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Use of Chemicals and Biological Products in Aquaculture in Bangladesh

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Abstract
The study attempt to document the chemicals and biological products that are in use in fish and shrimp culture in Bangladesh. Interviews were conducted with fish and shrimp farmers in Mymensingh aquaculture region, and two major shrimp producing regions, Khulna and Cox's Bazar. The study documented the use of 55 different chemicals and biological products in aquaculture in Bangladesh. The most commonly used products were vitamins and minerals (18), disinfectants (10), therapeutants (9) and water treatment compounds (8). Farmers in Mymensingh area were found to use 8 different chemicals and biological products, while the shrimp farmers in the south-western region (Khulna) used large number of such products than farmers in the other two regions. Laboratory trial of some of these products done by Bangladesh Fisheries Research Institute and the results are summarized in the paper.

Keywords: Chemicals, biological products, aquaculture

1. Introduction

In aquaculture, chemicals are used mainly in the treatment and prophylaxis of diseases, which constitute the largest single cause of economic losses. On the other hand, various chemicals/biological products are used in aquaculture as feed additives and water treatment compounds to target high fish production in the recent years. However, increasing use of the chemicals in aquaculture has lead to widespread public concern. The chemicals are different forms of limes, fertilizers, and various commercial forms of growth and water productivity enhancer products.

Many aquacultural chemicals degrade rapidly in aquatic systems. For example, formalin, a widely used parasiticide and fungicide, has a half-life of 36 hours in water (Katz, 1989). Furazolidone, an antibacterial, has a half-life of less than one day in sediments (Samuelsen *et al.*, 1991). Other chemicals may persist for many months, retaining their biocidal properties. Some antibacterials, notably oxytetracycline, oxolinic acid and flumequine, can be found in sediments at least 6 months following treatment (Weston, 1996). Very little is known about the environmental fate of many aquaculture drugs with available data (Graslund *et al.*, 2003).

Fish/shrimp culture in Bangladesh is sifting gradually towards commercial practice with the increase in stocking densities and use of commercial feeds. Management of water quality and maintenance of culture environment are becoming difficult, and thus the cultured species are becoming more susceptible to diseases. Farmers are now interested to use chemicals in feed, to maintain water quality, combat disease and increase production. So far, no significant work has been done on the impact of use of

chemicals in aquaculture practices in Bangladesh. However, some work has been done on the impact of use of pesticide in agriculture on the fishery resources (Mazid and Haldar, 2005).

With the intensification of aquaculture, different farms are trying to introduce chemotherapeutics, feed additives, growth enhancers etc. to increase the production and combat disease outbreaks. Different pesticide companies are advocating for their chemicals and biological products as remedy to diseases and as growth enhancers. Unfortunately, complete information on the use of chemicals in aquacultural practices in Bangladesh is not yet available (Faruk *et al.*, 2005). The present study provides a list of chemical and biological products that are in use in aquaculture in Bangladesh, and results of laboratory trial of some such products. Findings of this study will help to formulate guidelines for registration, licensing, regulation and guideline for the use of chemicals and biological products in aquacultural industry of the country.

2. Materials and Methods

2.1. Survey on the use of chemicals and biological products in aquaculture

A survey was conducted to find out the present status of the use of chemicals and biological products in fish/shrimp farming in Bangladesh. A set of questionnaires were prepared. Representative fish/shrimp farmers, extension workers, feed manufacturers and pesticide companies were interviewed. Data on product classification (pesticide, veterinary drug, medicated feedstuff, feed additive, poison, etc.), manufacturer's name, product name (official and scientific), active ingredients, chemical properties, efficacy, possible environmental impacts, etc. were collected and analyzed.

Altogether 65 respondents were interviewed in three major fish/shrimp producing regions in the country. The three regions were central region-Mymensingh as aquaculture region, shrimp producing south-western region- Khulna and south-eastern region- Cox's Bazar. The chemicals and biological products documented in the survey were sorted into the following major groups: therapeutants, disinfectants, water treatment compounds, vitamins & minerals, antibiotics, feed additives and hormons. Some products were identified with respect to chemical formula of active ingredient, whereas others were identified merely as a certain type of product (e.g. vitamins).

