



THERAPEUTICS IN AQUACULTURE

FSHM 2204

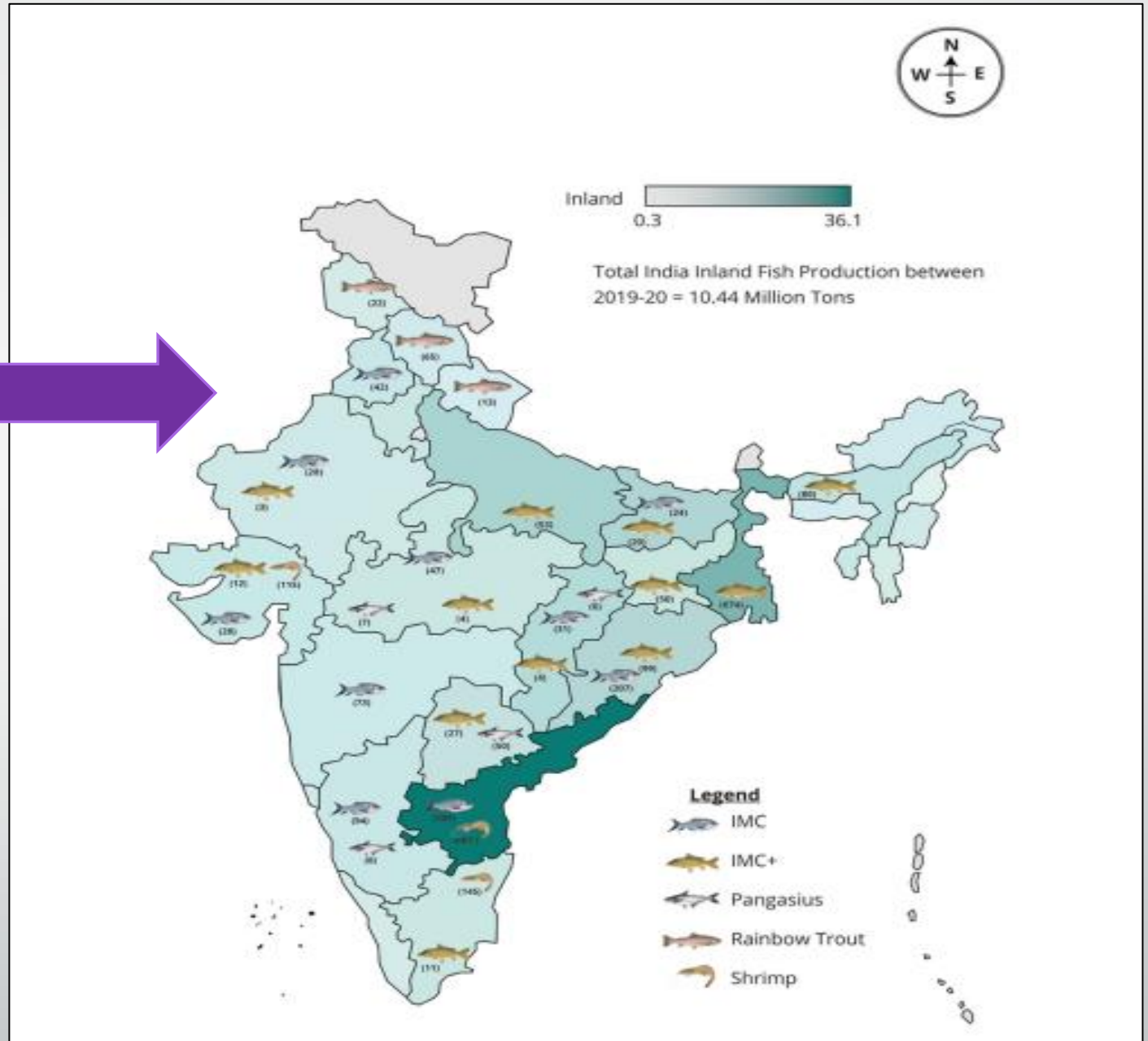
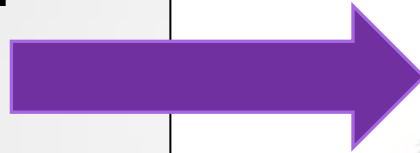
THERAPEUTICS

- **Therapeutics are treatments used to alleviate or prevent a particular disease**
- **Examples of therapeutics include drug therapy, medical devices, nutrition therapy and stem-cell therapies**
- **Therapeutics can be used in patients with active disease – to treat the disease itself or its signs and symptoms – in preventive medicine, or as palliative care**

WHY THERAPEUTICS ?

