橙皮苷对克氏原螯虾免疫相关基因表达的影响

摘　要： 近年来克氏原螯虾（*Procambarus clarkii*）已经成为我国重要的水生经济养殖动物，已经成为近年来我国水产行业中最具有发展前景的养殖品种之一。但是，随着人工养殖面积的迅速扩大，克氏原螯虾相关的疾病变得越来越频繁和严重。在养殖过程中，克氏原螯虾极容易被病菌感染，包副溶血性弧菌、白斑综合征病毒(WSSV)等，且此类病菌引起的疾病具有广泛的流行范围和很强的传染性等特性，目前尚无有效的治疗方法。橙皮苷（Hesperidins），是一种广泛存在于柑橘类水果中的类黄酮物质，其化学结构为具有双氢黄酮氧苷结构，呈弱酸性。本文以克氏原螯虾为研究对象，利用不同添加量的橙皮苷对克氏原螯虾进行饲喂，分析橙皮苷对克氏原螯虾免疫相关基因表达的影响。我们评价了橙皮苷对克氏原螯虾非特异性免疫的影响，将 900 只健康的克氏原螯虾随机分为 6 组：对照组和 HES25、HES50、HES75、HES100 和 HES150，饲料中分别添加 25、50、75、100 和 150mg/kg 的橙皮苷，并喂养 8 周。结果表明，与对照组相比，添加 50-150mg/kg 橙皮苷上调了亲环素 A、锌铜超氧化物歧化酶、GPxs、crustin、astacidin、Toll3 和 HSP70 mRNA 的表达（$p<0.05$）；减少了白斑综合症病毒（WSSV）感染后克氏原螯虾的死亡率。这结果表明，饲料中添加 50-150mg/kg 的最佳剂量的橙皮苷可以有效地提高克氏原螯虾的非特异性免疫。本文研究结果可以为今后深入研究橙皮苷等黄酮类化合物对克氏原螯虾在抗菌、抗病毒等方面的影响提供科学依据。

关键词： 克氏原螯虾；免疫基因；橙皮苷；基因表达；疾病免疫

Effects of hesperidin on the expression of immune-related genes in *Procambarus clarkii*

Abstract: In recent years, *Procambarus clarkii* has become an important aquatic economic breeding animal in China, and is one of the most promising breeding species in China's aquatic industry. However, with the rapid expansion of farmed areas, diseases are becoming more frequent and serious. In the process of culture, procambarus crustaceans are very easy to be infected by bacteria, vibrio parahaemolyticus, leukoplectic syndrome virus (WSSV), etc., and the diseases caused by such bacteria have the characteristics of wide epidemic range and strong infectivity, so there is no effective treatment method at present. Hesperidins (Hesperidins) is a kind of flavonoid substance widely existing in citrus fruits. Its chemical structure is characterized by dihydroflavonosides and weak acidity. In this paper, the effects of hesperidin on the expression of immune-related genes in *Procambarus clarkii* were studied by feeding *Procambarus clarkii* with hesperidin. We evaluated the effect of hesperidin on non-specific immunity of *Procambarus clarkii*. 900 healthy *Procambarus clarkii* were randomly divided into 6 groups: control group and HES25, HES50, HES75, HES100 and HES150. 25, 50, 75, 100 and 150mg/kg of hesperidin were added to the feed, and fed for 8 weeks. The results showed that, compared with the control group, adding 50-150mg/kg hesperidin upregulated the mRNA expression of cypA, ecCuZnSOD, GPxs, crustin, astacidin, Toll3 and HSP70 ($p<0.05$). The mortality rate of protocrayfish after infection with white spot syndrome virus (WSSV) was reduced. The results showed that the optimal dose of hesperidin (50-150mg/kg) could effectively improve the non-specific immunity of *Procambarus clarkii*. The results of this study can provide scientific basis for further study of the effects of hesperidin and other flavonoids on the antibacterial and antiviral effects of *Procambarus clarkii*.

Keywords: *Procambarus clarkii*; Immune genetic; Hesperidins; Gene expression; Immune disease

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