河南师范大学
HENAN NORMAL UNIVERSITY

读书报告

陈延娜

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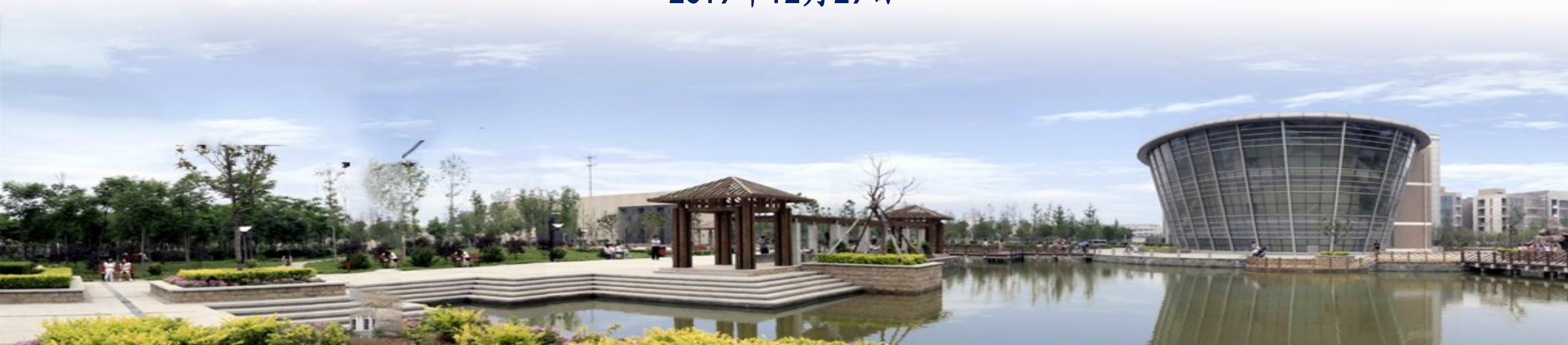

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Catching black soldier fly for meagre: Growth, whole-body fatty acid profile and metabolic responses

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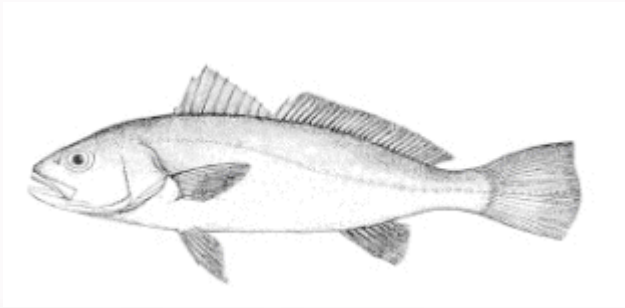


