Krill-Based Nutritional Products and their Role in Modern Aquaculture

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ABSTRACT

Krill are nutrient-rich crustaceans widely recognized for their potential in aquaculture nutrition. They contain high-quality protein, essential amino acids, phospholipids, omega-3 fatty acids, minerals, and astaxanthin, which contribute to improved growth, health, and feed utilization in aquatic animals. Various krill-derived products, including krill meal, krill oil, krill hydrolysate, freeze-dried krill, and krill protein concentrate, are increasingly used as functional ingredients in aquafeeds. Their bioactive compounds enhance feed palatability, osmoregulation, stress tolerance, and overall performance of cultured species. This article highlights the nutritional composition of krill and the applications of krill-based products in aquaculture.

INTRODUCTION

Krill belongs to the crustacean family and is rich in nutrients. According to the WoRMS taxon details of Euphausiacea (2023), a total of 91 krill species has been recognized worldwide. However, only a few species, such as *Terschellingia longicaudata* and *Meganyctiphanes norvegica* (Northern krill, North Atlantic Ocean), *Euphausia pacifica* (Pacific krill, North Pacific Ocean), and *E. superba* (Antarctic krill, Southern Ocean) are found in abundance (Kaur and Torrecillas, 2025). Krill are a rich source of carotenoids, astaxanthin.

Nutritional Composition of Antarctic krill

Proximate composition	Values	References
Crude protein	~17 %	Liu *et al*., 2011
Crude lipids	~ 3 %	
Chitin	~ 2 %	Grantham, 1977
Leucine	40 mg/g	Colletti *et al*., 2021; Tou *et al*., 2007
Isoleucine	25 mg/g	
Lysine	44 mg/g	
Methionine + Cysteine	24 mg/g	
EPA	17.4 %	
DHA	12.4 %	
Phospholipids	~30–65 %	
LC-PUFA	48.5 %	
Magnesium	360–458 mg/100 g	Liu *et al*., 2011; Skubic *et al*., 2020
Calcium	~1200 mg/100 g	Skubic *et al*., 2020; Tou *et al*., 2007
Phosphorous	~ 1400 mg/100 g	

Forms of Krill Used in Aquaculture

The following products are produced from krill and used for various purposes,

- Krill meal
- Krill oil
- Krill hydrosylate
- Freeze-dried krill
- Krill Protein Concentrate

Krill meal

It is the widely used commercial krill product. It contains 60 % of high-quality protein (Kader *et al*., 2012). The amino acid composition of krill meal is similar to that of fish meal (Kaur *et al*., 2022). It contains astaxanthin, and the impact of krill meal has been extensively studied in fish and shrimp. Kaur *et al*. (2022) reported that the most abundant phospholipids in krill are phosphatidylcholine (40-60%) and phosphatidylethanolamine (20-30%). Krill meal is reported to be rich in choline and trimethylamine N-oxide (TMAO). Choline is involved in digestion and osmoregulation. TMAO is also involved in osmoregulation and is a strong feed attractant.

Krill oil

It is obtained by non-solvent extraction of fresh krill or from dried krill meal. It is rich in phospholipids ranging from 40-81% (Colletti *et al*., 2021). The astaxanthin content of krill oil ranges between 40 and 5000 mg/kg (Sun *et al*., 2019). It is reported that it also contains sterols, cholesterol, vitamins E and A and flavonoids (Xie *et al*., 2019).

Krill hydrosylate

It is a liquid product prepared during the processing of krill and is produced by enzymatic hydrolysis. It has been reported to be used as a feed attractant in various fish larvae and juveniles. In shrimp, krill hydrosylate has been reported to replace 80% of fish meal successfully without compromising the growth and survival. Similarly, shrimp fed with feed containing krill hydrosylate had enhanced resilience in osmotic stress conditions (Josef, 2024).

Freeze-dried krill

The fresh krill, when preserved properly, can be used as freeze-dried krill. The freeze-dried krill retains the nutritional properties without affecting the protein level (Gigliotti *et al*., 2011).

Krill Protein Concentrate

Krill protein concentrate (KPC) produced through isopropanol extraction contains about 74.3% crude protein and very low lipid content (~0.3%), along with high levels of essential amino acids such as lysine, arginine, tryptophan, and threonine (Sidhu *et al*., 1970). It also shows higher concentrations of key amino acids, including isoleucine, leucine,

lysine, and methionine + cysteine, than soy protein concentrate, highlighting its potential as a superior alternative to plant-based protein sources in fish feeds (Tou *et al*., 2007).

When prepared using isoelectric solubilization/precipitation from krill powder, KPC contains approximately 78% protein and 8% lipids, providing the added benefit of increased levels of n-3 long-chain polyunsaturated fatty acids (LC-PUFAs) (Gigliotti *et al*., 2008).

CONCLUSION

Krill and krill-derived products are valuable functional ingredients in aquaculture due to their rich content of high-quality protein, essential amino acids, phospholipids, omega-3 fatty acids, minerals, and astaxanthin. Products such as krill meal, krill oil, krill hydrolysate, freeze-dried krill, and krill protein concentrate improve feed palatability, growth, health, and stress tolerance in aquatic animals. Their nutritional and functional properties make krill a promising and sustainable alternative ingredient for modern aquafeed development.

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