- **Pharmaceutical products and chemicals; improved human and animal health; livestock production: globally**
- **Similarly in aquaculture; higher production; improved environment; growth, and protection against microbial and parasitic diseases**
- **Chemicals, nutritional supplements, probiotics, disinfectants, antimicrobials and antiparasitic agents are applied in aquaculture operations**

COMMONLY CULTURED SPECIES



Farm groups	Species cultured	Major production system
IMC	<i>Labeo rohita</i> , <i>Catla catla</i> , <i>Cirrhinus mrigala</i>	Extensive, semi-intensive, rice fields, ponds, tanks, polyculture
IMC+	<i>Hypophthalmichthys molitrix</i> , <i>Ctenopharyngodon idella</i> , <i>Cyprinus carpio</i> , <i>L. bata</i> , <i>L. dero</i> , <i>L. fimbriatus</i> , <i>Hypselobarbus pulchellus</i> , <i>Oreochromis niloticus</i> , <i>O. mossambicus</i>	Extensive, semi-intensive, ponds, lakes, tanks, polyculture
Pangasius	<i>Pangasianodon hypophthalmus</i>	Intensive, pond, cages, wetlands, polyculture/ monoculture
Rainbow trout	<i>Oncorhynchus mykiss</i>	Raceways, monoculture
Shrimp	<i>Penaeus vannamei</i>	Semi-intensive, monoculture, pond

Note: IMC: Indian Major Carps; IMC+: IMC, exotic and minor carps, tilapia.

COMMON DISEASES IN INDIAN AQUACULTURE

TABLE 4 List of common diseases encountered in Indian aquaculture

Name of the disease/ syndrome	Etiological agent	Name of the host species
Bacterial haemorrhagic septicaemia, Aeromoniasis or Motile aeromonad septicaemia	<i>Aeromonas hydrophila</i> , <i>A. sobria</i> , <i>A. caviae</i>	<i>Catla catla</i> , <i>Labeo rohita</i> , <i>Cirrhinus mrigala</i>
Bacterial gill disease	<i>Flavobacterium branchiophilum</i> , <i>Chryseobacterium scophthalmum</i>	<i>Oncorhynchus mykiss</i> , <i>Tor putitora</i> , <i>C. catla</i> , <i>L. rohita</i>
Epizootic ulcerative syndrome (EUS)	<i>Aphanomyces invadans</i> / <i>A. piscicida</i>	<i>C. catla</i> , <i>L. rohita</i> , <i>C. mrigala</i> , <i>Cyprinus carpio</i> , <i>Clarias magur</i> , <i>Oreochromis niloticus</i> , <i>Puntius</i> spp., <i>Channa</i> spp, <i>Lates calcarifer</i> , <i>Mugil cephalus</i>
Columnaris disease	<i>Flavobacterium columnare</i>	<i>C. catla</i> , <i>L. rohita</i> , <i>C. mrigala</i> , <i>O. mykiss</i> , <i>O. niloticus</i> , <i>P. hypophthalmus</i>
Lactococcosis	<i>Lactococcus garvieae</i> , <i>L. piscium</i>	<i>O. mykiss</i> , <i>M. cephalus</i>
Tail rot/Gill rot/Fin rot/ulcerative syndrome	<i>Flexibacter columnaris</i> , <i>Nocardia</i> spp., <i>Mycobacterium</i> spp., <i>Pseudomonas</i> spp.	<i>O. mykiss</i> , <i>T. putitora</i> , <i>C. carpio</i> , <i>Pangasianodon hypophthalmus</i> , <i>Labeo catla</i> , <i>L. rohita</i>
White spot Ich disease	<i>Ichthyophthirius multifiliis</i>	<i>O. mykiss</i> , <i>P. hypophthalmus</i> <i>C. catla</i> , <i>L. rohita</i>

