Volume 9, Issue 12, pp. 20-23, 2025.
International Journal of Scientific Engineering and Science
ISSN (Online): 2456-7361

Fish Feed Enriched with *Eucheuma cottonii* to Enhance the Growth of Nile Tilapia (*Oreochromis niloticus*)

Stella Feska[1], Darsef Darwis[2], Rifka Liling Palinggi[1], Wijayanti Ristyaningrum[1], Adimas Bagus Fahturohman[1]
[1]Department of Aquaculture, Faculty of Animal Husbandry, Marine and Fisheries, Universitas Nusa Cendana, Kupang, East Nusa Tenggara, Indonesia-85001
[2]Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta, Jakarta, Indonesia -13220
Corresponding author: stella.feska@staf.undana.ac.id

Abstract—*Feed represents the predominant component of production costs in aquaculture, contributing approximately 80% of total expenses. High quality feed is essential for cultivating healthy, nutrient dense fish. This study aimed to formulate an Eucheuma cottonii seaweed based diet for Nile tilapia (Oreochromis niloticus) enriched with fatty acids, amino acids, minerals, and vitamins. Ninety male tilapia fingerlings were randomly allocated into three experimental groups with three replicates each, receiving diets F1, F2, and F3 over a 12 weeks feeding period. Fish body weight and total length (head to tail) were measured biweekly to evaluate growth performance. Results revealed that Eucheuma cottonii flour supplementation significantly improved absolute weight gain and absolute length gain (P < 0.05) in Nile tilapia, but had no significant impact on specific growth rate, feed utilization efficiency, feed conversion ratio or survival rate.*

Keywords— *Eucheuma cottonii, feed, weight, length, Nile tilapia.*

I. INTRODUCTION

Fish and fishery products constitute a critical component of the human diet and contribute substantially to maintaining health. They supply high-quality protein, omega-3 polyunsaturated fatty acids (n-3 PUFA) and key micronutrients, including vitamin D, selenium, calcium, iodine, and iron [1]. Habitual fish consumption has been associated with multiple health benefits, notably enhanced neurodevelopment during infancy and a lower risk of cardiovascular inflammatory disorders and insulin resistance [2].

Growing global population, rising incomes, and a dietary shift favoring animal over plant protein have driven a marked increase in demand for fish as a food source. Fish for human consumption is obtained primarily from two sectors, wild capture fisheries and aquaculture [3]. In Indonesia, total fisheries production in 2024 reached 17.65 million tons, corresponding to an average annual fish consumption of 62.5 kilograms per capita, an increase from 58.48 kilograms in the previous year, whereas fishery production volume as of November 2022 was reported to 10.25 million tons [4].

Aquafeeds continue a critical component in aquaculture production, representing approximately 50% of the variable production costs. The high nutritional requirements of fingerling feed, particularly with protein levels reaching up tp 40%, contribute significantly to their elevated cost [5]. Fish oil, the primary source of polyunsdaturated fatty acid (PUFAs) in aquafeeds is costly, with about 75% of the global annual fish oil production being utilized as a feed ingredient in aquaculture [6]. This extensive use decreases the availability of fish oil for direct human consumption, a situation further compounded by stagnant fish oil production levels [7]. Consequently, there is an urgent need to identify sustainable and economically viable alternative PUFA sources for aquafeeds. Seaweeds emerge as a promising candidate given their content of omega-3 fatty acids, specifically eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). These omega-3 fatty acids play a vital role in fish physiology by supporting cellular metabolism and maintaining the structural integrity of cell membranes [8].

