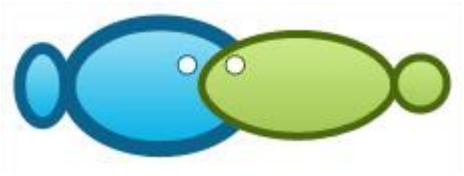

Survival and growth performance of snakehead juvenile (*Channa striata*) with various dosages of *Terminalia catappa* leaf powder

[1]Firman P. S. Nugraha, [1]Sinung Rahardjo, [2]Adang Saputra

[1] Study Program of Fisheries Resources Utilization, Jakarta Technical University of Fisheries, Jakarta, Indonesia; [2] Research Institute for Freshwater Aquaculture and Fisheries Extension, Bogor, West Java, Indonesia. Corresponding author: F. P. S. Nugraha, firmanpsnugraha@gmail.com

Abstract. Snakehead (*Channa striata*) is one of the local fish species with high economic value in Indonesia. The study was intended to increase the survival and growth performance of *C. striata* juvenile by determining the dosage of *Terminalia catappa* leaf powder. The study was conducted using a Completely Randomized Design (CRD). As treatment, *T.catappa* leaf powder was dosed at: 0 g L^{-1} (control), 0.25 g L^{-1}, 0.50 g L^{-1} and 0.75 g L^{-1}, with three replications for each dosage. The *C. striata* juvenile involved in this study had an average initial length of 7.77±0.01 cm and an average initial weight of 2.41±0.01 g. This research was carried out at the Multispecies Hatchery of Research and Development Installation for Environmental Technology and Toxicology of Freshwater Aquaculture, for 40 days. The results showed that the optimal survival and growth performance of snakehead juvenile was obtained by giving *T. catappa* leaf powder at a dosage of 0.50 g L^{-1}. This dosage showed the highest increase in survival (85.67%), specific growth rate (17.40% day^{-1}), feed conversion ratio (1.07) and protein efficiency ratio (0.93%) compared to the control group. At this dosage, the values of hematological parameters such as red blood cells, white blood cells, hemoglobin and hematocrit indicated normality in *C. striata* fish juvenile. The physico-chemical parameters during the treatment at a dosage of 0.50 g L^{-1} were within the tolerance range.
Key Words: water quality, hematological, tannin, specific growth rate.

Introduction. Snakehead (*Channa striata*) from the *Channidae* family is one of the local fish with high economic value and it is popular in developing countries like Indonesia (Bich et al 2020), as a consumption fish. It can be found in several areas of Indonesia such as Sumatra, Java and Kalimantan (Khasani & Astuti 2020). Its high albumin is attractive as it is used for medication, as an antioxidant, anti-diabetic, anti-inflammatory and anti-hypertensive (Mustafa et al 2012; Suhendi et al 2020). Albumin is a water-soluble protein (Radona et al 2020). *C. striata* is widely used as a basic ingredient of some processed fishery products such as meatballs, nuggets, crackers, and fishcake (Muthmainnah 2013; Yufidasari et al 2018). The use of *C. striata* as ingredient in food and drugs processing results in a high demand for snakehead. However, up until now, the supply of *C. striata* relies on catches from nature (Saputra et al 2018).

C. striata fishing is common in Java, Sumatra, and Kalimantan, especially in rivers and swamps (Selviana et al 2020). The overfishing of *C. striata* from the wild causes a population decline and even endangers its habitat (Hien et al 2016). According to Sofarini et al (2018), the rate of exploitation of *C. striata* in Kalimantan reaches 0.62, resulting in a natural population decrease. Therefore, the development of *C. striata* culture is one of the solutions to meet the supply of snakehead.

In general, aquaculture activities consist of several stages, namely: spawning, hatchery and enlargement nursery. Referring to Saputra (2018), the critical point in *C. striata* cultivation lies in the hatchery stage, starting from the larval-rearing phases, up to the juvenile-rearing phase. *C. striata* culture has encountered problems in providing

juvenile supply continuously. Like for other carnivorous fish, farmers still rely on the juvenile supply from nature. *C. striata* culture in controlled containers has not been widely practiced by farmers. This is due to the high mortality during the larval and juvenile stage of farmed snakehead (Hidayatullah et al 2015; Saputra et al 2018). In cultivating *C. striata* juvenile, the physical and chemical conditions of the environment have a strong effect on the physiological factors of the fish. The environmental factors, especially water quality parameters, that are different from their natural habitat result in juvenile mortality (Arifin et al 2018). This is in line with the results of a study conducted by Purnamawati et al (2019), stating that the high mortality of *C. striata* juveniles is caused by water quality. To reduce the mortality rate of snakeheads, water quality must be adjusted to the optimum conditions.

