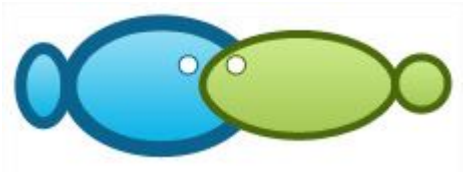

Growth performance and flesh quality of common carp, *Cyprinus carpio* feeding on the diet supplemented with cinnamon (*Cinnamomum burmannii*) leaf

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Abstract. This research was conducted in order to evaluate the effect of the diet supplemented with cinnamon (*Cinnamomun burmanni*) leaf on the growth performance and flesh quality of common carp (*Cyprinus carpio*). A triplicate experiment was conducted using fish with an initial body weight of 7.9±1.41 g. Ten fish were introduced into an aquaria with the size of 50 x 40 x 35 cm, and cultured for 37 days. Fish were fed on the diet containing either 0%, 0.25%, 0.5%, 0.75%, or 1% cinnamon leaf, respectively. The results showed that feeding on the diets supplemented with cinnamon leaf from 0% to 1% insignificantly affected the growth and survival rate of fish. However, feeding on the diet supplemented with cinnamon leaf reduced feed efficiency. Further more the total lipid of fish decreased linearly when fish fed on the diet supplemented with cinnamon leaf from 0% to 1%. On the other hand, flesh flavour and texture of fish were affected by the cinnamon leaf diet. The flesh of fish fed on the diet supplemented with 0.75% and 1% of cinnamon leaf were more compact and sweeter than others. Therefore, the optimal dose of supplementation cinnamon leaf into the diet was 0.75% due to its effect on flesh quality, e.g. flavour and texture of fish.
Key words: cinnamon, *Cinnamomun burmanni*, carp, growth.

Introduction. Currently, consumers began demanding aquaculture products with the quality and flavor according to their taste (Ogundari 2012). It was informed that in Kerinci, Jambi, some farmers have added cinnamon leaf (*Cinnamomum burmannii*) into commercial diet to get a sweeter taste of carp flesh to meet the preference of local consumers. However, there have never been any study on the level of cinnamon leaf content that should be incorporated into the formulated diet to produce a sweeter taste in the flesh of carp, *Cyprinus carpio* Linnaeus, 1758.

It is known that cinnamon bark is processed to produce essential oils, as well as utilized in the pharmaceutical industry, cosmetics, food, beverages, cigarettes, and so on (Sangal 2011). Cinnamon leaf is a waste of cinnamon utilization for industrial use, which only utilize the cinnamon bark. Even though it is not commonly used, cinnamon leaf has the same chemical character with cinnamon bark (Singh et al 2007). According to Thomas & Duethi (2001), cinnamon contains 10-12% ethanol extract and essential oil of 2.4%, whereas cinnamon leaf contains essential oils of 1.12% (Rusli & Abdullah 1988). Essential oil has a sweet taste and a yellow colour (Ardani et al 2010). Wang et al (2009) reported that the essential oil of cinnamon leaf contains trans-cinnamaldehyde (60.72%), eugenol (17.62%) and coumarin (13.39%). While Azima (2004) reported that cinnamon also contains anti-nutrients such as tannins, calcium oxalate, resin, and tanners.

The benefits of cinnamon and essential oils have been widely studied. The consumption of 6 g cinnamon lowers the rate of gastric emptying and lowering blood glucose levels after meals in human (Hlebowicz et al 2009). On the other hand, cinnamon also improves the function of insulin receptor by activating PI 3-kinase insulin receptor and inhibits the tyrosine phosphate (Hlebowicz et al 2007). The lower blood sugar was suspected due to the more efficient transport of blood sugar to the cell as an energy source, which can inhibit lipogenesis process, thereby reducing levels of fat in the body.

Cinnamon extract shows its potential as an anti-hypercholesterolemia due to its capability to reduce levels of total cholesterol, lowering LDL cholesterol, raise HDL cholesterol levels, and lowering triglyceride levels, also suppress fat accumulation in the liver of rabbit (Azima 2004). Based on the overall stated above, this study was designed to evaluate the addition of cinnamon leaf into the diet on growth performance and flesh quality of *C. carpio*.

