

The supplementation of common cumin (*Cuminum cyminum*) in artificial feed on the growth and survival of TGCG hybrid grouper

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Abstract. Common cumin (*Cuminum cyminum*) shows a potential as a natural feed additive and immunostimulant. Cumin supplementation in the feed is expected to enhance the growth performance and survival of hybrid grouper (tiger grouper ♀ × camouflage grouper ♂). This research evaluated the effects of common cumin supplementation on the growth and survival of hybrid grouper and determined the optimal supplementation dose. This experimental research was conducted for 10 days using hybrid grouper juveniles with an average initial weight of 1.31 ± 0.10 g fish⁻¹, reared in 0.5 m³ fiberglass tanks at a stocking density of 14 fish per tank. Three doses of cumin supplementation were used: 0.5% (A), 1% (B), and 2% (C), each with three replications. Growth parameters, including weight gain ratio (WGR), specific growth rate (SGR), and survival rate (SR), were analyzed using ANOVA, followed by polynomial modelling to estimate the optimal dose. The results showed that treatment B (1%) achieved the best performance, with mean WGR of 117.4%, SGR of 7.732%, and SR of 78.57%. However, ANOVA test revealed no significant differences among treatments ($p > 0.05$). Furthermore, the polynomial modelling indicated that the optimal dose of common cumin supplementation ranged between 1.02 and 1.42% for all growth and survival parameters.

Key Words: *Cuminum cyminum*, SR, SGR, TGCG hybrid grouper, WGR.

Introduction. The grouper (*Epinephelus* spp.) is a fish commodity with high demand in Indonesia and the world. In 2022, Indonesia's grouper aquaculture production reached 12,240 tons, including the TGCG hybrid grouper (local name: *kerapu cantik*). The increasing market demand for the live grouper fish has accelerated the grouper farming (Yang et al 2022a). Live hybrid grouper can sell over IDR 100,000 per kilogram (Aprilliani et al 2021). Groupers are naturally carnivorous that live around coral reefs (Huang et al 2022). *Kerapu cantik* is local variety referring to a hybrid of male tiger grouper (*Epinephelus fuscoguttatus*) and female camouflage grouper (*Epinephelus microdon*) (Loekman et al 2018; Effendi et al 2021). Hybrid grouper from aquaculture has faster growth and relatively high survival rate (DJPB 2017; Ismi 2017; Murwantoko et al 2017; Iswara et al 2018; Shapawi et al 2019; Muzaki et al 2021; Long et al 2022; Fan et al 2023; KKP 2022).

Several factors affect the production of the farmed grouper, including seed quality, feed quality and quantity, water quality, stocking density, and disease control (Awad 2025). The use of natural feed additives in aquaculture has shown potential in improving the growth, feed efficiency, and fish survival. Herbal nutraceuticals contain antioxidants, antimicrobial compounds, and immunomodulators that enhance the aquaculture production and performance (Goel et al 2020; Dawood et al 2022; Mohammadi et al 2022; Aqmasjed et al 2023; Aly et al 2024), which can also reduce the use of synthetic antibiotics (El Basuini et al 2020; La Muhamad et al 2021; Yang et al 2022b; Wijayanto et al 2022a, b; Samad et al 2022; Huang et al 2024; Wijayanto et al 2025).

As shown in prior research, herbal nutraceuticals can serve as alternatives to synthetic antibiotics (Park et al 2021; Varghese et al 2021; Wijayanto 2023). Common cumin (*Cuminum cyminum*) contains bioactive metabolites with antioxidant (Castro et al 2020), anti-inflammatory (Long et al 2022), antimicrobial (He et al 2022; Meng et al 2022), and immunomodulatory properties (Haghparast et al 2019). These compounds are significant in enhancing the immune response of fish. Experimental studies on various aquatic species including shrimp, tilapia, and common carp have shown positive effects of cumin on growth and disease resistance (Abdelkader et al 2025). However, excessive dose of cumin may bring adverse effects on the fish growth and survival rate (Asadi et al 2018; Deng et al 2023; Yigit et al 2024). The present research was performed to evaluate the effects of cumin supplementation on the growth performance and survival of the TGCG hybrid grouper.

Material and Method

Research location and time. The experiment was conducted for 10 days in June 2025 at the Laboratory of the Faculty of Fisheries and Marine Science, Universitas Diponegoro, Semarang, Indonesia.