One of the water quality factors that cause the death of *C. striata* juvenile is the non-optimum pH concentration (Astria & Fitrani 2013). Naturally, *C. striata* juveniles can grow in water with low pH concentrations (Agustin et al 2014; Nisa & Fitrani 2013). Environmental conditions are an indicator of the ideal life for *C. striata* juveniles (Saputra & Samsudin 2017). Therefore, in *C. striata* rearing, the attention to the cultivation media, especially regarding the pH concentration, alkalinity and temperature can increase the survival and growth of the fish (Saputra 2018). The low water pH can result in acidosis, in which the pH of fish and shrimp blood decreases, resulting in a suboptimal function of blood as an oxygen carrier (Suwoyo 2011). Conversely, high pH values can have a lethal effect on cultured fish due to an increase in un-ionized ammonia (Qin et al 1997). The toxicity of low pH level was demonstrated in pond-cultured fish *Helostoma temminckii*, where mortality occurred at a pH of 3-5 (Arifin et al 2018). The toxicity of high pH occurred in rainbow kuromoi fish (*Melanotaenia parva*), causing mortality at a pH of 10.7 (Kadarini 2018). According to Courtenay & Williams (2004), pH tolerance ranges from 4.25 to 9.4. For adjusting the water quality parameters of the culture environment, especially the pH level, adding synthetic or organic (natural) chemicals is required. However, the use of natural ingredients would be better since they are environmentally friendly, safe for consumption, inexpensive, and available in nature.

Indian almond (*Terminalia catappa*, alias the Ketapang) leaves are a natural ingredient that functions to reduce the pH level in waters (Bryan 2017; Priyanto et al 2016). It is widely grown in Indonesia, its habitats being widely distributed in Southeast Asia (Tampemawa et al 2016). One of the benefits of these plants is that the leaves can be used to improve the water quality such as pH (Caruso et al 2013). The tannin content of *T. catappa* leaves can reduce the water acidity (Ikhwanuddin et al 2014). Several studies have been conducted using *T. catappa* leaves to improve the survival and growth performance of gourami (Setiawan et al 2019), goldfish (Aminah et al 2014), tilapia (Priyanto et al 2016), tetra fish (Nurhidayat et al 2016), betta fish (Waris et al 2018) and shrimp (Ikhwanuddin et al 2014).

Despite its interest, the topic of the use of *T. catappa* leaves to improve water quality is under-studied. *T. catappa* leaves can be used as an alternative solution for maintaining the pH of the water by adjusting the *C. striata* juvenile habitat for an optimal survival and growth performance. Therefore, the aim of this study was to increase the survival and growth performance of *C. striata* juvenile by determining the dosage of *T. catappa* leaf.

Material and Method

Experimental location. The research was carried out from August to September 2020 at the Multispecies Hatchery of Research and Development Installation for Environmental Technology and Toxicology of Freshwater Aquaculture and Fisheries Extension which is a unit of the Research Institute for Freshwater Aquaculture Research and Fisheries Extension (BRPBATPP), Bogor, West Java, Indonesia. The measurement of water quality was carried out at the Research and Development Installation for Environmental Technology and Toxicology of Freshwater Aquaculture. The proximate analysis of feed and fish was carried out at the Nutrition and Feed Technology Laboratory, BRPBATPP, Bogor, West Java, Indonesia. Fish blood profile analyzes were carried out at the Fish

Health Laboratory, Department of Aquaculture, Faculty of Fisheries and Marine Sciences, Bogor Agricultural University, West Java, Indonesia.