2.2. Study the effects of chemicals on fish/shrimp and water environment

Fish/shrimp was exposed to different chemicals commercially introduced by different pesticide companies in Bangladesh. A series of laboratory trials on available chemicals/biological products were conducted to observe the effects of chemicals on fish, shrimp or water.

3. Results and Discussion

3.1. Field survey on use of chemicals/biological products

Results of field survey indicates that the use of chemicals in aquaculture is not well established in the country. Farmers use different chemicals and biological products rather than most commonly used lime and fertilizers, in a limited scale. Piscicides are used in some Asian countries to control predators prior to stocking of ponds, but the use of antimicrobials and disease-control chemicals is limited to a small percentage (<5%) of the fish producers (Phillips, 2000). Although large numbers of chemicals are now introduced by different agrochemical dealer and pesticide companies, their wide scale use could not be quantified. The available chemicals and biological products that are in used in the country are summarized in Table 1.

Table 1. Chemicals and biological products that are in use in fish and shrimp culture in Bangladesh

Sl No.	Product name	Producer	Marketing by	Ingredient	Purpose
Therapeutants					
1	Abacus	Biostadt Europe Ltd., India	Syngenta, Bangladesh	*Lactobacillus sporogenes*, *L. acidophilis*, *Bacillu subtilis*, *B. licheniformis*, *Saccharomyces cerevisiae*, sea weed extract	To improve efficacy of digestive system, absorption of nutrients, digestion of complex pertinacious materials, feed consumption rate and FCR, growth rate, weight gain, body's ability to resist stress and the attacks of pathogens etc.
2	Ablaze	Biostadt Europe Ltd., India	Syngenta, Bangladesh	Doxycycline, Collistine sulphate, minerals etc.	To prevent and cures a broad range of viral and bacterial diseases in fishes build resistance against diseases etc.
3	Aqua grow	USA	Eion Animal Health Products Ltd., Dhaka	DHA enriched micro diet supplement	To increases larval growth, disease resistance etc.
4	Ayumin	Dabur India Ltd., India	Dabur Ayurvet Ltd., India	Copper, cobalt, magnesium, iron, zinc, iodine, methionine, lysine, calcium, phosphorus etc.	To increase FCR, growth and disease resistance of fish etc.
5	Biolive powder	-	Biolab, Chittagong	Kalomegh, azoan, radhoni, naxvum, sodium selenite, cobalt chloride, herbal & sincona	To reduce ulcerative disease, enteric hemorrhage, hepatic septicemia, tail rot, gill rot of fish etc.
6	Biophos	-	Biolab, Chittagong	Ferum phos, trace elements, herbal extracts etc.	To reduce ulcerative disease, enteric hemorrhage, hepatic septicemia, tail rot, gill rot of fish etc.
7	Fish curepus	M/S M.R. Enterprise, Dhaka	M/S M.R. Enterprise, Dhaka	-	To increase nutrient and oxygen, to decrease diseases, to cure ulcerative disease
8	Oxycare pH-7	Beijing Lily Agrochemis, China	National Agricare, Bangladesh	-	To enhance growth and to treat diseases