Nile tilapia, like other aquatic organisms, require adequate nutrients such as proteins, lipids, and carbohydrates, followed by essential vitamins and minerals, for optimal growth, reproduction, and immune function [9]. A comprehensive understanding of these fundamental nutritional principles is critical for ration formulation and feed development. Nutrient deficiencies in fish can lead to various health disorders and potentially mortality. Incorporating seaweed flour as a feed ingredient can enhance the nutritional profile of Nile tilapia diets. Seaweed are rich in carbohydrates, proteins, fats, fibers, and contain high levels of essential amino acids, nucleic acids, as well as vitamin A, B, C, D, E, and K, alongside minerals such as magnesium, calcium, iodine, and sodium [10]. Specifically, *Eucheuma cottonii* seaweed has been reported to contain 9.76% protein, 1.10% lipid, 26.49% carbohydrate, 46.19% ash, 5.91% crude fiber, and 10.55% moisture. Additionally, seaweed is a source of potassium, calcium, magnesium, sodium, iron, zinc, iodine, vitamin C, and vitamin E, further contributing to its value as a nutritional supplement in aquafeeds [11].

Asaduzzaman et al [12] investigated the effects of Hypnea musciformis seaweed supplementation in feed on the growth performance and immune response of Nile tilapia (*Oreochromis niloticus*). Hematological parameters assessed included red blood cell (RBC) count, white blood cell (WBC) count, hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC). The results revealed that the highest RBC count (3.23 x 106 cells mm-3) and WBC count (12.86 x

All rights reserved

103 cells mm-3), along with superior values for other parameters, occured in treatment T4 compared to T3, T2, T1, indicating that seaweed supplementation positively influences fish growth ang immunity.

Study by Dantagnan et al [13] demonstrated that feeding rainbow trout with the brown seaweed Macrocystis pyrifera increased total muscle PUFA and omega-3 PUFA contents by approximately 73% and 64% respectively. The incorporation of plant derived ingredients at different inclusion levels in aquafeeds can also influence final product quality, including lipid profile, amino acid composition, fillet color, and texture. Evaluating the nutritional utilisation of any prospective feed ingredient through feeding trials and subsequent assessment of growth responses is a critical step in determining its suitability for aquafeed formulation. In this context, the present study aimed to investigate the effects of dietary supplementation with the brown seaweed Eucheuma cottonii on growth performance, body weight, and length of Nile tilapia.

II. Materials and Methods

Forty kilograms of Eucheuma cottonii seaweed were collected by hand-picking from Tablolong Village, Kupang, East Nusa Tenggara, Indonesia. The seaweed was initially washed with seawater to remove epiphytes and debris, then transported to Universitas Negeri Jakarta. There, it was rinsed under running tap water, oven-dried at 40°C for 24h to constant weight using a hot-air oven, and subsequently pulverized into fine powder. Other feed ingredients, including fish meal, earthworm powder, wheat bran, cassava flour, and vegetable oil, were procured from local suppliers.

A. The Feed Preparation

The dry ingredients for the diets were ground using a BArrisio Omniblend mill (model TM-767) and subsequently passed through a 1 mm mesh sieve (Endecotts Ltd, model BS419/1986). The ground ingredients were accurately weighed in triplicate and thoroughly mixed to archieve homogenization for the preparation of the experimental diets. The specific proportions of each ingredient utilized are detailed in Table 1.

TABLE I. Table formulation of the diets ingredients content in the feed in g/kg.

No.	Raw material (g/Kg, dryweight)	Formula 1 (F1)	Formula 2 (F2)	Formula 3 (F3)
1	Fish meal	100	100	100
2	Wheat bran	222	222	222
3	Wheat pollard	222	222	222
4	Cassava flour	75	75	75
5	Earthworn flour	169	75	75
6	Palm oil	50	50	50
7	Taro flour	152	152	152
8	Vitamin, mineral	10	10	10
9	*Eucheuma cottonii* powder	0	50	100

Diet formulation followed PEarson's square method, with fishmeal incorporated at a fixed 10% inclusion level across all diets, consistent with recommendations for organic aquaculture [8]. Experimental diets included seaweed supplementation at 0% (control), 5%, and 10% inclusion levels. Palm oil and water were added to the homogenized dry mixture to form a soft dough consistency, which was then extruded through a 2 mm die plate using an automated meat mincer. The resulting 2 mm pellets were sun dried to constant weight and stored in airtight containers until the feeding trial commenced.
Bulk density of feedn easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it.

