-10, Genacyn-Vet, Aci-Gent, Algenta-Vet Injection

Quantification of antibiotics: Antibiotics were found available in two different forms i.e solid and liquid. In solid form, total amount of antibiotics sold by different companies was 20,285 Kg with a total price of about Tk. 4.33 crore. In liquid form, total 23,958 Liter of antibiotics were sold with a price of Tk. 4.42 crore (Table II). Among the seven groups, tetracyclinewas the highest(10264 Kg) sold antibiotics and sulfonamides (441 kg) was the lowest in sold form. In terms of money, macrolides (Tk. 1.69 crore) was the highest sold antibiotic followed by tetracycline, aminoglycosides, β-lactams and fluoroquinolone. In liquid form, total 23,958 liter of antibiotics were sold in a year with a price of about Tk. 4.42 crore. Fluoroquinolones was the highest sold compound both in terms of amount and money whereas, β-lactams was the lowest (Table II).

Table II. Estimated amount of antibiotics sold in Mymensingh district during July 2021 to June 2022 for use in aquaculture

Antibiotic groups	Solid		Liquid	
	Amount (Kg)	Taka in Lakh	Amount (Liter)	Taka in Lakh
β-lactams	1498	34.00	55	3.10
Macrolides	5611	169.00	295	23.00
Sulfonamides	441	7.50	2350	23.50
Aminoglycosides	1179	43.50	640	25.50
Tetracycline	10264	145.75	960	12.50
Fluoroquinolones	1172	30.50	19,498	351.00
Others	120	3.00	160	4.00
Total	20,285	433.25	23,958	442.60
Grand Total				875.85

Company wise antibiotics sold in Mymensingh district: A total depot managers of 12 pharmaceutical companies operated in Mymensingh district were interviewed. Among the companies, the highest amount of antibiotics in solid form was sold by the ACI group (5.43 tons) followed by Eskayef, Square and Reneta Pharma and the lowest amount was sold by the Naafco group. In the case of liquid form of antibiotics, the highest amount was sold by Al- Madina (7 tons) followed by Eon, Acme and Eskayef (Fig. 1and 2). In terms of money, it was observed that the highest amount was sold by Al-Madina group (Tk. 185.5 lac) followed by ACI and Square and the lowest amount was sold by Opsonin Pharma (Fig. 3).

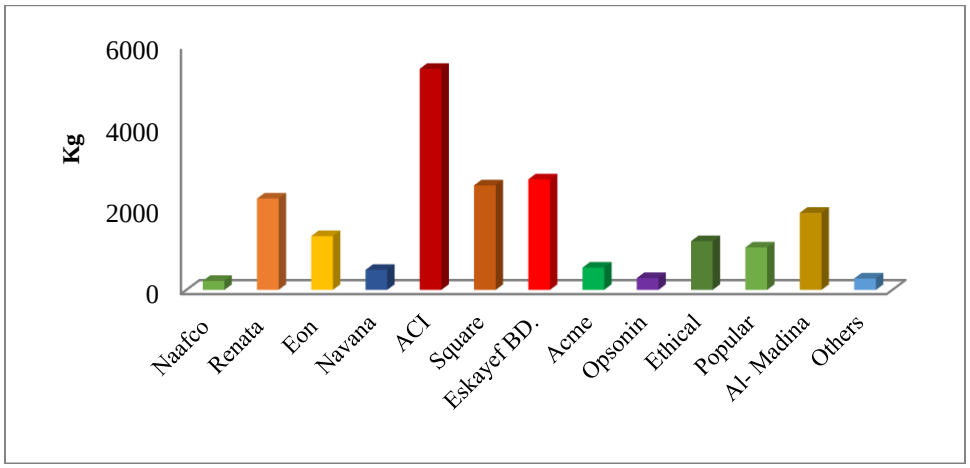

Fig. 1. Company wise antibiotics in solid form (Kg) sold during July 2021 to June 2022.

