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Making strides in aquaculture with natural trace minerals

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Trials in China show the unique effects of a certified organic trace mineral booster on growth in juvenile tilapia. The key to the mode of action is their role in protein synthesis.

Despite the need of many aquaculture farmers to use natural products in their feed and water, finding certified organic inputs has been a challenge for shrimp and fish farmers throughout Asia. However, many in aquaculture are having success by using a natural mineral product from Utah, USA which is also widely used in Asia.

This product is called AZOMITE® which is an acronym for 'A to Z of minerals including trace elements'. This is a certified organic trace mineral booster for animal feed and pond water. The product is mined from an ancient lakebed (now dry) into which volcanic ash was deposited. The deposit typically contains over 70 trace mineral elements.

In shrimp nutrition, it is well known that because of the rapid growth, the requirement for minerals is much higher than in many other species. Thus, supplementation in the feed is common. In addition, in a typical shrimp pond, often there are insufficient amounts of the minerals in the water to meet the requirements of the animal.

Trace mineral nutrition

Today, shrimp and fish nutritionists have a good understanding of the biochemical function of essential minerals such as calcium, phosphorus, potassium, sodium, iron, copper, zinc, cobalt, selenium and magnesium. However, it is recognised that 'trace' or 'micro-minerals' play an important role in fish and shrimp biochemistry, despite science's current knowledge gaps in the field of mineral nutrition.

Essential minerals are required for multiple biological functions and inorganic or organic compounds are included in trace mineral or vitamin premixes to provide essential micro-minerals such as manganese, iodine, and sometimes molybdenum to the diet or in pond water to increase algae growth.

The list of required or beneficial trace minerals continues to grow as our knowledge of the function of minerals increases. At least 11 elements were recently added to the list of minerals recognised as essential in animal nutrition, such as boron, bromine, fluorine, lithium, nickel, silicon, tin and vanadium. The dosage for these elements is usually less than one part per million, hence, these elements have been designated by some as 'ultra-trace minerals'. There is also evidence which suggests that aluminium, rubidium and germanium are also essential, and that tungsten has an important effect in some animals.

The lanthanide series of elements – the so-called 'rare earth elements' are particularly interesting because these elements are well known in the scientific literature for several beneficial effects in animal production, including that of fish and shrimp. There is evidence in the scientific literature that rare earth elements play an important role in protein synthesis. This may be a reason why trials with this trace mineral booster show improvements in weight gain as it contains these ultra-trace mineral elements. This may also explain why recent university studies in tilapia and *Penaeus vannamei* using ultra-trace mineral elements have shown positive results.

Tilapia and trace minerals

Prof. Xiang-Jun Leng, professor of Ichthyology at Shanghai Ocean University in Shanghai (SOU), China (PRC), conducted some trials with tilapia in 2010 which shed some light on a possible mode of action for the trace minerals present in the product with improved immunity and weight gain in the tilapia. The results have been published in the peer-reviewed Chinese Journal of Animal Nutrition, May 2010 issue.

The study with the trace mineral booster in tilapia at SOU consisted of two tests using two different fish sizes. In the first, the product was added to the tilapia feed at three inclusion rates: 0.25% w/w; 0.5% w/w; and 0.75% w/w. This was compared against a control without the product. This trial was conducted over 60 days with 1.0g tilapia fingerlings. There were three replicates for each treatment. The results of the first trial are given in Figure 1.

Figure 1. Growth, FCR and survival of tilapia (initial weight 1g) in test a 1 over 60 days.

[1]Inclusion rate %	0 (Control)	0.25	0.50	0.75
Initial body weight (g)	1.0	1.0	1.0	1.0
Final body weight (g)	13.39	15.45	16.06	15.37
Weight gain %	1239.7a	1445.0b	1506.0b	1437.9b
Improvement %	0	+16.5	+21.5	+15.9
Feed Conversion Ratio (FCR)	1.55a	1.38b	1.33b	1.35b
Survival rate	99.5	100	100	99.5

Data within rows with the same letters are not significantly different at (P<0.05)
[1]AZOMITE® www.azomite.com or www.azomiteinternational.com

The highest weight gain was shown by fish in the 0.5% inclusion group but this was not significantly different from the other two treatments. FCR was significantly lower as compared to that in the control. The best performance was in the treatment with the 0.5% inclusion which showed a 16.5% improvement in FCR from 1.55 (control) to 1.33.

