UNLOCKING PROTEIN DIGESTIBILITY TO REDUCE FEED COSTS IN AQUACULTURE

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"The aquaculture industry faces rising feed costs due to increasing fishmeal prices and sustainability concerns. Implementing alternatives like plant proteins is essential to reduce costs and enhance sustainability, although these proteins might not be as digestible as fishmeal. A promising solution is to boost protein digestibility with precision nutrition and natural active ingredients, enhancing nutrient absorption and maximizing plant protein benefits."

The aquaculture industry is experiencing significant growth, driven by the increasing global demand for fish and shrimp. This expansion, however, is accompanied by escalating feed costs, largely due to the rising prices of traditional protein sources such as fishmeal. As feed accounts for up to 70% of the total production cost in aquaculture, there is an urgent need for cost-effective and sustainable feed alternatives.

Moreover, according to Global shrimp aquaculture production survey and forecasts from the Global Seafood Alliance and Rabobank report published in November 2023, "Market prices" of aquaculture products now ranks as the top concern for the industry for 2024, while "Aquafeed (cost)", main concern in 2022 and 2023 now ranks at second. This highlights the dual challenges of high feed prices and production costs, coupled with oversupply and low market prices for some aquaculture products. The combination of these factors threatens the future growth and profitability of aquaculture activities.

This economic pressure makes it increasingly difficult for aquaculture operations to remain financially viable. In this context, reducing feed costs becomes paramount. By finding effective solutions to lower feed costs, producers can mitigate the impact of low market prices, maintain profitability, and ensure the sustainability of their operations. This strategy not only helps individual businesses thrive but also supports the overall growth and resilience of the aquaculture industry.

Economix, a product designed to enhance protein digestibility, offers a promising solution for reducing fishmeal use and substituting it with more affordable plant proteins. This article will examine the current challenges in fish feed costs, the necessity for innovative solutions, and how Economix can contribute to more sustainable and cost-effective aquaculture practices.

CURRENT CHALLENGES IN FISH FEED COSTS

Fishmeal remains a primary protein source in aquaculture feeds. It has seen a substantial price increase over the past years. This rise is driven by the limited supply of wild-caught fish used to produce

fishmeal, due to overfishing and climate change. As demand continues to outpace supply, prices are expected to remain high, placing financial strain on aquafeed and aquaculture producers.

The heavy reliance on fishmeal also poses sustainability issues. Overfishing and the depletion of marine resources threaten the ecological balance and long-term viability of aquaculture. Transitioning to alternative protein sources is crucial to mitigate these environmental impacts and secure the industry's sustainable future.

THE NECESSITY FOR ALTERNATIVE PROTEIN SOURCES

To address the rising costs and sustainability concerns, the aquaculture industry is exploring various alternative protein sources, including plant-based proteins, insect meals, and single-cell proteins. These alternatives can significantly reduce dependence on fishmeal, but their integration into aquafeeds must ensure that the nutritional requirements of the cultured species are met without compromising growth and health.

One of the primary challenges with alternative proteins is their lower digestibility compared to fishmeal. Poor digestibility can lead to reduced growth rates, increased feed conversion ratios (FCR), and higher waste outputs. Therefore, enhancing the digestibility of these alternative proteins is crucial to their successful implementation in aquafeeds.

ECONOMIX: A SOLUTION TO UNLOCK PROTEIN POTENTIAL

Economix is a plant-based feed additive designed to enhance protein digestibility in aquafeeds. It enhances protein breakdown by boosting acid production and enzymatic activity in the digestive tract of fish and shrimp. This leads to more efficient digestion of complex proteins into simpler, more absorbable forms, optimizing protein absorption and promoting better growth. By optimizing protein digestion, Economix enables a reduction in fishmeal inclusion by up to 2%, allowing for the substitution with more cost-effective and sustainable plant proteins.

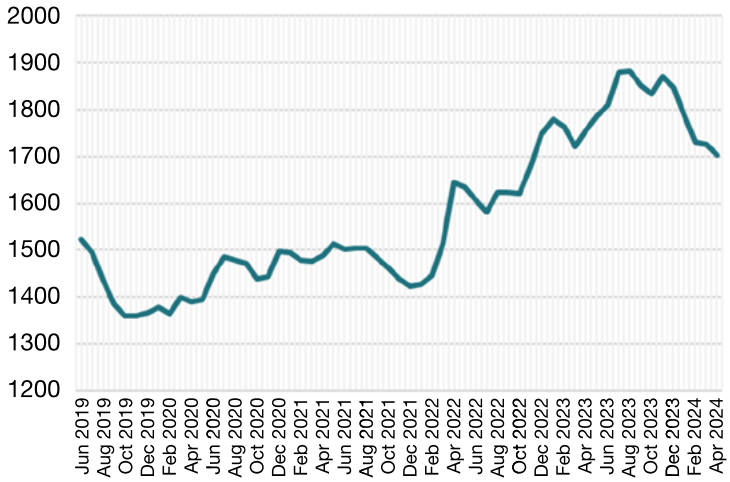

Figure 1. Fishmeal Monthly Price - US Dollars per Metric Ton (Source: Indexmundi, 2024)

