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THE EFFECTS OF RED YAM FLOUR (*Ipomoea batatas* L.) ON THE GROWTH, SURVIVAL RATE AND SKIN COLOR OF GOLDFISH (*Carrasius auratus*)[**]

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Running title: Effects of red yam flour on goldfish

ABSTRACT

This study evaluated the effects of commercial diets supplemented with 0%, 3%, 6%, 9%and 12% red yam flour (*Ipomoea batatas L.*) on the growth, survival rate and skin colour of goldfish (*Carrasius auratus*). A completely randomized experimental design was developed with five treatments and three replicates. Seventy-five goldfish with the average initial length of 4.4 cm were assigned to fifteen experimental tanks. The experiment had lasted for twenty-eight days. The results showed that the growth and survival rate were not significantly affected by dietary treatments (P > 0.05). However, red yam flour significantly affected the skin color of goldfish with the best concentration of 9%. It was concluded that the dietary administration of red yam flour of 9% was found to be a suitable dietary supplementation to ensure skin pigmentation as well as there were not bad effects on fish growth and survival rate.

Keywords: *Carrasius auratus*, Red yam flour, skin color.

INTRODUCTION

Goldfish (*Carassius auratus*) is one of the most popular ornamental fish in Indonesia. The fish has a body color ranging from red, yellow, green, black and silvery. Since it was first discovered to be nurtured, there are approximately fifteen species of goldfish that have been recognized and favored by public. Goldfish is also one type of ornamental fish that attract many world fish markets. In order to produce the best quality goldfish, a good environment and high nutrients feed are needed. The nutritional content of feed will support color, health and quality of good fish.

For most ornamental fish, many studies focused to achieve high levels of their skin pigmentation together with body shape, fin shape and body size of the fish using sinthtetic pigments and natural sources (Kalinowski et al., 2005; Shahidi et al., 1998). These belong to the most important quality characteristic informing their market levels (Paripatananont et al. 1999). Fish, similar to other vertebrate animals, can not perform de novo synthesis of carotenoids (Goodwin, 1984). Therefore, they depend on dietary supplies to obtain their own natural pigmentation. The color of fish is produced by the presence of chromatophoral cells existing in the dermis layer of skin

(Putra et al, 2012). Natural carotenoid substances can be found in plants and fruits in the form of β-carotene. Since the high cost of synthetic colourings, many studies on natural compounds such as *Chlorella zofin-giensis* (Bar et al. 1995) *Chlorococcum sp*. (Zhang et al. 1997); the green algae *Haematococcus pluvialis* (Harker et al. 1996; Yuan & Chen 2000 and *C. vulgaris* (Gouveia et al. 1996) have been done. Other latest works have been done using paprika (Minh et al, 2014); *Spirulina platensis* (Mahdi et al 2013), Medicago sativa (Mahmut et al 2008); and carrot starch (Pardosi et al 2016) as sources of dietary carotenoids. One of alternative sources of a cheap and easily available carotenoid source in Indonesia is red yam. Red yam, among other vegetables, is known to contain the highest source of beta carotene. According to Fatimah (2013), red yam contains the highest beta-carotene among other sweet potatoes. It contains 9900 mg (32 967 SI) of beta-carotene per 100 grams. The thicker the colour of red yam is, the higher the content of beta-carotene will be. However, studies on the effects of dietary red yam flour in fish feed on the growth and skin colour of goldfish (*Carassius auratus)* have not been done yet.

MATERIAL AND METHOD

Experimental design

The feeding trial was conducted in the Biology Laboratory of Faculty of Marine and Fisheries of Syiah Kuala University of Banda Aceh, Indonesia. It had been conducted for two months, from July to August 2017. Seventy five goldfish were purchased from a local market. Prior to the experiment, the fish had been acclimatized and fed with commercial ornamental fish for three days. Fish with the average length of 4.4 cm were randomly distributed into fifteen containers (volume 25 L each).

This research was done using an experimental method. The design used was Completely Randomized Design (RAL) with 5 treatments and 3 replications. The treatments used were: Treatment A: Control; without adding red yam flour; Treatment B: Red yam flour of 3%; Treatment C: Red yam flour of 6%; Treatment D: Red yam flour of 9%; Treatment E: Red yam flour of 12%. Fish maintenance had been lasted for 28 days and they had been fed three times a day at 09:00 am, 12:00 pm and 17:00 pm at each treatment. The amount of feed given was 5% of the average weight of the fish's body.

