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GROWTH PERFORMANCE OF NILE TILAPIA SEEDS (*Oreochromis niloticus*) THAT WAS GIVEN FERMENTED FEED BASED ON COCONUT WATER

Pertumbuhan Benih Ikan Nila (*Oreochromis niloticus*) Yang Diberi Pakan Fermentasi Berbasis Air Kelapa

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ABSTRACT

Research on fermented feed based on green coconut water combined with molasses and EM4 in the maintenance of tilapia (Oreochromis niloticus) fry in flooded soil ponds has not been conducted until now. Therefore, research using fermented feed needs to be conducted to obtain the right usage technique. This study aims to determine the effective dose of coconut water to improve the growth performance of tilapia fry maintained in soil ponds. This study used a completely randomized design (CRD) with four treatments and three replications. The treatments given in this study consisted of treatment A (Treatment without giving green coconut water, commercial pellet feed 1 kg + 200 mL boiled water + 20 mL molasses + 10 mL EM4 probiotic), B (Treatment commercial pellet feed 1 kg + 150 mL boiled water + 50 mL coconut water + 20 mL molasses + 10 mL EM4 probiotic), C (Treatment commercial pellet feed 1 kg + 100 mL boiled water + 100 mL coconut water + 20 mL molasses + 10 mL EM4 probiotic), and D (Treatment commercial pellet feed 1 kg + 200 mL coconut water + 20 mL molasses + 10 mL EM4 probiotic). Tilapia seeds measuring 2.66-3.06 g were randomly spread into 12 hapa nets measuring 1x1x1 m3, which were installed in an earthen pond with a stocking number of 30 fish/hapa net. The test fish were kept for 28 days and given test feed with a frequency of 1 time/day. The research parameters consisted of harvest biomass (Bt), daily growth rate (DGR), feed conversion ratio (FCR), feed efficiency (EP), and survival rate (SVR). Providing fermented feed based on green coconut water with the lowest and highest doses did not provide optimum results on the growth of catfish. Optimum results were obtained in treatment B.

Keywords: Growth Performance, Coconut Water, *Oreochromis niloticus*.

ABSTRAK

Penelitian mengenai pakan fermentasi berbasis air kelapa yang dikombinasikan dengan molase dan EM4 pada pemeliharaan benih ikan nila (*Oreochromis niloticus*) di kolam tanah tergenang hingga saat ini belum dilakukan. Oleh karena itu, penelitian menggunakan fermentasi pakan tersebut perlu dilakukan untuk memperoleh teknis penggunaan yang tepat. Penelitian ini bertujuan untuk mengetahui dosis air kelapa yang efektif untuk meningkatkan kinerja pertumbuhan benih ikan nila yang dipelihara di kolam tanah. Penelitian ini menggunakan rancangan acak lengkap (RAL) dengan empat perlakuan dan tiga ulangan. Perlakuan yang diberikan pada penelitian ini terdiri atas perlakuan A (Perlakuan tanpa pemberian air kelapa, pakan pellet komersial 1 kg + air matang 200 mL + molase 20 mL + probiotik EM4 10 mL), B (Perlakuan pakan pellet komersial 1 kg + air matang 150 mL + air kelapa 50 mL + molase 20 mL + probiotik EM4 10 mL), C (Perlakuan pakan pellet komersial 1 kg + air matang 100 mL + air kelapa 100 mL + molase 20 mL + probiotik EM4 10 mL), dan D (Perlakuan pakan pellet komersial 1 kg + air kelapa 200 mL + molase 20 mL + probiotik EM4 10 mL). Benih ikan nila berukuran 2,66-3,06 g ditebar secara acak ke dalam 12 unit jaring hapa berukuran 1x1x1 m3, yang dipasang dalam kolam tanah dengan jumlah tebar 30 ekor/jaring hapa. Ikan uji dipelihara selama 28 hari dan diberi pakan uji dengan frekuensi 1 kali/hari. Parameter penelitian terdiri atas biomassa panen (Bt), laju pertumbuhan harian (LPH), feed conversion ratio (FCR), efisiensi pakan (EP), dan tingkat kelangsungan hidup (TKH). Pemberian pakan fermentasi berbasis air kelapa hijau dengan dosis yang terendah dan tertinggi tidak memberikan hasil yang optimum pada pertumbuhan ikan patin. Hasil optimum diperoleh pada perlakuan B.

