Effect of Dietary Astaxanthin and Background Color on Pigmentation and Growth of Red Cherry Shrimp, *Neocaridina heteropoda*

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ABSTRACT

Effect of dietary astaxanthin and background color on pigmentation and growth of red cherry shrimp (*Neocaridina heteropoda*) was investigated. A 2x3 factorial in CRD with two types of diets (with astaxanthin supplementation of 200 mg astaxanthin.kg^{-1} and without supplementation) and three types of background colors (white, red and black) was conducted. After the 8 weeks feeding trial, the results indicated that dietary astaxanthin and background color had no interaction effect on pigmentation and growth performance ($P>0.05$). Astaxanthin-fed groups had significantly greater pigmentation than that of shrimp fed without astaxanthin ($P<0.05$). Pigmentation significantly increased as the darkness of background color increased ($P<0.05$). Astaxanthin-fed groups had significantly greater weight gain and SGR than that of shrimp fed with diets without astaxanthin ($P<0.05$). Weight gain and SGR also significantly increased as the darkness of background color increased ($P<0.05$). There was no difference in shrimp survival between diets with or without astaxanthin ($P>0.05$) and among background colors. All results indicated that red cherry shrimp fed with astaxanthin and reared in black or red background colors can increase pigmentation, weight gain and SGR.

INTRODUCTION

Red cherry shrimp (*Neocaridina heteropoda*) is a small freshwater shrimp species from Taiwan, and commonly kept in ornamental aquaria, with cultured aquatic plants. Red cherry shrimp's pigment is one of the most important quality criteria and dictates their market value. The pigment of shrimp is affected by culture conditions such as feed quality, temperature and water quality, including transportation. Astaxanthin as pigments is important to crustaceans and fish which are unable to synthesize pigments on their own and therefore have to rely on dietary supplements to achieve natural pigmentation (Estermann, 1994). Boonyaratpalin *et al*. (2001) and Wade *et al*. (2005) also noted that dietary supplementation could enhance color of fish. Moreover, environmental factors also affect crustacean color, such as light regime on *Penaeus monodon* (Pan *et al*., 2001), and background color on *Litopenaeus vannamei* (Parisenti

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et al., 2011) and *Macrobrachium rosenbergii* (Yasharian *et al*., 2005).

The aim of this study was to investigate the effect of dietary astaxanthin and background color on pigmentation and growth performance of red cherry shrimp.

MATERIALS AND METHODS

Experimental design

The experiment involved two factors: type of diets (with and without astaxanthin) and background color (white, red, black). Each treatment had four replicates, and each replicate had 20 shrimps (per tank).

Experimental protocol

1. Diet preparation

Commercial meal diets (Nutrena 8000 by Cargill Siam Ltd.) with 40% protein and 12% lipid, were used as basal diets. Astaxanthin (200 mg kg^{-1}) from marigold flower was added to one treatment diet (with supplementation). Another treatment diet had no astaxanthin added. Approximately 60% distilled water per kg was added, and diets were thoroughly blended. Pelleted diets were dried in hot air oven at 60°C. Diets were stored in plastic bags at a constant temperature of -20°C.

2. Shrimp preparation

Red cherry shrimp were collected from the Aquarium Fish Laboratory, Department of Animal Production Technology and Fisheries, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang (KMITL). The shrimp had a mean body weight of 0.0402-0.0411g. They were acclimated for 2 weeks in indoor plastic tanks and fed with commercial feed as the basal diet. Red cherry shrimp of uniform size were selected and transferred to plastic tanks (18.7 x 26.4 x 11.4 cm) containing gravel with different background colors (white, red or black) (Figure 1). Shrimp were fed daily at 4% body weight, split into two feedings per day, one in the morning and the other in the afternoon. Water was replaced every 3 days at approximately 10-20%.

