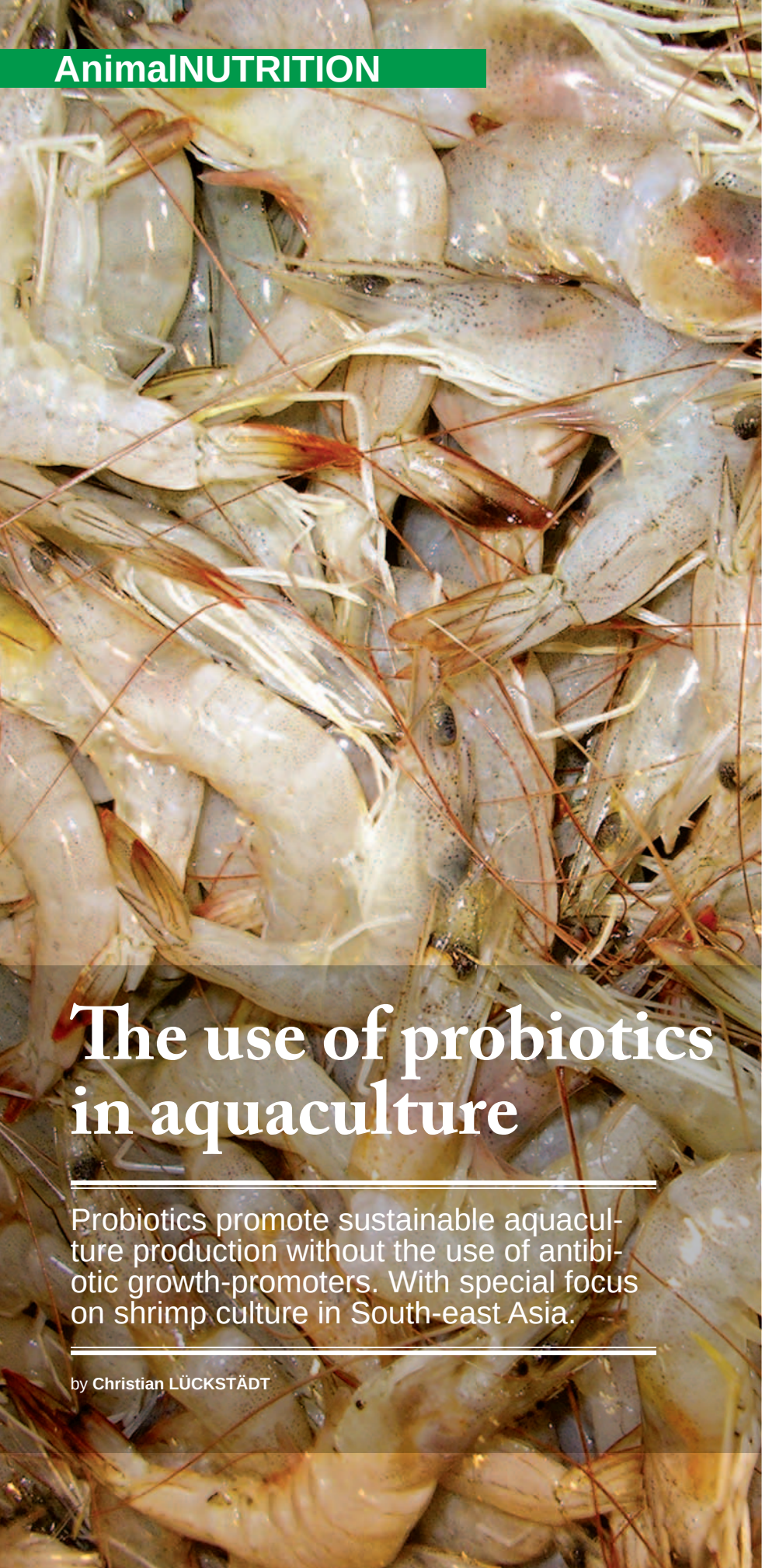


The use of probiotics in aquaculture

Probiotics promote sustainable aquaculture production without the use of antibiotic growth-promoters. With special focus on shrimp culture in South-east Asia.

by **Christian LÜCKSTÄDT**

THE CURRENT situation in world food supply calls for great efforts to be made to meet the requirements for staple diets and high-quality food amid a growing world population, as well as to bridge the widening gap between food demand and supply, especially in developing countries. Setbacks in any food production sector will place greater pressure on other sectors that supply to growing populations in urban and rural areas, particularly in less developed countries.

Around one billion people depend on fish as their main source of protein, and this number is likely to increase further as world population is estimated to grow at an annual rate of 2 percent. Aquaculture now provides more than 22 percent of consumable aquatic products.

Most aquaculture production takes place in developing countries and mainly in Asia. Between 1987 and 1996, aquaculture production of food fish increased by 148 percent per annum, while livestock meat and fisheries grew yearly by only 3 and 1.6 percent respectively. At present, aquaculture is the only sector of growth in the fishing industry and is also reputed to be the fastest growing food production sector in the world.

Since the early 1980s, aquaculture has seen yearly growth rates of about 10 percent. Still, the pace of increase

is much greater in the developing than developed world, because of Asia's economic progress. As a result, global production of farmed fish and shellfish has more than doubled in volume and value in the past 15 years. If aquaculture produce that is not directly consumed by humans, such as seaweed, is included, then world aquaculture production would have more than tripled by weight and value between 1984 and 1996. The contribution of aquaculture to total fish production directly consumed by humans is currently more than 25 percent.

