Can supplementation of a lyso-phospholipid-based additive fully replace lecithin in shrimp feeds?

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Lecithin plays a critical role in shrimp feed formulations, primarily due to its high phospholipid content, which is essential for shrimp growth and development. Phospholipids improve the absorption and transport of dietary fats and fat-soluble nutrients, contributing to better feed efficiency and nutrient utilization. Additionally, its emulsifying properties help stabilize the feed, allowing fats and oils to mix evenly within the feed particles, which further enhances nutrient uptake by shrimp.

Beyond its nutritional benefits, lecithin can also serve as a cost-effective source of energy in shrimp diets, especially when its market prices are low. During periods of lower prices, feed manufacturers can increase lecithin inclusion to reduce dependence on more expensive energy sources, thereby optimizing feed costs without compromising quality. However, this advantage is often offset by significant fluctuations in lecithin prices across different regions, particularly in areas where major shrimp producers are concentrated, such as Southeast Asia and Latin America. Lecithin prices can vary dramatically, sometimes soaring to as much as USD 3 per kilogram, which can substantially raise feed production costs.

Maintaining optimal lecithin levels in shrimp feeds, typically between 2-3% (20-30kg/ton feed), becomes particularly challenging when prices are high. Producers may be forced to reduce lecithin content or seek alternative feed ingredients, which can negatively impact shrimp growth rates and overall feed efficiency. The volatility in lecithin pricing is driven by a range of factors, including fluctuations in global soybean production, trade policies, regional demand, and logistical challenges. As a result, feed manufacturers must carefully balance cost management with the nutritional requirements of shrimp, ensuring that any adjustments to lecithin levels do not compromise the performance quality of the feed.

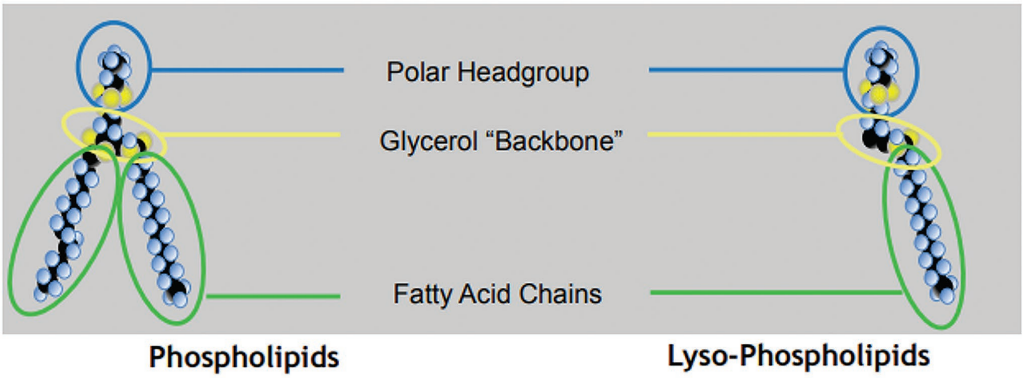

Figure 1. Structure of phospholipids and lyso-phospholipids. Lyso-phospholipids are obtained by enzymatic hydrolysis of phospholipids. The removal of one fatty acid increases the hydrophilicity and, therefore, lyso-phospholipids serve as better oil-in-water emulsifiers than phospholipids.

Table 1. Formulation of experimental diets in Trial 1

	Control 2% LEC	0% LEC	0% LEC + 0.1% LPL
Moisture	8.00	10.50	10.40
Crude protein	37.74	36.94	36.91
Crude Fat	**8.15**	**7.04**	**7.47**
Ash	6.97	6.86	6.74
Phospholipids	**1.14**	**0.16**	**0.15**
Cholesterol	**0.08**	**0.08**	**0.08**

The role of lyso-phospholipids as a strategy to replace lecithin in shrimp feed

Lyso-phospholipids (LPL), also known as lysolecithin, are produced through the enzymatic hydrolysis of phospholipids, during which one of the fatty acid tails is removed. As a result, LPL molecules are more hydrophilic than phospholipids, enhancing their ability to act as effective oil-in-water emulsifiers in the digestive tract of shrimp (Fig. 1). Typically, lecithin consists of approximately 40% phospholipids, with a residual LPL content of around 2%. However, after enzymatic hydrolysis, the phospholipid content decreases while the LPL fraction increases to about 15%. Lyso-phospholipids can be added to shrimp feed either in liquid form or as a powder with a carrier.

