Soy Peptides: A new ingredient for aqua feeds

To the wide range of soy products available to feed manufacturing, a new product has been added in the recent past. Soy peptides produced by bacterial fermentation of soy grits have unique nutritional and functional properties and offer interesting possibilities in aqua feed manufacturing.

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Soybean meal is the primary plant protein used in most animal feeds, including aquaculture feeds. Heat-treated soybeans, soybean meal, lecithin, crude soybean oil and isolates and concentrates of soybean protein are other soybean products that are used by the feed industry. The nutritive properties of various soybean products are well documented. A product that has recently been developed for application in both human and animal nutrition is soy peptides. This product offers several advantages as an ingredient in aquaculture diets, particularly in shrimp feeds. It serves as an excellent source of small-chain protein molecules that are easily absorbed in the animal's gut system. The presence of various free amino acids makes it as a potential source of attractants. Its physical form provides good binding characteristics in pellet processing. Its emulsification properties, besides serving a nutritional purpose, may also protect water soluble nutrients in the feed from leaching out into the water.

Manufacturing of Soy Peptides

Soy peptides are manufactured by fermentation of defatted soy grits. A simple illustration of the manufacturing process is as shown below:

Soy grits

1. Sterilization
2. Mixing with enzyme and broth
3. Inoculating with lactobacillus
4. Incubation for 48 Hrs
5. Drying with low temperature to keep high solubility
6. Grinding and packaging soy peptide

Soy peptide

Nutritive Properties of Soy Peptides

The soy grits undergo extensive hydrolysis during the fermentation process. As a result, many anti-nutritive factors of soybean are inactivated. Furthermore, high solubility and digestibility are achieved. So, soy peptides are very different from other soy products in their nutritive properties (Table 1; 2).

Table 1: Comparison of various soy products

	Soy protein concentrate	Hi-pro soy bean meal/or grits	Soy peptide
Crude Protein	65-68%	48-50%	53%
Urease activity, δpH	<0.01	0.3-0.02	<0.01
Nitrogen solubility Index (NSI)	5-10%	10-15%	38-43%

In aquaculture, fishmeal is often considered as the gold standard to compare other sources of protein with. However, fishmeal quality is highly variable. The protein digestibility of fish meal ranges from 80% to 95% depending upon the freshness of the fish and heat processing. Due to the nature of its processing, soy peptides are much more consistent. True ileal protein digestibility of soy peptides for pigs is 95% and the average true amino acid digestibility for broiler is 94.1%. Unlike fishmeal, the soy peptides do not contain biogenic amines such as histamine.

Table 2: Typical analysis of soy peptides

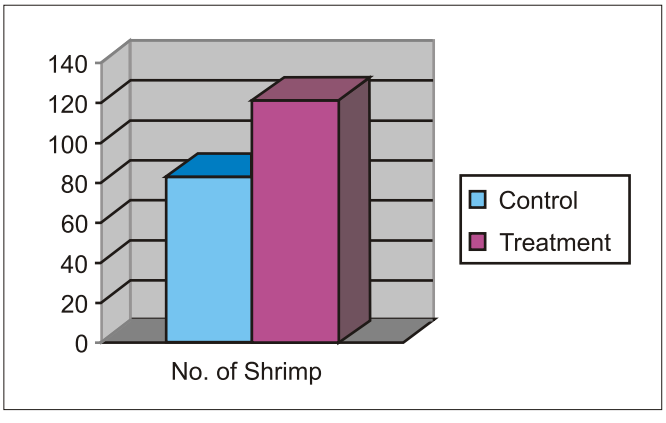
Moisture	8 %
Crude Protein	53 %
Crude Fat	0.8 %
Ash	6.8 %
Crude Fiber	3.5 %
Neutral Digestible Fiber	4.0 %
Acid Digestible Fiber	6.2 %
Digestible Energy*	4075 Kcal/Kg
Metabolizable Energy*	3635 Kcal/Kg
Net Energy*	2300 Kcal/Kg
Lactic acid	> 3.0%
pH Value	4.3-4.8
Trypsin Inhibitor	1 mg/g Protein
Oligosaccharides	<1 %
Antigenic Protein	$Log_2 < 1$
Urease Activity	<0.1 mg/g N
ß-conglycinine	<1 ppm
Saponins	Negative

