Newsletter

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> Editorial

Global aquaculture production has grown rapidly during the past decades, contributing significant quantities to the world's fish supply for human consumption. In 1980 just 9% of the fish consumed by humans came from aquaculture. Today, aquaculture accounts for 45% of the world's food fish. Fish farming has been the world's fastest growing food production sector, sustaining an annual growth rate of 8.8% since 1970. By way of comparison, livestock production, also considered a growth sector, increased at a rate of just 2.8% a year during the same period. Starting primarily in Asia, aquaculture has now spread to all continents, producing a range of species in all aquatic environments. From a small-scale and family-based activity, aquaculture is now evolving to large-scale commercial production of value species that are traded at national and international level. However, as aquaculture expands and develops, additional problems and challenges arise. Foremost is the insistence by consumers that the intensive farming of aquaculture is environmentally acceptable and sustainable. Biomin, as a global player in animal nutrition could not miss the "blue revolution" and has expanded its operations to the aquaculture industry. Continuous research work has been undertaken to develop a new line of products for modern and sustainable aquaculture. The Biomin Aqua Specials product line includes probiotics and bioremediation products for aquaculture as well as a range of natural growth promoters (NGP's) that combine different natural substances to improve gut health, performance and boost the immune-system of the target species.
Following our expertise in the field of mycotoxin deactivation, Biomin also offers to the aquaculture industry the Mycofix® range of products, a modular system of patented mycotoxin deactivation.

Pedro Encarnação

Biomin® Aqua Specials product line

As we can witness through our mycotoxin survey program, the contamination of feed and raw materials by mycotoxins is significant on a global basis making it increasingly likely that any given feedstuff could contain one or, more likely, several mycotoxins. The problem can be caused by many factors, such as low quality feed ingredients and inappropriate feed storage methods.

Mycotoxins: An overlooked threat for Aquaculture farming

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Mycotoxins are toxic substances known to be either carcinogenic (e.g. aflatoxin B_1, ochratoxin A, fumonisin B1), estrogenic (zearalenone), neurotoxic (fumonisin B_1), nephrotoxic (ochratoxin), dermatotoxic (trichothecenes) or immunosuppressive (aflatoxin B_1, ochratoxin A and T-2 toxin). These mould toxins vary in their toxicity toward different

animals species and while the effect of mycotoxins is relatively well known for most terrestrial farm animals the effect of mycotoxins on aquaculture species has not been studied extensively. Even though the information is limited, several studies have reported pathological signs of mycotoxin poisoning in fish and shrimp species *(Figures 1 & 2)*. The extent of disease, caused by consumption of mycotoxins, depends upon the age and species of the fish. Fry are more susceptible than adults and some fish species are more sensitive to mycotoxins than others. Marine and cold water species seem to be more sensitive to mycotoxins than warm water fish. Although less sensitive, warm water species are still affected by mycotoxin contamination.

The economic losses from mycotoxin contamination can be caused by exposure to high contamination levels, or by detrimental health effects in animals consuming low or moderate contamination levels. These subtle effects often go unnoticed and profits are lost due to decreased efficiency in production, such as slow growth, reduced weight, increase in FCR and increased medical costs.

The general disregard regarding the consequence of mycotoxin contamination in fish and shrimp feeds is directly related to the lack of information on the impact of the different mycotoxins.

