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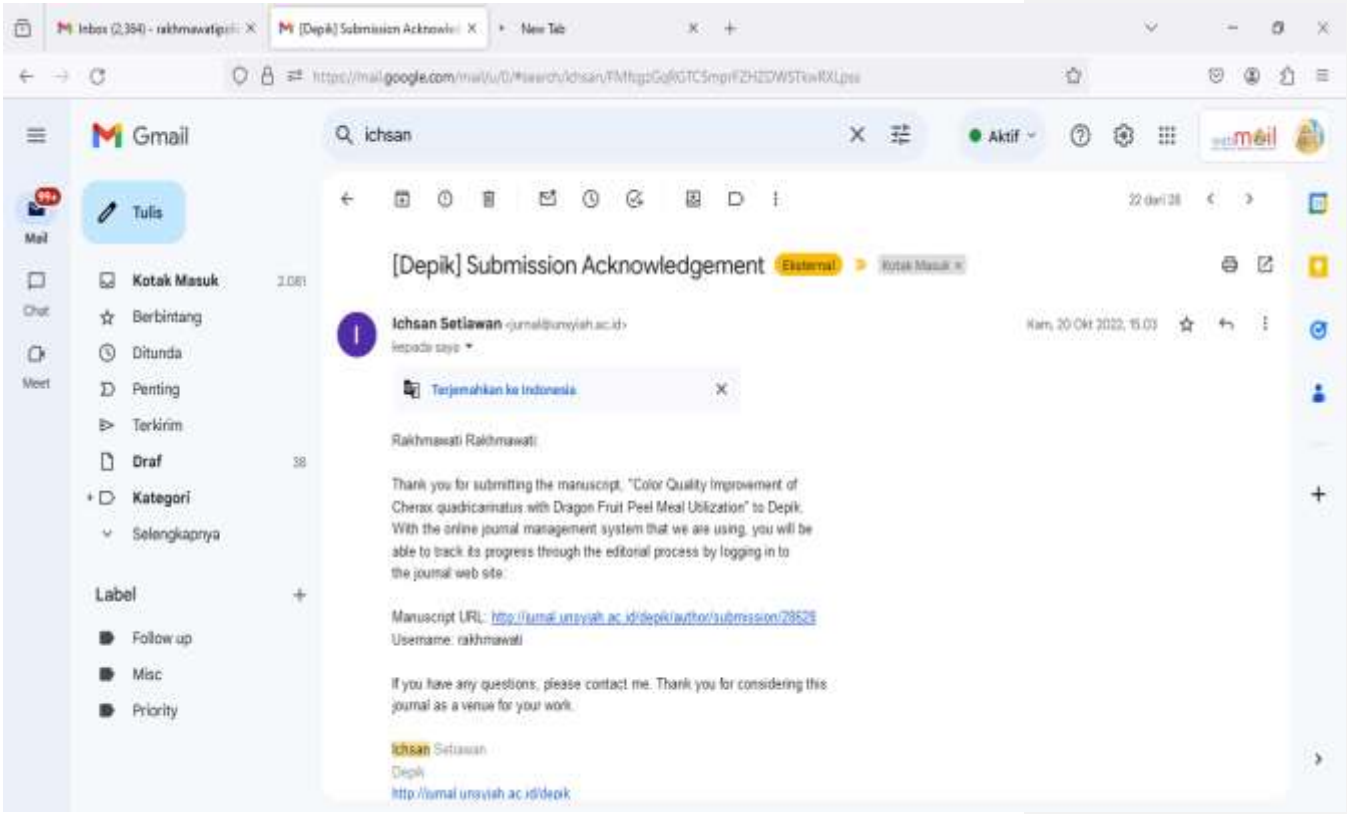

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p-ISSN 2089-7790; e-ISSN 2502-6194

DepikJurnalIlmu-IlmuPerairan, PesisirdanPerikanan
Volume x, Number x, Page 1-3

Perbaikan dari Reviewer 1

Color quality improvement of *Cheraxquadricarinatus* with dragon fruit peel meal utilization

ARTICLE INFO

Keywords:

Dragon fruit peel meal Utilization

Diet

Color quality

Cherax quadricarinatus

DOI: 10.13170/depik.x.x.xxxxx

ABSTRACT

This study aims to determine the effect of dragon fruit peel meal utilization in the diet to improving the color quality of freshwater crayfish (*Cheraxquadricarinatus*). This research was done from May to June 2022 at the Lampung State Polytechnic Fisheries Laboratory. The test animals used were freshwater crayfish with an average weight of 6.7 – 6.8 g/crayfish and a stocking density of 7 crayfish/aquarium. Feeding with a feeding rate of 3% twice a day. The experimental design used was a completely randomized design with 5 treatments and 3 repetitions. The treatments were A = commercial feed (control), B = 5% dose, C = 10% dose, D = 15% dose, E = 20% dose. The parameters observed in this study were an increase in color quality and water quality. The results of this study indicate that the difference in the dose of red dragon fruit peel meal in the diets can have a significant effect on the color brightness of freshwater crayfish (86.01 in claws and 87.59 in Chepalotorax to teslon). The conclusion of this research is that supplementation of red dragon fruit peel meal mainly at a dose of 10% in the feed can improve the color quality of freshwater crayfish from brown to bluish color.

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Introduction

The high demand for red clawed freshwater crayfish as an ornamental aquaculture commodity and as a consumption commodity in urban areas is a great opportunity to increase the productivity of its cultivation. Meanwhile, the availability of red clawed freshwater crayfish is still limited. Thus the price is still relatively high and is not available all the time.Other side, during the COVID-19 pandemic in recent years, the consumption of dragon fruit by the Indonesian people has increased, including in Lampung Province (BPS, 2019). Along with public awareness of the importance of increasing the vitality of the body by consuming fruit. This increase in consumption also causes the waste of dragon fruit peel to the environment to increase. This needs to be handled so that it can be utilized and the environment can be kept clean due to the reduction of the waste. Dragon fruit peel waste contains essential nutrients needed by fish or shrimp or crayfish to increase the productivity of their culture, especially through diets composition engineering technology. This can be a solution for feed producers and increase profits for freshwater crayfish (*Cheraxquadrinatus*) farmers.

One of the raw materials that can improve color quality and is a food waste is dragon fruit peel. Dragon fruit contains betacyanin, which is a red-violet pigment (Faridah *et al.,* 2014), and also contains anrosyanin, which is a red to blue pigment (Simanjuntak *et al.,* 2014; Ramadhani *et al.,* 2017). In addition, dragon fruit peel contains antioxidants, namely flavonoids, phenolics, and carotenoids (Wahdaningsih *et al.,* 2017; Pujiastuti and El'Zeba, 2021). These antioxidants are able to inhibit the activity of free radicals. Rahmawati (2017) reported that dragon fruit peel inhibits free radical activity by 50% by 397.64 ppm and contains vitamin C by 9.79 ppm. Aprilia and Rakhmawati (2021) reported that in terms of nutrients, fruit peel flour contains 5.08% protein; carbohydrates 50.74%; crude fiber 26.22%; ash 21.35% and fat 4.80% (wet weight).

Ingredient (g kg^{-1})	Supplementation of dragon fruit peel meal in the diets (g kg^{-1})				
	0	5%	10%	15%	20%
Fish meal	180	180	180	180	180
Soybean meal	350	350	350	350	350
DFPM	*0*	*50*	*100*	*150*	*200*
Cornstarch	300	250	200	150	100
Fish oil	50	50	50	50	50
Corn oil	50	50	50	50	50
CMC	20	20	20	20	20
Vitamin&Mineral	50	50	50	50	50
	1000	1000	1000	1000	1000

The challenge of red claw crayfish rearing so far is to improve the color quality when developed on certain media. This needs to be solved, considering that aquaculture commodities cannot synthesize color pigments in their bodies, so they must be fed from outside. In addition, low survival and slow growth are important issues to find a solution to increase the availability of this commodity and efforts are needed to improve the color quality. The use of dragon fruit peel meal has never been studied in red clawed freshwater crayfish (*C. quadricarinatus*). This can be achieved by using certain nutrients that support the color quality and health of red clawed freshwater crayfish. The results of research on the nutrient content of dragon fruit peel meal and its positive effect on improving the quality of fish color so it is necessary to do applied research in the application of freshwater crayfish culture.

Materials and Methods

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p-ISSN 2089-7790; e-ISSN 2502-6194

Preparation of dragon fruit peel meal

Dragon fruit peel meal was prepared according to Aprilia and Rakhmawati (2021). The Preparation of dragon fruit peel meal begins with cleaning and washing the skin of the scales. The dragon fruit peel was weighed and cut into small pieces, then dried in an oven at 50°C for 7 hours. After drying, it was milled with a blender and sieved using a 60 mesh sieve to obtain red dragon fruit peel meal. Dried dragon fruit peel meal will be mixed with other raw materials to make the experimental feed.

Preparation the experimental diets

The feed to be made contains 38% protein. The ingredients and composition of the test feed are presented in Table 1. This study used five types of test feed containing dragon fruit peel flour with different doses. The test feed was substituted with a dose of 0 (control, without dragon fruit peel flour); 5%; 10%; 15% and 20%.

All raw materials are weighed and mixed evenly, followed by the addition of oil and water. The feed was molded with a diameter of 1 mm, dried in a tumble dryer, and stored in plastic containers until use.

Table 1. Composition of feed ingredients with dragon fruit peel meal (DFPM) utilization

Experimental animal and rearing.

Two hundred red claw freshwater crayfish juvenile were obtained from Frandy Farm Freshwater Lobster, Natar District, South Lampung Regency, Lampung Province, Indonesia. Prior to the study, red clawed crayfish were kept for 1 week and given commercial feed (35% protein) for acclimatization to the research conditions. The test fish were reared for 28 days. At the beginning of the study, individual lobsters were weighed and randomly distributed into 15 aquariums (40 x 40 x 40 cm^3) with a density of 7 lobsters per aquarium. Feeding with a feeding rate of 3% twice a day. Continuous aeration was provided with 25% water change every 24 hours. Fish feces are siphoned from the tub at 16.00 every day. Water quality parameters in all experimental media include temperature, dissolved oxygen, total ammonia nitrogen and pH.

