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Phytotherapy Toxicity in Aquaculture

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Abstract

The fish disease significantly affects the aquaculture industry and causes economic harm. Antibiotics, chemotherapeutics and other synthetic pharmaceuticals are continuously used by farmers to mitigate infectious diseases. Phytotherapy without side effects is an eco-friendly, socio-economic and modern approach to mitigate disease. Toxicological and pharmacological studies are prerequisites for phytotherapy-related research and help to decide a safe dose for the main experiment and commercial aqua products. In toxicity studies, LD50 and LC50 are reliable and widely used acute toxicity parameters.

Keywords: Antibiotics; Toxicity; Phytotherapy; LD50 and LC50

Introduction

Aquaculture is an exponentially growing sector that diminishes hunger and malnutrition at the global level and is forecast to increase by 62% between 2010 and 2030 [1]. Aquaculture does not only provide an important source of protein and income but can also furnish ecosystem services such as wastewater treatment, bioremediation, habitat restoration and replenishment of wild populations [2]. The aquaculture sector faces numerous challenges that hamper its expansion. Aquatic animal diseases are considered one of the major limiting factors for aquaculture development [3], with increasing global trade, intensification of systems and climate change contributing to the emergence of infectious diseases [4]. To prevent and mitigate economic losses, farmers continuously use antibiotics, chemotherapeutics and other veterinary drugs such as disinfectants to rear aquatic animals [5]. On the other hand, chemotherapy and vaccination is a costly methods to control aquaculture disease [6].

In India, "Mrgayurveda," a subdiscipline of Ayurveda, focuses on animal life and the use of herbal medicines to treat animal diseases [7], because of the presence of strong bioactive compounds medicinal plant exhibit antioxidant, antimicrobial and immune-stimulating properties, and can be a promising tool for mitigation of disease in aquaculture. In contrast to chemotherapeutics, they appear to be delivered to fish without having any detrimental side effects. They are also affordable, readily accessible and biocompatible [8,9]. Thus, the use of medicinal plants in aquaculture has attracted a lot of attention globally and has become a subject of investigation [10]. The most common medicinal plants incorporated in fish diets as powder and extracts are *Azadirachta indica, Withania somnifera, Allium sativum, Zingiber officinale, Ocimum sanctum, Tinospora cordifolia, Aloe barbadensis, Achyranthes aspera* etc. [9,11,12].

To examine the potential effects of medicinal herbs on fish, toxicity studies are required before their usage in aquaculture. The acute toxicity tests appear to represent important tools for determining safe concentrations for

animals, humans and the environment (biotic and abiotic factors), based on ecotoxicology [13]. Toxicology and pharmacology studies can be evaluated by the effects of medicinal plants on the haematological, biochemical, histological and oxidative parameters of fish as well as water quality. Blood parameters are valuable criteria for detecting physiological changes in pre-clinical farmed fishes and can give vital information for disease diagnosis and prognosis (Table 1). Due to the presence of certain toxic phytoconstituents like tannins, taxine alkaloids, hydrocyanic acid, juglone toxin, calcium oxalate, lycorine alkaloids and natural LSD plants become toxic to fishes and other aquatic organisms [14].

An LC50 value, also known as the median lethal concentration or lethal concentration 50, is the concentration of a medicinal plant that will kill 50% of the test subjects (fishes) when administered as a single exposure for a set short period. This value provides insight into the relative acute toxicity of the medicinal herb [15].

Medicinal plant	Plant part used	Fish	Study period	LC_{50}/LD_{50}	References
Myrica esculenta	Leaf (extract)	Oncorhynchus mykiss	96	199.5 mg/L	[16]
Moringa oleifera	Seed (extract)	Cyprinus carpio	96	124.0 mg/L	[17]
Uncaria tomentosa	Bark (extract)	Hyphessobrycon eques	48	18.16 mL/L	[18]
Azadirachta indica	Leaf (extract)	Prochilodus lineatus	24	4.8 g /L	[19]
Mentha piperita	Leaf (Essential oil)	Arapaima gigas	4	38 mg/L	[20]

Table 1: List of medicinal plants used in acute toxicity analysis along with their part used, study hours and median lethal concentration against different fishes.

Acute toxicity analysis of herbs on fish is used to determine possible harm to fish species as well as other ecological regulatory issues related to surface water pollutants [21] (Tables 2 & 3).

Essential oil	LC50	Fish used	Study period(hours)
Thyme	6.6 mg/L	Oncorhynchus mykiss	96 hours
Thymol	2.6 mg/L		
Cumin	35 mg/L		
Caraway	14 mg/L		

Table 2: LC50 concentrations of essential oils against rainbow trout during 96 h acute toxicity test [22].

Medicinal plant	Part of the plant used	Fish used	LC50 (g/L)at various exposure periods			
			24 h	48 h	72 h	96 h
Euphorbia royleana	Bark extract	*Channa punctatus*	0.05	0.04	0.025	0.02
Jatropha gossypifolia			4.61	4.54	4.44	4.34
Nerium indicum			0.097	0.095	0.07	0.041
Thevetia peruviana			4.05	3.64	3.48	3.17

Table 3: Median lethal concentration analysis of 4 different bark extracts against *Channa punctatus* [21].

Conclusion

Phytotherapy is the inexpensive, easily available and biocompatible approach. Efficient toxicology and pharmacology investigation is strongly recommended to determine LD50, LC50 and sub-lethal doses. The phytochemical analysis is required to find potent bioactive compounds present in medicinal herbs. Hematology, histology, oxidative and biochemical parameter are very useful to evaluate the effect of medicinal plants on fish. Moreover, additional research on their mode of action, the stability of plant components in the aquatic environment, the

acceptance rate in fish and in vitro and in vivo toxicity tests are required for their safe use.

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