

Phytogenic feed additives: Garlic and cinnamon to improve health and growth performance in shrimp

Use of a phytogenic feed additive based on garlic and cinnamon benefits growth at lower inclusion, while it improves immune status and health of shrimp at higher inclusion

By Matthijs de Jong and Aurélie Montagnon

Production of white leg shrimp (*Litopenaeus vannamei*) has been increasing over the past decades and is expected to grow more in the (near) future. Shrimp farming is an exciting sector for the production of high-value end products, but it continues to face a growing number of challenges. Today, one of them is to combine improvement in productivity with the shift towards more sustainable farming, without compromising on shrimp health. Shrimp farming is under pressure to reduce its environmental impact whilst mitigating disease outbreaks. To maintain shrimp productivity and health and, at the same time cope with these challenges, the optimisation of feed is a necessity.

Phytogenic feed additives

A common nutritional strategy is the use of phytogenic feed additives (PFA). PFAs, such as garlic and cinnamon, are widely known as appetite stimulators, growth promoters and immune stimulants. Additionally, they often have anti-pathogenic, anti-bacterial and anti-parasitic properties. Garlic and cinnamon contain several bioactive molecules that can exert multiple effects on gut health. This includes an antimicrobial effect by disrupting the cellular membrane of pathogens. It can also boost host immunity, helping with anti-inflammatory and antioxidant reactions. This results in the redirection of energy to maintain or even increase animal performance during pathogenic challenges.

The mode of action behind these components can be attributed to the active compounds, which are allicin (garlic) and cinnamaldehyde (cinnamon). Both are known to be beneficial for animals. Orffa (Belgium) offers a very effective product called Excential Alliin Plus, where both garlic and cinnamon are freeze-dried and processed in a unique way to ensure optimal activity inside the animal's intestine (Figure 1).

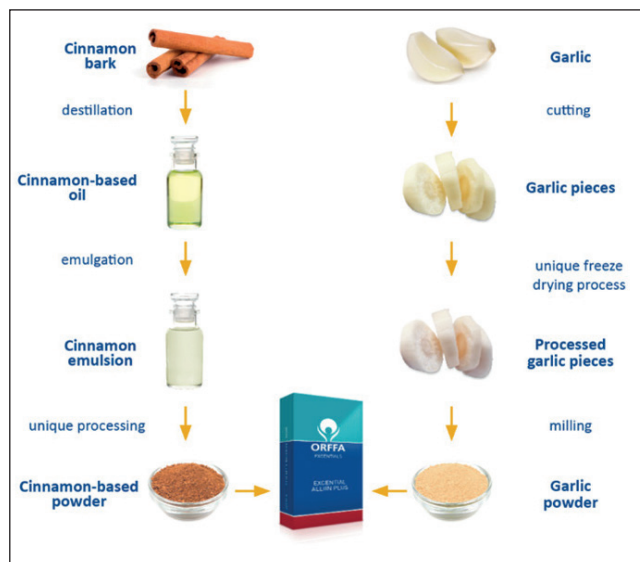


Figure 1. The unique production process of Excential Alliin Plus

The effect of garlic and cinnamon on bacteria and ectoparasites

Garlic and cinnamon usage in animal production has a long history. In livestock production, both components have been used for quite some time due to their effectiveness against parasites and opportunistic bacteria. In aquaculture, the use of garlic and cinnamon to support fish in their defense against pathogens is widely accepted. In farming of the cobia (*Rachycentron canadum*), it was observed that the inclusion of 1 kg/tonne of feed of a garlic and cinnamon product led to a significant decrease in the occurrence of sea lice on the fish by 60% (Table 1).

