



Dietary Effect of Red Paprika Used to Enhance the Coloration of Red Tilapia (*Oreochromis niloticus*)

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Abstract

Red tilapia (*Oreochromis niloticus*) is one of the famous fish cultures in the aquaculture industry, especially in Malaysia. The appearance of redness makes the fish more attractive for customers to buy. Therefore, to achieve quality products it is necessary to research how to improve the color quality of tilapia as desired by customers. The purpose of this study was to identify the dietary effect of red paprika used to enhance the coloration of red tilapia. This study is an experimental quantitative study. Red tilapia was obtained from Freshwater Hatchery, University Malaysia Terengganu. A descriptive analysis was used to analyze the data in this study. This study shows that red paprika has an effect on the length and weight of red tilapia, where the highest length and weight gained (1.79 cm and 12.37 g) given red paprika 2% and the lowest length and weight gained (0.63 cm and 2.5 g) which given 4% red paprika. Only 2% of red paprika treatment showed different growth performance. The crude protein, lipid, and moisture composition of tilapia were also higher at 2% red paprika treatment. Meanwhile, the highest composition of ash is feed with 4% red paprika content. The result of this research showed that the caudal and dorsal either muscle or fin showed the highest color at the fish which fed with 8% red paprika. It could also improve the coloration of the red tilapia. Future studies suggest the use of *Dunaliella salina* microalgae which is one of the richest sources of carotenoids.

INTRODUCTION

Fish is one of the sources of protein needed by humans. Tilapia is a type of freshwater fish that is easy to breed and breeds quickly. The world market demand for tilapia is increasing (Ng and Romano, 2013). This is evidenced by the increased production of tilapia which is the third most important commodity after carp and salmon (Fitzsimmons, 2000). Tilapia are widely bred in most tropical countries especially East Asia and the subtropics of the world (El-Sayed, 2006). Red tilapia is

an important tilapia for aquaculture in Asia (Welcomme and Vidthayanon, 1999). Red tilapia is one of the famous fish cultures in the aquaculture industry, especially in Malaysia. In Malaysia, aquaculture production is 506,465,25 tons and red tilapia contributes 30,359.45 tons while black tilapia is only 5,071.93 tons (Department of Fisheries Malaysia, 2010). The appearance of redness makes the fish more attractive for customers to buy it.

Sensory quality has been a major influence on how customers perceive high-quality products and customer preferences (Davis, 2015). Colorlessness is usually associated with poor health and low-quality products. In other words, bright color effects give high expectations for high quality, nutritious, and healthy foods (MacDougall, 2002). To achieve quality products by improving the quality of color desired by customers, an adequate supply of carotenoids for a practical diet is essential. Based on the composition of carotenoids, some nutrients can be produced to enhance the color of tilapia culture.

Naturally, the color comes from chlorophyll, carotenoids, and porphyrins. Carotenoids are one of the important colors in animals. Carotenoids are coloring that animals cannot synthesize naturally but require exogenous from the carotenoids they eat which are responsible for the colors red, yellow, and orange for many species including teleost fish (Fox and Vevers, 1960; Goodwin, 1984; Kodric-Brown, 1998). It is also not limited to body-color but has important functions in vision, antioxidants, and the immune system (von Schantz *et al.*, 1999; McGraw and Ardia, 2003; Hill and Johnson, 2012).

Color enhancement can be done by feeding fish with enriched carotenoids that will improve the quality and cost of fish. Plant resources should be used to induce the color in fish, especially red peppers from peppers (de la Mora *et al.*, 2006; Yanar *et al.*, 2007; Santos *et al.*, 2010; Lee *et al.*, 2010; Kim and Lee, 2012; Arous *et al.*, 2014). Paprika contains large amounts of carotenoids including cryptoxanthin, zeaxanthin, capsanthin, and β -carotene (Santos *et al.*, 2010). However, experimental diets specifically for tilapia are very few. Product appearance is one of the big criteria that customers choose when they buy food. Therefore, to achieve quality products it is necessary to research how to improve the color quality of tilapia fish as desired by customers. The purpose of this study was to identify the dietary effect of red paprika

used to enhance the coloration of red tilapia.