Lyso-phospholipids offer a wide range of applications in feed formulations. They can be supplemented to improve feed efficiency and shrimp performance or used to reduce overall feed costs while maintaining optimal growth. In this context, LPL are particularly valuable as a replacement for lecithin, specifically targeting lecithin's role in emulsification and its ability to enhance fat digestion and utilization. By improving the efficiency of lipid absorption, LPL help maintain growth and feed conversion rates even when lecithin levels are reduced from 2-3% to 1%, providing a cost-effective alternative for feed producers. LPL-based additives are used at a lower inclusion than that of lecithin (0.5-2 vs 10-30 kg/ton feed, respectively).

Is full replacement of lecithin in shrimp feeds possible?

To assess the full replacement of lecithin in shrimp feeds with an LPL-based additive (AQUALYSO®), two different trials were conducted at different dietary phospholipid levels, low and medium.

Trial 1. Full replacement of lecithin in shrimp diets with low phospholipids content

In this first trial, three different diets were tested: a control diet containing 2% lecithin, with fat content at 8% and phospholipids at 1.14%; a second diet with 0% lecithin, resulting in fat content reduced to 7% and phospholipids to 0.16%; a third diet with 0% lecithin, similar in fat and phospholipid content to the second diet but supplemented with 0.1% of AQUALYSO®. Cholesterol levels remained consistent across all diets at 0.08% (Table 1).

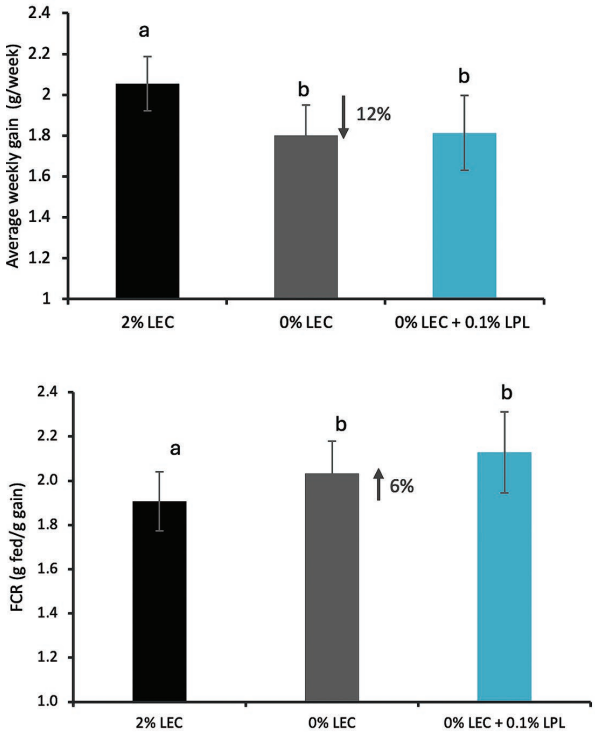

Figure 2. Average weekly gain (g/week) and feed conversion ratio (g fed/g gain) results of Trial 1 comparing a 2% lecithin diet (control), 0% lecithin diet (negative control) and one experimental diet with 0% lecithin and 0.1% LPL supplementation. Statistical differences are indicated by letters when not sharing the same one are considered significant (One-way ANOVA, post-hoc Tukey HSD, $p < 0.05$).

Table 2. Formulation of experimental diets in Trial 2

	Control 2% LEC	0% Lecithin	0% Lecithin + 0.1% LPL	0% Lecithin + 0.2% LPL
Moisture	9.296	9.130	9.119	9.141
Crude Protein	34.719	35.720	35.711	35.728
Crude Fat	**7.219**	**7.000**	**6.998**	**7.002**
Ash	7.292	7.236	7.236	7.237
Phospholipids	**1.897**	**0.900**	**0.953**	**0.897**
Cholesterol	**0.090**	**0.095**	**0.087**	**0.090**

Shrimp were housed in 30-L tanks, 5 shrimp per aquaria, and 10 replicates per diet. Shrimp were fed for six weeks (8 meals per day to satiation), during which their average body weight increased from 3 to 15 g. As anticipated, the removal of lecithin negatively impacted weekly growth gain and feed conversion ratio (FCR). LPL supplementation did not mitigate this effect, likely due to the low phospholipid levels in the diet (Fig. 2).

