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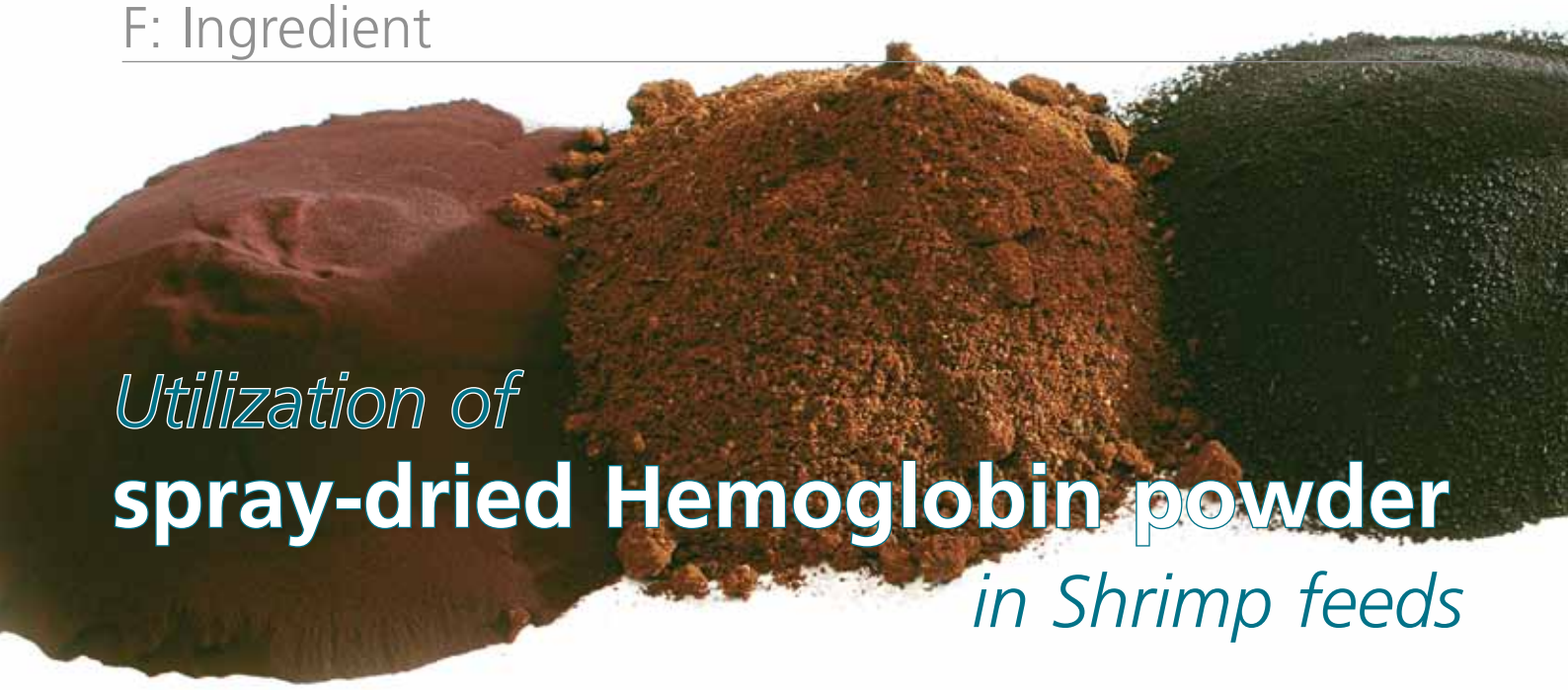

Utilization of spray-dried Hemoglobin powder *in Shrimp feeds*

by Eric De Muylder[1], Leon Claessens[2], Marjorie Roux[2], Carine van Vuure[3] and Geert van der Velden[3]
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As a result of the scarceness of fishmeal and higher demand, resulting in increasing prices, there is a growing interest to replace fishmeal with other protein sources.

Vegetable protein sources are widely available but the replacement of fishmeal by those vegetable proteins is limited in some aquatic species. The main nutritional problems associated with higher utilisation of vegetable protein sources are unbalanced amino acid profile, lower digestibility of amino acids, high fiber content, presence of anti-nutritional factors and low availability of phosphorus.

"In larval fish, carnivorous fish and shrimp the availability of proteins and amino acids is a limiting factor for growth. Hemoglobin powder is spray-dried, resulting in a non-denatured product with a higher digestibility"

This is especially true for more carnivorous fish species or for aquatic species with a rudimentary digestive system such as larval fish, juveniles and shrimp.