Evaluation of color change of red claw lobster

Observation of lobster body color was carried out once every 14 days for 4 weeks. Parameters observed in the study include the main parameters. The main parameter is the observation of red claw body color every 14 days using the scoring method by determining the red claw body color scale based on the Trumatch color standard, as applied in the study Amin et al. (2012).The color scale used is scale 1: light brown, scale 2: medium brown, scale 3: dark brown, scale 4: light green, scale 5: medium green, scale 6: dark green, scale 7: light blue, scale 8: medium blue, scale 9: dark blue.

The observations were carried out by three people to prevent deviations. Parameters observed were changes in the color of crayfish. The increase in color was observed by comparing the colors of the two parts, namely the claws and cephalothorax to the telson, with a color standard.

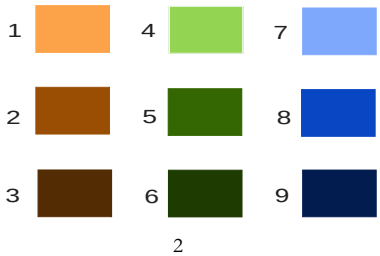

Figure 1. Trumatch color standard

Data analysis

The data that will be obtained will be analyzed descriptively. This analysis is to obtain the average value of the sample by adding up all the data values of a sample group, then dividing by the number of samples

Results

Color Changes in Freshwater Lobster Red clow (*cheraxquadricarinatus*). Color observations included two parameters, namely color observations on the claws and cephalothorax to the freshwater crayfish telson (*Cheraxquadricarinatus*). During the observation, an increase in color quality began to appear on the 14th day. Based on observations, the highest average value was 83.61 in the claws and 85.55 in the Chepalotorax section until telson began to appear in treatment C (10% dose) after 14 days. maintenance. Color scoring can be seen in Table 2.

The results of observations for 28 days, the color of the red claw crayfish changes every week, except for the first week because the crayfish are still adapting to the feed given. The increase in color quality every week is caused by the provision of a color pigment source, this indicates that there is a difference in color quality improvement in freshwater crayfish in the aquarium.The results showed that there was an increase in the quality of lobster color quality in treatment C (10% Red Dragon Fruit Peel Meal) with an average sample value of 86.01 for claws and 87.9 for chepalotorax to teslon.

Tabel 2. Scoring of increased brightness of claws and cephalothorax to teslon red claw (*Cherax quadricarinatus*) for 3 observations in 28 days of rearing.

Observed part	Ttreatment	Average Observation Score (Day-)		
		0	14	28
Claw	A	79.36	80.55	80.66
	B	77.77	78.95	83.69
	C	76.19	83.61	86.01
	D	77.77	80.13	83.69
	E	77.77	80	82.85
	A	74.60	80.55	84.25
	B	73.01	81.66	82.87
	C	73.01	85.55	87.59

*Chepalotho rax*up telson	D	73.01	85.55	86.50
	E	74.60	82.03	83.33

The increase in color quality in treatment D was not significantly different from treatment C, which ranged from 83.69 to claws and 86.50 to telson. The score in treatment B (Dose of 5%) was 83.69 on the skin and 82.87 on the Chepalotorax section, then the score on treatment E (20% dose) was 82.85 on the claws and 83.33 on the Chepalotorax up to telephone. While the lowest score is in treatment A (Control) with a value of 80.66 in the claw section and 84.25 in the Chepalotorax section to teslon.

The survival rate of freshwater crayfish for 28 days of rearing is in treatment A (control) of 90.47%, treatment B with a dose of 5% at 85.71%, treatment C with a dose of 10% at 71.42%, treatment D with a dose of 15%. of 80.95% and treatment E of 80.95%.

Water quality includes dissolved oxygen (DO), water temperature, acidity (pH), and ammonia could be seen in Table 3.

Table 3. Water quality during rearing

Treatments	Dissolve Oxygen (mg l^{-1})	Temperature (°C)	pH	Total ammonia nitrogen (mg l^{-1})
A	6.4	27.4	8.23	0.25
B	6.6	27.6	8.21	0.25
C	6.9	27.2	8.11	0.15
D	6.7	27.5	8.17	0.15
E	6.4	27.4	8.21	0.25

Discussion

The results of observations for 28 days, the color of the red claw crayfish changes every week, except for the first week because the crayfish are still adapting to the feed given. The increase in color quality every week is caused by the provision of a color pigment source, this indicates that there is a difference in color quality improvement in freshwater crayfish in the aquarium.Changes in the color of the clownfish began to occur on the 7th and 14th day with the addition of 5% red dragon fruit peel flour to the feed due to an increase in carotenoids in pigment cells (Simamora, 2019). Meanwhile, in sand lobsters, their entire body color changed after 97 days of rearing when they were fed spirulina-added feed (Soffa*et al.,* 2019).

In addition, the results showed that there was an increase in the quality of red claw crayfish color quality in treatment C (10% red dragon fruit peel meal) with an average sample value of 86.01 for claws and 87.9 for chepalotorax to teslon. The increase in color quality in treatment D was not significantly different from treatment C, which ranged from 83.69 to claws and 86.50 to telson. The score in treatment B (Dose of 5%) was 83.69 on

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The color appears first from the tip of the claw which then spreads to the base of the claw. Improving the quality of red claw body color is influenced by the amount of carotenoids contained in the exoskeleton. Beta-carotenoid, vitamins and anthocyanin in dragon fruit peel is thought to increase the skin color lightening of crayfish. The beta-carotenoid contained in it fulfills the needs of the crayfish body, because it cannot synthesize itself (Nururrahmah and Widiarnu, 2013; Kalidupa et al., 2018). Kembuan et al. (2012) and Noor et al. (2016) stated that the vitamin C contained in it acts as a strong antioxidant and is absorbed easily in the skin. The antioxidant content in super dragon fruit peel extract reaches 30 b/v (Ni'matusyukriyah and Sarwono, 2019) and even reaches 58 mg/l (Putri*et al.,* 2015). Anthocyanins act as nutrients that can provide an orange color and color strengthening (Priska*et al.,* 2018). The phenolic activity contained as an antioxidant is also thought to play a role in this. Lorith and Kanlayavattanakul (2013) stated that phenolic activity is the basis of an antioxidant mechanism that stabilizes pH and temperature and is responsible for brightening colors (Pramitasari*et al.,* 2022). The contents of beta-carotenoid, vitamins and antioxidants in dragon fruit peel meal, so the color will also first appear on that part of the body. After the color appears at the tips of the claws and cephalothorax, then the color spreads throughout the claws and abdomen to the telson.

Several previous research results on coloring ornamental fish using natural dyes with the addition of red dragon fruit peel meal in feed can increase the brightness of color in ornamental fish. This is proven by research conducted by Kalidupa*et al.* (2018) the administration of red dragon fruit peel meal in the feed significantly affected the increase in the brightness of the orange and black colors in koi carp. In addition, giving red dragon fruit peel flour with a dose of 15% in feed can increase the brightness of the orange and black colors in koi carp (Kalidupa*et al.,* 2018).Color improvement in koi fish fed 10% dragon fruit meal (Kurnia*et al.,* 2019) and in red cherry shrimp added astaxanthin and canthazanthin (Amin *et al.,* 2012). Apart from affecting the color of the dragon fruit skin, it can also affect health as a natural antibiotic that can suppress the attack of *Aeromonashydrophilla* bacteria on tilapia (Andayani*et al.,* 2018; Sudrajat, 2019) and increase growth in goldfish (Efianda*et al.,* 2018) and in snakehead fish (Rakhmawati*et al.,* 2021).

This study was conducted using raw materials in the manufacture of feed by mixing red dragon fruit peel flour as a natural dye. Each treatment had a different dose of red dragon fruit peel flour so that the proximate content was different. Based on the results of observations showed that each treatment there was an increase in the color quality of the lobster. The highest increase in color quality was found in lobsters fed C feed (10% dose). Followed by treatment D (15% dose), treatment E (20% dose), treatment B (5% dose) and the lowest was treatment A (without red dragon fruit skin flour). excessive and not lacking to obtain an increase in color quality in red claw lobster.Amiin*et al.* (2012) argued that to obtain optimal color improvement in red cherry shrimp by adding 100 mg/kg canthaxanthin. The same thing with rainbow trout, Meiliszaet *al.* (2021), Kurumoirain bow fish fed 2.6 g/kg asthaxanthinsupplementation had higher enhance color than 5.1 g/kg.

Color quality improvement in red claw crayfish (*C. quadricarinatus*) is influenced by several internal and external factors. Internal factors include species, gender, organs and hormones. External factors include background color of the rearing place, light intensity, temperature of rearing conditions and carotenoids in the feed. Other external factors besides carotenoids in the feed in the form of background color of the rearing place, light intensity and temperature of rearing conditions that affect the increase in red claw body color are important factors that also need to be considered (Diaz – Jimenez *et al.,* 2018).

Water quality parameters are still within the optimal range of rearing. So is the survival rate during maintenance. The survival rate can be said to be still high. Samad*et al.* (2022) stated that the survival rate of freshwater crayfish ranged from 80 to 93.33% which was still high. However, treatment C was still less than optimal due to cannibalism in freshwater crayfish during maintenance. The high survival rate of freshwater crayfish is due to both the amount and timing of feeding as well as the condition of water quality during maintenance which does not become a limiting factor in the survival of freshwater crayfish.

Commented [u1]:
Did the sex of the shrimp tested in this study consist of males and females?
Add an explanation regarding the results of observations during this research, were there any significant differences in color between the male and female test shrimp at the same dose?

Conclusion

The results showed that dragon fruit peel meal improve the color of freshwater crayfish(*Cheraxquadricarinatus*). The brightest color was lobster which was given a utilization of 10% dragon fruit peel meal from brown to a bluish color.

