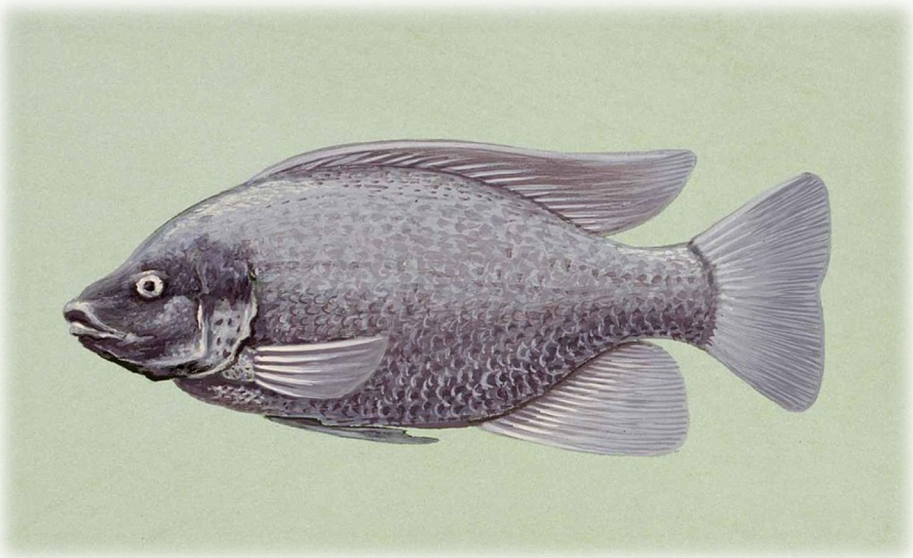
Effects of a corn protein concentrate on the performances of red tilapia (*Oreochromis sp.*) cultured in earthen ponds

By Nguyen Nhu Tri, Ph.D[1] & Nguyen Duy Hoa Ph.D[2]

(1): Dean - Faculty of Fisheries – Nong Lam University, Vietnam, (2): Technical Director – Empyreal Products, Cargill Inc.

Tilapia is an important freshwater fish species for aquaculture with annual global production around 5 million metric tons. The main culture system for tilapia is intensive model with high density and yield. In this model, feed cost comprises the main part of production cost. In commercial tilapia feed, fish meal is often supplemented at a level around 5% and is the most costly ingredient. In order to improve the profit of tilapia farming, feed cost should be reduced. One of the measures to reduce feed cost is to replace fish meal by other ingredients.



Empyreal® 75 is a protein concentrate product made from corn. This naturally pure protein source provides necessary nutrients for cultured aquatic animal species in general and tilapia in particular. Empyreal® 75 also provides even, consistent expansion in extruded feeds and extraordinary oil binding capacity in pelleted diet application. Therefore, it is feasible to utilize Empyreal® 75 to replace marine fish meal in tilapia feed.

Objective of the study

To evaluate the effects of graded marine fish meal replacement by Empyreal® 75 on the final mean weight, FCR, survival rate, SGR, ADG and feed cost of red

tilapia cultured in hapa (mesh cages) installed in an earthen pond.

Methodology

The present study was conducted at Experimental Station, Nong Lam University, Ho Chi Minh city, Viet Nam. This experiment consisted of 3 treatments with different levels of Empyreal® 75 to replace fish meal (Treatment 1: 0% marine fish meal (60% protein) and 4% Empyreal® 75, Treatment 2: 2% marine fish meal and 2.4% Empyreal® 75, Treatment 3: 5% marine fish meal and 0% Empyreal® 75). The diets were formulated to have similar protein, lipid and Gross Energy as well as similar profile of the balanced amino acids for the three diets (Table 1 and Table 2).

The experiment was designed with 4 replicates per treatment. Red tilapia fingerlings (37.3 ± 0.2 g) were randomly stocked into 12 2-m3 hapa (2x1x1.3m) installed in a 300-m2 earthen pond at 50 fish per hapa. Plastic net was installed on top of all hapa to prevent experimented fish from jumping out (Figure1). Floating feed was made by a commercial feed mill. Fish were fed to satiation twice a day. Left-over feed was collected 1 hour after each feeding to calculate feed intake. This experiment was conducted in 12 weeks. Fish were weighed every 4 weeks to monitor growth and survival rate. At the end of the experiment, fish were harvested, counted and group weighed to determine final mean weight, FCR, survival rate, SGR, ADG and feed cost to produce 1 kg of red tilapia. Skin and fillet color were also measured at the end of the experiment by NR-3000 Handy colorimeter (Figure 2).