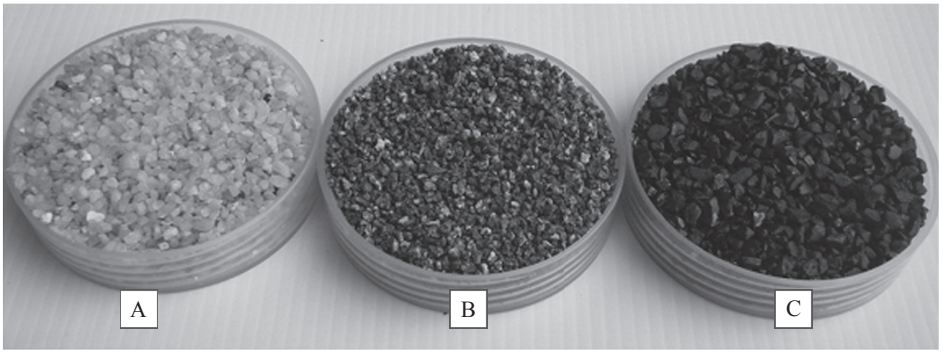


Figure 1. The style and color of the substrate as background in the experimental tanks: white (A), red (B), and black (C)

3. Data collection

Shrimp growth was measured biweekly. At the end of the experiment, the total number of cherry shrimp was determined to calculate the survival rate. Growth parameters which were calculated included weight gain and specific growth rate (SGR). Total carotenoids were analyzed according to the modified method of Yanar *et al*. (2004). Whole shrimp were homogenized and total carotenoid concentration was determined spectrophotometrically in petroleum-ether-acetone-water solution (15:75:10) 1:19 (w/v) incorporated with BHT 0.01%. Total carotenoid concentration was estimated with an $E_{(1\%,1cm)} = 1910$ at 473 nm.

4. Statistical analysis

All data were statistically analyzed by two-way ANOVA and the Duncan's new multiple range test (DUNCAN) to determine differences among treatments at 0.05 alpha levels. All results are given in means ± standard error (SE).

RESULTS AND DISCUSSION

Pigmentation

At the start of the experiment, the total carotenoid content in shrimp was 0.345 µg/g. After feeding for 8 weeks, dietary astaxanthin and background color did not have significant interactions on pigmentation ($p>0.05$) as shown in Table 1. Pigmentation significantly increased as darkness of background increased ($P<0.05$) (Figures 2 and 3). The total carotenoid content of shrimp fed on diets with astaxanthin was higher than that control diets($p<0.05$). The total carotenoids in shrimp reared in black and red gravels were higher than those in white gravel. Our study was similar to the experiment done by Parisenti *et al*. (2011) wherein white shrimp (*Litopenaeus vannamei*) was darker in a dark background than those in white background. Shrimp given diets with astaxanthin had stronger color intensity. Our study was similar to the experiment done by Boonyaratpalin *et al*. (2001) on *Penaeus monodon*, which showed that diets containing β-carotene from *Dunaliella salina* increased the intensity of color of the flesh. Moreover, the results of this study are comparable to that of Pan *et al*. (2001) who reported that an addition of carotenoid to shrimp diets could enhance pigmentation in shrimp.

Table 1. Effect of dietary astaxanthin and different background colors on the total carotenoid of red cherry shrimp

Factor	df	Mean Square	F	P
Astaxanthin	1	.217	10.380	.005
Background	2	.452	21.597	.000
Astaxanthin* Background	2	.042	1.985	.166
Error	18	.021		