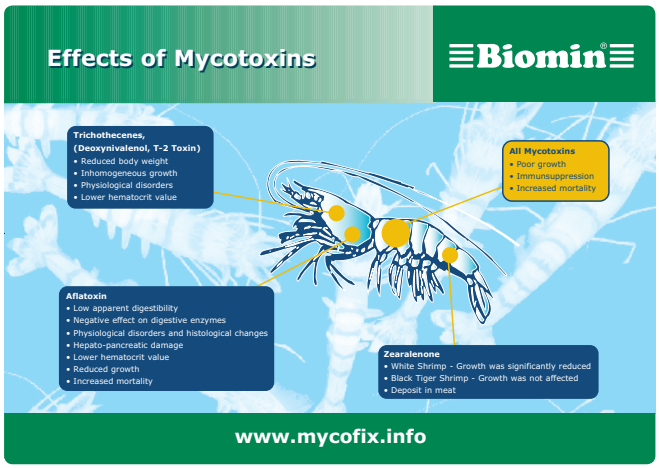

Figure 1 – Biomin postcard on effect of mycotoxins in shrimp

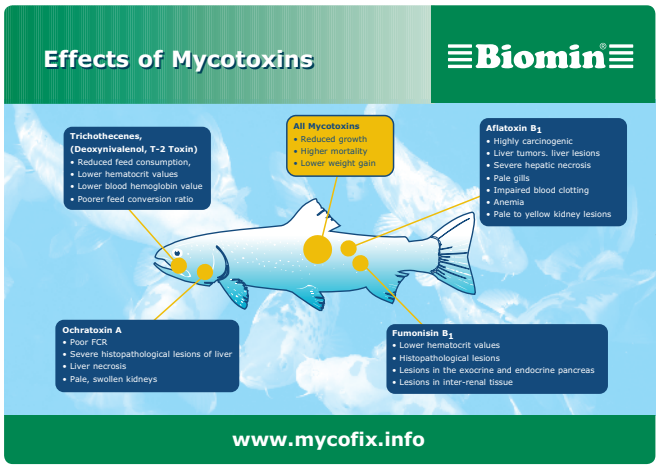

Figure 2 - Biomin postcard on effect of mycotoxins in fish

Aflatoxins

Aflatoxin B_1 (AFB_1) is one of the most potent, naturally occurring, cancer-causing agents in animals. Rainbow trout is reported to be one of the most sensitive animals to AFB_1 poisoning. In this species, an intake of 1 µg AFB_1/kg diet can already cause liver tumors (Lovel, 1989). Prolonged feeding of low concentrations of AFB_1 causes liver tumors, which appear as pale yellow lesions and which can spread to the kidney. AFB_1 is also known to be a powerful immune-suppressor. Recently some studies have also related the presence of AFB_1 in feed to the yellow coloring of the meat.

In carp, it was reported that aflatoxins are potential immune-suppressors. Studies on Nile tilapia and Thai catfish showed reduced growth rates when these fish were fed diets containing 0 to 230 ppb AFB_1 *(Figure 3 & 4)*. In addition, reports showed that diets containing 100 ppm AFB_1 caused weight loss and severe hepatic necrosis in Nile tilapia (Tuan, et al., 2002).

In shrimp, several studies (Boonyaratpalin et al., 2001, Bintvihok at al., 2003) showed that AFB_1 can cause abnormalities such as poor growth and physiological disorders in the hepatopancreatic tissue resulting in the modification of the digestive processes. The results showed that AFB_1 contamination in shrimp feed may cause economic losses by lowering shrimp production.

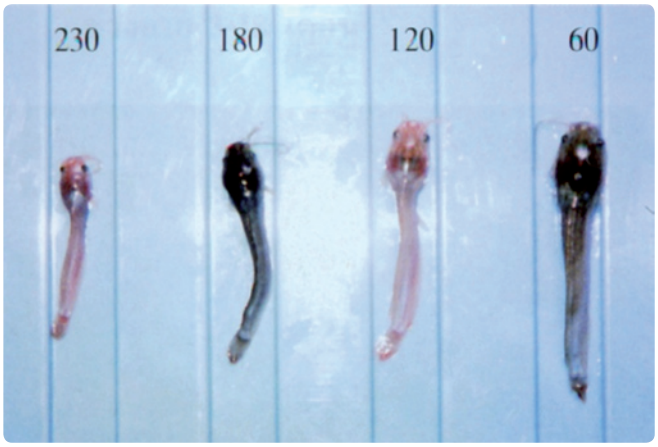

Figure 3 – Effects of increase levels of AFB1 in Thai hybrid catfish (source- Dr. J. Khajarern)