白姑鱼

1.前言

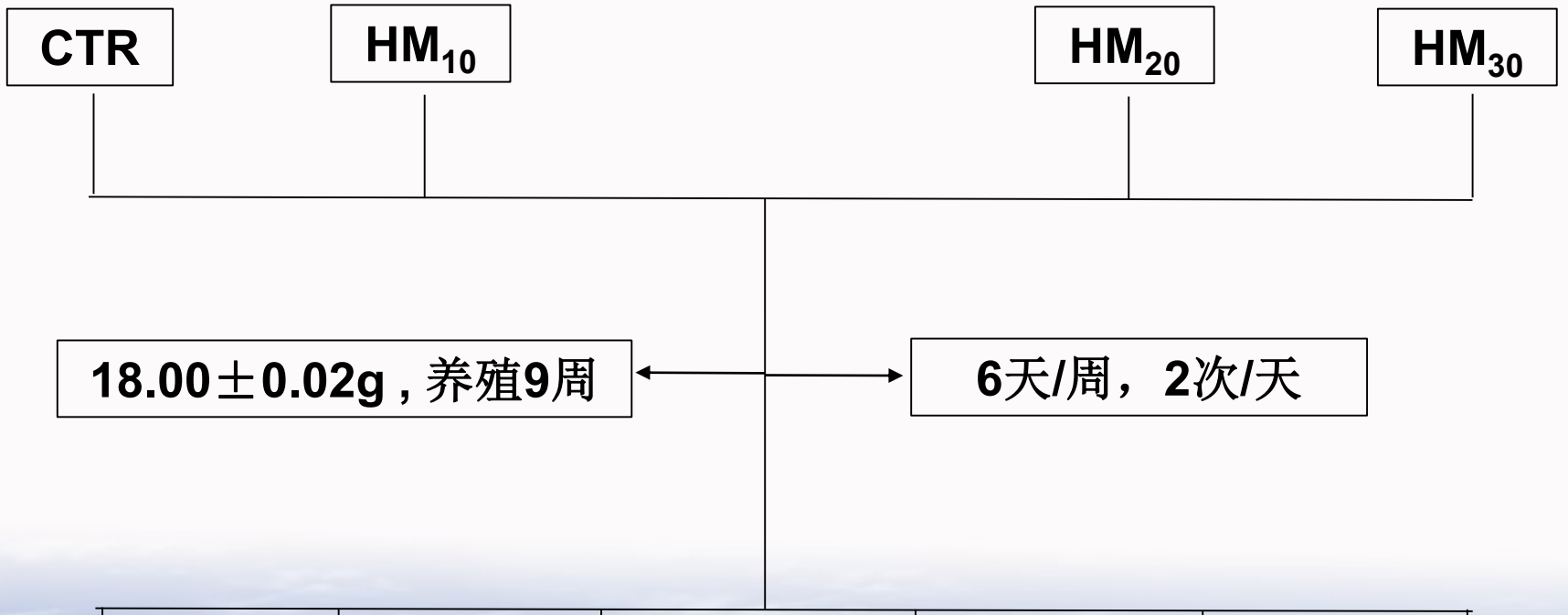
优点：

生长迅速，饲料转化率高，口感好，营养价值高等优点，是名贵的低温经济鱼类。

食性：

最适生长温度为17～21℃，自然环境状态摄食习性为肉食性，幼鱼期摄食甲壳类；成鱼则捕食小鱼、虾等。

2.材料方法


CTR
HM10
HM20
HM30
18.00±0.02g，养殖9周
6天/周，2次/天
生长性能
饲料利用率
常规组分
脂肪酸组成
各种酶活
血清生化指标

3.结果 饲料成分

Table 1
Ingredient composition and proximate analysis of the experimental diets fed to meagre.

	Diets			
	CTR	HM10	HM20	HM30
Ingredients (% dry weight basis)				
Fish meal[a]	40.0	33.1	26.1	19.2
Soluble fish protein concentrate[b]	2.5	2.5	2.5	2.5
Hermetia illucens[c]	–	10.0	20.0	30.0
Wheat gluten[d]	5.0	5.0	5.0	5.0
Corn gluten[e]	7.5	7.5	7.5	7.5
Soybean meal[f]	14.0	14.0	14.0	14.0
Wheat meal[g]	15.0	11.8	8.5	5.2
Fish oil	12.3	12.1	11.8	11.6
Vitamin premix[h]	1.0	1.0	1.0	1.0
Mineral premix[i]	1.0	1.0	1.0	1.0
Choline chloride (50%)	0.5	0.5	0.5	0.5
Binder[j]	1.0	1.0	1.0	1.0
Taurine[k]	0.2	0.2	0.2	0.2
Dibasic calcium phosphate	–	0.4	0.8	1.3
Proximate analyses (% dry weight basis)				
Dry matter	93.7	94.1	95.4	94.9
Crude protein	50.3	49.3	50.6	50.1
Crude fat	19.0	18.6	18.9	18.1
Ash	9.2	9.7	10.2	10.6
Energy (kJ g^{-1})	23.1	22.8	22.9	22.8
Chitin	0.0	0.6	1.1	1.6

3.结果 昆虫及饲料脂肪酸含量

Table 3
Fatty acid composition (% of total fatty acids) of *Hermetia illucens* and the experimental diets fed to meagre.

