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Defatted black soldier fly (*Hermetia illucens*) larvae meal in diets for juvenile Jian carp (*Cyprinus carpio* var. Jian): Growth performance, antioxidant

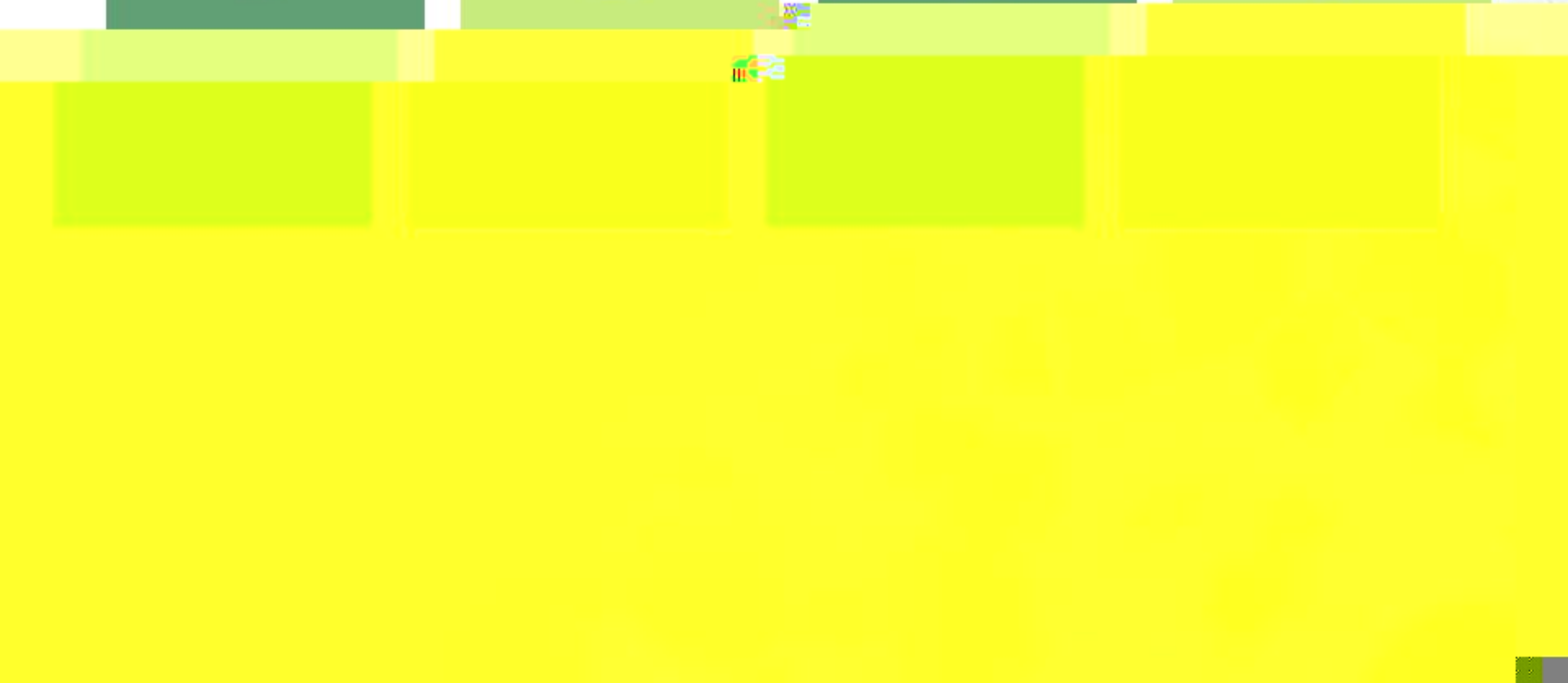


enzyme activities, digestive enzyme activities

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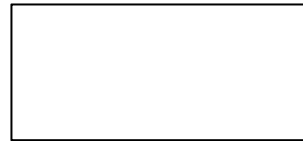
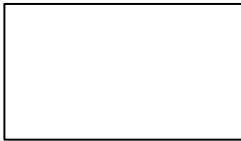
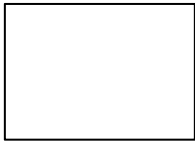
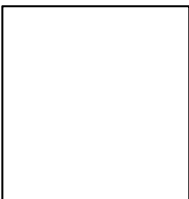
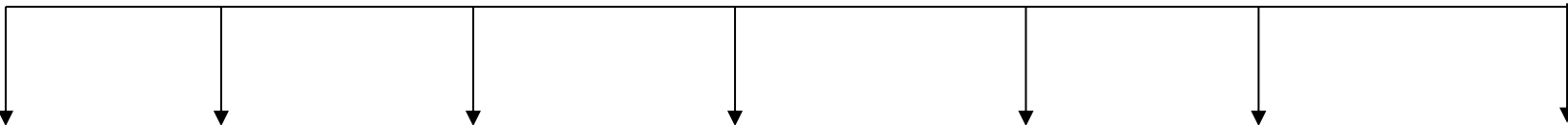
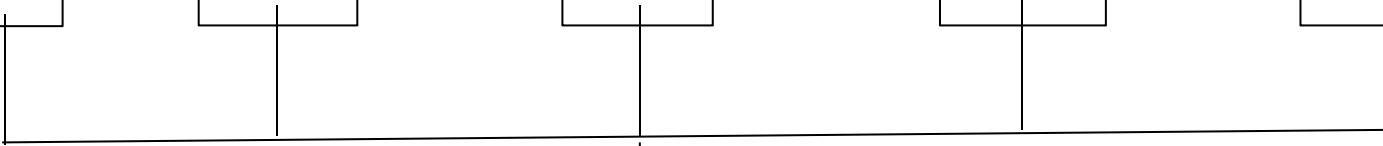


Table 1
Ingredients and proximate composition of the experimental diets.

	Experiment diets				
	FM ^a	DBSFLM25	DBSFLM50	DBSFLM75	DBSFLM100
Ingredients (g kg⁻¹)					
Defatted black soldier fly larvae meal	0	2.6	5.3	7.9	10.6
Fish meal	10	7.5	5	2.5	0
Meat bone meal	5	5	5	5	5
Soybean meal	17	17	17	17	17
Full fat soybean	3	3	3	3	3
Rapeseed meal	22	22	22	22	22
Cottonseed meal	22	22	22	22	22
Wheat flour	12.4	12.2	11.9	11.8	11.5
Soya oil	2.6	2.7	2.8	2.8	2.9
Monocalcium phosphate	2	2	2	2	2
Bentonite	2	2	2	2	2
Mixture ^b	2	2	2	2	2
Proximate composition					
Ash (%)	12.75	12.68	12.73	12.63	12.61
Moisture (%)	10.32	10.14	10.24	10.37	10.65
Lipid (%)	5.35	5.31	5.28	5.24	5.29
Crude protein (% N% × 6.25)	40.62	40.52	40.73	40.84	40.73



Table 4
Effect of DBSFLM on growth performance and biological indices of the experimental fish^a.

Index	Dietary groups				
	FM	DBSFLM25	DBSFLM50	DBSFLM75	DBSFLM100
FBW (g)	110.38 ± 3.34	106.86 ± 4.83	107.80 ± 1.26	111.33 ± 1.07	109.30 ± 4.11
WGR (%)	217.36 ± 9.61	211.79 ± 7.91	204.91 ± 10.16	220.10 ± 3.08	214.27 ± 11.82
SGR (%/d)	2.06 ± 0.05	2.03 ± 0.05	1.99 ± 0.06	2.08 ± 0.02	2.04 ± 0.07
FI (%/d)	2.79 ± 0.08	2.84 ± 0.05	2.87 ± 0.06	2.77 ± 0.01	2.80 ± 0.06
FCR	1.50 ± 0.07	1.55 ± 0.06	1.59 ± 0.08	1.48 ± 0.07	1.52 ± 0.07
PER	1.64 ± 0.08	1.60 ± 0.13	1.59 ± 0.07	1.62 ± 0.11	1.62 ± 0.08
HSI (%)	1.31 ± 0.02	1.28 ± 0.07	1.27 ± 0.01	1.29 ± 0.06	1.27 ± 0.07
VSI (%)	13.58 ± 0.31	13.47 ± 0.46	13.44 ± 0.17	12.78 ± 0.59	12.53 ± 0.34
IFI (%)	0.39 ± 0.04	0.38 ± 0.02	0.33 ± 0.06	0.33 ± 0.07	0.33 ± 0.04
CF	2.44 ± 0.10	2.57 ± 0.20	2.46 ± 0.14	2.38 ± 0.02	2.35 ± 0.01
RGL (%)	1.55 ± 0.10	1.56 ± 0.15	1.48 ± 0.06	1.42 ± 0.07	1.47 ± 0.05

Values are means ± standard deviations (n = 3).