Material and Method. To determine the content of the extract of cinnamon leaf, leaves were macerated in 96% ethanol at a ratio of 1:10 (w/v) following the procedure adopted by Prasad et al (2009). Cinnamon leaf extract obtained was approximately 12%. Cinnamon leaf used in this study has the following proximate composition: the water content of 7.15%, ash of 3.67%, 10.60% protein, 5.34% fat, crude fiber 24.80%, and extract materials without nitrogen (BETN) amounted to 48.74%. Anti-nutritive substance to be analyzed was tannin, with the levels of 771.5 mg kg^{-1}. Experiment was carried out in March-April 2012.

Test diet. The diet used in this study was a commercial diet mixed with cinnamon leaf at different levels. The treatment used was the addition of cinnamon leaves at either 0% (control), 0.25%, 0.5%, 0.75%, and 1% in the diet.

Cinnamon leaf was dried in an oven with a temperature of 70°C, then pulverized to form a powder. The mixing of cinnamon leaf into diet was as follows: commercial diet was milled until smooth, then cinnamon leaf flour was added according to the treatment procedure, and sago was added as a binder at 3%. All the ingredients were mixed evenly and molded into a 2 mm diameter dry pellet. Proximate result of the test diet is shown in Table 1.

Table 1

Proximate analysis of the diet (% dry base)

Nutrient	*Cinnamon leaf (%)*				
	0	*0.25*	*0.5*	*0.75*	*1.0*
Protein	33.38	32.55	32.45	32.24	32.14
Lipid	7.94	7.18	7.20	7.22	7.25
Fibre	4.29	4.44	4.55	4.62	4.75
Ash	11.02	10.70	10.61	10.69	11.52
NFE[1]	43.36	45.11	45.18	45.21	45.17
GE[2] (kcal kg^{-1})	439.4	434.8	434.7	433.9	433.4

[1]NFE: nitrogen free extract; [2]GE = gross energy (Watanabe 1988); 1 g protein = 5.6 kcal, 1 g NFE = 4.1 kcal, 1 g lipid = 9.4 kcal.

Fish rearing. The fish used in this study was *C. carpio* with innitial size of 7.9±1.41 g, from local hatchery (Bogor, Indonesia). The fish were distributed into 15 aquarium of 50 x 40 x 35 cm that assembled into a recirculation system. Ten fish were stocked in each aquarium and reared for 37 days. During culture period, the fish were fed on the diet at satiation three times per day around 08:00, 12:00, and 16:00. The amount of feed intake was recorded to determine the value of the feed efficiency at the end of the study. On day 37, the fish was harvested and weighed to determine the individual body weight.

To maintain good water quality, syphoning was done every day, removing the feces and other debris, followed by the replacement of 20% of the volume of water. A

water heater with the capacity of 350 watts was installed in the water reservoir so that the temperature of the water in the aquarium was stable at 28-30ºC. During culture period, pH was 6.9-7.0 and dissolved oxygen at 6.0-6.89 mg L^{-1} measured by Lutron PH 222 Pan pH meter and DO meter DO 5510, and total ammonia was 0.064-0.156 mg L^{-1} using spectrophotometer Optima SP-300.

Biological and chemical analysis. Biological analysis was done by using the specific growth rate (Huisman 1987), feed intake, feed efficiency, and the survival rate of fish. The fish body proximate composition analysis was done by using three fishes per aquarium. The proximate analysis include levels of protein, fat and water content following the procedure of AOAC (1990).

Organoleptic test was done to evaluate the taste and texture of flesh of the test fish. Organoleptic test was conducted by 16 randomly chosen people and carried out in accordance with SNI01-2346-2006 (BSN 2006). Test fish were killed, then the scales and inner organs were removed. The fish was then steamed for five minutes, and then was served to the panelists. The texture and taste of the flesh was scored by panelists. Each panelist tested one fish from each treatment. Examiners who have completed assessing the texture and flavor of the flesh, then filled the organoleptic sheet that have been provided (Table 2).

Table 2

Assessment sheet for organoleptic test

No.	*Parameter*	*Value*	*Sample code (treatment)*				
			A	*B*	*C*	*D*	*E*
1	*Texture*						
	Very compact	5					
	Compact	4					
	Less compact	3					
	Flabby	2					
	Very flabby	1					
2	*Taste*						
	Very sweet	5					
	Sweet	4					
	Less sweet, less delicious	3					
	Less delicious	2					
	Tasteless	1					

Statistical analysis. A completely randomized design (CRD) with five treatments and the three replications were used in this experiment. To evaluate the effect of the five treatments on the feed intake, daily growth rate, survival rate, feed efficiency and proximate composition of fish, variance analysis was used with 95% confidence level. Further tests using Duncan's multiple regions test were performed. Organoleptic data were analyzed using non-parametric tests Kruskal-Wallis, whereas the multiple comparison was done as further test.

