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REVIEW PAPER

Aquaculture chemotherapy in the Philippines: A review

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Abstract

Aquaculture plays a crucial role in global food security, yet it faces mounting challenges in promoting sustainable and responsible practices. In the Philippines, while the aquaculture industry significantly contributes to the economy, its reliance on chemicals—particularly antibiotics—poses serious risks to public health and the environment. The threat of applying excessive amounts of antibiotics in an aquaculture system is reportedly linked to drug-resistant animals. In consequence of the continued use of antibiotics in the system, transferable resistance genes and residues can be passed on to people as they consume animal products, complicating the treatment of conditions in humans. The industry's sustainable development is hindered by a lack of transparent regulatory oversight and limited access to eco-friendly alternatives. This review assesses the current state of chemical use in Philippine aquaculture, focusing on key species and related challenges. It also examines the effectiveness of the regulatory framework governing chemical use, explores emerging drug alternatives, and suggests strategies to improve regulatory oversight and encourage the adoption of environmentally sustainable practices. The Philippine aquaculture industry, dominated by seaweeds, milkfish, tilapia, shrimps/prawns, and shellfishes, is rapidly expanding. However, this growth is often accompanied by increased chemical usage, including antibiotics, antiparasitic agents, antifungal agents, disinfectants, vaccines, inorganic fertilizers, and more. Despite existing regulations, enforcement and public transparency remain questionable. The excessive use of chemicals in Philippine aquaculture poses significant threats to both public health and environmental sustainability. Urgent action is required to enhance regulatory oversight, encourage the use of eco-friendly alternatives, and ensure the industry's long-term viability. To address these challenges, it is recommended that the government enforce stricter regulations and monitoring mechanisms for chemical use in aquaculture, invest in research and development of sustainable alternatives, raise public awareness about the risks of chemical use, and collaborate with international organizations to share best practices and develop harmonized standards.

Introduction

Aquaculture, a key pillar of global food production, relies heavily on external inputs, including chemicals, to optimize yields. These inputs range from simple fertilizers in extensive systems to a complex array of natural and synthetic substances in intensive operations, making them essential for efficient aquaculture practices (Cruz-Lacierda et al., 2000; Subasinghe et al., 2000). The Philippines has experienced remarkable growth in its aquaculture sector, contributing substantially to the country's overall fishery production. In 2022, the industry achieved a total output of 2.35 million metric tons (MT), valued at US$ 2.2 billion (Bureau of Fisheries and Aquatic Resources (BFAR), 2023). Globally, the Philippines ranked 11th in aquaculture production for various aquatic species and 4th in aquatic plant production in 2021 (Food and Agriculture Organization (FAO), 2024). Key aquaculture commodities include seaweeds (*Kappaphycus* and *Eucheuma* spp.), milkfish (*Chanos chanos)*, tilapia (*Oreochromis* spp.), shrimps (*Penaeus* spp., *Metapenaus* sp., and *Macrobrachium* sp.), and shellfishes (*Crassostrea* spp., *Perna* sp., and *Modiolus* spp.), which together account for 98.15% of the total volume and 91.52% of the total monetary value. Milkfish is particularly dominant in the sector. The primary culture systems in use are fishponds, fish cages, fish pens, and mariculture, operating across brackish, freshwater, and marine environments (BFAR, 2023; PSA, 2023; Tahiluddin & Terzi, 2021a).

As aquaculture continues to expand and intensify, it is increasingly important to understand the potential risks associated with chemical use. The potential risks were highlighted with the correlation between rising aquaculture productivity and increased chemical utilization (Tacon & Metian, 2008). Furthermore, the long-term, direct, and indirect environmental impacts of these practices cannot be overlooked (Boyd et al., 2019; Diana et al., 2013). The irresponsible use of chemicals, particularly antibiotics and unsustainable aquaculture practices, poses serious threats to critical ecosystems and their biodiversity (De Silva, 2012; Diana et al., 2013; Garcia et al., 2014; Lavilla-Pitogo, 2011; Primavera, 2006).

While the Philippines' aquaculture industry has achieved significant success, it faces challenges in managing the responsible use of antibiotics. Regulatory oversight is actively involved in addressing antimicrobial resistance (AMR) through national policies aligned with global frameworks (Regidor et al., 2020). However, translating these policies into comprehensive technical regulations remains a challenge (Pineda-Cortel et al., 2024). Research evidence has documented the use of unauthorized substances and drug residues in various aquaculture species in the country, including shrimp, milkfish, tilapia, and their feeds, with some samples exceeding the Maximum Residual Limit (MRL) for antibiotics (Regidor et al., 2020).

There is a pressing need for intensified campaigns to promote the prudent use of antibiotics within both the pharmaceutical and aquaculture industries. In alignment with the U.S. Food and Drug Administration (FDA) approach to fish and fishery products, where information on approved drug effectiveness, dosage, animal safety, and human food safety is made publicly available (U.S. Food and Drug Administration (USFDA), 2024). Hence, the Philippine regulatory bodies should prioritize transparency, ensuring the accessibility of information on aquaculture pharmaceuticals, particularly veterinary medicines, is consistent with the global One Health approach (Pineda-Cortel et al., 2024).

This review synthesizes existing literature on the use of various chemicals in Philippine aquaculture, emphasizing their impact on key species and associated challenges. It examines the efficacy of the existing regulatory framework and explores promising alternatives to harmful chemicals using relevant online resources provided by different government regulatory bodies.

Philippine Aquaculture Production

Table 1 presents the leading aquaculture commodities produced in the Philippines in 2022, detailing their contributions in both volume and value. Seaweeds dominate production, accounting for 65.76% of the total volume (1.54 million MT) and 13.39% of the total value (US$ 292 million).

Milkfish ranks as the second-most produced commodity, comprising 16.51% of the total volume (0.39 million MT) and a significant 37.42% of the total value (US$ 817 million), underscoring its high economic importance. Tilapia contributes 10.72% of the total volume (0.25 million MT) and 17.29% of the total value (US$ 377 million). While shrimp/prawn and shellfish represent smaller portions of the total volume, they contribute substantially to the overall value, with shrimp/prawn at 2.99% of the volume and 22.29% of the value, and shellfish at 2.17% of the volume and 1.13% of the value. These data illustrate the diversity of aquaculture production in the Philippines, with seaweeds leading in volume, while milkfish and shrimp/prawn yield higher economic returns.

Table 1. Top produced aquaculture commodities in terms of volume and value, 2022 (BFAR, 2023; PSA, 2023)

Commodity	Volume (MT)		Value (USD)	
	Amount (in million)	% share	Amount (in million)	% share
Seaweeds (*Kappaphycus*, *Eucheuma* spp.)	1.54	65.76	292.12	13.39
Milkfish (*Chanos chanos)*	0.39	16.51	816.57	37.42
Tilapia (*Oreochromis* spp.)	0.25	10.72	377.21	17.29
Shrimp/Prawn (*Penaeus, Metapenaus, Macrobrachium* spp.*)*	0.07	2.99	486.27	22.29
Shellfishes (*Crassostrea* spp, *Perna* sp, *Modiolus* spp.*)*	0.05	2.17	17.98	1.13
Others	0.04	1.84	185.24	8.56
Total	2.35	100	2,181.68	100

Chemical Use in the Philippine Aquaculture

A wide array of chemicals, both established and emerging, are utilized throughout the aquaculture production cycle—from hatcheries to grow-out phases—to support the health and growth of cultured species. Table 2 categorizes these chemicals into various groups: antimicrobial/antibiotic agents, antiparasitic agents/pesticides, antifungal agents, disinfectants, vaccines, sex control agents, probiotics, immune enhancers, feed additives, soil and water treatment chemicals, plankton growth promoters, and organic matter decomposers (Coloso et al., 2015; Cruz-Lacierda et al., 2000; Somga et al., 2012). Table 3 lists commonly used chemicals in aquaculture, including those used for both consumption and ornamental purposes. Chemicals marked with an asterisk have maximum residue limits (MRLs) and must be applied within legally permitted levels to ensure the safety of fish, fish products, and consumers (Coloso et al., 2015).