^a FBW, final body weight; WGR, weight gain rate; SGR, specific growth rate; FI, feed intake; FCR, feed conversion ratio; PER, protein efficiency ratio; HSI, hepatosomatic index; VSI, viscera index; IFI, intraperitoneal fat index; CF, condition factor.





Table 6
Serum biochemical indices of the experimental fish^a.

Index	Dietary groups				
	FM	DBSFLM25	DBSFLM50	DBSFLM75	DBSFLM100
ALT	16.05 ± 3.05	12.20 ± 5.68	13.65 ± 2.17	13.05 ± 3.77	12.47 ± 2.96
AST	178.00 ± 71.76	120.43 ± 51.96	126.90 ± 45.69	108.67 ± 18.38	145.50 ± 66.74
TP	23.28 ± 2.29	18.88 ± 2.96	21.38 ± 2.67	19.80 ± 3.24	20.97 ± 3.10
ALB	11.18 ± 1.29	8.90 ± 1.36	10.00 ± 1.10	9.05 ± 1.32	9.80 ± 1.24
GLO	12.10 ± 1.11	9.98 ± 1.63	11.38 ± 1.73	10.75 ± 1.94	11.17 ± 1.92
A/G	0.92 ± 0.06	0.89 ± 0.04	0.89 ± 0.08	0.85 ± 0.04	0.89 ± 0.07
Glc	5.81 ± 1.33	5.35 ± 1.63	6.17 ± 2.85	4.82 ± 1.42	5.92 ± 1.45
Chol	3.11 ± 0.35 ^a	2.52 ± 0.40 ^b	2.52 ± 0.29 ^b	2.13 ± 0.23 ^b	2.47 ± 0.32 ^b
TG	2.52 ± 0.35	1.99 ± 0.38	2.20 ± 0.26	1.89 ± 0.34	2.18 ± 0.41

ALT (U ml⁻¹), alanine aminotransferase; AST (U ml⁻¹), aspartate aminotransferase; TP (g L⁻¹), total protein; ALB (g L⁻¹), albumin; GLO (g L⁻¹), globulin; A/G, albumin/globulin; Glc (mmol L⁻¹), glucose; Chol (mmol L⁻¹), cholesterol; TG (mmol L⁻¹), triglyceride.

^{a,b} Means with different letters are significantly different (*P* < 0.05) from each other.

^a Values are means and standard deviations with different superscripts in the same row are significantly different (*P* < 0.05, one-way ANOVA) from each other (*n* = 3).



Table 5Effect of DBSFLM on proximate composition in tissues of fish¹ (% wet weight).

Proximate composition	Dietary groups				
	FM	DBSFLM25	DBSFLM50	DBSFLM75	DBSFLM100
Hepatopancreas					
Crude protein	20.53 ± 1.18	20.61 ± 1.02	21.42 ± 1.06	20.71 ± 0.88	21.17 ± 0.29
Lipid	32.24 ± 4.18 ^a	25.56 ± 0.77 ^b	22.64 ± 2.50 ^b	25.94 ± 2.48 ^b	24.10 ± 4.05 ^b
Moisture	69.25 ± 2.59	71.38 ± 2.19	72.13 ± 5.53	72.26 ± 1.00	68.63 ± 2.55
Ash	1.64 ± 0.09	1.63 ± 0.18	1.50 ± 0.03	1.54 ± 0.11	1.62 ± 0.04
Muscle					
Crude protein	22.99 ± 1.95	23.30 ± 0.59	23.15 ± 0.57	23.50 ± 0.62	23.51 ± 1.19
Lipid	2.76 ± 0.12	2.76 ± 0.12	2.76 ± 0.12	2.76 ± 0.12	2.76 ± 0.12



