Applications of a single cell protein in the culture of whiteleg shrimp

By Allan LeBlanc and Josh Silverman

A total fishmeal replacement in whiteleg shrimp diets demonstrated improved growth and survival of shrimp at low inclusion levels.

Originally developed in Norway for the Atlantic salmon industry, there is a new and promising high-protein feed ingredient for marine shrimp. FeedKind Aqua protein (Calysta, USA) has a similar amino acid profile to fishmeal, is highly digestible, and can be incorporated into diets across all life stages. Table 1 shows the proximate, chemical and essential amino acids (EAA) composition of FeedKind *Aqua* protein and comparison with Peruvian Super Prime fishmeal (min. 68% crude protein).

FeedKind *Aqua* is a non-GMO (genetically modified organism) single cell protein produced via natural fermentation from a state-of-the-art production facility. Beginning ~~in~~ 2019, the product will be available year round, independent of weather events, and thus is able to protect the feed supply chain from volatility and risk.

This single cell protein is also traceable from factory to plate. Containing a unique elemental profile that persists in the feed and the final product, shrimp fed this product can be differentiated from shrimp fed on other diets. A simple test can guarantee that the shrimp in the freezer at the local grocer is the same one that came out of the pond. It has been approved for use in a wide range of fish and livestock in multiple regulatory jurisdictions around the world.

Nutritional value

To assess the beneficial effects of FeedKind protein in shrimp, a trial with the Pacific whiteleg shrimp *Litopenaeus vannamei* was conducted in partnership with Texas A&M University-Corpus Christi and Auburn University using material from Calysta's market introduction facility in the UK. Growth response and survival in juvenile shrimp fed graded levels of the protein was evaluated relative to a fishmeal-containing reference diet.

Nutritionally complete diets were prepared at Texas A&M AgriLife Research and compared in an indoor, 8-week growth trial, at the E.W. Shell Fisheries Research Station, Auburn University, Alabama. Juvenile shrimp of approximately 0.1g average weight were stocked at a density of 10 juveniles/80L tank. Each treatment had either five or six replicates; altogether there was a total of 39 treatment tanks. Treatment tanks were connected to a recirculating aquaculture system to maintain water quality conditions .

Table 1. Proximate and chemical comparison of FeedKind *Aqua* protein and comparison of essential amino acids (EAA) composition with Peruvian Super Prime fishmeal (min. 68% crude protein).

Proximate composition (Typical values, as-is basis)		EAA (g/kg)		
	FeedKind *Aqua* protein		FeedKind *Aqua* protein	Peruvian Super Prime fishmeal
Crude Protein	71%	Arginine	42	37
Crude Fat	8%	Cystine	4	7
Ash	9%	Methionine	18	20
Crude fiber	<1%y	Histidine	15	20
N-free extract	7%	Isoleucine	30	28
Moisture	5%	Leucine	50	52
Gross energy (MJ/kg)	22.1	Lysine	39	54
		Phenylalanine	29	27
Fatty acids (% of total)		Tyrosine	22	22
C14:0	6	Threonine	30	29
C16:0	54	Tryptophan	12	8
C16:0	35	Valine	39	35
Others	5			
		Histamine	<10 ppm	<500 ppm
		Antioxidants	None	<150 ppm Ethoxyquin

Shrimp were fed six different treatment diets including a control diet, which is based on a feed conversation ratio (FCR) of 1.8:1, with a doubling of weight every week until week five. The feeding rate was modified depending on the visual observation on consumption. Feeds comprised a basal control diet of 15% fishmeal and five diets of increasing concentrations of FeedKind protein to replace fishmeal, at 1.5%, 3.8%, 7.5%, 11.3%, and 15% of total feed. Diets also included krill meal and squid muscle meal as marine attractants that were kept constant in all diets. The average weight of shrimp at the termination of the experiment was 8-10g.

