A field trial study of AQUA-Cal+ on shrimp in earthen ponds

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Introduction

Shrimp farming has become a crucial part of aquaculture in many locations, considerably contributing to global seafood output and economic growth (B et al., 2022; Páez-Osuna, 2001). Shrimp farmers, on the other hand, frequently confront various obstacles in maintaining ideal circumstances for shrimp development, health, and survival (Jamal et al., 2019).

The quality of the aquaculture water in which shrimp are grown is a critical aspect that considerably impacts their output(Páez-Osuna, 2001).Water quality becomes undesirable when farmers opt for overstocking, overfeeding, and usingpolluted water. Poor water quality promotes ailments, mortality, poor growth, and low shrimp yield(Venkateswarlu et al., 2019).Another activity connected with environmental degradation in receiving waters is the discharge of pond water effluent(Venkateswarlu et al., 2019).Temperature, dissolved oxygen, pH, salinity, and nutrient levels, among other water quality characteristics, must be carefully regulated to provide an atmosphere suitable for practical shrimp farming. Alkalinity measures a water's ability to resist changes in pH, which is critical for aquatic organisms to maintain a stable environment. Managing alkalinity levels, however, can be difficult, especially in closed systems, where natural buffering systems are limited.

Earthen ponds are frequently employed in Indian shrimp farming because of their low cost and ease of building(Saraswathy et al., 2022). Bottled soil silt's composition greatly influences pond water's physical and chemical properties. Bottom soil sediment delivers both nourishment and shelter to shrimp in culture pond environments, as well as acting as a nutrient reservoir for the growth of microalgae, which are natural food for aquatic animals(Boyd & Green, 2002; Boyd & Tucker, 2012; Venkateswarlu et al., 2019). However, these ponds bring intrinsic water quality management difficulties, such as changes in pH, dissolved oxygen levels, and nutrient dynamics(Venkateswarlu et al., 2019). As a result, there is an increasing demand for practical solutions that may optimize water quality parameters in earthen ponds and increase shrimp farm productivity.

In recent years, the aquaculture industry has witnessed the emergence of various innovative products and approaches aimed at improving shrimp farm productivity. One such product is AQUA-Cal+, a mineral supplement for enhancing shrimp growth, survival, and overall pond water quality. AQUA-Cal+ is designed to address the unique challenges shrimp farmers face, particularly those cultivating shrimp in earthen ponds. AQUA-Cal+ is a product intended to maintain alkalinity levels in aquatic systems. AQUA-Cal+ offers versatility as it comes in different forms, such as powder, granules, and tablets, allowing aqua farmers to choose the most convenient application method.

It is user-friendly, as it dissolves rapidly, making it an ideal choice for aqua farmers seeking simplicity and efficiency in their operations. The product assists in pH stabilization, avoiding drastic shifts that can harm fish and other aquatic creatures. AQUA-Cal+ also promotes aquatic plant growth and development by supplying vital nutrients such as calcium and carbonate ions. Furthermore, the product aids in the reduction of harmful toxins such as ammonia and nitrite, which can be fatal to fish and other aquatic organisms.

A small shrimp farm in the West Godavari district of Andhra Pradesh, India, has encountered various difficulties. The farm has been dealing with unexpected fluctuations in magnesium, calcium, and alkalinity levels and an increased presence of bacteria. It has been further compounded by frequent sludge drainage, leading to a decline in the overall quality of the shrimp produced. A trial experiment was conducted in this shrimp pond, comparing a control pond that followed regular practices instead of dosing AQUA-Cal+ in other ponds. The water quality and shrimp yield in the two ponds were compared in this field study.

This article serves as a comprehensive introduction to the field trial study, setting the stage for the subsequent sections that delve into the methodology, results, and discussion surrounding the effectiveness of AQUA-Cal+ on shrimp in earthen ponds.

2. Methodology

2.1 Trial Settings

West Godavari district in Andhra Pradesh state, India was the Trial Location (Fig 1). The trial farm consists of 10 active ponds, each constructed using earthen materials. On average, these ponds cover an area of half a hectare and have a depth of one meter. To optimize space, the farm typically stocks 25 shrimp per square meter. It takes approximately 10-12 weeks for these shrimp to reach the desired size for harvesting. For the trail, ponds were named Control Pond, which does not receive AQUA-Cal+ treatment and AQUA-Cal+ pond,which received proper AQUA-Cal+ treatment. The stocking density and pond details of the trial ponds are given in the Table. 1. Dosing of AQUA-Cal+ pretreatment was four ppm, and it is suggested to dose 40 kg/pond till the 9th week of culture and 50 kg/pond from the 10th week to harvest (Table. 2).