9	Prokura efinol-L	USA	Eion Animal Health Products Ltd., Dhaka	-	To reduce stress and mortality rate of fish
Disinfectants					
10	Aldrin	-	-	Aldrin	To kill predator
11	Copper sulphate	-	-	$CuSO_4$	To control algal bloom
12	Lime	-	-	$CaCO_3$, CaO	To increase pH and to disinfect water
13	Malachite green	-	Aquatic, Dhaka	-	To control diseases
14	Malathion	-	-	Organophosphate	To kill insects
15	Phostoxin	-	-	-	To eradicate weed fishes
16	Rotenone	-	Aquatic, Dhaka	Derris root	To eradicate weed fishes
17	Sumithion	-	-	Organophosphate	To eradicate insects
18	Tea seed powder	China	Eion Animal Health Products Ltd., Dhaka	Natural saponin and crude protein	To eradicate weed fishes, snails etc.
19	Timsen	United Promotions Inc, USA	Eion Animal Health Products Ltd., Dhaka	En-alkylbenzyl dimithyl chloride	To prevent bacterial, viral, protozoan, algal and fungal infection and to reduce hardness
Water treatment compounds					
20	Alphamax	Biolab, Chittagong	Biolab, Chittagong	Calcium, Aluminium, Magnesium, trace elements, NPK	To reduce acidity and sulfide gas, maintain oxygen balance, remove lesion, and to reduce antenna rot
21	Banjo	Biostadt Europe Ltd., India	Syngenta, Bangladesh	Tetraacetyl ethylene diamine, sodium perborate, absorbants, de-odorizers	To release required amount of oxygen, to relieve shrimp from stress, to check the growth of anerobic bacteria, protozoa and secondary pathogens
22	Bio-Ade	USA	Eion Animal Health Products Ltd., Dhaka	Extract of *Euca cidigera*	To decrease ammonia and to maintain healthy environment in water
23	Dolo-lime	-	Ideal Trading Ltd., Dhaka	Dolomite (Mg & Ca enriched lime)	To reduce acidity of soil and water, to release calcium and magnesium, to increase plankton, to

					reduce turbidity of water
24	Dropper	-	-	Chloro alkyl phenyl urea	To inhibit growth of blue green algae and toxic plankton, to control plankton growth rate and water quality
25	Methylene blue	-	Aquatic, Dhaka	Methylene blue	To treat pond water
26	Oxyflow	-	-	-	To increase oxygen in water
27	Potassium permanganate	-	-	Potassium permanganate	To increase dissolved oxygen content of water
Vitamins and minerals					
28	Acimix super-B	-	ACI Animal Health, Dhaka	Vitamins, trace elements, amino acid	To increase growth, FCR and disease resistance capacity
29	Agox	Brookside ara L.C., USA	Qadside Bangladesh Ltd..	BHA, Ethoxion, EDTA, phosphoric acid, citric acid, mono/diglycerides, calcium silicate, silicon dioxide	To increase appetite and disease resistance
30	Alphavit C+E premix		Biolab, Chittagong	Vitamin C, Vitamin E, herbal extracts	To increase FCR and growth and to reduce stress
31	Alphavit	Biolab, Chittagong	Biolab, Chittagong	Vitamin B_1, B_2, B_6, B_{12}, niacin, folic acid, calpantho, lysine, methionine, iron, copper, manganese, zinc, boron, sodium selinite, cobalt chloride	To increase plankton, vitamin, minerals and amino acid and disease resistance
32	Alphavit WS	Biolab, Chittagong	Biolab, Chittagong	Vitamin B_1, B_2, B_6, B_{12}, K, niacin, folic acid, pantothenic acid, choline, lysine, methionine, tryptophan,	Toreduce tail and gill rot, dropsy etc.
33	Amnovit	Hoechst Roussel Vet Ltd., India	-	Vitamin B_2, B_6, B_{12}, niacin, folic acid, calpantho, lysine, methionine, iron, copper, manganese, zinc,	To use as a non-antibiotic growth promoter

