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THE EFFECT OF FEEDING WITH ADDITION OF CINNAMON BARK (*CINNAMOMUM BURMANNI*) FLOUR ON THE GROWTH PERFORMANCE OF PEARL SKINFISH (*CHANNA ASIATICA*)

Pengaruh Pakan Dengan Penambahan Tepung Kulit Kayu Manis (*Cinnamomum burmanni*) Terhadap Performa Pertumbuhan Ikan Gabus Mutiara (*Channa asiatica*)

Benny Diah Madusari, Muhammad Zulkham Yahya*, Ashari Fahrurrozi, Hisdha Ardhani

Aquaculture Study Program, Faculty of Fisheries, Pekalongan University

Sriwijaya Street No.3, Bendan, Pekalongan Bar. District, Pekalongan City, Central Java 51119

*Corresponding Author: zulkhamy33@gmail.com

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ABSTRACT

The business opportunities for ornamental fish, especially the Channa type, are very potential, so optimization must be done, especially in their growth. The aim of this research was to determine the effect of adding different doses of cinnamon bark flour to feed on the growth of pearl snakehead fish and to determine the best dose of cinnamon bark flour in feed for the growth of pearl snakehead fish. The seed samples used fish measuring 6-7 cm which were kept in jars with a capacity of 15 L. The research used an experiment with a completely randomized design (CRD) with 4 treatments and 3 replications, A (0 additions of cinnamon bark flour), B (0.5 g cinnamon bark flour/kg feed), C (1 g cinnamon bark flour/kg feed), and D (1.5 g cinnamon bark flour/kg feed). The addition of cinnamon bark flour to the growth of pearl snakehead fish was very significantly different to the growth of pearl snakehead fish seeds. The best growth dose in treatment D was 6.95 g with a daily growth of 0.25 cm and an additional length of 2.50 cm and an FCR value reaching 1.39, however the addition of cinnamon bark flour did not make a significant difference to the SR value. Observation results resulted in water quality temperature 27–30˚C, pH 7.1–7.3, DO 4.6–6.0 mg/L.

Keywords: Pearl Skin Fish, Cinnamon Bark, Growth

ABSTRAK

Peluang usaha ikan hias terutama jenis *Channa* sangat potensial sehingga harus adanya pengoptimalan terutama dalam pertumbuhannya. Tujuan dari penelitian ini untuk mengetahui pengaruh penambahan tepung kulit kayu manis dengan dosis yang berbeda pada pakan terhadap pertumbuhan ikan gabus mutiara dan untuk mengetahui dosis tepung kulit kayu manis terbaik pada pakan bagi pertumbuhan ikan gabus mutiara. Sampel benih menggunakan ikan berukuran berukuran 6-7 cm yang dipelihara pada toples berkapasitas 15 L, Penelitian menggunakan Experimen dengan rancangan acak lengkap (RAL) dengan 4 perlakuan dan 3 ulangan, A (0 penambahan tepung kulit kayu manis), B (0,5 tepung kulit kayu manis g/kg pakan), C (1 tepung kulit kayu manis g/kg pakan), dan D (1,5 tepung kulit kayu manis g/kg

pakan), Penambahan tepung kulit kayu manis terhadap pertumbuhan ikan gabus mutiara sangat berbeda nyata terhadap pertumbuhan benih ikan gabus mutiara. Dosis pertumbuhan terbaik pada perlakuan D yaitu 6.95 g dengan pertumbuhan harian 0.25 cm dan penambahan Panjang 2.50 cm serta nilai FCR mencapai 1.39, namun penambahan tepung kulit kayu manis tidak memberikan perbedaanya nyata terhadap nilai SR. Hasil pengamatan hasil kualitas air suhu 27–30˚C, pH 7.1–7.3, DO 4.6–6.0 mg/L.

Kata kunci: Ikan Gabus Mutiara, Kulit Kayu Manis, Pertumbuhan

INTRODUCTION

Ornamental fish farming opportunities are very popular in Indonesia. It is recorded that there are 400 species of freshwater ornamental fish in Indonesia (Administrator, 2018). This provides opportunities for farmers to increase ornamental fish production in Indonesia. The period for cultivating ornamental fish is relatively short, does not require special training or skills, does not require large capital, and does not require a large cultivation area. In recent years, the Channa genus fish has been very popular for ornamental fish collectors, in addition to its meat being used for consumption or traditional medicine, the Channa genus fish has a beautiful body pattern (Veronika, 2023). One of them is the Channa asiatica fish or often called the pearl snakehead fish which has tens of thousands of communities of lovers of this fish. (Hiko, 2020).

