Hydrolysed by-products in shrimp feed

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Abstract

Trials with AquaTrac sol SD in shrimp feed not only showed an increase in performance but also better water durability of the feed pellets. Furthermore, the protein concentrate adds important chemo-attractant to the feed.

1. Introduction

Processing waste and by-products into feed ingredients of extraordinary high feeding value for aquaculture feed is the premise of the future.
This can be achieved by hydrolysation, whereby solid material is converted into liquids. Particularly protein rich raw materials are used in this biotechnology process.
Hydrolysation of waste and by-products utilizes the experiences from the food processing industry which has used enzymatic hydrolysis since the 1960's to achieve better protein solubility.

2. Benefits of hydrolysation

Hydrolysation of by-products has been shown to have beneficial effects in shrimp feed. A study aimed at replacing fish meal in the diet of shrimp feed with 3.0 hydrolysed fish protein concentrate showed an improved weight gain of shrimps. However, higher inclusion rates have not resulted in additional weight gain.
These findings were supported by other studies in 2002 and 2004, which demonstrated that the enrichment of a shrimp diet with hydrolysed shrimp waste improved feed intake, growth rate and feed conversion significantly.
Another study looked at the substitution of soybean components by hydrolysed soybean meal in feed for shrimps, hybrid cat fish and tilapia and showed substantial animal performance increases.
The gut protecting properties of hydrolysed products have also been shown in piglets, where hydrolysed brewer's yeast showed a reduction in E.coli infections.

3. HPPC

The use of AquaTrac sol SD is gaining interest in shrimp farming. AquaTrac sol SD is processed from solid waste and by-products from poultry slaughterhouses. Feather meal, however, is not included in this material.
The raw material is minced to obtain a large surface area for a better and faster thermal hydrolyses. During the wet melting process protein, fat and water are separated by centrifuge. After completion of hydrolysation the insoluble matter such as bones and other indigestible solids are removed.
The liquid material is concentrated, pasteurized and spray dried.
The finished product is a powder of light brown colour and pleasant odour.
During the hydrolysation process temperature, time and pH have to be strictly controlled to produce and desired short-chained peptides.
These peptides have antimicrobial properties. Peptides are already used extensively in the food industry, e.g. in infant food and dental therapeutics (mouth rinses) because of these properties.
AquaTrac sol SD is characterized by its relatively high protein content. The in vitro protein digestibility (96%) is high. The dry matter level is about 94% while the crude fibre content on the other hand is noticeable low **(Table 1)**.

Table 1: Chemical composition of hydrolysed poultry protein concentrate (HPPC), in comparison to hydrolysed fish protein concentrate (HPFC) and hydrolysed soybean meal (HSM) (% as fed)

	HPPC	HPFC	HSM
Dry Matter	95.5	96.0	94.0
Crude protein	71.5	80.0	60.0
Crude fat	2.1	0.3	-
Crude fibre	0.6	1.0	5.5
Crude ash	8.7	-	-
N-free extract	12.6	-	23.0
Calcium	2.4	0.3	-
Phosphorus	2.4	0.6	
Digestible energy			
Kcal/kg	3755 [1]	4110 [2]	3150 [3]
MJ/kg	15.7	17.2	13.0

[1] Calculated [2] In vivo determined in salmonids [3] Pigs

The calculated digestible energy is high. This may refer to the fact that the thermal hydrolysation is a kind of "pre-digestion". The calcium and phosphorus level is not only high but almost equal.
This results in a favourable Ca:P ratio for aquaculture feed of almost 1:1. For AquaTrac sol SD it is claimed that it is not only a performance promoter but that is also has binding and chemo-attractant properties.
These three claims will be evaluated here.

4. Binding capacity

Pelletised shrimp feed has to be water durable for at least 2.5 hours in order to minimise feed losses. To achieve this target a pellet binder has to be added to the feed formulation.
In a laboratory study the binding capacity of AquaTrac sol SD in pelletised shrimp feed has been evaluated. Levels of 2.0% and 5.0% AquaTrac sol SD respectively, were included in a commercial shrimp feed.
The water durability of the experimental feed was analysed by the dry matter loss test and in addition rated by the subjective water durability rating system.
The dry matter loss test, as an indicator for water durability, was statistically significantly better for AquaTrac sol SD in comparison to the control.
The subjective rating has resulted in a positive improvement of 0.1 to 0.2 points in favour for AquaTrac sol SD (Results not presented). A study in 2005 testing water durability of AquaTrac sol SD reported similar results using a modified dry matter loss test. *(GEPRO Information 1/2005)*.
From the available test results, therefore, it can be concluded that AquaTrac sol SD contributes noticeably to the water durability of pelletised shrimp feed.