Animal proteins

Processed animal proteins are a valuable source of proteins and should be considered as alternative protein source in those diets. Hemoglobin powder needs to be considered because of its high protein content.

In larval fish, carnivorous fish and shrimp the availability of proteins and amino acids is a limiting factor for growth. Hemoglobin powder is spray-dried, resulting in a non-denatured product with a higher digestibility.

The goal – This was to test the inclusion of Hemoglobin powder (HGP) in feeds for shrimp (*Litopenaeus vannamei*) mainly to replace fishmeal.

Digestibility and composition - Amino acid content of Hemoglobin Powder is compared with amino acid requirements of shrimp, expressed as percentage of protein (D'Abramo et al, 1997)

Degree of hydrolysis (DH%) of various blood meals

Shrimp are poor digesters. Their digesting system is rudimentary and a lot of nutrients can pass their digestive system without being assimilated. The enzymes associated with shrimp also differ from other aquatic organisms. Therefore, it is important to evaluate ingredient digestibility with shrimp enzymes.

Protein digestion in shrimp digestive tract was simulated through the reaction of ingredient protein and shrimp proteolytic enzymes. Enzymes from the hepatopancreas (digestive gland) of *Litopenaeus vannamei* were employed in the present analysis.

Table 1: Hemoglobin powder has a high level of Lysine, but is deficient in Methionine. However, this deficiency is compensated by its higher digestibility.

Amino acid as % of protein	HGP	Shrimp requirement
Arginine	4,0	5.8
Histidine	7,8	2.1
Isoleucine	0,5	3.4
Leucine	13,5	5.4
Valine	9,2	4.0
Lysine	9,0	5.3
Phenylalanine	6,9	4.0
Methionine	0,7	2.4
Cystine	0,7	1.2
Threonine	3,1	3.6
Tryptophan	1,4	0.8

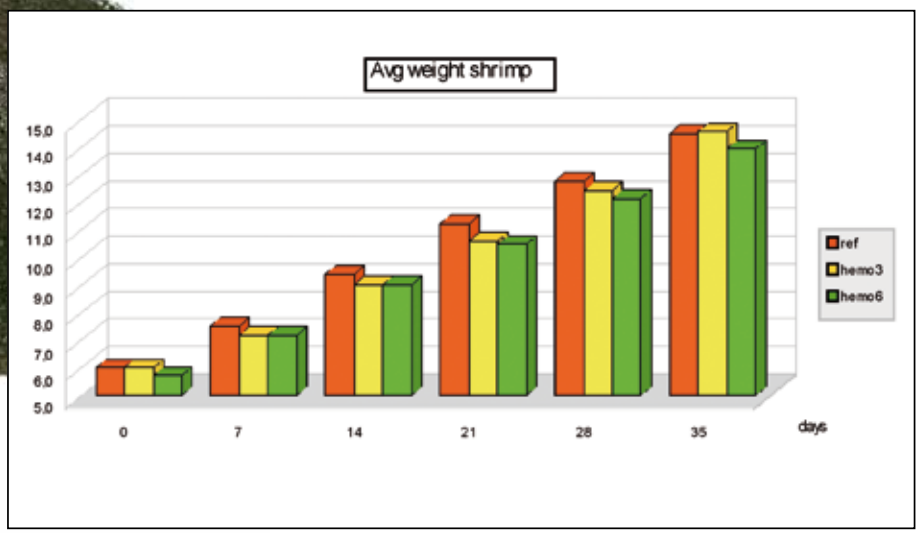


Table 2: Spray dried Hemoglobin powder shows a higher digestibility than Poultry blood meal and Porcine blood meal. This is due to the spray-drying, which doesn't denature the proteins.

Sample/Origin	(DH%)
Poultry blood meal	1.71
Porcine blood meal	1.45
Spray dried Hemoglobin powder	9.76
Soybean meal (as reference)	3,38

The assay is based on the breakage of peptide bonds of ingredient protein through digestive enzyme action. The degree of hydrolysis (DH%) obtained is proportional to the number of peptide bonds cleaved (Ezquerra et al., 1997; Lemos et al., 2000).

This degree of hydrolysis is related to the apparent digestibility of the feed or ingredient.

