

All-natural: Immune protection, enhanced performance

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In the fight against bacteria and viruses, there are high hopes for the role played by medium-chain functional lipids. Functional vegetable lipids can improve gut health by positively affecting the microbiota and immune function. Believe it or not, the antimicrobial properties of medium-chain functional lipids have been known since the 1800s, but have previously been overlooked as a value-added feed additive due to the use of antibiotics. Functional lipids incorporated into fish feeds are seen as a method to support immune function, resistance to stress and pathogens, and increase fish production. As such, German feed ingredients manufacturer Berg + Schmidt offers natural functional lipids that support the immune system and growth of fish. Thanks to expert knowledge and innovative technology, the company's functional lipids and fats are easy to use and offer numerous health benefits.

Gut health: Epicenter of immunity

The hot topic of gut health encompasses a number of factors. These range from an effective digestive function, optimal absorption of nutrients, the absence of gastrointestinal diseases, good immune status, healthy gut flora to the wellbeing of fish and shrimp. The gut microbiota, which resides in the gastrointestinal tract, provides essential health benefits to its host, particularly by regulating immune homeostasis. Moreover, it has become obvious that alterations to the gut microbial composition can cause immune dysregulation. To maintain this delicate status, a balance between nutrient intake, symbiotic microflora and an optimized mucosa must be maintained. Any negative impact on gut flora, e.g. by oral administration of antibiotics, stressful husbandry conditions, an unbalanced diet or stress, can result in reduced

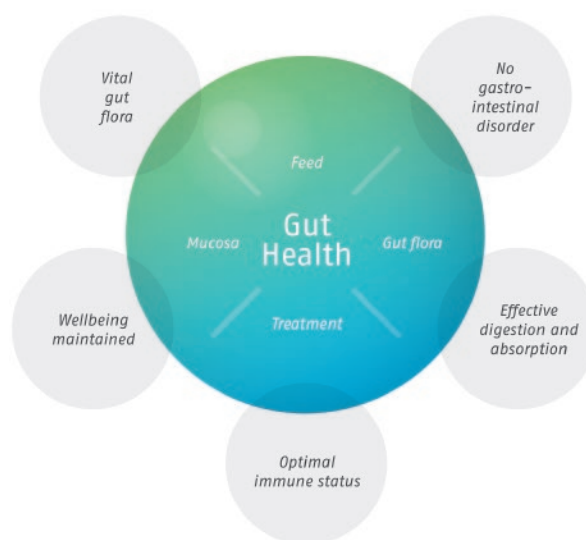


Figure 1. Major points for a healthy gastrointestinal system.

functionality and immune power of the gut. Here, medium-chain functional lipids play a key supporting role.

Smart way to beat pathogens

The antimicrobial properties of fatty acids have been known and used for many decades. However, antibiotic-resistant bacteria, legal regulations and increasing consumer demand for sustainable solutions have driven a need for alternatives such as those found in functional lipids. Medium-chain fatty acids, monoglycerides and triglycerides are saturated fatty acids with carbon lengths of 6, 8, 10 and 12, named caproic, caprylic, capric and lauric acids, respectively. Due to their chain length and unique structure (which is shown in Fig. 2) they can be used as antimicrobial, antiviral, antifungal and anti-inflammatory agents, and can be referred to as medium-chain functional lipids.

In nature, these lipids are found in palm kernel, coconut oil and milk fat. The most effective and powerful form of medium-chain functional lipids is achieved by esterifying with glycerine to form a monoglyceride. It is vital to attach the fatty acid in the 1-alpha position to achieve maximum efficacy of the medium-chain monoglyceride. This chemical structure provides fatty acids with high emulsifying properties, which enables them to interact with both water and lipids. Typically, free fatty acids exhibit their greatest emulsifying properties at lower pH in their non-ionized form. However, monoglycerides do not have a carboxyl group but instead are bound to glycerol. This imparts monoglycerides with emulsifying properties without being pH sensitive. Depending on the temperature, they can be liquid or solid for use in a wide range of applications.

