Improving the Quality of Red Claw Crayfish (*Cherax quadricarinatus*) using LED Light Treatment: Proximate and Organolpetic Analysis

Dewi Hidayati[1*], *Hikmal* Fasha Firmansyah[1], *Nurlita* Abdulgani[1], *Tutik* Nurhidayati[1], *Agus* Muhamad Hatta[2], *Iwan* Cony Setiadi[2], *Detak* Yan Pratama[2], *Aulia* Muhammad Taufiq Nasution[2], *Syarafina* Dzatil 'Ismah[1], *Bimo* Altaf Purnomo[1], *Carolyn* Melissa Payus[3]

[1] Department of Biology, Faculty of Science and Data Analytics, Institut Teknologi Sepuluh Nopember, Sukolilo, Surabaya, Indonesia.
[2] Department of Physics Engineering, Faculty of Industrial Technology and Systems Engineering, Institut Teknologi Sepuluh Nopember, Sukolilo, Surabaya, Indonesia.
[3] Faculty of Science and Technology, University Malaysia Sabah, Sabah, Malaysia

Abstract. Red claw crayfish (*Cherax quadricarinatus*) is recognized as a valuable cultured species, attributed to its superior taste and nutritional qualities. The use of Light Emitting Diode (LED) lamps with various colors has been proven to affect the survival rate and growth of freshwater lobster juveniles. However, research on the effect of LED light color on the composition of red claw crayfish for commodity quality is still very limited, as previous studies have focused on growth and behavior aspects. This study to determine the effect of red and blue LED light color on the proximate composition and organoleptic quality of juvenile *C. quadricarinatus*. This research found that blue light showed highest carbohydrate (2.68%) and fat (1.01%) content, while the red light treatment yielded the highest protein (12.94%) and ash (1.91%) content. The blue and red light treatment reduced water content, with the lowest value observed in the blue treatment (81.23%). In the organoleptic test, blue light received the highest preference scores for color (6.81), texture (6.31), aroma (5.68), and taste (6.64). The results of the study indicate that specific LED light treatments can improve the nutritional composition and quality of red claw crayfish meat.

1 Introduction

Red claw crayfish have economical value for consumption commodity which characterized by low fat, low cholesterol, high protein content [1]. The application of LED lighting in red claw crayfish cultivation has been shown to improve survival rates. Red light attributed to improved antioxidant hormone activity and faster growth under blue light due to increased expression of the α-amylase gene [2]. Refer to [2-3], the light is the one of physiological important factor for crustaceans growth and behaviour, due to their role in metabolic activities including enzymes, hormones and gene expression. The light exposures may trigger

* Corresponding author: d_hidayati@its.ac.id

the crustaceans hormone namely crustacean hyperglycemic hormone (CHH) which can stimulate the metabolism of carbohydrates, proteins, and fats so that it affects the activity pattern of crustaceans. However, research on the effect of LED lighting on the quality of crustaceans as food products particularly in terms of proximate composition and organoleptic traits remains limited. The organoleptic (color, aroma, taste, and texture) and proximate value are crucial quality and key consumer concern prior to marketing seafood products [4].

Accordingly, the research seeks to evaluate the use of LED light colors as an environmental factor to optimize red claw crayfish product quality. The evaluation focuses specifically on changes in proximate composition and organolaptic traits, which are critical for improving growth performance, survival rate, and marketable nutritional content.

2 Materials and methods

2.1 Experimental Procedures

2.1.1 Preparation

Eight glass aquaria (60 × 41 × 35.5 cm) were cleaned, leak-tested, and placed in a room maintained at 28°C. Juvenile Red claw crayfish obtained from Tanggulangin, Sidoarjo were selected by weight (±40–45 grams for large size and ±30–35 grams for small size) and acclimatized for seven days in aquaria containing 4–5 liters of tap water that had been settled for 24 hours. LED lamps of red and blue colors were installed at an intensity of 1500 lx.

2.1.2 Treatment

Lobsters were reared at a stocking density of 10 individuals per aquaria in a closed system at 28°C, with cleaning performed every Thursday. Lobster were fed Fengli pellets twice daily at 07:00 (20% of daily ration) and 19:00 (80% of daily ration), totaling 3% of individual body weight per day. Water quality was measured weekly with three replicates, including dissolved oxygen (DO), pH, and temperature. Lighting treatments used a 12L:12D photoperiod (19:00–07:00 WIB), while the control group received no artificial light exposure.

