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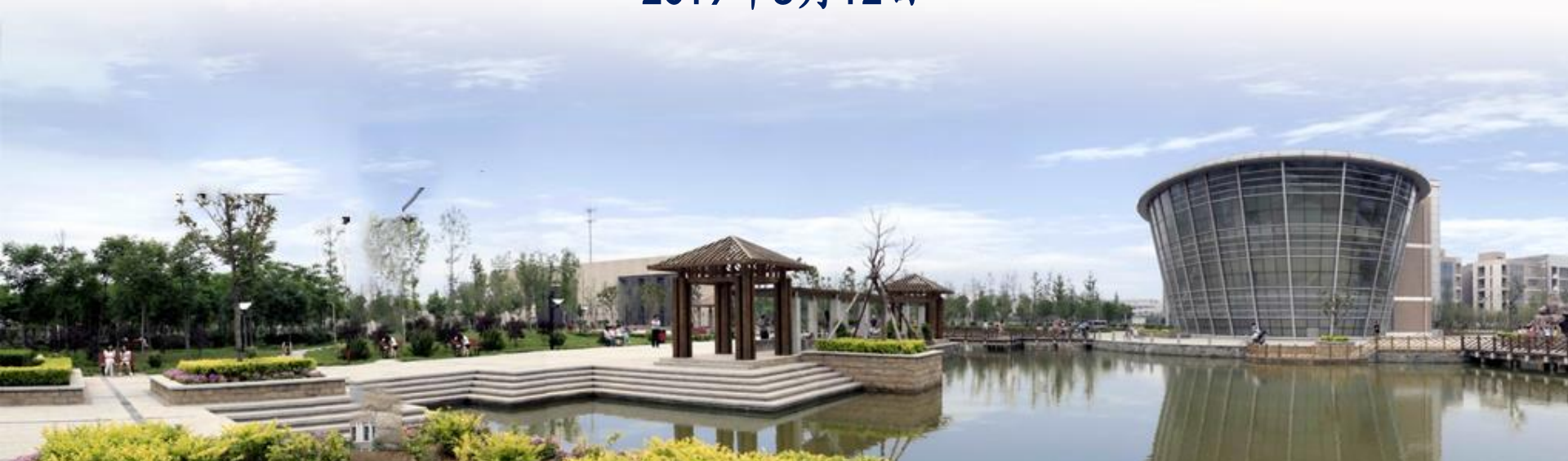
读书报告

陈延娜

2019年5月12日



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Evaluation of defatted black soldier fly (*Hermetia illucens* L.) larvae meal as an alternative protein ingredient for juvenile Japanese seabass (*Lateolabrax japonicus*) diets

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目录

日本鲈鱼

1.前言

鱼粉可用性下降，价格增加，植物蛋白含量低，氨基酸不平衡，具有抗营养因子(Aksnes et al., 2008; Pinto et al., 2013)，导致肠道炎症和适口性差（Merrifield et al., 2011）。

不够吃

1.前言

- 黑水虻能将废弃物转化为高蛋白物质，且有与鱼粉相似的氨基酸谱，是有前途的昆虫物种（Henry et al., 2015）。
- 黑水虻已被充分证明替代水产饲料中的鱼粉不会损伤生长性能和消化率 (Hu et al., 2017a, 2018; Cummins et al., 2017; Elhag et al., 2017; Park and Yoe, 2017; Dumas et al., 2018; Gasco et al., 2018b)。
- 并且欧洲委员会批准昆虫蛋白在水产饲料中的应用(Regulation, 2017/893/EC, 2017)。

