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Sciences of China

研究论文

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1, 2 1 1
, ,
, 266003;
, , 266200

(*Crassostrea gigas*) ,
‘ 3 ’ ,
(SOD) (LSZ) (T-AOC) (MDA)5
, 16℃ (2℃/d) ,
18℃ 22℃ 26℃ 30℃ 34℃ , ‘ 3 ’
temperature maximum, STMax) 33.63℃, (critical temperature maximum,
50% (50% critical temperature maximum, 50%CTMax) 36.67℃
(median lethal temperature)72-h LT_{50} 30.13℃ 5
12 h, CAT SOD LSZ T-AOC ,
, ‘ 3 ’
,

; ; CAT; SOD; LSZ; T-AOC; MDA; 3
A 1005−8737−(2

assostrea gigas) ,
32℃ ,
28℃
,
,
, ,

hopus jar
nnam

18-12-

(1
,

‘ 3 ’ ,
‘ 3 ’ ,
‘ 3 ’
(CAT) (SOD)
(LSZ) , (T-AOC)
(MDA) ,
,

‘ 3 ’
500 [
: (97.33±4.25) mm; : (47.21±3.35) mm;
: (28.52±6.82) mm; : (21.25±4.54) g;
n=100], 10 100 L ,
(34, 16℃), 1

1 30 L ,
100 W
24 h , 9: 00 21: 00
,
, 1/3 5 s
, ,
,

, 20 ‘
3 ’ , 16℃ 2℃/d
, , 12 h
, 3
(survival temperature maximum, STMax),
(critical temperature maximum, CTMax), SPSS
50%CTMax
,
20 ‘ 3 ’ 16℃
(18℃ 22℃ 26℃
30℃ 34℃) , 72 h ,
,

3 50%
72-h LT_{50} (median lethal temperature)

, 50 ‘
3 ’ 16℃ 18℃
22℃ 26℃ 30℃ 34℃ , 72 h
, 0 h 3 h 6 h 9 h 12 h
24 h 48 h 72 h
3

(
,
,
1 mL ,)
1.5 mL , ,
–80℃ ,
500 mg
1/15 mol/L (pH 6.4),
(10% *w*/*v*)
4℃ 10000 *g* 30 min, 4℃
Bradford

CAT SOD LSZ MDA
T-AOC , 3
CAT
H_2O_2 ,
H_2O_2
, 405 nm ,
CAT 1 μmol
H_2O_2 CAT SOD
SOD -
,
, ,
,
SOD
1 mL SOD 50%
SOD SOD LSZ
,

, ,
T-AOC
, Fe^{3+} Fe^{2+},
,

0.01
MDA (TBA) ,
532 nm ,
MDA

SPSS 16.0
,

(ANOVA), Duncan's
95%(P<0.05)

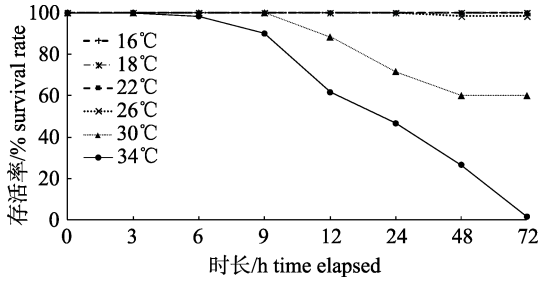
, ‘ 3 ’
1 33℃ ,
, 40℃ ,
16~30℃ ,
(P>0.05), 30~42℃ ,
(P<0.05)
‘ 3 ’ STMax
33.63℃, CTMax 40.13℃,
50% 50%CTMax 36.67℃(1)
, 72 h ‘ 3 ’
2 16℃ 18℃ 22℃ 26℃
, 72 h
30℃ 72 h 55%,

‘

34℃ 12 h 61%, 72 h
0% 72 h 72-h LT_{50}
30.13℃(1)

1 2℃/d ‘ 3 ’

Fig. 1 The survival rate of *Crassostrea gigas* ‘Haida No. 3’ when the water temperature was raised at 2℃/d



2 ‘ 3 ’

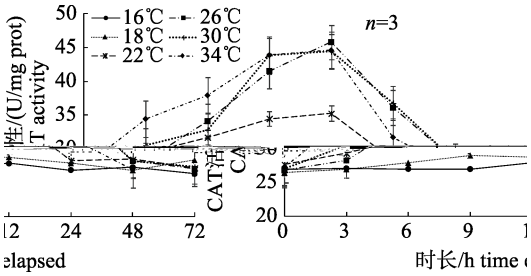
Fig. 2 The survival rate of *Crassostrea gigas* ‘Haida No. 3’ with acute high-temperature stress

, ‘ 3 ’
18~26℃ ,
98%, 30℃
, 55% ,
‘ 3 ’ 33℃ , 36℃
50%, 40℃
, ‘ 3 ’ 50% CTMax
72-h LT_{50},

Crassostrea gigas

group	CTMax	STMax	50%CTMax	72 h	72-h LT_{50}
1	40.30	33.80	36.90		30.12
2	39.70	34.20	37.00		30.09
3	40.40	32.90	36.10		30.18
$\bar{x}$ ± SE	40.13±0.38	33.63±0.67	36.67±0.49		30.13±0.05

