Effects of herbal growth promoters on common carp (*Cyprinus carpio*)

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Abstract. The common carp (*Cyprinus carpio*) is the most widely farmed freshwater fish in the world. Various aspects of cultivation continue to be developed to create an improved aquaculture business. Increasing fish growth and improving feed conversion efficiency are part of the popular topics, and the addition of herbal growth promoters to the diet is one of the promising approaches. This study aimed to determine the effect of adding mango leaves (*Mangifera indica*), guava leaves (*Psidium guajava*), and noni leaves (*Morinda citrifolia*) as growth promoters for carp. The method used was an experimental method using a 1-factor completely randomized design (addition of a growth promoter to commercial feed) with 4 treatment levels and 3 replications. The treatment levels were: T0 - commercial pellets without growth promoter (experimental control); T1 - mango leaves at a dose of 1.5 g 100 g^{-1} commercial feed; T2 - guava leaves at a dose of 1.5 g 100 g^{-1} commercial feed; T3 - noni leaves dosage of 1.5 g 100 g^{-1} commercial feed. Fish rearing was carried out in 12 units of floating net cages measuring 2x2x1 m. The density of fish per cage was 25 fish m^{-3}. The standard and formulated feeds were administered as much as 5% of body weight every day. Fish were maintained for 2 months, measuring length and weight every 10 days. The results showed that the herbal growth promoter of guava leaf (T2) showed the best effect, with an absolute weight growth of 69.67 g, specific growth rate of 2.90%, feed efficiency of 83.54% and feed conversion ratio of 1.14. It was followed by treatments T3, T1 and T0. This study recommends the addition of guava leaves into common carp feeds at a dose of 1.5 g 100 g^{-1} to increase growth rate and improve feed conversion ratio for carp culture.

Key Words: feed efficiency, herbal supplement, guava, mango, noni.

Introduction. Carp (*Cyprinus carpio*) is known as a freshwater fish, although recently it was discovered that it is also able to live in brackish water up to 15% salinity (Salati et al 2011; Singh et al 2018). This fish is widely cultivated in Asian countries and some European countries. China is the largest producer, with 70% of the world carp production (FAO 2019). In Indonesia, common carp started to be cultivated around the 1920s. Intensive monoculture production based on artificial feed can be carried out in cages, irrigation reservoirs, and ponds and running water tanks, or in recirculation systems. Its adaptability to the environment is relatively good, maintenance is easy, it can eat commercial feed, the maintenance cycle is relatively short, the taste of meat is preferred and the price is affordable (Khan et al 2016). Common carp is considered as a very important cultivated fish species in Indonesia. Raising common carp on a large scale is a lucrative business opportunity. Market demand for this fish continues to increase yearly. They can be produced in large quantities and in a short period of time (FAO 2019).

Medicinal plants have been reported to increase the growth of cultured fish. They increased digestive enzymes, thereby increasing the survival and growth of aquatic animals. *Spirulina platensis* in fish diet improved the growth of stellate sturgeon *Acipenser stellatus* (Salehi-Farsani et al 2014). Traditional Chinese medicine has a beneficial effect on the growth of carp (Jian & Wu 2004). Apines-Amar et al (2013) reported the benefits of dietary onion and ginger in promoting growth in brown marbled grouper, *Epinephelus fuscoguttatus*. Three herbs (*Alteranthera sessilis, Eclipta alba* and *Cissus quadrangularis*) have astringent effects and increase the activity of digestive enzymes (protease, amylase and lipase) in freshwater shrimp. This leads to increased feed utilization and ultimately to better growth rates, indicated by evidence of increased concentrations of vitamins, proteins, essential amino acids, unsaturated fatty acids and minerals. The content of vitamins C and E in the hepatopancreas as well as the content of sodium and potassium, and muscle in freshwater shrimp increased when the shrimp were fed herbal supplements (Radhakrishnan et al 2014).

Green tea, caraway seed and American ginseng increase the growth rate and feed utilization of tilapia, *Orechromis niloticus* (Abdel-Tawwab et al 2010; Ahmad & Abdel-Tawwab 2011; Abdel-Tawwab 2012). Papain enzyme-enriched diet improved feed efficiency and growth of fingerlings of Sangkuriang catfish, *Clarias gariepinus* (Rachmawati et al 2019). Fennel seed flour improves the growth performance and feed utilization in tilapia (Ahmad & Abdel-Tawwab 2011). Caffeine increases the growth of *Sparus aurata* at concentrations greater than 0.1% in feed (Chatzifotis et al 2008). Mixing the herbs Massa Medicata Fermentata, *Crataegi fructus, Artemisia capillary* and *Cnidium officinale* increased the growth and utilization of fatty acids in Japanese flounder, *Paralichthys olivaceus* (Ji et al 2007). *Quillaja saponins* has the ability to increase the growth rate and decrease the metabolic rate of tilapia (Francis et al 2005).

