FEED ADDITIVES TO DECREASE ANTIBIOTIC USE IN FISH AND SHRIMP PRODUCTION

Matthijs de Jong
Central Technical Manager
Orffa Additives BV.

"Overall, it can be stated that feed additives can play a vital role in the reduction of antibiotics. Feed additives, however, cannot stand alone in the mission to reduce the use of antibiotics. Next to the use of feed additives, it is important to have, for example, proper animal husbandry, feed management and disease prevention mechanisms."

Despite the current global challenges, the aquaculture sector has shown significant growth over the last few years. In 2020 a growth of 2.7% in volume was observed, which elevated the total volume of aquaculture, excluding algae, to 87.5 million metric tonnes. The expectation is, that in 2021 or 2022, the aquaculture volumes will have surpassed the capture fisheries volume, which was recorded at 90.3 million metric tonnes in 2020. One of the main drivers of these growth numbers is the intensification of aquaculture production. Growth rates and feed efficiency have been improved, whilst at the same time stocking densities have been increasing over the past years. Besides increased productivity, this also resulted in increased disease pressure. Over the past decades, diseases emerged globally, which disrupted production chains and led to enormous economic losses. The first response to this increased disease pressure was the massive use of antibiotics. However, the use of antibiotics is shown to be harmful to animals and the environment. Next to that, it is shown as unhealthy for humans since accumulation of antibiotics in animals might lead to health issues and/or bacterial resistance. Since the acknowledgement of the need for reduction of antibiotics, the industry and the academic world has been focusing on new solutions to increase fish and shrimp resilience, for example by using feed additives. The general hypothesis is, that when animal health and resilience are increased, the need for antibiotics will be reduced. In this article, several feed additives will be addressed on how they can help in the mission to reduce antibiotic use in aquaculture.

SELENIUM

Selenium is an important nutrient in animal production as it plays a vital role in the antioxidant defense of humans, livestock, fish and shrimp. Especially during stressful periods, for example during handling or diseases, this trace element will support the animal by contributing to the reduction of reactive oxygen species (ROS). The importance of selenium is widely known, but the consumption by aquatic animals of selenium is under pressure. Usually selenium is present in high concentrations in marine-based ingredients, yet with the increased use of plant-based ingredients in aquafeed, the amount of selenium in the fish and shrimp diets has been

decreasing. The decreased levels of selenium in the diet accompanied by the increased disease pressure highlights the importance of adding additional selenium to the feed. The addition of selenium in the organic form of L-selenomethionine is shown to be a good option, since selenium in this form can be stored in animal tissues. This allows for the best results, since it ensures a constant selenium supply by safe deposits of selenium that can thereafter be used by the animal during times of stress or when selenium uptake is limited. One example of this is a trial done in Thailand by Dr Wangkahart et al. (2022).

During a feeding trial of 8 weeks, Nile tilapia were either fed a control diet, without added selenium, or a diet with 1, 3 or 5 mg/kg selenium from sodium selenite, or a diet with 1, 3 or 5 mg/kg selenium from L-selenomethionine (Excential Selenium 4000, Orffa Additives BV). After 8 weeks of feeding the seven different diets, it was observed that addition of selenium as L-selenomethionine significantly improved the growth performance and feed efficiency compared to the control treatment, with an optimum dosage at 1 mg/kg selenium addition. At the same time, selenium from sodium selenite did not improve growth performance and feed efficiency compared to the control treatment. After 8 weeks the same fish were challenged with *Streptococcus agalactiae*. For 21 days the cumulative survival was measured and compared among all treatments. What could be observed was that, regardless of the source, selenium allowed for an increase of the cumulative survival in Nile tilapia. However, when looking at figure 1, it can be observed that L-selenomethionine (SeMet) supplementation led to significantly increased survival compared to sodium selenite (SS).