T. catappa source and preparation of powder. Fresh *T. catappa* leaves were collected in Bogor Regency, West Java, Indonesia, in dry conditions. The selected leaves were reddish yellow to brownish red. The leaves were cleaned and dried in the sun, then ground into powder (using a blender) and sieved. The powdered *T. catappa* leaves were then weighed and put into a non-woven paper teabag of 5.5 x 7 cm.

Experimental design. The current research was conducted using a completely randomized design (CRD). The treatments consisted of four dosages of *T. catappa* leaf powder: 0 g L^{-1} (control group), 0.25 g L^{-1}, 0.50 g L^{-1}, and 0.75 g L^{-1}, with three replications for each treatment.

Experimental fish. The fish used in this study were *C. striata* juveniles from spawning at the Freshwater Fisheries Germplasm Research Installation, Bogor, West Java, Indonesia. The snakehead juveniles had an average initial length of 7.77±0.01 cm and an average initial weight of 2.41±0.01 g.

Experimental tanks and mediums. The containers used were 12 fiber tanks with a diameter of 1.5 m. Each container was filled with 100 L of water that has been stored for 3 days. After the water was poured into the culture container, it was aerated and heated. *T. catappa* leaf powder that has been wrapped in tea bags was put into each container according to the dosage of treatment, then removed after 3 days. The container was covered with a net preventing the fish to escape from the container.

The rearing of the fish. The fish specimens were adapted to the new environmental conditions, in the laboratory. The adaptations were carried out in 4 fiber containers with a diameter of 2 m for 3 days. Then, the fish was acclimatized to the ambient temperature. The acclimatized snakehead juveniles were cultured in fiber containers with a stocking density of 2 fish L^{-1} (Hidayatullah et al 2015; Vivekanandan 1977). The culture of the experimental fish was carried out for 40 days. In all treatments, fish were given commercial feed with a protein content of approximately 40%, 2 times a day, at satiation. During the research, the containers were aerated continuously with no additional water.

The feeding rate and mortality (to calculate the fish survival) were recorded every day. Measurement of length and weight of fish was carried out at the beginning and end of the study to obtain data on the absolute length and weight growth. The physiological responses in the form of red blood cells, white blood cells, hemoglobin and hematocrit were measured at the end of the study. The measurement of water quality including the concentration of pH, temperature and dissolved oxygen was carried out every day, while the measurement of alkalinity ($CaCo_3$), ammonia (NH_3), nitrate (NO_3-), and nitrite (NO_2-) was performed once every 10 days.

Experimental parameters. In situ water quality parameters were measured, including pH level (with a pH meter) was used to, temperature (with a thermometer) and the dissolved oxygen (using a DO meter with an accuracy of 2 decimal places). Then ex-situ water quality parameters were measured, including alkalinity, ammonia, nitrate and nitrite. The sampling was carried out using a sample bottle which was then analyzed in the laboratory by referring to the APHA (2005) method. The proximate analysis of fish and feed was carried out according to the Takeuchi (1988) procedure. The measurement of red blood cells (erythrocytes) and white blood cells (leukocytes) used the Blaxhall & Daisley (1973) method, the hemoglobin measurement used the Sahli method, and the hematocrit levels measurement used the Anderson & Siwicki (1995) method. The survival refers to the ratio (percentage) of the final number of fish alive at the end of the study to the initial number of fish and it was calculated using the formula described by Goddard (2012) as follows:

$$SR = (N_t \times N_0^{-1}) \times 100$$

Where:
SR - survival rate (%);
N_t - number of fish at the end of the rearing (individual);
N_0 - number of fish at the beginning of the rearing (individual).

The specific growth rate (SGR) was calculated using the formula proposed by Lugert et al (2014) as follows:

$$SGR = [(\ln W_2 - \ln W_1)/t] \times 100$$

Where:
SGR - specific growth rate (% day^{-1});
W_1 - average weight of the fish at the beginning of the rearing (g);
W_2 - average weight of the fish at the end of the rearing (g);
t - rearing duration.

The absolute growth rate by length and weight were calculated using the formula proposed by Lugert et al (2014) as follows:

$$\Delta L = L_t - L_0; \Delta W = W_t - W_0$$

Where:
ΔL- absolute length growth (cm);
ΔW - absolute weight growth (g);
L_0 - initial length at the beginning of the rearing (cm);
L_t - final length at the end of the rearing (cm);
W_0 - initial weight at the beginning of the rearing (g);
W_t - final weight at the end of the rearing (g).