Mango (*Mangifera indica*), guava (*Psidium guajava*) and noni (*Morinda citrifolia*) are tropical plants that are widely grown everywhere, both cared for and free-growing in nature. In addition to the fruit, the leaves, bark, roots and other parts have also been used as medicinal supplements, including for fisheries needs. This study aimed to determine the effect of mango, noni, and guava leaves as growth promoters, to increase the growth performance of common carp.

Material and Method

Time and place of the study. This research was carried out from August to October 2021. Fish rearing was carried out at the floating net cage cultivation center in the Koto Panjang Hydroelectric Power Plant Reservoir, Kampar, Indonesia.

Materials*.* The fish tested were carp (*Cyprinus carpio*) with an average length of 10 cm and a weight of 15 g, purchased from local farmer. Before starting the experiment, the fish were aclimatized for 7 days. Commercial fish pellets Hi-Pro-Vite 781-2 produced by PT Central Panganpertiwi Tbk., Karawang, West Java, Indonesia, were used in this study. The growth-stimulating herbal ingredients were mango, guava and noni leaves, which grew around the Riau University Campus, Pekanbaru, Indonesia. Proximate analysis was carried out based on Ahmed et al (2013) and growth promoter phytochemical analysis was carried out according to Syawal et al (2021).

Preparation of fish feed. Growth promoter materials (guava, noni, and mango leaves) were collected and dried in the room at room temperature (±7 days). After drying, the leaves were mashed using a blender and sifted to get a fine leaf powder. Furthermore, 1.5 g of each leaf flour was added and mixed in 100 g of commercial pellets, and stirred homogeneously. The feed mix was milled and pelleted according to the size of the fish mouth opening and dried in the sun for 3-4 days at a temperature of 30-35^{o}C.

Research methodology. This experiment used a 1-factor completely randomized design (addition of a growth promoter to commercial feed) with 4 treatment levels and 3 replications. The treatments were: T0 - commercial pellets without growth promoter (experimental control); T1 - mango leaves at a dose of 1.5 g 100 g^{-1} commercial feed; T2 - guava leaves at a dose of 1.5 g 100 g^{-1} commercial feed; T3 - noni leaves dosage of 1.5 g 100 g^{-1} commercial feed. Fish rearing was carried out in 12 units of floating net cages measuring 2x2x1 m. The density of fish per cage was 25 fish m^{-3}. The formulated feeds were fed to fish as much as 5% of body weight daily. Fish were kept for 2 months, with weight measurements every 10 days.

Absolut growth rate. The absolute growth rate was calculated using the following formula:

$$AGR = Wt - Wo$$

Where: AGR - absolute growth rate (g); Wt - average weight of fish at the end of the study (g); Wo - average weight of the fish at the beginning of the study (g).

Specific growth rate. The specific growth rate is calculated using the formula:

$$SGR = \frac{Ln\ Wt - Ln\ Wo}{t} \times 100$$

Where: SGR - daily growth rate (% day^{-1}); Wt - weight of fish at the end of the study (g); Wo - weight of fish at the beginning of the study (g); T - length of study (days).

Feed conversion rate. Feed conversion was calculated using the following formula:

$$FCR = \frac{\Sigma F}{(Bt + Bm) - Bo}$$

Where: FCR - feed conversion rate; ΣF - amount of feed given during rearing (g); Bt - fish biomass at the end of rearing (g); Bo - fish biomass at the start of rearing (g); Bm - dead fish biomass during rearing (g).

Feed efficiency. Feed efficiency was calculated using the following formula:

$$FE = \frac{((Bt+Bd)-Bo)}{F} \times 100$$

Where: FE - feed efficiency; ΣF - amount of feed given during rearing (g); Bt - fish biomass at the end of rearing (g); Bd - biomass of fish that died during the study (g); Bo - fish biomass at the start of rearing (g).

Data analysis. Data obtained from physiological measurements were collected and tabulated. They were analyzed statistically using the SPSS version 23 software. The data were analyzed by using one way ANOVA at a 95% confidence level. The Student Newman Keuls test was used when differences were observed.