1.前言

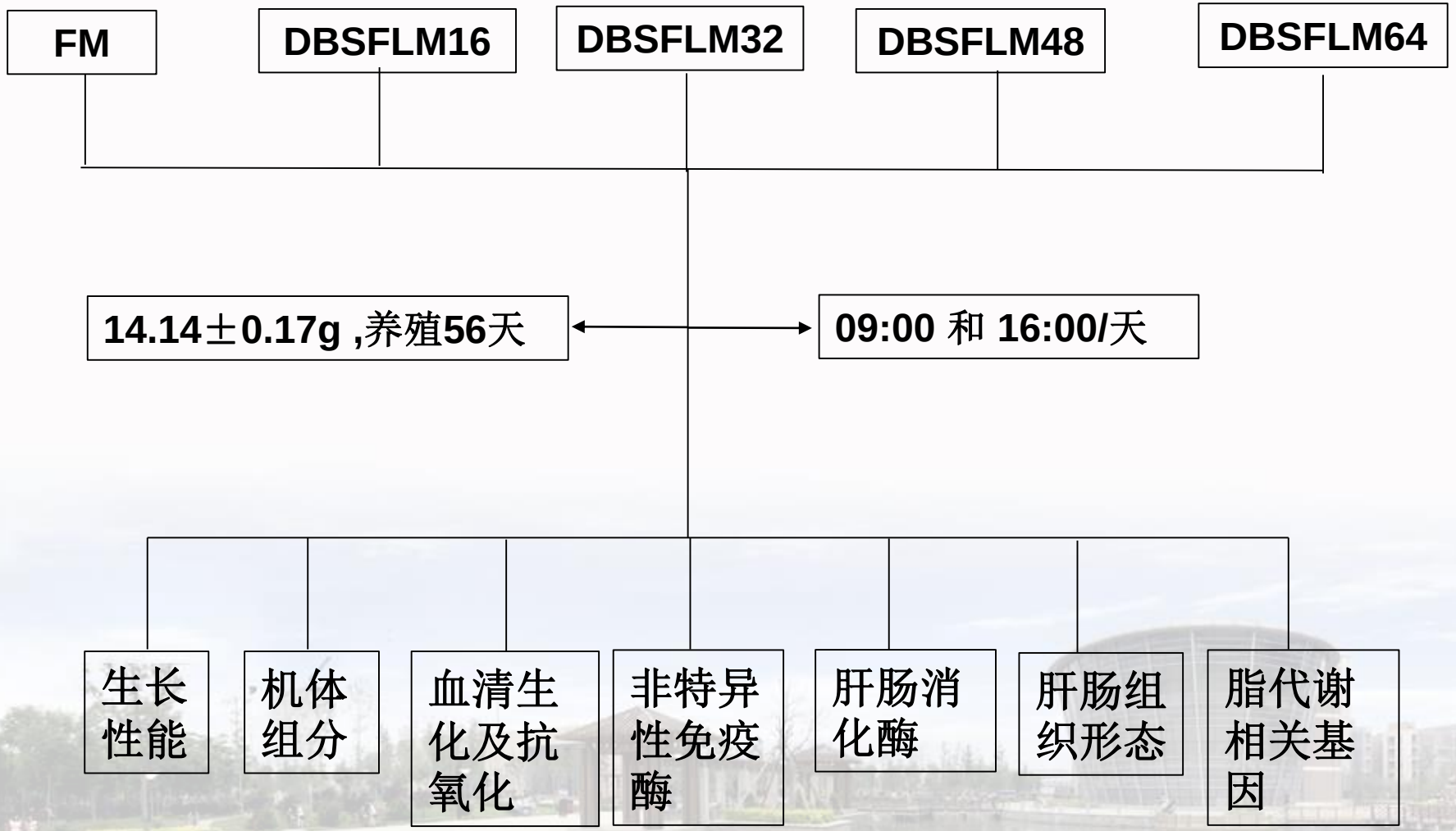
- 目前，仅有少数研究用于评估黑水虻脱脂粕对水生动物的影响，包括大西洋鲑（Belghit et al., 2018），虹鳟鱼（Renna et al., 2017., 2018），建鲤（Li et al., 2017a, 2017b）太平洋白虾（Cummins et al., 2017)等。
- 然而，黑水虻脱脂粉的营养价值尚未在日本鲈鱼上进行研究。

1.前言

本研究目的

评估黑水虻脱脂粉替代鱼粉对日本鲈鱼的生长性能，血液生化指标，消化酶活性，肝肠组织形态及脂代谢相关基因表达的影响。

2.材料方法


FM
DBSFLM16
DBSFLM32
DBSFLM48
DBSFLM64
14.14±0.17g ,养殖56天
09:00 和 16:00/天
生长性能
机体组分
血清生化及抗氧化
非特异性免疫酶
肝肠消化酶
肝肠组织形态
脂代谢相关基因

3.结果

生长指标

Table 5

Effect of substituting FM with DBSFLM on growth performance, somatic indexes and nutrient retention of juvenile *Lateolabrax japonicus*.

Items[2]	Treatments[1]				
	FM	DBSFLM16	DBSFLM32	DBSFLM48	DBSFLM64
FBW (g)	57.57 ± 0.99	57.94 ± 2.62	57.40 ± 2.22	61.26 ± 0.64	57.20 ± 0.81
WG (g)	43.27 ± 0.86	43.87 ± 2.59	43.22 ± 2.22	47.11 ± 0.66	43.20 ± 1.96
FI (g/fish/day)	1.05 ± 0.02^{c}	1.11 ± 0.02^{bc}	1.08 ± 0.02^{c}	1.15 ± 0.01^{b}	1.25 ± 0.02^{a}
FCR	1.37 ± 0.03	1.44 ± 0.07	1.41 ± 0.05	1.40 ± 0.02	1.50 ± 0.04
SGR (%)	2.49 ± 0.02	2.52 ± 0.08	2.49 ± 0.07	2.62 ± 0.02	2.51 ± 0.06
SR (%)	98.89 ± 1.11	97.78 ± 1.11	97.78 ± 1.11	95.56 ± 2.22	95.63 ± 2.19
CF (g/cm^3)	1.50 ± 0.04	1.46 ± 0.04	1.44 ± 0.02	1.48 ± 0.02	1.48 ± 0.02
VSI (%)	9.92 ± 0.42	9.39 ± 0.29	9.74 ± 0.56	9.43 ± 0.21	10.08 ± 0.38
HSI (%)	0.95 ± 0.06	0.97 ± 0.05	0.98 ± 0.08	1.04 ± 0.05	0.94 ± 0.06
ISI (%)	0.65 ± 0.05	0.65 ± 0.03	0.69 ± 0.07	0.71 ± 0.03	0.63 ± 0.03
IPF (%)	5.56 ± 0.35	5.12 ± 0.31	5.18 ± 0.37	4.95 ± 0.20	5.76 ± 0.34
PR (%)	29.27 ± 1.86	29.75 ± 1.30	30.24 ± 1.30	30.72 ± 0.42	27.65 ± 1.00
LR (%)	58.90 ± 5.98	66.73 ± 3.78	68.80 ± 7.32	69.57 ± 1.20	64.07 ± 3.27

采食量增加了，没有影响到生长性能。

3.结果

机体组分

Table 6

Effect of substituting FM with DBSFLM on whole body composition (% original substance) of juvenile *Lateolabrax japonicus* (n = 3).