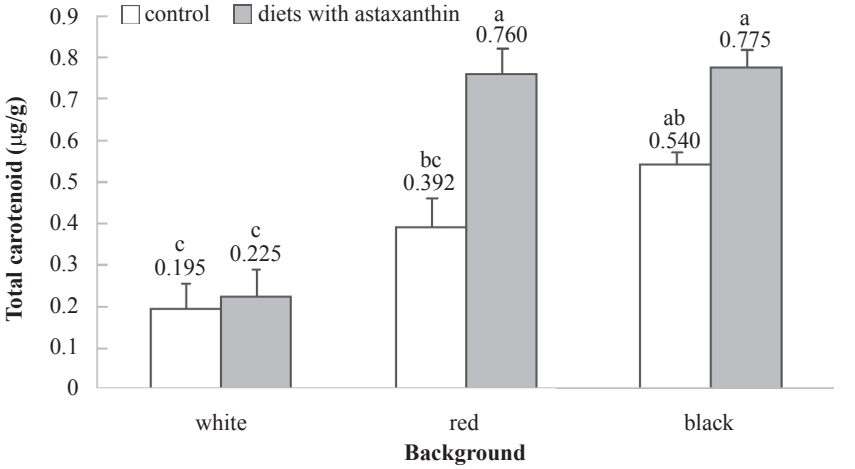


Figure 2. The total carotenoid in shrimp fed with astaxanthin-supplemented diets on 3 gravel colors (white, red and black). Different letters indicate statistical significance (DUNCAN, P<0.05)

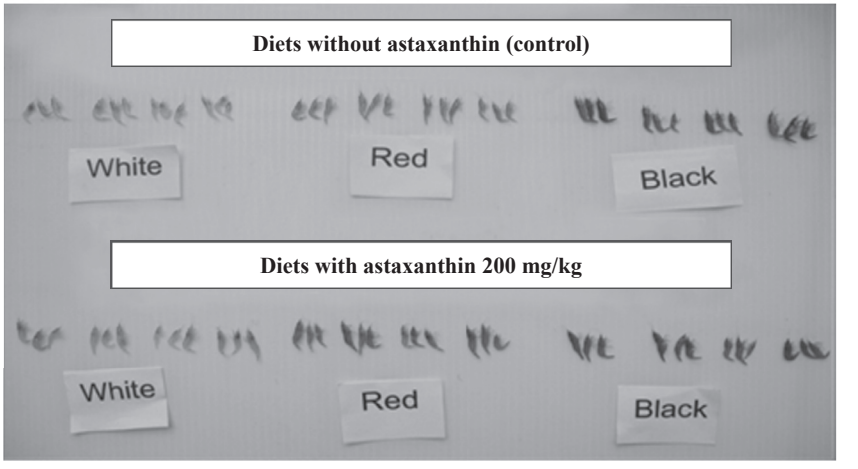


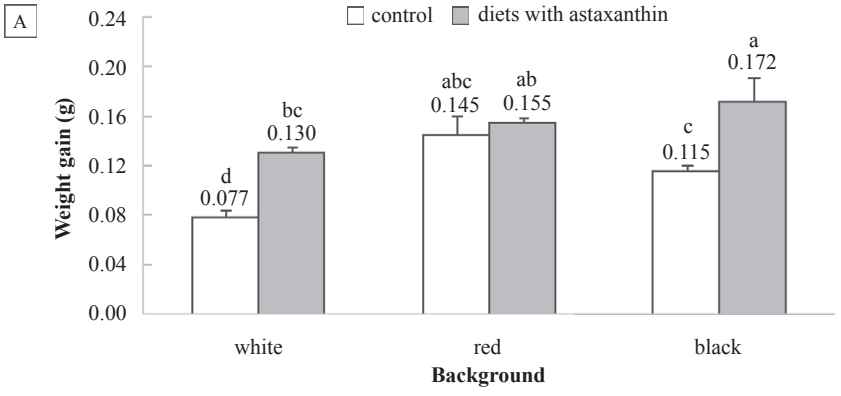
Figure 3. Color of red cherry shrimp fed on astaxanthin-supplemented diets reared on 3 gravel colors (white, red and black)