The feed conversion ratio (FCR) for snakehead juveniles was calculated using the formula proposed by Hertrampf & Piedad-Pascual (2012) as follows:

$$FCR = [F/((W_t + D) - W_0)] \times 100$$

Where:
FCR - feed conversion ratio;
F - amount of feed consumed (g dry weight);
W_0 - initial weight at the beginning of the rearing (g);
W_t - final weight at the end of the rearing (g);
D - the weight of dead fish during the rearing (g).

The protein efficiency ratio (PER) of snakehead juveniles was calculated using the formula proposed by Hertrampf & Piedad-Pascual (2012) as follows:

$$PER = [(W_t - W_0) \times Pi^{-1}] \times 100$$

Where:
PER - protein efficiency ratio (%);
W_0 - initial weight at the beginning of the rearing (g);
W_t - final weight at the end of the rearing (g);
Pi - total protein consumed (g).

Statistical analysis. The survival rate, SGR, absolute length and weight growth, feed conversion ratio, protein efficiency ratio and blood profile were analyzed through an analysis of variance (ANOVA) with a 95% confidence level. It was continued with the

Duncan Test to find a significant effect of the treatments. The physical and chemical parameters of water were interpreted descriptively.

Results and Discussion

Results. The physicochemical parameters such as water pH, temperature, dissolved oxygen, alkalinity, ammonia, nitrate and nitrite in each treatment, for the 40 days of *C. striata* juveniles rearing are presented in Table 1. The range of water quality in the culture medium varies in each given treatment. The range of water temperature and alkalinity of the control and experimental culture media did not differ. It was set to an optimal range for fish growth. The range of pH, dissolved oxygen, ammonia and nitrate for the growth of *C. striata* juveniles at various dosages of *T. catappa* leaf powder was significantly different. This can be seen from the lower pH of the media given *T. catappa* leaf powder compared to 0 g L^{-1} (control). The highest ammonia levels and the lowest dissolved oxygen were measured at the dosage of 0.75 g L^{-1} of *T. catappa* leaf powder, included in the tolerance range of water quality. The highest nitrate was found in the treatment of *T. catappa* leaf powder at the dosage of 0.5 g L^{-1} and 0.75 g L^{-1}.

As an indicator of the *C. striata* juvenile stress response, the hematological parameters of *C. striata* juveniles in each treatment varied. The number of red blood cells, white blood cells, hemoglobin and hematocrit increased with the increasing number of the treatment dosage.

The results of statistical calculations of the number of red blood cells, white blood cells, hemoglobin and hematocrit of *C. striata* juveniles showed a significant difference ($P<0.05$) at the dosage of 0.25 g L^{-1} and 0.50 g L^{-1} but they were not significantly different at a dosage of 0.75 g L^{-1} ($P>0.05$) (Table 2). The difference in the value of the hematological parameters of the cultured *C. striata* juveniles with different dosages of *T. catappa* leaf powder showed that the number of red blood cells, white blood cells, hemoglobin and hematocrit were influenced by the dosages of *T. catappa* leaf powder treatments($P<0.05$).

Biological performance data such as initial and final body weight, initial and final body length, specific growth rate, feed conversion ratio, absolute length and weight growth, and protein efficiency ratio are presented in Table 3. The weight and length of *C. striata* juveniles at the beginning of the study were 2.41 g and 7.77 cm, respectively in all treatments. The weight and length of *C. striata* juveniles showed differences between the treatments.

The quite significant difference ($P<0.05$) of the increases in *C. striata* juveniles were proportional with the dosage of *T. catappa* leaf powder although at a dosage of 0.75 g L^{-1} both weight and length experienced a decrease. The highest final weight and length of *C. striata* juveniles were obtained from the treatment with *T. catappa* leaf powder at the dosage of 0.50 g L^{-1}, followed by the dosages of 0.25 g L^{-1}, 0.75 g L^{-1} and 0 g L^{-1} (control group). This can be seen at the highest specific growth rate (SGR) obtained from the treatments with *T. catappa* leaf powder, at the dosages of 0.50 g L^{-1}, then 0.25 g L^{-1}, 0.75 g L^{-1} and 0 g L^{-1} (control group).

