CHAPTER 4

Results

4.1. Growth performance

With a specific growth rate of 2.79 – 2.86% in the different feeding groups the fish obtained a remarkable growth development within the 14 weeks rearing phase examined. The high survival rate with insignificant differences between the feeding groups underline the healthy development of the fish throughout the rearing phase. There was a clear growth advantage to be observed for the treatment groups with replacing fishmeal by 100 g FPH and more. The total weight gain (WG) of the feeding groups FPH100 and FPH150 exceeded the control group FPH0 by 6.83 g and 5.52 g or 8.6% and 7.2% respectively. Feeding more than 100 g FPH/kg mixed food did not yield any additional effect. Even though statically significant the slightly lower final weights of the FPH150 feeding group should not be overrated. On the other hand feeding only 50 g FPH/kg mixed food showed a very limited effect on growth performance. The values of the other parameters studied e.g. specific growth rate, average daily gain, feed conversion rate, protein efficiency ratio are corresponding to the growth performance. Better growth performance result in improved feed efficiency and require a higher daily and total feed intake. Details are given in Table 6.

Table 6 Growth performance of red tail catfish reared on diets with different replacement levels of fish meal by hydrolysates*

Dietary contain FPH (g/kg)	FPH0	FPH50	FPH100	FPH150
Initial weight (g)	5.54	5.53	5.52	5.53
Initial length (cm)	8.42	8.43	8.43	8.41
Final weight (g)	84.72^{c}	84.92^{c}	91.51^{a}	90.21^{b}
Final length (cm)	22.10^{b}	22.15^{b}	22.62^{a}	22.56^{a}
Weight gain (g)	79.16^{d}	79.37^{c}	85.99^{a}	84.68^{b}
Feed intake (g/fish)	141.64^{b}	142.14^{b}	147.72^{a}	148.69^{a}
SGR (%/day)	2.79^{b}	2.79^{b}	2.86^{a}	2.85^{a}
ADG (g/day)	0.81^{c}	0.81^{c}	0.88^{a}	0.86^{b}
FCR	1.79^{c}	1.78^{c}	1.71^{a}	1.75^{b}
FCG (baht/kg)**	56.17^{c}	56.08^{c}	54.10^{a}	55.58^{b}
PER	1.74^{c}	1.74^{c}	1.81^{a}	1.77^{b}
Survival (%)	100	100	99.44	99.44

*Difference letters in the same row are statistically different. ($P<0.05$)

**FCG: Feed Conversion per Gain = FCR*feed/kg

4.2 Water quality

Sufficient water quality is a fundamental prerequisite for successful fish cultivation. In the present study the water conditions could be maintained in a balanced range throughout the experimental period Average water temperature ranged between 25.37 – 27.99 °C with tolerable fluctuation during the day time due to differences in the outside temperature with min 23 – 24 ˚C at night and max 35 – 36 ˚C for daytime. Dissolved oxygen could be kept fairly constant with mean values of 8.21 – 8.32 mg/l. The slight increase in pH values were from 8.31 – 8.41 mg/l, of ammonia-nitrogen from 0.25 – 0.31 mg/l and of total alkalinity from 298.23 – 306.28 mg/l indicate a slight increase of the organic load due to increased fish and feed load in the recycling system towards the end of the experiment (Table 7). However the reading values of water quality were well within a range for growing red-tail catfish (Boyd, 1992).

Table 7 Water quality of recirculation system in the experimental period 24. to 38 week 2016

Date	Temperature (° C)				DO	pH	NH3	Total alkalinity	Total hardess
	Tank water		Evap house						
	Max	Min	Max	Min	mg/ml				
18/6/2016	28.5	25.3	36.5	20.5	8.32	8.31	0.25	298.23	207.52
02/7/2016	27.6	25.2	35.4	17.8	8.29	8.31	0.25	298.34	207.21
16/7/2016	28.2	25.4	36.2	19.2	8.28	8.33	0.27	299.42	206.88
30/7/2016	28.6	25.4	38.1	19.3	8.29	8.35	0.27	301.26	206.86
13/8/2016	28.7	25.4	37.5	18.8	8.28	8.35	0.28	302.53	206.76
27/8/2016	28.4	25.3	37.3	19.1	8.24	8.38	0.28	305.12	206.81
10/9/2016	28.4	25.3	36.8	18.5	8.22	8.39	0.29	305.34	206.75
24/9/2016	25.2	25.3	37.2	18.6	8.21	8.41	0.31	306.28	206.72

4.3. Carcass quality

The higher final body weight of the fish in the feeding groups with replacing fishmeal by 100 g FPH and more resulted in slightly higher fillet yield and weight of liver and viscera. Noticeably is the reduced deposition of lipids in the body cave with 2.56% for the FPH100 and FPH150 groups versus 2.92% for the control. This indicate a highly significant reduction of the fat deposition of 12.3% for these FPH groups. Due to the limited sample size of 9 fish per feeding group the measured mean carcass values in Table 8 do not have the same reliability as those generated for the growth parameters.