Experimental animals and rearing conditions. The test animals were juvenile TGCG hybrid grouper with an initial average body weight of 1.31 ± 0.10 g per fish. Fish were reared in 0.5 m^3 tanks at a density of 14 fish each filled with seawater with 34 ppt salinity. Each tank was equipped with a recirculating filtration system consisting of charcoal, coral fragments, sand, and synthetic fibers. Water quality was monitored using a multi-parameter water quality checker (Horiba U-50) to measure dissolved oxygen (DO), pH, salinity, and temperature. Individual weights were recorded at the beginning and end of the experiment.

Experimental design and feed test. A completely randomized design (CRD) with three treatments and three replications was used in this research. The test diet contained commercial pelleted feed enriched with common cumin at three different doses: 0.5% (treatment A), 1% (treatment B), and 2% (treatment C). Cumin seeds were finely ground, dissolved in water, and then coated onto the commercial feed pellets to be were air-dried before feeding. Fish were fed a controlled ad libitum ration equivalent to 4% of the total biomass per day.

Measured parameters. The parameters observed included weight gain rate (WGR), specific growth rate (SGR), and survival rate (SR). The formulas used in the calculation were proposed by Long et al (2022), Muyot et al (2021), Wijayanto et al (2022a), and Wijayanto et al (2022b) as follows:

$$\begin{aligned} \text{WGR (\%)} &= [(W_t - W_o) / W_o] \times 100 && \text{[1]} \\ \text{SGR (\% day}^{-1}\text{)} &= (\text{Ln } W_t - \text{Ln } W_o) / t && \text{[2]} \\ \text{SR (\%)} &= (N_t / N_o) \times 100 && \text{[3]} \end{aligned}$$

SGR represents the growth rate of fish, calculated based on the daily average weight gain in logarithmic form. WGR is the percentage increase in fish body weight over the rearing period. W_t denotes the average fish weight (g) on day t , while W_o is the average fish weight at the beginning of the experiment (g). Ln refers to the natural logarithm. SR is the percentage of fish that survived until the end of the rearing period, where N_t is the number of surviving fish at the end of the experiment and N_o is the initial number of fish.

Data analysis. The data obtained from the experiments were analyzed in one-way analysis of variance (ANOVA) at a 95% confidence level to determine significant differences among treatments. When significant differences were detected, Duncan's Multiple Range Test was applied as a post hoc analysis. Subsequently, mathematical modelling was performed for the optimization using the first derivative of the dependent variable function with respect to the independent variable until a zero value was obtained.

Results. The analysis of growth performance (WGR and SGR) and survival (SR) is presented in Table 1 and Table 2. Dietary treatments with common cumin supplementation at different doses resulted in variations in growth (WGR and SGR) and survival (SR) of the experimental fish. Treatment B (1% inclusion) tended to yield the highest growth and survival values (WGR 117.4% and SGR 7.73% day⁻¹), despite the absence of significant difference in the statistical analysis ($p > 0.05$). This finding suggests that the treatments do not differ significantly in terms of effectiveness. However, the 1% dosage showed a biologically positive trend in promoting growth and survival when applied accurately.

Table 1
Calculated values of WGR, SGR, and SR

Parameters	A (0.5%)			B (1%)			C (2%)		
	A1	A2	A3	B1	B2	B3	C1	C2	C3
Wo (g)	1.39	1.15	1.41	1.36	1.22	1.22	1.40	1.31	1.38
Wt (g)	2.47	2.43	2.59	3.24	2.36	2.69	3.06	2.39	3.21
WGR (%)	78	111	84	138	93	121	119	83	133
SGR (% day ⁻¹)	5.75	7.49	6.09	8.65	6.60	7.94	7.83	6.03	8.45
SR (%)	78.6	92.9	50.0	71.4	92.9	71.4	50.0	71.4	64.3

Table 2
Average of WGR, SGR, SR, and results of statistical analysis

	A (0.5%)	B (1%)	C (2%)	Sign. value	F test
WGR (%)	91.0	117.4	111.5	0.373	1.168
SGR (% day ⁻¹)	6.442	7.732	7.439	0.372	1.173
SR (%)	73.81	78.57	61.90	0.460	0.886

Note: No significant differences were found among treatments according to one-way ANOVA.