The antimicrobial mode of action of medium-chain functional lipids is believed to fall into different general categories: increased cell permeability, inhibition of enzymes and nutrient uptake, and disruption of the electron transport chain. Medium-chain functional lipids form double-layered micelles that can fuse with the bacterial cell membrane. This can result in the formation of membrane surface pores and tubes, causing cell leakage. At high enough concentrations,

fatty acids can completely solubilize membrane structure and fluidity, impairing the receptors and enzymes necessary to import key nutrients. To disrupt the electron transport chain in the cellular membrane, they bind directly to the transport carriers. This changes the structure via increased membrane fluidity, resulting in less energy for the cell. Other proposed modes of action for medium-chain functional lipids are the lowering of pH inside and outside the cell, reduction of pathogen toxin production, interference with pathogen adhesion and disruption of cell-to-cell signalling.

Trials with shrimp and fish

A study with *Penaeus vannamei* shrimp, conducted at the Kasetsart University (Bangkok, Thailand), demonstrated that *LipoVital Protect Aqua*, a special combination of medium-chain fatty monoglycerides, could improve performance and support gut health of fish and shrimps. The trial focused on growth, survival, immune response and intestinal bacteria composition. Numerous preliminary studies *in vitro* and *in vivo* compared the synergistic effects of monoglycerides against specific aquaculture pathogens. To determine the effects of *LipoVital Protect Aqua* on the resilience of white shrimp, the animals were especially challenged with low dissolved oxygen in laboratory conditions.

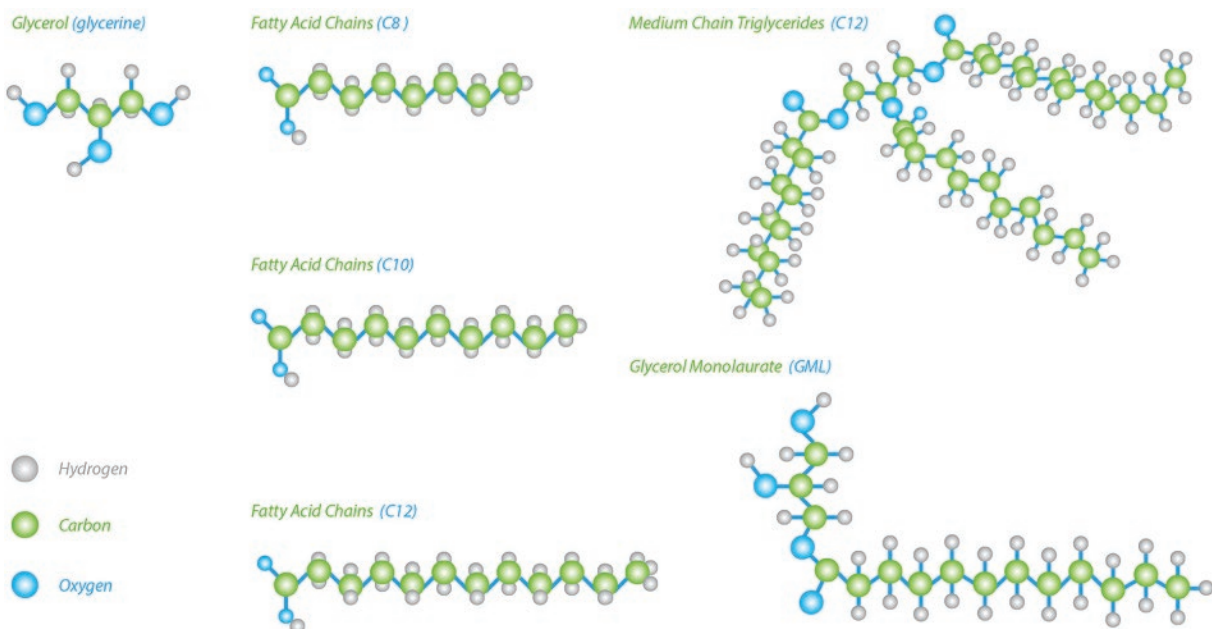


Figure 2. Structure of medium-chain fatty acids.