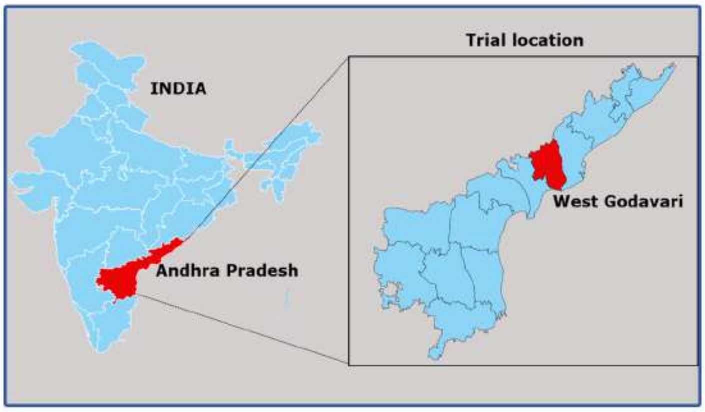

Fig. 1. Map of West Godavari district located in Andhra Pradesh state.

Pond	Size	PL age (days)	Stocking density (per m2)	Number of shrimp stocked	Duration of trail (days)
Control	0.64 HA	60	28	180000	30
AQUA-Cal+	0.8 HA	60	25	200000	30

Table 1. Earther ponddetails of the trail

Pond	Pre-treatment rate (ppm)	Pre-treatment rate (kg)
Control	0	-
AQUA-Cal+	4	40/week until 9th week, 50/week until harvest

Table 2. AQUA-Cal+ dosing details of the trail

2.2 Water quality parameter analysis

Water from each pond was sampled at the subsurface (0.3 m depth) by a water sampler. Samples were always taken in the morning (0600 to 0800) to minimize errors. Using commercially available kits, physical and chemical parameters of pond water, such as alkalinity, hardness, and ammonia levels, were measured by titration method as previously stated (APHA, 1992). Total vibrio was counted in Thiosulfate-Citrate-Bile salts-Sucrose (TCBS) culture medium. Parameters in this field trial study were analyzed at Angel Aqua Clinic, Bhimavaram, following standard methods described by American Public Health Association (APHA), American Water Works Association (AWWA), Water Environment Federation (WEF) (APHA et al., 1998).

3. Results and Discussion

NH_3

3.1 AQUA-Cal+ lowers alkalinity level

Alkalinity is critical in shrimp farming because it affects the molting process. When alkalinity levels are low, pH levels fluctuate significantly, hampering shrimp growth and possibly resulting in mortality. Excessive alkalinity, conversely, can interrupt the molting process by causing the shrimp to lose excess salt (Boyd et al., 2016). The AQUA-Cal+ procedure easily controls the alkalinity of the pond. AQUA-Cal+ stabilizes the alkalinity throughout the culture period and significantly reduces the alkalinity level by 10.4 % compared to the control pond (Fig 2). Increased alkalinity in untreated ponds might have resulted in undesirable pH and decreased the molting process.

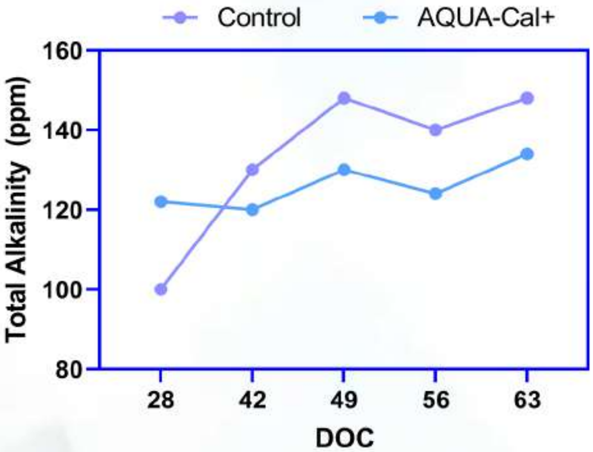

Fig. 2. Total Alkalinity in ppm of control and AQUA -Cal+ treated ponds. Alkalinity was more stable in the AQUA-Cal+ pond than in the control pond.

3.2 AQUA-Cal+ suppresses ammonia level

Ammonia is the primary byproduct of the breakdown of proteins in crustaceans, accounting for 40% to 90% of nitrogen excretion(Parry, 1960). The total ammonia level of the control pond is unstable throughout the culture period. AQUA-Cal+ treated pond showed a 16% reduction in ammonia level at the end of the culture period (Fig 3). Shrimp farmers take extra pond care to reduce ammonia levels in their ponds. As ammonia is excreted extensively by shrimps due to their metabolism, overstocked pond tends to have higher ammonia levels. Unionized ammonia (NH_3) is hazardous to shrimps due to its capacity to pass through cell membranes and cause undesirable effectson shrimps.