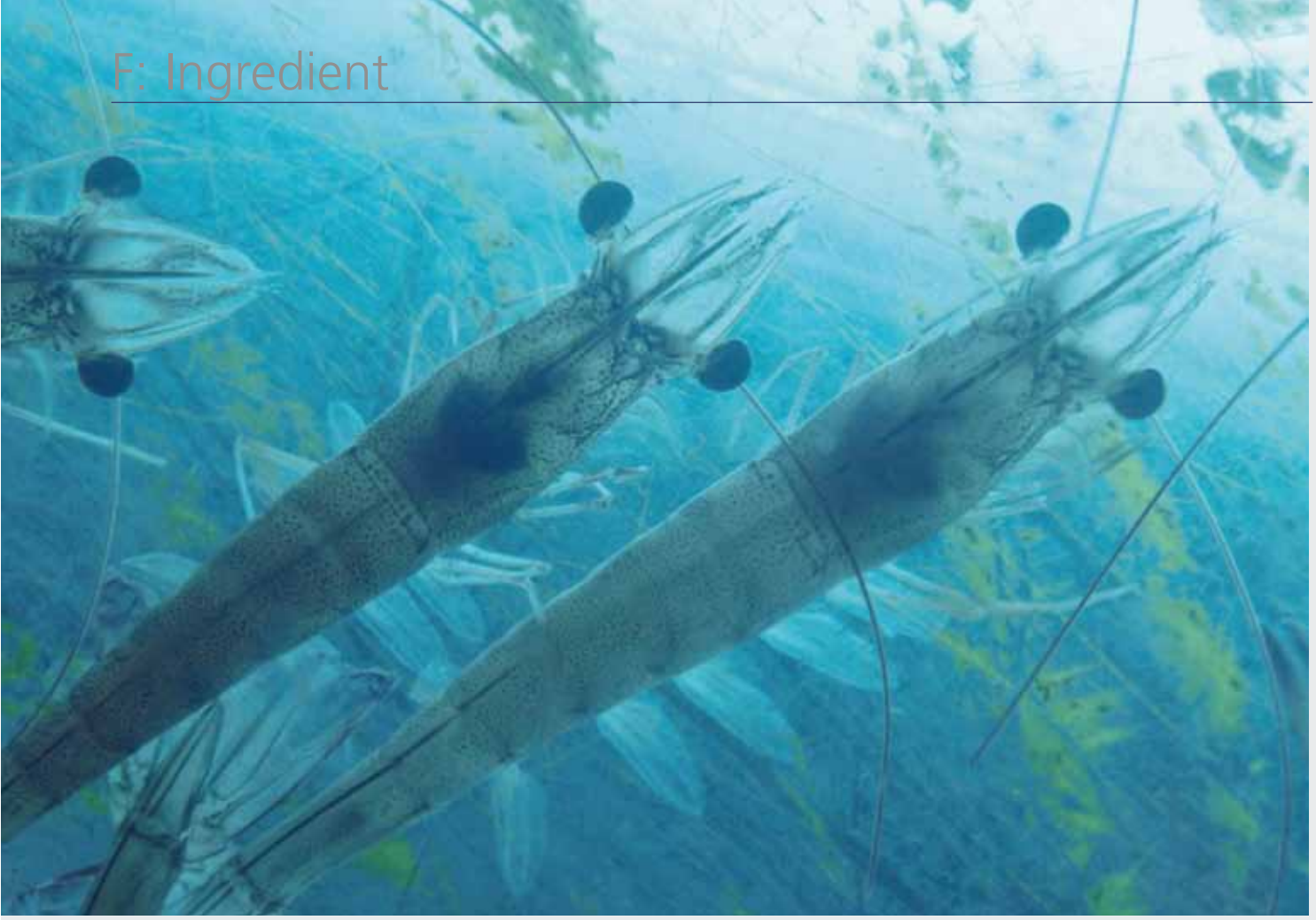
However, it is not possible to make a 100 percent relation between degree of hydrolysis and apparent digestibility measurements. The degree of hydrolysis can be better used as relative comparison. However, Lemos & Nunes (2007) showed that the degree of hydrolysis of commercials shrimp feed brands had the best correlation with actual shrimp growth, even better than apparent digestibility or amino acid balance.

Growth trial

Material and Methods

Diets

The Hemoglobin powder (HGP) was included in two inclusion levels: three and six percent, along with a reference diet without HGP (See table). Fishmeal content was reduced from 14 to 6,1 percent. Fish oil was adjusted to achieve the same lipid content for all diets.



Shrimp

31 shrimp were acclimatized in the nets during one week. They were than measured and the trial starter. Shrimp were obtained from the Happy Shrimp farm and transferred to AFT. The shrimp trial lasted for five weeks.