METHODOLOGY

Place and Time

This study was conducted for six weeks in October-November 2019 at the School of Fisheries and Aquaculture Sciences, University Malaysia Terengganu.

Research Material

Red tilapia used as an experimental material was obtained from Freshwater Hatchery, University Malaysia Terengganu. This study feed was used during research in the form of red paprika in the treatment of tilapia foods. It is fed through regular grinding of pellets and mixed with red paprika according to the treatment.

Research Design

This study is an experimental quantitative study. This study used five treatments that are the percentage of red paprika in fish food. The diet treatments were 0%, 2%, 4%, 6%, and 8%. The feed was given once a day with the satiety method.

Work Procedures

The experiment was conducted for 6 weeks, at ambient temperature under the natural time (approximately 12 hours of light: 12 hours of darkness). Before starting the experimental feeding experiment, let the tilapia get used to the new tank and be fed with commercial food for a week. At the beginning of the experiment, 30 uniformly (mean initial length: 3-4 inches) were in good condition and stored in a plastic tank. The fish are fed using the satiety method once a day in the afternoon. Observations were conducted to ensure that no unhealthy food items sank in the bottom tank. Water in each tank will be replaced by 33.33% daily. The ingredients and nutrient content in this experiment are shown in Table 1.

Table 1. Formulation and approximate chemical composition (g kg⁻¹) of diets.

g.kg ⁻¹	Percentage of red paprika				
	0%	2%	4%	6%	8%
Fishmeal	450	450	450	450	450
Palm moil	20	17	15	12	10
Fish oil	50	50	50	50	50
Wheat flour	315	315	315	315	315
Paprika	0	20	40	60	80
Vitamin and Mineral	30	30	30	30	30
Molasses	20	20	20	20	20
CMC	15	15	15	15	15
Alpha cellulose	100	83	65	48	30

g.kg ⁻¹	Approximate chemical composition of diets				
Crude Protein (Nx6.25)	44.81	41.27	43.12	42.77	44.30
Lipid	11.79	11.35	11.6	12.08	12.35
Ash	9.9	9.91	9.95	9.89	10.35
Moisture	4.35	3.83	4.94	4.13	3.16
Energy J/g	18974	19433	19292	18670	19750

Fish food is used as a source of protein. The source of lipid food comes from fish oil. Wheat flour is used as a source of carbohydrates. Table 1 shows that five practical diets (0%, 2%, 4%, 8%) were formulated with different percentage paprika content but were designed to be isoenergetic. The diet is stored in a 5°C refrigerator until used. The amount of food suitable for consumption for about a week is removed at room temperature and stored in a box. Alpha cellulose is used as a filler. All diets are available in the laboratory. Deliberately used food ingredients are carefully weighed and mixed thoroughly and mixed with all the ingredients involved with 70 percent water to form a stable dough. The finished dough is prepared with a pellet mill with a diameter of 3mm and dried for 24 hours at a temperature of 60°C.

Diets were analyzed for proximate composition. Nitrogen content was analyzed by steam distillation using the Kjeldahl Digestion (Kjeltec™ 2100 Distillation Unit - FOSS) and crude protein calculated as N x 6.25. The lipid content was determined by ether-extraction using the Foss-Labtec ST310. Moisture was determined by using the oven drying at 100 ± 5°C and ash by incineration at 600°C

for 6 hours. The gross energy of the formulated diet was determined using the bomb calorimeter (IKA C2000 basic, IKA KV600 digital). Carbohydrate was determined by the difference.