Items[2]	Treatments[1]				
	FM	DBSFLM16	DBSFLM32	DBSFLM48	DBSFLM64
DM	30.79 ± 0.21	30.53 ± 0.10	30.86 ± 0.80	31.70 ± 0.48	30.69 ± 0.37
CP	17.20 ± 0.13	17.22 ± 0.15	17.13 ± 0.18	16.82 ± 0.13	16.89 ± 0.16
CL	8.66 ± 0.14	8.26 ± 0.18	8.25 ± 0.38	8.88 ± 0.26	8.90 ± 0.22
Ash	4.48 ± 0.06^{a}	4.37 ± 0.02^{ab}	4.38 ± 0.17^{ab}	4.20 ± 0.11^{b}	4.14 ± 0.05^{b}

灰分降低，可能是由于所用的昆虫和饲养昆虫的底物不同。

3.结果

血清生化

Table 7
Effect of substituting FM with DBSFLM on serum biochemical parameters, antioxidant and non-specific immune indices of juvenile *Lateolabrax japonicus* (n = 3).

Items[2]	Treatments[1]				
	FM	DBSFLM16	DBSFLM32	DBSFLM48	DBSFLM64
Biochemical parameters					
TCHO (mmol/L)	5.36 ± 0.21^{a}	5.14 ± 0.27^{ab}	4.89 ± 0.06^{b}	4.78 ± 0.18^{b}	4.69 ± 0.04^{b}
TG (mmol/L)	5.30 ± 0.10^{a}	4.73 ± 0.18^{b}	4.63 ± 0.16^{b}	4.72 ± 0.26^{b}	4.72 ± 0.04^{b}
GLOB (g/L)	29.47 ± 0.58	28.77 ± 1.54	28.03 ± 0.59	27.87 ± 1.24	27.80 ± 0.78
GLU (mmol/L)	12.40 ± 0.91	10.75 ± 1.24	8.98 ± 0.94	11.37 ± 1.24	10.55 ± 1.12
BUN (mmol/L)	1.57 ± 0.07	1.47 ± 0.09	1.40 ± 0.06	1.47 ± 0.03	1.57 ± 0.09
AST (U/L)	82.00 ± 4.16	84.67 ± 4.33	75.67 ± 4.37	82.67 ± 3.18	87.50 ± 4.09
ALT (U/L)	15.33 ± 1.33	14.67 ± 2.73	12.00 ± 1.00	13.33 ± 1.20	13.33 ± 1.67
LDL-C (mmol/L)	0.26 ± 0.03	0.26 ± 0.02	0.25 ± 0.01	0.22 ± 0.02	0.21 ± 0.01
HDL-C (mmol/L)	2.08 ± 0.07^{a}	2.05 ± 0.11^{a}	1.71 ± 0.07^{b}	1.61 ± 0.06^{b}	1.60 ± 0.08^{b}
LDL-C/HDL-C	0.12 ± 0.01	0.13 ± 0.01	0.15 ± 0.01	0.14 ± 0.01	0.13 ± 0.01
DAO (U/L)	18.43 ± 0.58	18.79 ± 1.39	18.57 ± 1.63	18.24 ± 1.41	18.12 ± 1.03
LPS (pg/ml)	576.67 ± 23.95	529.67 ± 48.52	526.67 ± 25.59	529.75 ± 49.75	531.75 ± 36.26
D-LA (μmol/L)	2.93 ± 0.22	2.81 ± 0.17	2.67 ± 0.10	2.92 ± 0.29	3.29 ± 0.35

几丁质、免疫和肝脏的健康

3.结果

血清抗氧化酶和非特异性免疫酶活性

Antioxidant indexes					
CAT (U/ml)	21.10 ± 2.73	21.69 ± 1.15	19.20 ± 2.38	20.69 ± 1.67	20.52 ± 2.42
GSH-Px (U/ml)	309.57 ± 18.49	278.16 ± 14.87	268.77 ± 20.23	289.79 ± 16.46	292.29 ± 8.19
MDA (nmol/ml)	28.93 ± 3.91^{a}	17.90 ± 2.26^{b}	21.43 ± 1.54^{b}	19.94 ± 1.64^{b}	18.94 ± 1.15^{b}
SOD (U/ml)	22.12 ± 0.76	22.81 ± 0.65	23.00 ± 0.35	22.48 ± 0.55	21.96 ± 0.44
Non-specific immune indexes (U/ml)					
AKP	0.27 ± 0.01	0.25 ± 0.01	0.23 ± 0.01	0.24 ± 0.02	0.26 ± 0.02
ACP	0.52 ± 0.01	0.50 ± 0.01	0.52 ± 0.01	0.51 ± 0.01	0.50 ± 0.01
LZM	25.25 ± 2.19	23.41 ± 2.06	29.97 ± 1.43	27.64 ± 2.17	29.31 ± 1.56