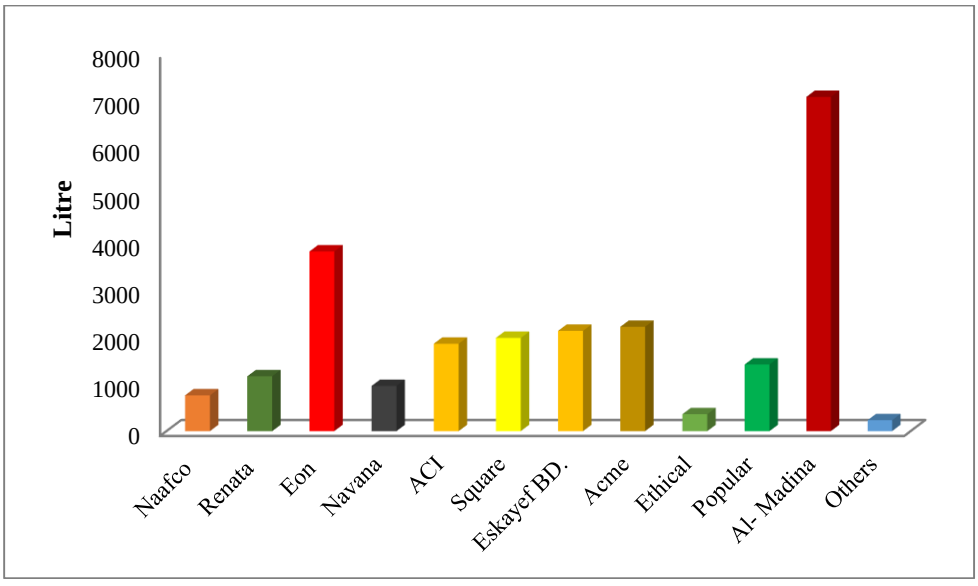

Fig. 2. Company wise antibiotics in liquid form (liter) sold during July 2021 to June 2022.

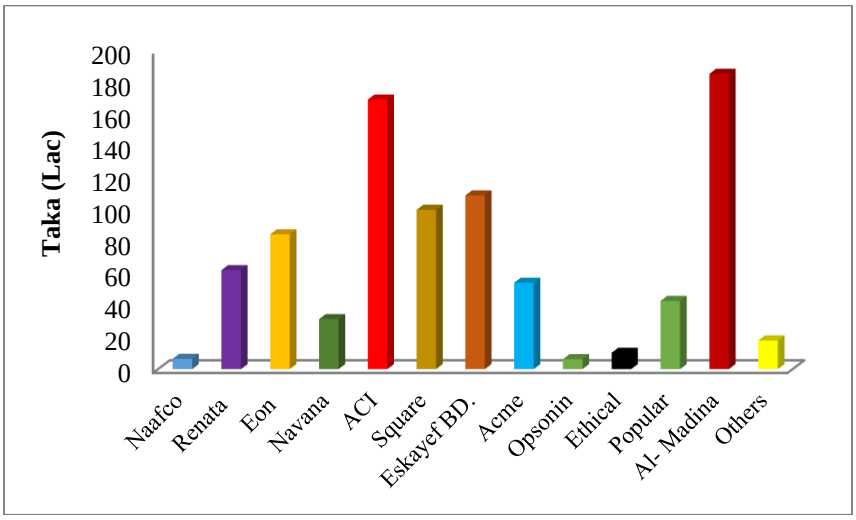

Fig. 3. Company wise antibiotics sold (Tk) during July 2021 to June 2022.

Antibiotics sold with major active ingredients: Among various active ingredients of antibiotics, oxytetracycline in solid form has been sold at the highest amount (7.57) tons followed by erythromycin, doxycycline, amoxicillin, chlortetracycline, levofloxacin, neomycin, gentamicin, sulphadrugs, and ciprofloxacin. In terms of money, erythromycin has been sold at the highest amount (Tk. 169 lac) followed by oxytetracycline, amoxicillin and gentamicin per year (Figs. 4 and 5). In liquid form,ciprofloxacinwas at the highest amount of around 10.24 tons followed by enrofloxacin, levofloxacin, sulphadrugs, oxytetracycline, gentamicin, tilmicosin, flumequine and amoxicillin. In terms of cash, ciprofloxacin has been sold at the highest amount of Tk. 188 lac followed by enrofloxacin, levofloxacin and gentamicin (Figs. 6 and 7). It was also found that ciprofloxacin (22%) has been sold at the highest amount in terms of percentage followed by erythromycin, oxytetracycline, enrofloxacin, levofloxacin, gentamicin, amoxicillin, sulphadrugs, chlortetracycline, doxycycline and tilmicosin (Fig. 8).