Aquaculture should be recognised as a part of the natural environment where different farming systems operate within larger ecosystems using available natural resources such as water, natural food supply, oxygen, harvested animals and also degraded resources. Folke and Kautsky (1992) described aquaculture as an economic subsystem of an overall ecosystem where the source of all energy and farm inputs lie. Recycling of waste matter is part of the process of this ecosystem.

Aquaculture production differs greatly between countries, cultures, climatic zones and local conditions as well as types of farmed animals. Therefore, production practices and the resulting impact on the ecosystem may vary widely. The promotion of environmentally sound practices in all fields of fish and shrimp production is an essential goal for the aquaculture industry, if sustainability is to be achieved.

To withstand the high stocking densities and related stress situations associated with shrimp production, directly fed probiotics provide a promising sustainable additive.

Consumers and producers have grown more aware of sustainability issues, and this has resulted in calls for responsible aquaculture production. Some regional aquatic practices, such as the much debated issues surrounding shrimp production in South-east Asia, have also come under public scrutiny. Public opinion and regulatory authorities in most export countries are focussing on the misuse of antibiotics in aquaculture, with public attention shifting towards methods of production.

Modern shrimp feed currently contains about 40 to 50 percent of crude protein. Essential amino acids for shrimps are arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, valine, threonine and tryptophan. The crude lipid content should be between 10 and 12 percent for shrimp grow-out and best with high amounts of n-3 series highly unsaturated fatty acids (HUFA). Carbohydrates make up about 20 percent of the diet, and are mostly requried to satisfy energy requirements and also for feed binding.

The energy content of such diets should be approximately from 2,850 to 3,700 kcal/kg of the shrimp diet. However, to withstand the high stocking densities in shrimp production (hatcheries and pond grow-out) and related stress situations (e.g. water parameters such as low dissolved oxygen contents early in the morning), directly fed probiotics provide a promising sustainable additive to stimulate shrimp growth and secure a low disease response. In shrimp grow-out, it was found that directly >>

How probiotics benefit aquaculture

Production of inhibitory compounds
Probiotic bacteria release chemicals which have a bactericidal or bacteriostatic effect. Some of these chemicals are bacteriosins, lysozyme, proteases and organic acids (pH-change).

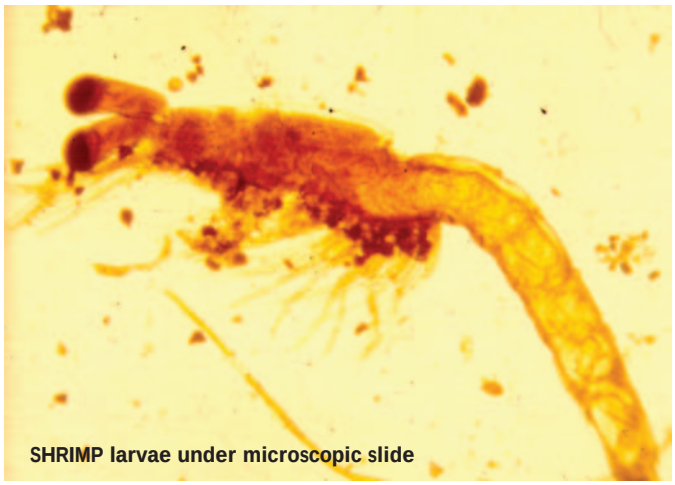
Reduced competition for available energy (nutrients)
Microbial competition for organic substrates (carbon and energy sources) in the intestinal tract of shrimp means that by increasing the relative numbers of probiotic bacteria, nutrients are consumed which would otherwise promote the growth of pathogenic bacteria.

Reduced competition for adhesion sites
Bacteria also compete for gut adhesion sites, where adhesion is a pre-requisite to colonisation in the intestinal tract. By introducing a high number (1,012) of beneficial bacteria (probiotics), harmful bacteria (pathogens) are not able to adhere and thus cannot proliferate.

Enhanced immune response
There are many publications available on immune stimulating substances. Most of these derive from the cell walls of various micro-organisms, such as ß-glucans, lipopolysaccharides (LPS) and peptidoglucan (PG). These substances counter micro-organisms which invade the shrimp's immune system.

Improved water quality
This is usually associated with the *Bacillus* species. In comparison to gram-negative bacteria, gram-positive strains like *Bacillus subtilis* are better converters of organic matter, thus producing carbon dioxide (CO2). This results in lower levels of residues in the pond, so that the biological oxygen demand (BOD) and the chemical oxygen demand (COD) are reduced.

Enzymatic contribution of digestion
Certain bacterial species such as *Bacillus subtilis* are known to produce and release enzymes (e.g. amylase, protease) that are able to improve the digestive process in shrimp.



SHRIMP larvae under microscopic slide

TIGER shrimp ready for harvest

fed probiotics serves as an effective tool to boost survival.

Biomin is a global player in the international feed additive business supporting the "natural way" for almost 20 years. The company recently developed a new line of products for modern sustainable aquaculture, Biomin Aqua Specials, including probiotics for shrimp hatcheries and pond grow-out as well as water treatment.

Those products contain single-strain fermented bacteria strains and cell wall fragments for immune support as described above. These were field-tested under aquaculture conditions in Southeast Asia and are currently used to support an antibiotic-free production of *P. monodon* in the region.

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This paper is based on an article, "Organic aquaculture—sustainable production without antibiotic growth-promoters" from the same writer, posted on May 2005 on www.efeedlink.com