* Swine

Functional Properties of Soy Peptides

The functional properties of soy peptides are derived from the fact that the hydrolysis of soy protein produces peptides with hydrophilic ends. Furthermore, the process creates peptides with super hydrogen bonds, particularly sulfa-hydrogen bonds. As a result, the peptides are highly soluble, yet form strong intra-molecular bonds that provide good stability. The presence of low molecular weight, short-chain peptides and free amino acids makes it a potentially good attractant.

Figure 1: Number of shrimp in the feeding trays containing feed with (treatment) and without (control) soy peptides



Soy Peptides as Attractants

Soluble peptides and amino acids stimulate the taste buds of livestock and cause taste. They also play a major role in the chemoattraction of aquatic animals, particularly shrimp. In a simple test conducted in Tainan, Taiwan, it was shown that a diet containing 10% soy peptide attracted more shrimp compared to the control diet that did not contain any soy peptide (Figure 1). The trial was conducted in a 5000 sq.m. pond (80 m×65 m). Three points along the side of pond were selected randomly to set feeding trays. At each point we set three pairs of feeding trays. In each tray, we put 100 g of shrimp feed and counted the number of shrimp present in the tray after 1 hour.

Binding Capacity of Soy Peptides

The binding capacity of soy peptide is estimated to be about a quarter of that of wheat gluten. The binding capacity of wheat gluten is due to the formation of protein matrix that provides both strength and non-permeation of water. It is suspected that wheat gluten may not be very well digested in neutral pH guts (such as that of shrimp) due to the latter reason. The binding ability of soy peptides is due to its hydrogen bonds. Though these bonds are weaker, they provide some binding effect while at the same time, are highly digestible. This has been indirectly demonstrated in pigs (Table 3).

Table 3: Protein digestibility of soy peptides vs. wheat gluten

	True Ileal digestibility (pig)	PDCAAS*
Soy Peptide	95%**	
Soy Protein Concentrate	92% (NRC)	0.99
Wheat gluten		0.25

** PDCAAS: Protein Digestibility Corrected Amino Acid Score. Source: FAO/WHO (1991) Protein Quality Evaluation Report of Joint FAO/WHO Expert Consultation, Food & Agriculture Organization of United Nations, FAO Food and Nutrition Paper No.51, Rome.*

*** Determined by Japan Scientific Feed Association*

We believe that soy peptide's function as an emulsifier also contributes to its binding capacity especially in feeds containing high levels of oil. We have found that a shrimp feed containing 6.5% fat could be made with 12% wheat flour and 7.5% soy peptide and maintain water stability for three hours

Soy Peptide as an Emulsifier

Soy peptide is an excellent emulsifier. Even though it does not contain phospholipids, it can be homogenized with water and oil at a ratio of 1:7:1 (w/w) to create a stable emulsion. Lecithin is a valuable ingredient in shrimp feeds because it supplies phospholipids and is an emulsifier. But, it is expensive and difficult to mix in the feed due to its stickiness. It is likely that soy peptide could substitute part of the lecithin in shrimp feeds.

Soy Peptides for Carnivorous Fish

Inclusion levels of vegetable protein in the diets of carnivorous fish are limited because most carnivores do not have enzymes to digest fibers and carbohydrates that are present in the vegetable protein sources. Of particular concern

are oligosaccharides that are indigestible to fish and result in flatulence due to bacterial action. Fermentation reduces the levels of indigestible nutrients and allows higher levels of vegetable protein addition in the feeds. In a study on eels, we substituted up to 40% of fish meal with soy peptide (see Table 4 for the formulas). After 13 weeks of feeding, there was no obvious difference in the weight gain of the eels fed the different diets (Table 5) showing that it is possible to substitute a significant portion of fishmeal with soy peptides in the diet of a carnivorous fish.