Acknowledgments

Thank you to Lampung State Polytechnic which has provided funds for this research through DIPA for Fiscal Year 2022 with Number: 321.59/PL15.8/PP/2022 on the Applied Research Scheme.

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Howto citethispaper:

Rakhmawati,R.,T.Aprilia, N. Indariyanti, A. Saputra, E. Marlina.2022.Color Quality Improvement of Cheraxquadricarinatus with Dragon Fruit Peel Meal Utilization.DepikJurnalIlmu-IlmuPerairan,PesisirdanPerikanan, v(n): 1-3.

Perbaikan dari Reviewer 2

Color quality improvement of *Cherax quadricarinatus* with dragon fruit peel meal utilization

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One of the raw materials that can improve color quality and is a food waste is dragon fruit peel. Dragon fruit contains betacyanin, which is a red-violet pigment (Faridah *et al.,* 2014), and also contains anrosyanin, which is a red to blue pigment (Simanjuntak *et al.,* 2014; Ramadhani *et al.,* 2017). In addition, dragon fruit peel contains antioxidants, namely flavonoids, phenolics, and carotenoids (Wahdaningsih *et al.,* 2017; Pujiastuti and El'Zeba, 2021). These antioxidants are able to inhibit the activity of free radicals. Rahmawati (2017) reported that dragon fruit peel inhibits free radical activity by 50% by 397.64 ppm and contains vitamin C by 9.79 ppm. Aprilia and Rakhmawati (2021) reported that in terms of nutrients, fruit peel flour contains 5.08% protein; carbohydrates 50.74%; crude fiber 26.22%; ash 21.35% and fat 4.80% (wet weight).

Ingredient (g kg^{-1})	Supplementation of dragon fruit peel meal in the diets (g kg^{-1})				
	0	5%	10%	15%	20%
Fish meal	180	180	180	180	180
Soybean meal	350	350	350	350	350
DFPM	*0*	*50*	*100*	*150*	*200*
Cornstarch	300	250	200	150	100
Fish oil	50	50	50	50	50
Corn oil	50	50	50	50	50
CMC	20	20	20	20	20
Vitamin&Mineral	50	50	50	50	50
	1000	1000	1000	1000	1000

The challenge of red claw crayfish rearing so far is to improve the color quality when developed on certain media. This needs to be solved, considering that aquaculture commodities cannot synthesize color pigments in their bodies, so they must be fed from outside. In addition, low survival and slow growth are important issues to find a solution to increase the availability of this commodity and efforts are needed to improve the color quality. The use of dragon fruit peel meal has never been studied in red clawed freshwater crayfish (*C. quadricarinatus*). This can be achieved by using certain nutrients that support the color quality and health of red clawed freshwater crayfish. The results of research on the nutrient content of dragon fruit peel meal and its positive effect on improving the quality of fish color so it is necessary to do applied research in the application of freshwater crayfish culture.

Materials and Methods

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p-ISSN 2089-7790; e-ISSN 2502-6194

Preparation of dragon fruit peel meal

Dragon fruit peel meal was prepared according to Aprilia and Rakhmawati (2021). The Preparation of dragon fruit peel meal begins with cleaning and washing the skin of the scales. The dragon fruit peel was weighed and cut into small pieces, then dried in an oven at 50°C for 7 hours. After drying, it was milled with a blender and sieved using a 60 mesh sieve to obtain red dragon fruit peel meal. Dried dragon fruit peel meal will be mixed with other raw materials to make the experimental feed.

Preparation the experimental diets

The feed to be made contains 38% protein. The ingredients and composition of the test feed are presented in Table 1. This study used five types of test feed containing dragon fruit peel flour with different doses. The test feed was substituted with a dose of 0 (control, without dragon fruit peel flour); 5%; 10%; 15% and 20%.

All raw materials are weighed and mixed evenly, followed by the addition of oil and water. The feed was molded with a diameter of 1 mm, dried in a tumble dryer, and stored in plastic containers until use.

Table 1. Composition of feed ingredients with dragon fruit peel meal (DFPM) utilization

Experimental animal and rearing

Two hundred red claw freshwater crayfish juvenile were obtained from Frandy Farm Freshwater Lobster, Natar District, South Lampung Regency, Lampung Province, Indonesia. Prior to the study, red clawed crayfish were kept for 1 week and given commercial feed (35% protein) for acclimatization to the research conditions. The test fish were reared for 28 days. At the beginning of the study, individual lobsters were weighed and randomly distributed into 15 aquariums (40 x 40 x 40 cm^3) with a density of 7 lobsters per aquarium. Feeding with a feeding rate of 3% twice a day. Continuous aeration was provided with 25% water change every 24 hours. Fish feces are siphoned from the tub at 16.00 every day. Water quality parameters in all experimental media include temperature, dissolved oxygen, total ammonia nitrogen and pH.

Commented [FMN2]: Add information about body weight and standar length or total length

Commented [FMN3]: Isn't the acclimatization time too short, only 1 week?

Commented [FMN4]: ??

Commented [FMN5]: ?

Evaluation of color change of red claw lobster

Observation of lobster body color was carried out once every 14 days for 4 weeks. Parameters observed in the study include the main parameters. The main parameter is the observation of red claw body color every 14 days using the scoring method by determining the red claw body color scale based on the Trumatch color standard, as applied in the study Amin et al., 2012. The color scale used is scale 1: light brown, scale 2: medium brown, scale 3: dark brown, scale 4: light green, scale 5: medium green, scale 6: dark green, scale 7: light blue, scale 8: medium blue, scale 9: dark blue.

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The observations were carried out by three people to prevent deviations. Parameters observed were changes in the color of crayfish. The increase in color was observed by comparing the colors of the two parts, namely the claws and cephalothorax to the telson, with a color standard.

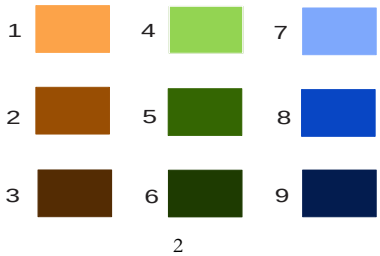

Figure 1. Trumatch color standard

Data analysis

The data that will be obtained will be analyzed descriptively. This analysis is to obtain the average value of the sample by adding up all the data values of a sample group, then dividing by the number of samples

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Results

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Color Changes in Freshwater Lobster Red clow (*cherax quadricarinatus*). Color observations included two parameters, namely color observations on the claws and cephalothorax to the freshwater crayfish telson (*Cherax quadricarinatus*). During the observation, an increase in color quality began to appear on the 14th day. Based on observations, the highest average value was 83.61 in the claws and 85.55 in the Chepalotorax section until telson began to appear in treatment C (10% dose) after 14 days. maintenance. Color scoring can be seen in Table 2.

The results of observations for 28 days, the color of the red claw crayfish changes every week, except for the first week because the crayfish are still adapting to the feed given. The increase in color quality every week is caused by the provision of a color pigment source, this indicates that there is a difference in color quality improvement in freshwater crayfish in the aquarium. The results showed that there was an increase in the quality of lobster color quality in treatment C (10% Red Dragon Fruit Peel Meal) with an average sample value of 86.01 for claws and 87.9 for chepalotorax to teslon.

Tabel 2. Scoring of increased brightness of claws and cephalothorax to teslon red claw (*Cherax quadricarinatus*) for 3 observations in 28 days of rearing.

Observed part	Ttreatment	Average Observation Score (Day-)		
		0	14	28
Claw	A	79.36	80.55	80.66
	B	77.77	78.95	83.69
	C	76.19	83.61	86.01
	D	77.77	80.13	83.69
	E	77.77	80	82.85
	A	74.60	80.55	84.25
	B	73.01	81.66	82.87
	C	73.01	85.55	87.59

Chepalotho rax up telson	D	73.01	85.55	86.50
	E	74.60	82.03	83.33

The increase in color quality in treatment D was not significantly different from treatment C, which ranged from 83.69 to claws and 86.50 to telson. The score in treatment B (Dose of 5%) was 83.69 on the skin and 82.87 on the Chepalotorax section, then the score on treatment E (20% dose) was 82.85 on the claws and 83.33 on the Chepalotorax up to telephone. While the lowest score is in treatment A (Control) with a value of 80.66 in the claw section and 84.25 in the Chepalotorax section to teslon.

The survival rate of freshwater crayfish for 28 days of rearing is in treatment A (control) of 90.47%, treatment B with a dose of 5% at 85.71%, treatment C with a dose of 10% at 71.42%, treatment D with a dose of 15%. of 80.95% and treatment E of 80.95%.

Water quality includes dissolved oxygen (DO), water temperature, acidity (pH), and ammonia could be seen in Table 3.

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Table 3. Water quality during rearing

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Treatments	Dissolve Oxygen (mg l^{-1})	Temperature (°C)	pH	Total ammonia nitrogen (mg l^{-1})
A	6.4	27.4	8.23	0.25
B	6.6	27.6	8.21	0.25
C	6.9	27.2	8.11	0.15
D	6.7	27.5	8.17	0.15
E	6.4	27.4	8.21	0.25

Discussion

The results of observations for 28 days, the color of the red claw crayfish changes every week, except for the first week because the crayfish are still adapting to the feed given. The increase in color quality every week is caused by the provision of a color pigment source, this indicates that there is a difference in color quality improvement in freshwater crayfish in the aquarium. Changes in the color of the clownfish began to occur on the 7th and 14th day with the addition of 5% red dragon fruit peel flour to the feed due to an increase in carotenoids in pigment cells (Simamora, 2019). Meanwhile, in sand lobsters, their entire body color changed after 97 days of rearing when they were fed spirulina-added feed (Soffa *et al.*, 2019).

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What kind of color change is meant, is it changing color or is the color getting firmer?