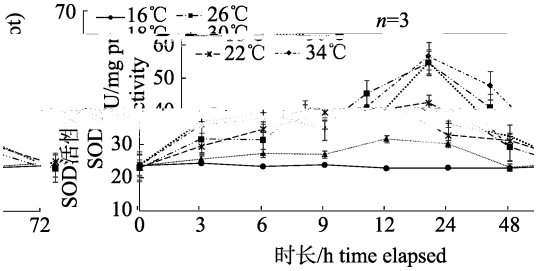
3 72 h ‘
3 ’ CAT 3 h
, 34℃ CAT 34.44 U/mg prot,
9~12 h ,
CAT ,
26℃ 3 CAT , 16℃
18℃ CAT
24 h CAT , 48 h
CAT 12 h
26℃ , CAT 45.81 U/mg prot



3 ‘ 3 ’CAT

Fig. 3 Changes in CAT activities of *Crassostrea gigas* ‘Haida No. 3’ exposed to the acute water temperature increase

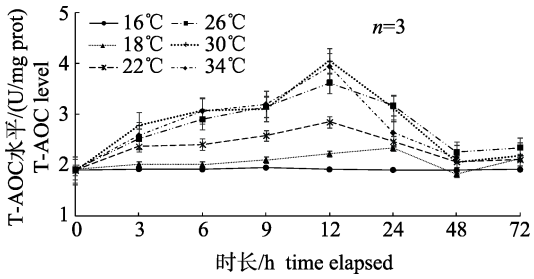
SOD 4
12 h , SOD
, 26℃ 30℃ 34℃ 3 SOD
3 (P<0.05) 24~48 h
SOD , 72 h SOD
, 9 h
30℃ SOD



4 ‘ 3 ’SOD

Fig. 4 Changes in SOD activities of *Crassostrea gigas* ‘Haida No. 3’ exposed to the acute water temperature increase

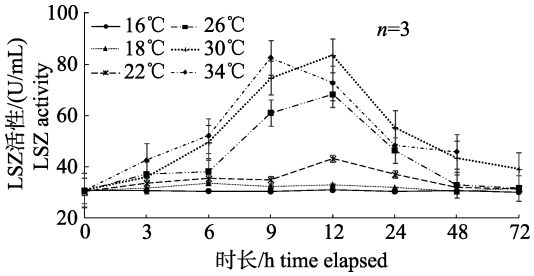
T-AOC 5 6 h ,
T-AOC (P<0.05) 6~12 h,
26℃ 3 T-AOC
3 (P<0.05) 12 h, 26℃
‘ 3 ’
12~48 h, T-AOC



5 ‘ 3 ’T-AOC

Fig. 5 Changes in T-AOC activities of *Crassostrea gigas* ‘Haida No. 3’ exposed to the acute water temperature increase

LSZ 30℃ 12 h
, 83.49 U/mL(6) 6 h, 30℃
34℃ LSZ
(P<0.05) 12 h , LSZ
(P<0.05), 22℃ 26℃ 30℃ LSZ
, 24 h
34℃ 9 h , 12 h ,
24 h , 72 h 34℃
,



6 ‘ 3 ’LSZ

Fig. 6 Changes in LSZ activities of *Crassostrea gigas* ‘Haida No. 3’ exposed to the acute water temperature increase

3 h, MDA
(P<0.05)(7) 30℃ 34℃
MDA 6~9 h , 30℃
34℃ MDA
12~24 h, 30℃ 34℃ MDA
(P<0.05), 24 h (P>0.05)
22℃ 26℃ MDA 9~12 h

ROS ,
,
LSZ 12 h
, LSZ ,
LSZ Muona [20]
(*Salmo salar*)
LSZ
(MDA)
,
[21]
‘ 3 ’ MDA
MDA
, , ROS ,
MDA 12 h
MDA ,
, Jiang
[18] ,
MDA Hao
[8] ,
MDA

, , ‘
3 ’ MDA

,
, ‘ 3 ’
, ‘ 3 ’
30.13℃,
(36.67℃);
CAT SOD LSZ
T-AOC MDA

:

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High seawater temperatures in summer have a significant effect on the biochemical responses of the Pacific oyster, *Crassostrea gigas,* and influence the survival rate of cultured oysters. In this study, we investigated the high temperature tolerance of *C. gigas* ‘Haida No. 3’ through exposure to acute and gradually increasing temperature stresses over 72 h, and measured changes in five immune indicators: catalase (CAT), superoxide dismutase (SOD), lysozyme (LSZ), total antioxidant capacity (T-AOC), and malondialdehyde (MDA). In the gradual temperature increase test, we increased the seawater temperature progressively (2℃/d). In the acute seawater temperature increase test, we transferred oysters from rearing temperature (16℃) to 18℃, 22℃, 26℃, 30℃, and 34℃ directly. The results showed that when the water temperature was increased gradually, the survival temperature maximum (STMax) of *C. gigas* ‘Haida No. 3’ was 33.63℃, that the critical temperature maximum (CTMax) was 40.13℃, and that the 50% critical temperature maximum (50%CTMax) was 36.67℃. In the acute water temperature increase test, the median lethal temperature after 72 h (72-h LT_{50}) was 30.13℃. In each treatment, the five immune indicators in the visceral mass changed significantly as exposure time increased. Within the first 12 h, significant increases were observed in the activities of CAT, SOD, LSZ, and T-AOC, after which their activities returned to their initial levels. The content of MDA was at its highest level between 6 h and 9 h, after which it decreased gradually. All of these results indicate that high-temperature stress induces significant changes in both the antioxidant immune response and in the activity of lysozyme in *C. gigas* ‘Haida No. 3’ and greatly influences its survival. The high temperature tolerance noted in this study will provide a reference for the application and promotion of Pacific oyster strain ‘Haida No. 3’.

Crassostrea gigas; high-temperature tolerance; survival rate; CAT; SOD; LSZ; T-AOC; MDA; Haida No. 3

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