White cottony wool-like growth	<i>Saprolegnia parasitica</i> , <i>S. diclina</i>	<i>C. catla</i> , <i>L. rohita</i> <i>O. mykiss</i> , <i>P. hypophthalmus</i>
Catfish septicaemia	<i>Edwardsiella ictaluri</i>	<i>P. hypophthalmus</i>
Argulosis	<i>Argulus</i> spp.	<i>C. catla</i> , <i>L. rohita</i> , <i>C. mrigala</i> , <i>T. putitora</i>
Caligus infestation	<i>Caligus</i> spp.	<i>L. calcarifer</i> , <i>Etroplus suratensis</i> , <i>Epinephelus tauvina</i>
Lernanthroposis	<i>Lernanthropus latis</i>	<i>L. calcarifer</i> , <i>M. cephalus</i>
Lernaea infestation	<i>Lernaea cyprinacea</i>	<i>C. catla</i> , <i>L. rohita</i> , <i>C. mrigala</i> , <i>T. putitora</i> , <i>C. carpio</i>
Vibriosis	<i>Vibrio</i> spp.	<i>O. niloticus</i> , <i>L. calcarifer</i> , <i>M. cephalus</i> , <i>Penaeus monodon</i> , <i>P. vannamei</i>
White spot disease	White spot syndrome virus	<i>P. monodon</i> , <i>P. vannamei</i>
Microsporidiasis	<i>Enterocytozoon hepatopenaei</i>	<i>P. vannamei</i> , <i>P. monodon</i>

Chemicals and product formulations used in aquaculture

- The chemicals and product formulations used in aquaculture:
 - ✓ Disinfectants
 - ✓ Probiotics
 - ✓ **Environmental modifiers**
 - ✓ Nutritional supplements
 - ✓ Antibiotics
 - ✓ Antifungal and antiparasitics
 - ✓ Natural anti-infective agents
 - ✓ Herbicides and piscicides
- The environmental modifiers included all the chemicals, natural products and minerals applied directly to the pond water for improving the natural productivity and water and soil quality parameters

USAGE OF CHEMICALS, BIOLOGICALS AND VMPS

- **Estimated that a total of 28.82 kg /t of inputs, used in Indian aquaculture;**
- ✓ Disinfectants (597 g /t)
- ✓ Probiotics (2.28 kg t¹)
- ✓ Environmental modifiers (22.82 kg/t)
- ✓ Nutritional supplements (1.96 kg/ t),
- ✓ Antibiotics (2 mg/PCU)
- ✓ Antifungal (4 mg /PCU)
- Antiparasitic agents (14 mg/ PCU)
- Natural anti-infective agents (293 g /t)
- Herbicide and piscicides (844 g/ t)

Categories of chemicals, biologicals and VMPs used

1.DISINFECTANTS

- IMC+ were found to use highest quantity of disinfectants (1.22 kg /t)
- Followed by IMC (0.97 kg/ t)
- Shrimp (0.32 kg /t)
- Pangasius (0.29 kg/t)
- Rainbow trout (0.18 kg /t)

Classification
Disinfectants
Ammonium chloride
Benzalkonium chloride
Bromine
Calcium hypochlorite
Chlorinated compounds
CIFAX
Formaldehyde
Hydrogen peroxide
Iodine compounds
Potassium permanganate
Sodium hypochlorite
Others

- The IMC farms used potassium permanganate predominately followed by iodine compounds, BKC and CIFAX®
- While IMC+ farmers commonly used potassium permanganate followed by CIFAX® and BKC
- Similarly, the pangasius farms used iodine compounds followed by BKC and ammonium chloride
- The raceways of rainbow trout have reported using potassium permanganate as a disinfectant
- **OVERALL;** The most commonly used disinfectants were potassium permanganate followed by CIFAX®, Benzalkonium Chloride (BKC) , iodine compounds, ammonium chloride and chlorinated compounds

2. PROBIOTICS

Probiotics; several groups

- **Bacteria (e.g. Bacillus spp., Lactobacillus spp.)**
- **Nitrifying bacteria (e.g. Nitrosomonas spp. Nitrobacter spp.)**
- **Sulphur oxidizing bacteria (e.g. Thiobacillus spp.)**
- **Photosynthetic bacteria (e.g. Rhodobacter spp.).**