几丁质多糖具有改善抗氧化的作用（Ngo et al., 2009; Ngo and Kim, 2014）。

3.结果

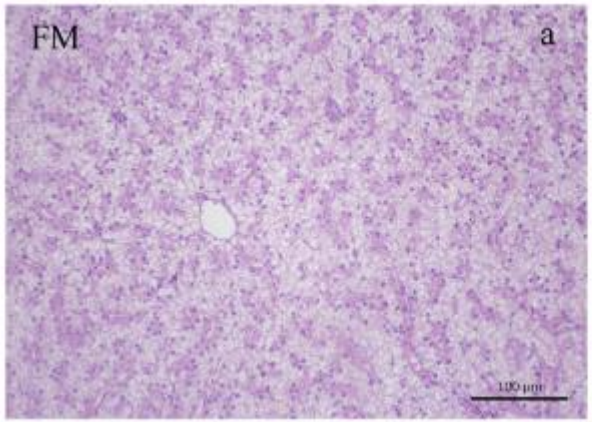
肝肠组织中消化酶活性

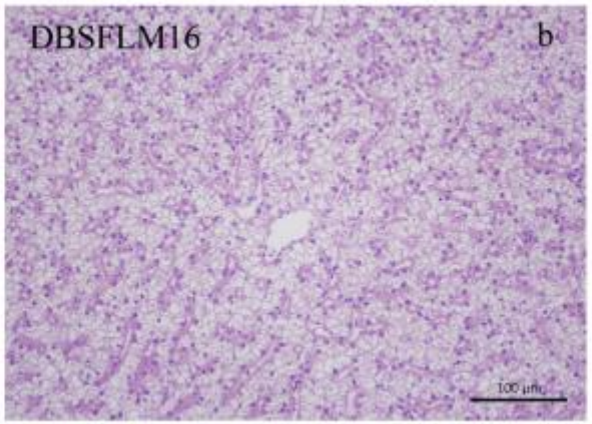
Table 8

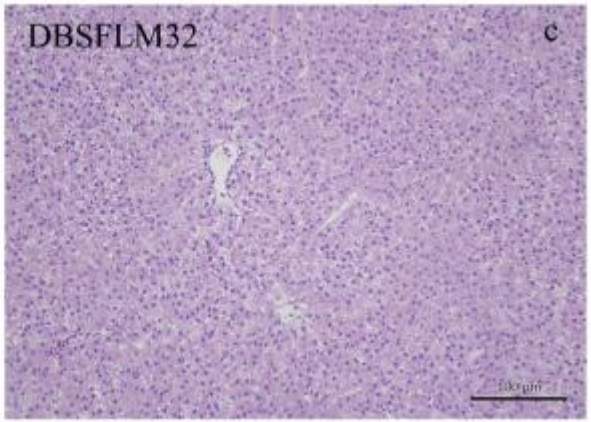
Effect of substituting FM with DBSFLM on digestive enzymes activity in the hepatopancreas and intestine of juvenile *Lateolabrax japonicus* (n = 3).

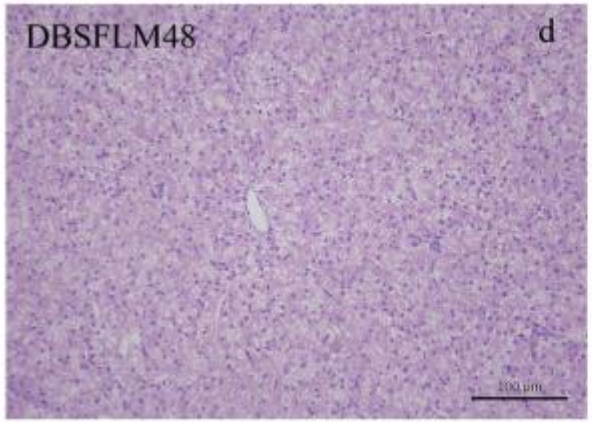
Items	Treatments[1]				
	FM	DBSFLM16	DBSFLM32	DBSFLM48	DBSFLM64
Hepatopancreas					
Trypsin (U/mg protein)	615.97 ± 11.85	594.74 ± 11.92	585.16 ± 17.85	616.88 ± 16.93	601.98 ± 21.11
Lipase (U/g protein)	2.44 ± 0.41	2.08 ± 0.32	2.00 ± 0.47	1.95 ± 0.51	2.10 ± 0.57
Amylase (U/mg protein)	0.10 ± 0.02	0.12 ± 0.01	0.12 ± 0.01	0.10 ± 0.01	0.10 ± 0.02
Intestine					
Trypsin (U/mg protein)	412.89 ± 13.22	398.36 ± 28.89	345.41 ± 17.61	403.52 ± 24.30	353.78 ± 28.91
Lipase (U/g protein)	6.91 ± 0.23^{b}	6.73 ± 0.21^{b}	7.64 ± 0.24^{b}	9.07 ± 0.32^{a}	8.81 ± 0.47^{a}
Amylase (U/mg protein)	0.62 ± 0.08	0.67 ± 0.07	0.65 ± 0.06	0.66 ± 0.02	0.66 ± 0.04