AquaTrac sol SD in shrimp feeding

In a 60-day aquarium experiment the feeding value of AquaTrac sol SD has been tested at inclusion rates of 1.0% and 2.0%, respectively. A total of 120 juvenile black tiger shrimps *(Penaeus monodon)* of a live weight of 0.54g were divided into three groups with two replicates each and kept in six aquaria with a water capacity of 450 l each.
The stocking density was equal to 24 shrimps / m².
The three groups were fed with a semi-intensive pelletised starter feed **(Table 2)** at a feeding rate of 10% of the animals' body weight, equally divided into five feeding times.
Left-over feed was collected two hours after each

Table 2: Nutritional content of the experimental feed			
HPPC %	0.0	1.0	2.0
Moisture %	9.2	10.6	9.9
Crude protein %	41.9	42.7	42.9
HCL- Pepsin Digestibility %	90.2	91.0	91.6
Crude fat %	7.0	7.3	7.2
Crude fibre %	1.8	1.7	1.9
Crude ash %	10.6	10.5	10.5
N-free extract %	29.5	27.2	27.6
Calcium %	2.7	2.8	2.7
Phosphorus %	1.7	1.8	1.7
Digestible energy			
Kcal/kg	3.611	3628.5	3.616
MJ/kg	15.1	15.2	15.1

feeding time to compute the true feed consumption.
The average water quality and microbiological parameters were equal for all groups and in the recommended range.
From early in the trial the two test groups surpassed the control group as indicated in the specific growth rate **(Figure 1)**.
This was maintained until the end of the experiment. For the entire trial period the specific growth rate was 18.9% better for 1.0% AquaTrac sol SD compared with the control, and 30.6% better for 2.0% AquaTrac sol SD.

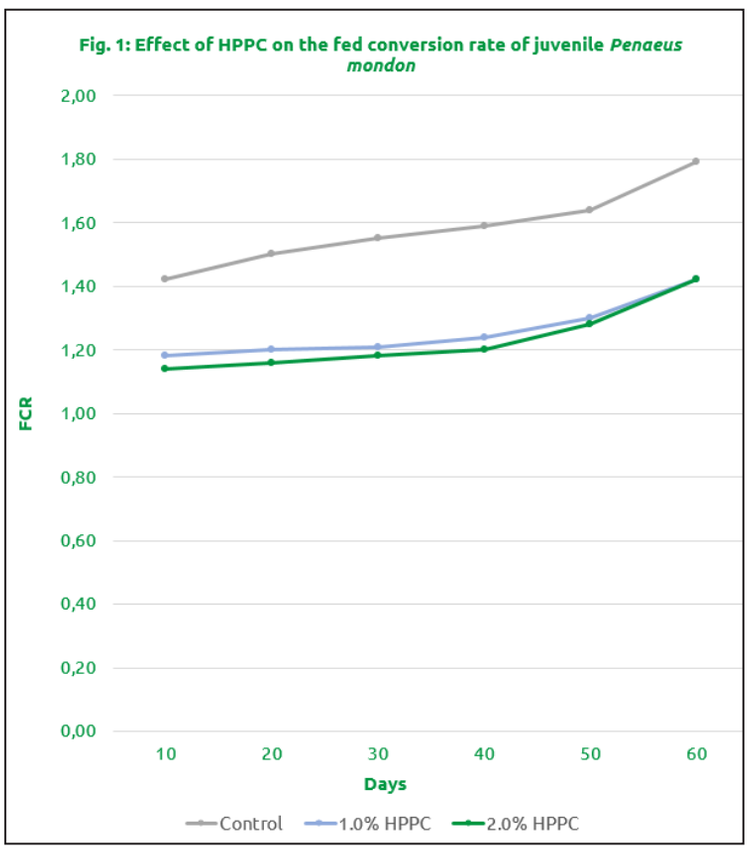
Table 3: Effect of feeding *Penaeus monodon* juveniles with HPPC				
HPPC		0	1	2
Animals	Numbers	40	40	40
Replicates	Numbers	2	2	2
Initial Live weight	g	0.54	0.55	0.53
Final Live weight	g	4.91	5.84	6.13
Weight gain	g	4.37 a)	5.29 b)	5.6
	rel.	100	121.1	128.1
Specific growth rate	%	809.26 a)	961.82 b)	1056.6 c)
	rel.	100	118.9	130.6
Feed conversion rate	1	1.67 a)	1.41 b)	1.4 c)
	rel.	100	84.4	83.8
Protein efficiency Ratio	1	1.29 a)	1.48 b)	1.52 c)
	rel.	100	114.7	117.8
Speediness of feed *First 30 min. after Feed application*	%	42 a)	54 b)	59 c)
Intake [1]	rel.	100	128.6	140.5
Molting	Numbers	74	86	98
	rel.	100	116.2	132.4