Aquaculture hatcheries employ various chemicals to prevent and treat health issues caused by bacteria, external parasites, and fungi. Antimicrobial, antiparasitic, antifungal, and disinfectant agents are widely used, particularly in hatcheries producing shrimp, tilapia, milkfish, and other commodities. Oxytetracycline is one of the most commonly used antimicrobials in aquaculture, often administered as a preventive measure across various species. Other antibiotics, such as trimethoprim-sulfadiazine, florfenicol, erythromycin, and amoxicillin, are used in lower doses, while rifampicin, sulfamonomethoxine, and oxolinic acid are more prevalent in shrimp hatcheries. However, the use of antibiotics, even in small amounts, carries risks, which are mitigated by adhering to prescribed withdrawal periods (Coloso et al., 2015). Formalin is the most widely used antiparasitic agent, effective against external fungal and bacterial infections and parasites. Sodium chloride is preferred for freshwater fish due to its accessibility, properties, and safety (Somga et al., 2012). Formalin, methylene blue, and trifluralin are commonly used antifungal agents, while malachite green is restricted to ornamental fish (Coloso et al., 2015; Somga et al., 2012). Disinfectants such as chlorine, formaldehyde, and iodophores are routinely employed in hatcheries to maintain sanitary conditions for equipment, facilities, and water. They are also used for routine disinfection procedures, including cleaning tanks and farm implements, conditioning water, and disinfecting broodstock, eggs, and larvae (Primavera et al., 1993; Somga et al., 2012). Vaccines, particularly those against *Streptococcus* spp. in tilapia, are less commonly used in Southeast Asia compared to Japan, where they are employed for fish disease prevention (Grisez & Tan, 2005; Somga et al., 2012). Both hatcheries and grow-out facilities utilize probiotics and immune-enhancing agents to improve environmental conditions, animal health, and productivity. Immune enhancers are especially common in shrimp production (Somga et al., 2012). In cases of deformities, diseases, or delayed development, various vitamins, minerals, and hormones are incorporated into feeds. Additionally, soil and water treatment chemicals, plankton promoters, and organic matter decomposers (bioaugmentation products) are employed to enhance the overall health of the primary culture organisms (Cruz-Lacierda et al., 2000; Primavera et al., 1993).

Table 2. Common chemicals used, species and culture, amount, purpose and chemical status of the common chemicals in the Philippine aquaculture (Coloso et al., 2015; Cruz-Lacierda et al., 2000; Primavera et al., 1993; Somga et al., 2012).

Chemicals used	Chemical group name	Species & culture system	Dosage/Amount used	Purpose used	Chemical status ***Prohibited*** – Total banned ***No*** – Currently not used ***NDA*** – No Data Available (Status not known) ***YES*** – Allowed to be used
Antibiotics/ Antimicrobials	Amoxicillin	Shrimp hatchery	Not indicated	Preventive measure	Yes
		Tilapia hatchery	80 mg/kg fish for 7 days		
		Marine fish grow-out			
	Doxycycline	Tilapia hatchery	10 mg/kg fish for 3–5 days	Preventive measure	Yes
	Erythromycin	Shrimp hatchery	2–3 ppm for 3 days	Disease control	Yes
		Tilapia hatchery	Not indicated	Preventive measure	
		Marine fish grow-out	Not indicated		
	Enrofloxacin	Tilapia hatchery	Not indicated		Yes
		Marine fish grow-out	Not indicated		
	Florfenicol	Shrimp hatchery & milkfish hatchery	2 ppm	Preventive measure	Yes
		Tilapia grow-out & marine fish grow-out	10 mg/kg fish for 10 days		
	Neomycin sulphate	Marine fish grow-out	Not indicated	Preventive measure	NDA
	Norfloxacin	Tilapia hatchery	50 mL/100 L of water for 10 days	Preventive measure	Yes
		Tilapia grow-out & marine fish grow-out	2.5–5 mg/kg fish for 5 days		
	Oxytetracycline	Shrimp hatchery & tilapia hatchery	2-4 ppm until the disease disappear	Daily disease control until disease disappears	Yes
		Marine fish grow-out	2–5 g/kg feed for 10 days		

		Tilapia grow-out	7-27 g/kg feed/day		
	Oxolinic acid	Shrimp hatchery	20 mg/kg for 7 days	Preventive measure	Yes
	Rifampicin	Shrimp hatchery	1–2 ppm for 7 days; 0.1 and 0.2 ppm	Preventive measure; and daily disease control until disease disappears	Yes
	Bactrin Forte	Shrimp hatchery	0.1 ppm	Every other day from Nuplii to harvest as substitute to rifampicin	NDA
	Sulfamonomethoxine	Shrimp hatchery	2–4 ppm daily	Preventive measure	NDA
	Sulfaquinoxaline	Tilapia hatchery	3 g/kg feed	Preventive measure	NDA
		Marine fish grow-out	4-14 g/kg feed/day		
	Trimethoprim-sulfadiazine	Shrimp hatchery & tilapia hatchery	not indicated	Preventive measure	NDA
		Marine fish grow-out	15–20 g/kg feed for 7 days	Preventive measure	
	Chloramphenicol	Shrimp hatchery	1ppm and 2-4 ppm	Every other day from Z_1 to harvest; and disease control	Prohibited
	Nitrofuran (Furazolidone,98%	Shrimp hatchery	0.5-1 ppm; and 2-3 ppm	Every other day from Z_1 to harvest; and disease control	Prohibited
	Prefuran	Shrimp hatchery	1 ppm	Disease/Preventive measure	NDA
Antiparasitic agents/Pesticides	Belzalkonium chloride (BKC)	Shrimp hatchery	0.5-1 ppm	Treats external parasites; and disease control	Yes
		Tilapia hatchery	1 ppm		
	Copper sulphate	Tilapia and shrimp hatchery, marine fish grow-out	2–5 ppm as 30 min bath	Disease/Preventive measure	Yes
	Formalin	Shrimp hatchery	1–2 ppm	Disease/Preventive measure	Yes
		Tilapia hatchery	200 ppm as 10–30 min bath (also for tail rot, fin rot)		
		Marine fish grow-out	20 ppm as 30-minute bath (also for tail rot, fin rot)		
	Hydrogen peroxide	Marine fish grow-out	2–5 ppm as 30-minute bath	Disease/Preventive measure	Yes