The amount of NH_3 greatly depends on pH and temperature, fluctuation in pH may directly raise ammonia levels and cause ammonia toxicity(Bower & Bidwell, 1978). Therefore, controlling ammonia (NH_3) in shrimp ponds is crucial for shrimp health.

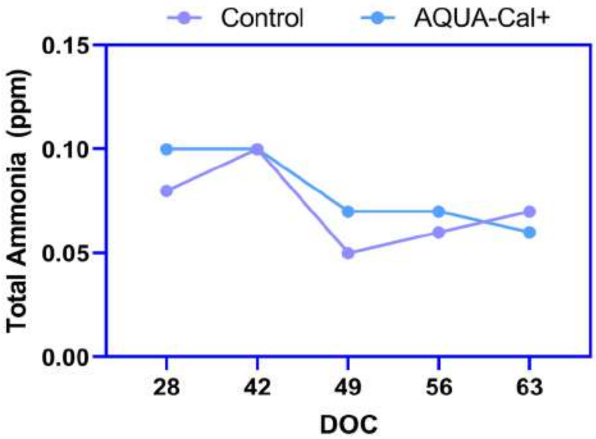

Fig. 3. Total Ammonia in ppm of control and AQUA-Cal+ treated ponds. AQUA-Cal+ suppresses ammonia levels when compared with untreated control ponds.

3.3 AQUA-Cal+ reduces hardness

Maintaining appropriate hardness levels in a shrimp farm is crucial for the overall health and well-being of the shrimp. By maintaining optimal hardness levels, shrimp farmers can create an environment that promotes healthy shell development, proper osmoregulation, stable pH, nutrient availability, and reduced risks of metal toxicity, ultimately leading to improved shrimp growth, survival, and overall farm productivity(Boyd et al., 2016).Hardness was higher in the control pond than AQUA-Cal+ treated pond throughout the culture period (Fig 4). AQUA-Cal+ significantly reduced the hardness by 23.9% than untreated control ponds—AQUA-Cal+ aids in maintaining optimal hardness for the growth vannameiin Indian culture.

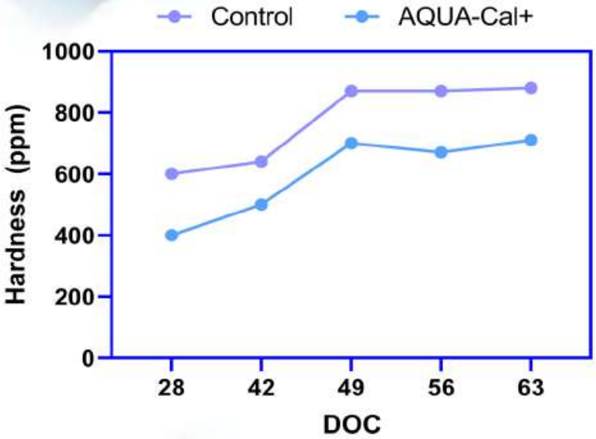

Fig. 4. Hardness of water in ppm of control and AQUA-Cal+ treated ponds.

3.4 AQUA-Cal+ controls vibriosis

Vibrio outgrowth is a common factor in shrimp culture and drastically affects cultured species leading to economic loss. Vibrio bacteria thrive in poor water quality conditions, particularly in ponds with high organic matter content, low dissolved oxygen levels, and inadequate water exchange(Chandrakala & Priya, 2017). Vibrio is introduced mainly through contaminated water;water pretreatment is crucial in controlling vibriosis.AQUA-Cal+ treated pond showed a significantly reduced vibriosis (yellow colonies) than untreated control ponds (Fig 5). Antibiotic use will be reduced if the farmer opts for AQUA-Cal+. It will significantly help reducethe environmental impact and promote environmentally-friendly farming methods.

