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The oxidative stress and antioxidant responses of live Chinese shrimp, *Fenneropenaeuschinensis*, to low temperature and air exposure

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15 **Abstract**

16 Low temperature and air exposure were the key attributes for waterless transportation
17 of fish and shrimp. In order to investigate the oxidative stress and antioxidant
18 responses of the live shrimp *Fenneropenaeuschinensis* in the mimic waterless
19 transportation, live Chinese shrimp were cooled at 13°C for 3 min, stored in oxygen at
20 15°C for 12 h, and then revived in water at 25°C. The survival rate of shrimp under
21 this waterless transportation system was over 86.67%. The ultrastructure of
22 hepatopancreas cells were observed while activities of superoxide dismutase (SOD),
23 peroxidase (POD), catalase (CAT), glutathione peroxidase (GSH-Px), antiperoxidase
24 anion free radicals (ASA FR), total antioxidant capacity (TAOC), reactive oxygen
25 species (ROS) production, content of malondialdehyde (MDA) and relative mRNA
26 expressions of CAT and GSH-Px in the hemolymph and hepatopancreas were
27 determined. Slight distortions of some organelles in hepatopancreas cells was
28 reversible upon the shrimp revived from the cold shock. The activities of SOD, POD,

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