By referring method from Yanar *et al.* (2004), Total Carotenoid Contents (TCC) was determined (Figure 1). TCC was determined by using the spectrophotometer (Model UVmini-1240, UV-VIS Spectrophotometer, Shimadzu) by scanning the supernatant using an absorption value of 480nm. The computational formula was:

$$TCC (\mu\text{g.g}^{-1}) = A_{\lambda=480} \times K \times V / (E \times G)$$

Where $A_{\lambda=480}$ nm is the absorbance value at $\lambda=480$ nm; and G is the sample mass (g). K is a constant (104); V is the volume of the extracting solution (ml); E is the coefficient (1900).

Skin colors were measured in three perceptually relevant color axes: 'L' represents darkness/lightness, 'a' represents a scale from green (negative values) to red (positive values) and 'b' represented a scale from blue (negative values) to yellow (positive values). All the fish treatments were originally selected partly based on their visual appearances to determine their range intensity of color. Two selected types of parts of fish were

determined for the color measurement. Fin (dorsal, anal, and caudal) and muscle (caudal, dorsal, anal, and head region) are the focusing part of the carotenoid

measurement. The L*a*b* values were determined by using a chromameter (model CR-400, Konica Minolta, Japan).

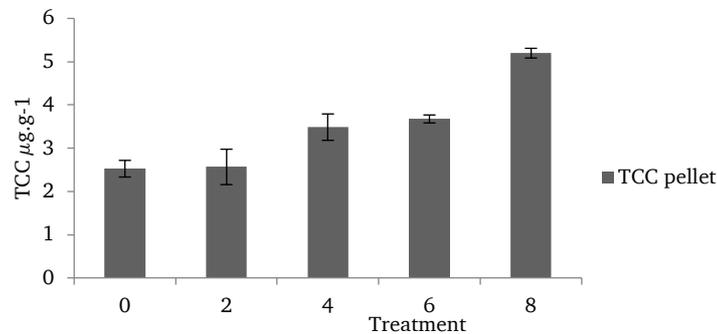


Figure 1. Total carotenoid content (TCC) in the different formulated diet.

Data Analysis

This study is quantitative. Descriptive analysis such as frequency and percentage were used to analyze the data in this study.

RESULTS AND DISCUSSION

A descriptive analysis was used to analyze the data in this study. Table 2 shows that after six (6) weeks of the feeding trial, all the fish gained some length of average 1.44 cm. Feed with 2% paprika the highest length gained (1.79 cm) and feed with 4% paprika is the lowest length gained (0.63 cm). Fish fed

with 0%, 6%, and 8% of paprika, length gained 1.54 cm, 1.61 cm, and 1.64 cm respectively. Besides, fish fed with 2% and 4% have the highest weight gained at 12.37 g and the lowest weight gained at 2.5 g respectively. The highest Specific Growth Rate (SGR) fishes fed with 2% of paprika content (29.45) follow by 8%, 0%, 6%, and 4%. Feed content with 4% of paprika showed the lowest SGR (5.95). For the Feed Conversion Ratio (FCR), the lowest is the fish which fed with 2% of paprika content (3.62) and follow closely with 8% treatment (3.63). The highest FCR is the fish fed with 4% of paprika content (17.92).

Table 2. The effect of dietary paprika on the length, weight, and specific growth rate.

Parameter	Percentage of red paprika				
	0%	2%	4%	6%	8%
Length Initial (cm)	7.23 ± 0.17	7.02 ± 0.62	7.49 ± 0.33	6.89 ± 0.12	7.12 ± 0.17
Length Final(cm)	8.77 ± 0.07	8.81 ± 0.19	8.12 ± 0.20	8.5 ± 0.2	8.76 ± 0.22
Length Gain(cm)	1.54	1.79	0.63	1.61	1.64
Weight Initial (g)	10.87	11.23	15.60	16.50	12.00
Weight Final (g)	21.25	23.60	18.1	21.00	24.33
Weight Gain(g)	10.38	12.37	2.5	4.5	12.33
Specific Growth Rate (SGR)	24.70	29.45	5.95	10.71	29.36
Feed Conversion Ratio (FCR)	4.32	3.62	17.92	9.96	3.63

Based on Table 3, the tilapia fish chemical composition, fish fed with 2% of paprika has the highest crude protein, lipid, and moisture. Besides, the lowest for crude protein and lipid composition at the

feed with 6% paprika content. The highest composition of ash is the feed with 4% of paprika content and the lowest composition of ash is the feed with 2% of paprika content.