Trial 2. Full replacement of lecithin in shrimp diets with medium phospholipids content

In this trial, basal feed was reformulated with the objective of increasing phospholipids and fat content. Four different new diets were tested: a control diet with 2% lecithin and 1.9% phospholipid; a 0% lecithin diet in which phospholipids dropped to 0.9% (much higher than Trial 1); and two 0% lecithin diets with 0.9% phospholipid content and supplemented with 0.1% and 0.2% of AQUALYSO®. Fat and cholesterol levels were consistent across treatments at 7% and 0.09%, respectively (Table 2).

Shrimp were stocked in 30-L aquaria, 5 shrimp per aquaria, and 9 replicates per experimental diet were considered. Shrimp were fed for 6 weeks (8 meals/day to satiation), average body weight increased from 6 to 23 g.

As expected, the removal of lecithin from shrimp diets resulted in a noticeable reduction in both average weekly weight gain and feed efficiency. However, when the LPL-based additive was included in the diet, it effectively compensated for the absence of lecithin, maintaining both weekly gain and feed efficiency at levels comparable to the control diet (2% lecithin) (Fig. 3).

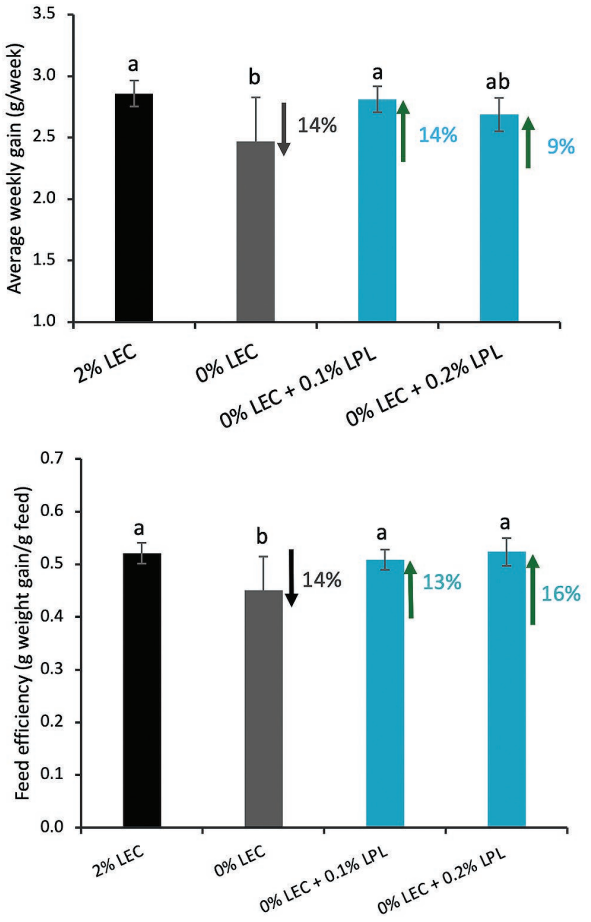

Figure 3. Average weekly gain (g/week) and feed efficiency (g wt gain/g fed) results of Trial 2 comparing a 2% lecithin diet (control), 0% lecithin diet (negative control) and two experimental diets with 0% lecithin and 0.1-0.2% LPL supplementation, respectively. Statistical differences are indicated by letters when not sharing the same one are considered significant (One-way ANOVA, post-hoc Tukey HSD, $p < 0.05$).

Conclusions

Results show that the LPL-based additive AQUALYSO® can fully replace lecithin in shrimp feeds under certain conditions.

While lyso-phospholipids can replace the emulsifying capacity of lecithin, full lecithin replacement is feasible as long as the diet can maintain the minimum level of phospholipids required for shrimp growth and performance. This means that phospholipids should be sourced from other ingredients.

This approach offers flexibility in feed formulation while reducing dependency on lecithin during periods of price increase or low availability.

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