Kata kunci: Kinerja Pertumbuhan, Air Kelapa, *Oreochromis niloticus*.

INTRODUCTION

Tilapia is one of the cosmopolitan species that has physiological adaptation competence and is very tolerant to aquatic environmental conditions, both freshwater and brackish ponds, because it is able to survive and maintain very good growth performance (Cnaani & Hulata 2011) related to the balance of osmotic and bioenergetic homeostasis control regulations (Kultz 2015). Several species or strains of tilapia that live with relatively high growth performance and disease resistance in Indonesia include JICA, Nirwana, Gesit, Larasati, BEST, Anjani, Srikandi, Sultana, red tilapia Nilasa, Salina and Sukamandi tilapia (*Oreochromis* spp.) (Setyawan *et al*., 2022). According to Dewi *et al*., (2012) tilapia can grow optimally in addition to improving health status, if the pond or pond where it lives is abundant with a diversity of phytoplankton and zooplankton species, especially *Calanus* sp., *Acartia* sp., and *Fillinia* sp.

The acceleration of aquaculture productivity in 2024 is evidence of the implementation of the significant performance of the Ministry of Maritime Affairs and Fisheries to develop aquaculture villages in the integrated farming smart aquaculture framework. Tilapia (*Oreochromis niloticus*) is one of the leading economically important commodity species in order to support and realize Indonesia's food security among the other five mainstay species, namely shrimp, lobster, crab and seaweed. Indonesia's total tilapia production reaches around 1.4 million tons, experiencing a significant increase compared to 2023 of 1.3 million tons (DJPB 2024). This shows that the increasing need for tilapia meat consumption is increasingly strategic from year to year, considering the content of essential amino acids and the soft texture of the meat and its good taste.

The success of tilapia aquaculture production cannot be separated from the innovation approach and cultivation technology that is based on the principle of eco-friendly orientation and local socio-economic wisdom of the community. Various efforts to increase the harvest biomass of this fish species have been carried out carefully, one of which is through nutritional engineering, including the use of probiotics, prebiotics, synbiotics and biofloc. Probiotics in general from the genus Bacillus and Lactobacillus, as well as Aspergillus oryzae and Chlorella vulgaris can improve growth performance, kidney, liver and gill performance against the effects of chronic sodium arsenite toxicity and tilapia immunity against various potential pathogens, such as *A. hydrophila P. fluorescens* and *S. iniae* (Dawood *et al*., 2019; Van Doan *et al*., 2018; Wael *et al*., 2009; Zahran *et al*., 2019). Likewise, the various important benefits of the application of prebiotics MOS, β-glucan, MOS, FOS, inulin and Helianthus tuberosus and the use of synbiotics (combination of probiotics with prebiotics) Bacillus sp. and sweet potato oligosaccharides of Sukuh variety on increasing growth parameters and resistance of tilapia (Abd El-latif *et al*., 2015; Poolsawat *et al*., 2020; Selim & Reda 2015; Tiengtam *et al*., 2015; Widanarni & Tanbiyaskur 2015).

Exploration of new sources of probiotics and prebiotics continues to be carried out, considering the abundance of germplasm resources and the nutrient content in them is of very high quality, besides being very easy to prepare at a low price. One of these food crop products is coconut, whose water is thought to have the potential to be a prebiotic. Several superior varieties of dwarf coconut plants that have been released by the Ministry of Agriculture, Directorate General of Plantations of Indonesia, include the Salak dwarf coconut from South Kalimantan, the Pandan Wangi dwarf coconut from North Sumatra, and the Kopyor dwarf coconut from Pati, Central Java. Recently, the Ministry of Marine Affairs and Fisheries has tried to evaluate the innovative application of coconut water utilization in the tilapia aquaculture industry, namely the masculinization program for tilapia larvae for 2 weeks by mixing with feed, which was able to produce around 70% male tilapia seeds (DJPB 2024). However, studies on the application of coconut water to improve the growth performance of tilapia seeds have not been carried out so far. Therefore, on this occasion, it is necessary to test applied innovations in the form of research activities by fermenting coconut water-based tilapia seed feed to evaluate its growth performance.