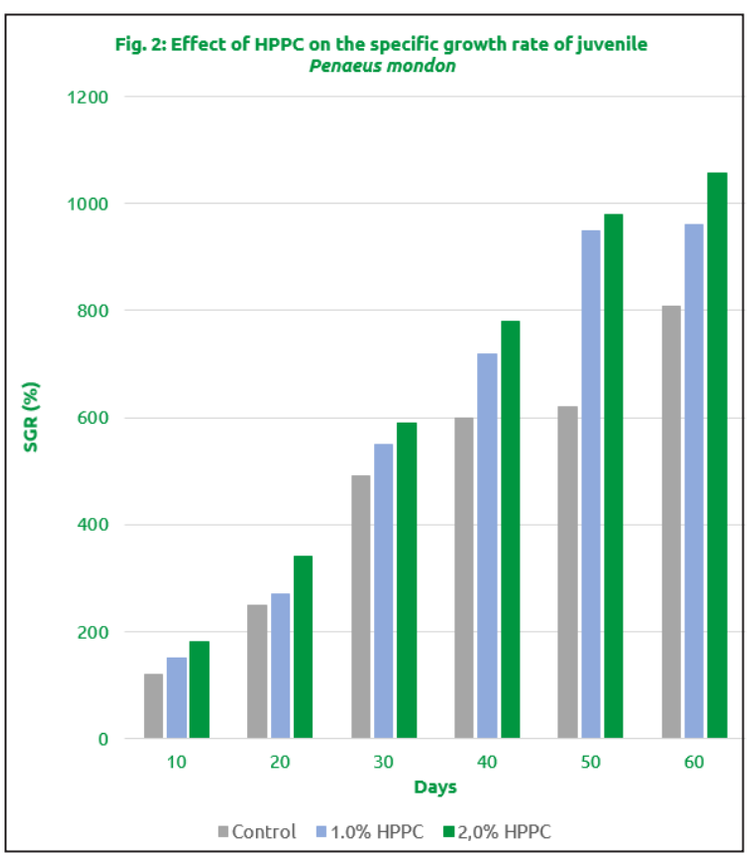
[1)] Feed consumed in the first 30 minutes after feed application
Different letters in the superscript in any one row denote statistically significant differences between means (P<0.05)

The differences to the control are statistically significant. However, this is not the case between both AquaTrac sol SD groups **(Table 3)**.
In this context it has to be noticed that the final live weight standard deviation for the control group is higher than for both test groups which expresses that the animals of the control group are less equal in size.
The feed conversion is best for 2.0% AquaTrac sol SD (1.40) followed by 1.0% AquaTrac sol SD (1.41) and the control with 1.67. The positive differences to the control of 15.6% and 16.2%, respectively significance between 1.0% and 2.0% AquaTrac sol SD. **Figure 2** demonstrates the development of the feed conversion rate and shows the gap to the control group from the beginning of the trial.
The same tendency applied for the protein efficiency ratio **(Table 3)**. The AquaTrac sol SD fed animals have molted statistically significantly more often than the control shrimps. The faster growth of the former increased the frequency of throwing off the exoskeleton. During the entire trial period no animals were lost.
At the tested inclusion rates of 1.0% and 2.0%, respectively, AquaTrac sol SD is highly beneficial for the development of Penaeus monodon. Similar observations were reported by a study in 2005, in cage trials conducted with AquaTrac sol SD in juvenile Litopenaeus vannamei.

5. Chemo-attractant properties

Formulated shrimp feed is fortified with chemo-attractants, also named phagostimulatory substances. They provide the proper "signal" that allow shrimps to recognize the pellet as a potential food source.
Effective attractants which stimulate the gustatory (taste) and olfactory (smell) senses of shrimps are merely all products of marine animal origin.
For obtaining information of the chemo-attractant properties of AquaTrac sol SD, the speediness of the feed intake by shrimps was used as a parameter.
The feed consumption in the first 30 minutes after feeding was recorded. The 2.0% AquaTrac sol SD group has ingested the feed 40.5% faster than the control animals followed





by 28.6% by the 1.0% AquaTrac sol SD group. The differences to the control are statistically significant, but not between both AquaTrac sol SD groups **(Table 3**).

The results correlate with previous findings in tests with HPPC in Litopenaeus vannamei. Without doubts, therefore, AquaTrac sol SD provides chemo-attractants to shrimp feed.

AquaTrac sol SD for all cited trials were provided be GEPRO Geflügel-Protein Vertriebsgesellschaft mbH & Co.KG. Diepholz / Germany,

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