THE ALLEVIATING EFFECT OF BETAINE ON VARIOUS STRESS-INDUCED RESPONSES

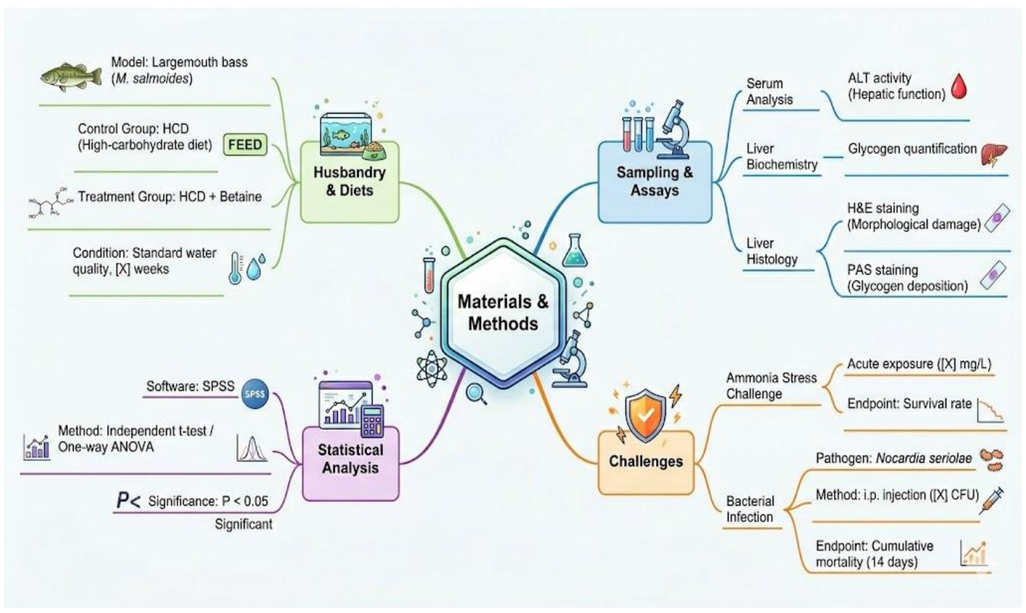
Huijuan Ren* , Qingchao Wang
Huazhong Agricultural University
Wuhan, Hubei Province, China， 430070
18627101622@163.com

Introduction

- In intensive aquaculture, dietary and environmental stressors frequently compromise the health and sustainability of farmed species. High-carbohydrate diets (HCD), while economically favorable, often induce severe metabolic disorders and hepatic injury in carnivorous teleosts, thereby impairing their stress tolerance and disease resistance. Consequently, developing effective nutritional interventions is urgently needed.

- Betaine, a vital methyl donor recognized for its anti-stress and osmoregulatory functions, remains underexplored in aquatic species. Using largemouth bass (*Micropterus salmoides*)—a basal teleost highly sensitive to dietary carbohydrates—as a model, this study evaluates the efficacy of dietary betaine supplementation in mitigating HCD-induced hepatic injury. Furthermore, we investigate its role in enhancing resistance to acute ammonia stress and *Nocardia seriolae* infection. Ultimately, this study aims to characterize betaine as a dual-function nutrient conferring stress tolerance and disease resistance, proposing it as a key metabolic biomarker with potential comparative insights for human liver pathology.

Methods



Results

Dietary betaine alleviated HC-induced hepatic sinusoidal disruption (Fig. 1A), reduced serum ALT activity (Fig. 1B), and decreased hepatic glycogen accumulation (Fig. 1C, D).

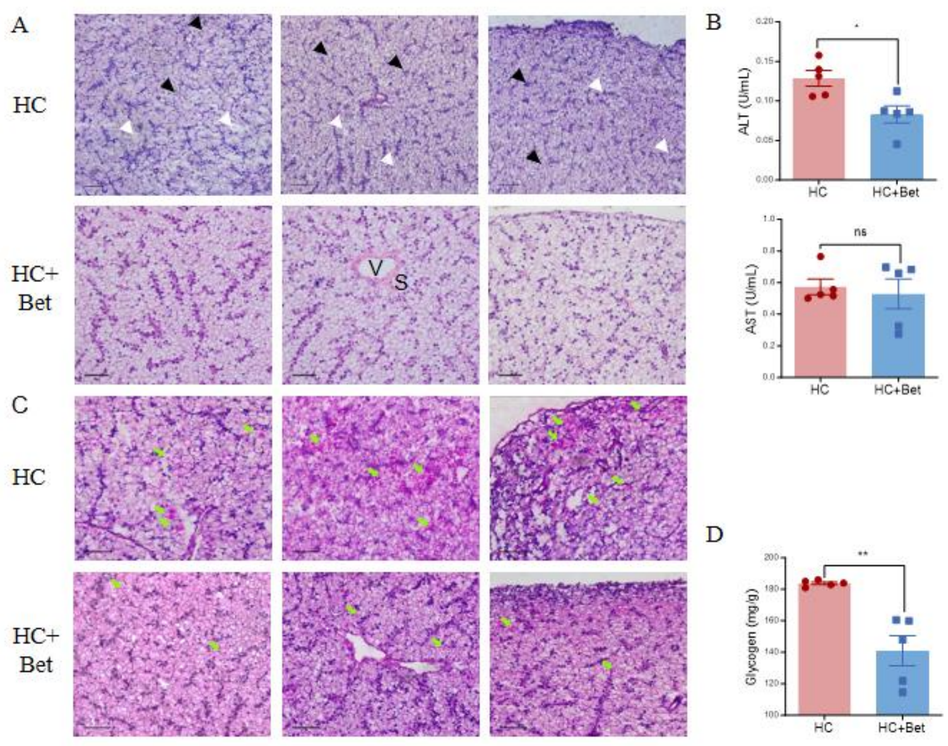


Fig.1 Dietary betaine alleviates high carbohydrate-induced hepatic injury, mitigates elevated serum ALT levels, and attenuates aberrant glycogen deposition in largemouth bass.