| | Cage 1 | Cage 2 | Cage 3 | Cage 4 | Cage 5 | Cage 6 | Cage 7 | Cage 8 | Cage 9 |
|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| wk 4 | 0.5 | 0.7 | 0.3 | 0 | 0.4 | 0 | 0 | 2.1 | 0.7 |
| wk 5 | 1.2 | 0.4 | 1.1 | 4.6 | 2 | 0 | 2 | 1.1 | 3.5 |
| wk 7 | 5 | 2 | 0 | 5 | 0 | 2.4 | 6 | 1.8 | |
| wk 8 | 10.4 | 1 | 2 | 3.8 | 4.4 | 2.2 | 14.7 | 3.2 | 3.6 |
| wk 9 | 4 | 0.2 | 1.4 | 0.2 | 1.2 | 0.8 | 6.8 | 0 | 1.2 |
| Avg | 4.2 | 0.9 | 1 | 2.7 | 1.6 | 1.1 | 5.9 | 1.6 | 2.3 |

| Average Alliin Plus | Average Control |
|---------------------|-----------------|
| 0.15 | 0.63 |
| 0.55 | 2.11 |
| 1.2 | 3.3 |
| 2.1 | 5.87 |
| 1.1 | 1.94 |
| 1.05 | 2.74 |

Table 1. Sea lice count in cobia fish fed diets without and with 1 kg Excential Alliin Plus/tonne feed.

Additionally, in this same trial, 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.

Besides repelling parasites, it is known that allicin and cinnamaldehyde are both very effective against opportunistic pathogenic bacteria. Looking at an allicin *in vitro* trial, it can be observed that it is stronger against pathogenic bacteria compared to other known health stimulators or even some medicines (Figure 2). The circles seen around each product in Figure 2 show the inhibition zone against the tested opportunistic pathogenic bacteria, *Escherichia coli* and *Salmonella*. Larger inhibition zones mean a stronger anti-bacterial effect against that specific pathogen. These results indicate that the use of this PFA can lead to a decreased need of adding antibiotics in aquaculture. Similar effects are observed when cinnamaldehyde is used, pointing out the anti-pathogenic power of the product combination.



Figure 2. Anti-pathogenic power of allicin compared to other anti-bacterial components.

The effect of garlic and cinnamon in shrimp

Bacterial, viral and parasitological pathogens pose serious challenges for the entire aquaculture sector. However, in shrimp, the harmful effects can be immense, since their immune system is less developed as compared to fish. Therefore, the need to derive a workable strategy to reduce the impact and increase shrimp resilience is necessary. PFAs are believed to have beneficial effects on shrimp performance and health. This was confirmed by a trial at the Kasetsart University in Bangkok, Thailand. Under the guidance of Dr Orapint Jintasatoporn, Associate Professor, Faculty of Fisheries, an experiment was conducted to evaluate the efficacy of the garlic-cinnamon (GC) blend in white leg shrimp based on growth performance and immunity, in an unchallenged situation and after a bacterial challenge with *Vibrio parahaemolyticus*.

To investigate its efficacy, 300 shrimp (2.21 ± 0.06g) were divided into 15 tanks. These tanks were randomly assigned to three dietary treatments, with five replicates per treatment. The control diet was a basal commercial diet with 1,000ppm calcium carbonate added as a placebo. The treatment diets, with low (500ppm) and high (1000ppm) content of garlic-cinnamon blend, are described in Table 2. After 8 weeks of feeding, shrimp growth performance was measured, in terms of weight gain, specific growth rate (SGR), feed intake and feed conversion ratio (FCR). Additionally, after 4 weeks of feeding, the total haemocyte count, haemolymph protein and phenoloxidase activity were measured and compared among the treatments. After 8 weeks in the feeding trial, shrimp were challenged with *V. parahaemolyticus*. After 12 hours, the immune parameters were measured again together with lysozyme activity, superoxide dismutase activity and glutathione peroxidase activity.

| | | Basal commercial diet | Calcium carbonate | Garlic-cinnamon (GC) blend Excential Alliin Plus |
|-----------------|---------|-----------------------|-------------------|---|
| Control diet | | + | 1000 ppm | - |
| Treatment diets | GC low | + | 500 ppm | 500 ppm |
| | GC high | + | - | 1000 ppm |

Table 2. Control and treatment diets for the trial on efficacy of the garlic-cinnamon (GC) blend.



