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Quick, hydrated limes impractical for controlling vibriosis in shrimp ponds

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Use can be harmful to workers and cause stress to shrimp during an outbreak

Shrimp farmers in Latin America commonly use hydrated lime at rates of 75-100 kg/ha to manage outbreaks of pathogenic Vibrio species with uncertain results. Eventually, many have to use probiotics or antibiotics to control the vibriosis.

Although the application of lime has proven to be beneficial in controlling shrimp diseases like Taura syndrome and white spot syndrome by keeping optimum alkalinity levels, trials conducted at the Fisheries Engineering Faculty of Tumbes University in Peru showed that using lime for controlling vibriosis can be im-practical.

This is based on the minimum inhibitory concentrations (MICs) found for hydrated and quick lime against pathogenic strains of *Vibrio parahaemolyticus* and *V. alginolyticus*. For instance, it would require applications of 4,000 kg/ha hydrated lime to control *V. alginolyticus* and 9,000 kg/ha for *V. parahaemolyticus*. If applied at such high concentrations, the lime would cause drastic pH changes in pond water and stress the affected shrimp.

Inhibitory concentrations

Research was done to determine the minimum inhibitory concentrations of calcium oxide quick lime and calcium hydroxide hydrated lime against pathogenic strains of *Vibrio parahaemolyticus* and *V. alginolyticus* identified in a shrimp farm next to the Tumbes University campus and isolated in agar.

Both types of lime were tested at a pure bacterial concentration of 5 x 10^3 colony-forming units (CFUs) per mL for an incubation period of 24 hours at 28 degrees-C. Using an adaptation of the standard methods described by the U.S. National Committee for Clinical Laboratory Standards, researchers found MIC values of 30 ppm for calcium oxide use against both *V. parahaemolyticus* and *V. alginolyticus*, 900 ppm for calcium hydroxide treatment of *V. parahaemolyticus* and 400 ppm for control of *V. alginolyticus* with calcium hydroxide.

Trials were conducted in two phases: an exploratory phase using a wide range of concentrations for both types of lime and a final phase in which more accurate values were obtained (Tables 1-4).

Portal, Inhibitory effects of calcium oxide, Table 1

Calcium Oxide Concentration	Replicate 1	Replicate 2	Replicate 3	Replicate 4	Replicate 5	Rate of Effectiveness
100 ppm	+	+	+	+	+	100%
90 ppm	+	+	+	+	+	100%
80 ppm	+	+	+	+	+	100%
70 ppm	+	+	+	+	+	100%
60 ppm	+	+	+	+	+	100%
50 ppm	+	+	+	+	+	100%
40 ppm	+	+	+	+	+	100%
30 ppm	+	+	+	+	+	100%
20 ppm	+	+	–	–	–	40%
10 ppm	–	–	–	–	–	0%
0 ppm	–	–	–	–	–	0%

+ = positive inhibitory effect, – = negative inhibitory effect

Table 1. Inhibitory effects of calcium oxide against a pathogenic strain of *Vibrio parahaemolyticus*.

Portal, Inhibitory effects of calcium oxide, Table 2

Calcium Oxide Concentration	Replicate 1	Replicate 2	Replicate 3	Replicate 4	Replicate 5	Rate of Effectiveness
100 ppm	+	+	+	+	+	100%
90 ppm	+	+	+	+	+	100%
80 ppm	+	+	+	+	+	100%
70 ppm	+	+	+	+	+	100%
60 ppm	+	+	+	+	+	100%
50 ppm	+	+	+	+	+	100%
40 ppm	+	+	+	+	+	100%
30 ppm	+	+	+	+	+	100%
20 ppm	+	–	–	–	–	20%
10 ppm	–	–	–	–	–	0%
0 ppm	–	–	–	–	–	0%

+ = positive inhibitory effect, – = negative inhibitory effect

Table 2. Inhibitory effects of calcium oxide against a pathogenic strain of *Vibrio alginolyticus*.