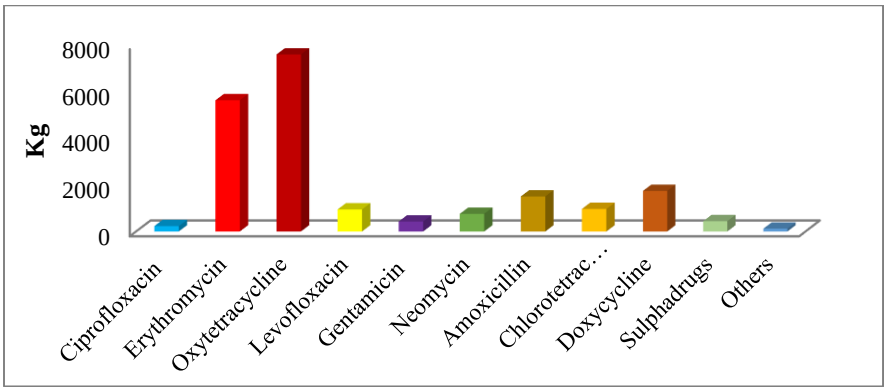

Fig.4. Amount (Kg) of active ingredients of antibiotics sold in solid form.

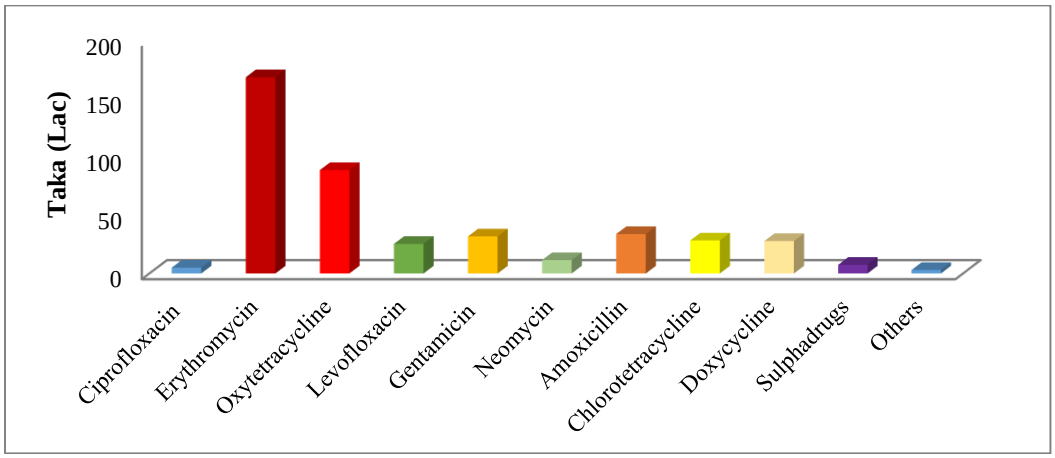

Fig. 5. Amount (Taka) of active ingredients of antibiotics sold in solid form.