	Insect meal	Diets			
	Hermetia illucens	CTR	HM10	HM20	HM30
12:0	36.1	0.12	3.71	6.45	8.29
14:0	8.75	8.61	8.96	8.62	8.11
15:0	0.16	0.88	0.81	0.70	0.61
16:0	21.6	25.3	24.7	23.3	22.3
17:0	0.18	0.49	0.46	0.43	0.39
18:0	2.81	3.15	3.04	2.94	2.98
ΣSFA	69.6	38.6	41.6	42.5	42.6
14:1	0.16	0.33	0.31	0.29	0.23
16:1	2.85	8.34	8.00	7.52	6.72
17:1	0.00	0.15	0.17	0.12	0.12
18:1	14.8	22.7	22.1	22.0	21.8
20:1	0.00	2.27	2.08	2.13	2.36
22:1	0.00	1.17	1.07	1.26	1.60
ΣMUFA	17.8	35.0	33.7	33.3	32.9
18:2 n-6	10.8	8.77	9.22	9.17	9.32
20:2 n-6	0.00	0.21	0.10	0.20	0.21
20:4 n-6	0.00	0.45	0.34	0.35	0.36
Σn-6PUFA	10.6	9.43	9.67	9.73	9.88
18:3 n-3	0.72	2.26	2.11	2.01	1.89
18:4 n-3	0.32	2.23	1.91	1.37	1.62
20:4 n-3	0.00	0.30	0.28	0.32	0.33
20:5 n-3	0.00	4.51	3.98	3.86	3.62
22:6 n-3	0.00	3.57	2.99	3.11	3.38
Σn-3PUFA	1.03	12.9	11.3	10.7	10.8
Σn-3LC-PUFA	0.00	8.39	7.25	7.29	7.33
SFA:PUFA	5.88	1.58	1.81	1.90	1.90
n3:n6	0.10	1.37	1.17	1.10	1.10
Unsaturation Index[a]	42.8	122.5	112.8	110.1	110.8

3.结果 生长指标是否受到黑水虻替代的影响

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Table 4

Growth performance and feed utilization efficiency of meagre fed the control and *Hermetia illucens* diets.

	Diets				One-way ANOVA	Polynomial contrasts		
	CTR	HM10	HM20	HM30	*p-value*	Linear	Quadratic	Cubic
Final body weight (g)	80.5 ± 8.9[b]	78.8 ± 1.5[b]	69.6 ± 1.3[ab]	60.6 ± 4.6[a]	0.005	0.001	0.250	0.565
Daily growth index (%)[a]	2.73 ± 0.25[b]	2.69 ± 0.05[b]	2.41 ± 0.04[ab]	2.11 ± 0.16[a]	0.003	0.001	0.185	0.593
Feed intake (g kg ABW^{-1} day^{-1})	16.3 ± 0.6	16.6 ± 0.6	16.2 ± 0.5	16.9 ± 2.1	0.891	0.651	0.797	0.583
Feed efficiency[b]	1.25 ± 0.03	1.22 ± 0.04	1.17 ± 0.04	1.05 ± 0.17	0.097	0.022	0.407	0.817
Protein efficiency ratio[c]	2.49 ± 0.05	2.48 ± 0.09	2.32 ± 0.07	2.09 ± 0.34	0.086	0.020	0.347	0.877
Nitrogen								
Intake (g kg ABW^{-1} day^{-1})	1.31 ± 0.05	1.31 ± 0.05	1.31 ± 0.04	1.35 ± 0.17	0.921	0.595	0.708	0.889
Retention (g kg ABW^{-1} day^{-1})	0.57 ± 0.03[b]	0.56 ± 0.02[ab]	0.53 ± 0.01[ab]	0.50 ± 0.03[a]	0.036	0.006	0.429	0.820
Lipid								
Intake (g kg ABW^{-1} day^{-1})	3.10 ± 0.12	3.09 ± 0.12	3.06 ± 0.10	3.05 ± 0.38	0.994	0.794	0.996	0.958
Retention (g kg ABW^{-1} day^{-1})	1.46 ± 0.11	1.35 ± 0.03	1.23 ± 0.10	1.39 ± 0.16	0.156	0.278	0.067	0.344
Energy								
Intake (kJ kg ABW^{-1} day^{-1})	376.7 ± 14.9	378.3 ± 14.7	371.2 ± 12.4	384.9 ± 48.5	0.94	0.809	0.710	0.686
Retention (kJ kg ABW^{-1} day^{-1})	138.9 ± 10.1	135.2 ± 6.7	123.1 ± 1.5	125.8 ± 11.1	0.134	0.042	0.514	0.308