Portal, Inhibitory effects of calcium hydroxide, Table 3

Calcium Hydroxide Concentration	Replicate 1	Replicate 2	Replicate 3	Replicate 4	Replicate 5	Rate of Effectiveness
1 ppt	+	+	+	+	+	100%
900 ppm	+	+	+	+	+	100%
800 ppm	+	–	–	+	–	40%
700 ppm	–	–	–	–	–	0%
600 ppm	–	–	–	–	–	0%
500 ppm	–	–	–	–	–	0%
400 ppm	–	–	–	–	–	0%
300 ppm	–	–	–	–	–	0%

200 ppm	–	–	–	–	–	0%
100 ppm	–	–	–	–	–	0%
0 ppm	–	–	–	–	–	0%

+ = positive inhibitory effect, – = negative inhibitory effect

Table 3. Inhibitory effects of calcium hydroxide against a pathogenic strain of *Vibrio parahaemolyticus*.

Portal, Inhibitory effects of calcium hydroxide, Table 4

Calcium Hydroxide Concentration	Replicate 1	Replicate 2	Replicate 3	Replicate 4	Replicate 5	Rate of Effectiveness
1 ppt	+	+	+	+	+	100%
900 ppm	+	+	+	+	+	100%
800 ppm	+	+	+	+	+	100%
700 ppm	+	+	+	+	+	100%
600 ppm	+	+	+	+	+	100%
500 ppm	+	+	+	+	+	100%
400 ppm	+	+	+	+	+	100%
300 ppm	–	–	–	–	–	0%
200 ppm	–	–	–	–	–	0%
100 ppm	–	–	–	–	–	0%
0 ppm	–	–	–	–	–	0%

+ = positive inhibitory effect, – = negative inhibitory effect

Table 4. Inhibitory effects of calcium hydroxide against a pathogenic strain of *Vibrio alginolyticus*.

Both quick and hydrated limes used at their MICs showed inhibitory effects that worked through a sudden pH increase of the medium. The inhibitory effects occurred at pH levels above 9.5 for quick lime and over 9.0 for hydrated lime. When these MIC values for both types of lime were applied in pond water, it was found that the action of quick lime lasted for 10 minutes, and the action of hydrated lime lasted for 15 minutes.

Vibriosis management?

Some Latin-American shrimp farmers have reported beneficial results in the use of hydrated lime against pathogenic *Vibrio* attacks at concentrations of 75-100 kg/ha based on the "disinfectant power" of such concentrations. However, the authors have visited many shrimp farms in Latin America that have had uncertain results with the application of these liming rates. Farmers who limed at 75-100 kg/ha eventually had to use other methods, such as the application of probiotics or antibiotics in feed, to overcome *Vibrio* outbreaks.

Also in this study, quick and hydrated limes were applied at 75 kg/ha to tanks containing pond water with the pathogenic *Vibrio* strains tested for MICs. Results showed the applications were not successful in controlling the bacterial populations, even under optimal water parameters (Table 5).

Portal, Pond water parameters, Table 5

Pond Water Parameter	Before Lime Application	One Hour After Application Control	One Hour After Application Calcium Oxide	One Hour After Application Calcium Hydroxide
pH	8.5	8.6	9.8	9.5
Temperature (° C)	30	30.5	30.6	30.5
Dissolved oxygen (mg/L)	5.5	5.4	5.4	5.6
Total alkalinity (ppm)	158	153	159	162
Total hardness (ppm)	3,560	3,550	3,540	3,550

Table 5. Pond water parameters taken before and one hour after the application of quick and hydrated limes.

Perspectives

Although this study found that a smaller amount (300 kg/ha) of quick lime was required for inhibiting *Vibrio* species than the 4,000 and 9,000 kg/ha of hydrated lime needed, the use of quick lime is not recommended because it can be harmful to workers who apply it. The sudden rise in water pH quick lime generates can also cause stress to shrimp during a *Vibrio* outbreak.

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