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The nutritional & immune impact of Azomite in Tilapia and Shrimp

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Azomite® is the trade name for a naturally occurring mineral product that has been used to supplement livestock and aquatic diets throughout the world for over a decade.

During this time, a significant amount of data has been accumulated from the use of the product in farm trials, university tests and private research organisations. At this point, it is clear that azomite improves the quality of animal feed and this leads to improvements in performance, but a solid understanding of the exact mode of action remains illusive.

The name is an acronym for 'A to Z of minerals including trace elements'.

It is mined from a deposit rich in trace minerals in the central part of the state of Utah in the United States. Millions of years ago this region was part of a freshwater lake and the azomite site was formed when a volcano spewed millions of tons of ash into that lake.

Today, the deposit exists as several large hills and the site provides the source of the natural inorganic mineral, which typically contains approximately 70 trace elements. The chemical composition reflects both the volcanic and freshwater sources (www.azomite.com).

The material is listed in the US Code of Federal Regulations (21 CFR 582.2729) as an anticaking agent for livestock feed and is generally recognised as safe (GRAS) by the US Food and Drug Administration (FDA).

Agriculture and livestock producers have used azomite to improve feed quality and as everyone knows improving feed quality leads to better livestock health and plant nutrition. Azomite falls well within the guidelines for use in animal feed by the Association of American Feed Control Officials (AAFCO).

Hundreds of years ago it was used by the local native people in agriculture. This eventually led European settlers to explore the natives' use of it for their animals and gardens. In modern times, an entrepreneur named Rollin Anderson mined the product in the 1940s and gave samples to friends, some of whom were skilled at testing agricultural products. Mr Anderson's activity paved the way for azomite's use in sizeable international animal and agriculture markets.

Poultry, shrimp and tilapia farmers have used it in their feed in conjunction with their regular trace mineral mix for many years and claim that it boosts the quality of their feed and leads to improvements in weight gain, feed conversion and livability. Examples of the impact that the product has on live performance in tilapia and shrimp (Burapa and Shanghai Ocean Universities, respectively) are shown here. This research has shown improvement in weight gain and feed conversion of up to 10 percent in multiple scientific tests.

Improved availability

Trace minerals are essential in animal diets because they participate in biochemical processes required for normal growth and development.

However, examination of azomite and its typical amount of 70 elements reveals that there are not enough of the essential trace and 'ultra trace' elements to be the sole mineral source for the proper nutritional development of animals and plants (Hooge, 2008).

Moreover, perhaps no more than one percent of this inorganic product is soluble in water (Ba, B, Ce, Co, Cr, Ln, & Zn are sparingly soluble, Larsen 1990s), and X-ray diffraction analysis reveals that the product exhibits <18 percent physical structure (due to a small amount of granite and pseudo granite in the product) and the remainder of the product is amorphous, without discernible physical structure.

Perhaps this lack of physical structure improves the availability, but that has not yet been tested.

Although the product is an HSCAS (Hydrated Sodium Calcium Alumina Silicate) the lack of physical structure makes it an atypical HSCAS.

When the materials was introduced to the meat industry, researchers already knew that natural inorganic minerals in use at that time were poorly absorbed and did not fully satisfy an animal's nutritional needs.

Efforts to increase the absorption and metabolism of six or seven of the well-known trace minerals are still underway, but efforts have already provided metal chelates that exhibit much improved bioavailability due to unique chemical characteristics (AAFCO, 1997). The use of natural inorganic minerals in animal diets has decreased because they typically provide <25 p[ercent of the minerals needed by animals.

Significant improvement

Azomite does not appear to fit the generalisations about inorganic minerals.

Two decades of animal scientific testing of the product for weight gain, feed conversion and livability improvements revealed that >85 percent of the tests yielded significant ($p < 0.05$) improvements.

In these tests, all feeds contained the regular commercial trace minerals to which azomite was added. These successes raise a question: with a trace mineral content that is low and practically insoluble in water, what

Table 1:

AZOMITE® %	1st Deaths (O2)	50% Death (O2)	100% Death (O2)
0 %	4th Hr (1.2 mg/L)	11th Hr (0.05 mg/L)	14th Hr (0.03 mg/L)
0.8%	" "	" "	" "
0.2%	5th Hr. (0.6 mg/L)	14th Hr. (0.03 mg/L)	16th Hr. (0.025mg/L)
0.6%	" "	" "	" "
0.4%	>5th Hr. (<0.6 mg/L)	14th Hr. (<0.03 mg/L)	17th Hr. (0.02 g/L)

could explain these benefits? That question leads to a multitude of hypothetical explanations, but we tested two simple hypotheses:

1) that azomite inclusion in feed leads to improvements in animals because digestive enzymes are boosted and;

2) improved livability is due to increases in innate immune enzymes (Liu et al. 2009) and (Fodge et al. 2011).

A few other supportive tests were also conducted.

Studies in feed

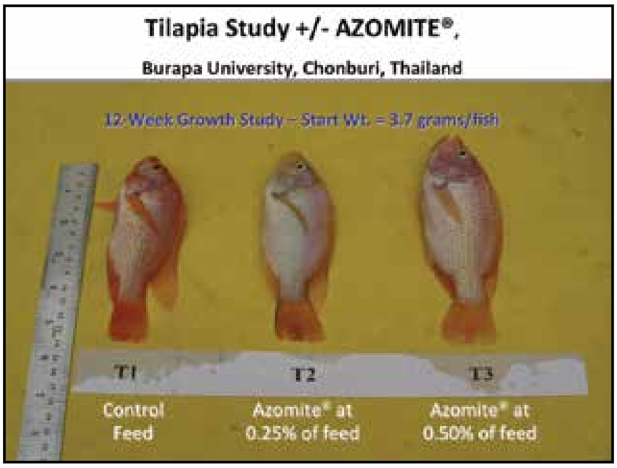
Researchers added test amount of azomite to standard tilapia and shrimp rations.