Omnicide	Shrimp hatchery	1–1.25 ppm for *Zoothamnium*	Disease/Preventive measure	Yes
Praziquantel	Tilapia and marine fish grow-out	Not indicated	Disease/Preventive measure	Yes
Potassium permanganate	Shrimp hatchery and grow-out, tilapia hatchery and grow-out, marine fish grow out	1-2 ppm	Pond preparation, spray; and preventive measure	Yes
Quinacrine hydrochloride	Shrimp hatchery	2–3 ppm (mysis) 3–5 ppm (PL	Parasites and disease control	-
Sodium chloride	Tilapia hatchery and grow-out	0.25–1 ppt as indefinite bath	Disease/Preventive measure	Yes
Trichlorfon	Marine fish grow-out	0.5–1 ppm indefinite bath 30 ppt as short bath	Disease/ Preventive measure	-
Saponin (Teaseed powder, 10%)	Shrimp grow-out ponds	8 – 30 ppm; 5 – 25 ppm; and 15 – 35 ppm	Pond preparation, broadcast; Rearing phase; and disease control	Yes
	Milkfish ponds	5 – 400 kg/ha	Pond preparation, broadcast	Yes
Copper control	Shrimp grow-out ponds	2 ppm; and 2 kg/ha/d	Pond preparation, spray; and rearing phase, until phytoplankton bloom	Yes
Nicotine (Tobacco dust, 10%)	Milkfish ponds	400 kg/ha	Pond preparation, broadcast, substitute for teaseed	-
Rotenone (Derris root,10%)	Milkfish ponds	300-800 kg/ha	Pond preparation, broadcast,	Yes
Organotin (Brestan, 60%)	Milkfish ponds	250-600 g/ha	Pond preparation, 1/yr-1/3 yr, broadcast or spray	Prohibited
Gusathion	Milkfish ponds	0.1 ppm	Pond prep	Prohibited
Azimphos ethyl Saponin, flavonoid, and tannin (Hostathion Protek FP (24.5%)	Milkfish ponds	1 L/3 ha; and 45-75 kg/ha	Pond preparation; Pond preparation, broadcast	-

	Benzene hexachloride Endosulfan (Diazinon/Zumithion;and Thiodan)	Milkfish ponds	0.1 ppm	Pond preparation; Pond preparation, broadcast	Prohibited
Antifungal agents	Formalin	Shrimp hatchery, tilapia hatchery, marine fish grow-out	40–60 ppm as indefinite bath	Preventive measure	Yes
	Malachite green	Shrimp hatchery	20 ppm as 20 min bath (not advisable to apply)	Preventive measure	Prohibited
		tilapia hatchery, marine fish grow-out			
		Shrimp hatchery	0.003 – 0.015ppm	Every other day from M_1 to harvest	
		Shrimp grow-out ponds	1 kg/ha	disease control	
	Methylene blue	Tilapia hatchery, shrimp hatchery	3–5 ppm as indefinite bath	Preventive measure	Yes
	Trifuralin (Treflan-R)	Shrimp hatchery	0.05–0.1 ppm for 24 h over 2–3 days	Preventive measure	Yes
		Tilapia hatchery and grow-out marine fish grow-out	0.5 ppm for 14 days		
		Shrimp hatchery	0.1ppm; 5 ppm; and 1 ppm	every 3-5 d from stocking to harvest; for spawners; and disease control	
Disinfectants	Chloramine-T	Shrimp hatchery	Not indicated	For shrimp egg disinfectant	Yes
	Chlorine	Shrimp hatchery and grow-out, tilapia hatchery and grow-out, milkfish/marine fish grow-out	20–100 ppm	For disinfection of water, tanks, pipes and equipment	Yes
	Cypermethrin	Shrimp hatchery	125–200 mL/1 000 m^3 water	Preventive measure/Disinfection	Yes
	Dichlorvos	Shrimp grow-out	1.5–2 ppm	Preventive measure for pond preparation	Yes

Formaldehyde	Shrimp hatchery, tilapia hatchery, marine fish grow-out	50 mL/L	Preventive measure for disinfection of tanks and equipment	Yes
	Shrimp hatchery	8 ppm for water disinfection before stocking, then stock shrimp nauplii after 3 days		
Formalin	Shrimp hatchery	100–500 ppm; and 25 ppm	Shrimp spawner disinfectant; and Rearing phase	Yes
Hydrogen peroxide	Tilapia hatchery	70 ppm as 2-hr flush	For disinfection of tanks, pipes and equipment	Yes
	Shrimp hatchery	Not indicated	Preventive measure/Disinfection	
Iodophores	Shrimp hatchery and grow-out, marine fish grow-out	1–2 ppm	For water conditioning	-
Omnicide	Shrimp hatchery and grow-out	1:400; and 1:100	For routine disinfection and aerial fogging; and for wheel/foot bath:	Yes
Potassium monopersulphate	Shrimp hatchery	50 ppm as 1-min dip	Preventive measure/Disinfection	-
	Shrimp grow-out	3–6 kg/ha at 1 m water depth		
	Tilapia hatchery and grow-out, marine fish grow-out	0.3 ppm as 24-hour bath		
Potassium permanganate	Shrimp hatchery and grow-out	10 ppm	For disinfection of surface, spray; use in foot/vehicle tire bath in shrimp grow-out pond	Yes
	Shrimp grow-out ponds	2 kg/ha	Pond preparation, spray	
Povidone-iodine	Shrimp hatchery	200 ppm; and 20 ppm	For 30 seconds egg washing; and broodstock disinfection upon arrival	NDA

	Trichlorfon	Shrimp grow-out	0.5–1 ppm	Preventive measure for the preparation prior to stocking	Yes
	Calcium hypochlorite (70% chlorine)	Shrimp hatchery	200–1000 ppm; 5–70 ppm; 10–200 ppm; and 20 ppm	disinfection of rearing tanks; rearing water; hatchery paraphernalia; and diseased stocks	Yes
	Benzalkonium chloride	Shrimp grow-out ponds	0.5–6 ppm	Disease control	Yes
	Cococide chloride	Shrimps grow-out ponds	0.5–1 ppm	Rearing phase	NDA
	Didecyl dimethyl ammonium bromide ($C_{22}H_{48}NBr$) (Bromosept-50 50%)	Srimps grow out ponds	0.5–5 ppm; and 0.5–3 ppm	Rearing phase; and disease control	-
	Alkyl dimethyl benzyl ammonium chloride (Fabcide B-50)	Shrimp grow-out ponds	0.5–1 ppm	Preventive measure in rearing phase	-
	Iodine (Biodin)	Shrimps grow-out ponds	5 L/ha	Preventive measure in pond preparation	Yes
	Alkyl dimethyl benzyl ammonium chloride (Aquasept)	Shrimps grow-out ponds	0.25–1 ppm; and 0.5-1.5 ppm	Rearing; and disease control	-
Vaccines	Streptococcus sp. Bacterin	Tilapia hatchery	1 000 mL:100 kg fingerlings by immersion one time	Fingerlings are vaccinated prior for stocking	-
Sex control (hormone)	17 Alpha methyltestosterone	Tilapia fry	60 mg/kg feed until 21 days	For faster and shorter culture period	Yes
Probiotics		Shrimp hatchery and grow-out, tilapia hatchery and grow-out, milkfish/marine fish hatchery and grow-out	Depends on the product applied either in pond or via feeds	For maintaining good environmental culture condition	-