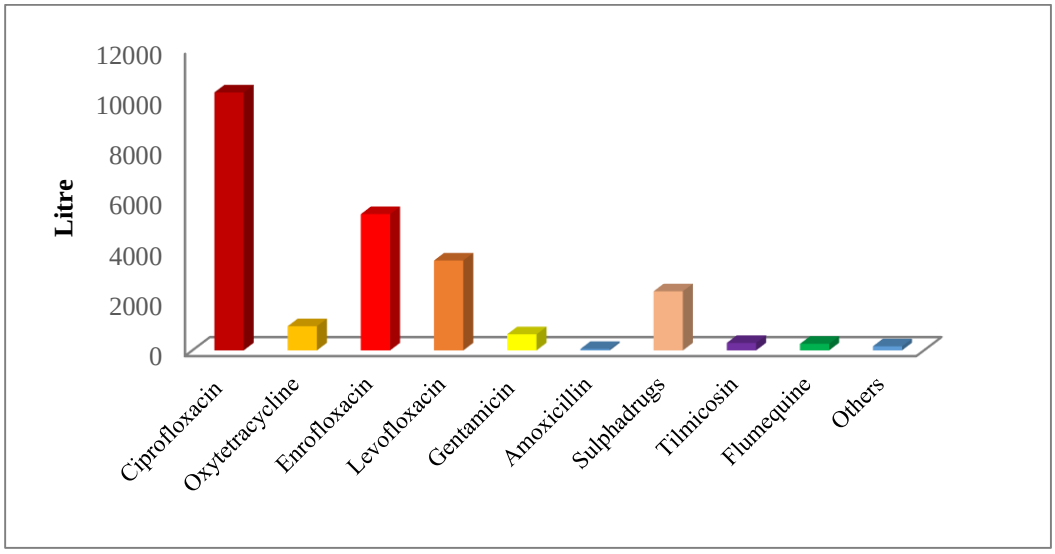

Fig. 6. Amount (Liter) of active ingredients of antibiotics sold in liquid form.

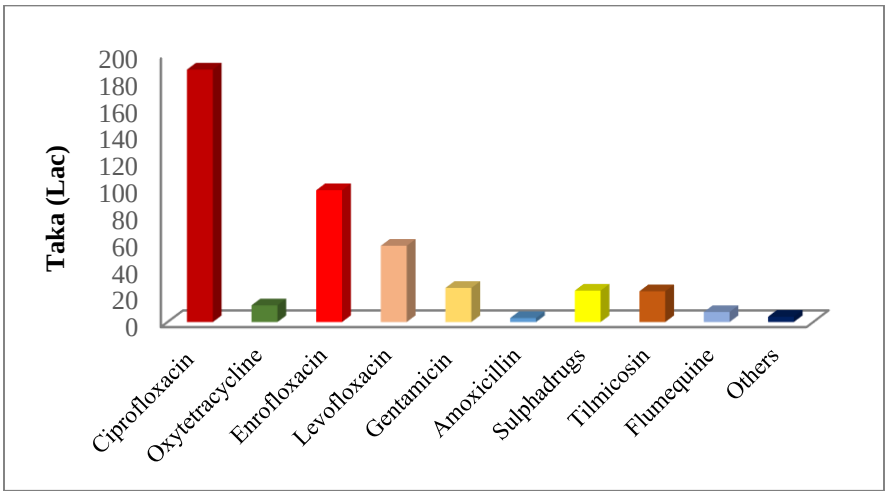

Fig. 7. Amount (Taka) of active ingredients sold (liquid form).

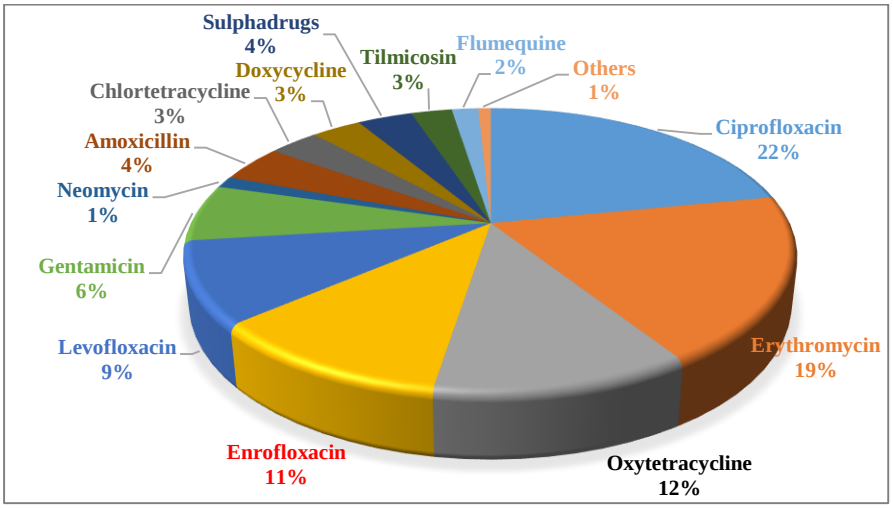

Fig. 8. Active ingredients (%) of antibiotics sold during July 2021 to June 2022.