This solution is the result of an extensive literature review examining the impacts of various ingredients on protein utilization and feed efficacy. Over 150 articles were meticulously analyzed and synthesized, focusing on ingredients influencing protein utilization in fish and shrimp. Key parameters assessed included protein digestibility, protein efficiency ratio (PER), feed conversion ratio (FCR), protein retention, feed efficiency, and feed intake. A broad spectrum of ingredients was examined, including algae, enzymes, plant derivatives (whole, extracts, or essential oils), organic acids

and their derivatives, probiotics, and prebiotics. This comprehensive study enabled the identification of ingredients with the greatest potential to enhance protein utilization in aquafeed from a zootechnical perspective. Palatability and feed consumption were also considered in the ingredient selection process. As the aim is to reduce aquafeed costs, the costs of these ingredients were carefully evaluated. This approach enabled the design of several products, which were subsequently tested to validate the optimal composition for this additive.

ECONOMIX: PROVEN RESULTS THROUGH COMPREHENSIVE TRIALS

Improved FCR in a shrimp trial conducted in India

This trial, led by Dr. Ambasankar and his team at the Central Institute of Brackishwater Aquaculture (CIBA) in India, evaluated the effects of five different formulas on the growth of vannamei shrimp. The formulas labeled Economix and Negative Control contained the same raw materials as the Positive Control, but with a reduction in fish meal from 15.56% to 12% and corn gluten from 4% to 3.5%. These reductions were offset by adding soybean meal, groundnut oil cake, and gingelly oil cake, resulting in a lower protein content of the formulas. The Economix formula included an additional 2 kg/MT of Economix supplement, unlike the Negative Control which did not include any (Table 1). A second set of formulas incorporated rice distillers dried grains with solubles (DDGS, 45% protein) at 3% (Table 1). This included a Negative Control + DDGS and an Economix + DDGS formula with an additional 2 kg/MT of Economix. The feed costs for the Economix and Economix + DDGS were reduced by 1.62% and 2.49%, respectively, compared to the control. Each treatment was tested in triplicate. Shrimps (mean body weight of 3.35 g) were stocked at a density of 60 per m^2 for a period of 8 weeks.

The FCR were significantly different (p-value <0.01). Overall, the data showed slightly lower growth in the negative control diets. Specifically, the Negative Control and Negative Control + DDGS diets had final weights that were reduced by 0.2 g and 0.23 g, respectively, compared to the Positive Control diet. In contrast, the Economix diets exhibited slightly higher growth (+0.1 g). The results for Economix + DDGS were similar to those of the control diet (Figure 3).

This trial highlights the potential benefits of including Economix to the production of more cost-effective shrimp feeds while maintaining performance compared to a standard shrimp diet.

Increased final body weight in a shrimp trial conducted in Mexico

This trial conducted in Mexico assessed the impact

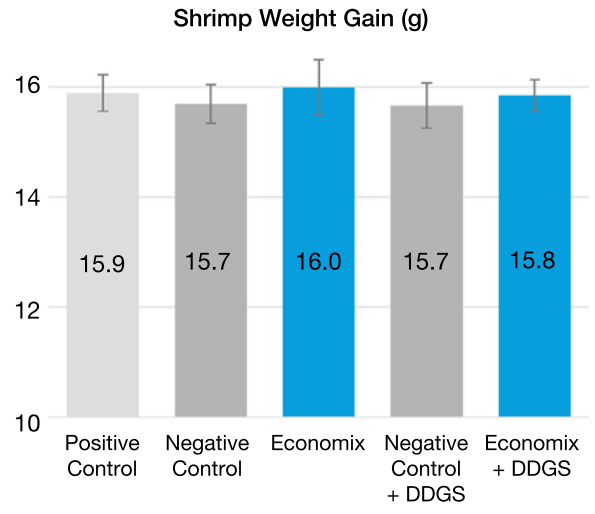

Figure 2A: Weight Gain of shrimp raised during trial in Central Institute of Brackishwater Aquaculture (India,2023)