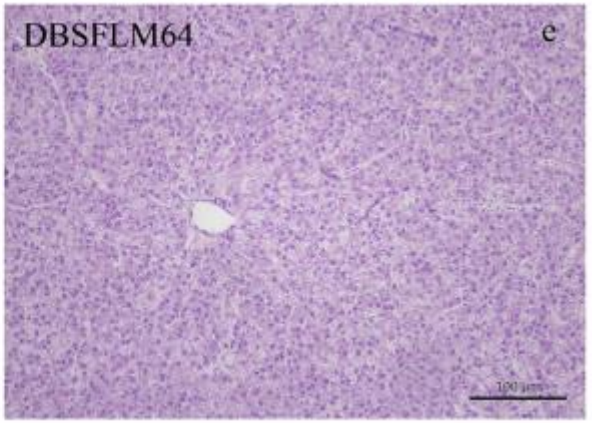
3.结果



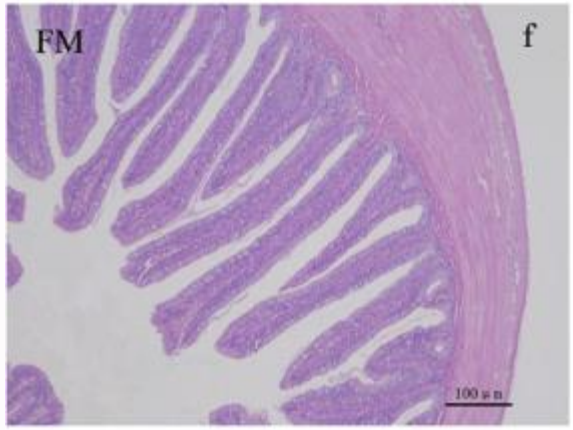


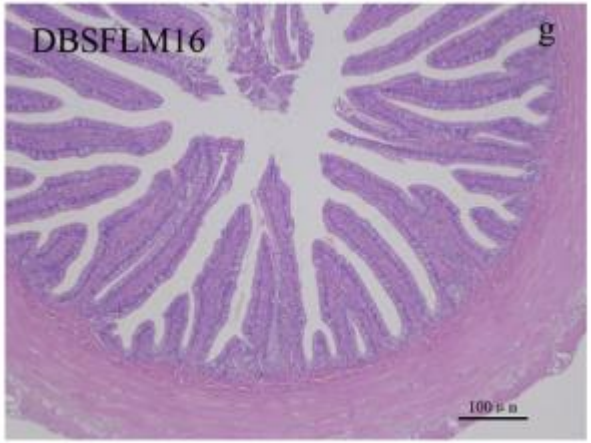


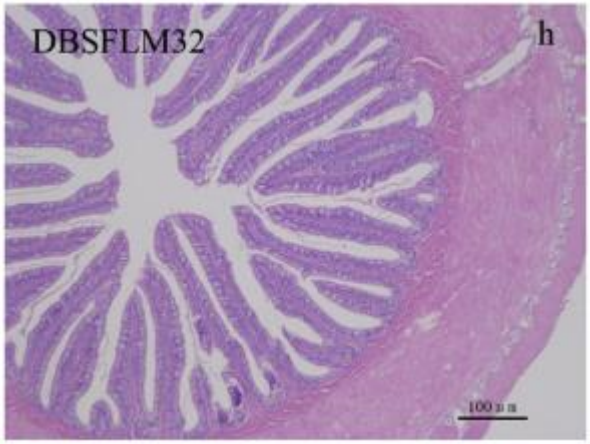


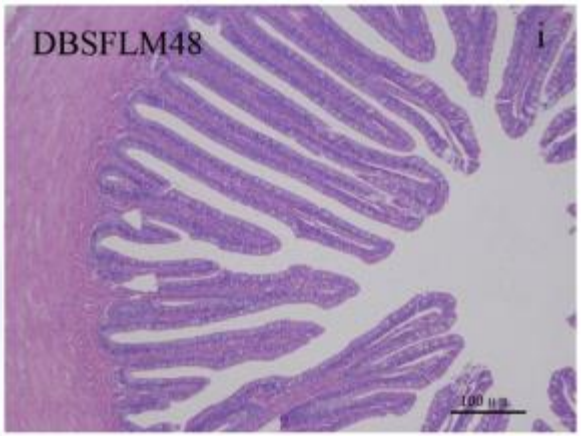


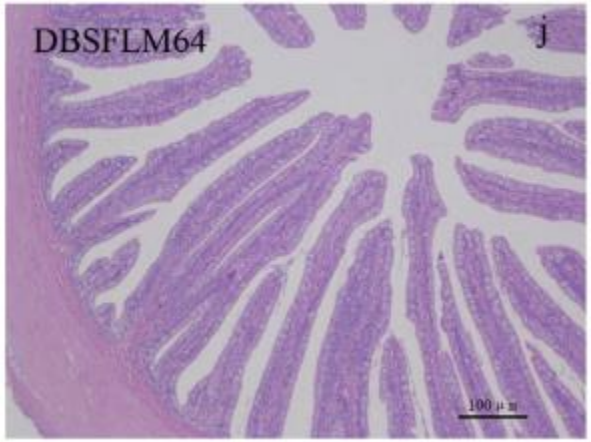
3.结果


FM
f
100 μm


DBSFLM16
g
100 μm


DBSFLM32
h
100 μm


DBSFLM48
i
100 μm


DBSFLM64
j
100 μm

3.结果

肠道参数

Table 9

Effect of substituting FM with DBSFLM on intestinal morphology of juvenile *Lateolabrax japonicus*.