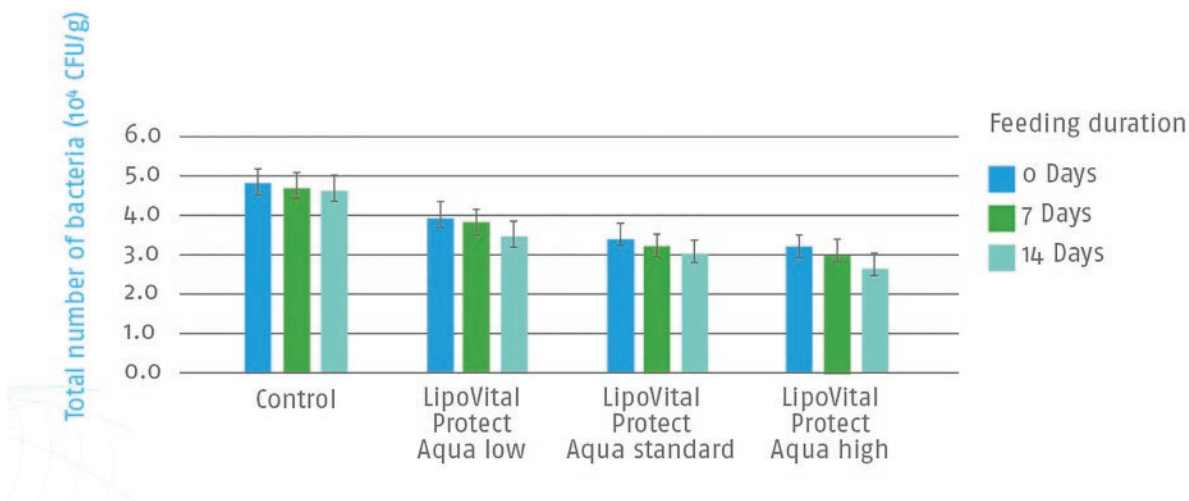


Figure 3. Application of the monoglyceride form of *Lipovital Protect Aqua*.

In conclusion, the study proved that a naturally sourced and specifically composed mix of different medium-chain functional lipids, increased immune function and performance, and reduced the mortality rate. Moreover, *LipoVital Protect Aqua* reduced the count of *Vibrio* spp. Figure 3 shows a dosage-dependent reduction in the total *Vibrio* count. Increasing the length of the feeding period with medium-chain functional lipids showed a further reduction in potentially pathogenic bacteria.

At farm level, *LipoVital Protect Aqua* contributes to more profitable and sustainable production. *LipoVital* can be supplied as a high-purity raw material, and as a customized compound with desired physical criteria. *LipoVital* is effective at low doses. The inclusion rate can be increased under challenging conditions. Berg + Schmidt is currently working with renowned institutes on further trials for the use of *LipoVital* in aquaculture, with promising initial results in salmon and shrimp feeding.

Lecithins: Another powerful ingredient

Besides monoglycerides, lecithins are also a powerful additive providing essential nutrients, stimulating the metabolism, strengthening the immune system and providing high energy content. Furthermore, lecithins are emulsifiers and thus play an important role in fat digestion, and also enable the feed producer to unlock the full energy potential of added oils and fats. Obtained from plants such as soy, rapeseed or sunflower, lecithins can be processed into powders

or liquids. Added to feed solutions for aquaculture, they boost the growth rate and development of young fish, advance the feed conversion and liver metabolism.

As an ingredient with added value, lecithins can also facilitate production processes. Their excellent emulsifying capacity improves the miscibility of raw materials and gives pellets or flakes greater elasticity. In addition, production throughput is increased because lecithin acts as a lubricant. Thanks to their antioxidative qualities, finished products score with a longer shelf life. Since the 2000s, Berg + Schmidt has supplied proven products to the aquaculture business.

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