B. Bulk Density of Feed

The measuring cup was weighed empty, after which feed was added and leveled by gentle shaking. The cup was reweighed, and the feed weight was determined by difference, with its volume measured directly. Bulk density was subsequently calculated using the standard equation.

$$\text{Bulk density} = \frac{\text{Weight of feed}}{\text{Volume of feed}}$$

C. Experimental Set-Up

Cylinder tank preparation, ninety fingerlings were randomly allocated into nine circular cylindrical tanks, each with a capacity of 50 liters, arranged in a completely randomized block design with three replicates per treatment. Each tank was stocked with 10 fingerlings and filled with 30 liters of water, resulting in a stoking density of 10 fish per tank. The fingerlings had an initial average weight of 26.11±0.60 g and an average length of 8.5±0.04 cm (head to tail). Prior to the experiment, fish were acclimated to the experimental conditions to minimize environmental stress. The cylindrical tanks were thoroughly cleaned and dried for 24 hours before use.

Measuring cup was weighed empty, after which feed was added and leveled by gentle shaking. The cup was reweighed, and the feed weight was determined by difference, with its volume measured directly. Bulk density was subsequently calculated using the standard equation.

D. Fish Maintenance

The feeding trial lasted 8 weeks, during which fish were fed 5% of their body weight twice daily at 10:00 and 16:00. Body weight and length measurements were conducted at weeks 4 and 8, with individual fish weighed using an analytical balance (0.1 g precision) and measured directly.

E. Monitoring Water Quality

Water quality was maintained through daily siphoning and partial water exchange equivalent to 20% of the total tank volume. Water quality parameters, including temperature, pH, total dissolved solids (TDS), and conductivity, were measured every 10 days using a digital multi-parameter probe, with assessments conducted weekly.

F. Growth Parameter

Fish growth performance was evaluated through measurements of the body weight, length, survival rate, and feed efficiency indices, including specific growth rate (SGR) and condition factor (K). These parameters were calculated using the standard equations presented below.
Survival Rate

$$\text{SR}(\%) = \frac{\text{Number of live Nile tilapia at end of experiment}}{\text{Initial number of Nile tilapia}} \text{ x } 100$$

http://ijses.com/
All rights reserved

International Journal of Scientific Engineering and Science
Volume 9, Issue 12, pp. 20-23, 2025.
ISSN (Online): 2456-7361

Weight Gain

$$WG\ (g) = \text{Average final weight} - \text{Average initial weight}$$

Length Gain

$$LG\ (cm) = \text{Average final length} - \text{Average initial length}$$

Survival Growth Rate

$$SGR\ (\%) = \frac{\ln \text{ of final weight} - \ln \text{ of initial weight}}{\text{Experiment period}} \times 100$$

Condition Factor

$$CF = \frac{\text{Final weight (g)}}{\text{Final length (cm)}}$$

Feed Conversion Ratio

$$FCR = \frac{\text{Total feed intake (g)}}{\text{Total wet weight gain (g)}}$$

Feed Utilization Efficiency

$$EPP = \frac{\text{Final weight} - \text{initial weight}}{\text{Amount of feed consumed (g)}} \times 100\%$$

G. *Proximate Analysis of The Feed*

Proximate composition analysis of the experimental diets and fish muscle, including moisture, crude protein, crude lipid, crude fat, crude fiber, and ash content, was conducted following the AOAC method 950.46 specifications (AOAC, 1995).

Moisture content was determined by weighting 2 g of sample into pre-weighed moisture dishes, which were then placed in an oven preheated to 105°C for 3 h. After drying, dishes were cooled in a desiccator, reweighed, and moisture calculated as the percentage weight loss (AOAC method 925.10, 1995). Ash content was determined by incinerating samples in an electric muffle furnace at 550°C for 12 h.