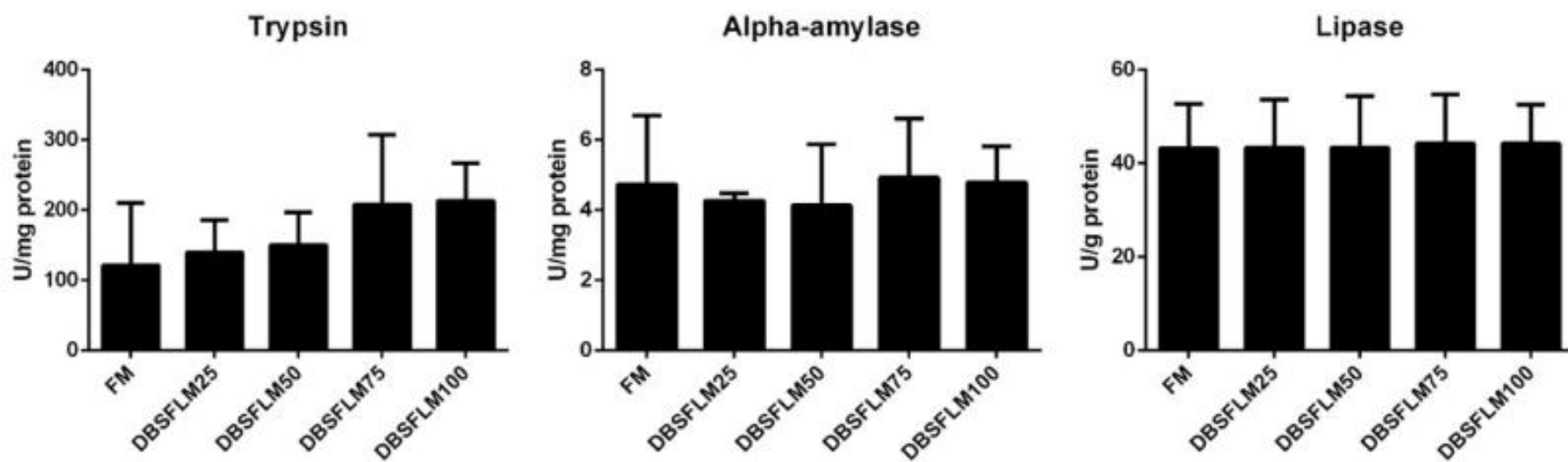


Fig. 1. Alpha-amylase, lipase and trypsin in the intestine of Jian carp fed diet substituting fishmeal with defatted black soldier fly larvae meal for 8 weeks.