Farm level use of antibiotics: Among the interviewed fish farmers, 60% farmers practiced monoculture and 40% farmers polyculture of fish. Major cultured species were rohu (*Labeo rohita*), catla (*Catla catla)* and *carpio* (*Cyprinus carpio*), shing (*Heteropneustes fossilis)*, koi (*Anabas testudineus*), gulsha (*Mystus cavasius*), tilapia (*Oreochromis niloticus*) and pangasius (*Pangasinodon hypophthalmus*). Gulsa and shing were cultured with carps *viz.*, rui, catla, carpio in polyculture system. koi, pangasious and tilapia were found to culture as major species in monoculture system. The study showed that farmers spent around Tk. 5.5 lac for all medicines used in the culture period of a single cycle where they spent around Tk. 1.9 lac (34%) for antibiotics and around Tk. 3.65 lac (66%) for other medicines (Fig. 9).

Antibiotics sold for terrestrial animal and aquaculture: It was estimated that of the total antibiotics sold in a year by the interviewed pharmaceutical companies, 72% were used for terrestrial animal health and 28% were used in aquaculture (Fig. 10).

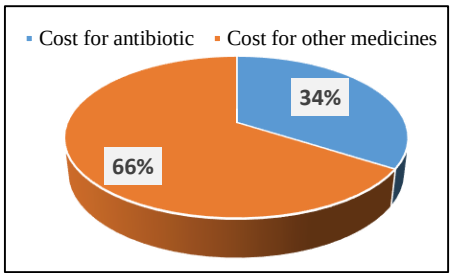

Fig. 9. Proportion of fund (%) incurred for antibiotics and other drugs by the fishfarmers.

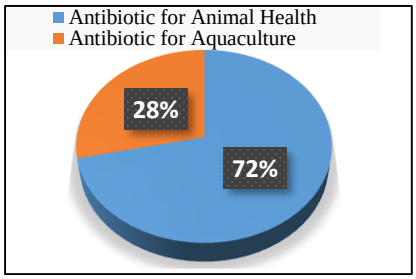

Fig. 10. Proportion of antibiotics (%) applied for terrestrial animal health and aquaculture.

Discussion

Use of drugs and chemicals have become crucial components of effective aquaculture production. Antibiotics are frequently used in aquaculture to treat or prevent fish diseases. The current research was carried out to determine the amount of antibiotics used in aquaculture in Mymensingh district. Seven groups of antibiotics having twenty-five different active compounds with 82 trade names were identified. The major active ingredients of such antibiotics were amoxicillin, erythromycin, levofloxacin, ciprofloxacin, oxytetracycline, doxycycline, chlortetracycline, sulfadiazine and enrofloxacin. Sharker (2014) stated that antibiotics with different trade names such as renamycine, bactitab, chlorsteclin, cotrimVet, orgacycline, oxysentin, and sulfatrim were seen in the market and utilized by fish farmers. The active components of such antibiotics are mostly oxytetracycline, chlortetracycline, amoxicillin, co-trimoxazole, sulphadiazine, and sulphamethoxazole. Faruk *et al.* (2008) found 14 branded antibiotics with distinct trade names on the market and being utilized by fish farmers. The active ingredients of such antibiotics were mainly oxytetracycline, chlortetracycline and amoxicillin.

The present research estimated total 20.28 tons of solid and 23.96 tons of liquid antibiotics in the study area. Rahman (2019) quantified three major aquaculture medicinal products (AMPs) that included antibiotics, disinfectants and probiotics used in aquaculture in the Mymensingh district. Among these three AMPs, selling of solid antibiotic was (19.8 tons) and liquid antibiotics was (10.4 tons). Total price of antibiotics sold per year were Tk. 5.41 crores. Six groups of antibiotics having seventeen different active compounds with 53 trade names were found. Jahan (2017) found six groups of antibiotics having 10 different active compounds with 46 trade names in the drug retailer shops.