Pearl snakehead fish are spread from East Asia including Japan (Ishigaki Shima and Ryuku Islands), China (middle and lower Chang Jiang, and Xub River basin), and Taiwan, to Southeast Asia, precisely in East Vietnam (Jayakarila, 2019). Often found in rice fields, rivers, and lakes (Dahlia *et al*., 2022). The advantage of pearl snakehead fish is that it can maintain its body in an environment with minimal oxygen. Because according to Pertiwi et al., (2017) this fish utilizes the absorption of atmospheric oxygen with a labyrinth organ covered with respiratory epithelium. Even pearl snakehead fish can survive for 72 hours against pH changes from 4.3 to 9.4 due to poor pond conditions (Britannica, 2021). However, the problems that are often faced when domesticating snakehead fish are carried out in ponds or aquariums are feed and growth.

Trash fish is often the choice for snakehead fish feed but has the risk of inducing disease and environmental problems, especially the diverse nutritional content of trash fish makes the growth of snakehead fish unpredictable (Djauhari *et al*., 2022). So there must be feed innovation to support the growth of snakehead fish. One of them is using commercial feed that has a clear nutritional content which is added with natural ingredients as feed additives (Yahya *et al*., 2022). Feed additives function to reduce the cost of purchasing feed and support environmentally friendly growth for pearl snakehead fish.

Cinnamon (*Cinnamomum burmanni*) is very potential as a feed additive agent that improves fish growth performance by utilizing secondary metabolism compounds from cinnamon such as flavonoids that can help form muscle (meat) by increasing the performance of protein and collagen biosynthesis in body tissues (Takasao *et al*., 2012). The use of cinnamon has been proven to be able to increase the growth of several fish such as grouper (Habiba *et al*., 2021), catfish (Tartila *et al*., 2021) and patin fish (Rolin *et al*., 2015; Setiawati et al., 2014). So the purpose of the study was to determine the effect of adding cinnamon bark flour and the best dose that can be added to feed for the growth of pearl snakehead fish.

RESEARCH METHODS

Place and Time

The research was conducted at the Fisheries Research Lab, Pekalongan University, Pekalongan City from November to December 2023.

Tools and Materials

Research equipment includes maintenance jars, aeration equipment, water quality measuring devices, sieves, grinders, digital scales and stationery. The materials used are 6–7 cm pearl snakehead fish seeds, commercial feed and cinnamon bark flour.

Research Design

The study applied the Completely Randomized Design method with 4 treatments in triplicate and was experimental in nature. The treatment dose applied in this study refers to the research of Setiawati *et al*., (2014) namely:
Treatment A: 0.0 g cinnamon bark flour/ kg feed
Treatment B: 0.5 g cinnamon bark flour/ kg feed
Treatment C: 1.0 g cinnamon bark flour/ kg feed
Treatment D: 1.5 g cinnamon bark flour/ kg feed

Procedure

Preparation of research containers and equipment and sterilization by cleaning with soapy water, adding PK (Calcium Permanganate) powder and drying by drying in direct sunlight. There are 12 research containers in the form of 15 L jars and equipped with aeration equipment per container. After the container is ready, it is filled with sterile water as much as has been previously settled. Spreading pearl snakehead fish seeds measuring 6-7 cm as test animals with a stocking density of 5 per container with a water capacity of 1 fish/L (Yahya *et al*., 2022) and carrying out an acclimatization process for 2-3 days so that the fish seeds adapt to the maintenance environment.

After the maintenance media is ready, the preparation of test feed is continued, which was previously carried out by making cinnamon bark flour by cleaning and drying the cinnamon bark. Furthermore, the flouring process is carried out with a grinder. The finished flour is weighed according to the reference dose and mixed into commercial feed by adding enough water to the cinnamon bark flour (Sandriyani *et al*., 2015). After mixing, the test feed is air-dried so that the nutrients in the feed do not change.

Maintenance is carried out for 4 weeks with daily feeding given a dose of 5% of the biomass to support maximum growth (Yulfiperius *et al*., 2022) which is divided into 2 times, namely morning and evening. By giving it gradually into each maintenance container (Iskandar & Elrifadah, 2015)

Test Parameters

Absolute length is measured using the formula of Lucas *et al*., (2015), namely as follows:

$$\mathbf{L = L_t - L_0}$$

Information:
L = Length of reared fish (cm); Lt= final length of fish kept (cm); L0= initial length of fish kept.

Average Daily Growth (ADG) calculated by the formula (Kusuma *et al.,* 2024):

$$\boldsymbol{ADG = \frac{Gt - G0}{H}}$$

Information:
ADG = Daily weight gain; Gt = final weight (g); G0 = initial weight (g); H = maintenance interval (days)

The growth of the biomass of snakehead fish seeds utilizes weight calculations from the formula (Yulfiperius, 2021), namely:

$$G = W_t - W_0$$

Information:
G = Absolute biomass growth of fish (g); Wt = Final biomass of fish (g); W0 = Initial biomass of fish (g).