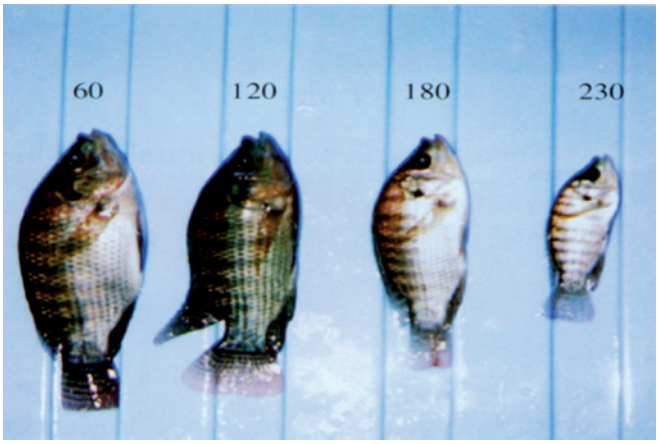

Figure 4 – Effects of increase levels of AFB_1 in Nile tilapia (source- Dr. J. Khajarern)

Fumonisins

Although the importance of fumonisins as toxic agents in fish remains poorly understood, adverse effects of fumonisin contaminated diets have been reported in tilapia and catfish. Studies revealed that FB_1 is toxic to tilapia and channel catfish by suppressing growth and/or causing histopathological lesions. In carp, long-term exposure to 0.5 and 5.0 mg per kg body weight is not lethal, but can produce adverse physiological effects.

Trichothecenes

Trichothecenes are a group of mycotoxins produced by fungi of the genus Fusarium that infects grains, wheat by-products and oilseed meals. Studies have shown that the type A trichothecene, T-2 toxin, can depress growth, reduce FCR and lower immune parameters in catfish, trout, carp and shrimp. A study with channel catfish showed that disease resistance of juvenile channel catfish was reduced when fed T-2 toxin, resulting in significantly greater mortality when challenged with Edwardsiella ictaluri compared to a control (Manning et al., 2005). In white shrimp, it was observed that growth was significantly reduced by T-2 toxin at 0.1 ppm while for black tiger shrimp reduced growth was observed at levels of 2.0 ppm (Supamattaya et al. 2006). The presence of T-2 toxin at 1.0-2.0 ppm produced atrophic changes and severe degeneration of hepatopancreas tissue *(Figure 5)*.

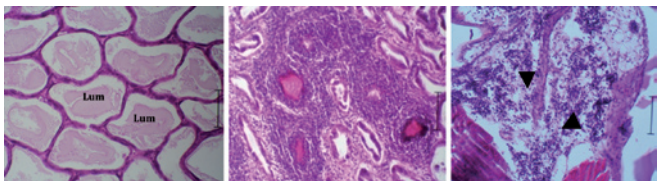

Figure 5 – a) Atrophic changes of hepatopancreatic tubule produced by T-2 toxin at 1.0 ppm for 8 weeks. b Tubular degeneration and encapsulation were observed in white shrimp fed zearalenone at 1.0 ppm for 8 weeks. C. Loose contact and necrosis of hemopoietic tissue affected by T-2 toxin at 2.0 ppm in white shrimp (source Supamattaya et al., 2006).

Deoxynivalenol (DON), also known as vomitoxin, and other type B trichothecenes are produced by Fusarium sp. and can be an important contaminant of wheat and other vegetable protein sources. DON levels of 0.2, 0.5, and 1.0 ppm in the diet significantly reduced growth rate in white shrimp (Trigo-Stockli et al., 2000). Reduced weight gain has also been noted in rainbow trout fed DON-contaminated feed, which showed sensitive taste acuity for DON and reduced their feed intake as the concentration of DON increased from 1 to 13 ppm of diet (Woodward et al., 1983) *(Figure 6)*.