Table 1. Feed formula of the three diets.

Ingredient	Treatment 1 (%)	Treatment 2 (%)	Treatment 3 (%)
MBM – HF	10.00	10.00	10.00
Marine fishmeal	0.00	2.00	5.00
SBM	39.20	39.50	39.70
Tuna soluble	1.50	1.50	1.50
Cassava	14.55	14.07	13.64
Marine fish oil (spray)	1.50	1.50	1.50
Marine fish oil add in mixer	0.30	0.20	0.00
Salt (NaCl)	0.10	0.10	0.10
Fresh rice bran	17.00	17.00	17.00
Empyreal 75	4.00	2.40	0.00
MCP	0.30	0.30	0.30
Feed wheat	10.00	10.00	10.00
Vitamin premix	0.27	0.27	0.27
Mineral premix	0.27	0.27	0.27
Stay C 35%	0.03	0.03	0.03
Methionine	0.235	0.235	0.240
Lysine	0.340	0.245	0.100
Threonine	0.235	0.220	0.195
Tryptophan	0.02	0.011	0.00
Choline Chloride	0.10	0.10	0.10
Mold inhibitor	0.05	0.05	0.05
Total	100	100	100

Table 2. Proximate analysis

Proximate	Treatment 1	Treatment 2	Treatment 3
Crude Protein (%)	33.46	33.70	33.87
Crude Fat (%)	6.11	6.32	5.77
Crude Fiber (%)	2.58	2.62	2.55
Ash (%)	9.39	9.51	10.19
Moisture (%)	8.71	8.42	8.81
Gross Energy (Kcal/kg)	3,938	4,013	4,114

Figure 1: Hapa installed in an earthen pond for the experiment

The experiment was designed with 4 replicates per treatment. Red tilapia fingerlings (37.3 ± 0.2 g) were randomly stocked into 12 2-m3 hapa (2x1x1.3m) installed in a 300-m2 earthen pond at 50 fish per hapa. Plastic net was installed on top of all hapa to prevent experimented fish from jumping out (Figure1). Floating feed was made by a commercial feed mill. Fish were fed to satiation twice a day. Left-over feed was collected 1 hour after each feeding to calculate feed intake. This experiment was conducted in 12 weeks. Fish were weighed every 4 weeks to monitor growth and survival rate. At the end of the experiment, fish were harvested, counted and group weighed to determine final mean weight, FCR, survival rate, SGR, ADG and feed cost to produce 1 kg of red tilapia. Skin and fillet colour were also measured at the end of the experiment by NR-3000 Handy colorimeter (Figure 2).

During the experiment, water quality variables were measured as follow: Dissolved oxygen, temperature and pH were measured twice a day (7 AM and 4 PM) using YSI-550 digital oxygen/ temperature meter and SERA pH test kit (Figure 3). Total ammonia nitrogen and nitrite were measured twice a week by spectrometric method. Water in the pond was exchanged regularly and aeration system was installed into the pond to maintain ideal environmental condition for the entire experimental period.

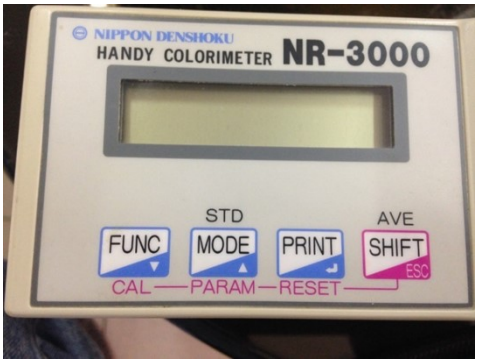


Figure 2: NR-3000 Handy colorimeter.

Statistical analysis

Statistical analyses were performed using SPSS software. Data collected from the experiment were analyzed using one-way analysis of variance to determine if significant differences ($P<0.05$) in final mean weight, FCR, survival rate, SGR, ADG and feed cost between treatments. Duncan multiple comparison test was utilized to determine differences among treatment means.

Figure 3: DO meter and pH test

"From the results of this study, it is concluded that Empyreal® 75 could be used to replace up to 100% of fish meal in a commercial diet for the red tilapia without affecting the performances as well as the skin's redness and the whiteness of fillet.

Results

Water quality

The value of water quality parameters in the earthen pond during the experimental period were presented in Table 3.

Table 3: Value of water quality parameters during the experimental period.