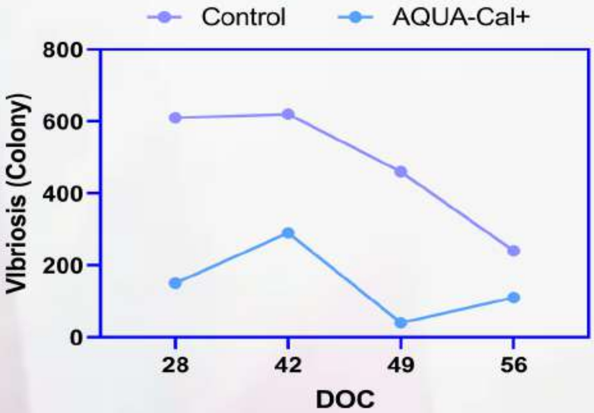

Fig. 5. Vibrio outgrowth in control and AQUA-Cal+ treated ponds. Vibrio growth was much lesser in AQUA-Cal+ pretreated ponds.

3.5 AQUA-Cal+ increased the chance of shrimp survival

Shrimp survival depends on upholding suitable water quality. Poor water quality can cause stress, impair the shrimp's immune system, and make them more vulnerable to diseases and infections.Regular pond maintenance, including toxic sludge removal, is essential for maintaining good water quality and reducing the risk of disease outbreaks. Proper pond preparation contributes to a healthier and more conducive environment for survival for shrimp.The estimated survival rate (E.SVR %) was much higher in AQUA-Cal+ treated ponds than in untreated control ponds (Fig 6). AQUA-Cal+ increased the survival by about 5% to control ponds.This result shows the potential of AQUA-Cal+ in increasing the revenue and economy of shrimp culture in India.

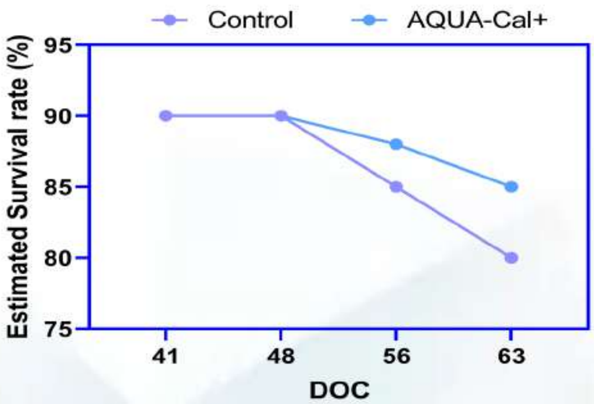

Fig. 6. Estimated survival rate in control and AQUA-Cal+ treated ponds. Due to water quality improvement, AQUA-Cal+ treated pond showed a higher survival rate.

3.6 Increase in Average daily growth in AQUA-Cal+ pond

The average daily growth of shrimps was 5.2% higher in the AQUA-Cal+ pond than control pond (Fig 7A). It implies that AQUA-Cal+ treatment Could increase the daily growth of shrimps. Shrimp's average growth rate depends on water quality, feed, stocking density, and farm management. As stated earlier, water quality was improved in AQUA-Cal+ ponds. In return, the shrimp growth performance was also improved. The feed conversion ratio was low in AQUA-Cal+ ponds (Fig 7B). Shrimps in AQUA-Cal+ ponds showed 4% less FCR than control shrimps. It helps in generating higher revenue by low feed input.

3.7 Increase of biomass in AQUA-Cal+ pond

Increasing biomass in a shrimp farm is a goal for many shrimp farmers as it directly translates to higher productivity and profitability.The estimated Biomass of AQUA-Cal+ ponded shrimp was significantly higher by 19.5% than the untreated control pond (Fig 8A). Average body weight of the shrimp in the AQUA-Cal+ pond was also increased by 13.1 g,which is 5.7% higher than the control shrimps (Fig 8B). This shows that AQUA-Cal+ promotes the growth of the shrimps. AQUA-Cal+ has improved the water quality, resulting in improved survival and biomass (Fig 9). Low vibrio growth also indirectly contributes to biomass increase, as vibrio may hinder shrimp growth and productivity.

Pond	Avg. body weight (g)	Survival (%)	FCR	Harvest weight (kg)	Difference against Control (%)			
					Avg. body weight (g)	Survival (%)	FCR	Harvest weight (kg)
Control	12.4	79	1.3	1686	+5.7 ↑	+ 7 ↑	-4 ↓	+19.5 ↑
AQUA-Cal+	13.11	86	1.25	2097				

Table 3. Growth parameters at the end of the trail.

Fig. 9. Harvested shrimps of control (without AQUA-Cal+) and AQUA-Cal+ treated ponds.

Objectives	Properties
Alkalinity stability	Maintained between 110 – 150 ppm
Nitrite control	Maintained at 0 ppm
Hardness	Maintained between 700 - 730
Water turbidity	Minimal turbid against control with better water clarity
ADG	Around 16% higher against control
ABW	Around 23% higher against control
FCR	Around 10% lower against control
Vibriosis control	Controlled yellow colonies and no growth of green colonies

Table 4. Measurement observed in AQUA-Cal+ treated ponds.