				boron	
34	Anafish	-	-	Vitamins, minerals, antibiotic	To enhance growth and to prevent stress and sickness
35	Biophyl	Avitec Lab., France	-	Minerals, vitamins, amino acids	To enhance growth and to prevent stress and sickness
36	Cencalcium-plus	Senavisa Lab. Spain	Impex Marketing Ltd. Dhaka	Minerals, vitamins, trace elements, amino acids	To better formation of scales and bones
37	Fish premix	USA	Eion Animal Health Products Ltd., Dhaka	Vitamins, minerals	To increase health and daily growth of fish and shrimp
38	M:H-10	Agrosystem, Italy	Genetica, Bangladesh	Protein, vitamins, minerals, UGF	To increase growth, disease resistance and plankton in water
39	SPA	Biostadt Europe Ltd., India	Syngenta, Bangladesh	Protein, cholesterol, calcium, vitamin-D, careotenoid	To bind all powder form medicinal ingredients, nutrients and probiotic supplements to the feed, to make feed supplements water stable and bioavailable, to improve pigmentation in shrimps
40	Super grow	China	Eion Animal Health Products Ltd., Dhaka	Zn premix	To enhance growth and molting of shrimp
41	Vitafish-V	-	Agro Products, Dhaka	Vitamin B_1, B_2, B_6, manganese sulphate	To increase appetite, growth and disease resistance, to help in protein, lipid and carbohydrate metabolism
42	Vitam-C	-	Agriman, Dhaka	Vitamins, trace minerals, amino acids mix.	To use as a vitamin, trace mineral, amino acid mix. for fish
43	Vitam-P	-	Agriman, Dhaka	Vitamins, trace minerals, amino acids mix.	To use as a vitamin, trace mineral, amino acid mix. for catfish
44	Vitam-S	-	Agriman, Dhaka	Vitamins, trace minerals, amino acids mix.	To use as a vitamin, trace mineral, amino acid mix. for shrimp
45	Zeolite	Zeoan Forein Trade	National Agricare,	Calcium, magnesium,	To remove toxic gases as an alternative to lime

		Co., China	Bangladesh	potassium, phosphorus, silicon, aluminum, ferrous, sodium	and to produce plankton
Feed additives					
46	Flo-Bond	Brookside ara L.C., USA	Qadside Banladesh Ltd.	Hydrated sodium calcium alumino-silicate	To use as a micotoxin binder in feed
47	Novasil plus	USA	Eion Animal Health Products, Dhaka	Toxin binder	To prevent alpha-toxin in feed
48	Oxistat	Agril Ltd., UK	-	Butylated hydroxytoluine, butylated hydroxyanisole, ethoxyquin, sodium citrate	To use as anti-oxidant for feed
49	Pegabind	USA	Eion Animal Health Products Ltd., Dhaka	Pellet feed binder	To use as feed binder
Antiobiotics					
50	Chlorsteclin	Huazhong Chia Co. Ltd., China	Novertis (Bangladesh) Ltd.	Chlorotetracycline 15%	To prevent and cure tail and gill roty, dropsy, EUS etc.
51	Oxy-tetracycline	-	-	Oxytetracycline	To use as an antibiotic
52	Tetracycline	-	-	Tetracycline	To use as an antibiotic
Hormons					
53	Flash	Biostadt Europe Ltd., India	Syngenta, Bangladesh	Synthetic Gonadotropin releasing hormone analogue	To increase fertilization and hatching rate and minimize stress to the brood stock
54	Sex-F	-	Aquatic, Dhaka	-	
55	Sex-M	-	Aquatic, Dhaka	-	To make all male fish

The surveyed products can be classified as therapeutants, disinfectants, water treatment compounds, vitamins and minerals, feed additive, antibiotic and hormon. Among them, the most commonly used products were vitamins and minerals (18), disinfectants (10), therapeutants (9) and water treatment products (8). Multinational pesticide company like Syngenta has been marketing a variety of therapeutants, water treatment compounds and vitamins and minerals for use in aquaculture. The pesticide companies target shrimp and freshwater aquaculture industries for marketing of their products. Use of chemicals and other products was found to be more in shrimp culture than in carp culture and a variety of chemicals

found in the markets are believed to be in use in shrimp culture. Farmers of Khulna region use the highest number of chemicals especially therapeutants and water treatment compounds than those of Cox's Bazar and Mymensingh regions. Vitamins and minerals are mostly used with feed in Mymensingh and Cox'S Bazar regions. Antibiotics and hormones are solely used in carp hatchery operation. It was revealed from the survey that each farmer of Mymensingh use at least 7 types of chemicals in aquaculture practices (pangus culture). Shrimp farmer of Khulna and Cox'S Bazar used 10 and 8 types of chemicals, respectively.