Immune Enhancer	Ergosan (Extract of *Laminaria digitata*, 99% and *Ascophylum nodosum*, 1%)	Shrimp hatchery	0.1–0.7 g per ton of larval rearing tank daily	For immune booster	-
		Tilapia hatchery and grow out, milkfish hatchery and grow out, shrimp grow-out	2–5 g/kg feed daily		
	Shrimp Active (Glucan and mannan polysacharides	Shrimp hatchery a. Zoea b. Mysis c. Early PL1–7 d. PL 8–15 Shrimp grow-out	a. 12.5 g/100 000 fry b. 19 g/100 000 fry c. 25 g/100 000 fry d. 60 g/100 000 fry 2 g/kg of feed		-
Feed additives	Vit C (Enervon C and Oderon C)	Shrimp hatchery	1 ppm	For M_1 to harvest, mix w/artificial feed	-
	Immune enhancer	Shrimp hatchery	0.5 – 1ppm	For every 3-4 days from Z_1 to harvest, long bath	-
Antimicrobials	Chloramphenicol	Shrimp grow-out ponds	3 g/kg feed; and 2 – 2.5 g/kg feed	For feeding DOC 1-30; and disease control	Prohibited
	Tetracycline (Oxytetracycline)	Shrimp grow-out ponds	3 g/kg feed; and 1–5 g/kg	For feeding DOC 1-30; and disease control, 3x/d for 3-7d	Yes
	Oxolinic acid	Shrimps grow-out ponds	1 g/kg feed; and 0.2-4 g/kg feed	For feeding DOC 12-60,1-3x/d; and disease control, 1-3x/d for 7d	Yes
	Furazolidone (98%)	Shrimp grow-out ponds	1 g/kg feed; and 1-2.5 g/kg	For feeding, DOC 1-100, 5x/d; and disease control	-
	PE-30	Shrimps grow-out ponds	20 g/kg feed	For feeding, DOC 1-35, alternate w/ vitamin, all feeding for 5-7d	-
	PE-40	Shrimps grow-out ponds	20 g/kg feed	For disease control, 2-3x/d fro 5-7d	-
	PE-60	Shrimps grow-out ponds	20 g/kg feed	For feeding, DOC 1-30, alternate w/ PE-30,4-5x/d	-

Vitamins/Lipids/ Minerals/ Protein	Vit C, Ascorbic acid	Shrimps grow-out ponds	1-5 g/kg feed	For rearing phase, DOC 60-120, 1x/d	-
	Vit C, Aquamix	Shrimps grow-out ponds	20 g/kg feed	For feeding, DOC 37 to harvest, 3x/wk	-
		Shrimps grow-out ponds	20 g/kg feed	For disease control, daily for 3-5 d	
	Rovimix Stay C	Shrimps grow-out ponds	1-20 g/kg feed	For rearing phase, DOC 1 to harvest,1x/d	-
	Enervon C (capsule)	Shrimps grow-out ponds	0.5-5 g/kg feed	For rearing phase	-
	Enervon C (syrup)	Shrimps grow-out ponds	10 mL/kg feed	For rearing phase	-
	SVT	Shrimps grow-out ponds	25 mL/kg feed	For rearing phase	-
	Stroner	Shrimps grow-out ponds	2-3 g/kg feed	For rearing phase, DOC 13 to harvest,5x/d	-
	Hypo 66	Shrimps grow-out ponds	25 g/kg feed	For rearing phase, DOC 1 to harvest, 2x/d	-
	Bactozyme	Shrimps grow-out ponds	5 g/kg feed	For rearing phase, DOC 13 to harvest, 5x/d	-
	Astaxanthin + Vitmin C (Nutri Asta-C)	Shrimp grow-out ponds	4-5 g/kg feed; and 5-10 g/kg feed	For feeding DOC 1 to harvest, 1x/d; and for disease control, 3-4x/d	-
	Vitamin A, C, E (Aquace)	Shrimps grow-out ponds	1-2 g/kg feed	For feeding DOC 1 to harvest, 1x/d	-
	Vitamin A, D + fatty acid + protein (Nutri-Pro)	Shrimps grow-out ponds	5-10 g/kg feed	For rearing phase, 5x/d	-
	Enzyme/vitamin/mineral (Nutri)	Shrimps grow-out ponds	1 g/kg feed	For rearing phase	-
	Fatty acid (Aquatak)	Shrimps grow-out ponds	20 mL/kg feed	Coating medium	-
	Fatty acid (Grow-Well)	Shrimps grow-out ponds	30 mL/kg feed	Coating medium	-

	Fatty acid (Nutri-oil)	Shrimps grow-out ponds	20 mL/kg feed	Coating medium	-
	Fatty acid (Fin-oil)	Shrimps grow-out ponds	2 g/kg feed	Coating medium	-
	Fatty acid (cooking/squid/cod liver oil)	Shrimps grow-out ponds	10 –20 mL/kg feed	Coating medium	-
	Fatty acid (Chicken egg)	Shrimps grow-out ponds	1-2 pc/kg feed	Coating medium	-
	Calcium compound (Calcium lactate)	Shrimps grow-out ponds	10 tablet/kg feed	For rearing phase, 1 wk prior to harvest, 1x/d	-
	Calcium compound, HUFA (B-meg)	Shrimps grow-out ponds	10 mL/kg feed	For rearing phase, 5 d, 5x/d	-
Antimicrobial/Vitamin/Mineral mix	Inoxyline	Shrimps grow-out ponds	2 g/kg feed	For feeding DOC 1-30, 2x/d	-
	Ino-Forte	Shrimps grow-out ponds	2 g/kg feed	For disease control, 10 d, 5x/d, 30 d withdrawal	-
	Ino-moto	Shrimps grow-out ponds	2-3 g/kg feed	For rearing phase, 5x/d	-
	Ino stress	Shrimps grow-out ponds	2-3 g/kg feed	For disease control, 5x/d	-
	Terravite	Shrimps grow-out ponds	5 g/kg feed	For rearing phase, DOC 1-30, 5x/d, alternate with Inoxyline or PE-30	-
	Chronic Prevention Herbal	Shrimps grow-out ponds	20 g/kg feed	For disease control, 7 d, 1x/d	-
Soil and Water treatment chemicals	Lime (Hydrated lime)	Shrimp grow-out ponds	500-2000 kg/ha; 20-300 kg/ha; 50-300 kg/ha	For pond preparation (broadcast); rearing phase; and disease control	-
		Milkfish ponds	150-1,000 kg/ha	For pond preparation, broadcast	-

	Lime (Agricultural lime)	Shrimps grow-out ponds	200-800 kg/ha; 10-500 kg/ha; and 100-300 kg/ha	For pond preparation, broadcast; Rearing phase (1x/wk-daily; and disease control	-
		Milkfish ponds	300-5,000 kg/ha	For pond preparation, broadcast	-
	Calcium hypochlorite (70% chlorine)	Shrimps grow-out ponds	50-150 kg/ha	For pond preparation	-
	Dolomite	Shrimps grow-out ponds	100 kg/ha; and 50-250 kg/ha	For pond preparation; and Rearing phase	-
	Biolite	Shrimps grow-out ponds	100 kg/ha; and 100 kg/ha	For Pond preparation; and rearing phase	-
	Zeolite	Shrimps grow-out ponds	80-300 kg/ha; and 50 kg/ha	For rearing phase; and for disease control, daily until disease disappears	-
	Daimetin	Shrimps grow-out ponds	100-150 kg/ha	For rearing phase	-
	Health lime	Shrimps grow-out ponds	150kg/ha	For rearing phase,1x/wk until harvest	-
	Health stone/Wonder stone	Shrimps grow-out ponds	200-400 kg/ha	For disease control, plankton die-off	-
Plankton growth promoters	Inorganic fertilizer (16-20-0,monoammonium phosphate)	Shrimps grow-out ponds	4-100 kg/ha; and 150-300 kg/ha	For pond preparation, broadcast; and rearing phase, periodic, broadcast	-
		Milkfish ponds	100-300 kg/ha; and 3.2kg/ha	For pond preparation, broadcast; and Rearing phase, every 15 d up to harvest, broadcast	-
	18-46-0, diammonium phosphate	Shrimps grow-out ponds	3.2-50 kg/ha; 0.6-20kg/ha	For pond preparation; and rearing phase	-
		Milkfish ponds	50-150 kg/ha	For pond preparation, broadcast	-
	14-14-14, NPK, complete fertilizer	Shrimps grow-out ponds	7.5-15 kg/ha; and 3 kg/ha	For pond preparation; and rearing phase	-
	46-0-0, urea	Shrimps grow-out ponds	5-120 kg/ha; and 3.2-5kg/ha	For pond preparation; and rearing phase	-