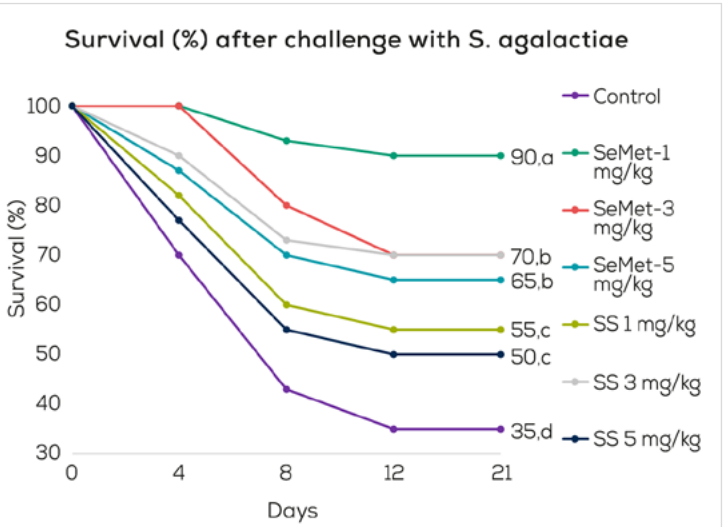

Figure 1. *Cumulative survival of Nile tilapia fed selenium at 0, 1, 3 and 5 mg/kg from either L-selenomethionine (SetMet) or sodium selenite (SS) (P<0.05).*

The combination of growth and increased survival during pathogenic pressure showed that including selenium in the diet can be a viable strategy to reduce antibiotic use in aquaculture.

PHYTOGENIC FEED ADDITIVES: GARLIC AND CINNAMON

Phytogenic feed additives are based on plant-derived materials. Phytogenic feed additives are widely known as appetite stimulators, growth promoters and immune stimulants. Additionally, they have anti-pathogenic, anti-bacterial and anti-parasitic properties. For example, garlic and cinnamon contain several bioactive molecules that can exert multiple effects on gastrointestinal (GI) health. This includes antimicrobial effect by disrupting the cellular membrane of pathogens. Additionally, it can cause a boost of the host immunity providing support in anti-inflammatory and antioxidant reactions, and resulting in the redirection of energy to maintain or even increase animal performance during pathogenic challenges.

In aquaculture, the use of garlic and cinnamon to support fish in their defense against pathogens is widely accepted. For example in cobia fish, it is observed that the inclusion of 1 kg/MT of a garlic and cinnamon product, in the form of Excential Alliin Plus (Orffa Additives BV), has led to a significant decrease in the occurrence of sea lice on the fish by 60% (Table 1).

Additionally, it was observed that the size of the wounds, caused by sea lice on the fish fed the garlic and cinnamon product, were smaller and, in those fish, wound regeneration capacity was also increased.

In shrimp, similar results have been observed. In a trial performed in Thailand, by Dr Orapint, shrimp were fed either 0, 0.5 or 1 kg/MT from the garlic-cinnamon blend (Excential Alliin Plus, Orffa Additives BV). Addition of the phytogenic feed additive led to increased growth performance and feed efficiency, regardless of the source. But next to that, the inclusion of the garlic-cinnamon blend in the diet led to overall higher disease resistance. The same shrimp were challenged with *Vibrio parahaemolyticus*, after which immune parameters were measured. In general, hemocyte count, hemolymph protein and phenoloxidase activity were all elevated by the garlic-cinnamon blend (Figure 2). These parameters are indicators of the innate immune response and antioxidant capacity, which aid the shrimp in a swift and effective response against pathogens. Besides these parameters, lysozyme activity was significantly improved when the garlic-cinnamon blend was added at 1 kg/MT.

Both trials showed an increased resilience against common disease in aquaculture when adding a garlic-cinnamon blend to the feed, decreasing the need for antibiotics.

Table 1. Sea lice count in cobia fish fed diets with (1 kg/MT; cages 1, 2, 4, 5, 7, 8 and 9) and without Excential Alliin Plus (cages 3 and 6)

	Cage 1	Cage 2	Cage 3	Cage 4	Cage 5	Cage 6	Cage 7	Cage 8	Cage 9	Average Alliin Plus	Average Control
wk 4	0,5	0,7	0,3	0	0,4	0	0	2,1	0,7	0,15	0,63
wk 5	1,2	0,4	1,1	4,6	2	0	2	1,1	3,5	0,55	2,11
wk 7	5	2	0	5	0	2,4	6	1,8	-	1,20	3,30
wk 8	10,4	1	2	3,8	4,4	2,2	14,7	3,2	3,6	2,10	5,87
wk 9	4	0,2	1,4	0,2	1,2	0,8	6,8	0	1,2	1,10	1,94
ave	4,2	0,9	1	2,7	1,6	1,1	5,9	1,6	2,3	1,05	2,74