In addition, the results showed that there was an increase in the quality of red claw crayfish color quality in treatment C (10% red dragon fruit peel meal) with an average sample value of 86.01 for claws and 87.9 for chepalotorax to teslon. The increase in color quality in treatment D was not significantly different from treatment C, which ranged from 83.69 to claws and 86.50 to telson. The score in treatment B (Dose of 5%) was 83.69 on

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the skin and 82.87 on the Chepalotorax section, then the score on treatment E (20% dose) was 82.85 on the claws and 83.33 on the Chepalotorax up to telephone. While the lowest score is in treatment A (Control) with a value of 80.66 in the claw section and 84.25 in the chepalotorax section to teslon.

The color appears first from the tip of the claw which then spreads to the base of the claw. Improving the quality of red claw body color is influenced by the amount of carotenoids contained in the exoskeleton. Beta-carotenoid, vitamins and anthocyanin in dragon fruit peel is thought to increase the skin color lightening of crayfish. The beta-carotenoid contained in it fulfills the needs of the crayfish body, because it cannot synthesize itself (Nururrahmah and Widiarnu, 2013; Kalidupa et al., 2018). Kembuan et al. (2012) and Noor et al. (2016) stated that the vitamin C contained in it acts as a strong antioxidant and is absorbed easily in the skin. The antioxidant content in super dragon fruit peel extract reaches 30 b/v (Ni'matusyukriyah and Sarwono, 2019) and even reaches 58 mg/l (Putri *et al.,* 2015). Anthocyanins act as nutrients that can provide an orange color and color strengthening (Priska *et al.,* 2018). The phenolic activity contained as an antioxidant is also thought to play a role in this. Lorith and Kanlayavattanakul (2013) stated that phenolic activity is the basis of an antioxidant mechanism that stabilizes pH and temperature and is responsible for brightening colors (Pramitasari *et al.,* 2022). The contents of beta-carotenoid, vitamins and antioxidants in dragon fruit peel meal, so the color will also first appear on that part of the body. After the color appears at the tips of the claws and cephalothorax, then the color spreads throughout the claws and abdomen to the telson.

Several previous research results on coloring ornamental fish using natural dyes with the addition of red dragon fruit peel meal in feed can increase the brightness of color in ornamental fish. This is proven by research conducted by Kalidupa *et al.* (2018) the administration of red dragon fruit peel meal in the feed significantly affected the increase in the brightness of the orange and black colors in koi carp. In addition, giving red dragon fruit peel flour with a dose of 15% in feed can increase the brightness of the orange and black colors in koi carp (Kalidupa *et al.,* 2018). Color improvement in koi fish fed 10% dragon fruit meal (Kurnia *et al.,* 2019) and in red cherry shrimp added astaxanthin and canthazanthin (Amin *et al.,* 2012). Apart from affecting the color of the dragon fruit skin, it can also affect health as a natural antibiotic that can suppress the attack of *Aeromonas hydrophilla* bacteria on tilapia (Andayani *et al.,* 2018; Sudrajat, 2019) and increase growth in goldfish (Efianda *et al.,* 2018) and in snakehead fish (Rakhmawati *et al.,* 2021).

This study was conducted using raw materials in the manufacture of feed by mixing red dragon fruit peel flour as a natural dye. Each treatment had a different dose of red dragon fruit peel flour so that the proximate content was different. Based on the results of observations showed that each treatment there was an increase in the color quality of the lobster. The highest increase in color quality was found in lobsters fed C feed (10% dose). Followed by treatment D (15% dose), treatment E (20% dose), treatment B (5% dose) and the lowest was treatment A (without red dragon fruit skin flour). excessive and not lacking to obtain an increase in color quality in red claw lobster. Amiin *et al.* (2012) argued that to obtain optimal color improvement in red cherry shrimp by adding 100 mg/kg canthaxanthin. The same thing with rainbow trout, Meilisza *et al.* (2021), Kurumoi rainbowfish fed 2.6 g/kg asthaxanthin supplementation had higher enhance color than 5.1 g/kg.

Color quality improvement in red claw crayfish (*C. quadricarinatus*) is influenced by several internal and external factors. Internal factors include species, gender, organs and hormones. External factors include background color of the rearing place, light intensity, temperature of rearing conditions and carotenoids in the feed. Other external factors besides carotenoids in the feed in the form of background color of the rearing place, light intensity and temperature of rearing conditions that affect the increase in red claw body color are important factors that also need to be considered (Diaz – Jimenez *et al.,* 2018).

Water quality parameters are still within the optimal range of rearing. So is the survival rate during maintenance. The survival rate can be said to be still high. Samad *et al.* (2022) stated that the survival rate of freshwater crayfish ranged from 80 to 93.33% which was still high. However, treatment C was still less than optimal due to cannibalism in freshwater crayfish during maintenance. The high survival rate of freshwater crayfish is due to both the amount and timing of feeding as well as the condition of water quality during maintenance which does not become a limiting factor in the survival of freshwater crayfish.

Conclusion

The results showed that dragon fruit peel meal improve the color of freshwater crayfish (*Cherax quadricarinatus*). The brightest color was lobster which was given a utilization of 10% dragon fruit peel meal from brown to a bluish color.

Acknowledgments

Thank you to Lampung State Polytechnic which has provided funds for this research through DIPA for Fiscal Year 2022 with Number: 321.59/PL15.8/PP/2022 on the Applied Research Scheme.

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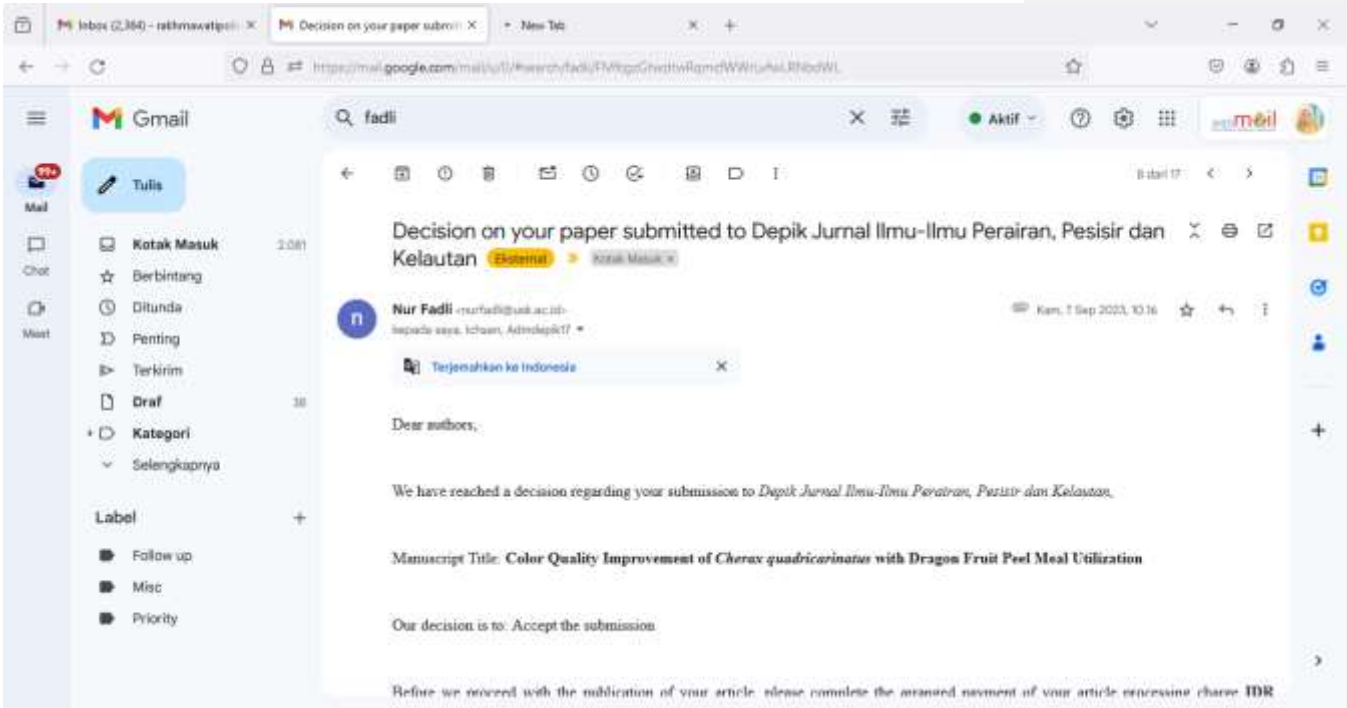
How to cite this paper:

Rakhmawati, R., T. Aprilia, N. Indariyanti, A. Saputra, E. Marlina. 2022. Color Quality Improvement of Cherax quadricarinatus with Dragon Fruit Peel Meal Utilization. Depik Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan, v(n): 1-3.



Depik Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan
Volume x, Number x, Page 1-3

Manuskrip yang telah direvisi

Color quality improvement of *Cherax quadricarinatus* with dragon fruit peel meal utilization

ARTICLE INFO

Keywords:

Dragon fruit peel meal Utilization

Diet

Color quality

Cherax quadricarinatus

DOI: 10.13170/depik.x.x.xxxxx

ABSTRACT

This study aims to determine the effect of dragon fruit peel meal utilization in the diet to improving the color quality of freshwater crayfish (*Cherax quadricarinatus*). This research was done from May to June 2022 at the Lampung State Polytechnic Fisheries Laboratory. The test animals used were freshwater crayfish with an average weight of 6.7 – 6.8 g/crayfish and a stocking density of 7 crayfish/aquarium. Feeding with a feeding rate of 3% twice a day. The experimental design used was a completely randomized design with 5 treatments and 3 repetitions. The treatments were A = commercial feed (control), B = 5% dose, C = 10% dose, D = 15% dose, E = 20% dose. The parameters observed in this study were an increase in color quality and water quality. The results of this study indicate that the difference in the dose of red dragon fruit peel meal in the diets can have a significant effect on the color brightness of freshwater crayfish (86.01 in claws and 87.59 in Chepalotorax to teslon). The conclusion of this research is that supplementation of red dragon fruit peel meal mainly at a dose of 10% in the feed can improve the color quality of freshwater crayfish from brown to bluish color.

