11. Implications of Aflatoxins in fish feed

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Introduction

Aflatoxins are a serious source of contamination in foods and feeds in different parts of the world. Aqua feeds depend on fishmeal as a protein source, but the trend has moved towards replacing fish meal with less expensive sources of protein of plant origin. Because of this issue, aquaculture feeds are facing a higher risk of contamination by one or more types of aflatoxins. Aflatoxicosis is a disease that can affect many species of fish due to the consumption of feed contaminated with aflatoxins. The first documented incidences of aflatoxicosis affecting fish health occurred in the 1960s in trout hatcheries.

Aflatoxins are mycotoxins and they are commonly found in animal feed ingredients such as maize, sorghum grain, rice meal, peanuts, cottonseed meal, groundnuts, wheat and soybeans etc. They are known as food-borne carcinogens, have been associated with serious harmful effects on the health of humans and animals. Aflatoxins are chemical toxins produced by some species of naturally occurring fungi, *Aspergillus flavus* and *Aspergillus parasiticus* commonly known as molds. These species can grow in a wide variety of substrates and under different environmental conditions. Other strains, such as *Aspergillus nomius*, *Aspergillus tamari,* and *Aspergillus pseudotamarii* are also associated with astaxanthin production. Most mycotoxins are often identified in their original form in the final product

because they are not destroyed by feed or food processing because of their highly stable chemical structure. In tropical and subtropical conditions, this potential is further augmented due to storage under humid and hot conditions. The toxin has been incriminated as the cause of high mortality in aquaculture and in some cases of death in human beings.

Toxicology of aflatoxins

There are 20 similar compounds called aflatoxins. Only 4 have been substantially studied in regard to their biological properties and health concerns. *A. parasiticus* produces all four major toxins AFB1, AFB2, AFG1, and AFG2, while *A. flavus* produces only AFB1 and AFB2. Due to their heterocyclic chemical structure, B and G aflatoxins show fluorescence only when exposed to ultraviolet light. The B and G designations are determined by the fluorescent color that occurs after exposure to ultraviolet-light: blue for AFB1 and AFB2, and yellow-green for AFG1 and AFG2 . However, the most important types in terms of health and medical interest identified are AFB1, AFB2, AFG1 and AFG2. Two other aflatoxins M1 and M2, have been identified as hydroxylated mammalian metabolites of AFB1 and AFB2 since they were isolated from the milk of lactating cows fed with aflatoxin contaminated feed.

Among all known naturally occurring aflatoxins AFB1 is the most toxic, followed in order of decreasing toxicity of aflatoxins AFG1, AFB2, and AFG2. In liver cells AFB1 is converted to several metabolites that may be transmitted to edible animal products. As for human and animal health, biological effects of aflatoxins may be carcinogenic, mutagenic, teratogenic, hepatotoxic, and immunosuppressive. All these aflatoxin effects are

influenced by variations according to the animal species, sex, age, nutritional status, and effects of other chemical products, besides the dose of toxin and the length of exposure of the organism to it.

Aflatoxicosis is the poisoning that results from ingesting aflatoxins. Factors that increase the production of aflatoxins in feeds include environmental temperatures above 27°C, humidity levels greater than 62%, and moisture levels in the feed above 14%. The extent of contamination will vary with geographic location, feed storage practices and processing methods. Improper storage is one of the most important factors favoring the growth of aflatoxin producing molds, and it is a major element that can be controlled. Aflatoxins can cause disease indirectly through their effects on essential nutrients in the diet like fat soluble antioxidants, such as vitamin A, and water soluble antioxidants and vitamins, such as vitamin C and thiamin, in feeds can be destroyed by these toxins. A reduction in growth is one of the main adverse effects reported due to contamination aflatoxin B1. In the majority of aquatic organisms exposed to AFB1, the toxic signs as anorexia, yellowing of the body surface, weight loss, feed efficiency reduction, liver dysfunction and histological damage are commonly observed.

Even though aflatoxin synthesis is generally considered to occur principally in vegetables growing in field or during the storage of corn, fishmeal and fish by-product contamination also occurs during the milling process and the ensiling period, or directly on the farm under improper storage conditions. Due to high costs, the possible replacement of marine fishmeal with vegetable feedstuffs might allow a significant cost reduction

in aquaculture and could represent a sustainable alternative source of fish feed. Negative effects of aflatoxins to aquatic environment are increasingly recognized in Aquaculture. Hence monitoring of environmental effects of aflatoxins in aquaculture is very important for conservation of aquatic ecosystems.