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Responsibility

Shrimp production systems with low/no water exchange

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Nutritional strategies for phosphorus management

Since excess phosphorus in pond effluents can cause pollution, its use in aquaculture feeds should be carefully controlled.

Shrimp have the ability to assimilate minerals directly from the aquatic environment. However, phosphorus is supplied in feed because its concentration in water is usually very low. In shrimp, phosphorus plays an important metabolic role and also serves as a pH regulator of intracellular and extracellular fluids. Structurally, phosphorus is mainly found associated with calcium in the exoskeleton.

Minimizing phosphorus in effluents

Phosphorus in effluent discharge waters from shrimp farms has been identified as a polluting agent to the environment. In addition, phosphorus build-up in the culture system can be detrimental, because it may favor the growth of unwanted algae and cyanobacteria.

Feeds are the vehicle for exogenous phosphorus in production systems. Thus, efforts should be directed to optimize dietary phosphorus levels and minimize phosphorus loading in the culture system, without inhibiting the survival and growth of shrimp.

Trial at Texas A&M

A 21-day experimental trial was conducted at the Shrimp Mariculture Research facility at Texas A&M University in Port Aransas, Texas, USA to test three dietary phosphorus levels (0.4, 0.8, and 1.2 percent with NaH2PO4 as the inorganic source of phosphorus), and three phosphate salts (NaH2PO4, Na2HPO4 and CaHPO4) at a dietary level of 0.8 percent.

Postlarval (PL) Litopenaeus vannamei shrimp of 0.9 mg mean initial weight were stocked at a density of 1.5 PL per liter in an indoor system with constant aeration and no water exchange. Water temperature was maintained at 27 to 29 degrees-C, and salinity was maintained at 23 to 25 ppt.

Total reactive phosphorus was measured at the end of the trial. Data obtained from this completely randomized design with seven replicates per treatment were statistically analyzed to determine significant differences among treatment means.

Survival and growth

PL survival was over 81 percent for all treatments. Growth of postlarvae fed diets with different phosphorus levels was not significantly different (Fig. 1).

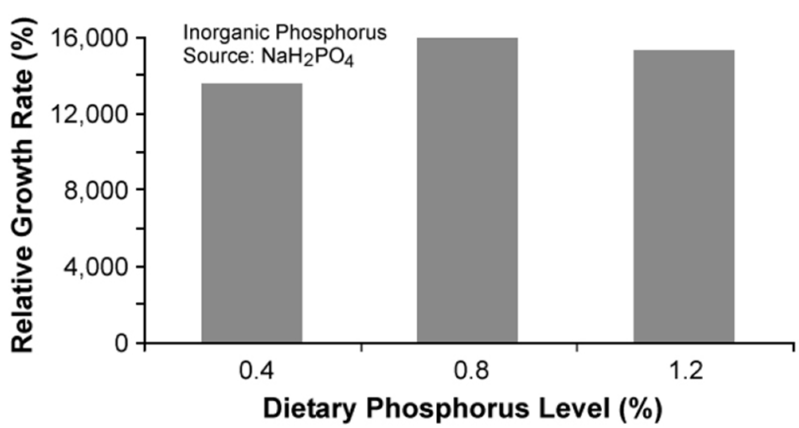

Fig. 1: Effect of phosphorus level on shrimp growth.

Total reactive phosphorus accumulation

However, total reactive phosphorus accumulation in the water significantly increased with higher phosphorus levels (Fig. 2). Again, PL growth was consistent, regardless of phosphate salt used in the diet (Fig. 3). But phosphorus accumulation was significantly lower with the diet supplemented with CaHPO4 compared to the diets containing dibasic or monobasic forms of sodium phosphate (Fig. 4).

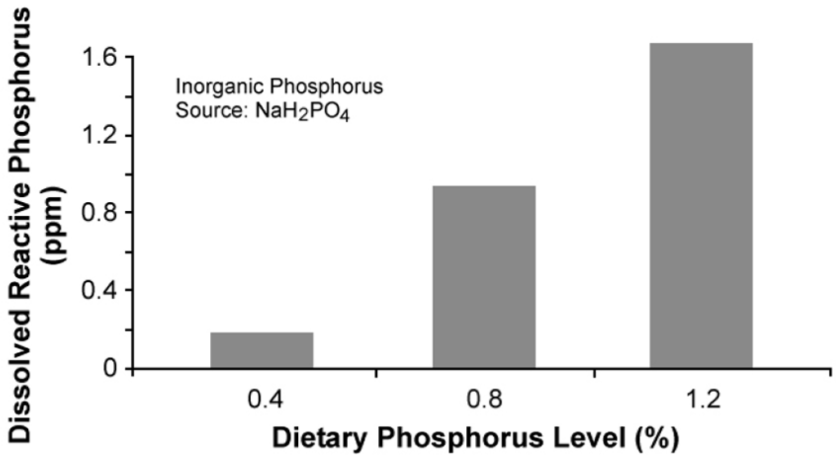

Fig. 2: Dissolved reactive phosphorus build-up.

