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 Aquafeeds

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# Single-cell proteins from food byproducts provide protein in aquafeed

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**Material contains beneficial nutrients and is free of deleterious levels of mycotoxins and anti-nutritional factors**



In this full-scale production reactor, food-processing wastes are converted into a single-cell bacteria product with protein and amino acid content similar to that of fishmeal.

The aquaculture industry currently supplies approximately 40 percent of the world's food-fish supplies, and projections indicate this number will continue to increase. Because most production of the aquafeed required to support this industry relies on supply-limited sources of protein such as fishmeal, some individuals and institutions predict future shortages for use in aquafeed.

For example, Norway's Aquaculture Protein Center website states: "The trends within the industry indicate an insufficient supply of protein sources in the future. Fish protein as an ingredient in fish feed is now more or less fully exploited. Alternative sources must be found. Such alternatives can be plant-derived protein, protein from microorganisms, or from other marine organisms further down the food chain."

Oberon FMR, Inc., a Denver, Colorado, USA-based biotechnology firm, has developed technology to convert wastes produced during food processing into a valuable single-cell protein (SCP) ingredient for aquafeed. This process, which evolved over the last decade, is applicable to a wide variety of plant-based carbohydrate residuals and has cost advantages over other premium proteins.

## Ingredient alternative

Over the past 40 years, much research has been performed in the area of protein and food alternatives. These studies have included yeast, algal and bacterial SCPs derived from plant and animal wastes, as well as petrochemicals and hydrocarbons. Many of these efforts showed that SCPs have many desirable characteristics as a feed ingredient. More recently, products including distillers grains and other fermented products have come to market on a large scale.

The benefits of microbes in the form of biofloc – a mixture of algae, bacteria and multicellular organisms – within shrimp and tilapia culture systems are well known. Bacteria and fermented products are clearly part of aquaculture's future.

The waste-based bacterial SCP product is a nutritious and desirable ingredient for use in feeds (Table 1). The material contains beneficial quantities of vitamins and minerals, coenzymes and free nucleic acids (8 to 12 percent of sample), and is free of deleterious levels of mycotoxins, anti-nutritional factors and other constituents that limit its use in aquafeeds.

**Table 1. Nutritional characteristics of bacterial SCP.**

Composition		%	Amino Acids		As Fed (%)
Crude protein		65.0-67.0	Alanine		3.82
Crude fat		6.5	Arginine		3.60
Mineral Material		12.5	Aspartic acid		6.36
Crude fiber		1.0-2.0	Glutamic acid		8.04
Carbohydrate		13.0-14.0	Glycine		2.81
<b>Vitamins</b>			Histidine		1.46
Niacin		83.3 mg/kg	Isoleucine		3.38
Thiamine B1		7.7 mg/kg	Leucine		5.06
Riboflavin		39.0 mg/kg	Lysine		4.34
Vitamin B12		12.0 mg/kg	Methionine		1.41
Vitamin E		29.8 IU/kg	Cysteine		0.55
<b>Other</b>			Phenylalanine		3.29
Fatty acids		4-5%	Proline		2.77
Ubiquinone		0.004%	Serine		2.82
Moisture		Less than 5%	Taurine		0.25
Color		Light Brown	Threonine		3.11
			Tryptophan		0.98
			Tyrosine		2.83
			Valine		3.52
			Total		60.4

## SCP production



Bacterial waste can be economically converted into a valuable single-cell protein ingredient for aquafeed.

Production of SCPs through the utilization of food-processing wastes offers varied benefits. The utilization of a waste as the growth medium significantly improves the economics. Bacteria can thrive in a variety of environments and utilize a variety of growth substrates, which leads to a scalable process.

The protein content and amino acid composition of bacterial cells is very similar to those of fishmeal. Bacterial generation times are much shorter than those of yeasts or algae, often on the order of 20 to 30 minutes rather than the hours or even days required by the other organisms.

The authors estimate that the global production potential of food-processing SCPs is in excess of 1 mmt annually. Large-scale production of this bacterial SCP for use in aquaculture could result in environmental benefits to marine and coastal ecosystems, as the need for wild fish as an aquafeed ingredient is reduced. In addition, wastewater treatment center operations will see economic benefits by realizing a valuable product from wastes that currently require disposal. Improved economics of wastewater treatment will also provide a stimulus for increased treatment of wastes in the developing world, where much wastewater is discharged without treatment.

## Feeding trials

The authors performed feeding trials with Pacific white shrimp (*Litopenaeus vannamei*) and recorded excellent growth and health in animals that consumed SCPs in their diet (Fig. 1). During a trial at Texas Agrilife Mariculture Lab in Port Aransas, Texas, USA, white shrimp performed as well or better on feeds formulated with SCP and no fishmeal as they did on fishmeal-based feeds. This work is ongoing.

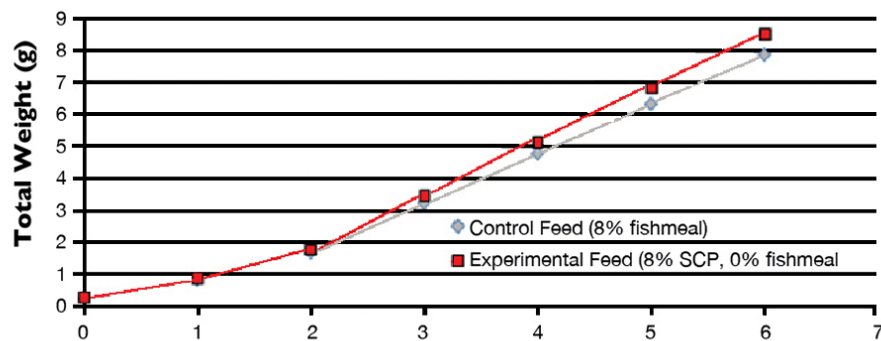


Fig. 1: White shrimp growth using fishmeal- or SCP-based feeds.

Past and ongoing feeding trials with salmon, rainbow trout, tilapia, yellowtail, poultry and pigs have also shown promising results.

Recent activities included a full-scale demonstration at a major brewer in the United States. Full-scale implementation of the SCP process – planned for September 2011 – would result in the daily production of 15 tons of SCP. To meet the anticipated needs of the industry, additional production facilities could be started every 10 months thereafter.

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