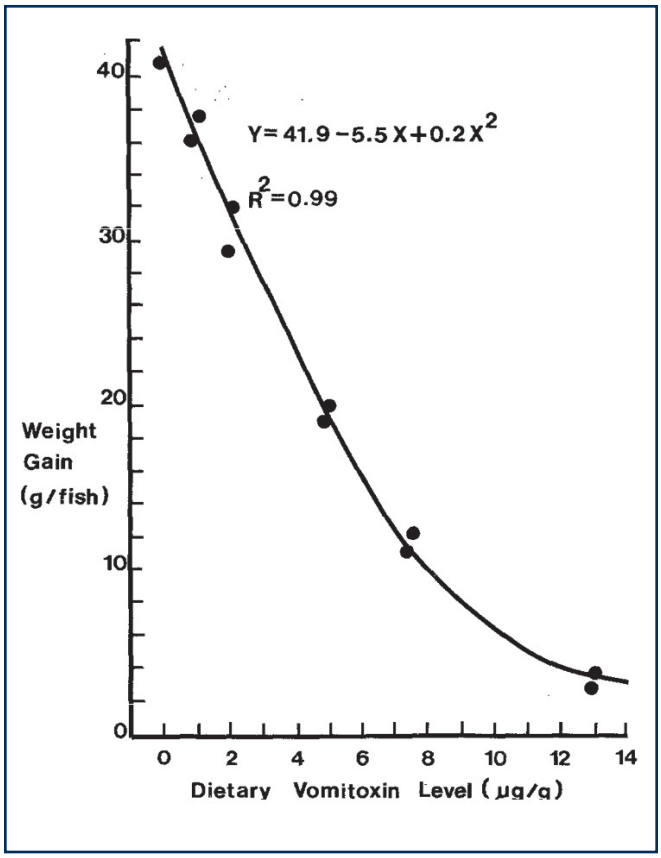

Figure 6 – Regression curve of 4 week weight gain vs dietary DON level (Woodward et al., 1983)

Combating mycotoxins

Although the presence of mycotoxins in feed represents a threat to aquaculture production there are several options available to prevent or reduce the risk of mycotoxicoses associated with mycotoxin contamination. These range from careful selection of raw materials, maintaining good storage conditions and using an effective mycotoxin deactivator product to combat the widest possible range of different mycotoxins that may be present. Binders or adsorbents have been used to neutralize the effects of mycotoxins by preventing their absorption from the animal's digestive tract. Unfortunately, different mycotoxin groups are different in their chemical structure and therefore it is impossible to equally deactivate all mycotoxins using only a single strategy. While adsorption works well for aflatoxin, mycotoxins which are less, or non-absorbable, like ochratoxin, zearalenone and DON, have to be deactivated using a different approach.

Biotransformation is defined as detoxification of mycotoxins using microorganisms or enzymes which specifically degrade the toxic structures to non-toxic metabolites. Mycofix® Plus is a mycotoxin deactivator which combines adsorption and biotransformation to break functional groups of different mycotoxins. Mycofix® Plus combines different micro-organisms, live bacteria and yeast strains to successfully counteract all relevant mycotoxins in a biological way. BBSH 797, a Eubacterium species patented by Biomin®, produces enzymes, so-called de-epoxidases, which degrade the toxic epoxide ring of trichothecenes. T. mycotoxinivorans (vorans lat. degrade, eat), a yeast strain, successfully counteracts ochratoxin A and zearalenone by enzymatic cleavage. Mycofix® Plus also includes selected plant extracts which stimulate the immune system.

Application of Mycofix products in aqua-feeds

Two types of pellets are normally used in the aquaculture industry; compressed pellets (sinking pellets) and extruded pellets (floating and slow-sinking). The Mycofix® product line consists of three products: Mycofix® Eco, Mycofix® Select and Mycofix® Plus. While there are no constraints for the application of the different Mycofix® products in standard steam pelleted feeds, or Mycofix® Eco in all Aqua feeds, the application of Mycofix® Select and Mycofix® Plus in extruded feed represents a challenge. This is due to the fact that the bioactive components (BBSH and MTV) present in Mycofix® Plus and Mycofix® Select will not resist the high temperatures and pressure of the extrusion process. A solution to this loss of activity during extrusion is to add the active ingredient subsequently to the extrusion process.
This can easily be achieved by mixing Mycofix® Plus or Mycofix® Select with oil and top coating into the feed after the extrusion. Simple fat coating can be performed by a disc-coater which applies a thin layer of oil to the pellet surface. This is a normal procedure used in extruded fish feeds to improve palatability and reduce feed dust. Recently, new methods of adding vitamins and other bioactive compounds to feed were developed, using a vacuum coater and infusion system. In this process of oil coating after drying, emulsified oil with vitamins, pigments and the bioactive compounds such as Mycofix® can be effectively added to the feed.

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> IMPRESSUM

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