为什么生长性能降低了呢？

小结

为什么生长性能降低？

采食量？氨基酸？

据报道，当几丁质达到了2%时，罗非鱼的生长性能及大西洋鲑的生长性能，饲料效率和脂质消化率均降低（Olsen et al.,2006 ； Shiau and Yu, 1999）。

3.结果

	Initial	CTR	HM10	HM20	HM30	*p-value*	Linear	Quadratic	Cubic
12:0	0.0	0 .00 ± 0.00^{a}	1.23 ± 0.08^{b}	2.51 ± 0.19^{c}	3.91 ± 0.14^{d}	0.000	0.000	0.274	0.846
14:0	3.8	6.20 ± 0.25^{a}	6.88 ± 0.30^{ab}	6.99 ± 0.54^{ab}	7.71 ± 0.04^{b}	0.004	0.001	0.929	0.208
15:0	0.5	0.78 ± 0.03	0.78 ± 0.03	0.71 ± 0.06	0.69 ± 0.03	0.034	0.008	0.820	0.184
16:0	24.3	25.3 ± 1.09	25.8 ± 0.86	24.8 ± 0.73	25.5 ± 0.45	0.568	0.791	0.812	0.193
17:0	0.4	0.49 ± 0.04^{b}	0.47 ± 0.04^{b}	0.44 ± 0.01^{ab}	0.38 ± 0.03^{a}	0.015	0.003	0.277	0.912
18:0	4.8	3.43 ± 0.11	3.25 ± 0.04	3.40 ± 0.06	3.25 ± 0.05	0.029	0.075	0.753	0.011
ΣSFA	33.9	36.2 ± 1.38^{a}	38.4 ± 1.21^{ab}	38.9 ± 1.39^{ab}	41.4 ± 0.38^{b}	0.004	0.001	0.766	0.246
14:1	0.1	0.25 ± 0.02	0.27 ± 0.03	0.23 ± 0.01	0.22 ± 0.02	0.116	0.056	0.246	0.251
16:1	7.5	8.07 ± 0.44	8.04 ± 0.14	8.01 ± 0.37	7.93 ± 0.31	0.964	0.634	0.889	0.957
17:1	0.0	0.16 ± 0.02^{b}	0.15 ± 0.02^{b}	0.12 ± 0.02^{ab}	0.09 ± 0.01^{a}	0.008	0.001	0.816	0.681
18:1	28.2	24.1 ± 0.65	23.9 ± 0.66	24.2 ± 0.49	23.4 ± 0.37	0.380	0.333	0.367	0.251
20:1	1.2	2.34 ± 0.17^{b}	2.00 ± 0.14^{ab}	2.08 ± 0.20^{ab}	1.86 ± 0.11^{a}	0.036	0.011	0.561	0.119
22:1	0.5	0.66 ± 0.48	0.82 ± 0.08	0.95 ± 0.04	0.85 ± 0.29	0.681	0.377	0.457	0.796
ΣMUFA	37.5	35.5 ± 1.07	35.1 ± 0.65	35.6 ± 0.29	34.4 ± 0.53	0.194	0.141	0.322	0.177