Items	Treatments[a]				
	FM	DBSFLM16	DBSFLM32	DBSFLM48	DBSFLM64
Villus length (μm)	341.52 ± 16.01	313.26 ± 15.40	316.64 ± 19.80	349.78 ± 10.84	318.42 ± 13.38
Villus width (μm)	44.81 ± 1.05	43.27 ± 0.94	42.93 ± 0.72	44.91 ± 0.78	44.40 ± 1.35
Inherent thickness (μm)	126.25 ± 2.62	138.84 ± 5.81	137.60 ± 5.56	129.91 ± 7.82	131.90 ± 7.19
Muscular thickness (μm)	19.12 ± 0.88	21.82 ± 0.99	20.96 ± 0.76	21.24 ± 0.93	19.84 ± 0.80
Goblet cells per villus	32.76 ± 1.88	29.79 ± 1.44	30.26 ± 1.71	34.54 ± 1.21	33.67 ± 1.16

肠道组织形态没有受到影响。

3.结果

肠刷边界酶，抗氧化和炎症细胞因子指数

Table 10

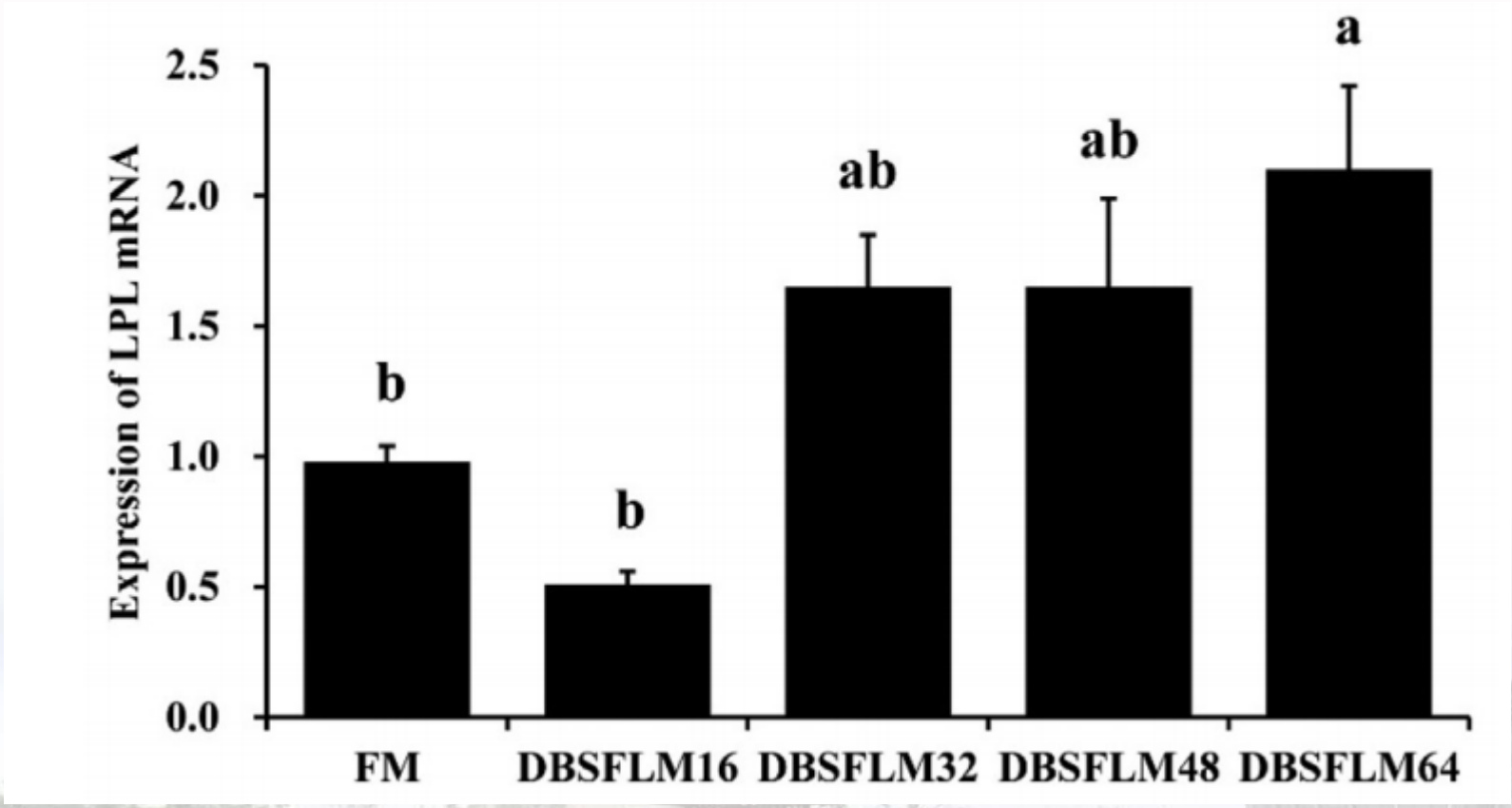
Effect of substituting FM with DBSFLM on intestinal brush border enzymes, antioxidant and inflammatory cytokines indexes of juvenile *Lateolabrax japonicus* (n = 3).