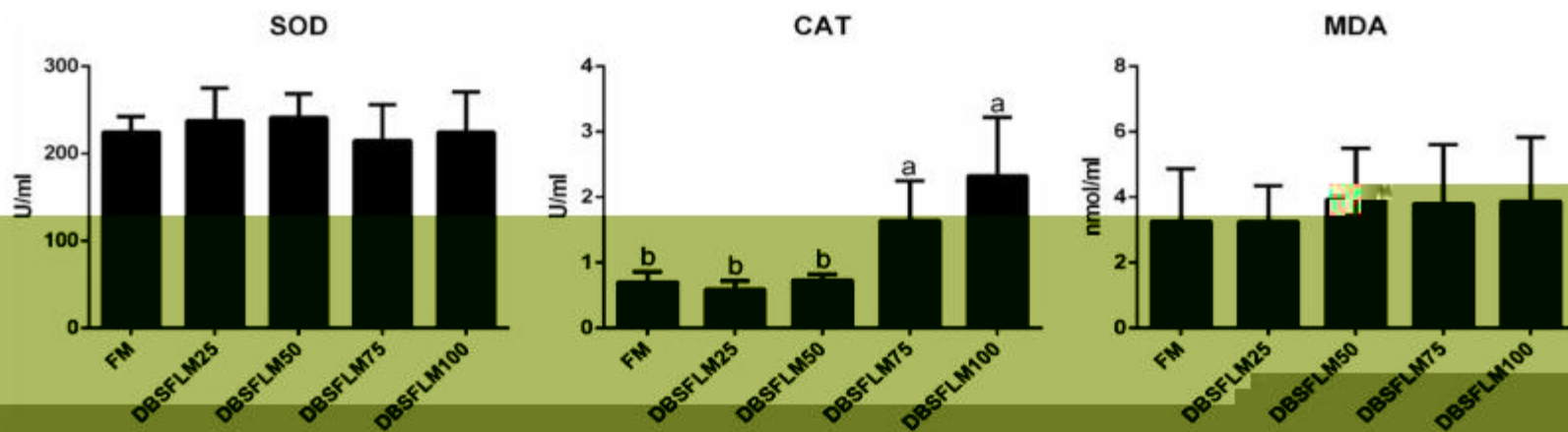
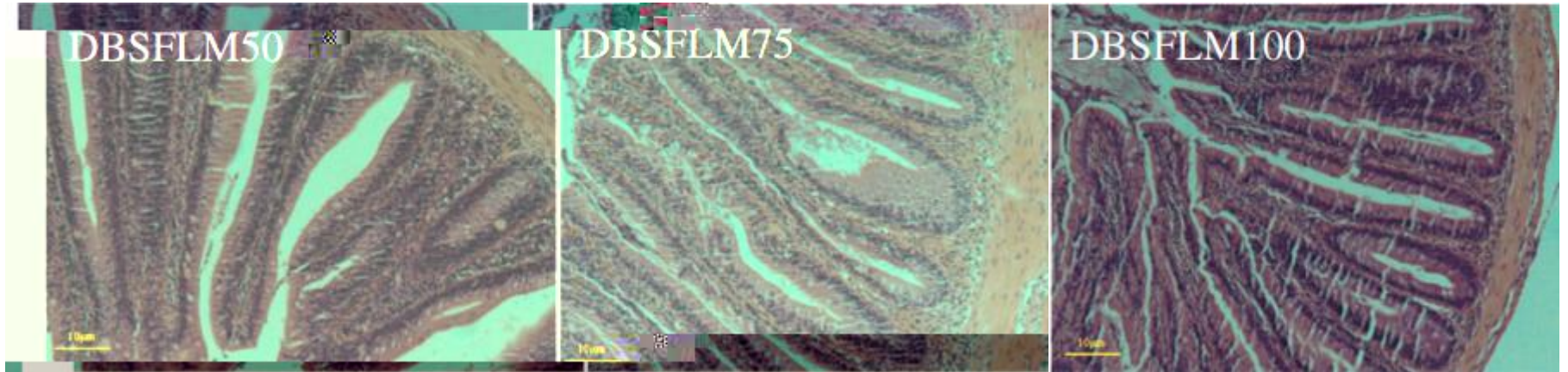
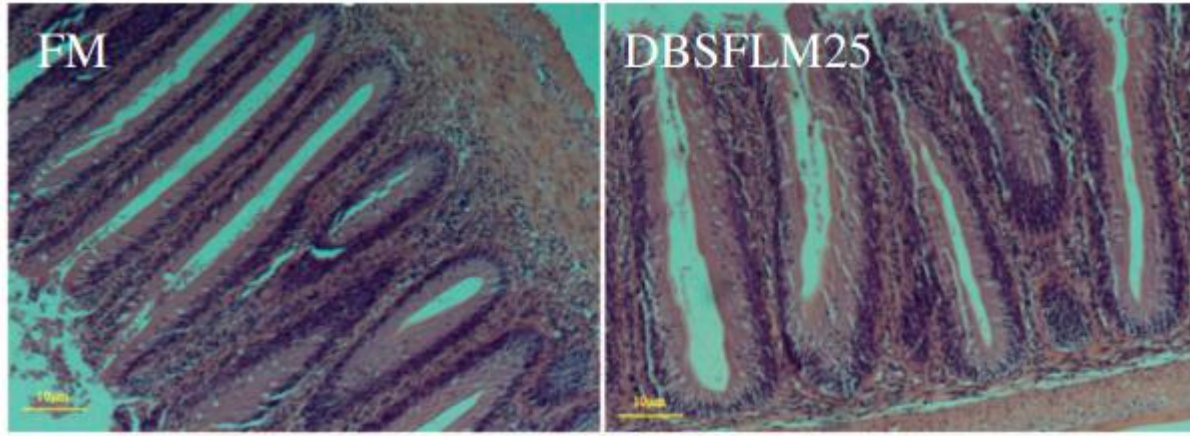