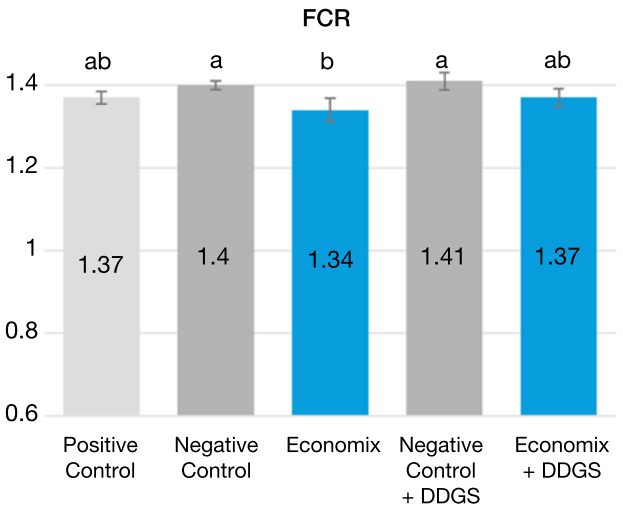

Figure 2B: FCR of shrimp raised during trial in Central Institute of Brackishwater Aquaculture (India, 2023) Values denoted by different letters are statistically different (p < 0.01)

Table 1. Formulas used for the trial in 2023 carried out at the Central Institute of Brackishwater Aquaculture, India.

Formula / Raw material	Positive Control	Negative Control	Economix	Negative Control + DDGS	Economix + DDGS
Fish meal (64%)	15.56	12.00	12.00	12.00	12.00
Soybean meal	33.50	35.00	35.00	34.29	34.29
Corn gluten meal	4.00	3.50	3.50	2.00	2.00
Groundnut oil cake	3.00	4.00	4.00	3.00	3.00
Gingelly oil cake	3.00	4.00	4.00	3.00	3.00
Wheat gluten meal	1.00	1.00	1.00	1.00	1.00
DDGS				3.00	3.00
Wheat grain	22.03	20.01	19.81	21.10	20.90
Broken rice	12.00	14.00	14.00	14.00	14.00
Fish oil	3.03	3.21	3.21	3.37	3.37
Soy lecithin	0.75	0.75	0.75	0.75	0.75
MC Phosphate	0.75	1.09	1.09	1.11	1.11
Lysine	0.18	0.23	0.23	0.19	0.19
Methionine	0.10	0.10	0.10	0.10	0.10
Premixes & Additives	1.10	1.10	1.10	1.10	1.10
Economix			0.20		0.20

Nutrients (theoretical)	Unit	Value	Value	Value	Value	Value
Protein	%	36.00	35.00	35.00	34.50	34.50
Fat	%	6.00	6.00	6.00	6.00	6.00
Fiber	%	2.81	3.07	3.07	2.97	2.97

Analysis results	Unit	Value	Value	Value	Value	Value
Protein	%	36.50	35.70	35.18	35.69	35.07

Cost reduction (vs positive control)			-1.62%		-2.49%

of Economix on the growth of vannamei shrimp. Three feed formulas were tested: a Control diet, an Economix diet replacing 2% of fishmeal with canola meal, corn DDGS, and wheat while adding 2 kg/MT of Economix, and a third formula Economix "on top" incorporating Economix as a supplement of the control formula. The Economix diet was 2.2% less expensive than the Control diet. It can be noted that the Control diet contains a protease. Each treatment was tested in five replicates, using 3 x 3 x 1 m cages submerged in a commercial aquaculture pond, with 225 shrimps (mean body weight of 3.08 g) per replicate. The trial was conducted over a period of 60 days.

The results indicated that the inclusion of Economix significantly enhanced the individual final body weight (p-value <0.01), with the highest body weight achieved in the Economix "on top" diet, followed by the Economix diet and the Control. Additionally, both the Economix and Economix "on top" diets demonstrated numerically lower feed conversion ratios (FCR) of 1.62 and 1.59, respectively, compared to the Control diet's FCR of 1.67.

This trial demonstrates that the Economix concept enables the production of more cost-effective and higher-performance feeds compared to a standard shrimp feed. Moreover, the Economix "on top" diet achieved a reduction in FCR by 0.08 points, an increase in final body weight by 0.3 grams, and a 6% boost in final biomass. These results suggest that Economix can also be utilized as a supplement to enhance shrimp zootechnical performance (see Figure 3).