Table 8 Carcass Quality of red-tail catfish reared on different replacement levels of fish meal by hydrolysates

Factors	FPH0	FPH50	FPH100	FPH150
Final body weight (g)	85.67^{c}	84.67^{c}	91.67^{a}	90.05^{b}
Carcass percentage				
Fillet yield with skin (%)	43.71^{a}	41.72^{b}	44.61^{a}	44.07^{a}
Viscera weight (%)	13.49^{c}	13.64^{c}	14.18^{b}	14.32^{a}
Liver weight (%)	3.63^{a}	3.94^{a}	4.24^{a}	4.32^{a}
Head weight (%)	22.05^{b}	22.43^{ab}	23.27^{ab}	22.46^{a}
Lipid weight (%)	2.92^{a}	2.72^{b}	2.56^{c}	2.55^{c}
Rest (%)	14.21^{b}	15.55^{a}	11.14^{c}	12.28^{bc}

^{ab} Means in the same row followed by different superscript are significantly different ($p < 0.05$)

4.4 Muscle composition

The improved growth performance of the feeding groups FPH100 and FPH150 was leading to higher moisture content of 81.45% and 81.56%, ≈ 1% higher than the control and FPH50 group. Especially noteworthy is that the muscle lipid contents were significantly affected by FPH feeding. Independent from the FPH level applied the lipid content was reduced to the same extent of ≈ 2.7% (from 13.32% to 10.63%). On the other hand muscle protein content and ash percentage did not show greater differences between the feeding groups. The pH values after slaughtering were measured in order to characterize the eating properties and the suitability for consumption of the fresh fish. The pH values of the raw Asian red-tail catfish samples were measured 45 minutes and 24 hours after slaughtering. The pH values were not affected by feeding protein hydrolysates. The measured values are within the normal range for fresh fish meat between pH 6.67 – 6.72 for 45 minute and pH 6.29 – 6.36 for 24 hours (Table 9).

Table 9 Fresh muscle nutritional composition of juvenile red-tail catfish by proximate analysis (%)

Feeding group	Moisture	Crude protein	Lipid	Ash	pH	
					45 min	24 h
FPH0	80.47[b]	16.61[a]	13.32[a]	5.43[b]	6.67[a]	6.29[a]
FPH50	80.25[b]	16.63[a]	10.54[b]	5.57[a]	6.72[a]	6.36[a]
FPH100	81.45[a]	16.66[a]	10.73[b]	5.69[a]	6.71[a]	6.36[a]
FPH150	81.56[a]	16.69[a]	10.63[b]	5.61[a]	6.72[a]	6.36[a]

[a,b] Means in the same column followed by different superscript are significantly different ($P < 0.05$)

4.5 Flesh color analysis

The flesh color of fish may vary from one to the other part of the body. Therefore the color measurements were taken at the focal point of the fillets. The obtained color measurements did not appear very consistent over the feeding groups. In tendency the control group show a brighter appearance with an average L* of 40.9 and the FPH150 group a more bluish meat and skin color with b* values of 0.07 and -0.44 respectively. However, all metrics of l* a* b* of meat and skin fillet samples are not significantly different ($P>0.05$). (Table 10).

Table 10 Color analysis of raw fillets from juvenile red-tail catfish

sample	Fish part	L*	a*	b*
FPH0	skin	36.44	1.45	-1.54
	meat	40.9	2.08	-0.25
FPH50	skin	39.46	1.36	-3.25
	meat	39.84	3.06	-0.8
FPH100	skin	35.49	1.25	-1.17
	meat	40.1	2.78	-0.53
FPH150	skin	33.53	2.17	-0.44
	meat	40.71	2.48	0.07

4.6 Lysozyme activity

The lysozyme activity measured in the blood serum of 12 fish per feeding group showed a gradual increase with increased FPH in the diet, ranging from 2.27 to 2.42 µl/ml. However due to the limited sample sizes this increase was not statistically significant (Fig 4.1).

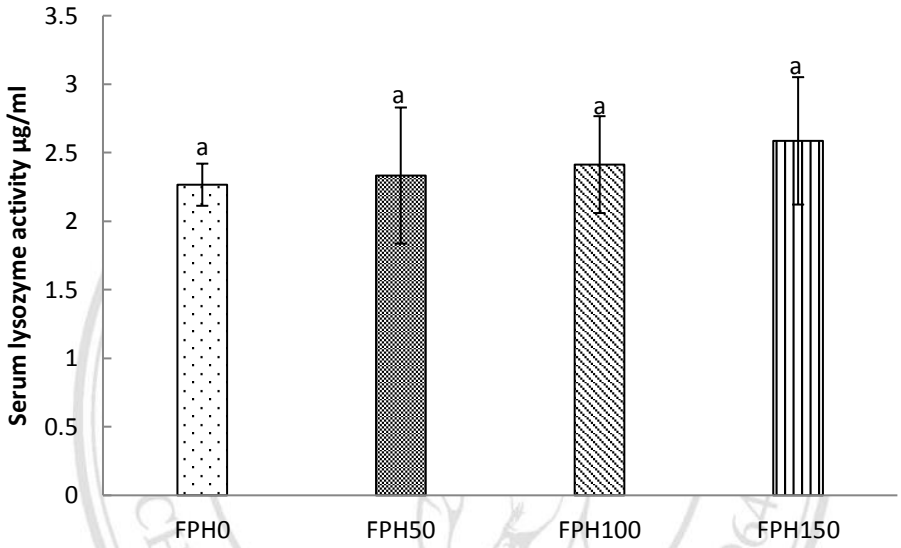

Figure 4.1 Lysozyme activities with increased FPH in the diet