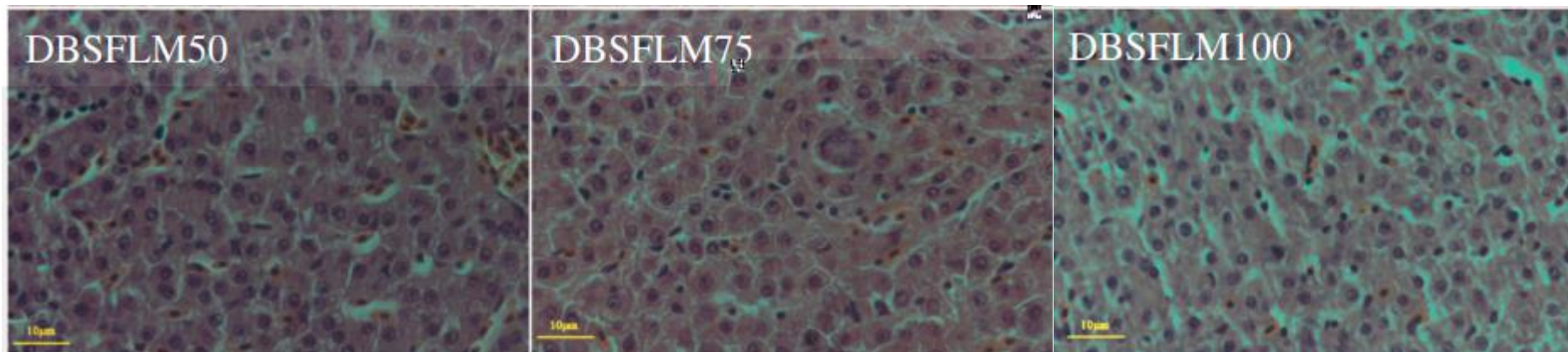
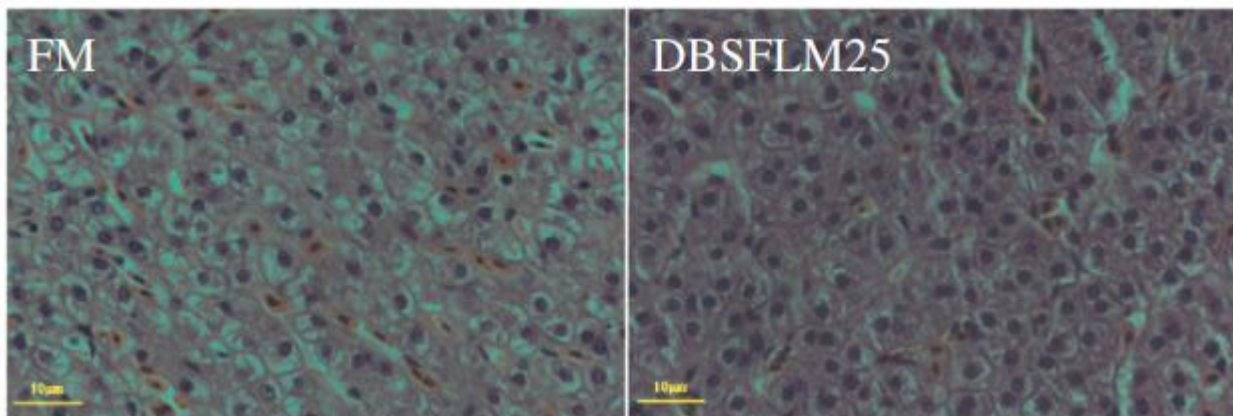