Lulijwa *et al.* (2020) showed that 11 of the top 15 fish-producing countries utilized 67 antibiotic compounds, with oxytetracycline, sulphadiazine, and florfenicol accounting for 73% of them. Among the 15 countries, antibiotics were most commonly utilized in Vietnam (39 antibiotics), China (33 antibiotics) and Bangladesh (21 antibiotics). In aquaculture, the majority of

these countries reported using oxytetracycline, sulphadiazine, and florfenicol. According to Orubu *et al.* (2021), 1338 drugs were licensed for veterinary usage in Bangladesh, with 818 (61%) of them being antimicrobials. Fluoroquinolone, tetracycline, penicillin, and sulfonamide were the most commonly used antibiotic classes. The top licensed antibiotics were oxytetracycline, ciprofloxacin, amoxicillin, metronidazole, gentamycin, ceftriaxone, and a combination medication containing sulphamethoxazole and trimethoprim, doxycycline, neomycin, a combination of benzylpenicillin and procaine penicillin. Anwar *et al*. (2018) mentioned that for disease treatment, most farmers utilized oxysentin 20%, captor, acimox (vet) power, aquamycine, oxy-dox-F 100, oxy-D vet, renamycin soluble powder, moxilin vet, tetravet and doxy-a vet.Shorna (2019) investigated that there were nine groups of antibiotics with 38 trade names found in drug shop. Oxyteracycline and amoxicillin were the most sold antibiotics followed by ciprofloxacine, sulfadiazine and enrofloxacin. Schar *et al.* (2020) noticed that most commonly used classes of antimicrobials were, by frequency of use, quinolones (27%), tetracyclines (20%), amphenicols (18%), and sulfonamides (14%). Hasan*et al*. (2020) reported that renamycin was the most often used antibiotic in the Patuakhali district of Bangladesh. Rahman*et al.* (2017) found that to treat sick fish 44% of farmers in the Cumilla region of Bangladesh used oxytetracycline. Rahman *et al.* (2015) noticed that oxytetracycline is the main antibiotic applied in aquaculture in the northeastern region of Bangladesh. Adhikary *et al.* (2018) noticed that most farmers used oxysentin, captor, acimox (vet) power, aquamycine, oxy-dox-f 100, oxy-D vet, renamycin soluble powder, moxilin vet, tetravet, doxy-A vet for disease treatment in aquaculture at Jessore sadar upazila. In Bangladesh, a lack of diagnostic capacityhampers farmers from detecting diseases quickly and correctly, which may lead to antibiotic use or misuse. Also, prophylactic antibiotic use to prevent diseases during aquaculture production is on an increasing trend. If farmers after using antibiotics do not observe proper withdrawal periods before harvesting fish, there is a risk that antibiotic residues may affect the health of consumers.

In conclusion, the study's findings provided evidence of amount of antibiotic used in aquaculture activities in Mymensingh district of Bangladesh. Enforcement by the national and local authorities to control and monitor antibiotic usage and sale are important to reduce unnecessary use of antibiotics in aquaculture. The present research has been conducted only in the Mymensingh district and to have a clear picture of the total amount of antibiotics used in aquaculture in Bangladesh, a comprehensive study needs to be conducted in all districts of the country.

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Literature Cited

Adhikary, R.K., M. Rahman and A. Asif. 2018. Present status of aqua-medicines used in aquaculture at Jessore sadar upazila, Bangladesh. *Asian J. Biol. Med. Sci*.,4(3): 288-297.

Alderman, D.J. and T.S. Hastings. 1998. Antibiotic use in aquaculture: development of antibiotic resistance-potential for consumer health risks. *Int. J. Food Sci. Technol.*, 33: 139-155.

Anwar, M.A., M.M. Rashid, M.A.H.M. Kamal, M.M. Rahman and D. Pandit. 2018. Aqua drugs and chemicals used in aquaculture in Jamalpur Sadar Upazila of Bangladesh. *Asian J. Fish. Aqua. Res.*, 2(2): 1-13.

DoF. *Yearbook of Fisheries Statistics of Bangladesh* 2017–18; Fisheries Resources Survey System (FRSS), Dept. of Fisheries, Dhaka, Bangladesh, 2019.