The feed conversion ratio or FCR is calculated by applying the formula from Maulizar et al., (2019), namely:

$$FCR = \frac{F}{(Wt + D) - W0}$$

Information
FCR = feed conversion ratio F = Accumulated feed consumed (g); Wt = final fish biomass (g); W0 = initial fish biomass (g); D = accumulated dead fish biomass.

Survival rate calculated by the formula Muchlisin *et al.,* (2017):

$$KH = \frac{No - Nt}{No} x\ 100$$

Information:
KH = Survival (%); Nt = Accumulation of dead fish (tails); No = Total accumulation of initial fish (tails)).

Data Analysis

Research data collection was conducted every week except for water quality data which was collected every day. In addition to water quality which was analyzed descriptively, other research data were analyzed statistically using ANOVA analysis of variance to obtain the effect of mean differences between treatments which were previously pre-tested by looking at the normality and homogeneity of data distribution with normality tests and homogeneity tests. After being analyzed using ANOVA, a Tukey test was carried out with a 5% test level for the real difference test (HSD) between treatments.

RESULT

Growth Performance

The results of the growth performance parameters of the pearl snakehead fish are summarized in Table 1.

Table 1. Results of the growth performance of the pearl snakehead fish

Parameters	Dosage for adding cinnamon bark flour to feed			
	0 g/kg	0.5 g/kg	1 g/kg	1.5 g/kg
Absolute Length (cm)	1.60±0.05^{d}	1.70±0.05^{c}	2.00±0.08^{b}	2.50±0.05^{a}
Absolute Biomass (g)	4.30±0.05 ^{d}	4.81±0.19 ^{c}	5.71±0.31 ^{b}	6.95±0.11^{a}
Average Daily Growth (g)	0.15±0.0049 ^{d}	0.17±0.0066^{c}	0.20±0.0112^{b}	0.25±0.0039^{a}

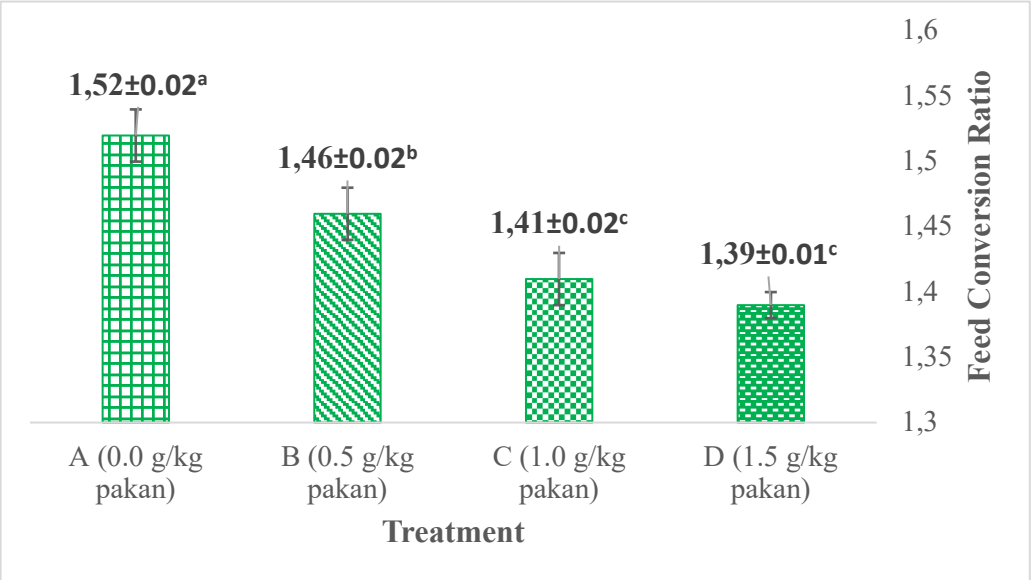
Description: differences in notation symbols indicate significant differences between treatments at p>0.05

Cinnamon bark flour has a significant effect (p<0.05) on the growth performance of pearl snakehead fish such as Absolute Length, Biomass and ADG. From these results, the best dose was produced to increase the growth performance of pearl snakehead fish, namely in treatment D (2.5 g/kg) with an average biomass growth result reaching 6.95 g with a daily growth rate of 0.25 g with an absolute length reaching 2.50 cm. These results are able to provide direct growth performance results compared to research from Setiawati et al., (2014) which obtained the best

dose at 1% cinnamon flour which was able to increase 2 times the total digestibility of feed than feed without additional cinnamon flour but was unable to provide a significant increase in the growth rate of catfish.

Feed Conversion Ratio (FCR)

The results of the feed conversion that can be utilized by pearl snakehead fish to be made into meat can be seen in Figure 1.