2.2 Proximate Analysis

The proximate analysis including the content of carbohydrate, protein, fat, water, and ash was conducted refer to the Indonesian National Standard (SNI 01-2891-1992). Specifically, protein content was determined using the Kjeldahl method, fat content by Soxhlet extraction with hexane, ash content by gravimetric analysis after incineration at 550°C, and moisture content by oven-drying at 105°C. Carbohydrate content was calculated by difference. These methods enabled accurate determination of the basic chemical composition of the red claw crayfish samples by accounting for weight changes before and after treatment. The results obtained were subsequently calculated using the respective formulas for each method to determine the percentage composition of carbohydrates, proteins, fats, moisture, and ash in the samples [5].

2.3 Organoleptic Test

Red claw crayfish meat samples were taken from the abdomen, steamed in a 0.6 L magic jar for 15 minutes, cut into four pieces, and served on coded styrofoam plates. Following SNI

01-2346:2006 [6], a hedonic sensory test was conducted to evaluate texture, taste, aroma, and color. The test involved 16 non-trained panelists aged 20–22 years. Each panelist received a hedonic form and descriptive instructions to assess the samples (Table 1). During testing, panelists were kept away from distracting odors and were asked to rinse their mouths between samples.

Table 1. Hedonic Test Form (based on SNI 01-2346:2006).

Treatment Group	Code	Appearance	Texture	Aroma	Taste
Control	KB				
	KK				
Blue	BB				
	BK				
Red	MB				
	MK				

Hedonic Test Assessment Specifications based on SNI 01-2346:2006: 1= Dislike Extremely; 2= Dislike Very Much; 3= Dislike Moderately; 4= Dislike Slightly; 5= Neutral; 6= Like Slightly; 7= Like Moderately ; 8= Like Very Much; 9= Like Extremely.

3 Result and discussions

3.1 Proximate Composition

This study assessed the effect of LED light color (red and blue) and without light exposure (control) on the proximate composition of composite samples of juvenile red claw crayfish meat, which were divided into five nutritional fractions, including carbohydrates, protein, fat, moisture content, and ash, are shown in Figure 1.

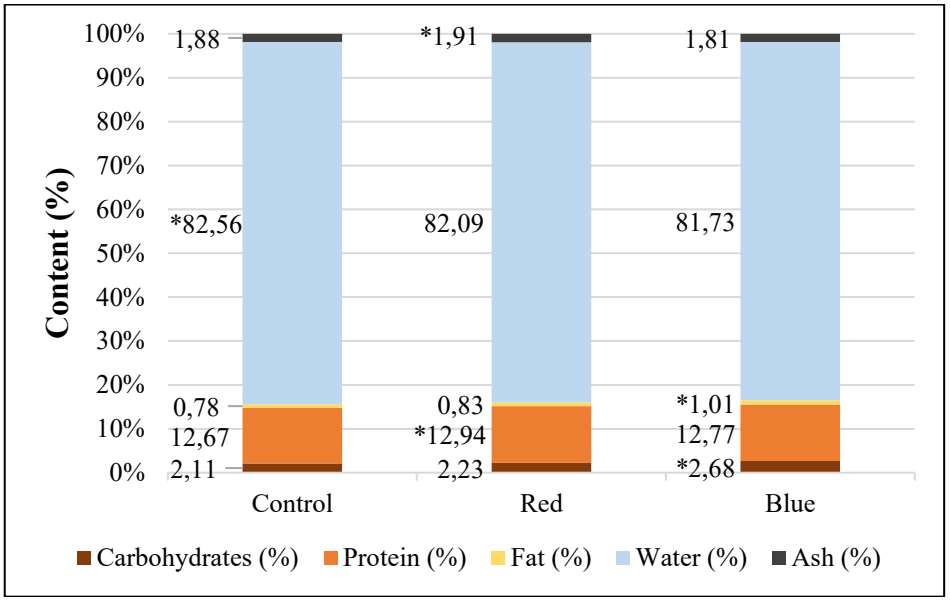

Fig. 1. Graph of Proximate Composition of Composite Samples of Red Claw Crayfish Meat in Response to LED Light Variation Treatment, Note: (*) = Highest Value

Based on Figure 1, it is known that LED light treatment resulted in lower moisture content (Red = 82.09%; Blue = 81.73%) than the treatment without LED light (Control = 82.56%), with the lowest moisture content shown in the blue light treatment. However, in general, the LED light treatment resulted in higher ash, protein, fat, and carbohydrate nutrient values compared to the control treatment. The red light treatment showed the highest ash and protein levels, at 1.91% for ash and 12.94% for protein, while the blue light treatment showed the highest fat and carbohydrate levels, at 1.01% for fat and 2.68% for carbohydrates.

The highest carbohydrate content was found in the blue light treatment, is posibly obtained likely the capasity of blue light to increase the expression of the α-AMY gene, characterized by increased appetite and increased nutrient absorption as energy reserves accumulate [2]. The blue light also can decrease the regulation of molting inhibitory hormone (MIH) which increasing the carbohydrate to support the energy for molting activitys [3]-[7].