Items[b]	Treatments[a]				
	FM	DBSFLM16	DBSFLM32	DBSFLM48	DBSFLM64
Brush border enzymes					
CK (U/mg protein)	0.26 ± 0.02	0.24 ± 0.02	0.24 ± 0.01	0.23 ± 0.05	0.28 ± 0.03
Na^+, K^+-ATPase (U/mg protein)	0.88 ± 0.05	0.88 ± 0.06	0.95 ± 0.02	0.88 ± 0.09	0.98 ± 0.08
Antioxidant indexes					
MDA (nmol/mg protein)	2.42 ± 0.32	2.08 ± 0.48	2.25 ± 0.46	2.49 ± 0.21	2.05 ± 0.32
PC (nmol/mg protein)	2.40 ± 0.27	2.50 ± 0.11	1.87 ± 0.20	1.86 ± 0.36	2.00 ± 0.09
Inflammatory cytokines indexes					
TNF-α (fmol/ml)	4.26 ± 0.42	3.99 ± 0.68	3.31 ± 0.48	5.23 ± 0.58	4.33 ± 0.94
IGF-I (ng/ml)	17.71 ± 2.15	16.81 ± 0.93	18.22 ± 1.76	14.02 ± 1.06	15.30 ± 2.94
IL-6 (pg/ml)	5.79 ± 1.10	6.88 ± 0.35	4.97 ± 0.21	5.65 ± 1.03	4.81 ± 0.67
IL-8 (pg/ml)	13.20 ± 0.80	12.42 ± 1.35	11.10 ± 0.30	13.55 ± 1.65	10.25 ± 0.50

以上指标均未受到影响。

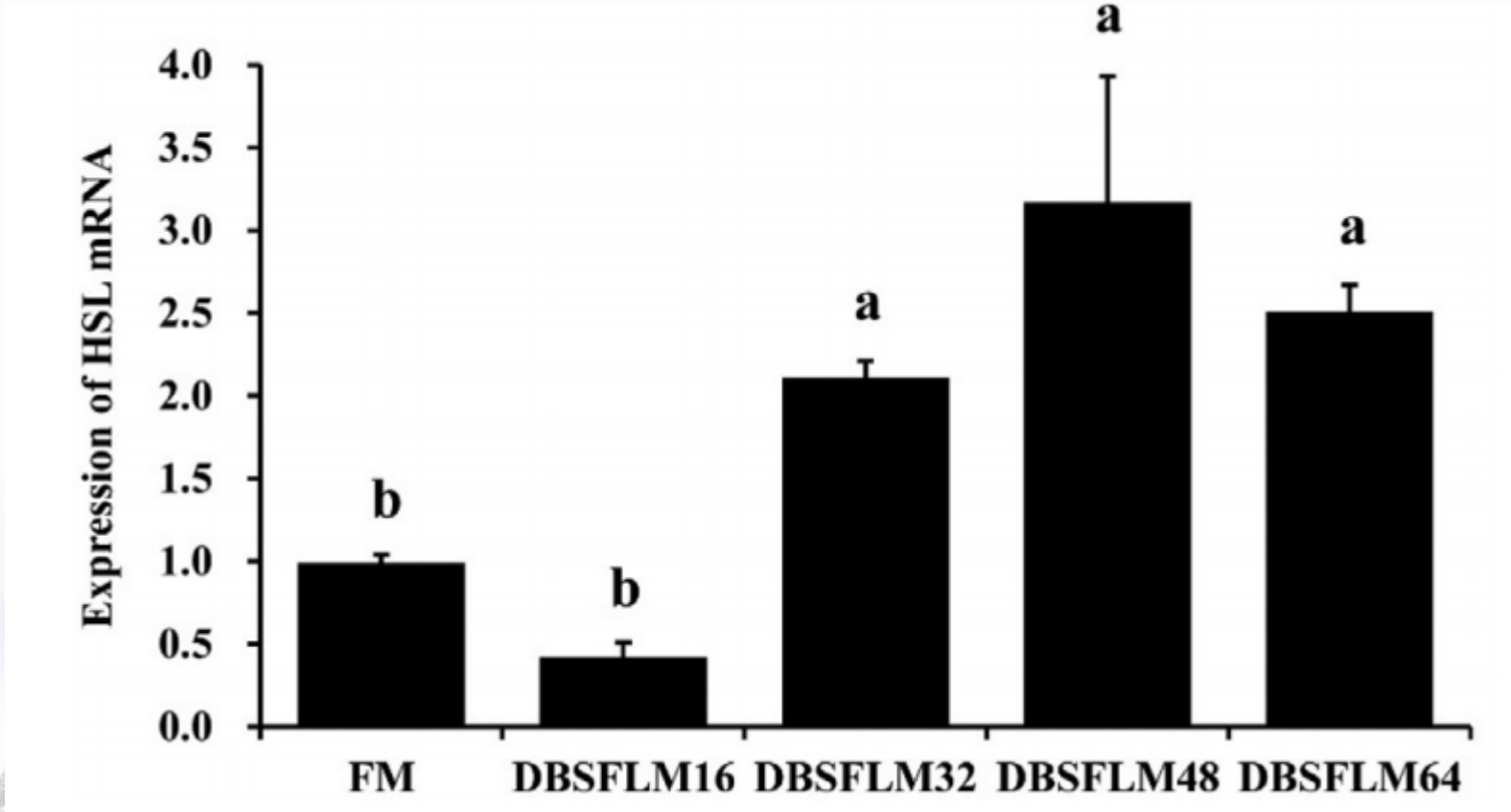
3.结果

LPL


Expression of LPL mRNA
2.5
2.0
1.5
1.0
0.5
0.0
b
b
ab
ab
a
FM
DBSFLM16
DBSFLM32
DBSFLM48
DBSFLM64