An equal amount of flour was replaced in the experimental diets by the azomite, and the diets were not isocaloric. Three or four replications per test group were used in the tests. Dissolved oxygen, pH, temperature, etc. were maintained as close to normal as possible. Enzyme activities were measured using standard test materials available commercially.

In addition to the measurements of enzyme activities, investigators also measured weight gain, livability and feed conversion (FCR) and although not shown, weight gain boosts were @15%, FCR improvements @10% and livability was better in the presence of the material.

As is clear from the study on digestive enzymes shown below, 0.2% to 0.5% azomite boosted the activity of 4/5 of the proteolytic enzyme activities that were measured and also increased lipase activity in the shrimp. Some enzyme activities were increased as much as 30-40%, and this result helps explain why one obtains weight and FCR improvements.

Although not shown, dry matter and crude protein digestibility were assayed in the tilapia and both were improved ($p < 0.05$) 9.9% and 1.75%, respectively.



Enzymes of tilapia and shrimp innate immune systems were examined next, and the table below shows the results.

azomite in the feed boosted tissue concentrations of lysozyme (+ @40%), superoxide dismutase (+ @15%), phenoloxidase (+ >90%) and alkaline phosphatase (+25%). The increases in both digestive and immune enzymes may be a hint that the explanation for the mechanism is quite complex.

To illustrate the potential complexity, azomite's contribution of individual trace minerals to feed would contribute @0.1 to 1.0mg/kg to the feed of aquatic animals that require several trace minerals at the level of many mg/kg of each.

To add to the potential complexity of the mechanism, anecdotal reports indicate that less diseased pepper, tomato and grapes occur in the presence of azomite than in it's absence. It is known that plants depend on an innate immune system that somewhat resembles that of invertebrates (Jones and Dang, 2006). Could it be that something more than simple availability or ratio of trace mineral X to Y would be required to explain azomite's mechanism?

Although the mechanism for induction of such large amounts of enzymes may elude us at this time, shrimp and fish are subjected to more challenges by pathogens and opportunistic pathogens than other commercial animals, and it is interesting that feeding animals a small amount of asomite appears to more adequately equip them to meet such challenges.

To establish that an increase in immune enzymes was not an artifact, the researchers challenged shrimp with Vibrio alginolyticus and measured the accumulated mortality four days after infection.

Only 13.5% of the shrimp that did not receive any AZOMITE® in their diets were alive after four days, but @ 43.5% of those with @ 0.4% azomite in their feed were still alive.

The aquaculture research and development teams did not measure antibody synthesis +/- azomite, but poultry researchers have, as the test result below indicates.

There were four test groups with eight baby chicks per test group.

Feed for each group received 0.5% of sand or calcium bentonite or sodium bentonite or azomite, all of which were similar particle size. At 16 days, each chick was injected with sheep red blood cells (SRBC) and six days later blood samples were taken from each bird to measure total antibody and IgG activities/ml specific toward SRBC.

As is clear, the antibody level in blood from the birds eating azomite contained @66% more antibody activity than any of the other groups ($p < 0.05$).

Next, the aquaculture researchers wanted to determine if azomite-treated feed would help shrimp survive hypoxia. They subjected shrimp that had consumed azomite in the feed to gradual oxygen deprivation (see below).

The group with 0.4% azomite in the feed withstood hypoxia the best, but in our opinion more rigorous testing is needed to confirm this result.

Nonetheless, lack of dissolved oxygen for shrimp and fish has a profound impact due to the extreme growth densities of commercial animals. Invertebrates depend on hemocytes to phagocytize pathogens identified by innate immune receptors. Movement of hemocytes to sites of invasion and the total number of hemocytes produced under low oxygen tensions would be stressed if animals depend on anaerobic energy metabolism (Direkbusarakom and Danayadol, 1998 and Le Moullac et al., 1998).

Studies when added to shrimp pond soils

Shrimp farms have tested azomite by fertilizing the soil of the ponds between grow-out periods. Pond soils are treated with @200kg/ha. Live performance, mortality, pH, phytoplankton and zooplankton and dissolved oxygen levels are measured.

In one thorough field study (six matched ponds – three were control and three were test ponds), an average of 17% increased weight and 30% less mortality were observed in the azomite ponds.

Moreover, both zooplankton and phytoplankton levels were boosted 800-900%. pH values taken in the morning and at noon were numerically slightly higher in the test group than the control, but dissolved oxygen in the test group was increased @30% in the morning and was still 8% better at noon than the control values.

Currently, asomite is added to the pond soil between grow-outs at shrimp farms, especially extensive farms, in several countries.

For years it has been known that it is necessary to have the correct forms of trace minerals available for animals and to provide those trace minerals in the correct proportions - an observation that is perhaps as important as the presence of a 100% available metal-chelated mineral.

Little research is underway that explores the ratios of ultra trace minerals to each other as 'university personnel' who might be able to provide answers are faced with limited available funding for such exploratory research.

Our conclusion is that the proportions of trace minerals should receive higher priority in future research.

Conclusion

Azomite appears to enhance tissue protein synthesis (perhaps even beyond simply digestive and innate immune enzymes) leading to improvements in weight gain, feed conversion ratio and lean yield in aquatic species.

Moreover, the product improves the survival rate, apparently due to its ability to boost the immune enzyme response and perhaps also increase mucosal and shell strength.

It is clear to us that azomite provides some trace minerals that are important in animal nutrition. It will be satisfying to determine the exact nature of those minerals that are not currently being added in most animal diets.

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