Results of the survey and discussion meetings with the farmers led to the conclusion that the farmers are mainly searching for solutions to the day-to-day problems they face, particularly when disease outbreaks are encountered in fish/shrimp ponds. Farmers select chemicals from their own experiences, suggestions from other farmers or from pesticide sellers. Many products documented in the survey were used for the purpose of preventing, treating or mitigating disease outbreaks, and the products used by a farmer may have been influenced by the presence or immediate risk of disease outbreaks. A variety of feed additives were reported to be used by the feed manufactures and progressive farmers to increase production, although efficacy of such additives was not well established.

The most common chemicals used in aquaculture are lime i.e. agricultural lime and quick lime, and fertilizers such as urea, TSP, MP etc. Dolomite also a form of lime now used in aquaculture practices. Liming does not cause environmental problems, and liming and inorganic fertilizer compounds do not cause food safety concerns. Fertilizers are highly soluble and release nutrients that can cause eutrophication of natural waters. An array of other substances is used less frequently in aquaculture including: oxidants, disinfectants, osmoregulators, algicides, coagulants, herbicides, and probiotics. These compounds or biological products quickly degrade or precipitate. Most of the substances used in pond aquaculture to improve soil or water quality cause little or no risk to food safety (Boyd and Massaut, 1999). However, high application rates of lime (<2,250 kg/ha) in fish ponds reduced survival, growth, maturity index and fecundity of fish significantly (Konar *et al.*, 1990).

3.2. Characteristics of chemicals commonly used in aquaculture

Chemicals have many uses in aquaculture, the types of chemicals used depending on the nature of the culture system and the species being cultured. Since the first true antibacterial agents were introduced in the 1930s, users have been coping with the emergence of drug resistance among target organisms. As each new drug was developed, major successes in therapy were achieved but, within a few years, the first cases of drug resistant strains began to appear. In intensive aquaculture antibacterial agents are used universally to treat bacterial disease and there is widespread prophylatic use. The most common routes of application are oral or by immersion. In both the cases, significant quantities of antibacterial may reach the environment and lead to the selection of resistance. Table 2 present the chemicals approved for aquaculture.

3.3 Marketing and testing of chemicals

In Bangladesh, there is no specific legislation regarding the use of therapeutic drugs and chemicals in aquaculture. As a result, their uses are unregulated. Most of the drugs are similar to those that are used in human medicine, while the chemicals used in aquaculture are the same as those used for agricultural purposes. Recently, the pesticide companies are marketing directly many products for aquaculture (Table 1). There is no registration system for importation of chemicals for use in aquaculture. As consequence of the expansion of aquaculture, chemical usage has become increasingly a part of management.

Table 2. List of chemicals approved for aquaculture*

Product	Use as
THERAPEUTANTS	
Acetic acid	Parasiticide
Formalin	Parasiticide and fungicide
Romet 30 (sulfadimethoxine and orthomeprim)	Bactericide
Salt	Osmoregulatory enhancer
Sulfamerizne	Bactericide
Oxytetracycline (Terramycin)	Bactericide
DISINFECTANTS	
Calcium hypochlorite	Disinfectant, algicide, and bactericide
WATER TREATMENT	
Fluorescein sodium	Dye
Lime (calcium hydroxide, oxide, or carbonate)	Pond sterilant
Potassium permanganate	Oxidizer and detoxifier
Rhodamine B and WT	Dye
Copper sulfate	Algicide and herbicide
Copper, elemental	Algicide and herbicide
2, 4-D	Herbicide
Diquat dibromide	Algicide and herbicide
Endothall	Algicide and herbicide
Simazine	Algicide and herbicide
Clean-Flo (aluminum sulfate, Calcium Sulfate, and boric acid)	Algicide and herbicide
Glyphosate	Herbicide
Potassium ricinoleate	Algicide
Xylene	Herbicide
ANESTHETICS	
Carbonic acid	Anesthetic
MS 222 (tricaine methane-sulfonate)	Anesthetic and sedative
Sodium bicarbonate	Anesthetic

*Chemicals registered or approved by the U.S. Food and Drug Administration for use in food fish culture.
Source: ICES (1988).