The lowest FCR was obtained from the treatment with *T. catappa* leaf powder at the dosages of 0.50 g L^{-1}, then of 0.75 g L^{-1}, 0.25 g L^{-1} and 0 g L^{-1} (control group). The highest protein efficiency ratio (PER) values were observed at the dosages of 0.50 g L^{-1} followed by a dosage of 0.75 g L^{-1}, 0.25 g L^{-1} and the smallest at 0 g L^{-1} (control group).

Table 1

The values of physico-chemical parameters of water in each treatment, for 40 days of *Channa striata* juveniles rearing

Parameters	*The dosage of Terminalia catappa leaf powder (g L^{-1})*				*Tolerance and optimal range*
	0 (control)	*0.25*	*0.50*	*0.75*	
pH	7.69-8.28	6.14-7.75	5.72-7.75	5.54-7.75	4.25-9.4 [*1)]
Temperature (°C)	28.70-31.30	28.70-30.50	28.90-31.30	28.80-31.30	26-32 [**1)]
Dissolved oxygen (mg L^{-1})	6.48-7.28	5.70-6.68	5.74-6.56	5.33-5.92	>5 [**1)]
Alkalinity (mg L^{-1})	85.43-97.63	79.33-97.63	79.33-97.63	79.33-97.63	20-150 [*3)]
Ammonia (mg L^{-1})	0.0181-0.0223	0.0189-0.0226	0.0236-0.0400	0.0189-0.0400	≤1.57 [*4)]
Nitrate (mg L^{-1})	4.8381-6.0171	5.2461-6.1861	6.2521-7.2941	5.8511-7.2941	0.2-10 [*2)]
Nitrite (mg L^{-1})	0.0111-0.0131	0.0121-0.0141	0.0141-0.0161	0.0121-0.0141	<0.1 [*2)]

[1)]Courtenay & Williams (2004); [2)]Boyd (1998); [3)]Wedemeyer (1996); [4)]Qin et al (1997); [*)] Tolerance range; [**)] Optimal range.

Table 2

The hematological parameters of the cultured *Channa striata* juveniles with different dosages of *Terminalia catappa* leaf powder for 40 days of *Channa striata* juveniles rearing

Parameter	*Terminalia catappa leaf powder dosages (g L^{-1})*			
	0 (control)	*0.25*	*0.50*	*0.75*
Red blood cells count (x10^5 cell mm^{-3})	21.25±0.50^a	25.70±1.56^b	25.95±2.20^b	19.20±1.13^a
White blood cells count (x10^5 cell mm^{-3})	0.86±0.08^a	0.94±0.07^b	0.95±0.06^b	0.76±0.03^a
Hemoglobin (%)	6.70±0.14^b	7.50±0.42^c	7.50±0.28^c	5.70±0.14^a
Hematocrit (%)	22.05±0.21^a	25.08±1.98^b	25.35±0.50^b	21.70±1.56^a

Different superscript letters on the same row indicates significantly different results (P <0.05).

Table 3

Biological performances of *Channa striata* juveniles at different dosages of *Terminalia catappa* leaf powder for 40 days of *Channa striata* juveniles rearing

Parameters	*Dosages of Terminalia catappa leaf powder (g L^{-1})*			
	0 (control)	*0.25*	*0.50*	*0.75*
Initial body weight (g)	2.41 ± 0.01^{a}	2.41 ± 0.01^{a}	2.41 ± 0.01^{a}	2.41 ± 0.01^{a}
Final body Weight (g)	6.43 ± 0.11^{a}	8.74 ± 0.23^{b}	9.37 ± 0.26^{c}	8.22 ± 0.36^{b}
Initial body length (cm)	7.77 ± 0.01^{a}	7.77 ± 0.01^{a}	7.77 ± 0.01^{a}	7.77 ± 0.01^{a}
Final body length (cm)	9.45 ± 0.06^{a}	10.92 ± 0.18^{bc}	11.17 ± 0.34^{c}	10.70 ± 0.20^{b}
Specific growth rate (% day^{-1})	10.06 ± 0.29^{a}	15.82 ± 0.57^{b}	17.40 ± 0.65^{c}	14.52 ± 0.88^{b}
Feed conversion ratio	1.86 ± 0.09^{d}	1.54 ± 0.12^{c}	1.07 ± 0.04^{a}	1.27 ± 0.08^{b}
Absolute length growth (cm)	0.84 ± 0.30^{a}	1.58 ± 0.09^{bc}	1.70 ± 0.17^{c}	1.47 ± 0.10^{b}
Absolute weight growth (g)	4.02 ± 0.11^{a}	5.81 ± 0.92^{b}	6.96 ± 0.26^{c}	5.81 ± 0.36^{b}
Protein Efficiency ratio (%)	0.54 ± 0.03^{a}	0.65 ± 0.05^{b}	0.93 ± 0.04^{d}	0.79 ± 0.06^{c}