3.结果

HSL


Expression of HSL mRNA
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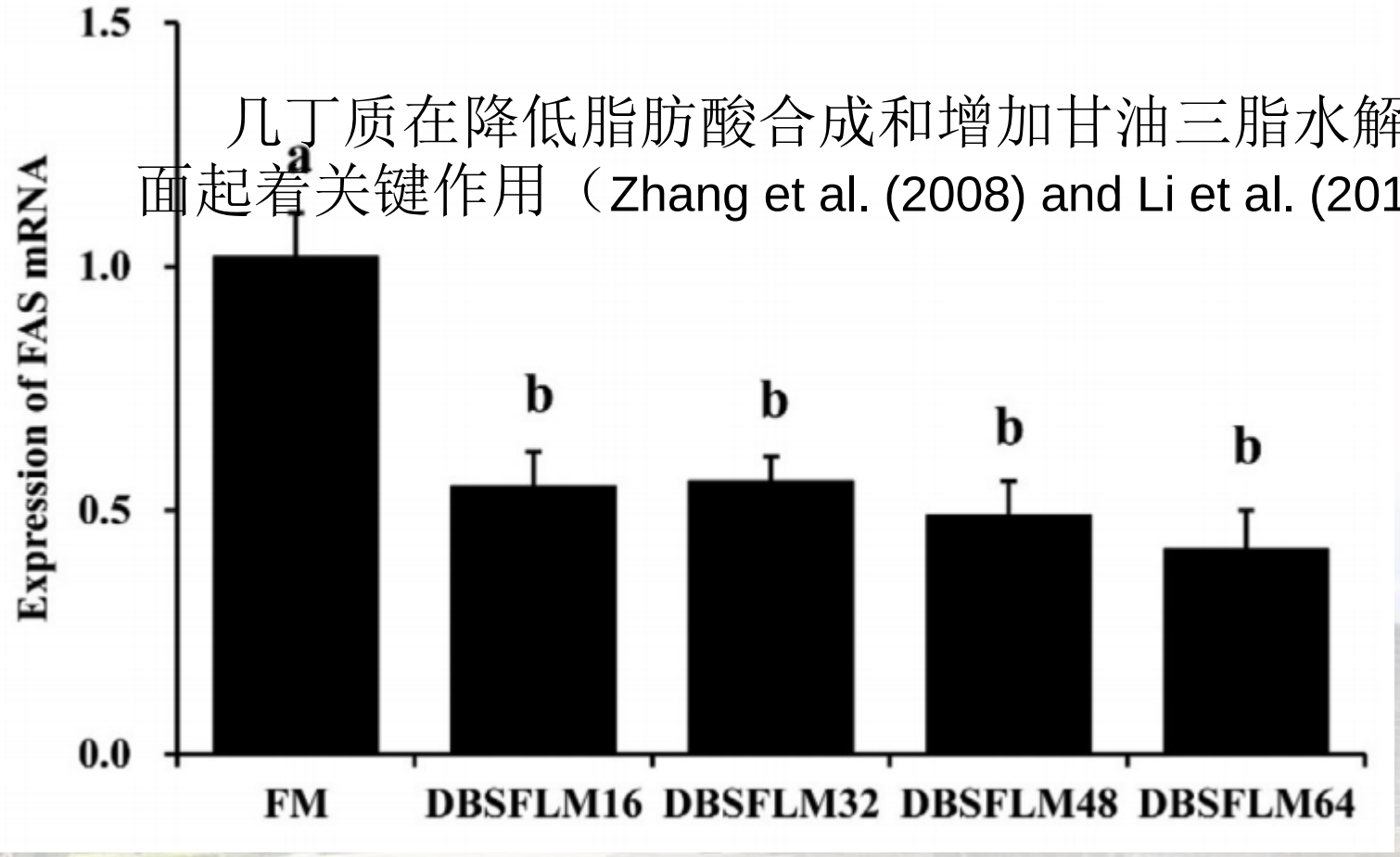
3.0
2.5
2.0
1.5
1.0
0.5
0.0
b
b
a
a
a
FM
DBSFLM16
DBSFLM32
DBSFLM48
DBSFLM64

3.结果

FAS



几丁质在降低脂肪酸合成和增加甘油三脂水解方面起着关键作用（Zhang et al. (2008) and Li et al. (2016)。

总结

- ✓ 替代64%鱼粉，不会影响生长性能，肝脏和肠组织形态。
- ✓ 肠道抗氧化和免疫力没有受到影响。
- ✓ 增加了FI，降低了血清TCHO,TG和MDA，促进灰分保留。
- ✓ 上调肝脏LPL和HSL，下调 FAS基因，抑制肝脏脂肪沉积。

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恳请各位老师批评指正