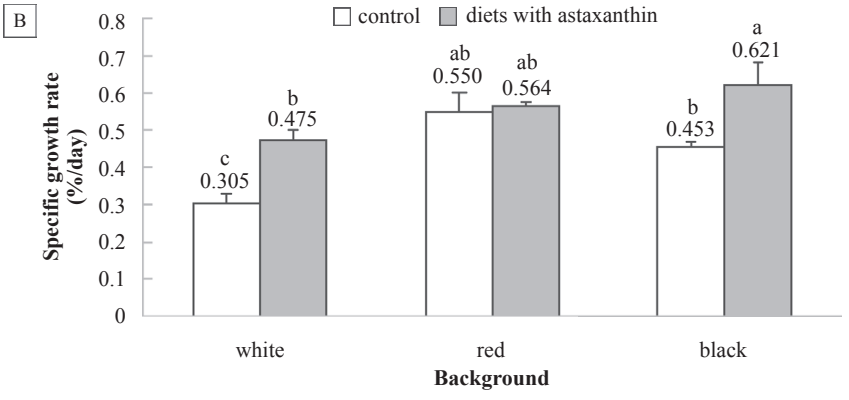
Growth

Dietary astaxanthin and background color did not have significant interactions on growth performance (P>0.05) as shown in Table 2. The weight gain and SGR significantly increased as the darkness of background color increased (P<0.05) (Figures 4A and 4B). Luchiari *et al*. (2012) explained that in *L. vannamei*, the increase in growth performance under black substrate may be related to the color that best mimics the natural environment of the species. In all treatments, no signifcant differences in survival of shrimp were found (Figure 4C). This is not in agreement with Yasharian *et al*. (2005) who reported that background color did not affect the growth of *Macrobrachium rosenbergii.*

Table 2. Effect of dietary astaxanthin and different background colors on weight gain, SGR, and survival of red cherry shrimp

	Factor	df	Mean Square	F	P
Weight gain	Astaxanthin	1	.008	17.615	.001
	Background	2	.006	13.559	.000
	Astaxanthin*Background	2	.001	2.631	.099
	Error	18	.000		
SGR	Astaxanthin	1	.082	14.485	.001
	Background	2	.066	11.724	.001
	Astaxanthin*Background	2	.016	2.847	.084
	Error	18	.006		
survival	Astaxanthin	1	66.667	2.595	.125
	Background	2	3.125	.122	.886
	Astaxanthin*Background	2	13.542	.527	.599
	Error	18	25.694		





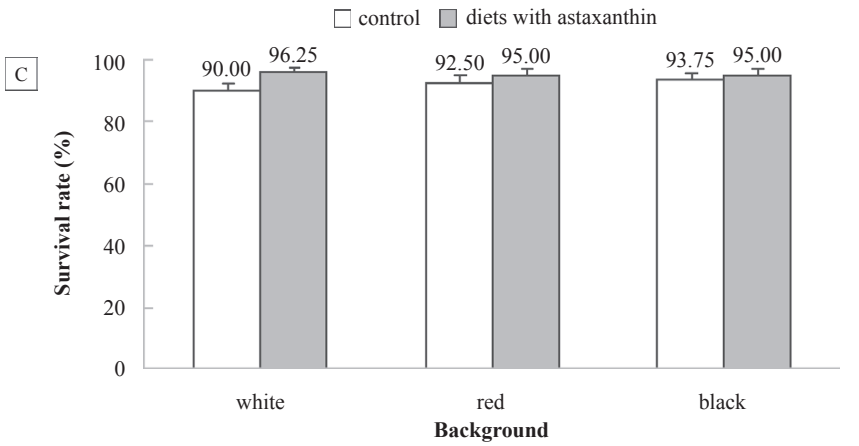


Figure 4. The effect of diets with astaxanthin and background colors on weight gain (A), SGR (B), and survival rate (C). Different letters indicate statistical significance (DUNCAN, $P<0.05$)

CONCLUSION

Red cherry shrimp fed on diets with astaxanthin has greater weight gain, SGR, pigmentation and total carotenoid than those of shrimp fed on diets without astaxanthin ($p<0.05$). Shrimp cultured in red and black backgrounds showed greater weight gain, SGR, pigmentation and total carotenoid than shrimp reared in a white background ($p<0.05$). The survival rates in all treatments were not different between treatments ($p>0.05$).

ACKNOWLEDGEMENT

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