Description: differences in notation symbols indicate significant differences between treatments at p>0.05

Figure 1. Feed Conversion Ratio (FCR) of Pearl Snakehead Fish

From Figure 1, the results of the addition of cinnamon bark flour have a significant effect on the level of feed conversion ratio in snakehead fish. However, between treatments D (1.5 g/kg) and C (1 g/kg), the feed conversion ratio value is not significantly different. From Figure 1, it can be seen that the best FCR value in this study was 1.39, which is the average FCR value in treatment D (1.5 g/kg).

Survival Rate

The results of the study showed that the treatment of cinnamon bark flour was unable to provide an effect on the percentage of survival of pearl snakehead fish, but in this study, pearl snakehead fish seeds were able to defend themselves well. This can be seen from Table 2.

Table 2. Survival Rate of Pearl Snakehead Fish

	Treatment				
Test	A	B	C	D	**Total**
1	5	5	5	5	
2	5	5	5	5	
3	5	5	5	5	
Amount	**15**	**15**	**15**	**15**	**60**
SR%	100±0.00a	100±0.00a	100±0.00a	100±0.00a	

From Table 2, the results of the percentage of pearl snakehead fish survival in all treatments obtained a percentage value of 100% or there was no death of any pearl snakehead fish seeds during maintenance.

Water Quality

The results of quality observations in all maintenance media can be seen in Table 3.

Table 3. Water Quality Parameter Values for Pearl Snakehead Fish Maintenance Media

Water Quality Parameters	Observation result	Optimal Value
Temperature (°C)	27 – 30	25 – 30 (PuskoMedia, 2023)
pH	7.1 – 7.3	6.2 – 7.8 (Muslim & Yonarta, 2017)
Dissolved oxygen (mg/L)	4.6 – 6.0	3.0 – 6.0 (Kordi, 2019)

DISCUSSION

Growth Performance

Fish will experience a growth process by utilizing excess energy from the remaining process of carrying out all functions to maintain their lives. The more energy left after fulfilling the functions of all their bodies, the more energy can be used for the growth process. This main energy is obtained by fish from the feed consumed. In addition, the environment, genetics and the ability of fish to convert the feed consumed into energy greatly affect fish growth (Sonavel et al., 2020). So that growth is closely related to the health and stress factors of fish that affect the performance of fish in responding to the energy received.

The results of the performance parameters of the growth of pearl snakehead fish seeds fed with additional cinnamon bark obtained the best dose in increasing the growth performance of pearl snakehead fish seeds, namely the addition of cinnamon bark flour 1.5 g / kg of feed (treatment D) with an absolute length growth of 2.5 cm and biomass reaching 6.95 g with a daily rate of 0.25 g / day. Compared to other doses such as treatment C (1 g/kg) which obtained a length growth of 2 cm and biomass of 5.71 g with a daily rate of 0.2 g and treatment B (0.5 g/kg) with a length growth of 1.70 cm and biomass of 4.81 g with a daily growth rate of 0.17 g. This also proves that the addition of cinnamon bark flour has a positive impact on the growth of snakehead fish compared to the control treatment (0 g/kg) which obtained the lowest growth performance with a length growth of 1.60 cm and biomass of 4.30 g with a daily rate of 0.15 g. This study provides a more significant effect on growth compared to the study of Setiawati *et al*., (2014) which did not significantly affect the growth rate of catfish. It is suspected that the addition of cinnamon bark flour can increase the appetite of pearl snakehead fish and add nutrition to the feed given.

Cinnamon bark contains flavonoid and tannin compounds (Lusiana et al., 2012). These compounds act as antioxidants that function to form new cells and protect cells from pathogens. In line with Sianturi *et al*., (2013) who explained that this antioxidant functions to neutralize free radicals and helps rearrange the structure of red blood cells and supports increased growth value. The highest content in cinnamon bark is cinnamaldehyde content. According to Takasao *et al*., (2012) the presence of cinnamaldehyde increases the process of tissue collagen and protein biosynthesis by stimulating the performance of insulin-like growth factor (IGF-1) so that more protein can be used for muscle formation (meat). Another abundant content in cinnamon bark is essential oils of the phenol group which contain simple fats, sugars and proteins (Ervina *et al*., 2016; Al-Dhubiab, 2012). The addition of fat, sugar and protein from this essential oil provides increased nutrition in feed. Audina *et al*., (2018) added that this essential oil provides a relaxing effect and produces better digestive performance so that it stimulates increased appetite and ultimately helps provide additional energy to increase growth.

Cinnamon bark also contains vitamins A, B, and K. Vitamin A is related to stimulating the physiological performance of fish, especially in vision, embryogenesis and reproduction and helps in growth and provides protection for epithelial cells (Héctor & Hardy, 2020). Vitamin B also provides growth support by stimulating the optimization of body cell function and DNA production in the fish's body, thereby stimulating the fish's appetite. And vitamin K

is related to bone mineralization, thus helping to strengthen the fish's bone structure to grow (Krossøy *et al*., 2011).

