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# Meta-analysis of the feed additive Novacq in Pacific white shrimp diets

5 June 2023

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**Viet-Uc and CSIRO collaboration demonstrates that the  
product outperformed a control diet in both shrimp  
growth and survival**



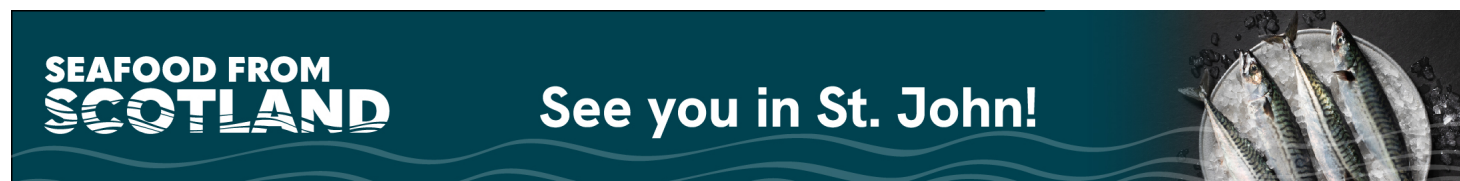
This study presents the results of a Meta-analysis of the efficacy of the feed additive Novacq in Pacific white shrimp, in a joint research effort between Viet-Uc and CSIRO. Results show that this commercial additive outperformed the control diet, with larger animals (an average of 4 grams) and 25 percent greater survival rates, and also bested a benchmark commercial feed. Since 2017, Viet-Uc and the CSIRO Aquaculture Nutrition and Production Systems group have been collaborating with Viet-Uc to understand the efficacy of this additive in *L. vannamei* nutrition.

Viet-Uc Seafood Corporation (Viet-Uc) is an important shrimp aquaculture company with involvement in the whole production value chain and is particularly dominant in the production of postlarvae of Pacific white shrimp (*Litopenaeus vannamei*) in Vietnam.

Over the last seven years, Viet-Uc has developed aquaculture nutrition capability to develop sustainable shrimp feeds. Central to this strategy is Novacq<sup>TM</sup>, a microbial biomass additive developed by Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) that enhances shrimp growth, feed efficiency and overall health. Novacq was produced and assessed in Vietnam by Viet Uc.

Since 2017, Viet-Uc and the CSIRO Aquaculture Nutrition and Production Systems group have been collaborating with Viet-Uc to understand the efficacy of this additive in *L. vannamei* nutrition. Until then, most of the published research on its efficacy relates to studies on black tiger shrimp (*Penaeus monodon*). Its effect across various life stages (e.g., postlarvae, juvenile and broodstock) and feed formulations (e.g., plant-based, low protein and low marine-origin ingredients) through its application as a strategic feed additive has shown improvements in feed intake, nutrient retention efficiencies, digestive physiology (e.g., nutrient absorption, gut transit microbiome) and immune response.

Most shrimp nutrition research is constrained, as experiments are conducted in small tanks over short periods (e.g., six weeks) in clear water and controlled conditions to ensure the results only reflect dietary treatments. However, the findings from these experiments do not always translate to commercial environments due to the large differences in culture conditions and farming practices. To help address these deficiencies, pilot-scale systems were developed to obtain more commercially relevant results whereby the effect of diets could be assessed throughout a harvest cycle (post-larvae to harvest size over a period of 13 weeks) and in larger culture systems (7-cubic-meter cement raceways). Use of pilot trials enables our research to investigate the efficacy of additives like Novacq™ under conditions that better mimic commercial conditions.



(<https://events.seafoodfromscotland.org/>).

This article reports on the results of several years of research into the efficacy of Viet-Uc-produced Novacq when fed to *L. vannamei* shrimp using both small experimental tank and pilot-scale trials, with a focus on fostering industry adoption.

## **Viet-Uc nutrition facilities**

The nutrition research at Viet-Uc is carried out at the Ba Tri shrimp hatchery in Ben Tre province, Vietnam. The research facilities and experimental protocols were developed in collaboration with the CSIRO Aquaculture Nutrition and Production Systems group to ensure that the research was scientifically robust and conducted to a high standard.