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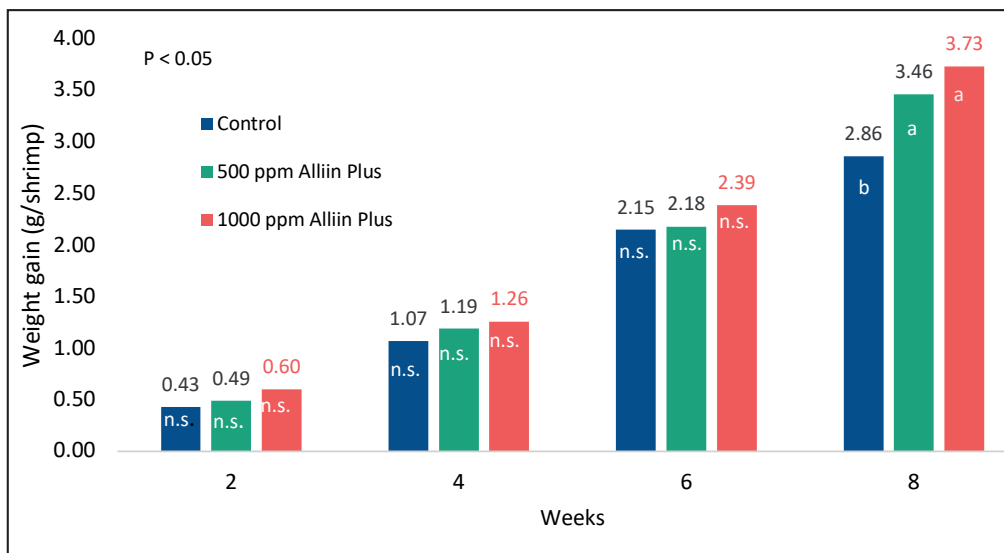


Figure 3. Weight gain of white leg shrimp fed Excential Alliin Plus at 500 or 1,000ppm.

Growth performance

Looking at the growth performance, it was observed that the PFA addition gave a significantly higher weight gain and specific growth rate regardless of the inclusion level (Figure 3). The best numerical growth was observed in treatment GC high (3.73g) compared to treatment GC low (3.46g), and both groups were significantly better than the control (2.86g). Similar results with growth performance indicators were observed. For the SGR (percentage of growth per day), it can be observed that after 8 weeks, the control group was significantly lower (1.47%/day) compared to treatments GC low (1.67%/day) and GC high (1.78%/day).

Feed intake

Amongst treatment diets, feed intake was unaffected by the inclusion of PFA, indicating that the increased growth is the result of a more efficient feed utilisation by the shrimp fed the product. This is confirmed by the FCR in treatment GC high that was 1.18, which was significantly lower than GC low (1.27) and control (1.52), after 8 weeks of feeding.

Since the nutritional value of Excential Alliin Plus is low (it is not a protein, fat nor energy source) and the inclusion levels are negligible, the increased feed efficiency is probably linked to increased health status of the shrimp. The beneficial effect of this PFA was confirmed in this trial,

where it was observed that the overall immunity status in an unchallenged situation improved, especially in GC high treatment diet (Figure 4).

Immune parameters

In particular, we observed that haemolymph protein activity, an anti-pathogenic protein, and phenoloxidase activity, a defensive enzyme, were significantly improved by the PFA addition to the feed, with 1,000ppm as optimal inclusion level (Figure 4). The improved immune status is linked to the increased growth since healthier shrimp grow better. Another interesting aspect was the difference in immune status after a challenge with *V. parahaemolyticus*. Twelve hours after the challenge, immunity parameters were analysed again (Figure 5). It can be observed that the differences in immunity status improved, and that 1,000ppm showed a strong effect especially on the phenoloxidase activity. Additionally, it was observed that shrimp fed the GC high treatment diet had a significantly higher lysozyme activity (610 unit/mL) compared to GC low (323 unit/mL) and control (227 unit/mL). Both in challenged and unchallenged situations, 1,000ppm of Excential Alliin Plus is seen to be beneficial for immune status and health of the shrimp. Accompanied by the results on shrimp growth performance, the ideal inclusion level of Excential Alliin Plus in shrimp diets is 1 kg/tonne of feed.