The water quality measurement (Table 3) showed that the rearing environment remained within suitable ranges for grouper culture. DO levels ranged from 5.17 to 5.50 ppm, exceeding the minimum requirement for marine fish (≥ 4 ppm) (Yudhiyanto et al 2017). Adequate oxygen supply is critical for respiration, growth, and stress resistance in fish (Varghese et al 2020). The DO levels maintained during the experiments indicated that the aeration system and water quality management were sufficient. The pH ranged from 7.10 to 7.30 within neutral and acceptable standard for marine aquaculture (7.0-8.5) (WWF-Indonesia 2015). Stable pH is essential for it affects the fish metabolism and nutrient availability in the water. The water temperature remained between 27.03 and 27.50°C, which is within the optimal range for tropical marine fish culture (27-30°C) (Yudhiyanto et al 2017). The results of the optimization modelling are presented in Table 4 and Figure 1.

Table 3
Water quality during the experiment

Code	pH	Temperature (°C)	DO (ppm)
A1	7.10±0.10	27.33±0.35	5.30±0.30
A2	7.17±0.21	27.10±0.10	5.50±0.44
A3	7.20±0.17	27.03±0.46	5.47±0.06
B1	7.23±0.23	27.47±0.21	5.33±0.31
B2	7.20±0.26	27.40±0.10	5.23±0.21
B3	7.27±0.21	27.37±0.06	5.40±0.21
C1	7.17±0.21	27.40±0.10	5.37±0.20
C2	7.23±0.23	27.47±0.12	5.43±0.25
C3	7.30±0.26	27.50±0.10	5.17±0.15
Reference	7.00-8.50 ^a	27.00-30.00 ^b	4.00-8.00 ^b

Note: Salinity of all test media was maintained at 34 ppt. (a) WWF-Indonesia (2015); (b) Yudhiyanto et al (2017).

Optimization of treatment dosage

Parameters	Treatment dosage
SGR	1.4243%
WGR	1.4235%
SR	1.0227%

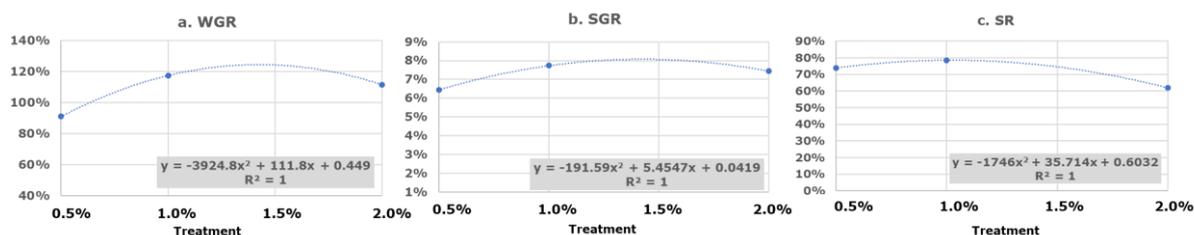


Figure 1. Polynomial modelling of SGR, WGR, and SR.

Feed treatment with dosage optimization in this research produced the best outcomes within the range of 1-1.5%. Based on the polynomial modelling, the optimal dosage for SGR was 1.4243%, for WGR was 1.4235%, and for SR was 1.0227%. These results confirm that feed additives at a dosage between 1 to 1.4% can enhance fish growth and survival optimally. Figure 1 illustrates a quadratic curve pattern, showing an increasing trend at low to moderate dosages, followed by a decline at higher dosages (2%). This condition demonstrates that the precise use of feed additives provides significant benefits, whereas excessive application leads to decreased fish performance.

Discussion. Common cumin as a feed additive has been widely reported to act as immunostimulant, antioxidant, and growth promoters when applied at appropriate doses. The main bioactive compounds in common cumin such as thymoquinone, saponins, cuminaldehyde, flavonoids, and alkaloids enhance immune responses, antioxidant activity, and feed utilization efficiency (Patra & Saxena 2009; Monteiro-Neto et al 2020; Singh et al 2021). However, excessive dose of these bioactive compounds may become toxic. Excessive doses of common cumin can suppress growth and survival rates by increasing oxidative stress and disrupting metabolic processes (Hosseinzadeh et al 2013; Wang et al 2022). Saponins at excessive dose can also cause erythrocyte hemolysis and reduce digestive enzyme activity. Therefore, it is crucial to determine the optimal dose to achieve biological benefits without adverse effects.

