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Ultraviolet A photoperiod regimes have varying effects on Pacific white shrimp

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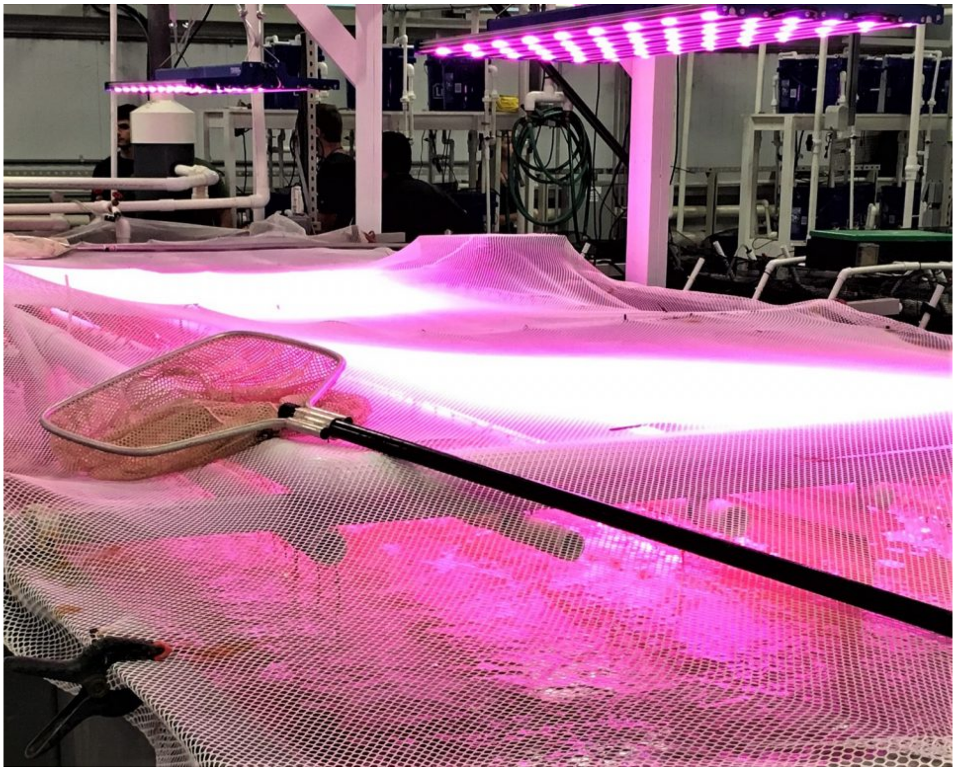
Different UVA photoperiods can affect growth, immune responses and other physiological parameters of *L. vannamei*



This study reviewed the effects of different UVA photoperiod regimes on Pacific white shrimp and how they impact growth, immunity, FCR and mortality. Photo by Darryl Jory.

Ultraviolet light (UV) is a crucial element on the natural light spectrum and serves a variety of ecological purposes. In recent decades, due to climate challenges such as global warming and ozone layer depletion, the amount of ambient UV radiation reaching the Earth's surface has grown, which has ramifications for ecosystems.

Like visible light, which has different colors that can be seen in a rainbow, the **UV radiation** (https://www.who.int/news-room/questions-and-answers/item/radiation-ultraviolet-(uv)) spectrum is divided into three regions called UVA, UVB and UVC. As sunlight goes through the earth's atmosphere, most UVB and all UVC are absorbed by ozone, oxygen, water vapor and carbon dioxide – but UVA is not significantly filtered by the atmosphere.

The impact of exposure to ambient UV light has been reported for several aquatic species, including the harmful effects of UVA and UVB radiations on various fish species at different life cycle stages, including embryo, larvae, juveniles and adults. However, there have been few similar studies in shrimp species. Based on **previous research** (https://doi.org/10.1016/j.aquaculture.2020.735013) in our laboratory, the full-light spectrum plus a UVA light environment was most conducive for the culture of the Pacific white shrimp (*Litopenaeus vannamei*).

L. vannamei is the most important cultured shrimp species in China, and indoor recirculation aquaculture systems (RAS) have advanced quickly in recent years, showing promise for long-term in the country. But light levels in indoor aquaculture environments can be very diverse, as indoor shrimp culture, in contrast to traditional outdoor pond farming, restricts natural light. Furthermore, **previous**

research (https://doi.org/10.1111/j.1749-7345.2011.00512.x) has revealed that shrimp are extremely light-sensitive, and that light directly or indirectly affects their development, feeding, growth and survival. Currently, the use of supplemental UVA is rare in commercial shrimp farming.

This article – adapted and summarized from the **original publication** (https://doi.org/10.3390/antibiotics11010037) [Wang, X. et al. 2022. The Effects of Different UVA Photoperiods on the Growth Performance, Immune Responses, Antioxidant Status and Apoptosis-Related Gene Expression of the Pacific White Shrimp (*Penaeus vannamei*). *Antibiotics* 2022, *11*(1), 37] – reports on the results of a recent study to investigate how different UVA photoperiod supplementation affected the growth, immune responses and other physiological parameters of shrimp, with the goal to improve artificial light addition approaches to indoor shrimp farming.