		Milkfish ponds	25-200 kg/ha; and 12 kg/ha	For pond preparation, broadcast; and rearing phase, every 15d up to harvest, broadcast	-
	0-20-0, solophos	Shrimps grow-out ponds	3-20 kg/ha; and 5-10 kg/ha	For pond preparation ; and rearing phase	-
	21-0-0, ammonium sulfate	Shrimps grow-out ponds	100-500 kg/ha	For pond preparation	-
	Calcium nitrate	Shrimps grow-out ponds	3-50kg/ha; and 5-10kg/ha	For pond preparation, broadcast; and rearing phase broadcast	-
Organic Fertilizers	Chicken manure	Shrimps grow-out ponds	100-300kg/ha; and 100-1000kg/ha	For pond preparation, tea bags; and rearing phase, tea bags	-
		Milkfish ponds	500-3,000 kg/ha; and 200 kg/ha	For pond preparation, broadcast; and rearing phase, tea bags	-
	Cow manure	Shrimps grow-out ponds	100-500 kg/ha; and 100-200 kg/ha	For pond preparation, tea bags; and rearing phase, tea bags	-
	Carabao manure	Shrimps grow-out ponds	240-300 kg/ha; and 100-200 kg/ha	For pond preparation, tea bags; and rearing phase, tea bags	-
	VIMACA, chicken/pig manure	Shrimps grow-out ponds	1000 kg/ha	For pond preparation, tea bags	-
	Goat/Pig manure	Milkfish ponds	500-1,000 kg/ha	For pond preparation, broadcast	-
	Bioearth	Milkfishponds	500 kg/ha	For pond preparation, broadcast	-
	B4	Shrimps grow-out ponds	50 kg/ha	Pond preparation, substitute for manure	-
other nutrients	Lab-me	Shrimps grow-out ponds	200 mL/ha/wk	For pond preparation, 2 applications	-
	Algae grow	Shrimps grow-out ponds	0.5 ppm	For pond preparation	-
	Unknown growth factor	Shrimps grow-out ponds	30 kg/ha	For pond preparation, broadcast	-
	PA-100	Shrimps grow-out ponds	0.1-0.2 ppm; and 15 kg/ha	For pond preparation; and Rearing phase, every 15 d up to DOC 90	-

Organic matter decomposers	ER 49	Shrimp grow-out ponds	4-5 kg/ha	For pond preparation, broadcast	-
Bacteria + enzyme preparation	NS-SPO	Shrimps grow-out ponds	160-320 g/ha; 2-3 kg/ha/culture; and 1L/ha	For pond preparation; rearing phase, every 7d until harvest; and disease control	-
	Biozyme	Shrimps grow-out ponds	5 kg/ha; and 5kg/ha	For pond preparation; and rearing phase, every 7d until harvest	-
	Micro aid activator	Shrimps grow-out ponds	5-20 kg/ha; and 5-20 kg/ha	For pond preparation; and rearing phase, 1x/wk up to harvest	-
	Aquazyme	Shrimps grow-out ponds	0.5 kg/ha; and 2 kg/ha	For rearing phase, 2x/wk, every water change; and disease control, daily for 3d	-
	Twinner	Shrimps grow-out ponds	5 kg/ha	Rearing phase, every 7d	-

Table 3. List of chemicals used for food consumption and ornamental fish in Philippine aquaculture (Coloso et al., 2015)

Chemicals	**Status**	
	Prohibited – Total banned ***No*** – Currently not used ***NDA*** – No Data Available (Status not known) ***YES*** – Allowed to be used	
Antibiotics/Antimicrobial	**Fish For Food Consumption**	**Ornamental Fish**
Tetracyclines *	Yes	Yes
Nitrofurans	Prohibited	Yes
Chloramphenicol	Prohibited	No
Oxolinic acid *	Yes	Yes
Erythromycin *	Yes	Yes
Dimetridazole/Metronidazole	Prohibited	No
Elbaju/Ebazine	NDA	No
Sulfonamides *	Yes	Yes
Oxytetracyclines	Yes	Yes
Chlortetracycline *	Yes	Yes
Sulfamerazine *	Yes	Yes
Nifurpirinol	No	No
Amoxicilin	Yes	Yes
Doxycyclin	Yes	Yes
Enrofloxacin *	Yes	Yes
Florfenicol	Yes	Yes
Norfloxacin	Yes	Yes
Rifamicin / or Rifampicin	Yes	Yes
Ciprofloxacin	NDA	NDA
Sarafloxacin	NDA	NDA
Ormethoprim	NDA	NDA
Sulfadimethoxin + Ormethoprim *	NDA	Yes
Sulfadimethoxin + trimethoprim	Yes	Yes
Disinfectants		
Belzalkonium chloride (BKC)	Yes	-
Calcium Hypochlorite	Yes	-
Lime	Yes	-
Formalin	Yes	-
Sodium chloride	Yes	-
Potassium permanganate	Yes	-
Methylene blue	Yes	-
Malachite green	Prohibited	-
Copper sulphate	No	-
Acetic acid	No	-
Acriflavin	No	-
Hydrogen peroxide	Yes	-
Sodium hypochlorite	Yes	-
Iodine	Yes	-
Cypermethrin	Yes	-
Potassium monopersulfate	Yes	-
Omnicide	Yes	-
Trichlorfon	Yes	-
Glutaraldehyde	No	-
Chloramin T	Yes	-
Sodium Dichloroisoyanurate	No	-
Tricholoroicyanuric acid	No	-
Myristalkonium chloride	No	-
Ethylenediamine tetraacetic acid (EDTA)	No	-
Potassium peroxymonosulfate	No	-
Chemotherapeutants agents		
Copper sulfate	Yes	Yes
Trichlorfon	Yes	Yes
Trifluralin	Yes	Yes