Under ammonia stress, HC-fed fish exhibited severe liver damage, including vacuolar degeneration and upregulated IL-18/IL-1β expression, whereas betaine supplementation prevented these changes (Fig. 2).

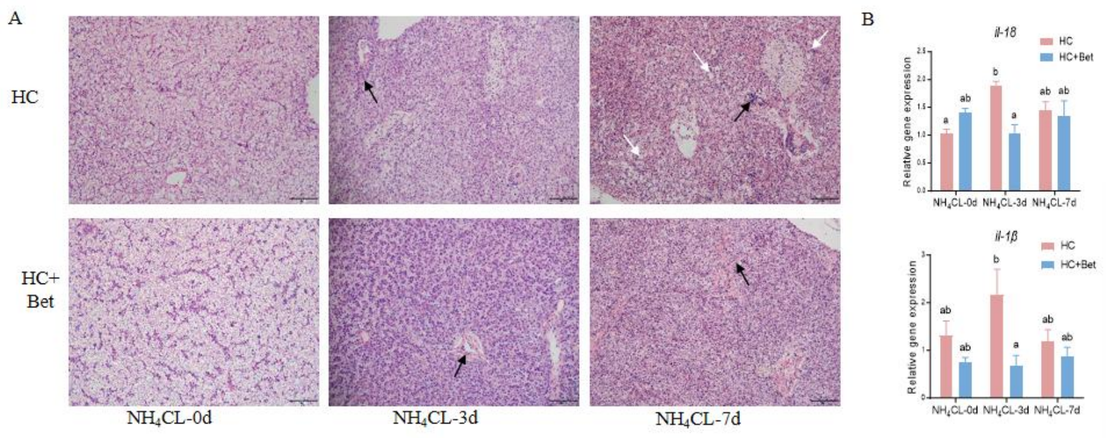


Fig. 2 Dietary betaine supplementation significantly enhanced the resistance ability in liver of largemouth bass against ammonia stress.

In NOC-infected hepatocytes, betaine mitigated mitochondrial swelling, nuclear pyknosis, and pyroptotic body formation (Fig. 3).

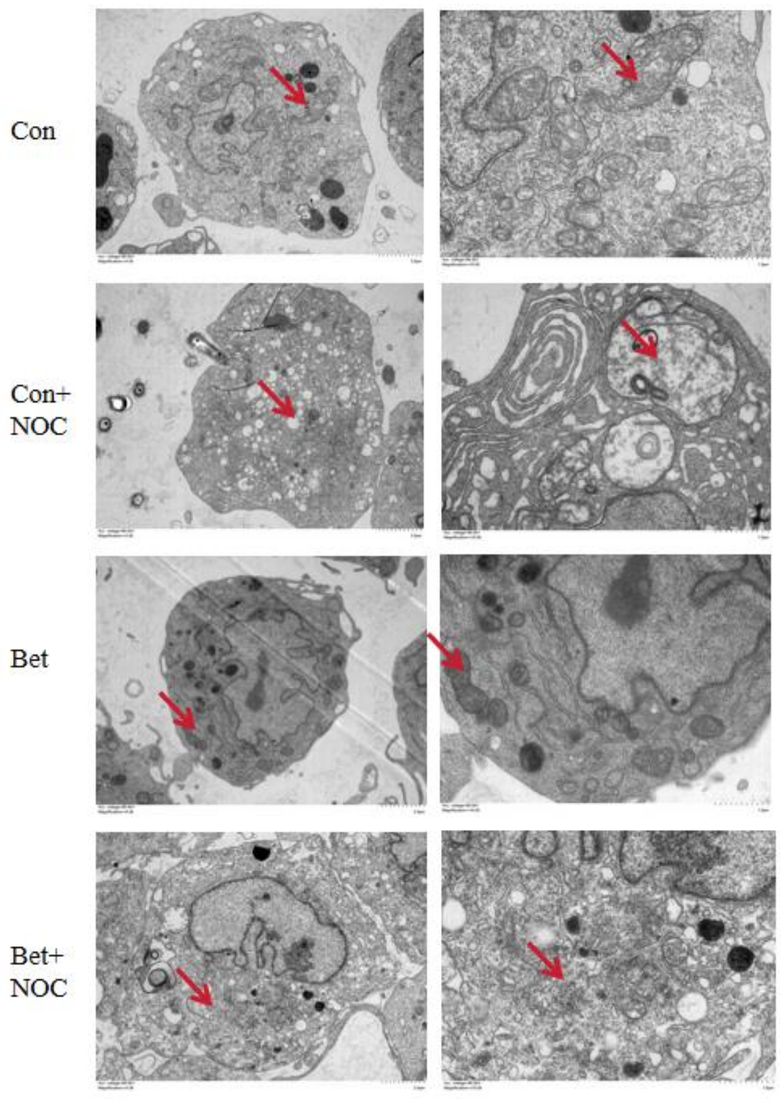


Fig. 3 Betaine supplementation enhanced the resistance of largemouth bass hepatocytes against *Nocardia* infection.

Conclusions

Dietary betaine significantly alleviates multiple stressor-induced hepatic injuries in teleosts by preserving hepatic structure, downregulating inflammation, and inhibiting pyroptosis. Thus, it is a highly effective nutritional intervention for enhancing comprehensive stress resilience.