In hybrid grouper culture, growth performance indicators such as SGR and WGR, and SR are influenced by internal and external factors. The internal factors include physiological condition, genetics, and fish health, whereas external factors consist of feed quality, stocking density, husbandry practices, and water quality (Lin et al 2024; Márquez et al 2024; Kolygas et al 2025). High-quality feed with sufficient protein and energy can maximize the growth and feed conversion efficiency (Huang et al 2024). Feed size and feeding frequency should also be accurately determined and adjusted to the requirements to optimize feed conversion. Additives such as probiotics, enzymes, or herbal ingredients like common cumin can also be added at the right dose to enhance digestibility, improve feed conversion ratio (FCR), and stimulate immune responses, ultimately improving SGR, WGR, and SR (Halver & Hardy 2002; Guerreiro et al 2018; Wang et al 2020; Huang et al 2023; Han et al 2024).

The SR of hybrid grouper is also affected by the cannibalistic nature of the fish during the early nursery phase, particularly when juveniles are smaller than 5 cm. Cannibalism is driven by the carnivorous and aggressive nature of groupers which can be exacerbated by insufficient feed supply, irregular feeding schedules, size variation among juveniles, and high stocking density (Rimmer et al 2004; Sugama et al 2012). Effective management that includes regular size grading, proper stocking density, and timely feeding is essential to reduce cannibalism by 20-40% during early rearing.

The findings of this research reinforce the potential of common cumin as a natural nutraceutical ingredient to be added to fish feed. Herbal additives are increasingly favoured over synthetic antibiotics due to their safety, environmental friendliness, and minimal harmful residues that can lead to antimicrobial resistance (Harikrishnan et al 2011; Park et al 2021; Varghese et al 2021; Wijayanto 2023). Previous research has demonstrated that dietary supplementation of common cumin enhances growth, feed efficiency, and disease resistance in various species such as shrimp and Nile tilapia (*Oreochromis niloticus*) (El-Dakar et al 2004; Deng et al 2023; Niroomand et al 2024). Similar effects have been reported in marine fish, where herbal feeds containing common cumin improved protein digestion, reduced oxidative stress, and strengthened immunity (Elumalai et al 2020). The antioxidant property of cuminaldehyde has been shown to mitigate oxidative stress under intensive culture conditions which support sustainable aquaculture practices (Kareem et al 2016; Yang et al 2016).

The results of the optimization analysis in this research indicated that the addition of common cumin of 1-1.5% to the fish feed provided the best balance between growth and survival rates of the fish. The quadratic response pattern observed shows positive effects at low to moderate dosages followed by performance decline at higher doses. The finding aligns with previous reports on *O. niloticus*, where supplementation of 1-2% common cumin improved growth and feed efficiency (El-Dakar et al 2004; Li et al 2021), and on *Litopenaeus vannamei*, where 1% supplementation enhanced SR, growth, and feed utilization (Asadi et al 2018; Niroomand et al 2024).

In general, the present research demonstrates that incorporating common cumin into grouper diets at the proper dosage is an innovative and environmentally sustainable strategy for improving aquaculture productivity. Common cumin can be an alternative nutraceutical solution for intensive and eco-friendly marine fish farming as it enhances the fish growth performance, feed efficiency, and disease resistance, while reducing the use of synthetic antibiotics. Further research on lower dosage ranges, other test species, and larger culture scales should be performed to guarantee the consistency and applicability of these findings under commercial farming conditions.

Conclusions. Common cumin (*C. cyminum*) shows a potential as a natural feed additive to improve the growth performance and survival of hybrid grouper. The best outcomes were observed at the 1% dose, yielding a WGR of 117.4%, SGR of 7.732%, and SR of 78.57%. Nevertheless, statistical analysis showed no significant differences ($p > 0.05$) among treatments. Polynomial modelling suggested that the optimal dietary dose of common cumin ranges between 1.02 and 1.42%. Further research with longer experimental durations and smaller dosage intervals (1-2%) need to be conducted to refine the optimal range. In addition, economic feasibility assessments such as benefit–cost ratio and palatability testing are also deemed necessary to evaluate technical and economic viability in the fish farming.

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

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