Introduction

The high demand for red clawed freshwater crayfish as an ornamental aquaculture commodity and as a consumption commodity in urban areas is a great opportunity to increase the productivity of its cultivation. Meanwhile, the availability of red clawed freshwater crayfish is still limited. Thus the price is still relatively high and is not available all the time. Other side, during the COVID-19 pandemic in recent years, the consumption of dragon fruit by the Indonesian people has increased, including in Lampung Province (BPS, 2019). Along with public awareness of the importance of increasing the vitality of the body by consuming fruit. This increase in consumption also causes the waste of dragon fruit peel to the environment to increase. This needs to be handled so that it can be utilized and the environment can be kept clean due to the reduction of the waste. Dragon fruit peel waste contains essential nutrients needed by fish or shrimp or crayfish to increase the productivity of their culture, especially through diets composition engineering technology. This can be a solution for feed producers and increase profits for freshwater crayfish (*Cherax quadrinatus*) farmers.

One of the raw materials that can improve color quality and is a food waste is dragon fruit peel. Dragon fruit contains betacyanin, which is a red-violet pigment (Faridah *et al.,* 2014), and also contains anrosyanin, which is a red to blue pigment (Simanjuntak *et al.,* 2014; Ramadhani *et al.,* 2017). In addition, dragon fruit peel contains antioxidants, namely flavonoids, phenolics, and carotenoids (Wahdaningsih *et al.,* 2017; Pujiastuti and El'Zeba, 2021). These antioxidants are able to inhibit the activity of free radicals. Rahmawati (2017) reported that dragon fruit peel inhibits free radical activity by 50% by 397.64 ppm and contains vitamin C by 9.79 ppm. Aprilia and Rakhmawati (2021) reported that in terms of nutrients, fruit peel flour contains 5.08% protein; carbohydrates 50.74%; crude fiber 26.22%; ash 21.35% and fat 4.80% (wet weight).

The challenge of red claw crayfish rearing so far is to improve the color quality when developed on certain media. This needs to be solved, considering that aquaculture commodities cannot synthesize color pigments in their bodies, so they must be fed from outside. In addition, low survival and slow growth are important issues to find a solution to increase the availability of this commodity and efforts are needed to improve the color quality. The use of dragon fruit peel meal has never been studied in red clawed freshwater crayfish (*C. quadricarinatus*). This can be achieved by using certain nutrients that support the color quality and health of red clawed freshwater crayfish. The results of research on the nutrient content of dragon fruit peel meal and its positive effect on improving the quality of fish color so it is necessary to do applied research in the application of freshwater crayfish culture.

Ingredient (g kg^{-1})	Supplementation of dragon fruit peel meal in the diets (g kg^{-1})				
	0	5%	10%	15%	20%
Fish meal	180	180	180	180	180
Soybean meal	350	350	350	350	350
DFPM	*0*	*50*	*100*	*150*	*200*
Cornstarch	300	250	200	150	100
Fish oil	50	50	50	50	50
Corn oil	50	50	50	50	50
CMC	20	20	20	20	20
Vitamin&Mineral	50	50	50	50	50
	1000	1000	1000	1000	1000

Materials and Methods

Preparation of dragon fruit peel meal

Dragon fruit peel meal was prepared according to Aprilia and Rakhmawati (2021). The Preparation of dragon fruit peel meal begins with cleaning and washing the skin of the scales. The dragon fruit peel was weighed and cut into small pieces, then dried in an oven at 50^{o}C for 7 hours. After drying, it was milled with a

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The feed to be made contains 38% protein. The ingredients and composition of the test feed are presented in Table 1. This study used five types of test feed containing dragon fruit peel flour with different doses. The test feed was substituted with a dose of 0 (control, without dragon fruit peel flour); 5%; 10%; 15% and 20%.

All raw materials are weighed and mixed evenly, followed by the addition of oil and water. The feed was molded with a diameter of 1 mm, dried in a tumble dryer, and stored in plastic containers until use.

Table 1. Composition of feed ingredients with dragon fruit peel meal (DFPM) utilization

Experimental animal and rearing.

Two hundred red claw freshwater crayfish juvenile were obtained from Frandy Farm Freshwater Lobster, Natar District, South Lampung Regency, Lampung Province, Indonesia. Prior to the study, red clawed crayfish were kept for 1 week and given commercial feed (35% protein) for acclimatization to the research conditions. The test fish were reared for 28 days. At the beginning of the study, individual lobsters were weighed and randomly distributed into 15 aquariums (40 x 40 x 40 cm^3) with a density of 7 lobsters per aquarium. Feeding with a feeding rate of 3% twice a day. Continuous aeration was provided with 25% water change every 24 hours. Fish feces are siphoned from the tub at 16.00 every day. Water quality parameters in all experimental media include temperature, dissolved oxygen, total ammonia nitrogen and pH.

Evaluation of color change of red claw lobster

Observation of lobster body color was carried out once every 14 days for 4 weeks. Parameters observed in the study include the main parameters. The main parameter is the observation of red claw body color every 14 days using the scoring method by determining the red claw body color scale based on the Trumatch color standard, as applied in the study Amin et al., 2012. The color scale used is scale 1: light brown, scale 2: medium brown, scale 3: dark brown, scale 4: light green, scale 5: medium green, scale 6: dark green, scale 7: light blue, scale 8: medium blue, scale 9: dark blue.

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The observations were carried out by three people to prevent deviations. Parameters observed were changes in the color of crayfish. The increase in color was observed by comparing the colors of the two parts, namely the claws and cephalothorax to the telson, with a color standard.

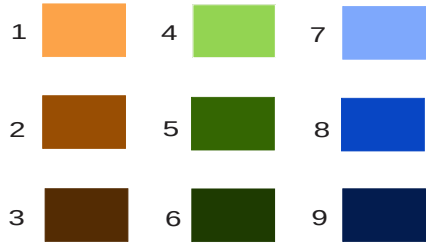

Figure 1. Trumatch color standard

Data analysis

The data that will be obtained will be analyzed descriptively. This analysis is to obtain the average value of the sample by adding up all the data values of a sample group, then dividing by the number of samples

Results

Color Changes in Freshwater Lobster Red clow (*cherax quadricarinatus*). Color observations included two parameters, namely color observations on the claws and cephalothorax to the freshwater crayfish telson (*Cherax quadricarinatus*). During the observation, an increase in color quality began to appear on the 14th day. Based on observations, the highest average value was 83.61 in the claws and 85.55 in the Chepalotorax section until telson began to appear in treatment C (10% dose) after 14 days. maintenance. Color scoring can be seen in Table 2.

The results of observations for 28 days, the color of the red claw crayfish changes every week, except for the first week because the crayfish are still adapting to the feed given. The increase in color quality every week is caused by the provision of a color pigment source, this indicates that there is a difference in color quality improvement in freshwater crayfish in the aquarium. The results showed that there was an increase in the quality of lobster color quality in treatment C (10% Red Dragon Fruit Peel Meal) with an average sample value of 86.01 for claws and 87.9 for chepalotorax to teslon.

Tabel 2. Scoring of increased brightness of claws and cephalothorax to teslon red claw (*Cherax quadricarinatus*) for 3 observations in 28 days of rearing.

Observed part	Ttreatment	Average Observation Score (Day-)		
		0	14	28
Claw	A	79.36	80.55	80.66
	B	77.77	78.95	83.69
	C	76.19	83.61	86.01
	D	77.77	80.13	83.69
	E	77.77	80	82.85
	A	74.60	80.55	84.25
	B	73.01	81.66	82.87
	C	73.01	85.55	87.59

Chepalotho rax up telson	D	73.01	85.55	86.50
	E	74.60	82.03	83.33

The increase in color quality in treatment D was not significantly different from treatment C, which ranged from 83.69 to claws and 86.50 to telson. The score in treatment B (Dose of 5%) was 83.69 on the skin and 82.87 on the Chepalotorax section, then the score on treatment E (20% dose) was 82.85 on the claws and 83.33 on the Chepalotorax up to telephone. While the lowest score is in treatment A (Control) with a value of 80.66 in the claw section and 84.25 in the Chepalotorax section to teslon.

The survival rate of freshwater crayfish for 28 days of rearing is in treatment A (control) of 90.47%, treatment B with a dose of 5% at 85.71%, treatment C with a dose of 10% at 71.42%, treatment D with a dose of 15%. of 80.95% and treatment E of 80.95%.

Water quality includes dissolved oxygen (DO), water temperature, acidity (pH), and ammonia could be seen in Table 3.

Table 3. Water quality during rearing

Treatments	Dissolve Oxygen (mg $l^{-1)}$	Temperature (^oC)	pH	Total ammonia nitrogen (mg l^{-1})
A	6.4	27.4	8.23	0.25
B	6.6	27.6	8.21	0.25

C	6.9	27.2	8.11	0.15
D	6.7	27.5	8.17	0.15
E	6.4	27.4	8.21	0.25

Discussion

The results of observations for 28 days, the color of the red claw crayfish changes every week, except for the first week because the crayfish are still adapting to the feed given. The increase in color quality every week is caused by the provision of a color pigment source, this indicates that there is a difference in color quality improvement in freshwater crayfish in the aquarium. Changes in the color of the clownfish began to occur on the 7th and 14th day with the addition of 5% red dragon fruit peel flour to the feed due to an increase in carotenoids in pigment cells (Simamora, 2019). Meanwhile, in sand lobsters, their entire body color changed after 97 days of rearing when they were fed spirulina-added feed (Soffa *et al.,* 2019).

In addition, the results showed that there was an increase in the quality of red claw crayfish color quality in treatment C (10% red dragon fruit peel meal) with an average sample value of 86.01 for claws and 87.9 for chepalotorax to teslon. The increase in color quality in treatment D was not significantly different from treatment C, which ranged from 83.69 to claws and 86.50 to telson. The score in treatment B (Dose of 5%) was 83.69 on the skin and 82.87 on the Chepalotorax section, then the score on treatment E (20% dose) was 82.85 on the claws and 83.33 on the Chepalotorax up to telephone. While the lowest score is in treatment A (Control) with a value of 80.66 in the claw section and 84.25 in the chepalotorax section to teslon.