The positive effects obtained from the addition of cinnamon bark flour were very much felt in the results of this study. However, in the control treatment (0 g/kg), the benefits of cinnamon bark could not be obtained because there was no addition of cinnamon bark flour added to the feed consumed by pearl snakehead fish so that the growth performance results from the control treatment or treatment A produced the lowest growth performance.

Feed Conversion Ratio

The feed conversion ratio or FCR is closely related to the ability of fish to utilize feed nutrients to be converted into additional meat quantity. Optimizing feed absorption with minimal feed consumed results in a better feed conversion ratio value. The best FCR value produced by adding cinnamon bark flour to snakehead fish seeds is 1.39 in treatment D (1.5 g/kg) and the lower the dose of cinnamon bark flour addition will produce a greater FCR value such as treatment C (1 g/kg) produces an FCR value of 1.41, treatment B (0.5 g/kg) produces an FCR value of 1.46. However, the results of adding cinnamon bark flour have a significant effect on the FCR value of pearl snakehead fish seeds compared to the control treatment (treatment A: 0 g/kg) which produces an FCR value of 1.56.

This is related to the abundance of antioxidant content contained in cinnamon bark such as its main compound, namely Cinnamaldehyde or cinnamaldehyde and other compounds such as essential oils, eugenol, cinnamic acid (Maslahah & Nurhayati, 2023). The antioxidant content in cinnamon bark is able to activate increased digestive enzyme function in the form of multiplying mitochondrial antioxidant enzymes (Li *et al*., 2023), Antioxidants are able to increase the antioxidant system in the intestine, minimize inflammation and help the work of intestinal microbes to break down nutrients into forms that are more easily absorbed by the body (Yang *et al*., 2024). According to Uyun *et al*., (2021) antioxidant compounds play a role in protecting and repairing cells against damage from free radicals.

These antioxidants are able to degrade Reactive Oxygen Species (ROS) such as catalase, superoside dismutase to various peroxidases. ROS are organic compound products produced from cellular redox processes and disrupt the structure of DNA and proteins (Hikmah & Hardiany, 2021). So in addition to preventing oxidative stress, antioxidants can stimulate increased nutrient absorption and immunity from fish. This causes an increase in fish digestibility to utilize the nutrients in the feed consumed optimally. This is also assisted by the presence of essential oils that provide an increase in the balance of nutrients and energy that are managed in the physiological process by providing a sense of calm to the fish so that the fish are able to carry out the metabolism process optimally, especially in the breakdown of nutrients into energy to increase the quantity of meat formation (Pratama *et al*., 2017; Setiawati et al., 2014).

Meanwhile, the high FCR value in the control treatment (treatment A) compared to the feed treatment that added cinnamon bark flour was due to the fish's imperfect absorption of feed due to the absence of additional functions that could support increased digestibility of feed. This is in line with the opinion of Arief *et a*l., (2016) that the high FCR value is influenced by feed that is not absorbed optimally and more will be wasted as feces. However, this FCR value is still in the good category because according to Armando *et al*., (2021) the FCR value of snakehead fish is in the good range, namely no more than 1.6.

Survival Rate

The ability of fish to survive is supported by the condition of the fish, the nutrients consumed and the maintenance environment. In this study, the addition of cinnamon bark flour did not affect the Survival rate (SR) of pearl snakehead fish seeds even though there were

additional beneficial compounds from cinnamon bark flour consumed by the fish. In all treatments, the SR results were equally good, namely with an SR Level of 100%, which means there was no mortality from all treatments, both test and control treatments. This is inseparable from the ability of snakehead fish to adapt to a good environment (Tjahjaningsih, 2019). In addition, it is supported by a controlled maintenance environment, especially the application of maintenance media in optimal conditions to support fish during maintenance. Control of maintenance media, such as temperature, dissolved oxygen (DO) and pH, is always carried out every day to ensure that the conditions are appropriate for pearl snakehead fish to maintain all their body functions (Juliyanti *et al*., 2016). The use of feed also plays a role in the high SR Level in this study. The commercial feed used contains 35% protein. Because according to Masdianto *et al*., (2021) to maintain high viability, snakehead fish should use feed with a protein content of more than 30%, while feed with a protein content of less than 30% will have an effect on reducing the body function of snakehead fish, especially for growth.

Water Quality

Water quality is an important factor for fish to live and carry out their bodily functions, poor water quality can cause several physiological disorders, high stress levels and even cause fish death (Sieger *et al*., 2019). Because the decline in water quality is one of the factors of unconsumed feed or that is excreted by fish in the form of feces (Dwiputra *et al*., 2021). In this study, controlled water quality conditions in optimal conditions support fish to maintain their lives.