Table 4: Experimental feed formulas for the eel feeding trial

	SP-0	SP-10	SP-20	SP-30
Soy Peptide	0	100	200	300
White fish meal 66%	690	590	490	390
a-starch	180	180	180	180
Skim Milk	44	44	44	44
Yeast Powder	25	25	25	25
Liver meal	30	30	30	30
Salt	6	6	6	6
Premixes	60	60	60	60
Cod oil	0	6	12	18
Crude Protein%	48.0	46.6	44.8	43.2
Crude fat %	4	4	4	4

Can Soy Peptides Conserve Water Quality?

One of the interesting properties of soy peptides we have discovered is that it takes a long time to deteriorate in water. Soy peptides can be soaked in water 8 times of its weight and yet would have not spoilt for 5 days. If soy peptides are mixed with fish meal at a ratio of 1:3 and soaked in water 8 times of its weight and not have spoilt for 2 days. We have done a small experiment in which we have mixed soy peptide and fishmeal at different ratios and then soaked the mixture in water for 24 hours. The nitrite content of the water was measured initially and after 24 hours. The results (Table 6) clearly demonstrated that there was no increase in the nitrite content when soy peptides were added to fishmeal. It is also noteworthy that the fishmeal had some nitrite as evident from the initial data. The water quality protection capacity of the soy peptides may be due to the production of lactic acid (due to fermentation by *Lactobacillus*).

Table 5: Results of the 13-week eel feeding trial (see table 4 for formulas)

	SP-0	SP-10	SP-20	SP-30
Number of eels	500	500	500	500
Avg. initial weight (g/eel)	85.0±6.1	83.4±5.8	85.8±5.9	84.6±6.3
Avg. final weight (g/eel)	234.2±8.9	231.4±12.6	234.4±11.2	232.0±10.3
Gain (g/eel)	149.2±9.3	148±11.4	148.6±10.7	147.4±9.8
FCR	2.46	2.48	2.47	2.49

Health Effects

Some peptides are known to have human health functions. Soy peptides have been shown to lower serum cholesterol, inhibit tumor growth and stimulate immune system in humans. In baby pigs, we have preliminary evidence that it helps increasing trace mineral absorption probably through chelate formation with the peptides. The health aspects of soy peptide in aquatic animal health have not been investigated.

Table 6: Nitrite-Nitrogen levels in water in which different amounts of soy peptide and fishmeal were soaked for 24 hours

	Control	Treatment 1	Treatment 2	Treatment 3
Soy Peptide (g)	0	10	20	30
Fishmeal (g)	40	30	20	10
Water (c.c.)	320	320	320	320
NO2-N content (ppm)				
Initial	0.05	0.04	0.03	0.02
After 24hrs	0.5	0.04	0.03	0.02

Conclusions

The ability to include higher levels of plant proteins in aqua feeds is a key to the future sustainability of aquaculture. Fermentation offers a way to increase plant protein use in aqua feeds without lowering animal performance. Preliminary research has demonstrated clearly that soy peptides have a great promise as aqua feed ingredients. Its nutritive and functional superiority means that it could become a viable fishmeal substitute in aqua feeds.

Mr. Teddy Liao was born in 1956 in Taiwan. He graduated from the Department of Animal Science, National Taiwan University in 1980. He is the President of DaBomb Protein Corp., Taiwan.

NOTE: Soy peptides used in all trials were supplied by DaBomb Protein Corp. and identified by the trademark DaBomb-P. Contact: Alice Liu (*alice@dabombprotein.com*) for more details of the trials and the product. Also, check out the website *http://www.dabombprotein.com.tw*