## Commercial microbial biomass additive evaluated in black tiger shrimp diets

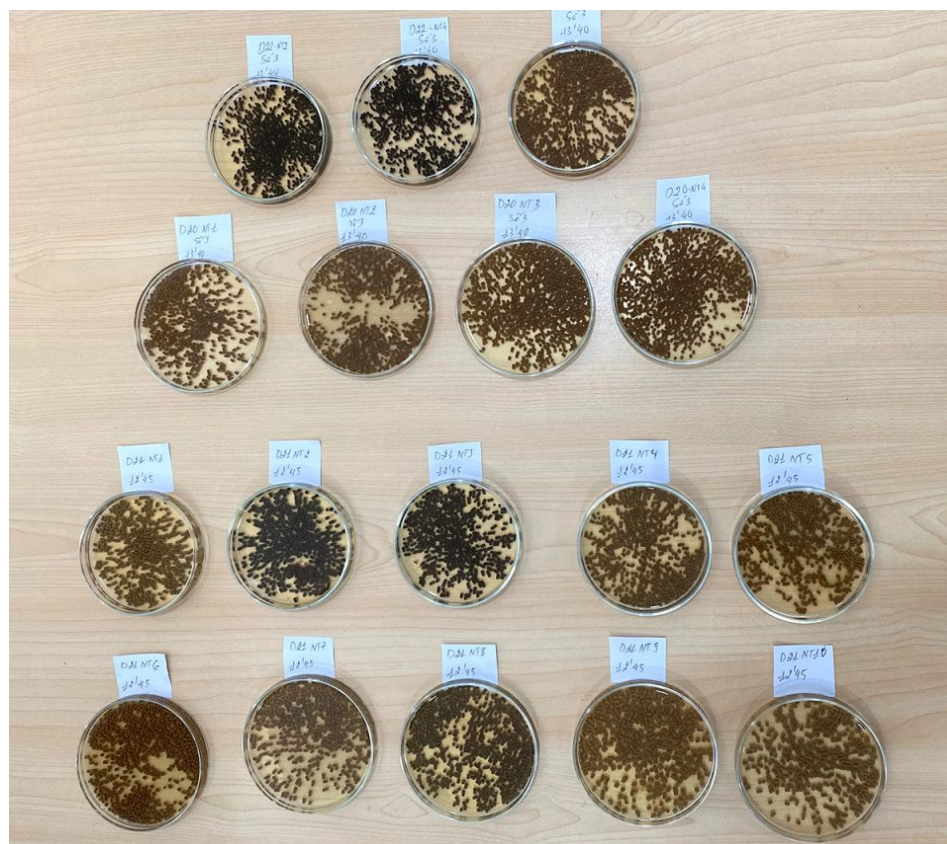
Initial insights on the effects of the commercial marine microbial biomass Novacq as an additive in feeds for black tiger shrimp postlarvae and juveniles.



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## Experimental feed manufacturing

A feed manufacturing laboratory was established to manufacture feeds for both the small-tank (2 kg per treatment) and pilot-scale trials (250 kg per treatment, of various sizes, see Table 1 for details).



View of the experimental feeds manufactured for and tested in this study.

## Rombenso, Novacq, Table 1

Feed type	Feed size (mm)
Feed No. 0 (PL10 > PL18)	Fine crumble (0.1–0.3)
Feed No. 1 (PL18 > PL28)	Crumble (0.3–0.7)
Feed No. 2 (PL28 > 1g)	Crumble (0.7–1.0)
Feed No. 3 (1g > 4g)	Pellet (1.2)
Feed No. 4 (4g > 12g)	Pellet (1.5)
Feed No. 5 (12g > 20g)	Pellet (1.8)

Table 1: A list of the different feed sizes manufactured for each treatment for the pilot-scale trials.