18:2n-6	14.9	10.5 ± 0.28	10.9 ± 0.48	11.4 ± 0.37	11.5 ± 0.42	0.039	0.007	0.535	0.526
20:2n-6	0.0	0.23 ± 0.02	0.17 ± 0.08	0.18 ± 0.06	0.16 ± 0.01	0.350	0.142	0.471	0.474
20:4n-6	0.8	0.67 ± 0.03	0.42 ± 0.21	0.51 ± 0.09	0.45 ± 0.03	0.110	0.098	0.184	0.139
Σn-6PUFA	15.8	11.4 ± 0.28	11.5 ± 0.54	12.1 ± 0.49	12.1 ± 0.43	0.132	0.036	0.909	0.305
18:3n-3	1.8	2.03 ± 0.08^{b}	1.98 ± 0.06^{b}	1.93 ± 0.05^{b}	1.73 ± 0.05^{a}	0.002	0.000	0.070	0.438
18:4n-3	0.7	1.56 ± 0.08^{c}	1.49 ± 0.06^{bc}	1.38 ± 0.06^{ab}	1.27 ± 0.04^{a}	0.001	0.000	0.534	0.700
20:4n-3	0.2	0.33 ± 0.06	0.24 ± 0.03	0.26 ± 0.10	0.23 ± 0.07	0.363	0.170	0.453	0.407
20:5n-3	2.7	3.94 ± 0.38^{b}	3.29 ± 0.10^{a}	3.39 ± 0.18^{ab}	2.97 ± 0.09^{a}	0.004	0.001	0.397	0.055
22:6n-3	3.1	4.98 ± 0.90	3.79 ± 0.58	3.65 ± 0.63	3.22 ± 0.46	0.056	0.013	0.356	0.453
Σn-3PUFA	8.5	12.8 ± 1.37^{b}	10.8 ± 0.71^{ab}	10.6 ± 0.99^{ab}	9.4 ± 0.47^{a}	0.014	0.003	0.462	0.278
Σn-3LC-PUFA	6.0	9.20 ± 1.30^{b}	7.30 ± 0.70^{ab}	7.30 ± 0.90^{ab}	6.40 ± 0.60^{a}	0.028	0.007	0.352	0.272
SFA:PUFA	1.3	1.37 ± 0.11^{a}	1.58 ± 0.10^{ab}	1.59 ± 0.17^{ab}	1.76 ± 0.04^{b}	0.024	0.005	0.810	0.261
n-3:n-6	0.5	1.13 ± 0.14^{b}	0.94 ± 0.09^{ab}	0.87 ± 0.05^{a}	0.78 ± 0.06^{a}	0.009	0.001	0.431	0.571
Unsaturation Index^{a}	116.4	128.5 ± 6.33^{b}	116.4 ± 4.13^{ab}	117.0 ± 7.16^{ab}	110.1 ± 2.77^{a}	0.018	0.004	0.432	0.181

3.结果 脂肪酸沉积效率

Table 7
Whole-body fatty acid retention (% fatty acid intake) of meagre fed the control and *Hermetia illucens* diets.