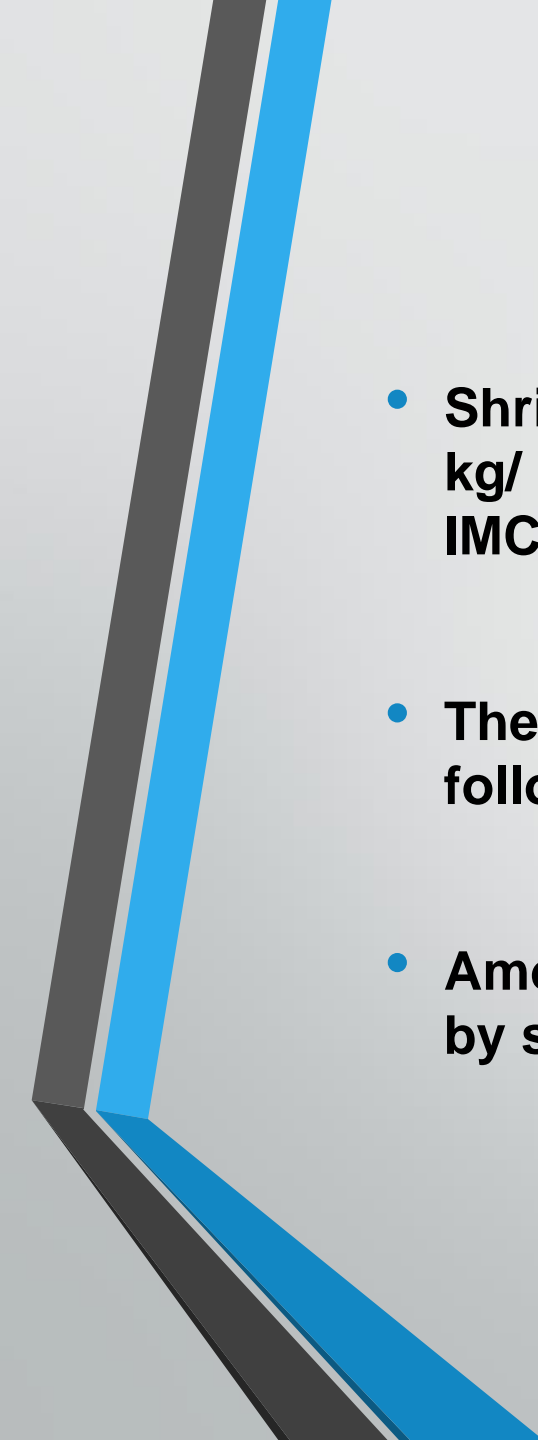
Probiotics

Environmental probiotic

Gut probiotic

Soil probiotic

water probiotic

- 
- **Shrimp farmers were found to use the highest quantity of probiotics (6.10 kg/ t of produce) followed by pangasius (2.90 kg/ t), IMC (1.84 /kg t) and IMC+ (0.58 kg/ t)**
 - **The probiotics formulations were most commonly used in shrimp, followed by pangasius , IMC, and IMC+ farms**
 - **Among the probiotics, water probiotics were the most common, followed by soil probiotics and gut probiotics**

3. ENVIRONMENTAL MODIFIERS

The compounds used for maintaining the water and soil quality in aquaculture farms

The highest usage was in IMC+ and least in pangasius farms while the rainbow trout raceways were hardly using any of the environmental modifiers

Majority of the farmers used liming materials like calcium oxide and calcium carbonate followed by minerals toxin binders others and oxygen enhancers

The environmental modifiers were most commonly used in IMC

Farm-group culturing IMC+ was also found to use phytoplankton enhancers, pH modifiers and osmoregulatory compounds

Environmental modifiers
Liming material
Minerals
Osmoregulatory compounds
Oxidizing agents
Oxygen enhancer
pH modifier
Phytoplankton enhancers
Toxin binders
Others

4. NUTRITIONAL SUPPLEMENTS

Pangasius farmers used the highest quantity of nutritional supplements (4.17 kg/ t) followed by IMC (2.79 kg/ t), IMC+ (2.48 kg/ t) and shrimp (350 g/ t)

Minerals were the most commonly used nutritional supplements in the surveyed farms followed by natural products , vitamins , and products containing the mixture of vitamins/minerals/amino acids

The duration and frequency of application were found to vary depending on targeted yield, growth stage and the species cultured

Nutritional supplements

Binders

Enzymes

Essential amino acids

Minerals

Mixtures

Vitamins

Natural products

5.ANTIBIOTICS

Farmers culturing IMC+ and pangasius were found to use the higher quantity of antibiotics (4 mg /PCU) followed by IMC (2 mg/ PCU)

The most commonly used antibiotics were tetracyclines followed by enrofloxacin and doxycycline and sulfamethoxazole+trimethoprim

Interestingly none of the surveyed shrimp farmers reported the use of antibiotics.