The odd red yam were purchased from traditional market in Banda Aceh city. The red yam used in this study was dried first. Then, the red yam was ground using a laboratory grinder until it become flour, and then mixed the red yam flour with progol as binder in accordance with the dosage (2-3 g / kg of feed) in one container, stirred until evenly and adding water at a volume of 150 ml / kg, poured the commercial ornamental fish feed into a different dosage of mixture of red yam flour and dried for 30-60 minutes. If the mixed feed color and smell changed, experimental feed must be re-mixed During this period, the water temperature ranged from 25 ° C-32 ° C with pH from 6 to 9 and the dissolved oxygen was approximately 5 mg/l.

Observation of fish color change

The color measurements of the tested fish were adopted from Sitorus et al. (2015). Fish color were measured using Toca Color Finder (TCF) observed by 5 panelists who do not have visual impairments (color blindness and farsightedness). Fish color was tranforming into a scores by scaling on color measuring paper. Color observation was done every 7 days for 28 days.

Calculations and statistical analysis

Absolute weight growth (AWG) = Fish weight at time-initial weight

Absolute lenght (AL) = Fish length at time-initial length

Survival rate (SR) (%) = 100 x (final fish number/initial fish number)

Specific growth rate (SGR) = (Initial weight-initial weight) x 100/days

Results were delivered as means± SE (Standard Error). All data were analyzed by one-way ANOVA using SPSS 14.0 for windows (Kalinowski et al., 2005). The level of significance was set at $P > 0.05$, and Duncan test was used to compare the mean values.

RESULTS AND DISCUSSION

The results showed that red yam flour has siginificant effect on color change of the goldfish (*Carracius auratus*) ($P<0.05$) (table 1). Duncan's advanced test showed that the best color change occured in treatment D (the dose of 9%) and the lowest shown in treatment A (control) (Figure 1). According to upstream et al. (2015), the color enhancement in fish varies according to the fish absorption capacity of the pigment type and the dose administered in each treatment. Based on these changes, the color of goldfish in each treatment was different and the dose used was different while the caratenoid material used was similar. In this study it is showed that the addition of 9% red yam flour was the best and the most effective treatment to improve the color of goldfish. According to Barus et al. (2014), fish takes a longer period to break the carotene material into color pigments if the pigment is present in large quantities. Panjaitan et al. (2016) mentioned that carotene added to the fish feed with excessive doses that to some extent affect the color of fish does not improve the color of the fish. Moreover, it can reduce the color value of fish.

An interesting finding seen on day 14, the color of the goldfish began to be brighter color at day-21 (Figure 1). It is in accordance with a previous research done by Sitorus et al. (2015), which stated that the administration of caratenoid in feed for two weeks showed the color improvement of goldfish. The provision of caratenoid for three weeks resulted in maximum color enhancement.

More than 3 weeks, the color will be stable due to the increase of caratenoid in the pigment cells (chromatophore) of goldfish.

The fluctuation of color intensity is caused by the changes of chromatophore cells. The changes are divided into two parts i.e. physiologically and morphologically. Physiological changes are the changes caused by chromatophore cell activities that are spread and concentrated in epidermis cells. The spread of chromatophore pigment stimulates the pigment to absorb the sun perfectly, which then results in an increase of intensity of the fish body. Whereas, the pigment of chromatophore that concentrates or gathers near the nucleus can decrease the intensity of fish body color so that it will become darker or paler. The movement of pigments in the epidermal layer is caused by external stimulation such as temperature, pH and light intensity. The morphological changes are due to the amount and composition in the feed containing the caratenoid sources (Sari et al., 2012).

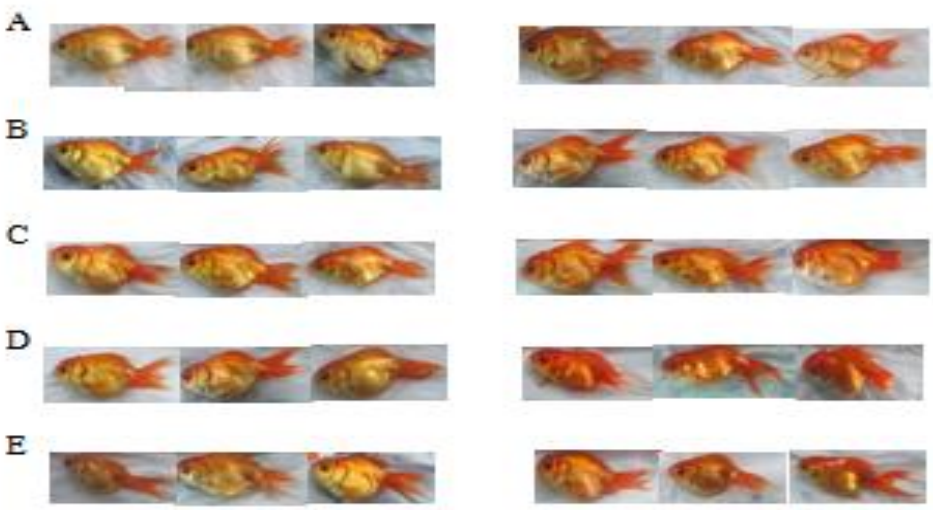

Figure 1 Color changes in the goldfish *(Carassius auratus)* (A: Control; Red yam flour of 0%; B: Red yam flour of 3%; C: Red yam flour of 6%; D: Red yam flour of 9%; E: Red yam flour of 12%)