Various types of commercial products are produced to meet the demand. There is an increasing level of suppliers also. Some suppliers import the products and some producers produce the products locally. Efficacy of most of the products is generally not tested before marketing. A few leading pesticide/marketing companies contact Department of Fisheries or Ministry of Fisheries and Livestock for testing their products before marketing. They are ultimately referred to the Bangladesh Fisheries Research Institute (BFRI) for testing their products. Some times they directly contact BFRI for testing.

Table 3. Laboratory trial of some chemicals to be used in aquaculture

Sl. No.	Product name and manufacturer/importer	Ingredients and recommended dose	Probable use/benefits	Results and remarks
Therapeutant				
1.	Abacus Syngenta Bangladesh Ltd.	*Lactobacillus sporogenes, L. acidophillus, Bacillus subtilis, B. licheniformis, Saccharomyces cervisiae,* Sea weed extract, Enzymes, Vitamin C, B_1 & B_6, Sodium benzoate etc.	• Better absorption & synthesis of minerals, trace elements and nutrients. • Phosphorus supplementation checks the loosening of the shell problem. • Higher feed consumption rate with better FCR. • Enhances the body's ability to resist stress and the attacks of pathogens.	• Abacus administrated with feed to observe juvenile shrimp growth. The increases in weight was negligible. • No significant change in water quality parameters changes was observed after application of Abacus. • Bacteria *Vibrio* spp. was identified from diseased shrimp. Abacus did not act as growth promotor of shrimp. However, it acted significantly to control disease in shrimp.
2.	Ablaze Syngenta Bangladesh Ltd.	Doxycline, Colistine sulphate, mineral mixture with essential vitamins.	• Effectively prevents and cures a broad range of viral and bacterial diseases. • Helps in the building resistance against diseases. • Helps in the reducing the stress in the fish.	• In aquarium, Ablaze resulted 20-25% curing of diseased Pangas fish, while no individual survived in the control group. In cistern trial, 22-25% diseased pangas cured, while the control group showed only 5% improvement. • In experimental ponds, Ablaze showed 35% improvement in diseased pangus. In farmer's polyculture pond, 55% affected rohu, catla, mrigal, sarputi and silver carp were cured. • Water quality parameter in pond showed that pH and alkalinity were increased due to application of Ablaze, whereas harmful ammonium was reduced in water. • Quantitative plankton study showed

				significant reduction in number plankton/L of pond water after application of Ablaze.
Disinfectant				
3.	Calix Hadeeka	Rotenone Dose- 36 g/dec. ($40m^2$) for 2 ft. water depth.	Control of unwanted and undesirable fish species.	Cent percent mortality of test fish, *Barbodes gonionotus* was observed by the application of recommended dose. Calix has lethal toxic affect on fish.
Water treatment compound				
4.	Aqua Nourish M/S Aqua Chemicals	Silica, Calcium, Magnesium, Sodium, Potassium, Iron and Aluminum Dose- 50 kg/ha	Helps to increase pH, dissolved oxygen, reduces turbidity and un-ionized ammonia in water.	Application of Aqua Nourish increased pH, dissolved oxygen, and reduced turbidity and total ammonia in pond water.
5.	Bannzo Syngenta Bangladesh Ltd.	Tetraacetyl etylene diamine, sodium perborate, absorbents, de-odorizers Dose- 500 g/ha	• Releases required amount of oxygen and helps in restoring the pond bottom. • Hinder the growth of anaerobic bacteria, protozoa and secondary pathogen like Bacculovirus.	Banzo can increase and maintain oxygen level of pond. Application of Banzo can be helpful in case of sudden fall of O_2 level in shrimp pond.
6.	Dolomite Moonlit Feeds Co. Ltd.	Calcium, Magnesium, Potassium paramagnet, Potash alum Dose- 15-20 kg/ha	Provides nutrients for development of micro flora and fauna in pond water. It increases pH and reduces turbidity in water.	Application of Dolomites increases pH, and alkalinity and also natural food organisms in pond water.
7.	Matrix Hadeeka	Silicon oxide, Ferrous oxide, Calcium oxide, Magnesium oxide Dose: Pond preparation- 125 kg/ha Culture management- 50 kg/ha	Helps to increase pH, dissolved oxygen and plankton biomass in water and reduces turbidity and un-ionized ammonia	Application of Matrix increases pH, dissolved oxygen, total alkalinity, ammonia and plankton biomass (>30%) in pond water.