Reasults and Discussion. After cultured for 37 days, diet with the addition of cinnamon leaf of 0%, 0.25%, 0.5%, 0.75% and 1% provide sufficient growth for carp. Increased biomass during cultivation were 2.6 to 2.9 times compared to the initial biomass of test fish (Table 3). The increase of the number of cinnamon leaf used in the diet significantly increased the feed intake of carp. However, the increase in feed consumption was not followed by an increase in the growth of the fish, so the value of daily growth rate of fish in each treatment were not significantly different. Due to the increase of feed intake and the equal of growth rate between the treatment, the feed efficiencies was decreased significantly with the increase of the cinnamon used in the diet. The survival rate of fish in all treatments were not significantly different, between 93.3 to 100%.

Table 3

Growth performance of carp after feeding on the diet supplemented with cinnamon leaf for 37 days

Parameter	Cinnamon leaf (%)				
	0	0.25	0.5	0.75	1.0
Initial weight (g)	7.5±0.35	7.9±0.09	7.4±0.33	7.5±0.18	8.0±0.04
Final weight (g)	21.0±0.49	22.8±1.04	21.1±0.38	21.8±0.18	23.4±0.32
Feed consumption (g fish^{-1})	16.9±0.08*^{a}	19.1±0.75^{bc}	18.2±0.21^{b}	19.5±0.60^{c}	20.1±0.24^{c}
Daily growth rate (%)	2.8±0.07^{a}	3.0±0.1^{a}	2.9±0.09^{a}	2.9±0.06^{a}	2.9±0.03^{a}
Feed efficiency (%)	79.7±0.49^{b}	78.0±4.17^{ab}	75.5±0.16^{ab}	73.6±2.14^{a}	77.0±2.06^{ab}
Survival rate (%)	100.0±0^{a}	93.3±5.77^{a}	100.0±0^{a}	96.7±5.77^{a}	96.7±5.77^{a}

*Different letters indicate significant differences ($p < 0.05$).

Table 4 shows the proximate composition of test fish before and after the 37 days of experiment. Fish that consumed the diet containing cinnamon leaf had a significantly lower fat content with the increase of cinnamon leaf content in the diet. Diet containing cinnamon leaf of 1% can produce fish with the highest protein content than other treatments. Along with decreased levels of fat content, the water content increased with the addition of cinnamon leaf in the diet.

Table 4

Proximate compositions of whole body of carp after feeding on the diet supplemented with cinnamon leaf for 37 days

Parameter	Cinnamon leaf (%)				
	0	0.25	0.5	0.75	1.0
Protein	15.1±0.26^{a}	15.3±0.56^{a}	14.8±0.02^{a}	15.4±054^{a}	17.2±0.53^{b}
Lipid	8.2±0.28^{e}	6.3±0.17^{d}	5.6±0.02^{c}	5.1±0.11^{b}	4.4±0.02^{a}
Moisture	70.0±0.98^{a}	71.4±0.80^{ab}	72.9±0.12^{ab}	72.4±0.62^{ab}	73.2±0.85^{b}

Different letters indicate significant differences ($p < 0.05$).

The results of organoleptic test are shown in Table 5. The more cinnamon leaf were added to the feed, the more the fish flesh was changing. The flesh texture of fish fed on the diet contained 0% cinnamon leaf were soft, while the one fed on the diet contained 0.25% and 0.5% cinnamon leaf were rather compact, and compact (0.75% and 1.00% cinnamon leaf).

Fish flesh in the group feeding on the diet contained 0% cinnamon leaf had a rather savory flavor without any sweetness, while those fed on 0.25% and 0.5% cinnamon leaf had a rather savory flavor and a sweetness that slowly emerge, and have a sweet taste without any savory flavor (0.75% and 1% cinnamon leaf). Thus, the addition of cinnamon leaf by more than 0.75% in the diet causes the fish flesh to have a compact texture and with a sweet taste.

Table 5

Organoleptic test of flesh texture dan taste of carp after feeding on the diet supplemented with cinnamon leaf for 37 days

Parameter	Cinnamon leaf (%)				
	0	0.25	0.5	0.75	1.0
Texture	2.44*^{a}	3.06^{a}	3.19^{ab}	4.13^{c}	4.06^{bc}
Taste	2.25^{a}	2.94^{ab}	3.06^{ab}	3.75^{b}	3.94^{b}

*Different letters indicate significant differences ($p < 0.05$).