Water quality. The water quality parameters measured were temperature, pH, dissolved oxygen and ammonia by using a Horiba U-52G-2 Multi-Parameter Water Quality Meter and DLAB Spectrophotometer SP-V1100. Measurements were collected in the afternoon every 10 days during the study.

Results and Discussion

Proximate analysis. The results of the proximate analysis of commercial feed and growth promoter ingredients were normal (Table 1).

Table 1

Proximate analysis of the feed containing the herbal growth promoters

Treatment	*Protein (%)*	*Fat (%)*	*Crude fiber (%)*	*Water (%)*
Commercial pellets (T0)	31.00	6.00	5.00	10
Mango leaves (T1)	30.97	9.53	6.07	9.25
Guava leaves (T2)	31.27	8.79	7.73	9.12
Noni leaves (T3)	31.44	10.66	5.70	9.84

Water quality. Water quality during the study was in a range adequate to the growth of carp in the Koto Panjang Hydroelectric Power Station reservoir. Water temperature ranged from 28 to 31°C, pH was between 6.4-6.9, and ammonia between 0.0015-0.0018 mg L^{-1}. The optimal temperature for carp growth in the region is 28-32°C and pH between 6.4-7 (Budijono et al 2021). From this data, it can be concluded that the quality of the water used to keep the fish was in normal conditions.

Growth performance. Feeds containing growth promoters had a significant effect (p< 0.05%) on absolute growth rate, specific growth rate, feed efficiency and feed conversion rate. The absolute growth rate ranged from 37.8 to 69.67 g. T2 provided the best AGR (69.67 g), while the lowest was observed in T0 (37.8 g). The best specific growth rate was also recorded in T2 (2.9%), followed by T3 (2.70%), T1 (2.45%) and finally T0 (2.12%). Feed efficiency ranged from 62.98 to 83.54%, with the highest value noted in T2 (83.54%), followed by T3 (82.01%), T1 (71.13%) and finally T0 (62.98%). A similar pattern was also recorded in the variable feed conversion ratio. The lowest feed conversion ratio was recorded in T2 (1.14), followed by T3 (1.15), T1 (1.31) and finally T0 (1.43). More detailed data are presented in Table 2.

Table 2

Absolute growth rate, specific growth rate, feed efficiency and feed conversion rate of carp (*C. carpio*)

Experimental treatments	*Absolut growth rate (g)*	*Specific growth rate (% day^{-1})*	*Feed efficiency (%)*	*Feed conversion*
T0	37.8±0.9^{a}	2.12±0.03^{a}	62.98±1.84^{a}	1.43±0.02^{c}
T1	49.37±1.56^{b}	2.45±0.04^{b}	71.13±1.69^{b}	1.31±0.03^{b}
T2	69.67±1.76^{d}	2.9±0.03^{d}	83.54±1.62^{c}	1.14±0.02^{a}
T3	59.9±3.34^{c}	2.7±0.08^{c}	82.01±2.17^{c}	1.15±0.01^{a}

Note: superscripts on the same row show significant differences (p<0.05).

The results of statistical analysis showed that the addition of herbal growth promoters to the feed was able to increase the growth of carp significantly (p<0.05). Guava leaves (T2) gave the best results in the growth of common carp, with an absolute weight of 69.67 g, specific growth rate of 2.9% day^{-1}, feed efficiency of 83%, and a FCR of 1.14. The lowest effect was found in the treatment without the addition of herbal growth promoter (T0), namely absolute weight, specific growth rate, feed efficiency, and FCR of 37.8 g, 2.12% day^{-1}, 62.98%, and 1.43, respectively (Figure 1).