Different superscript letters in the same row indicate significantly different results ($P<0.05$).

The percentage of *C. striata* juvenile survival rate is presented in Figure 1.The effects of *T. catappa* leaf powder dosages on the *C. striata* juvenile survival rate showed significant differences ($P<0.05$). The highest survival rate was obtained at a dosage of 0.50 g L^{-1} (85.67%), followed by 0.75 g L^{-1} (78.00%), 0.25 g L^{-1} (61.00%) and by the control group with a dosage of 0 g L^{-1} (54.33%).

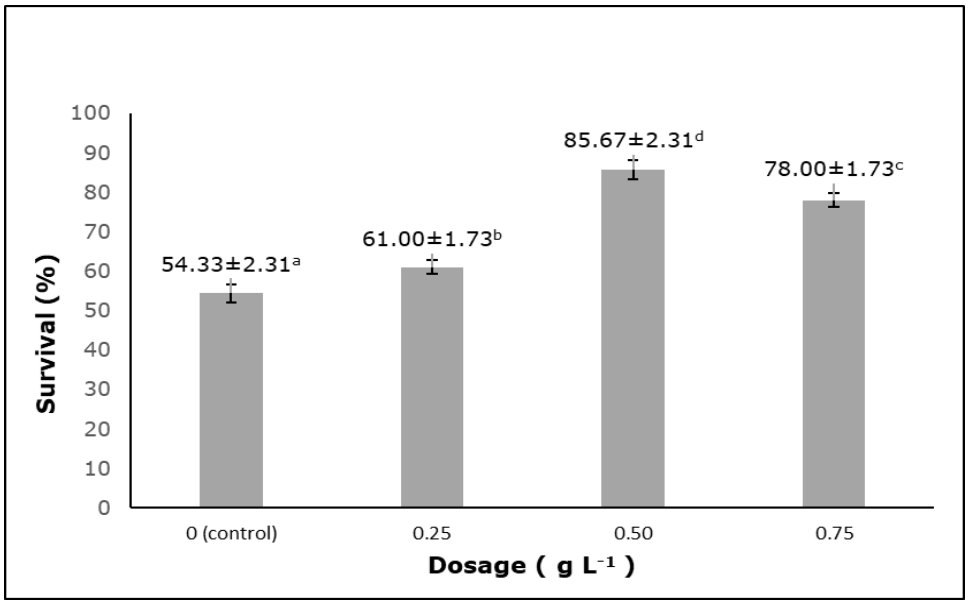

Figure 1. *Channa striata* juvenile survival rate with different dosages of *Terminalia catappa* leaf powder.

Discussion. The survival rate and growth performance of *C. striata* juveniles are largely determined by environmental factors (Puspaningsih et al 2019; Vahira et al 2020). A higher dosage of *T. catappa* leaf powder affected the water quality parameters resulting in a decrease of the pH. This is in line with research conducted by Chansue & Assawawongkasem (2011), stating that dried *T catappa* leaves can affect the water quality by reducing the pH of the water. The decreased pH was caused by the tannin content in the *T. catappa* leaves (Sung & Abol-Munafi 2019) and the the pH level ranging between 5.54 and 7.75 (with the treatment) was within the tolerance range of 4.25-9.4 for the *C. striata* juvenile culture (Courtenay & Williams 2004).