ECONOMIC AND ENVIRONMENTAL BENEFITS OF ECONOMIX

Cost Savings

By reducing the reliance on expensive fishmeal and incorporating more affordable plant proteins, Economix offers substantial cost savings in feed formulation. These savings can directly enhance the profitability of aquaculture operations, making them more economically viable.

Sustainability

Economix contributes to the sustainability of aquaculture by decreasing the dependence on ma-

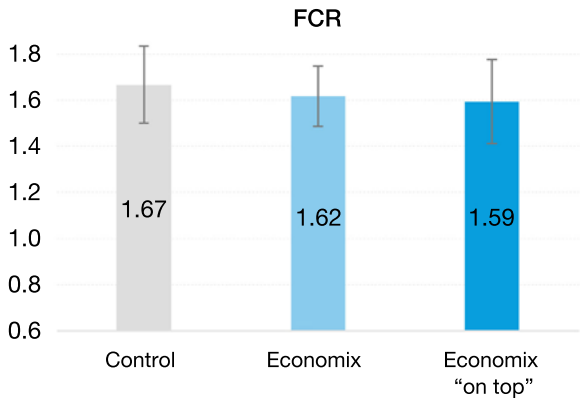

Figure 3A: FCR of shrimp raised during trial in Granja experimental Malta Texo (Mexico, 2023)

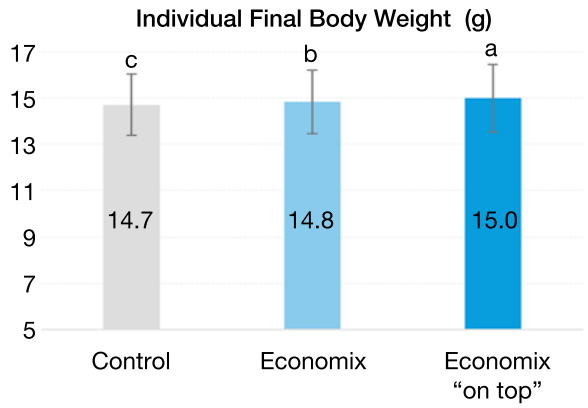

Figure 3B: Weight Gain of shrimp raised during trial in Granja experimental Malta Texo (Mexico, 2023) Values denoted by different etters are statistically different (p < 0.05)

Table 2. Formulas used for the trial in 2023 carried out at the Granja experimental Malta Texo, Mexico

Formula / Raw material	Control	Economix	Economix "On top"
Fishmeal (60%)	8.00	6.00	8.00
Porcine meal (50%)	12.00	12.00	12.00
Soybean meal	36.88	33.68	36.88
Canola meal	3.04	4.50	3.04
DDGS	4.50	6.00	4.50
Wheat	15.00	17.15	15.00
Sorghum	7.00	7.00	7.00
Wheat flour	8.20	8.00	8.20
Vegetable oil	1.00	1.00	1.00
Soybean oil	1.00	1.00	1.00
Fish oil	1.34	1.43	1.34
Methionine	0.17	0.18	0.17
Premixes & Additives	1.85	1.85	1.85
Protease enzyme	0.02		0.02
Economix		0.20	0.20

Nutrients (theoretical)	Unit	Value	Value	Value
Protein	%	35.00	33.50	35.00
Fat	%	7.00	7.00	7.00
Fiber	%	3.50	3.72	3.50

Analysis results	Unit	Value	Value	Value
Protein	%	37.23	35.00	36.46
Cost reduction (vs control)			-2.20%	

rine resources and promoting the use of alternative protein sources. This shift not only reduces the environmental impact of aquaculture but also supports the industry's long-term growth and resilience.

CONCLUSION

The rising costs of fish feed ingredients pose a significant challenge to the aquaculture industry. Economix, with its ability to enhance protein digestibility, offers a viable solution by enabling the reduction of fishmeal and the incorporation of cheaper, more sustainable protein sources. Through successful trials across the world, Economix has demonstrated its potential to improve cost-effectiveness, feed performance, and overall profitability in aquaculture. In addition to offering additives like Economix, Techna provides essential support to its partners through consultancy services in aquaculture nutrition.

About Nicolas Tanrattana

Nicolas Tanrattana is an expert in aquaculture nutrition at Techna. His work focuses on developing innovative products and additives to enhance the nutrition, health, and performance of fish and shrimp. With a strong background in aquaculture, Tanrattana combines scientific research with practical applications, driving advancements in sustainable aquaculture practices on an international scale.