The second test was conducted with 20g tilapia with the same inclusion rates as the first test with three replicates per treatment and 20 fish per replicate over a 35 day period. Figure 2 shows the results of this test.

Figure 2. Growth, FCR and survival of tilapia (initial weight 20g) in test 2 over 25 days.

Inclusion rate %	0	0.25	0.50	0.75
Initial body weight (g)	20.1	20.0	20.1	20.0
Final body weight (g)	37.9	40.4	40.1	40.1
Weight gain %	88.5a	102.0.0b	99.2b	100.7b
Improvement %	0	+15.3	+12.1	+13.8
Feed Conversion Ratio (FCR)	1.50a	1.27b	1.33b	1.29b
Survival rate	100	100	100	100

Data within rows with the same letters are not significantly different at (P<0.05)

The results with 20g tilapia also produced statistically significant improvements over the control. However, at the lowest inclusion rate in the feed (0.25%), weight gain improved over that of the control by 15.3% and FCR was low from 1.50 (control) to 1.27 (treatment with 0.25%). It must be noted that while the addition of the trace mineral booster improved weight gain and FCR as compared to the control,

there were no significant differences for all parameters at the three inclusion rates.

A possible mode of action of AZOMITE® was clear after Prof. Leng tested the digestive enzymes in the stomach and small intestine of the tilapia. He found an increase in a few of the key enzymes needed by the fish for protein digestion. The pepsin and pancreatic protease in both tests yielded significant improvements as shown in Figure 3.

Figure 3. Data on pepsin and pancreatic protease in digestive enzymes.

Inclusion rate %	0	0.25	0.50	0.75
Pepsin	2943.9a	3764.6b	3715.6b	3135.8a
Pancreatic protease	779.8a	1119.9b	975.9b	945.5b
Data within rows with the same letters are not significantly different at (P<0.05)				

It is well known that the synthesis of enzymes requires a wide range of trace minerals for optimisation. Presumably, this is the cause of the increase in the important digestive enzymes of the tested tilapia. Prof. Leng's test revealed that this increase in enzymes also resulted in an increase in dry matter utilisation and crude protein digestibility (Figure 4).

Figure 4. Dry matter utilisation and crude protein digestibility.

Inclusion rate %	0	0.25	0.50	0.75
Dry matter digestibility	52.26a	57.83c	56.27bc	56.09b
Crude protein digestibility	73.19a	74.49b	74.47b	74.29ab
Data within rows with the same letters are not significantly different at (P<0.05)				

These results are some of the evidence that the trace minerals present in the product are required by the animals for optimum enzyme synthesis. The key digestive enzymes in the gut are boosted, allowing the animal to digest the feed more completely, lowering FCR and increasing weight gain.

Trace minerals and white shrimp

In addition to the tilapia test, SOU is conducting tests with *P. vannamei* shrimp. The preliminary results, as in tilapia, have shown an improvement in weight gain and livability, including a boost in the enzyme lysozyme in the shrimp. Lysozyme degrades the cell walls of pathogenic bacteria in order to kill them. An increase of this important enzyme in the presence of the natural mineral booster is an indication that the immune system is healthier than in control animals, and is an indication this may improve shrimp immunity against a wide variety of bacterial pathogens.

Natural productivity

Aside from dietary inclusion in aqua feed, the product is used widely in *P. vannamei* and *P. monodon* culture to stimulate algae growth in pond water. Typically, farmers add this into the water on a weekly basis and/or to treat the soil in the pond bottom between culture cycles. This has proven to be effective in maintaining quality phytoplankton and zooplankton population as well as keeping blooms stable during the grow-out period. This may also be important for shrimp because they can absorb minerals directly from the water. In many countries where salinity is low or even zero, shrimp farmers struggle with the problem of 'soft' or 'loose' shells in farmed shrimp. Testimonials from these farmers indicate that the use of the trace mineral booster has significantly reduced the soft shell problem, a further indication that the minerals are being absorbed by the animals.

Trace minerals required by shrimp and fish are similar to most animals. In fact, an ash analysis of a shrimp, fish, chicken or any other terrestrial and aquatic species commonly reveals the presence over 60 trace minerals. The animal's biochemistry may be using these elements in thousands of ways – both known and unknown. Supplementing aqua feed and pond water with AZOMITE® is an important way to provide these trace minerals to fish and shrimp

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