Table 3. Chemical composition of red tilapia.

Composition	Percentage of red paprika				
	0%	2%	4%	6%	8%
Crude Protein	82.31±3.2	85.13±0.1	78.71±5.2	71.86±0.1	79.74±0.9
Lipid	3.51±0.4	9.48±0.1	2.69±2.6	0.5±0.0	4.45±0.0
Ash	7.35±0.6	5.47±0.5	8.62±0.2	5.89±0.1	7.83±0.5
Moisture	56.70±2.6	57.85±1.5	53.25±2.0	54.06±0.1	56.01±0.5

Figure 2 showed that the initial fish have high total carotenoid content compare to other treatments. The possible explanation regarding this that the tank that rears the initial fish was contained high algae. The green algae in the water provide good carotenoid contained and some of the initial samples from grow-out

fish. The pattern showed that the carotenoid contained in the fish is increasing from the control formulated diet to the highest feed with carotenoid content. The initial carotenoid contained showed the highest among the peak ($1.74 \mu\text{g}\cdot\text{g}^{-1}$).

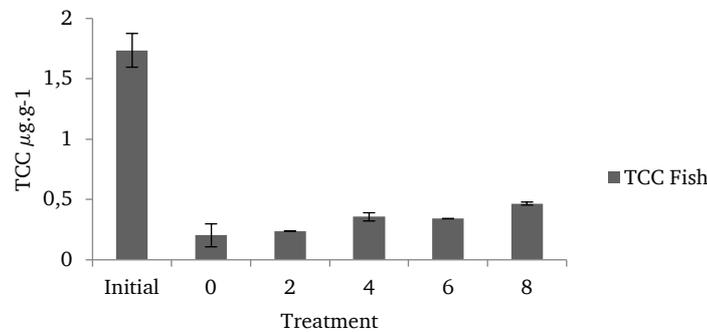


Figure 2. Total carotenoid content in different fish body muscle.

This red paprika has been extensively studied that act as the natural pigment sources for fish (de la Mora *et al.*, 2006; Yanar *et al.*, 2007; Santos *et al.*, 2010; Lee *et al.*, 2010; Kim and Lee, 2012; Arous *et al.*, 2014). Generally, the skin color of the fish affected by several factors which include carotenoid sources, dietary lipid combination, fish species, and environmental condition (Kang and Ha, 1994; Baker *et al.*, 2002; Diler and Gokoglu, 2004; de la Mora *et al.*, 2006; Hynes *et al.*, 2009). Kim and Lee (2012) reported that that the increase of paprika concentration on the diet does not affect improved the skin redness on the skin. However, the study from Lee *et al.* (2010) contradicts that showed when increasing the paprika to 8% showed could improve

the skin color of the fish. Most of the papers experimented on the combination of lipid and the effect of the paprika diet. Lee *et al.* (2010) said that the lipid content of the skin and muscle was not affected by dietary paprika levels.

The graphs in Figure 3 showed that the caudal part of the muscle has the highest value of the hue color (delta E) and the anal part has the lowest hues color. For the dorsal and anal part region, the highest value of delta E for the fish fed with 2% of paprika. For the caudal region, delta E showed the highest reading at the 8% treatment fish. For the head region, the highest value of delta E for the fish fed with 0% (7.42) but the value closely the same with the treatment 2% (7.30) and 6% (7.33).