III. RESULT

A. *Growth Performance of Nile tilapia*

The results on the growth performance and survival of *Eucheuma cottonii* are presented in Table 2.

TABLE 2. Growth performance and survival rate of Nile tilapia fed on three different diets for 8 weeks

Formula	Weight(g)		Length(cm)		SR	SGR	FCR	CF
	Final	Gain	Final	Gain				
1	55.19	24.08	`11.63	3.13	93.33	0.33	1.55	0.02
2	58.61	11.63	11.62	3.12	100	0.36	1.60	0.02
3	62.12	35	12.37	3.87	100	0.38	1.64	0.02
LSD	5.80	5.80	1.23	1.23	6.66	0.04	0.04	0.002

B. *Vitamin Composition*

The experimental diets were supplemented with the following vitamins per kg vitamin A (600 IU), vitamin D3 (100 IU), vitamin e (3 IU), vitamin K (menadione, 0.42 mg), vitamin B1 (0.25 mg), vitamin B2 (0.6 mg), vitamin B6 (0.5 mg), vitamin B12 (0.0011 mg), nicotinic acid (2.5 mg), pantothenic acid (2.2 mg), folic acid (0.15 mg), biotin (0.001 mg), and vitamin C (1 mg).

C. *Mineral Composition*

Mineral included per kg of diet copper (0.5 mg), manganese (15 mg), zinc (4.5 mg), iodine (0.14 mg), selenium (0.012 mg), choline chloride (15 mg), and iron (4 mg).

D. *Body Weight*

Final body weight and weight gain of Nile tilapia increased progressively with higher levels of seaweed supplementation, with fish fed the 10% seaweed diet exhibiting the highest values (62.12 g and 25 g, respectively). Dietary seaweed inclusion had no significant effect on fish length or condition factor. Survival rate was lowest in the control group (93.33%), while spesific growth rate (SGR) showed a significant difference ($P < 0.05$) between the control (0.33%) and 10% seaweed treatments (0.38%), with SGR increasing in tandem with seaweed supplementation levels. Asaduzzaman et al. [12] reported that Nile tilapia fed diets containing 30% Hypnea musciformis achieved an average weight gain of 12.49 g and specific growth rate (SGR) of 5.69% day^{-1} in a recirculating aquaculture system. Similarly, Rakocy et al. [16] documented an SGR of 4.4% day^{-1} for Nile tilapia in an intensive aquaponic production system integrated with basil cultivation. These findings indicate that the growth performance observed in the present study with seaweed supplemented feeeds was highly satisfactory.

The elevated feed conversion ratio (FCR) observed is attributed to the high fiber content in the diets, which reduces fish digestibility. Hilton explained that protein digestibility declines due to fish physyological limitations in digesting proteins beyond a certain threshold, particularly influenced by crude fiber levels in plant based feed ingredients. Additionally, FCR is affected by multiple factors, with Erich et al. [18] identifying feed quality and quantity, fish species, size, and water quality as the most critical determinants.

After 8 weeks of feeding with artificial diets supplemented with varying concentrations of *Eucheuma cottonii* flour, Nile tilapia survival rates raanged from 93.93% to 100%. Statistical analysis revealed no significant effect of seaweed flour supplementation on the survival rate of Nile tilapia fingerlings.

E. *Bulk Density of The Feed*

Bulk densities and sinking velocities of the experimental pellets are presented in Figure 1. No significant differences were observed in bulk densities among the control diet and seaweed supplemented diets, with the 10% seaweed treatment exhibiting the highest value (354 g/L). Pellet sinking velocities differed significantly ($P < 0.05$) across treatments, with the control diet density and sinking velocity.

