Glycometabolism reprogramming in Yesso scallop (*Patinopecten yessoensis*) enhance energy supply and repair DNA damage under high temperature stress

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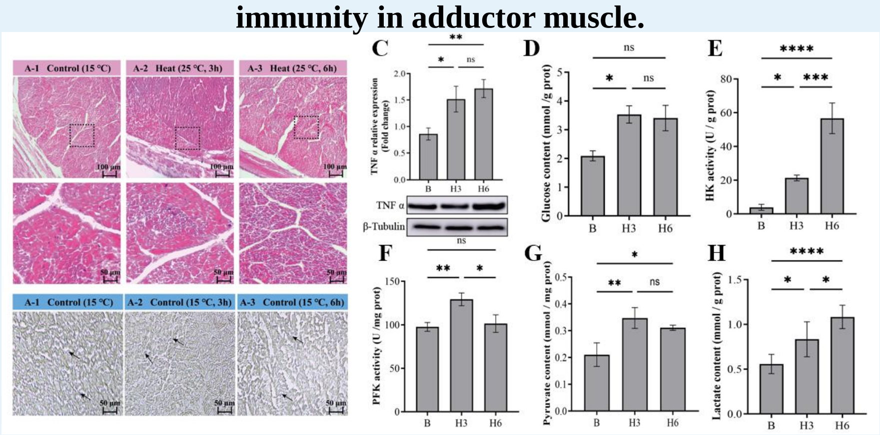
Abstract: Global climate warming has led to a continuous rise in seawater temperature, severely affecting the growth of the cold-water shellfish *Patinopecten yessoensis*. This study aimed to reveal the mechanism of *P. yessoensis* in response to high temperature (25°C) from the perspective of glycogen metabolism. At 3h after high temperature treatment, the content of lactate and the expression of TNFα protein both significantly increased. Based on transcriptome analysis, the Glycolysis/Gluconeogenesis pathway were notably enriched, and the activities of PK and LDH as well as the content of pyruvate and NAD^+ all significantly increased. Moreover, the TCA cycle was weakened, however, glycolytic energy supply was enhanced. At 6 h after high temperature treatment, the pentose phosphate pathway were significantly enrichedm, and meanwhile, G6PD activity significantly increased. However, PK activity, ROS content and the expression of PARP1 all significantly decreased. All above results indicated that glycometabolism reprogramming enhanced Glycolysis/Gluconeogenesis pathway (3 h and 6 h) and PPP flux (6 h), generating large amounts of NADPH to scavenge ROS and repair damaged DNA, while the TCA cycle was augmented to oxidise non-glycans for energy supply (6 h) after high temperature treatment. This study provides new insights into the molecular mechanisms by which mollusks respond to environmental stress.

Keywords: *Patinopecten yessoensis*, Glycometabolism reprogramming, pentose phosphate pathway, DNA damage, high temperature stress

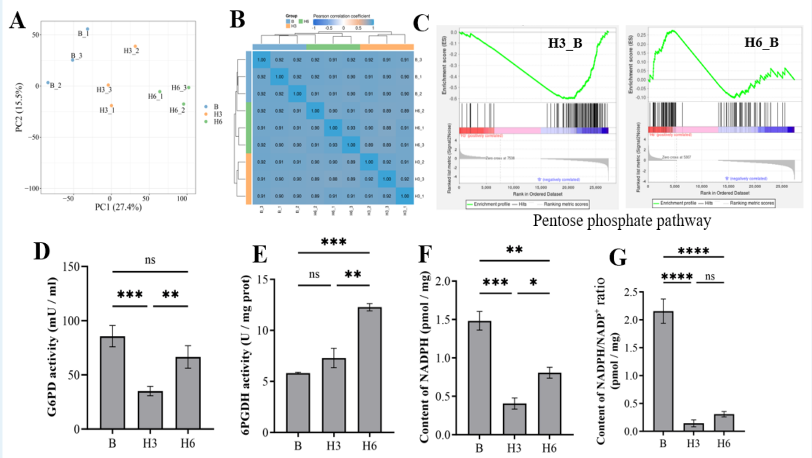
Results

Fig. 1 Effect of high temperature on metabolism and immunity in adductor muscle.



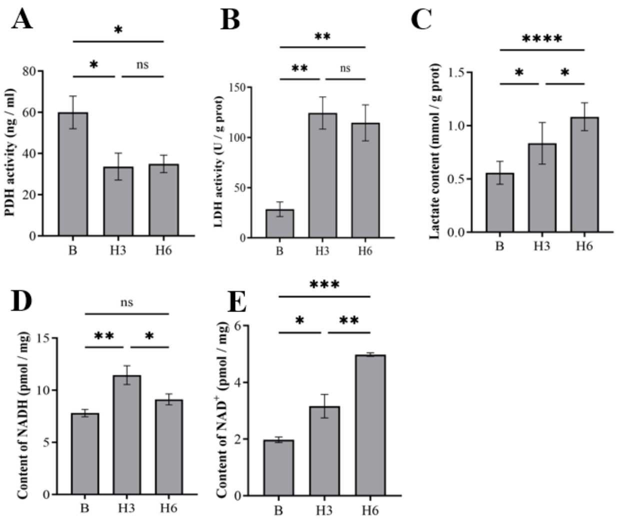
The contraction of adductor muscle fibers and an increase in nucleus concentration after high temperature treatment, accompanied by inflammation, enhanced glycolytic pathways, and a significant elevation in lactate content.

Fig. 2 Enhancement of the glycolytic pathway due to enhancement of the pentose phosphate pathway.



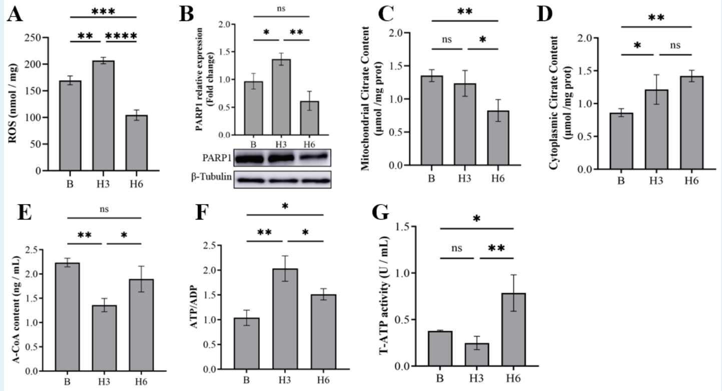
At 6 h after high temperature, the PPP was significantly enhanced, and the G6PD and 6PGDH activities were significantly increased, while the NADPH/$NADP^+$ content ratio was significantly decreased.

Fig. 3 Increased demand for NAD^+ leads to a shift from pyruvate to lactate production.



LDH activity and NAD^+ content significant increased, suggesting enhanced glycolysis and increased lactate accumulation due to NAD^+-NADH cycling. Decreased PDH activity also ensures shift from pyruvate to lactate.

Fig. 4 Glycometabolism reprogramming for energy supply and repair of DNA damage under high temperature stress.



Compared to the results at 3 h, the ROS content and the expression of PARP1 protein significantly decreased, while the mCA and A-CoA content, T-ATP activities, and ATP/ADP ration significantly decreased.