The color appears first from the tip of the claw which then spreads to the base of the claw. Improving the quality of red claw body color is influenced by the amount of carotenoids contained in the exoskeleton. Beta-carotenoid, vitamins and anthocyanin in dragon fruit peel is thought to increase the skin color lightening of crayfish. The beta-carotenoid contained in it fulfills the needs of the crayfish body, because it cannot synthesize itself (Nururrahmah and Widiarnu, 2013; Kalidupa et al., 2018). Kembuan et al. (2012) and Noor et al. (2016) stated that the vitamin C contained in it acts as a strong antioxidant and is absorbed easily in the skin. The antioxidant content in super dragon fruit peel extract reaches 30 b/v (Ni'matusyukriyah and Sarwono, 2019) and even reaches 58 mg/l (Putri *et al.,* 2015). Anthocyanins act as nutrients that can provide an orange color and color strengthening (Priska *et al.,* 2018). The phenolic activity contained as an antioxidant is also thought to play a role in this. Lorith and Kanlayavattanakul (2013) stated that phenolic activity is the basis of an antioxidant mechanism that stabilizes pH and temperature and is responsible for brightening colors (Pramitasari *et al.,* 2022). The contents of beta-carotenoid, vitamins and antioxidants in dragon fruit peel meal, so the color will also first appear on that part of the body. After the color appears at the tips of the claws and cephalothorax, then the color spreads throughout the claws and abdomen to the telson.

Several previous research results on coloring ornamental fish using natural dyes with the addition of red dragon fruit peel meal in feed can increase the brightness of color in ornamental fish. This is proven by research conducted by Kalidupa *et al.* (2018) the administration of red dragon fruit peel meal in the feed significantly affected the increase in the brightness of the orange and black colors in koi carp. In addition, giving red dragon fruit peel flour with a dose of 15% in feed can increase the brightness of the orange and black colors in koi carp (Kalidupa *et al.,* 2018). Color improvement in koi fish fed 10% dragon fruit meal (Kurnia *et al.,* 2019) and in red cherry shrimp added astaxanthin and canthazanthin (Amin *et al.,* 2012). Apart from affecting the color of the dragon fruit skin, it can also

affect health as a natural antibiotic that can suppress the attack of *Aeromonas hydrophilla* bacteria on tilapia (Andayani *et al.,* 2018; Sudrajat, 2019) and increase growth in goldfish (Efianda *et al.,* 2018) and in snakehead fish (Rakhmawati *et al.,* 2021).

This study was conducted using raw materials in the manufacture of feed by mixing red dragon fruit peel flour as a natural dye. Each treatment had a different dose of red dragon fruit peel flour so that the proximate content was different. Based on the results of observations showed that each treatment there was an increase in the color quality of the lobster. The highest increase in color quality was found in lobsters fed C feed (10% dose). Followed by treatment D (15% dose), treatment E (20% dose), treatment B (5% dose) and the lowest was treatment A (without red dragon fruit skin flour). excessive and not lacking to obtain an increase in color quality in red claw lobster. Amiin *et al.* (2012) argued that to obtain optimal color improvement in red cherry shrimp by adding 100 mg/kg canthaxanthin. The same thing with rainbow trout, Meilisza *et al.* (2021), Kurumoi rainbowfish fed 2.6 g/kg asthaxanthin supplementation had higher enhance color than 5.1 g/kg.

Color quality improvement in red claw crayfish (*C. quadricarinatus*) is influenced by several internal and external factors. Internal factors include species, gender, organs and hormones. External factors include background color of the rearing place, light intensity, temperature of rearing conditions and carotenoids in the feed. Other external factors besides carotenoids in the feed in the form of background color of the rearing place, light intensity and temperature of rearing conditions that affect the increase in red claw body color are important factors that also need to be considered (Diaz – Jimenez *et al.,* 2018).

Water quality parameters are still within the optimal range of rearing. So is the survival rate during maintenance. The survival rate can be said to be still high. Samad *et al.* (2022) stated that the survival rate of freshwater crayfish ranged from 80 to 93.33% which was still high. However, treatment C was still less than optimal due to cannibalism in freshwater crayfish during maintenance. The high survival rate of freshwater crayfish is due to both the amount and timing of feeding as well as the condition of water quality during maintenance which does not become a limiting factor in the survival of freshwater crayfish.

Conclusion

The results showed that dragon fruit peel meal improve the color of freshwater crayfish (*Cherax quadricarinatus*). The brightest color was lobster which was given a utilization of 10% dragon fruit peel meal from brown to a bluish color.

Acknowledgments

Thank you to Lampung State Polytechnic which has provided funds for this research through DIPA for Fiscal Year 2022 with Number: 321.59/PL15.8/PP/2022 on the Applied Research Scheme.

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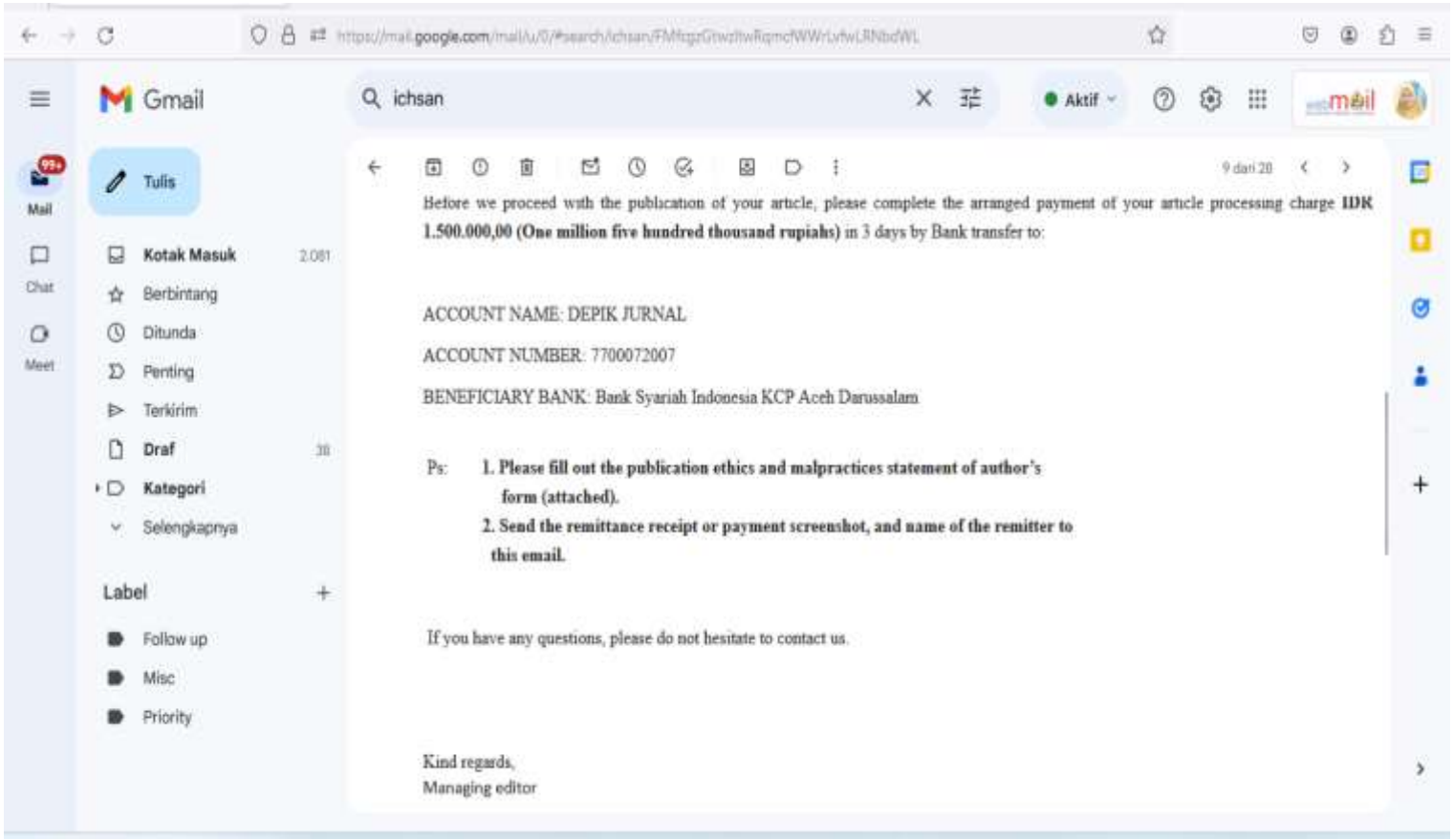
How to cite this paper:

Rakhmawati, R., T. Aprilia, N. Indariyanti, A. Saputra, E. Marlina. 2022. Color Quality Improvement of Cherax quadricarinatus with Dragon Fruit Peel Meal Utilization. Depik Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan, v(n): 1-3.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Authors	Rakhmawati Rakhmawati, Tulas Aprilia, Nur Indariyanti, Andre Saputra, Eulis Marlina
Title	Color quality improvement of Cherax quadricarinatus with dragon fruit peel meal utilization
Original file	28628-93817-1-SM.DOCX 2022-10-20
Supp. files	None
Submitter	Rakhmawati Rakhmawati
Date submitted	October 20, 2022 - 03:03 PM
Section	Articles
Editor	Agung Batubara
Abstract Views	0

Status

Status	Published Vol 12, No 3 (2023): DECEMBER 2023
Initiated	2023-12-26
Last modified	2024-05-27