Study setup

Our study was carried out at Yuhai Hongqi Ocean Engineering Co. Ltd., in Rizhao, Shandong, China. *L. vannamei* juveniles (initial wet weight: 9.56 ± 0.10 grams) were purchased from a local farm. All shrimp used appeared to be in good physical condition, showed no symptoms of trauma, and were acclimated in aquaria for seven days before the experiment to adapt to the experimental settings.

A commercial UV lamp was used to provide UVA light, and the experiment involved a control group of shrimp (receiving the full-spectrum treatment) and four full-spectrum treatments with different UVA (peak at 400 nm) photoperiod environments (2L: 22D, 4L: 20D, 8L: 16D and 12L: 12D) were used. The photoperiod of the full spectral light was 12L: 12D. A commercial spectroradiometer was used to measure various light parameters. Each UVA treatment group received a solar irradiation of 1 Watt per square meter (1 Watt per square meter) light and the intensity of the full-spectrum light was also 1 Watt per square meter. The local UVA light intensity was measured every two hours from 6:00 to 18:00 and averaged to produce 50 percent of the experimental light intensity. To avoid light pollution, the various treatment groups were separated by blackout coverings.

Each treatment included three 70-liter tanks in a recirculating aquaculture system and each tank contained 30 shrimp. The shrimp were fed a commercial feed three times per day to keep them completely nourished. Water quality parameters in the tanks were maintained within recognized ranges for *L. vannamei* culture. Shrimp production data (growth, weights) and tissue samples were collected for laboratory analyses.

For detailed information on the experimental setup and animal husbandry; sample collection and analyses; and data processing, refer to the original publication.

Green-lighting growth: Green LED light shows promise in flounder farming

Japanese researchers say that deploying green LED light above flounder grow-out tanks encourages rapid growth and feed intake among the fish.

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Results and discussion

UV light is a vital component of the natural spectrum, serves a variety of ecological roles, and has been shown to affect the growth and feeding of marine ectotherms such as fish and invertebrates in various **previous studies** (https://doi.org/10.1016/j.aquatox.2020.105651). Thus, adding UV could exert a variety of effects on aquatic species, with each effect being species-specific.

In our study, shrimp growth rates in the 2L:22D and 4L:20D groups were significantly higher, while the feed conversion ratios (FCR) in the 2L:22D and 4L:20D groups were significantly lower compared with the other treatment groups. This might mean that adding a particular quantity of UV to a shrimp's environment increases feeding and, as a result, shrimp growth. Furthermore, we observed that the shrimp in the 4L:20D group grew faster than those in the 2L:22D group, suggesting that *L. vannamei* prefers this UVA photoperiod.

Our results showed that the long UVA photoperiod groups (8L:16D and 12L:12D) produced lower enzyme activities than those in other groups. This could be related to immunosuppression or immunological weariness brought on by prolonged exposure to stimuli. Overall, our data illustrate that short-duration UVA irradiation could enhance the immune response and that prolonged UVA irradiation could suppress immune functions in *L. vannamei*.

Most crustaceans have a high content of carotenoid pigments [yellow, orange and red pigments produced by plants, algae, some fungi and bacteria] that support various essential functions in the immune and antioxidant systems of these animals, and may help regulate the deleterious consequences of increased UV exposure. Our findings suggest that under the protection of carotenoids, particularly 2L:22D, a short UVA photoperiod may boost the antioxidant potential of shrimp to some extent. However, the long UVA photoperiod groups (8L:16D and 12L:12D) demonstrated the opposite result: the activities of these enzymes were lower than in other groups. We speculate that when it is exposed to prolonged UVA lighting since the antioxidant system is unable to remove excessive reactive oxygen species, ROS [highly reactive and potentially harmful compounds formed from oxygen] in a timely manner, oxidative damage and decreased enzyme function occur.

Almost all multicellular animals use the process of apoptosis [natural, programmed cell death] to remove unwanted, contaminated or harmful cells. It is a system for controlling the course of an immune response, as well as establishing immunological memory and tolerance. Our results indicate that short-duration UVA irradiation does not significantly affect apoptosis, while prolonged UVA irradiation induces substantial stress, leading to apoptosis. Long UVA photoperiods (more than eight hours) not only produced poor growth but may also have caused a stress response, which might consequently lead to elevated hepatopancreas oxidation rates and depress immunity in *L. vannamei*.

Although the growth performance, different immune parameters, antioxidant status and apoptosis-related gene expression of shrimp in different UVA photoperiods have been studied, molecular mechanisms are scarce and need to be elucidated further in future studies.

Perspectives

We investigated the growth performance, immune responses, antioxidant status and apoptosis-related gene expression of *L. vannamei* under five different UVA photoperiods in full-spectrum background light (12L:12D). Our data showed that exposure to 2L:22D and 4L:20D UVA photoperiods resulted in increased growth performance and immune responses while decreasing stress responses, whereas the opposite results were found for the long UVA photoperiod groups (8L:16D and 12L:12D).

The apoptosis-related gene expression levels in the 2L:22D and 4L:20D groups were lower than with the other treatments, except for the control group (0L:24D). As a consequence, supplementing with UVA light at specific periods activated antioxidant enzyme activity and the immunological defense system, protecting cells from oxidative stress.

We believe that selecting a specific UVA photoperiod is beneficial to *L. vannamei* shrimp growth and immunological function and that the beneficial effects of choosing 2L: 22D and 4L:20D UVA photoperiods can be significant, based on our results.

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