	Diets				One-way ANOVA	Polynomial contrasts		
	CTR	HM10	HM20	HM30	*p-value*	Linear	Quadratic	Cubic
12:0	–	15.7 ± 1.2[a]	17.1 ± 1.0[a]	23.9 ± 4.2[b]	0.000	0.008	0.191	–
16:0	47.3 ± 3.3	45.8 ± 1.1	42.6 ± 3.1	52.9 ± 10.1	0.228	0.377	0.104	0.322
ΣSFA	44.5 ± 2.8	40.6 ± 0.9	37.1 ± 2.6	45.6 ± 9.0	0.209	0.983	0.06	0.377
18:1n-9	49.3 ± 3.8	46.4 ± 1.6	43.3 ± 1.8	48.5 ± 9.9	0.569	0.717	0.235	0.566
ΣMUFA	47.7 ± 3.8	45.2 ± 1.7	42.6 ± 2.1	47.9 ± 10.4	0.640	0.899	0.265	0.592
18:2n-6	54.6 ± 4.4	49.8 ± 2.5	48.3 ± 2.4	55.3 ± 11.1	0.468	0.970	0.14	0.746
Σn-6PUFA	55.3 ± 4.4	50.1 ± 1.9	48.3 ± 2.9	54.9 ± 11.0	0.455	0.859	0.135	0.760
18:3n-3	42.7 ± 3.5	41.3 ± 1.3	38.7 ± 1.6	41.9 ± 7.4	0.689	0.661	0.380	0.524
20:5n-3	42.1 ± 3.9	36.7 ± 2.1	35.9 ± 3.3	38.2 ± 8.4	0.481	0.367	0.218	0.918
22:6n-3	67.3 ± 11.3	56.4 ± 10.8	47.7 ± 9.8	44.9 ± 15.7	0.180	0.041	0.579	0.909
Σn-3PUFA	48.1 ± 4.9	42.6 ± 4.1	40.6 ± 4.9	40.8 ± 10.3	0.501	0.193	0.479	0.944

Table 5
Whole-body (%) initial and final composition, hepatosomatic and visceral indexes of meagre fed the control and *Hermetia illucens* diets.

		Diets				One-way ANOVA	Polynomial contrasts		
	Initial	CTR	HM10	HM20	HM30	*p-value*	Linear	Quadratic	Cubic
Whole-body composition									
Dry matter	20.3	26.3 ± 0.63	25.9 ± 0.64	25.6 ± 0.19	26.5 ± 1.08	0.425	0.847	0.149	0.486
Protein	14.3	16.8 ± 0.16	16.7 ± 0.47	16.7 ± 0.19	16.8 ± 0.62	0.978	0.945	0.688	0.919
Lipid	1.86	5.97 ± 0.27	5.57 ± 0.12	5.28 ± 0.40	6.15 ± 0.60	0.092	0.810	0.022	0.329
Ash	5.13	3.74 ± 0.02	3.83 ± 0.16	3.89 ± 0.12	4.07 ± 0.18	0.088	0.018	0.596	0.642
Energy (kJ g^{-1})	3.85	6.14 ± 0.20	6.03 ± 0.24	5.80 ± 0.03	6.20 ± 0.37	0.257	0.961	0.101	0.261
Indexes									
Hepatosomatic index (HSI)[a]	–	1.31 ± 0.11	1.46 ± 0.36	1.26 ± 0.06	1.40 ± 0.04	0.615	0.901	0.975	0.208
Viscerosomatic index (VSI)[b]	–	3.50 ± 0.16	3.60 ± 0.37	3.39 ± 0.14	3.58 ± 0.10	0.653	0.977	0.728	0.247

3.结果 血清生化指标

Table 8
Plasma glucose, cholesterol, triglycerides, total lipids (mmol L^{-1}), and total proteins (g dL^{-1}) levels of meagre fed the control and *Hermetia illucens* diets.

	Diets				One-way ANOVA	Polynomial contrasts		
	CTR	HM10	HM20	HM30	*p-value*	Linear	Quadratic	Cubic
Glucose	3.49 ± 0.51	3.91 ± 0.44	3.84 ± 0.97	4.66 ± 1.71	0.148	0.040	0.579	0.393
Cholesterol	2.49 ± 0.29	2.73 ± 0.33	2.58 ± 0.33	2.56 ± 0.29	0.444	0.858	0.223	0.287
Triglycerides	6.2 ± 0.68	6.6 ± 0.79	5.9 ± 1.19	5.4 ± 0.93	0.050	0.033	0.133	0.310
Total lipids	15.9 ± 1.9^{ab}	16.1 ± 1.54^{b}	14.8 ± 2.22^{ab}	13.3 ± 2.16^{a}	0.022	0.005	0.211	0.602
Total proteins	2.97 ± 0.21	3.23 ± 0.16	2.96 ± 0.38	2.97 ± 0.12	0.060	0.448	0.132	0.029