Alkalinity has a role as a water quality parameter, since it buffers against rapid pH changes. Alkalinity during the study ranged from 79.33-97.63 mg L^{-1} and its values were included in the appropriate range for preventing drastic changes in pH. Wedemeyer

(1996) stated that alkalinity tolerance in aquaculture ranges from 20-150 mg L^{-1}. Oxygen is needed for the survival of an organism, being involved in the respiration and metabolism processes. The results of this study showed the dissolved oxygen differences between the treatment and the control groups. The higher the dosage of *T. catappa* leaf powder, the lower the dissolved oxygen in the culture container. This is because the tannins in *T. catappa* leaf powder can reduce the dissolved oxygen content in water (Earl et al 2015). However, according to Courtenay & Williams (2004), a good oxygen content for supporting the growth of snakehead juveniles is more than 5 mg L^{-1}. Thus, the dissolved oxygen content in the culture media was in the optimum range. The temperature ranges obtained during the treatment were between 28.70°C and 31.30°C that are still considered optimal (Courtenay & Williams 2004). According to Saputra (2018), appropriate water temperatures will influence the metabolic rate of snakehead larvae so that they can grow and develop optimally. The concentrations of ammonia, nitrate and nitrite measured in this study were still within the tolerance range of water quality for *C. striata* juvenile rearing. The tolerance limit for ammonia concentration according to Qin et al (1997) is 1.57 mg L^{-1}. Meanwhile, Boyd (1998) stated that the tolerance limit for nitrite concentrations in aquaculture ponds is less than 0.1 mg L^{-1} and for nitrate concentrations it is between 0.2 and 10 mg L^{-1}. *C. striata* juveniles grow and develop naturally in waters with low pH (Agustin et al 2014; Nisa & Fitrani 2013). In addition, the optimum alkalinity level and temperature will make *C. striata* juveniles grow and develop optimally.

The treatment of *T. catappa* leaf powder can increase the survival rate and growth performance of *C. striata* juveniles. Based on the results of the study, the best survival rate of *C. striata* juveniles was obtained from the treatment of *T. catappa* leaf powder at a dosage of 0.50 g L^{-1} (85.67%), compared to a dosage of 0.75 g L^{-1} (78%) and to a dosage of 0.25 g L^{-1} (61%), as well as to the control group at 0 g L^{-1} (53.33%) as shown in Figure 1. The absolute fish juveniles' growths in length and weight have a positive correlation. This is in line with the research result conducted by Saputra et al (2018), stating that the relationship between the weight and length of *C. striata* is linear. The best growth in length and absolute weight were obtained from the treatment of *T. catappa* leaf powder at a dosage of 0.50 g L^{-1}, namely 1.70 cm and 6.96 g, respectively. According to the research conducted by Nurhidayat et al (2016), the treatment of *T. catappa* leaves at a dosage of 0.50 g L^{-1} given to Tetra fish juveniles can increase their absolute length by 1.28 cm and absolute weight by 0.092 g, with a 100% survival rate. At the daily specific growth rate, the treatment of *T. catappa* leaf powder with a dosage of 0.50 g L^{-1} can increase the growth of *C. striata* fish juveniles by 17.40% day^{-1} compared to the control treatment of 0 g L^{-1} with a growth of 10.06 % day^{-1}. The FCR in this study showed a significant difference ($P<0.05$) between treatments. The results showed that the best FCR value, of 1.07, was obtained in the treatment at a dosage of 0.50 g L^{-1} and the highest, of 1.86, was observed in the control treatment of 0 g L^{-1}. The FCR value is linear with the value of PER where the best use of protein in feed was obtained in the treatment at the dosage of 0.50 g L^{-1} (0.93%) and the lowest was in the control treatment, at the dosage of 0 g L^{-1} (0.54%).

Based on the survival rate and growth performance of the snakehead juveniles, the treatment with *T. catappa* leaf powder provided them the required comfort. This was also proven by testing the hematological parameters of *C. striata* juveniles. Hematological parameters are diagnostic indicators to monitor the health status of fish against changes related to nutrition, water quality and disease (Fazio 2019). According to Barton (2002), hematological parameters such as red blood cell count, white blood cell count, hemoglobin and hematocrit are very important in providing information on the status of physiological conditions and secondary responses to stress.