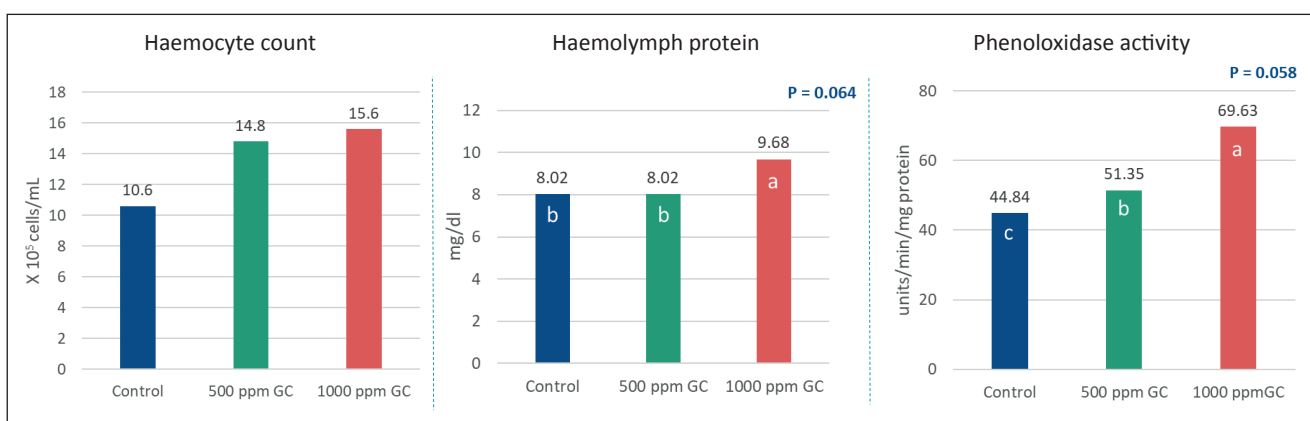


Figure 4. Immune status of shrimp fed Excential Alliin Plus at different levels.

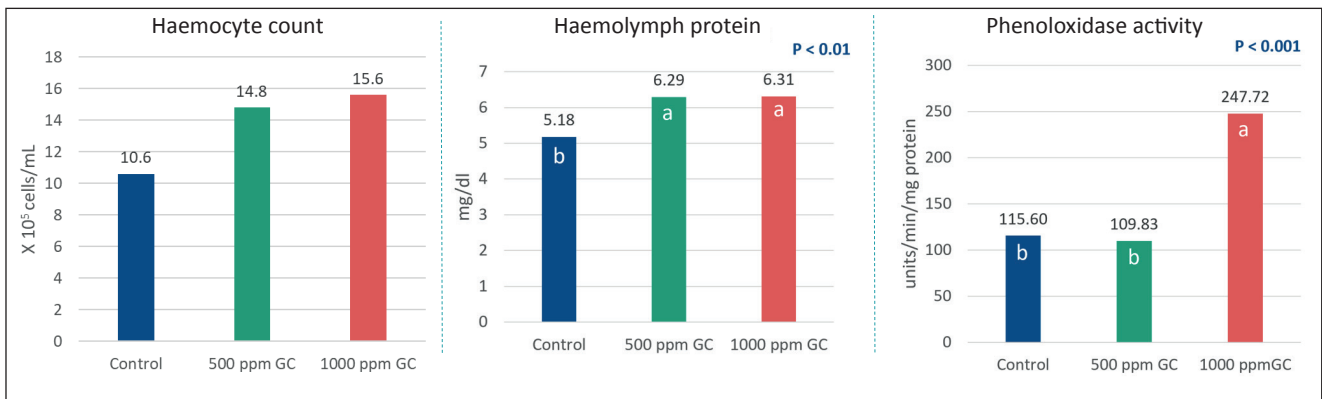
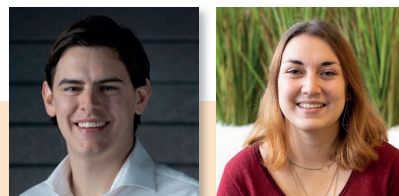


Figure 5. Immune status of shrimp fed Excential Alliin Plus at different levels after *Vibrio* challenge.

Conclusion

The use of Excential Alliin Plus in both livestock and aquaculture is already widely accepted. The experiment described in this article showed the potential of the product in shrimp, in challenged and unchallenged situations. Growth performance can be improved at an inclusion level of 500g/tonne of feed. However, higher inclusion levels have a more pronounced effect. The inclusion of 1 kg/tonne gives an even better growth performance and overall, an improved health status of shrimp. With the increasing pressure for more intensive and productive shrimp farming, the use of a phytogenic feed additive based on garlic and cinnamon might be the optimal strategy to reduce pathogenic pressure, environmental impact and antibiotic usage.



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