Cypermethrin	Yes	NDA
Sodium chloride	Yes	Yes
Formaldehyde	Yes	Yes
Hydrogen peroxide	Yes	Yes
Praziquantel	Yes	Yes
Potassium permanganate	Yes	Yes
Methylene blue	Yes	Yes
Bronopol	No	No
Levamisol	No	No
Piscicide (use in pond preparation or early culture		
Saponin	Yes	-
Rotenone	Yes	-
Organophosphates (OPs) - The two most commonly used OPs are dichlorvos (dichlorovos) and trichlorfon (dipterex, and neguvon)	Yes	-
Cyanide	No	-
Fentin acetate	No	-
Deltamethrine	NDA	-
Hormones		
Human chorionic gonadotropin (HCG)	Yes	Yes
Luteinizing Hormone – Releasing Hormone Analogues (LHRHa)	Yes	Yes
Gonadotropin Releasing Hormone Analogues (GnRHa)	No	-
Ovaprim	No	No
Pituitary extract	Yes	-
Puberogen	No	No
17 α methyltestosterone	Yes	-
Androgen	No	No
17 - Beta estradiol	No	-
Ovatide	No	No
Anaesthetics		
Tricane methanesulphonate (TMS222)	Yes	Yes
Eugenol, Aqui-S	Yes	Yes
Quinaldine	No	No
Tranquil (Aquacalm)	No	No
Benzocaine	No	No
Phenoxy ethanol	Yes	Yes
Culture System Preparation		
Calcium Hypochlorite	Yes	-
Lime	Yes	-
Urea	Yes	-
Zeolite	Yes	-
Calcium chloride	Yes	-
EDTA	NDA	-
Sodium thiosulphate	Yes	-

*Residues with Maximum Residual Limit

Use of Authorized Chemicals and Antibiotic Resistance in Philippine Aquaculture

Several drugs, including nitrofurans, chloramphenicol, dimetridazole/metronidazole, olaquindox, carbadox, malachite green, and gentian violet, as well as beta-agonist drugs for food animals, are banned for use in food-producing animals in the Philippines (Coloso et al., 2015; DA-BAFS, 2014; Department of Agriculture A.O. No. 60 and Department of Health A.O. No. 91, Series of 1990; Somga et al., 2012). However, there is evidence that some banned chemicals are still used despite these regulations (Regidor et al., 2020; Tahiluddin et al., 2021b). Other aquaculture substances are currently in use, but strict adherence to regulations is necessary to ensure fish producers comply with minimum withdrawal limits and maximum residue limits (MRLs).

The seaweed industry in the Philippines plays a crucial role in aquaculture production, providing an environmentally sustainable source of income for coastal communities (Trono, 1999). In the southern Philippines, seaweed farmers use inorganic fertilizers, such as ammonium phosphate (16-20-0, NPK) and complete fertilizer (14-14-14, NPK), to enhance growth and boost disease resistance (Muyong & Tahiluddin, 2024; Tahiluddin & Damsik et al., 2023; Tahiluddin et al., 2023; Tahiluddin et al., 2022a; Tahiluddin et al., 2022b; Tahiluddin et al., 2022c; Tahiluddin et al., 2021a; Tahiluddin et al., 2021b). The emerging use of inorganic fertilizers in seaweed cultivation is under scrutiny to assess potential negative effects. Currently, the Philippine National Standard on "Seaweeds – Code of Good Aquaculture Practices (GAqP)" discourages the use of inorganic fertilizers in seaweed farms (BAFS, 2021). However, the use of inorganic fertilizers in seaweed aquaculture persists despite these guidelines (Tahiluddin & Eldani-Tahiluddin, 2024; Tahiluddin & Roleda, 2025).

The irresponsible use of chemicals in aquaculture, particularly for chemotherapy, exacerbates the development of antimicrobial resistance and introduces unprecedented risks. In the Philippines, aquaculture is dominated by tilapia, milkfish, shrimp/prawns, seaweeds, and shellfish, which are also major export commodities. These organisms are commonly cultured in fish ponds, cages, fish pens, and mariculture systems (BFAR, 2023). To mitigate losses, farmers apply various antibiotics and chemical agents as both prophylaxis and therapeutic measures, particularly for finfish and shellfish aquaculture (Baticados & Paclibare, 1992; Coloso et al., 2015; Primavera et al., 1993; Regidor et al., 2020; Somga et al., 2012; Tendencia & De La Peña, 2001).

Although tilapia is a relatively hardy fish, it is not immune to bacterial infections (BFAR, 2023; Tahiluddin & Terzi, 2021b). Common antibiotics used in tilapia culture include chloramphenicol, ampicillin, tetracycline, and erythromycin (Regidor et al., 2020; Tahiluddin & Terzi, 2021b). Studies have reported antibiotic resistance in Nile tilapia, including resistance to oxolinic acid and sulfamethoxazole-trimethoprim (Legario et al., 2020). Resistance to ampicillin, tetracycline, and polymyxin B was also reported in Nile tilapia from Lingayen, Pangasinan (Langaoen et al., 2018). Additionally, antibiotic residues such as tetracycline, ceftiofur, quinolone, and florfenicol have been detected in Nile tilapia cultured in Laguna de Bay (Revilleza et al., 2021). High resistance of *Aeromonas hydrophila* and *A. sobria* to amoxicillin, erythromycin, neomycin, and oxytetracycline, with many isolates showing resistance to at least three antibiotic categories, indicating multiple drug resistance was reported (Pakingking et al., 2022). Heavy metals like lead, cadmium, and chromium have also been detected in tilapia marketed in Metro Manila (Solidum et al., 2013). Despite increased awareness, continuous education campaigns and regular inspections are essential to address the use of chemicals and residue buildup (Coloso et al., 2015; Cruz-Lacierda et al., 2000; Regidor et al., 2020; Subasinghe et al., 2000).

Milkfish, another key export commodity, also faces issues with unauthorized substances and antimicrobial treatments (Langaoen et al., 2018; Regidor et al., 2020; Solidum et al., 2013). When cultured with shrimp, it can harbor pathogenic bacteria (Arnaiz, 2015). Studies have documented antibiotic and multi-drug resistance in milkfish from Lingayen, Pangasinan (Langaoen et al., 2018). Organochlorine pesticides (OCPs) exceeding threshold limit values have been detected in brackish water ponds used for milkfish, tiger shrimp, tilapia, and other aquaculture commodities (Catacutan et al., 2015). Heavy metal contamination, such as cadmium in organic milkfish farming in Negros Occidental was documented (Albarico & Pador, 2019). Other contaminants like lead, cadmium, and chromium in milkfish marketed in Metro Manila were also reported (Solidum et al., 2013). These challenges pose further health issues not only for the culture stock but for the consumer and the environment too.

The shrimp aquaculture industry is grappling with significant multi-drug resistance challenges. The presence of an identified multidrug-resistant strain of *Salmonella enterica* serotype isolated from seafood in Asia, including shrimp imported from the Philippines, was documented (Karp et al., 2020). Similarly, a reported multidrug-resistant strain of *Vibrio parahaemolyticus* from a shrimp farm was found (Saloma et al., 2019). The antibiotic-resistant pathogen found in shrimp ponds was primarily caused by Vibrios, especially *Vibrio harveyi* (Tendencia & De La Peña, 2001). The antibiotics detected included oxytetracycline, furazolidone, oxolonic acid, and chloramphenicol. Earlier studies had already reported resistance to erythromycin, kanamycin, penicillin, and streptomycin in luminous strains of *V. harveyi* and *V. splendidus* isolated from shrimp larvae (Baticados et al., 1990). High levels of antimicrobial resistance to oxytetracycline (OTC) and oxolinic acid have also been observed in *P. monodon* ponds (Tendencia & Dela Peña, 2002). A survey conducted in the selected areas further detected chlortetracycline residues above the maximum residue limit (MRL) in shrimp, suggesting the widespread use of antibiotics (Regidor et al., 2020).