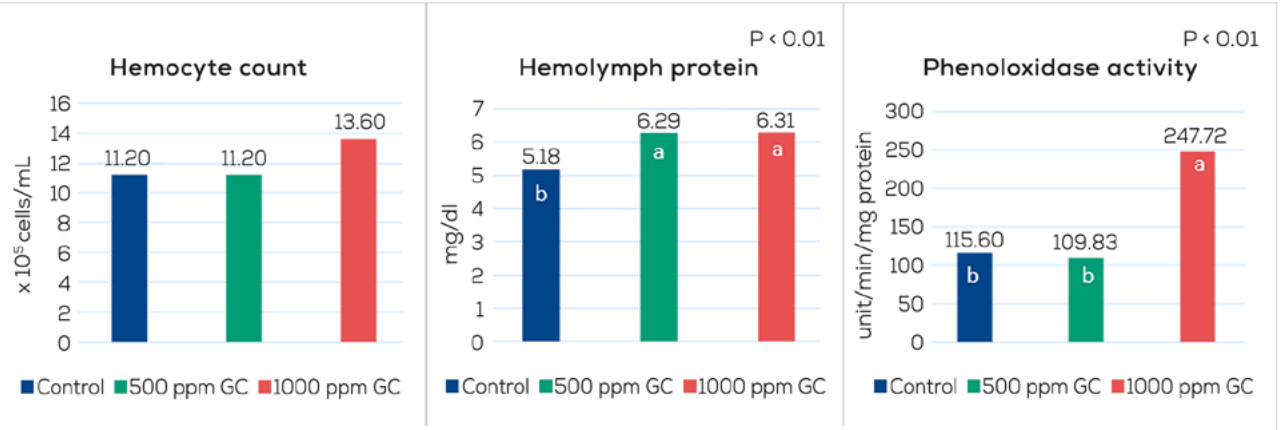

Figure 2. *Immune status of shrimp fed the garlic-cinnamon blend at different levels after Vibrio challenge*

BUTYRATE

Butyrate, also known as butyric acid, is a short-chain fatty acid that has been shown to have several benefits in the diets of fish and shrimp. It has been found to improve the growth and health of animals. One of the main benefits of butyrate in aquafeed is its ability to improve gut health. Butyrate has been shown to enhance the integrity of the gut epithelium, the layer of cells lining the gut. This can help to prevent the entry of harmful bacteria and toxins into the body of fish and shrimp and can improve overall digestive health.

In addition to its effects on gut health, butyrate has also been shown to improve immune functioning of animals. This can help to protect the animals from diseases and infections and can improve overall survival rate. Butyrate has also been found to have anti-inflammatory effects, helping to reduce the damage caused by infections and other stressors. An example of increased survival rate after addition of butyrate to the diet can be seen in a trial with black tiger shrimp. This trial compared the efficacy of different organic acids in 5 diets; a control without any organic acid added, BUT with 10 g/kg butyrate addition, SUC with 10 g/kg succinate addition, FUM with 10 g/kg fumarate addition and ALL with all three organic acids at 10 g/kg each (total organic acids addition of 30 g/kg of feed). After a feeding trial of 42 days, it could be observed that the overall survival was significantly highest in the shrimp fed butyrate (Figure 3).

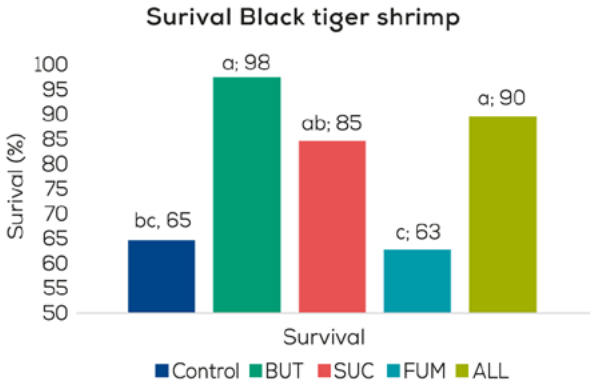

Figure 3. *Survival of black tiger shrimp fed a control diet without organic acids or butyrate, succinate, fumarate or combination of the products.*

Furthermore, butyrate has also been shown to improve the growth and development of animals. Butyrate can increase the absorption of nutrients from the diet and can enhance the utilization of energy from the feed. This can lead to improved growth rates and overall productivity of fish and shrimp. In the same trial as discussed in the section above, it could be observed that the use of butyrate significantly improved weight gain compared to the other organic acids and the control diet.