Water quality such as the temperature of the maintenance media is 27-30 °C. This maintenance temperature is still in optimal conditions for snakehead fish because the optimal value of good snakehead fish water temperature is around 25-30 °C (PuskoMedia, 2023). Dissolved oxygen (DO) in the maintenance media ranges from 4.6-6.0 mg/L with a DO value that can be accepted by snakehead fish to maintain their physiological functions ranging from 3.0 - 6.0 mg/L (Kordi, 2019). And the pH of the maintenance media water is maintained in the range of 7.1–7.3 with the optimal pH of the maintenance of snakehead fish ranging from 6.2–7.8 (Muslim & Yonarta, 2017). This is achieved by maintaining the quality of the maintenance media water quality such as monitoring, using aeration and filtration systems, cleaning and regular water changes. In addition, regulating the density of the fish population in each test container also supports maintaining the quality of water quality.

CONCLUSION

The conclusion of this study is that the growth performance of pearl snakehead fish seeds is very significantly influenced by feed that is given additional cinnamon bark flour with the best dose resulting in 1.5 g/kg of feed which produces absolute length growth of 2.5 cm and biomass reaching 6.95 g with a daily rate of 0.25 g/day.

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REFERENCES

Administrator. (2018). untuk Mewujudkan Indonesia Menjadi Eksportir Ikan Hias Terbesar di Dunia. 22 September 2023.

Al-Dhubiab, B. E. (2012). Pharmaceutical Applications and Phytochemical Profile of *Cinnamomum burmannii. Pharmacognosy Reviews*, *6*(12), 125–131.

Arief, M., A., Manan., & Pradana, C. A. (2016). Penambahan Papain pada Pakan Komersial terhadap Laju Pertumbuhan, Rasio Konversi Pakan dan Kelulushidupan Ikan Sidat (*Anguilla bicolor*) Stadia Elver. *Jurnal Ilmiah Perikanan dan Kelautan*, 8(2), 67–76. https://dx.doi.org/10.20473/jipk.v8i2.11179

Audina, E.Y. I., Syakirin, M. B., & Linayati. (2018). The Effect of Curcuma Flour on Feed to The Growth of *Oreocromus niloticus*. *National Proceeding. Dies Natalis Pekalongan University 37th.* Pekalongan.

Britannica, (2021). Mengenal Lebih Dekat Ikan Hias Channa dari Keistimewaan Hingga Cara Merawatnya. 02 Oktober 2023.

Dahlia, Syafrialdi, S., & Kholis, M.N. (2022). Studi Morfometrik Ikan Gabus (*Channa striata*) di Rawa Genangan Banjir Air Gemuruh Kecamatan Batin III Kabupaten Bungo Provinsi Jambi. *SEMAH: Jurnal Pengelolaan Sumberdaya Perairan, 6*(2), 64–75.

Djauhari, R., Siburian, E.L.S., Wirabakti, M.C., Monalisa, S.S., & Christiana, I. (2022). Kinerja Pertumbuhan Ikan Gabus (*Channa striata*) yang Diberi Prebiotic Madu dan Probiotik *Lacticaseibacillus paracasei*. *Jurnal Perikanan, 12*(3), 457–466. https://doi.org/10.29303/jp.v12i3.344

Dwiputra, B. P., Harwanto, D., & Samidjan, I. (2021). Pengaruh Penggunaan *Hydrilla verticillate* sebagai Fitoremediator terhadap Kualitas Air dan Pertumbuhan Ikan Manfish (*Pterophyllum scalare*) pada Sistem Resirkulasi. *Jurnal Sains Akuakultur Tropis, 5*(2), 223–235.

Ervina, M., Nawu, Y. E. & Esar, S. Y. (2016). Comparison of In Vitro Antioxidant Activity of Infusion, Extract and Fractions of Indonesian Cinnamon (*Cinnamomum burmannii*) bark. *Int. Food Res. J., 23*(3), 1346–1350.

Habiba, M. M., Hussein, E. E., Ashry, A. M., El-Zayat, A. M., Hassan, A. M., El-Shehawi, A., Sewilam, H., Doan, H. V., & Dawood, M. A. O. (2021). Dietary Cinnamon Successfully Enhanced the Growth Performance, Growth Hormone, Antibacterial Capacity, and Immunity of European Sea Bass (*Dicentrarchus labrax*). *Animal, 11*(7), 2128. https://doi.org/10.3390/ani11072128

Héctor, L., & Hardy, R.W. (2020). Vitamin A Functions and Requiremets in Fish. *Aquaculture Research,* 51(8). http://dx.doi.org/10.1111/are.14667

Hikmah, F., & Hardiany, N.S. (2021). Peran Reactive Oxygen Spesies (ROS) dalam Sel Punca Kanker. *Jurnal Kedokteran Yarsi, 29*(3), 120–134.