Antibiotics

Cephalexin

Doxycycline

Enrofloxacin

Erythromycin

Sulpha methoxazole-trimethoprim

Tetracyclines

6.ANTIFUNGAL AGENTS

Fluconazole was the only antifungal agent applied through the feed

Farmers culturing pangasius were found to use higher quantity of Fluconazole (15mg /PCU) followed by IMC (6 mg/PCU) farms

Antifungal agent

Fluconazole

ANTIPARASITIC AGENTS

The pangasius farmers used the highest quantity of antiparasitic agents (41 mg/PCU) followed by IMC (24 mg/PCU) and IMC+ (6 mg/PCU) farms

The most commonly used antiparasitic agent was deltamethrin followed by quinalphos, ivermectin, amitraz , cypermethrin and albendazole

<i>Antiparasitic agents</i>
Albendazole
Amitraz
Cypermethrin
Deltamethrin
Doramectin
Flubendazole
Ivermectin
Levamisole+Oxyclozanide
Quinalphos

Natural anti-infective agents

- **Similarly, compounds containing multi-herbal extracts were used as antiparasitic substances in, IMC+ and IMC farm groups**
- **Interestingly, the rainbow trout raceways used only raw salt (1.38 kg/t1) immersion to control parasitic infestations**

OVERALL USAGE PATTERN

TABLE 6 Quantity of chemicals, biologicals and VMPs used in each farm group (kg t⁻¹ of harvest)

Classification	IMC	IMC+	Pangasius	Rainbow trout	shrimp	Average
Disinfectants	0.967 (2.62)	1.223 (2.48)	0.291 (1.21)	0.184 (11.76)	0.320 (0.99)	0.597 (2.07)
Probiotics	1.841 (4.99)	0.576 (1.17)	2.900 (12.09)	-	6.100 (18.91)	2.283 (7.92)
Environmental modifiers	31.230 (84.67)	40.820 (82.64)	16.570 (69.07)	-	25.490 (79.01)	22.822 (79.19)
Nutritional supplements	2.793 (7.57)	2.480 (5.02)	4.170 (17.38)	-	0.350 (1.08)	1.960 (6.80)
Antibiotics	0.002 (0.01)	0.004 (0.01)	0.004 (0.02)	-	-	0.002 (0.01)
Antifungal products	0.006 (0.02)	-	0.015 (0.06)	-	-	0.004 (0.01)
Antiparasitic agents	0.024 (0.07)	0.006 (0.01)	0.041 (0.17)	-	-	0.014 (0.05)
Natural anti-infective agents	0.009 (0.03)	0.076 (0.15)	-	1.381 (88.24)	-	0.293 (1.02)
Herbicides and piscicides	0.009 (0.03)	4.211 (8.52)	-	--	-	0.844 (2.93)

Note: Numbers in parenthesis are percentage values.

CONCLUSION

- **Application of chemicals, biologicals and VMPs has played a significant role in improving the quality of the culture environment and effective management of aquatic animal health, thereby achieving higher productivity**
- **Disinfectants play a significant role in health maintenance and are an integral part of an effective biosecurity program in aquaculture**
- **Oral administration of probiotics in aquaculture improves feed conversion efficiency and disease resistance by modifying the gut microbial activity, while water application will improve the quality of the culture environment by mitigating the accumulated toxic metabolites**

- **The use of gut probiotics for improving disease resistance and digestibility, water probiotics for mitigation of toxic nitrogenous metabolites and soil probiotics for mitigation of sulphur metabolites are commonly used in Indian aquaculture**
- **Toxin binders are used to mitigate the nitrogen and sulphur metabolites; comparative lesser use of these compounds in pangasius farms and higher use of water and soil probiotics suggest bioremediation as a preferred method adopted by the farmers**
- **A majority of the fish farms and shrimp farms used minerals, vitamins, enzymes, amino acids and other natural products as feed top dressing to meet the optimum nutritional requirement for higher growth and production**
- **Antibiotics to control bacterial infections were used mostly in the IMC+ farm located in the state of West Bengal and Andhra Pradesh while MOC as piscicide was reported from the state of West Bengal**