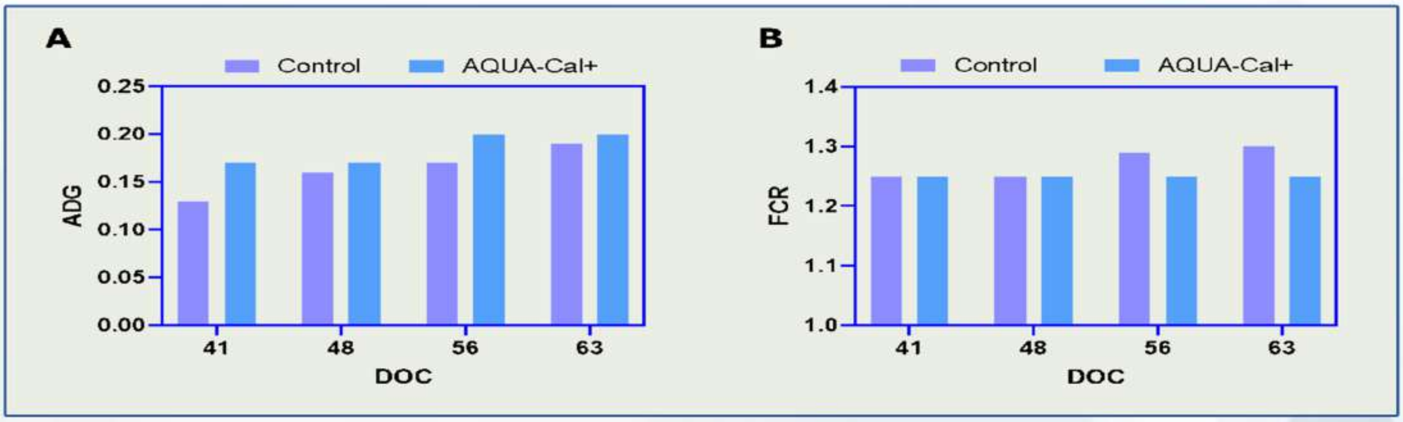

Fig. 7. (A) Average daily growth (ADG) and **(B)** feed conversion ratio (FCR) of control and AQUA-Cal+ treated ponds. ADG was improved, and FCR was reduced in AQUA-Cal+ n AQUA-Cal+ treated ponds.

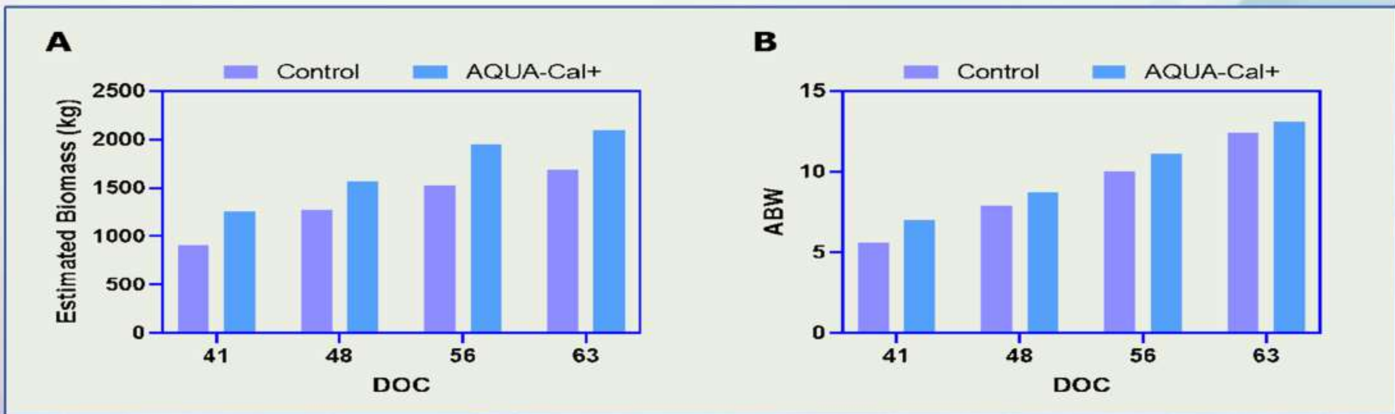

Fig. 8. (A) Estimated Biomass in kg and **(B)** average body weight (ABW) of control and AQUA-Cal+ treated ponds. Both biomass and ABW were improved in the AQUA-Cal+ pond compared to the control pond.