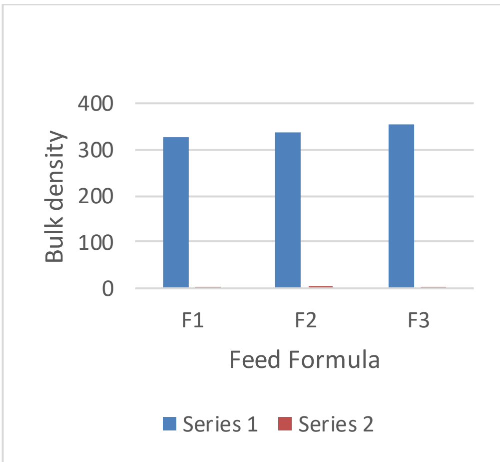

Fig. 1. Effect of formula feed on bulk density

F. *Feed Utilization Efficiency*

http://ijses.com/
All rights reserved

International Journal of Scientific Engineering and Science
Volume 9, Issue 12, pp. 20-23, 2025. ISSN (Online): 2456-7361

After 8 weeks of feeding artificial diets supplemented with varying concentrations of *Eucheuma cottonii* flour, feed utilization efficiency in Nile tilapia ranged from 33.78% to 39.99%. Statistical analysis indicated no significant effect of seaweed flour supplementation on feed utilization efficiency.

G. Proximate Analysis of The Feed

No significant differences ($P > 0.05$) were observed in muscle dry matter content across the three experimental diets. Crude ash content showed no significant difference ($P > 0.05$) between the control diet and the 10% seaweed supplemented diet, however ash content was significantly lower ($P < 0.05$) in fish fed diet 2 compared to diet 3, as presented in Table 3.

TABLE 3. Proximate Composition of The Fish Feed

No.	Proximate	F1	F2	F3	pValue
1	Dry matter	94.66	93.41	93.89	0.005
2	Ash content	7.35	8.88	9.57	0.0018

Ash content in feed served as an indicator of mineral concentration, with higher levels reflecting greater inorganic content. These minerals are essential for fish growth, metabolic processes, and osmotic balance maintenance. Dietary minerals can minimize osmoregulatory ion losses by replenishing expended ions, thereby conserving energy for somatic growth.

H. Water Quality

Water quality parameters during 8 weeks Nile tilapia maintenance period are presented in Table 4.

No.	Parameter	F1	F2	F3	pValue
1	pH	8.1	8.1	7.9	0.005
2	Temperature (°C)	27	27	27	0.005
3	TDS (mg/L)	0.15	0.12	0.13	0.005
4	Conductivity (µS/cm)	234	215	231	0.005

Data from Table 4 indicate that water quality parameters remained within acceptable ranges for Nile tilapia culture throughout the 8 weeks trial.

IV. Conclusion

This study demonstrates that incorporating 5% and 10% *Eucheuma cottonii* into aquafeeds enhances the fatty acid profile of Nile tilapia (*Oreochromis niloticus*), while simultaneously improving growth performance and proximate composition. Diets containing 10% seaweed significantly elevated key growth metrics, including final body weight and specific growth rate. Seaweed supplementation increased protein, ash, and nitrogen free extract levels in the feed, as well as lipid and fiber contents in fish muscle. It also boosted omega-3 fatty acids across treatments and optimally enhanced omega-6 levels at 5% inclusion. Consequently, low-level *Eucheuma cottonii* inclusion in fish feeds offers potential to enrich polyunsaturated fatty acid content while promoting overall growth.

References

[1] Maria Qubay, Maheswara Rao Vegi, Eric Mutegoa. 2025. Proximate composition and mineral content of the common fish species in the selected lakes of Tanzania. *Journal of Food Composition and Analysis,* 142.

[2] Ni Li, Xiaoting Wu, Wen Zhuang, Lin Xia, Yi Chen, Chuncheng Wu, Zhiyong Rao, Liang Du Rui Zhao, Mengshi Yi, Qianyi Wan, Yong Zhou. 2020. Fish consumption and multiple health outcomes: Umbrella review. *Trends in Food Science & Technology,* 99: 273-283.