Submission Metadata

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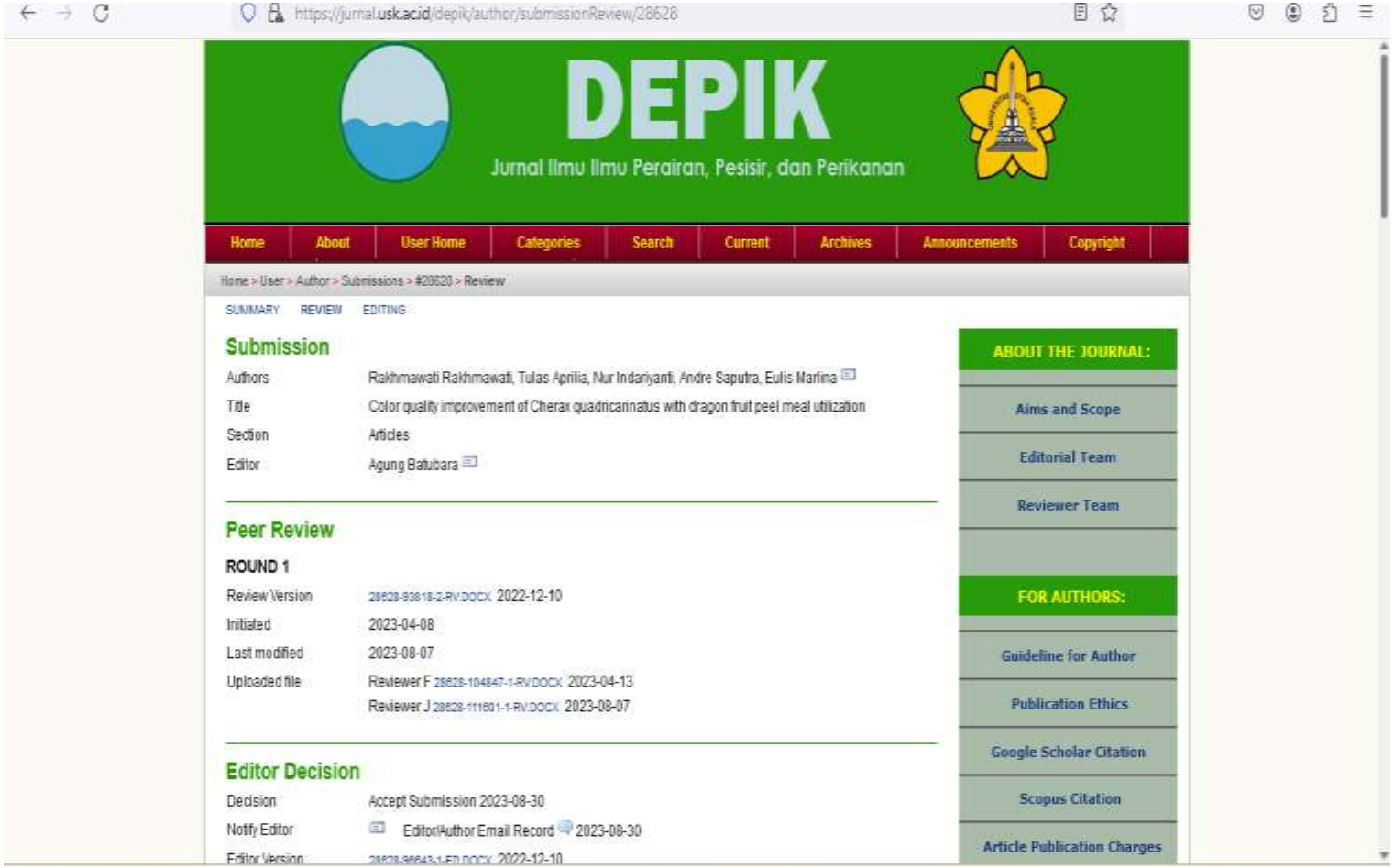
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Title
Color quality improvement of Cherax quadricarinatus with dragon fruit peel meal utilization
Section
Articles
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Review Version
28628-93618-2-RV.DOCX 2022-12-10
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2023-04-08
Last modified
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Uploaded file
Reviewer F 28628-104847-1-RV.DOCX 2023-04-13
Reviewer J 28628-111601-1-RV.DOCX 2023-08-07
Editor Decision
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Editor Version
28628-98643-1-ED.DOCX 2022-12-10
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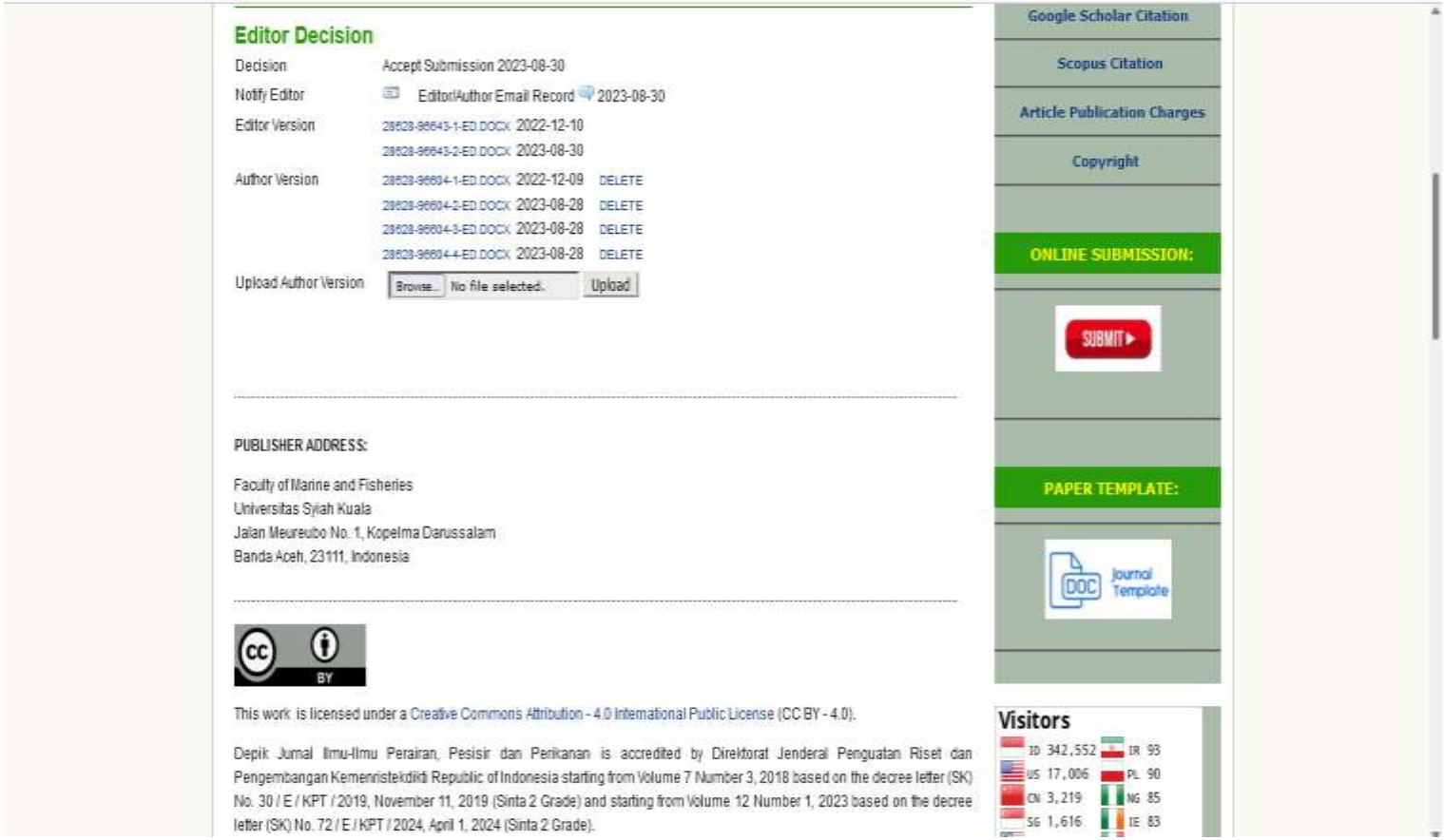