The shellfish industry in the Philippines is primarily focused on oysters and mussels (*Crassostrea* spp., *Perna* sp., and *Modiolus* spp.) (BFAR, 2023). Studies conducted in Lingayen Gulf have detected cadmium, lead, arsenic, and mercury in oysters, with cadmium levels exceeding acceptable limits (Vinarao et al., 2014). These heavy metals pose serious risks to public health. In Bacoor, Cavite, isolates of pathogenic Vibrios, including *V. alginolyticus*, *V. cholerae*, *V. parahaemolyticus*, and *V. vulnificus*, from mussels were found to be resistant to ampicillin, nalidixic acid, tetracycline, co-trimoxazole, and neomycin (Tabo et al., 2015). Some of these isolates were even multidrug-resistant. Studies also reported a high incidence of microbial pathogens *Escherichia coli*, *Salmonella*, and *Vibrio* spp. load in bivalve flesh and its water growing area, possibly due to the discharge of wastewater from residential houses and aquaculture activities (Peralta & Andalecio, 2011). Additional studies have reported high counts of *E. coli*, *V. parahaemolyticus*, *V. cholerae*, and *Salmonella* spp. in culture waters and sediment in Capiz, Western Visayas (Nuñal et al., 2023). The isolation of these potential pathogens from mussels and oysters underscores the health risks involved, highlighting the need for long-term monitoring programs. The reported use of various chemicals in key aquaculture species in the Philippines raises significant concerns about environmental issues, food safety, and public health.

The reported studies on the threat of using excessive antibiotics in any aquaculture system have been linked to drug resistance in animals. Due to the prolonged use of antibiotics in the system, the transfer of resistance genes can be passed on to humans when consuming animal products, complicating the treatment of infections in humans (Pelić et al., 2024; Schar et al., 2020)

Regulatory Framework for Veterinary Drugs and Products in Philippine Aquaculture

The distribution and marketing of veterinary drugs and aquaculture products in the Philippines are subject to strict regulatory oversight. Prior registration with the appropriate authorities is mandatory, requiring a thorough examination and certification of products as per the guidelines established in the Food and Drug Administration Act of 2009. A comprehensive legal framework, including various Philippine legislations such as Republic Acts (RAs), Administrative Orders (AOs), and Memoranda, ensures effective monitoring of retail outlets, accredited laboratories, aquaculture farms, feed mills, and the distribution and sale of these products (Table 4). To promote intra- and extra-Association of Southeast Asian Nations (ASEAN) trade and enhance the long-term competitiveness of ASEAN food, agriculture, and forestry products, the Philippines has implemented the Philippine National Standards for Code of Good Aquaculture Practices. This initiative highlights the country's commitment to maintaining high standards in the aquaculture sector.

Table 4. Various Government competent authorities governing the registration of veterinary drugs, products, and technical requirements and standards for aquaculture commodities.

RA/AOs/Memoranda No/PNA	Title	Agency
RA No. 9711, 2009	the Food and Drug Administration (FDA) Act of 2009	Food and Drug Administration (FDA)
RA NO. 1556, 1956	the Livestock and Poultry Feeds Act	Bureau of Animal Industry (BAI)
RA No. 3720, 1963	the Food, Drug, and Cosmetic Act	Department of Health (DOH)
RA NO. 6675, 1988	the Generics Act of 1988	Department of Health (DOH)
RA No. 1071, 1954	An Act to Regulate the Sale of Veterinary Biologics and Medicinal Preparations	
RA NO. 8550 as amended by RA10654, 2014	the Philippine Fisheries Code of 1998	Department of Agriculture, Bureau of Fisheries and Aquatic Resources (DA-BFAR)
RA NO. 7394, 1992	the Consumer Act of the Philippines	Department of Health (DOH)
Special Order No. 167, Series 2004	Creation of Aquatic Feeds Monitoring Task	Department of Agriculture (DA)
Special Order No. 69, Series of 2004	Deputation of BFAR Fish Health Officers and DA Regional Veterinary Personnel as Aquatic Animal Feed and Veterinary Drug and Product Control Officers Following the Terms of Agreement in the Memorandum of Agreement Between BAI and BFAR	Department of Agriculture (DA)
Memorandum Circular No. 6, Series of 2003	Guidelines Governing the Disposal and Destruction of Banned Veterinary Drugs and Products Used in All Food-producing Animals	Bureau of Agricultural Industry (BAI)
Special Order No. 23, Series of 2002	Deputation of BFAR Fish Health Officers as Aquatic Animal Feed and Veterinary Drug and Product Control Officers	Department of Agriculture (DA)
DA-BFAR and BAI Memorandum of Agreement (2001)	Regulation on Animal Feed, Veterinary Drugs and Products in Aquaculture	Department of Agriculture Bureau of Fisheries and Aquatic Resources and Bureau of Animal Industry (DA-BFAR and BAI)
AO No. 9, Series of 1994	Guidelines Governing the Conduct of Clinical Trials of Veterinary Drugs and Products	Bureau of Agricultural Industry (BAI)
AO No. 27, Series of 1993	Minimum Requirements for Determining/Evaluating the Efficacy and Safety of Veterinary Drugs to Target Animals	Bureau of Agricultural Industry (BAI)
AO No. 35, Series 1975	Rules and Regulations Governing the Manufacture, Importation, Labelling, Advertising, Distribution and Sale of Livestock and Poultry Feeds and Feeding Stuffs	Bureau of Agricultural Industry (BAI)
AO No. 118, Series of 1992	Rules and Regulations on the Process of Review and Evaluation of Questioned Veterinary Drugs or Veterinary Drugs Combinations	Department of Agriculture Administrative Order (DA AO) No. 3 and Department of Health (DOH)
AO No. 111-A and AO No. 33, Series of 1991	Rules and Regulations on Registration of Veterinary Drugs and Products	Department of Health and Department of Agriculture (DOH and DA)
Special Order No. 23, Series of 2002 and Special-Order No. 69, Series of 2004	Aquatic Animal Feed and Veterinary Drug and Product Control Officers	Department of Agriculture Bureau of Fisheries and Aquatic Resources (DA-BFAR) (Fish Health Officers)
PNS/BAFS 334:2022	Grouper – Code of Good Aquaculture Practices (GAqP)	Department of Agriculture, Bureau of Agriculture and Fisheries Standards (DA-BAFS)

PNS/BAFS 208:2021	Seaweeds – Code of Good Aquaculture Practices (GAqP)	Department of Agriculture, Bureau of Agriculture and Fisheries Standards (DA-BAFS)
PNS/BAFS 280:2019	Code of Good Aquaculture Practices (GAqP) on Hatchery for Shrimp	Department of Agriculture, Bureau of Agriculture and Fisheries Standards (DA-BAFS)
PNS/BAFS 281:2019	Code of Good Aquaculture Practices (GAqP) on Hatchery for Freshwater Prawn	Department of Agriculture, Bureau of Agriculture and Fisheries Standards (DA-BAFS)
PNS/BAFS 196:2017	Code of Good Aquaculture Practices (GAqP) for Milkfish and Tilapia	Department of Agriculture, Bureau of Agriculture and Fisheries Standards (DA-BAFS)
PNS/BAFS 197:2017	Code of Good Aquaculture Practices (GAqP) for Shrimp and Crab	Department of Agriculture, Bureau of Agriculture and Fisheries Standards (DA-BAFS)
PNS/BAFS 101:2016	Halal Agriculture and Fisheries Products	Department of Agriculture, Bureau of Agriculture and Fisheries Standards (DA-BAFS)
PNS/BAFS 187:2016	Organic Aquaculture Feeds	Department of Agriculture, Bureau of Agriculture and Fisheries Standards (DA-BAFS)
PNS/BAFS 135:2014	Code of Good Aquaculture Practices	Department of Agriculture, Bureau of Agriculture and Fisheries Standards (DA-BAFS)
PNS/BAFPS 84:2010	Philippine National Standard for Aquaculture feeds	Department of Trade and Industry-Bureau of Product Standards (DTI-BPS)