为什么血浆的甘油三酯和总脂质降低？

3.结果

Table 9
Hepatic amino acid catabolic (alanine aminotransferease, ALAT, aspartate aminotransferease, ASAT, and glutamate dehydrogenase, GDH), and lipogenic (glucose-6-phosphate dehydrogenase, G6PD, malic enzyme, ME, and 3-hydroxyacyl-CoA dehydrogenase, HOAD) enzyme activities (mU mg protein^{-1}) in meagre fed the control and *Hermetia illucens* diets.

	Diets				One-way ANOVA	Polynomial contrasts		
	CTR	HM10	HM20	HM30	*p-value*	Linear	Quadratic	Cubic
ALAT	329.4 ± 40.8	390.3 ± 81.7	358.8 ± 36.7	369.4 ± 68.8	0.207	0.329	0.218	0.142
ASAT	1518.5 ± 278.9	1710.8 ± 176.4	1616.8 ± 188.7	1761.8 ± 327.3	0.198	0.099	0.779	0.170
GDH	49.2 ± 11.7^{ab}	54.1 ± 5.9^{b}	41.8 ± 4.5^{a}	56.5 ± 12.2^{b}	0.015	0.496	0.129	0.004
G6PD	72.4 ± 6.2	77.0 ± 9.8	72.7 ± 15.7	85.0 ± 19.7	0.236	0.132	0.442	0.265
ME	20.1 ± 2.1	18.3 ± 2.1	20.2 ± 6.4	19.5 ± 3.5	0.766	0.964	0.696	0.320
HOAD	50.1 ± 11.6^{b}	42.4 ± 6.3^{ab}	40.8 ± 9.5^{ab}	32.7 ± 6.4^{a}	0.002	0.000	0.949	0.342

谷丙转氨酶（ALAT），谷草转氨酶（ASAT），谷氨酸脱氢酶（GDH）
6-磷酸葡萄糖脱氢酶（G6PD），苹果酸（ME），三羟基酰基辅酶A脱氢酶（HOAD）

结论

1. 添加30％的黑水虻脱脂粉影响了白姑鱼的生长性能。

2. 随着饲料中黑水虻粉替代水平的提高，全鱼SFA和n-6PUFA的含量升高，而n-3PUFA和n-3LC PUFA的含量降低。

3. 建议在饲料中添加10%的黑水虻脱脂粉，即替代17%的鱼粉。

启发

1. 材料方法及讨论的写法值得我参考。

2. 实验方案及检测的指标比较新颖和全面。

3. 改善黑水虻脱脂粉的加工工艺，添加几丁质酶和利用微生物发酵等方法来提高利用率。

启发

4. 添加一些富含EPA，DHA的油。

5. 通过改变饲养黑水虻的底物来改善脂肪酸的组成。

6. 通过基因编辑的方法改良黑水虻的品种。

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恳请各位老师批评指正

3.结果

6-磷酸葡糖脱氢酶，它催化6-磷酸葡萄糖脱氢，形成6-磷酸葡糖酸。以NADP为电子受体。整个反应的平衡是趋向于NADPH的生成，后者用于脂肪酸等的还原性生物合成反应。

苹果酸酶有助于脂肪的合成，如果缺少这种酶的话油脂的合成可能要停止。

3-羟酰CoA脱氢酶

体长，头相对大。口端位，无须。眼很小。侧线明显，延伸到尾鳍。第2背鳍远大于第1背鳍。臀鳍具第1根短硬棘刺和第2根很细的棘刺。鳔上有几个分叉的附器，可振动产生典型的“咕哝”声。耳石很大。体色银灰，背部青铜色。鳍基红褐色，口腔金黄色。死后颜色发褐色。可长到2米长和50公斤重。