Better survival

The mean survival of all the diets was 93.5% over the 8-week period, indicating that the experimental conditions were adequate for shrimp growth. Survival rates varied from 84% for the control diet to 97% for the diet with 100% fishmeal replacement. The exception was the 3.8% group, showing significant ($p<0.05$) improvement relative to the control (Figure 1). This improvement in survival demonstrates that FeedKind protein is well-tolerated in shrimp relative to fishmeal and can improve the health of the animals under research conditions. Additional farm-scale trials will be conducted to assess the magnitude of this benefit at commercial scale.

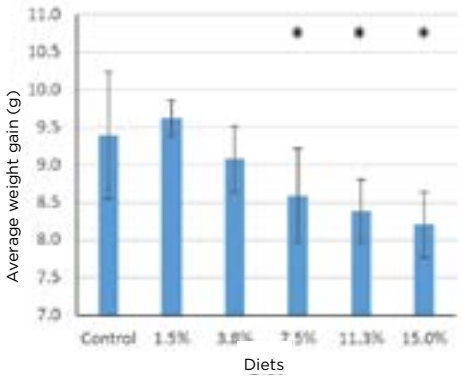

Figure 1. Average weight gain (g) of shrimp fed diets with increasing levels of FeedKind *Aqua* to replace fish meal

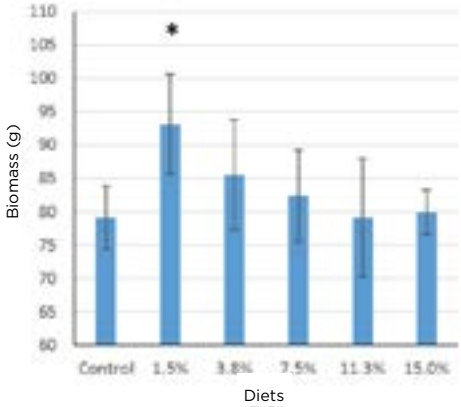

Figure 2. Average biomass per tank (g) of shrimp fed diets with ncreasing levels of FeedKind *Aqua* to replace fish meal

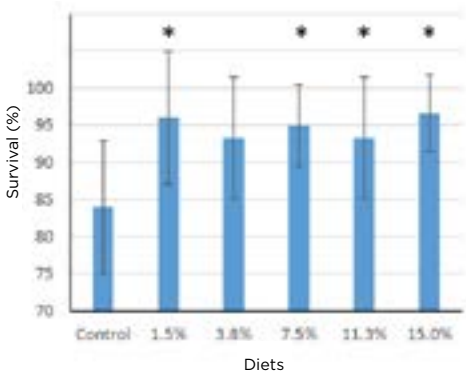

Figure 3. Survival rates (%) of shrimp fed diets with increasing levels of FeedKind *Aqua* to replace fish meal

Total biomass

The inclusion of this single cell protein resulted in significant ($p<0.05$) increases in aggregate shrimp weight in the 1.5% and 3.8% diet groups (Figure 2). The largest increase was a total biomass/tank improvement from 80g/tank up to 93g/tank in the 1.5% protein diet, representing an 18% increase in total productivity. Shrimp fed the treatment diet with no fishmeal performed equally well, as compared to the control, indicating that a 100% replacement of fishmeal with FeedKind can be achieved without a loss of productivity.

Weight gain

The average weight gain was also assessed (Figure 3). Unfortunately, the significant differences in survival among the groups complicated the interpretation of this parameter. The 7.5%, 11.3%, and 15% FeedKind diets all showed a significant decrease in average shrimp weight relative to the control. This is likely due to the fact that the feed amounts were held constant for all tanks, even though there were more live shrimp in the test diet tanks than the control tanks. Therefore, it is likely that individual shrimp in the control diet tanks were able to grow larger due to having more food available. In the control tanks, an inverse correlation was observed between survival and average weight gain in individual shrimp, thus supporting this hypothesis.

The data from this trial show that this single cell protein can successfully replace fishmeal in diets for whiteleg shrimp. The improved growth and survival of shrimp with low levels of this protein inclusion indicate that performance of these diets may even be superior to fishmeal under certain conditions. Additionally, as a reliable and traceable feed ingredient, FeedKind protein stands to dramatically improve consumer confidence in the supply chain.

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