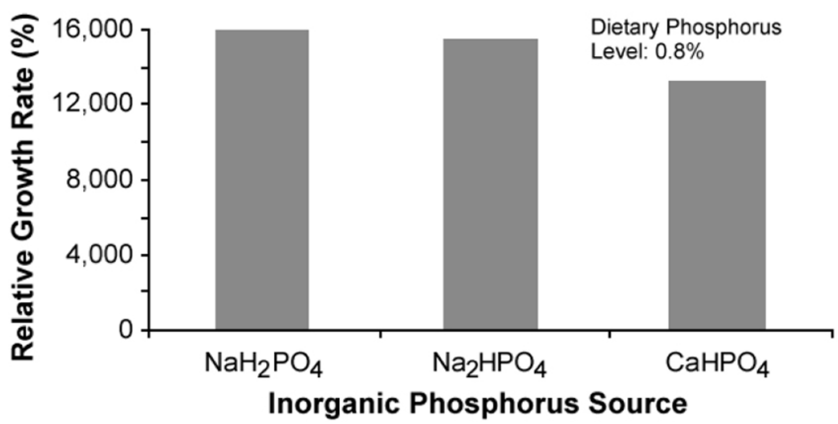

Fig. 3: Phosphorus source effect on growth.

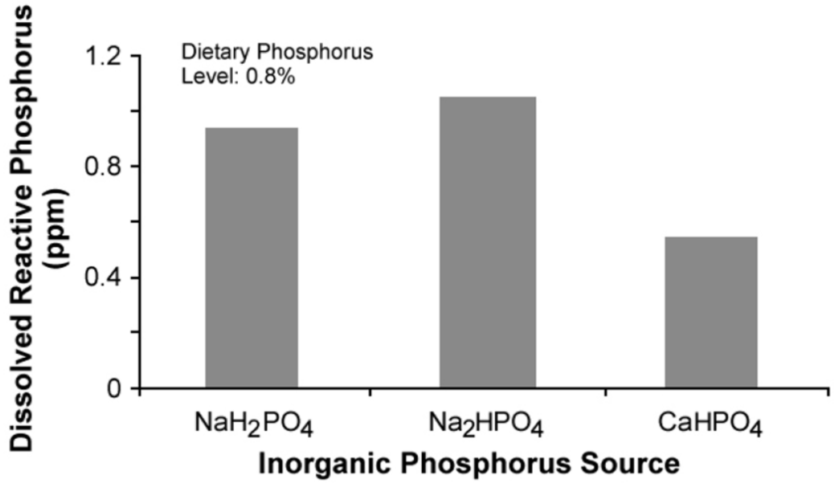

Fig. 4: Dissolved reactive phosphorus build-up.

FCR

Feed-conversion ratios ranged 1.1-0.9.

Nitrogen

Mean concentrations of total ammonia-nitrogen and nitrite-nitrogen were 0.25 (pH = 7.9) and 2.1 milligram per liter, respectively.

Phosphorus

Mass balance analysis of phosphorus (Table 1) indicated that as the dietary phosphorus level decreased, percent phosphorus retention in shrimp tissue increased. Consequently, less phosphorus ended up in the water.

Velasco, Mass balance analysis of phosphorus, Table 1

Phosphorus Source	Dietary Level (%)	Feed (mg P)	PL (mg P)	Net P Retention (%)
$CaHPO_4$	0.8	26.4	9.4	35.3
$Na2HPO_4$	0.8	26.4	11.4	42.9
$NaH2PO_4$	0.8	26.4	11.3	42.5
$NaH2PO_4$	0.4	14.1	9.3	65.1
$NaH2PO_4$	1.2	38.6	11.0	28.3

Table 1. Mass balance analysis of phosphorus.

Conclusion

Results from this research in a culture system without water exchange indicated that biological performance of postlarvae was similar regardless of varied dietary phosphorus level or inorganic phosphorus source. However, these factors greatly influenced total reactive phosphorus accumulation in the water.

Thus, careful consideration should be given to phosphorus levels and phosphorus sources when formulating aquatic feeds. These should be selected in terms of shrimp biological performance, cost, availability and environmental impact on the culture water.

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