The highest protein content was obtained in the red light treatment, which is likely because red light can increase the molting frequency in juvenile lobsters due to an increase in the EcR gene that affects molting frequency [8]-[9]. These results are in line with the studies by Cheng et al. [2], which show that exposure to red light can increase the expression of the Ecdysteroid receptor (EcR) as the main regulator of the ecdysone signaling pathway, which can affect the molting frequency of red claw crayfish. Proteins play a crucial role in the formation of enzymes, cells, and muscle tissue, so the protein synthesis process leads to an increase in muscle mass, which correlates with an increase in meat protein content [3]-[10].

The highest fat content was found in the blue light treatment, indicating that blue light exposure can efficiently absorb food as energy reserves in the form of essential fats, which are a group of lipids [4]. This is in line with the research by Cheng et al. [2], which states that blue light exposure in red claw crayfish can increase the expression of the α-AMY gene, resulting in efficient nutrient absorption as energy reserves. The expression of the α-AMY gene can facilitate the formation of glycogen and triglyceride reserves as energy reserves in preparation for molting [11].

The lowest water content was found in the blue light treatment, indicating that blue light can increase dry biomass in meat, resulting in denser muscle growth due to increased deposition of nutrients such as protein and lipids [12]. This is in line with the research by Cheng et al. [2], which found that exposure to blue light can increase the expression of the α-AMY gene in red claw crayfish.

The highest ash content was found in the red light treatment, which is possibly caused the increasing of osmoregulatory activity and hepatopancreatic performance in accelerating mineral metabolism accumulation [13].

3.2 Organoleptic Quality

The results of hedonic test involving 16 panelist concerning the resulting organoleptic values are provided in Tabel 2 and Table 3. Based on the average panelist assessment results shown in Table 2 and Table 3, the LED light exposure treatment provided a more favorable average score than the control or without LED lights (KB; KK). The highest average scores for the all parameters were shown in the blue light treatment (BB), with average organoleptic scores between 5.58 untill 6.81 and the mean rank between of 4.94 to 5.53. Among the organoleptic parameters exhibited that color and taste have higher value. Moreover, the Friedmant test was conducted to obtained the mean rank of each organoleptic parameter.

Table 2. Average Panelist Assessment Results for Organoleptic of Red Claw Crayfish Meat.

No.	Treatment Group	n	Assessment Parameter			
			Color	Texture	Smell	Taste
1.	KB	48	6.62	6.06	5.00	5.89
2.	KK		6.06	5.93	5.00	6.10
3.	BB		**6.81**	**6.31**	**5.68**	**6.64**
4.	BK		6.50	5.56	5.68	6.10
5.	MB		6.68	5.31	5.06	5.84
6.	MK		6.18	5.37	5.43	5.91

Table 3. Results of Friedman test on Organoleptic of Red Claw Crayfish Meat.

No.	Treatment Group	n	Mean rank Each Assessment Parameter			
			Color	Texture	Smell	Taste
1.	KB	48	4.75	4.53	3.47	3.93
2.	KK		3.72	4.66	3.50	4.47
3.	BB		**5.06**	**5.53**	**4.94**	**5.06**
4.	BK		4.41	3.84	4.75	4.17
5.	MB		4.91	3.63	4.00	3.88
6.	MK		3.63	3.50	4.19	3.72
p-value			0.001	0.000	0.000	0.000

The highest average score by panelists on the parameter was obtained in the blue light treatment (BB) with an average organoleptic score of 6.81 in the "like moderately" category. The color observed during organoleptic assessment in this study was the result of the post-steaming process. The steaming method can increase the astaxanthin content in meat because it triggers protein inactivation. Astaxanthin is a type of carotenoid that can give crustaceans their unique red color [13]. The highest average rating by the panelists was obtained in the blue lamp treatment (BB) with an average organoleptic score of 6.64 in the "like moderately" category. The results obtained show that blue light can affect changes in muscle fiber and amino acid content. Lobster meat contains glutamate amino acids, which can produce a savory taste in meat [14]. According to Ramli [15], a product is considered worthy of organoleptically acceptance if the percentage of rejection of the "dislike slightly " category by the panelists is less than 25%.

4 Conclusions

The research found that the lighting of blue color provide the optimum environment for the red claw crayfish culture including the increasing of growth, survival rate, and nutritional values. The organoleptic test revealed that the cultured red claw crayfish exposed to LED lighting exhibited significantly higher overall acceptance compared to the control (without LED light). Specifically, the blue light spectrum was particularly effective, resulting in improved color and taste.

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