## Small-tank and pilot-scale trials

An experimental system was constructed to enable the testing of many diets (15-40+) with high replication (five to eight tanks). For each experiment, this system is stocked with juvenile shrimp ranging from 0.35 to 0.55 grams at a stocking density of 10 animals per tank (30 liters) for six weeks. Water quality is maintained within the optimum ranges for the species with a flow-through of one



exchange per hour, with a water temperature of 28–29 degrees-C. Shrimp are fed to slight excess six times (two times hand-feed and four times using an auto feeder) a day, seven days a week throughout the experiment. For more details on the experimental design, please see our **peer-reviewed publication** (<https://doi.org/10.1016/j.aquaculture.2020.735959>).

Pilot-scale trials are used to validate the findings from the juvenile trials and compare diet performance with commercial diets. The trials are conducted in rooms that each house 20 tanks of 7 cubic meters, where postlarvae-12 are stocked from 1,000 to 2,300 animals per tank (stocking densities 150–300 shrimp per square meter). Animals were hand-fed five times a day, seven days a week for 91 days. Water quality parameters, including ammonia, carbonate hardness, pH, salinity, dissolved oxygen and temperature, are measured regularly. Water is exchanged to maintain those parameters within the optimum range for the species. Upon completion of the trial, 100 shrimp per replicate are individually weighed and 50 shrimp of those are submitted to a coloration assessment, both before and after cooking. The remaining animals are individually counted and bulk-weighed.

View of the tanks used in the study.

Testing the coloration of the shrimp harvested.

## Novacq efficacy meta-analysis

The results of trials conducted in both small and pilot-scale tanks completed in the last years were compiled to evaluate the efficacy of feeding the additive compared to a control for *L. vannamei*. All data were submitted to statistical meta-analyses of means using SPSS, an approach that has been underutilized by the aquaculture industry to validate products.

In small-tank trials, Novacq repeatedly outperformed the control diet resulting in larger animals (an average of 4 grams) and 25 percent greater survival rates, with one exception (Fig. 1). It is worthwhile mentioning that animals fed this additive also outperformed those fed a benchmark commercial feed

(Fig. 2).

Fig. 1: Meta-analyses of percent weight gain and survival percent of 23 juvenile nutrition trials testing Novacq™ against a basal control diet. Trials were sorted by mean efficacy levels. Red circles illustrate the additive treatment of an individual study. The size of the red circle represents the number of tank replications with larger circles having higher replications. The yellow diamond represents the average value. Significant differences are present when horizontal blue lines do not touch the vertical line ( $P < 0.05$ , meta-analysis in SPSS 11.0).

Fig. 2: Meta-analyses of final weight (grams) and survival percent of 12 juvenile nutrition trials testing Novacq against a benchmark commercial diet. Trials were sorted by mean efficacy levels. Red circles illustrate the additive treatment of an individual study. The size of the red circle represents the number of tank replications with larger circles having higher replications. The yellow diamond represents the average value. Significant differences are present when horizontal blue lines do not touch the vertical line ( $P < 0.05$ , meta-analysis in SPSS 11.0)

In pilot trials, similar Novacq efficacy responses were observed, whereby the product again outperformed the control in terms of survival, final biomass and feed conversion ratio (Fig. 3).

Fig. 3: Meta-analyses of final biomass (kg), survival (%), and feed conversion ratio of 11 pilot-scale nutrition trials testing Novacq against a basal control diet. Trials were sorted by mean efficacy levels. Red circles illustrate the additive treatment of an individual study. The size of the red circle represents the number of tank replications with larger circles having higher replications. The yellow diamond represents the average value. Significant differences are present when horizontal blue lines do not touch the vertical line ( $P < 0.05$ , meta-analysis in SPSS 11.0).

## Ongoing research

Currently, there are several small-tank and pilot-scale experiments in progress that are assessing the following areas: ingredient quality and feed additive efficacy, inclusion rates, digestibility, feed formulation, feeding management and final product quality. Significant to this research effort is the development of novel tools to measure ingredient and diet composition and efficacy.

## Perspectives

The Viet-Uc and CSIRO collaboration is a partnership between a private aquaculture company and a research agency that is accelerating the adoption of research outcomes by industry. Research completed using both controlled laboratory conditions and at pilot scale enables more confidence in the application of research outputs on an industrial scale. This is relevant for the many feed mills in Vietnam that are testing and validating formulations and feeds.

*References available from the corresponding author.*

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