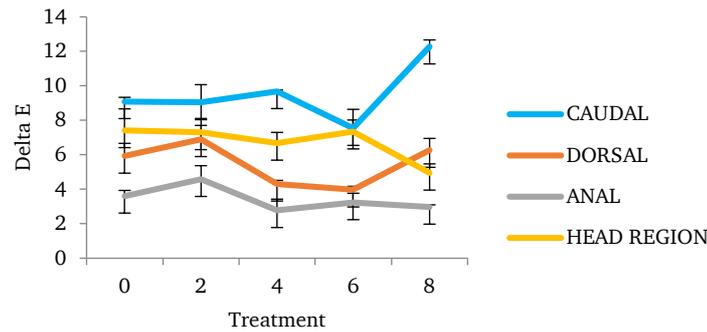


Figure 3. The measurement skin color of the muscle region of the tilapia.

The overall pattern in Figure 4 showed that the caudal fin has the highest value of hue color (delta E) and the dorsal fin has the lowest hue color most of the treatment except 8% diet with paprika. For the caudal fin, fish fed with 8% paprika has the highest delta E (20.702)

and the lowest 0% diet (14.346). Anal fin showed that fish fed with 4% diet paprika has the highest delta E and the lowest is 6% treatment fish. Dorsal fin showed quite high at the 8% diet (16.918) compare to the other treatment.

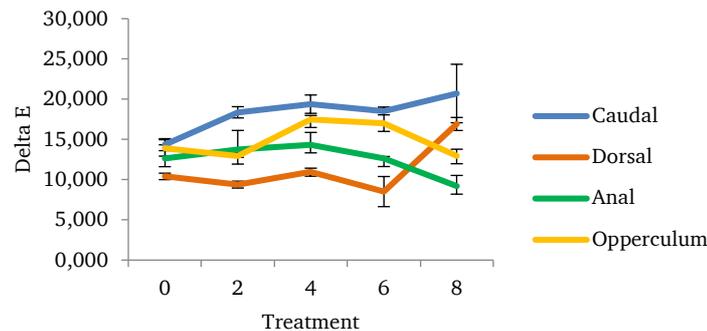


Figure 4. The measurement skin color of the fin of the tilapia.

Arous *et al.* (2014) reported that the lowest flesh color either redness or yellowness was in the control diet which no added supplementation of carotenoid. The result of this research showed that the caudal and dorsal either muscle or fin showed the highest color at the fish which fed with 8% paprika. This result is supported by Lee *et al.* (2010) that 8% of paprika content feed can increase skin color without adverse effects on the growth performances.

(2003) reported that the skin pigmentation of goldfish and koi carp only after 4weeks of feeding a diet containing paprika The finding also found that 8% red paprika containing diet feed for 6weeks could improve the coloration of the red tilapia.

Feeding diets that contained natural carotenoid sources such as paprika, microalgae, and shrimp shell meal could improve the skin color of some fish species including koi carp red porgy, and goldfish (Gouveia *et al.*, 2003; Hancz *et al.*, 2003; Kalinowski *et al.*, 2005). Hancz *et al.*

CONCLUSION

Demand for tilapia especially growing red tilapia. This has an impact on the rapid production of tilapia, especially for aquaculture in Asia. Red tilapia is one of the famous fish cultures in the aquaculture industry in Malaysia. The bright color effect on tilapia gives high hopes that the fish is of high quality, nutritious, and healthy. This experimental

quantitative study aims to identify the effects of red paprika on the coloring of red tilapia. Red tilapia used as an experimental material was obtained from Freshwater Hatchery, University Malaysia Terengganu. This study shows that giving red paprika influences the length and weights of tilapia. The findings of this study found that only 2% of red paprika treatment showed different growth performance. The crude protein, lipid, and moisture composition of tilapia were also higher at 2% red paprika treatment. Meanwhile, the highest composition of ash is feed with 4% red paprika content. The result of this research showed that the caudal and dorsal either muscle or fin showed the highest color at the fish which fed with 8% red paprika. The finding also found that 8% red paprika containing diet feed for six weeks could improve the coloration of the red tilapia. Future studies suggest the use of *Dunaliella salina* microalgae which is one of the richest sources of carotenoids used as dyes in food.

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