Hiko. (2020). *Channa: Si Gabus Hias*. Jakarta: Agromedia Pustaka.

Iskandar, R., & Elrifadah. (2015). Pertumbuhan dan Efesiensi Pakan Ikan Nila (*Oreochromis niloticus*) yang Diberi Pakan Buatan Berbasis Kiambang. *Jurnal Ziraa'ah, 40*(1), 18–24.

Jayakarila, H. H. T. A. (2019). *Chana Si Gabus Hias*. Jakarta: Penerbit Agromedia Pustaka.

Juliyanti, V., Salamah, & Muliani. Pegaruh Penggunaan Probiotik pada Media Pemeliharaan terhadap Benih Maskoki (*Carassius auratus*) pada Umur yang Berbeda. *Acta Aquatica: Auatic Sciences Journal, 3*(2), 66–74.

Kordi M. G. (2019). *Akuakultur*. Jakarta: Penerbit Indeks Jakarta.

Krossøy, C., R. Waagbø, & Ørnsrud, R. (2011). Vitamin K in Fish Nutrition. *Aquaculture Nutrition, 17*(6), 585–594. https://doi.org/10.1111/j.1365-2095.2011.00904.x

Kusuma, N. P. D., Tangguda, S., & Lau, J. R. (2024). Analisis Kualitas Air dan Hubungannya dengan Pertumbuhan Ikan Lele Sangkuriang (*Clarias gariepinus*) pada Padat Teber Berbeda. *Jurnal Galung Tropika, 13*(2), 256–267. https://doi.org/10.31850/jgt.v13i2.1219

Li, F., Sun, H., Li, Y., He, D., Ren, C., Zhu, C., & Lv, G. (2023). Effects of Fucoidan on Growth Performance, Immunity, Antioxidant Ability, Digestive Enzyme Activity, and Hepatic Morphology in Juvenile Common Carp (*Cyprinus carpio*). *Frontiers in Marine Science*, 10: 1167400. https://doi.org/10.3389/fmars.2023.1167400

Lucas, F. G. W., Kalesaran, J. O., & Lumenta, C. (2015). Pertumbuhan dan Kelangsungan Hidup Larva Gurame (*Oshpronemus gourami*) dengan Pemberian Beberapa Jenis Pakan. *Jurnal Budidaya Perairan, 3*(2), 19–28.

Lusiana, K., P. Magatra & Martono, Y. (2012). Ekstrak Limbah Biji Pepaya (*Carica papaya*) Anti Penyakit Jantung Koroner. *Porisiding Seminar Nasional Sains dan Pendidikan Sains VII.*

Masdianto, Khaeriyah, A., & Burhanuddin. (2021). Optimasi Kebutuhan Protein Pakan untuk Pertumbuhan dan Sintasan Ikan Gabus (*Channa striata*). *Octopus: jurnal Ilmu Perikanan, 10*(1), 33–42.

Maslahah, N., & Nurhayati, H. (2023). Kandungan Senyawa Bioaktif dan Kegunaan Tanaman Kayu Manis (*Cinnamomum burmannii*). *Warta BSIP Perkebunan, 1*(3), 5–7.

Maulizar, M., E-rahimi, S.A., Hasri, I., Dewiyanti, I., & Nurfadillah, N. (2019). Pengaruh Variasi Periode Penyinaran (Fotoperiode) terhadap Pertumbuhan dan Kelangsungan Hidup Benih Ikan Depik Rasbora tawarensis. *Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah, 4*(2), 74–81.

Muslim, M., &Yonarta, D. (2017). Penetasan Telur Ikan Gabus (*Channa striata*) dalam Media Inkubasi Dengan Lama Pemberian Oksigen Berbeda. *Jurnal* Perikanan Tropis, *4*(1), 185–197

Pertiwi, S. L., Zainuddin, & Rahmi, E. (2017). Gambaran Histologi Sitem Respirasi Ikan Gabus (*Channa striata*). *JIMVET, 1*(3), 291–298.

Pratama, A. W., Sulmartiwi, L., & Rahardja, B. S. (2017). Potensi Sedasi Minyak Atsiri Daun Bandotan (*Ageratum conyzoides*) terhadap Ikan Koi (*Cyprinus carpio*). *Jurnal Ilmiah Perikanan dan Kelautan, 9*(2), 107–117. https://doi.org/10.20473/jipk.v9i2.7639

PuskoMedia, I. (2023). *Kualitas Air yang Ideal untuk Sukses dalam Budidaya Ikan Gabus*: Parameter kunci. 24 Januari 2024.