The result of ANOVA test showed that feeding of red yam flour has no significant effects on absolute weight growth, absolute length, specific growth rate and survival rate (P> 0.05) (Table 1).

Table 1 Changes in color, growth, survival and specific growth rate of goldfish for 28 days rearing.

Treatment	Test parameters				
	Color change	Absolute weight growth (gram)	Absolute length (mm)	Specific growth rate (% / day)	Survival rate (%)
A (control)	0.93 ± 0.31^{a}	2.44 ± 0.57^{a}	11.99 ± 1.60^{a}	2.28 ± 0.26^{a}	100 ± 0.00^{a}
B (3%)	1.20 ± 0.00^{ab}	2.90 ± 0.33^{a}	13.75 ± 0.75^{a}	2.71 ± 0.46^{a}	100 ± 0.00^{a}
C (6%)	1.80 ± 0.53^{b}	2.35 ± 0.42^{a}	13.08 ± 2.76^{a}	1.93 ± 0.50^{a}	93.33 ± 11.55^{a}

D (9%)	3.87 ± 0.31[d]	2.17 ± 0.65 [a]	12.46 ± 3.22 [a]	2.21 ± 0.53 [a]	100 ± 0.00[a]
E (12%)	2.47 ± 0.31[c]	2.18 ± 0.43 [a]	10.48 ± 2.93 [a]	2.24 ± 0.22 [a]	100 ± 0.00[a]

Description: Different superscripts in the column show significant differences (P <0.05) between treatments based on Duncan Test.

The results of the study of color changes of goldfish during the study period of 28 days in each treatment can be seen in Figure 2.

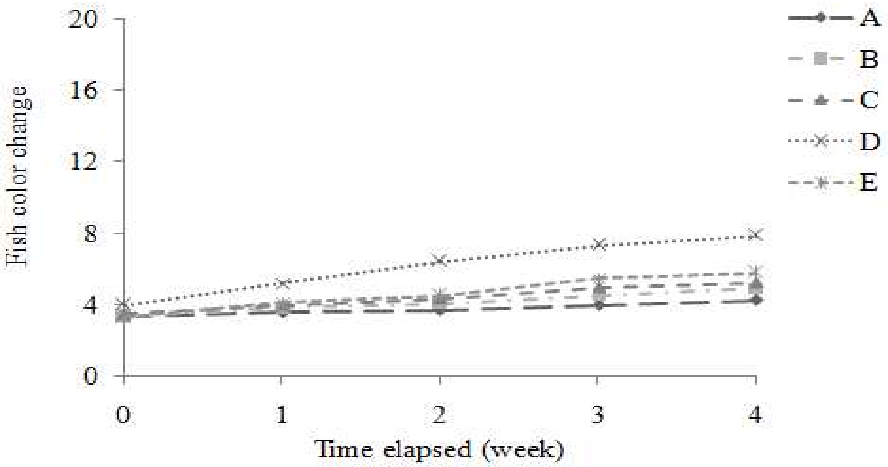

Figure 2 Fish color changes of goldfish (A: Control; Red yam flour of 0%; B: Red yam flour of 3%; C: Red yam flour of 6%; D: Red yam flour of 9%; E: Red yam flour of 12%)

The growth parameters (absolute weight growth, absolute length growth and specific growth rate) of goldfish increase in each treatment; both control feed and artificial feed with the addition of red yam flour (Figure 3 and 4) but no signifcant different (P > 0.05). This indicates that fish are able to utilize the feed given for their growth and body maintenance (Putra et al, 2016). Feeding increasing the growth of goldfish is considered to meet the nutritional needs of goldfish. It can be seen from the nutritional content in the feed and the resulted performance. According to Subamia et al. (2013), growth occurs when there are excess energies that once; the available energy was used for metabolism, digestion and activities. The result of ANOVA analyses showed that the treatment of red yam flour with different doses did not give significant effect to the growth parameters of goldfish, namely absolute weight growth, absolute length growth and specific growth rate (P> 0.05).