The increased levels of cinnamon leaf in the diet increases feed intake by fish. Therefore, it is suggested that cinnamon may act as attractants, thereby increases the appetite of

fish. This characteristic as attractant was associated with a distinctive aroma of cinnamon leaf supplemented diet. As revealed by Rust (2002), the smell of food may attract fish appetite. Distinctive aroma of cinnamon was derived from cinnamon oil, especially trans-cinnamaldehyde (Wang et al 2009). Solvent extracted with ethanol showed that cinnamon leaf which is used in this study contains 12% extract. This concentration was almost the same with solvent extracted from cinnamon bark (10 to 12%), as reported by Thomas & Duethi (2001).

The increase of feed intake in carp with the increase supplementation of cinnamon leaf in diet was not followed by the increase in the growth of fish. The increase of feed intake that was not followed by an increase in growth can occur due to the presence of antinutrition substances like tannin in cinnamon leaf. Mandal & Ghosh (2010) found that tannin reduces the digestive enzymes activity of Indian major carps. The growth performance of tilapia was decreased after feeding on the diet containing more than 15 mg tannin kg^{-1} (Buyukcapar et al 2011). The level of tannin in cinnamon leaf was 771.5 mg kg^{-1}. The 1% cinnamon leaf supplemented diet has a tannin content of 7.7 mg kg^{-1}. Thus, tannin content in this diet was low to affect the growth performance of carp.

Some research suggested that essential oil has antimicrobial effects. Chang et al (2001) reported that the essential oil from *Cinnamomum osmophloeum* leaf with a dose of 250 µg mL^{-1} was able to inhibit the growth of bacteria. The antimicrobial properties have been reported also by Rattanachaikunsopon & Phumkhachorn (2010) which evaluated diet supplemented with 0.3% essential oil of Cinnamomum verum for tilapia. After being infected by *Streptococcus iniae*, there was no tilapia mortality, whereas the mortality rate of tilapia fed by the control diet (without the addition of essential oil) was 50%. However, in that experiment, feeding on the diet supplemented with cinnamon leaf did not gave deleterious effect on growth and feed conversion. In our experiment, the essential oil content in the diet was less than 0.12%, and the growth performance of fish was the same in all treatments. These data suggested that the anti-microbial properties of essential oils have no impact on the survival of the microflora.

The fat body content of the fish decreased in accordance with the increase in the precentage of cinnamon leaf that was added into the diet. The low level of fat body content was assumed to be associated with the low blood glucose due to the longer rate of gastric emptying (Hlebowicz et al 2007). The low blood sugar was suspected due to the more efficient tranportation of glucose to the cells as an energy source, which can inhibit lipogenesis process, which in turn will reduce levels of fat in the body. Furthermore, Azima (2004) showed that cinnamon extract was able to lower cholesterol and triglyceride levels in the body of a rabbit, and able to suppress the occurrence of fat deposition in rabbits. These results indicate that cinnamon extracts play a role in increasing the rate of fatty acid oxidation in the cell membrane, which in turn will lower body fat deposits.

Organoleptic test is a procedure to use human senses as a main tool to assess the quality of a dietary product. Assessment using sensing devices include quality of appearance, smell, taste, and consistency/texture as well as several other factors that are needed to assess product (BSN 2006). In this study, an increase in the percentage of cinnamon leaf added to diet leads to changes in the texture and flavor of the fish. The higher the amount of cinnamon leaf, the flesh texture has change from mushy to compact.

The alteration of the flesh texture correlated with reduced levels of fat in the body of the fish. Low levels of fat in the treatment of 0.75% and 1% cinnamon leaf causes the compact texture of the fish flesh. Likewise with the taste of fish flesh. The higher the supplementation of cinnamon leaf added into diet, the more the fish flesh changed from rather savory (without sweetness) to becoming sweet. Fish fed 0.75% and 1% cinnamon leaf supplemented diet have a sweet taste. This change was attributed to the accumulation of volatile oil in cinnamon leaf in fish flesh. As stated by Ardani et al (2010), one of the properties of essential oils was a sweet taste.

Conclusions. From this research, it was concluded that the supplementation of cinnamon leaf in the diet has not affected growth performance of carp. On the other hand, supplementation of 0.75% and 1% of cinnamon leaf have produced flesh texture to be more compact and brought sweeter taste. Therefore, the optimal supplementation of cinnamon leaf in carp diet was 0.75%.

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