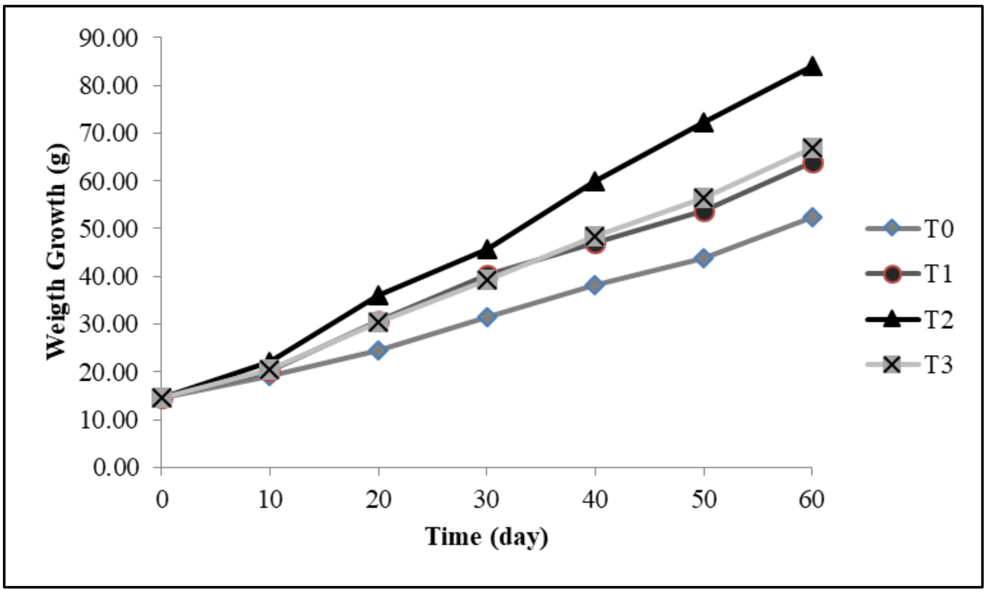

Figure 1. Carp (*C. carpio*) weight growth during the study.

The addition of mango leaves, guava and noni leaves as growth promoters caused a positive effect on the growth of carp. Some researchers have reported that a number of plants increased fish growth. For example, mango leaves increased the growth of carp and tilapia (Achioye-Nzeh & Obaroh 2010; Obasa et al 2013; Fawole et al 2018; Amulejoye et al 2020), noni leaves improved tilapia development (Kristiana et al 2020), mango leaves improved growth in rainbow trout (Awad & Austin 2010). Noni also helped the growth of African catfish (Azizah et al 2020), and guava leaves the development of tilapia (Abdel-Tawwab & Hamed 2020; Ceballos-Francisco et al 2020; Omitoyin et al 2020), striped catfish (*Pangasianodon hypophthalmus*) (Nhu et al 2020) and common carp (Hoseinifar et al 2019).

The addition of guava in feed increased feed efficiency and decreased FCR for the 60 days of rearing. The content of secondary metabolite compounds from guava such as saponins, phenols, and tannins can increase the growth and appetite of fish, as well as the absorption of nutrients. According to Das et al (2012), saponins function as permeabilizing membranes and can affect growth and increase animal feeding responses. According to Omitoyin et al (2019), phenols, tannins, and saponins from guava stimulate the secretion of digestive enzymes, thereby affecting the growth and absorption of nutrients by fish. The impact obtained in this study is better than that reported by Omitoyin et al (2019). It was reported that tilapia reared for 84 days, fed a diet containing guava leaf herbal growth promoter (a dose of 0.75%), resulted in a growth of 4.76 g of tilapia.

The guava leaves were also able to increase the specific growth rate of carp by 2.9%. This result was better than the research of Omitoyin et al (2019), where the specific growth rate of tilapia fed a diet containing herbal medicine at a dose of 0.50% resulted in a specific growth rate of 1.56%. This is presumably due to several things, including the proximate levels of guava leaf protein.

Guava leaves also contain essential oils (Olusola & Olorunfemi 2017; Sobral-Souza et al 2019), which improve feed quality, productivity, and health. Essential oils mixed with feed can stimulate the central nervous system, which ultimately results in an increase in appetite and consumption of nutrients. The presence of essential oils can stimulate the production of digestive juices that produce a suitable pH for digestive enzymes, such as peptinase (Weli et al 2018). At the same time, there is an increase in the activity of digestive enzymes, the real effect of this mechanism being the improvement of energy conversion and digestion of food substances and a positive influence on the metabolism of nitrogen, amino acids and glucose (Lin et al 2006; Yu et al 2009).

The higher feed efficiency or the lower FCR indicate the more efficient use of feed. The values of feed efficiency and FCR are closely related to the growth rate, because a greater weight gain of fish comes with an increase of the feed conversion (Fry et al 2018; Abdel-Rahim et al 2019).

Conclusions. The results showed that the addition of the herbal growth promoters from mango, guava and noni leaves to the commercial fish feed had a positive effect on the growth of common carp. Guava leaves showed better results in terms of absolute growth rate, specific growth rate, feed efficiency and feed conversion ratio. Therefore, it can be recommended to add guava leaves to feeds up to 1.5 g 100 g^{-1} feed.

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Conflict of Interest. The authors declare that there is no conflict of interest.

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