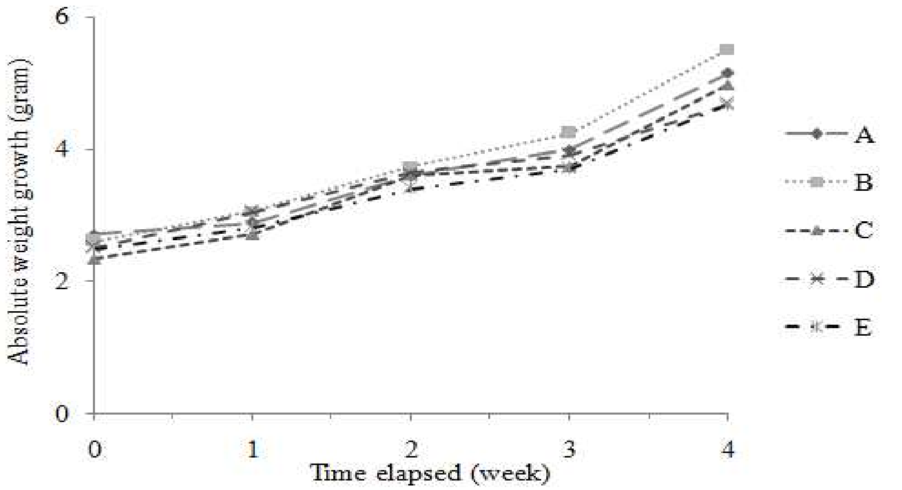

Figure 3 Absolute weight growth of goldfish (A: Control; Red yam flour of 0%; B: Red yam flour of 3%; C: Red yam flour of 6%; D: Red yam flour of 9%; E: Red yam flour of 12%)

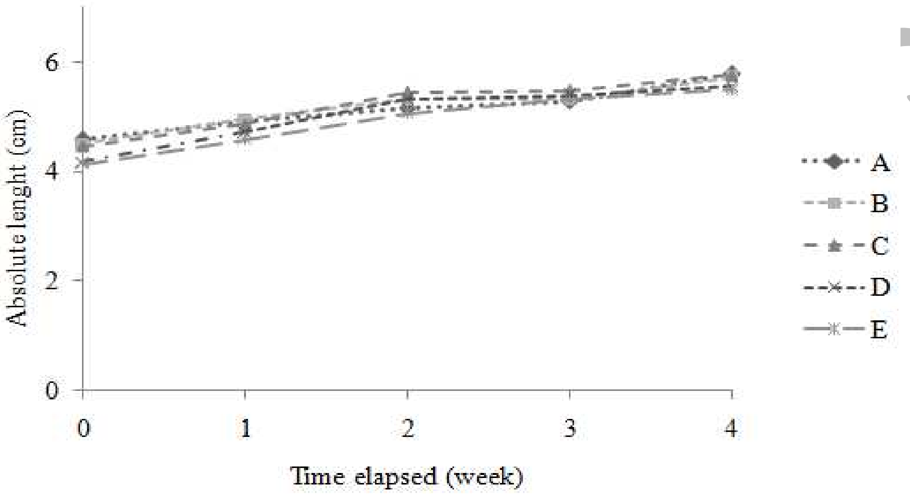

Figure 4 Absolute length growth of goldfish (A: Control; Red yam flour of 0%; B: Red yam flour of 3%; C: Red yam flour of 6%; D: Red yam flour of 9%; E: Red yam flour of 12%)

The survival rates of goldfish during the 28-day study period gave no significant effects in each treatment. It is allegedly due to the lack of protein content in red yam flour. The survival of goldfish is also influenced by water quality. According to Noviyanti et al. (2015), the optimal water temperature for the goldfish is around 25 ° C-32 ° C. The temperatures obtained in maintaining media ranged between 27 ° C-29 ° C. The optimal degree of acidity (pH) of water for goldfish is around 6-9. The water quality parameters measured during the study were DO, temperature and pH within feasibility limits for the maintenance of goldfish. The over tolerance of water quality of fish may cause fish stress. It is in accordance to Barus et al. (2015), stated that an ornamental fish in a state of stress can cause its color to fade. It is due to the gathering of pigment granules in the middle of the cell, so that the fish loses its color.

CONCLUSION

The administration of red yam flour (*Ipomoea batatas L.*) at different concentration in fish feed has a significant effect on color improvement with the optimal dose in D treatment (dose of 9%). However, the administration does not significantly affect the increases of absolute weight, absolute length, daily growth rate and the survival of the goldfish (*Carassius auratus*). Red yam flour can be considered as a potential feed supplement to enhance the economical value in ornamental fish markets.

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