Experimental system

There are 12 nets of 150 L. The nets are submerged in a bigger tank, which is connected to a biofloc reactor. Water quality is maintained through bioflocs and is the same in all nets.

There are 4 replicates for each diet.

Each net was stocked with 31 shrimp of 6 g each.

"The replacement of fishmeal in the diet of Litopenaeus vannamei by HGP at three percent results in improved growth and FCR"

Measurements during trial:

At the start and each week, the shrimp were weighted together and counted, to have the average weight and total biomass. Feeding gift was adjusted daily according to an expected growth curve and average weight from last measurement.

At the end of the experiment, all shrimp were weighed individually.

Water quality

DO was more than 6 ppm at all times. Temperature was between 27,2 and 27,7 °C

Salinity was kept between 14 and 15 ppt. pH was between 7,3 and 7,7

Results

All shrimp showed very good growth (>1,5 g/week) during the experiment and more than doubled their individual weight at start.

Table 3

Raw Material :	reference	Hemo 3	Hemo 6
Corn gluten	11	11	11
Danish fishmeal	14	10,05	6,1
Squid meal	4	4	4
Hemoglobin powder 92P		3	6
Rapeseed meal	12	12	12
Wheat flour	31,4	32,05	32,7
Soybean meal	16	16	16
Fish oil	3,4	3,7	4
Other	8,2	8,2	8,2
Total	100	100	100

Composition	reference	Hemo 3	Hemo 6
Protein	37,99	38,00	38,01
Lipids	8,56	8,57	8,58
HUFA	0,80	0,82	0,84
Fibers	2,95	2,92	2,90
Ash	6,50	5,99	5,47

The average weight of the shrimp receiving some HGP in their diet was lower during the first weeks of the experiment. However, when shrimp were bigger, there was an increase in growth resulting in a better result for shrimp receiving three percent HGP in the diet.

Growth results of the shrimp show the same trend:

Now we can see that the growth of the three percent HGP was better than the reference diet during week four and five, resulting in an overall better performance.

The shrimp receiving six percent HGP had a slightly slower growth, but certainly not significantly different.

The feed conversion ratio (FCR) follows the same trend: Again, we observe a very good FCR for all diets. This means that feeding gift was optimal and the feeds were not given in excess. This is important to note because a deficiency will show faster if FCR is low.

Conclusions

Hemoglobin Powder shows a high protein content and a good digestibility. The digestibility of an ingredient is the most important quality parameter for some aquatic species, which will result in a better feed conversion.

The replacement of fishmeal in the diet of *Litopenaeus vannamei* by HGP at three percent results in improved growth and FCR. The inclusion of six percent give almost similar results as the reference diet and could be an economic valuable option.

It seems that bigger shrimp (>10 g) have a better ability to cope with the inclusion of HGP in the diet. This could be due to an improved digestibility system or a better adaptation of the digestive system to the presence of HGP in the diet.

For optimal results, it is recommended to include three percent HGP in diets for *Litopenaeus vannamei* shrimp.

Hemoglobin Powder is produced by SONAC BV.

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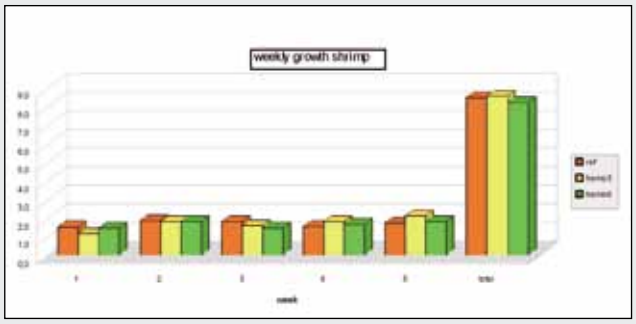

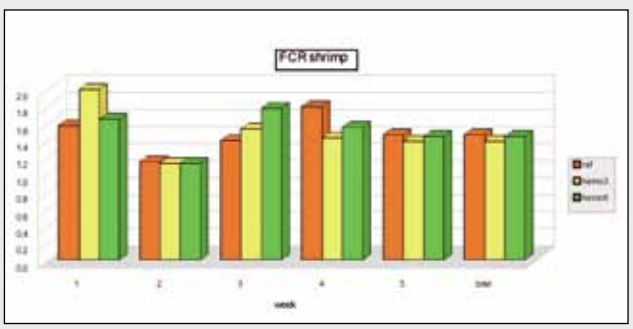

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