Editor Decision

Decision	Accept Submission 2023-08-30
Notify Editor	Editor/Author Email Record 2023-08-30
Editor Version	28628-96643-1-ED.DOCX 2022-12-10
	28628-96643-2-ED.DOCX 2023-08-30
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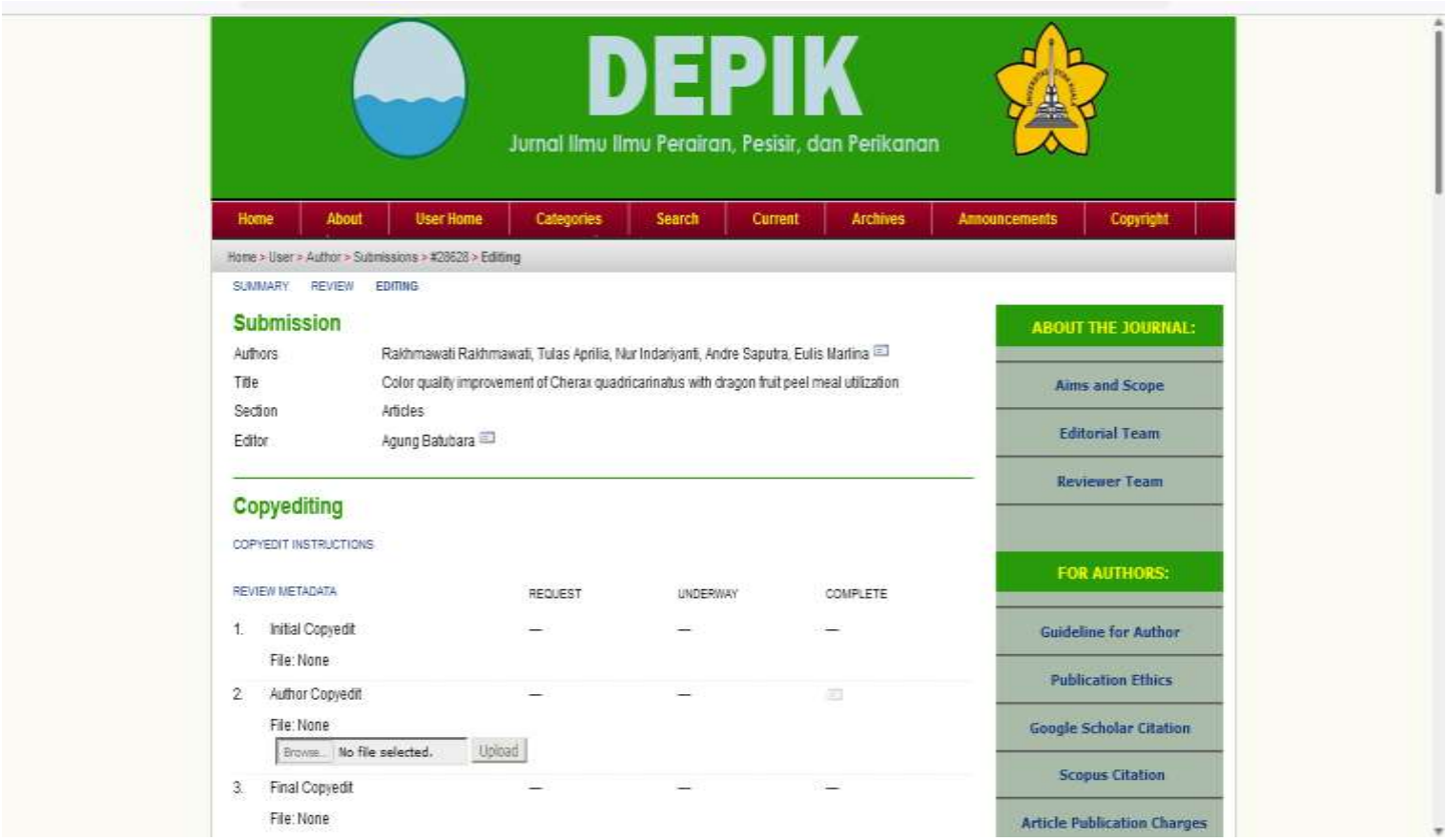
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Color quality improvement of Cherax quadricarinatus with dragon fruit peel meal utilization
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Aims and Scope
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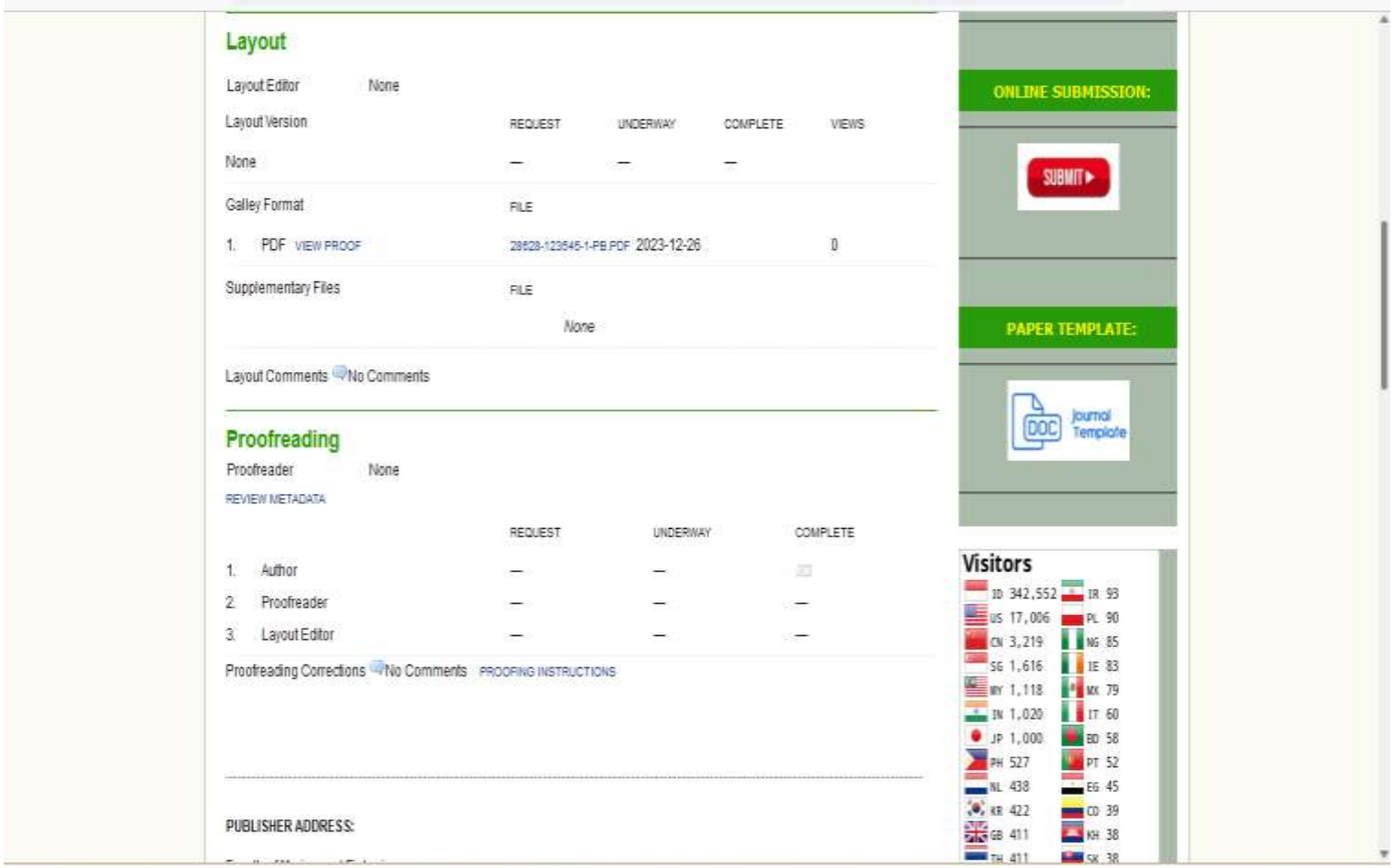

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1. PDF VIEW PROOF 28628-123645-1-PB.PDF 2023-12-26 0

Supplementary Files FILE

None

Layout Comments No Comments

Proofreading

Proofreader None

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3. Layout Editor	—	—	—

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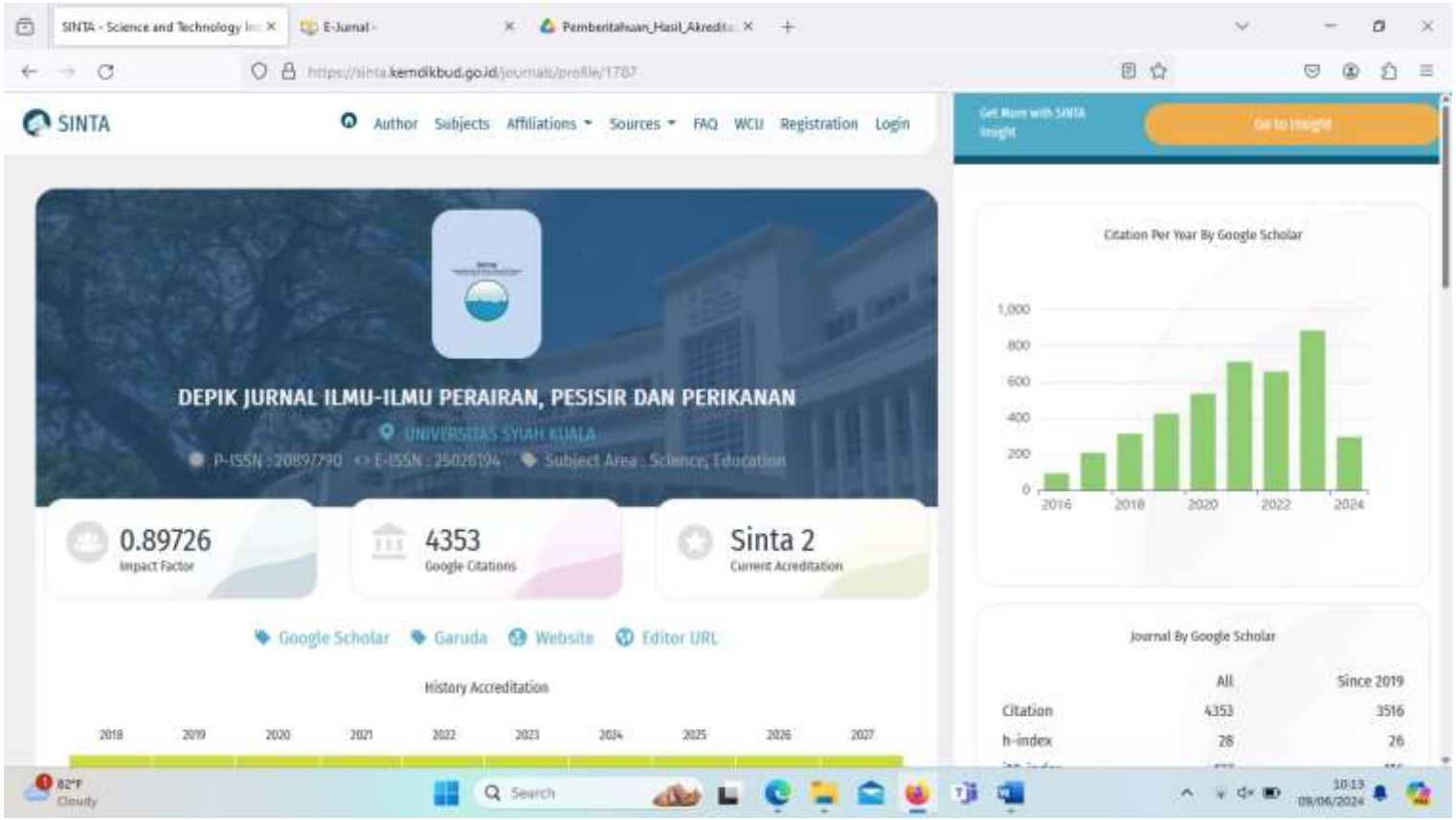
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