[3] FAO Report: 2024. Global fisheries and aquaculture production reaches a new record high.

[4] Ministry of Marine Affairs and Fisheries Indonesia report: Performance report triwulan 2024.

[5] Klinger, D., & Naylor, R. 2012. Searching for solutions in aquaculture: charting a sustainable course. *Annual Review of Environment and Resources,* 37: 247-276.

[6] Auchterloneie, N. 2018. The continuing importance of fishmeal and fish oil in aquafeeds. *In Aquafarm Conference, Pordenone,* Italy: 15-16.

[7] Sheperd, C.J., & Jackson, A.J. 2013. Global fishmeal and fish-oil supply: inputs, output and markets. *Journal of Fish Biology,* 83: 1046-1066.

[8] Sneh Punia, Kawaljit Singh Sandhu, Anil Kumar Siroha, sanju Bala Dhull. 2019. Omega 3 metabolism, absorption, bioavailability and health benefits-A review *Pharma Nutrition*, 10:100162.

[9] Santoso P.Lall, Andre Dumas. 2022. Nutritional requirements of cultured fish: formulating nutritionally adequate feeds. Seed and Feeding Practices in Aquaculture (Second Edition) Woodhead Publishing Series in *Food Science, Technology and Nutrition*: 65-132.

[10] Bocanegra, A., Bastida, S., Benedi, J., Rodenas, S., & Sanchez-Muniz, F.J. 2009. Characteristics and nutritional and cardiovascular-health properties of seaweeds. *Journal of medicinal food,* 12: 236-258.

[11] Matanjum, P., Mohamad, S., Mustapha NM., Muhammad K. 2009. Nutrient Content of Tropical Edible Seaweeds Eucheuma cottonii, Caulerpa lentilifera, and Sargassum polycystum. *Journal of Applied Phycology,* 21: 75-80.

[12] Assaduzzaman Nur, Md., Foysul Hossain, Md., Nahid Hasan, Saida Zannat, Koushik chakroborty and SM Rafiquzzaman. 2020. Effect of selected seaweed powder as a fish feed on growth and immune system of Nile Tilapia Oreochromis niloticus). *International journal of Fisheries and Aquatic Studies.* 8: 24-30.

[13] Dantagnan, P., Hernandez, A., Borquez, A., &Mansilla, A. 2009. Inclusion of macroalgae meal (*Macrocystis pyrifera*) as feed ingredient for rainbow trout (*Oncorhynchus mykiss*): effect on flesh fatty acid composition. *Aquaculture Research,* 41: 87-94.

[14] De Francesco, M., Parisi, G., Medale, F., Lupi, P., Kaushik, S.J., & Poli, B. M. 2004. Efffect of long-term feeding with a plant protein mixture-based diet on growth and body/fillet quality traits of large rainbow trout (*Oncorhynchus mykiss*). *Aquaculture,* 236: 413-429.

[15] Glencross, B.D. 2020. A feed is still only as good as its ingredients: An update on the nutritional research strategies for the optimal evaluation of ingredients for aquaculture feeds. *Aquaculture Nutrition,* 26: 1871-1883.

[16] Rakocy JE, Masser MP, Losordo TM. 2006. Resirculating aquaculture tank production systems: Aquaponics-integrating fish and plant culture. SRAC Publication No. 454.

[17] J. W. Hilton, J.L. Atkinson, S.J. Singer. 2011. Effect of Increased Dietary Fiber on The Growth of Rainbow Trout (Salmo gairdneri). *Canadian Journal of Fisheries and Aquatic Sciences,* 40: 81-85.

[18] Eirch H Van Ham, Marc H. G. Berntssen, Albert Imsland. 2003. The influence of temperature and ration on growth, feed conversion, body composition and nutrient retention of juvenile turbot (*Scophthalmus maximus*). *Aquaculture*, 217: 547-558.

http://ijses.com/
All rights reserved