The BFAR has appointed Fish Health Officers as Aquatic Animal Feed and Veterinary Drug and Product Control Officers (AAFDVPCOs). These officers are crucial in regulating the use of veterinary drugs and products in the aquaculture sector. AAFDVPCOs are tasked with inspecting and sampling at aquaculture facilities, fish ports, processing plants, and markets. They are also authorized to diagnose fish diseases and recommend suitable medications for aquatic animals. However, the use of restricted veterinary drugs necessitates a prescription from a licensed veterinarian and must adhere to relevant regulations, including those specifying minimum withdrawal periods (Somga et al., 2012). This regulatory framework is designed to ensure the responsible use of veterinary drugs in aquaculture, thereby protecting human health by minimizing potential drug residues in seafood products.

Alternative Antibiotic Strategies in Philippine Aquaculture

Given the growing issue of antibiotic resistance, it is crucial to explore alternative strategies for controlling its spread in aquaculture. This study categorizes the alternatives into pathogen-directed and host-directed approaches. Pathogen-directed strategies include inhibiting the growth and virulence of pathogens, using antibacterial compounds, and employing phage therapy. Host-directed strategies focus on enhancing overall health, reducing stress, stimulating the immune system, and selective breeding for disease resistance (Defoirdt et al., 2011).

Adhering to Good Aquaculture Practices (GAqPs), such as maintaining high water quality, proper sanitation, and balanced nutrition, is essential for both aquaculture farms and feed manufacturers (Regidor et al., 2020). Preventive measures throughout the production cycle, from hatchery to grow-out, are beneficial when implemented correctly. Natural substances like derris roots, rotenone, and tobacco dust can effectively manage pests, predators, and other undesired species (Cruz-Lacierda et al., 2000). Prophylactic agents act as a primary defense against infections, helping to prevent the development of pathogenic and drug-resistant strains (Cruz-Lacierda et al., 2000; Primavera, 1993).

In response to antibiotic-resistant pathogens, environmental and biological disease prevention methods are gaining prominence (Cruz-Lacierda et al., 2000). The Food and Agriculture Organization (FAO) and the World Health

Organization (WHO) advocate for the use of probiotics in aquaculture to enhance the aquatic environment (FAO/WHO, 2001; Sharifuzzaman & Austin, 2017). Probiotics offer numerous benefits, including improved health, disease prevention and control, enhanced growth performance, better body composition, reduced malformations, improved gut morphology and microbial balance, increased feed efficiency, and enhanced water quality (Das et al., 2017; Hancz, 2022; Merrifield et al., 2010). Recent studies in the Philippines have explored probiotic applications. For instance, *Staphylococcus aureus* isolated from saline tilapia in green water culture systems has shown promise in inhibiting gut colonization and protecting against *A. hydrophila* infections *in O. niloticus* (Albances & Traifalgar, 2022). *Bacillus* spp. isolated from African nightcrawlers (*Eudrilus eugeniae*) have been reported to improve growth, feed utilization, and disease resistance in Nile tilapia (Samson et al., 2020). Probiotic-treated groups infected with *A. hydrophila* exhibited higher survival rates (Hortillosa et al., 2022). Encapsulated probiotic isolates, including *Lacticaseibacillus* sp. FSPL001, *Saccharomyces* sp. FSPL011, and *Bacillus* sp. FSPL020, have been used to supplement tilapia diets, leading to increased body weight gain without adverse effects on feed utilization (Dumandan et al., 2024). Meanwhile, two strains of probiotic *Bacillus* isolated from the mucus of tilapia significantly helped to decline the population of *V. harveyi* resulting higher survival rate (Doroteo et al., 2018). Additionally, probiotics such as *Bacillus subtilis* BF12 and *Proteus mirabilis* MJA2.6S have been shown to inhibit pathogenic *V. parahaemolyticus* and *V. harveyi* in *P. monodon* culture, resulting in better growth, survival, and reduced ammonia levels (Apines-Amar et al., 2022; Temario et al., 2022). Probiotics have also positively impacted water quality and milkfish production in polluted ponds (Pleto et al., 2021).

Harmonization of Drug Registration Requirements in the Philippines

Harmonizing national drug registration requirements with VICH (International Cooperation on Harmonization of Technical Requirements for Registration of Veterinary Medicinal Products) guidelines involves aligning local regulations with globally recognized standards. This process aims to streamline the global registration and approval of veterinary medicinal products (VMPs), ensuring their safety, efficacy, and quality (Holmes & Hill, 2007).

The Philippines actively engages with VICH to help establish standardized guidelines and protocols for pharmaceutical product registration. By aligning its regulations with VICH standards, the Philippines aims to enhance the efficiency of its drug registration process, improve public health and safety, and increase access to high-quality medications. This engagement highlights the country's commitment to international cooperation and best practices in pharmaceutical regulation.

Several government agencies, including the FDA, DA-BAI, DA-BFAR, DOH, and DTI, collaborate to ensure that the Philippines meets its obligations to international harmonization efforts like those promoted by VICH. This coordinated approach benefits public health and safety and facilitates access to quality pharmaceutical products.

Despite existing legislation governing VMP use, challenges persist in implementation, affecting end-users and consumers. Unregulated use of VMPs can result in antibiotic residues passing from cultured animals to humans, underscoring the need for stricter regulation and ongoing monitoring (Pineda-Cortel et al., 2024).

While the Philippines may not fully meet all VICH technical requirements, its efforts to harmonize international regulatory standards are noteworthy. Continued dedication to international cooperation, including adopting best practices, enforcing stricter regulations, and conducting periodic monitoring and reporting on chemical production, is crucial. To prevent chemical hazards and ensure food safety, promoting regulatory harmonization based on international guidelines and adopting sound stewardship in Philippine aquaculture are essential. While antimicrobial treatments may be necessary for efficient animal production, they should not replace proper nutrition and hygiene management.

Conclusion

The rapid expansion of the Philippine aquaculture industry necessitates stringent measures to ensure the safety and quality of aquatic products, especially in the context of global trade. Food safety is a critical concern for the seafood industry, making compliance with regulatory frameworks essential to protect public health. Proper chemical use in aquaculture is crucial and must adhere to guidelines established by competent authorities. Aquaculturists and ornamental fish hobbyists should consult regulatory bodies or veterinarians to ensure the use of approved chemicals and their responsible application. Adhering to withdrawal periods is essential to avoid excessive chemical residues in edible aquatic products. A shift towards more sustainable and environmentally friendly practices, including reduced chemical use, is encouraged. Interagency collaboration is vital to mitigate chemical hazards and safeguard food safety. Harmonizing domestic and international regulations, alongside implementing robust stewardship programs for antimicrobial agents, will support responsible chemical use in aquaculture. Additionally, establishing transparent systems for reporting and tracking chemical usage, particularly antibiotics, can improve accountability and support evidence-based decision-making.

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Ethical approval

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Informed consent

Not available

Conflicts of interest

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