FAO. 2022. *The State of World Fisheries and Aquaculture.* Rome, Italy: FAO, 266p.

FAO. 2018. The State of World Fisheries and Aquaculture 2018—Meeting the sustainable development goals. Rome. http://www. fao.org/3/i9540 en/I9540 EN.pdf

FAO/WHO. *Code of Practice for Fish and be Fishery Products*. Codex Alimentarius Commission. FAO, Rome: CAC/RCP; 2003, 238p.

Faruk, M.A.R., M.M. Ali and Z.P. Patwary. 2008. Evaluation of the status of use of chemicals and antibiotics in freshwater aquaculture activities with special emphasis to fish health management. *J. Bangladesh Agric. Univ*., 6 (2): 381–390.

Goldburg, J. Rebecca, S. Matthew, Elliot, and L.N. Rosamond. 2001. Marine Aquaculture in the United States: Environmental Impacts and Policy Options. Report prepared for the Pew Oceans Commission. Arlington, Virginia.

Hasan, J., M.H. Rahman, M.R. Ullah and M.M.H. Mredul. 2020. Availability of aqua drugs and their uses in semi intensive culture farms at Patuakhali district in Bangladesh. *Arch. Agri. Sci. J*. 5(3): 368–376.

Jahan, F. 2017. Use of Extra-Label Drugs in Commercial Aquaculture, MS Thesis, Department of Aquaculture, Bangladesh Agricultural University, Bangladesh.

Lulijwa, R., E.J. Rupia and A.C. Alfaro. 2020. Antibiotic use in aquaculture, policies and regulation, health and environmental risks: a review of the top 15 major producers. *Rev. Aquac*.,12 (2): 640–663.

OECD/FAO. 2018. "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database). https ://doi.org/10.1787/agroutl-data-en.

Okocha, R.C., I.O. Olatoye and O.B. Adedeji. 2018. Food safety impacts of antimicrobial use and their residues in aquaculture. *Public Health Rev.,* 39:21.

Orubu, E.S.F., M.A. Samad, M.T. Rahman, M.H. Zaman and V.J. Wirtz. 2021. Mapping the antimicrobial supply chain in Bangladesh: a scoping-review-based ecological assessment approach. *Glob. Health Sci. Pract.,* 9 (3): 532–547.

Prescott, J.F. 1997. Antibiotics: miracle drugs in pigs? *Can. Vet. J.* 38: 763–766.

Rahman, M.M., M.M.M Alam, S.M.I. Khalil, S.M. Bari and M.M. Rashid. 2015. Status of chemicals and aqua drugs used in freshwater aquaculture in north-eastern Bangladesh. *J. Sylhet Agril. Univ.,* 2: 243–252.

Rahman, M.Z., A. Khatun, M.I. Kholil and M.M.M. Hossain. 2017. Aqua drugs and chemicals used in fish farms of Comilla regions. *J. Entomol. Zool. Stud.,* 5: 2462–2473.

Rahman, N. 2019. Quantification of Major Aquaculture Medicinal Products (AMPs) Used in Mymensingh District, MS Thesis, Department of Aquaculture, Bangladesh Agricultural University, Bangladesh.

Schar, D., E. Klein, R. Laxminarayan, M. Gilbert and T.P.V. Boeckel. 2020. Global trends in antimicrobial use in aquaculture. *Sci. Rep.,* 10: 21878.

Sharker, M. 2014. Drugs and chemicals used in aquaculture activities for fish health management in the coastal region of Bangladesh. *Int. J. Life Sci. Biotec. Pharma Res.,* 3:

Shorna, H.K. 2019. Use and Impact of Veterinary Drugs and Chemicals in Fish Health Management, MS Thesis, Department of Aquaculture, Bangladesh Agricultural University.

Smith, P. 2008. Antimicrobial resistance in aquaculture. *Rev. Sci. Tech.,* 27: 243–264.

Van Boeckel, T.P., C. Brower, M. Gilbert, B.T. Grenfell, S.A. Levin, T.P. Robinson, A. Teillant, and R. Laxminarayan. Global trends in antimicrobial use in food animals. *Proc. Natl. Acad. Sci.* U S A. 2015:5649–54.

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