This study showed that the number of red blood cells in the control treatment ($21.25x10^5$ cell mm^{-3}) and in the treatment at a dosage of 0.75 g L^{-1} ($19.20x10^5$ cell mm^{-3}) was lower than at the dosages of 0.25 g L^{-1} ($25.70x10^5$ cell mm^{-3}) and 0.50 g L^{-1} ($25.95x10^5$ cell mm^{-3}). Red blood cells are very important in distributing oxygen and nutrients to all fish body tissues. According Wahyu et al (2017), the normal range of average number of red blood cells in snakehead is 19.80 x 10^5 cell mm^{-3}. The lack of red

blood cells can result in abnormal physiological processes of an organism such as anemia (Shen et al 2018).

The number of white blood cells is used as an indicator of the body's defense system in fish (Roberts 2012). The number of white blood cells in the treatment with *T. catappa* leaf powder at the dosages of 0.25 g L^{-1} ($0.94x10^5$ cell mm^{-3}) and 0.50 g L^{-1} ($0.95x10^5$ cell mm^{-3}) were higher than at the dosage of 0.75 g L^{-1} ($0.76x10^5$ cell mm^{-3}) and in the control group ($0.86x10^5$ cell mm^{-3}). This high level of white blood cells was due to an increase of the immunity in fish, caused by flavonoids from *T. catappa* leaf powder. Flavonoids in *T. catappa* leaves can be biocatalysts of the white blood cells production, increasing the non-specific immunity of fish (Nugroho et al 2016).

Hemoglobin parameter in fish blood is a protein in red blood cells. Low hemoglobin causes the fish to develop anemia. A sign of anemia is when fish are hanging at the water surface with weak movements. Hemoglobin's function is to transport oxygen in the blood. The ability to carry oxygen depends on the hemoglobin concentration in red blood cells. Based on the results of the study, the treatments showed significant differences in hemoglobin levels. The lowest hemoglobin level was seen in the treatment of 0.75 g L^{-1} (5.70%), while the highest was of 7.50%, in the treatments at the dosages of 0.25 g L^{-1} and 0.50 g L^{-1}. High hemoglobin levels indicate that the fish had enough oxygen in the blood so that there is no metabolic disorder (Purnamawati et al 2017). The high availability of oxygen in the blood without metabolic disorders makes the fish healthier.

The next hematological parameter is the hematocrit, the percentage of erythrocytes volume in fish blood. Hematocrit parameter values can be used to determine the physiological conditions of fish. The results showed that there were differences in the levels of hematocrit in each treatment. The lowest level of hematocrit was found in the treatment at a dosage of 0.75 g L^{-1} (21.70%) and in the control group (22.05%), while the highest was found in the treatments at the dosages of 0.25 g L^{-1} (25.08%) and 0.50 g L^{-1} (25.35%). The hematocrit levels are directly proportional to the number of red blood cells. Normally, the hematocrit level of snakehead can reach 21.2% (Wahyu et al 2017). The incompatibility of environmental conditions and the environmental pollution will cause the hematocrit value to decrease due to the stress response in fish.

Conclusions. Based on the results of the study, the maximum survival rate and the optimal growth performance of *C. striata* juveniles were obtained using a dosage of *T. catappa* leaf powder of 0.50 g L^{-1}. The results of statistical analysis showed that the use of *T. catappa* leaf powder at the dosage of 0.50 g L^{-1} had the highest survival rate (86.67%) with the specific growth rate of 17.40% day^{-1}. Optimality of this dosage is proven by the value of the hematological parameters which suggest a healthy status of the *C. striata* juveniles. The physico-chemical parameter values at this dosage were within the tolerance range.

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Authors:
Firman Pra Setia Nugraha, Jakarta Technical University of Fisheries, Study Program of Fisheries Resources Utilization, 12520 South Jakarta, Indonesia, e-mail: firmanpsnugraha@gmail.com
Sinung Rahardjo, Jakarta Technical University of Fisheries, Study Program of Fishery Resource Utilization, 12520 South Jakarta, Indonesia, e-mail: snngrahardjo@gmail.com
Adang Saputra, Institute for Freshwater Aquaculture Research and Fisheries Extension, Jalan Sempur No. 1 Bogor, 16151 West Java, Indonesia, e-mail: adang_pusrisdkp@yahoo.com

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