Rolin, F., Setiawati, M., & Jusadi, D. (2015). Evaluasi Pemberian Ekstrak Daun Kayu Manis *Cinnamomum burmannii* pada Pakan terhadap Kinerja Pertumbuhan Ikan Patin *Pangasianodon hypophthalmus* Sauvage, 1878. *Jurnal Iktiologi Indonesia, 15*(3), 201–208.

Sandriyani, N., Septina, F., & Mangitung. (2015). Pemanfaatan Tepung Daun Kayu Manis (*Cinnamomun burmanni*) terhadap Pertumbuhan dan Efisiensi Pakan Ikan Sidat (*Anguilla marmorata*). *J. Agrisains, 18*(1), 46–54.

Setiawati, M., Jusadi, D., Marlinda, S., & Syafruddin, D. (2014). Pemberian Daun Kayu Manis *Cinnamomun burmanni* dalam Pakan terhadap Kinerja Pertumbuhan dan Komposisi Nutrient Tubuh Ikan Patin *Pangasius hypopthaimus*. *Jurnal Ilmu Pertanian Indonesia, 19*(2), 80–84.

Sianturi, S., Tanjung, M., & Sabri, E. (2013). Pengaruh Buah Terong Belanda *(Solanum betaceum Cav*.) terhadap Jumlah Eritrosit dan Kadar Hemoglobin Mencit Jantan (*Mus musculus L*.) Anemia Strain DDW Melalui Induksi Natrium Nitrit ($NaNO_2$). *Saintia biologi, 1*(2), 49–54.

Sieger, W. H., Prayitno, Y., & Sari, A. (2019). Pengaruh Kualitas Air terhadap Pertumbuhan Ikan Nila Nirwana (*Oreochromis* sp.) pada Tambak Payau. *The Journal of Fisheries Development, 3*(2), 95–104.

Sonavel, N. P., Deny, S. C. U., & Diantari, R. (2020). Pengaruh Tingkat Pemberian Pakan Buatan terhadap Performa Ikan Jelawat (*Leptobarbus hoeveni*). *Jurnal Sains Teknologi Akuakultur, 3*(1), 52–65.

Takasao, N., Tsuji-Naito, K., Ishikura, S., Tamura, A., & Akagawa, M. (2012). Cinnamon Extract Promotes Type I Collagen Biosynthesis via Activation of IGF-I Signaling in Human Dermal Fibroblasts. *Journal of agricultural and food chemistry, 60*(5), 1193 – 2000. https://doi.org/10.1021/jf2043357

Tartila, S. S. Q., Jusadi, D., Setiawati, M., & Fauzi, I. A. (2021). Evaluation of Dietary Supplementation with Cinnamon Products on Growth, Blood Composition, Liver Structure, and Meat Quality of Striped Catfish (*Pangasianodon hypophthalmus*). *Aquaculture International*, *29*(5): 2243-2257. https://doi.org/10.1007/s10499-021-00746-x

Tjajaningsih, W. (2019). *Diversitas Genetik Ikan Gabus di Sungai Brantas*. 17 Februari 2024.

Uyun, S., Damayanti, A.A., & Azhar, F. (2021). The Effect of Cherry Leaves Extract (*Muntingia calabura*) on Growth Performance of White Shrimp (*Litopenaeus vannamei*). *Jurnal Biologi Tropis, 21*(1), 262–270. http://dx.doi.org/10.29303/jbt.v21i1.2450

Veronika, N. (2023). *Mengenal Jenis-Jenis dan Makanan Ikan Channa*. 22 September 2023.

Yahya, M. Z., Linayati, & Furoidah, A. F. (2022). Penambahan Tepung Kencur (*Kaempferia galanga* L.) terhadap Efisiensi Pemanfaatan Pakan dan Rasio Konversi Pakan Ikan Bandeng (*Chanos chanos*). *PENA Akuatika: Jurnal Ilmiah Perikanan dan Kelautan, 21*(1), 1–14. https://doi.org/10.31941/penaakuatika.v21i1.1765

Yang, H., Mo, A., Yi, L., Wang, J., He, X., & Yuan, Y. (2024). Selenium Attenuated Food Borne Cadmium-Induced Intestinal Inflammation in Red Swamp Crayfish (*Procambarus clarkii*) Via Regulating PI3K/Akt/NF-κB Pathway. *Chemosphere,* 349: 140814. https://doi.org/10.1016/j.chemosphere.2023.140814

Yulfiperius, Firman, Mahmudin, A., & Utami, R.T. (2022). Pengaruh Pemberian Jenis Pakan Buatan dan Dosis Pakan yang Berbeda terhadap Pertumbuhan Benih Ikan Gabus (*Channa striata*). *Jurnal Agroqua, 20*(2), 440–450. https://doi.org/10.32663/ja.v20i2.3132

Yulfiperius. (2021). *Petunjuk Praktis Budidaya Ikan*. Yogyakarta: Deepublish.