8. Mutiplex Karnataka Agro Chemicals, India	Zinc, Magnesium, Manganize, Boron, Potassium, Calcium, Molybdenum, Copper, Iron and Cobalt Dose- Initially 25 kg/ha. Repeat 10-15 kg/ha once in two months.	Provides nutrients for development of micro flora and fauna including planktons in pond water.	Application of Multiplex has increased plankton in pond water.
Feed additive			
9. SPA Syngenta Bangladesh Ltd.	Each 10 g contains Protein 100 mg, Cholesterol 100 mg, Calcium 10 mg, Vitamin D 20 µg, Carotenoid 50 µg.	• Water stable and increases the bioavailability of the feed supplements. • Enrichment with carotenoid content, which improves pigmentation in shrimp. • Easily digestible.	• SPA showed no positive or negative effect on growth and survival of fish and shrimp in a 28 days rearing trial. • However, SPA is water stable and can effectively be used in feed formulation as a binder.
Hormon			
10. Flash Syngenta Bangladesh Ltd.	Per 10 ml contains Synthetic gonadotropein releasing hormone 0.002%, Domperidon 0.998%, Prepilene glycol 99.000% Dose- 0.30-0.50 ml for female and 0.10-0.30 ml per kg body wt. of male	Release of quality egg and thereby production of healthy spawn at mass scale by a female fish with reduced mortality.	Flash fish hormon is found to be good inducing agent for fish breeding of catla, rohu and mrigal.

On the other hand, most of the suppliers of the country are indiscriminately marketing their products without prior test. Test results of 10 chemicals (2 therapeutants, 5 water treatment compounds and one each of disinfectant, feed additive and hormone group as reported by BFRI are presented in Table 3. Most of the water treatment compounds were found to be effective for purpose as stated by the manufactures/ suppliers. However, field level trials are required to establish the usefulness of these chemicals in our aquatic environment.

4. Conclusion and Recommendations

On a worldwide basis, only a small number of chemicals are legally approved for use in aquaculture. Chemicals can react differently in water depending upon the water quality, the target species and the life stage of the species. Water quality factors such as temperature, pH, alkalinity and organic matter content can often have a bearing on the effectiveness or toxicity of a chemical. Larval stages and younger fish are usually more sensitive to chemicals. Furthermore, a fish already weakened by stress or disease may succumb to a "normal" chemical dose. Recommended dosages and methods of application should be followed closely. To avoid complications following chemical application, a simple "bioassay" can be conducted to determine the response to the treatment. A sample of fish from the pond or tank is placed in a small container and treated with the proposed chemical and dosage. The test should be run using water from the pond or tank to be treated. Following recommendations may be considered for judicial use of chemicals in the country:

- Undertake proper labeling of drugs/chemicals (ingredients, methods of use, handling, risks etc.) and undertake responsibilities for substantiating claims on products.
- When multiple chemical alternatives are available, farmers should select drugs not only on the basis of efficacy data but also on the basis of available information regarding environmental persistence, potential effects on non-target organisms, propensity to stimulate microbial resistance and rate of residue elimination.
- Scientists need to conduct more research on chemical use in aquaculture to ensure their effectiveness and safe uses.
- Standards for aquaculture-grade chemicals and their use should be set and enforced.

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