Overall, the inclusion of butyrate in the diet of fish and shrimp can provide a wide range of benefits, such as improved gut health, enhanced immune function, and improved growth and development.

As a result, butyrate has become an important ingredient in aquafeed to reduce the need for antibiotics and use of this ingredient is expected to continue to grow in the future.

BETAINE

Betaine is a compound commonly used in aquaculture to improve the growth and health status of fish and shrimp. It is known for multiple beneficial effects on aquatic animals, including enhanced digestion and absorption of nutrients, reduced stress and disease susceptibility, and improved overall health and performance of animals.

One of the key benefits that betaine has on aquatic animals is by improving the osmotic status of fish and shrimp in the body, which helps the animals to retain water and maintain the healthy status of body cells. Betaine also helps to improve the digestion and absorption of nutrients, which can enhance the growth and development of the animals.

Another major benefit of betaine in aquaculture is its ability to reduce the negative impacts of stress. Betaine has been shown to reduce the levels of stress hormones in the body, which can help to improve the overall health and well-being of animals. Stress is known to lead to reduced growth, impaired immune function, and increased susceptibility to diseases. An example of decreased disease susceptibility can be seen in an experiment with Nile tilapia, where either spirulina (TS) at 0.3%, betaine (TB) at 0.5% and the combination of both (TSB) were compared with a control diet without these feed additives. After a challenge with *Aeromonas hydrophilia*, betaine significantly improved survival compared to the control diet and similar results with the spirulina-enriched diets (Figure 4).

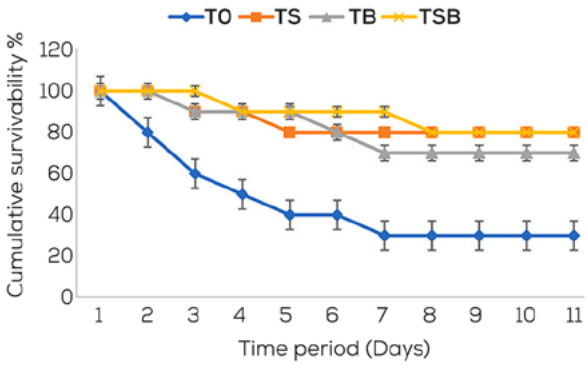

Figure 4. *Cumulative survival of Nile tilapia after a challenge with Aeromonas hydrophilia fed either betaine (TB), spirulina (TS) or a combination of both (TSB).*

"Betaine has been shown to reduce the levels of stress hormones in the body, which can help to improve the overall health and well-being of animals."

In addition to these benefits on osmotic status and reduction of stress, betaine has also been shown to improve the overall performance of aquatic animals in aquaculture. It has been shown to increase the growth rate, feed efficiency, and survival rate of fish and shrimp, which can help to improve the profitability of aquaculture operations.

Overall, betaine is an important supplement in aquaculture, and its use is expanding. Addition of betaine can be an effective way to improve the health, growth, and performance of aquatic animals, helping to make aquaculture operations more sustainable, profitable and less reliable on antibiotics.

FEED ADDITIVES: AQUACULTURE PATHWAY TO DECREASED ANTIBIOTIC USE

Overall, it can be stated that feed additives can play a vital role in the reduction of antibiotics. Feed additives however, cannot stand alone in the mission to reduce the use of antibiotics. Next to the use of feed additives, it is important to have, for example, proper animal husbandry, feed management and disease prevention mechanisms. All these components combined are important to maintain productivity without the need of adding antibiotics.

About Matthijs de Jong

Matthijs de Jong is Central Technical Manager Aqua at Orffa Additives BV. Matthijs graduated from Wageningen University and research in 2021, with a bachelor Animal Sciences and a Master Aquaculture and Marine Resource Management.