Parameter	Value
DO (mg/L) - Morning	3.48 ± 0.51
DO (mg/L) - Afternoon	5.85 ± 1.00
Temperature (^{o}C) - Morning	29.8 ± 3.1
Temperature (^{o}C) - Afternoon	31.7 ± 0.8
pH - Morning	7.6 ± 0.2
pH - Afternoon	8.0 ± 0.3
TAN (mg/L)	0.356 ± 0.107
Nitrite (mg/L)	0.035 ± 0.029

Data in Table 3 are expressed as Mean ± SD.

The performances of experimented fish

Final mean weight, FCR, survival rate, SGR, ADG and feed cost of experimented fish are presented in Table 4.

Table 4. Final mean weight, FCR, survival rate, SGR, ADG and feed cost of experimented fish.

Parameter	T1	T2	T3
Initial Wt. (g)	37.3 ± 0.1^{a}	37.3 ± 0.2^{a}	37.4 ± 0.1^{a}
Final Wt. (g)	310.0 ± 11.5^{a}	323.4 ± 19.6^{a}	317.3 ± 19.8^{a}
SGR (%/day)	2.52 ± 0.04^{a}	2.57 ± 0.08^{a}	2.54 ± 0.07^{a}
FCR	1.41 ± 0.02^{a}	1.33 ± 0.05^{a}	1.42 ± 0.07^{a}
Economic FCR	1.41 ± 0.04^{a}	1.36 ± 0.07^{a}	1.46 ± 0.10^{a}
Survival rate (%)	98.0 ± 2.8^{a}	96.5 ± 2.5^{a}	96.0 ± 3.7^{a}
ADG (g/day)	3.25 ± 0.14^{a}	3.41 ± 0.24^{a}	3.33 ± 0.24^{a}
Feed price (VND/kg)	9,093	9,204	9,306
Feed cost (VND)	12,849 ± 320^{a}	12,474 ± 648^{a}	13,560 ± 944^{a}

Data in table 4 are expressed as Mean ± SD. Data with the same superscript in the same row are not significant differences (P>0.05).

Economic FCR = Total weight of feed consumed/(Total final weight – Total initial weight)

FCR = Total weight of feed consumed/(Total final weight – Total initial weight + Total weight of dead fish)

Feed cost to produce 1 kg of the red tilapia = Economic FCR*Feed price.

All the values are the statistical average values of the four replicates, except the Feed price.

Data presented in Table 4 showed that all parameters were not significantly different among the 3 treatments (P>0.05). Empyreal® 75 could replace up to 100% of marine fish meal in a commercial diet for the red tilapia. The lowest feed cost was obtained at treatment 2 (60% fish meal was replaced by Empyreal® 75). The supplementation of Empyreal® 75 to replace fish meal could reduce feed cost from 711 VND (Treatment 1) to 1,086 VND (Treatment 2). Therefore, the supplementation of Empyreal® 75 to replace fish meal in commercial diet for the red tilapia could increase profit for farmers remarkably.

Table 5. The redness of skin at the darkest point, middle of the body and the tail as well as the whiteness of fillet of experimented fish.

Parameter	T1	T2	T3
Redness-Darkest point	9.62 ± 6.23[a]	9.94 ± 5.91[a]	10.38 ± 4.09[a]
Redness-Middle	10.70 ± 7.33[a]	9.79 ± 5.90[a]	9.62 ± 5.51[a]
Redness-Tail	15.53 ± 6.07[a]	12.17 ± 6.35[a]	12.23 ± 5.52[a]
Whiteness of fillet	40.19 ± 1.74[a]	41.15 ± 1.68[a]	40.44 ± 1.64[a]

The redness of skin at the darkest point, middle of the body and the tail as well as the whiteness of fillet of experimented fish were presented at Table 5.

The skin's redness of 3 different points along the body and the whiteness of fillet were not significant difference. The supplementation of Empyreal® 75 to replace fish meal at different levels, even at 100% replacement level does not affect the skin's redness and whiteness of the fillet (Figure 4).

Conclusions

From the results of this study, it is concluded that Empyreal® 75 could be used to replace up to 100% of fish meal in a commercial diet for the red tilapia without affecting the performances as well as the skin's redness and the whiteness of fillet. Therefore, this ingredient is recommended to be used in the feed to eliminate fish meal and increase return on investment as well as the sustainability of the red tilapia farming industry.

Figure 4: The whiteness of fillet of all 3 treatments.

Dr. Nguyen Nhu Tri

Dr. Nguyen Duy Hoa

More information

Dr. Nguyen Duy Hoa,
Technical Director – Empyreal Products, Cargill Inc.

E: DuyHoa_Nguyen@cargill.com