Fig. 2. Serum oxidation indices: superoxide dismutase (SOD) activity, malondialdehyde (MDA) content, catalase (CAT) activity. Values are means (\pm SD) of three replications containing three fish per replication. ^{a,b}Means with different letters are significantly different ($P < 0.05$) from each other.









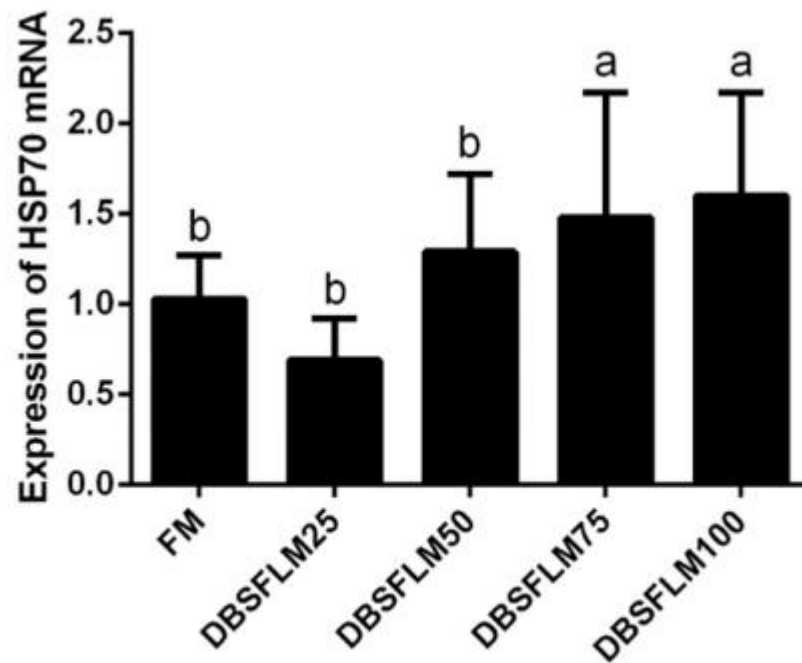


Fig. 5. Expression of hepatic HSP70 gene. Values are means (\pm SD) of three replications containing three fish per replication. ^{a,b}Means with different letters are significantly different ($P < 0.05$) from each other.





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