METHODS

This study used a completely randomized design (CRD) consisting of four treatments of green coconut water supplementation doses in the feed fermentation process and three replications. The treatments were:

A. Treatment without giving coconut water, 1 kg commercial pellet feed + 200 mL boiled water + 20 mL molasses + 10 mL EM4 probiotics.
B. Commercial pellet feed treatment 1 kg + 150 mL boiled water + 50 mL coconut water + 20 mL molasses + 10 mL EM4 probiotics.
C. Commercial pellet feed treatment 1 kg + 100 mL boiled water + 100 mL coconut water + 20 mL molasses + 10 mL EM4 probiotics.
D. Commercial pellet feed treatment 1 kg + 200 mL coconut water + 20 mL molasses + 10 mL EM4 probiotics.

Place and Time

This research was conducted in April to May 2025 at a fish pond owned by local residents located on Jalan Soekarno, Palangka Village, Jekan Raya District, Palangka Raya City.

Alat dan Bahan

The tools used in this study include a digital scale with a capacity of 500 g x 0.01 g, 12 pieces of 1 x 1 x 1 m3 hapa nets, measuring cups, spoons, trays, thermometers, Lutron DO-5510 DO meters, and ATC digital pH meters. The materials used in this study were 360 tilapia fish, 1 L of green coconut water, EM4 probiotics, boiled water and commercial pellet feed with a protein content of 40%.

Procedure

Fermented Feed Making and Fish Maintenance

The feed used during maintenance was PF500 pellet feed containing 40% protein and 6% fat. Preparation of test feed was done by adding and mixing commercial feed with boiled water, coconut water, molasses and EM4 probiotics according to the treatment. Furthermore, the feed was fermented in a plastic thermos container for 3 days and after that it was ready to be given to the test fish. Maintenance of tilapia seeds was carried out for 30 days. Fish were fed once a day with a feeding rate of 3.75%. Feeding time was 12.00 WIB.

The fish used in this study were tilapia seeds obtained from the Mandiangin Freshwater Aquaculture Center, Banjarbaru, South Kalimantan. The test fish had an average initial weight of 2.66-3.06 g. The fish seeds were acclimatized for 7 days before being transferred into a hapa measuring (1x1x1) m3 as a research container. The stocking density of fish in each hapa was 30 fish. The water quality of the maintenance media is monitored during maintenance with the following parameters and ranges: temperature 30-31.9 ºC, DO 6.4-8.0 mg/L, and pH 6.79-7.37.

Data collection

Fish weight data was taken every 10 days during the 30-day maintenance period. Weight measurements were carried out using a digital weighing device with an accuracy of 0.01 g. Water quality was measured at the beginning, middle and end of the study. The water quality measured was temperature, pH and dissolved oxygen.

Research Parameters

The research parameters measured consisted of survival rate, amount of feed consumption, feed conversion ratio, feed efficiency, daily growth rate, final body weight and harvest biomass.

Data Analysis

Data analysis using Microsoft Excel 2016 and SPSS version 25.0 software. Statistical analysis was performed using SPSS version 25.0 software. Testing for homogeneity of variance and normality of data was performed using the Levene test and the Shapiro-Wilk test. Analysis of variance (one-way ANOVA) was then performed and significant differences between treatments were determined using the Duncan test using a 95% confidence interval. Explanation of the quality of the maintenance media water was done descriptively.

RESULT

Table 1. Initial body weight (Wo), final body weight (Wt), initial biomass (Bo), final biomass (Bt), difference between final and initial biomass (ΔB), amount of feed consumption (JKP), feed conversion ratio (FCR), feed efficiency (EP), daily growth rate (DGR), and survival rate (SGR) of tilapia fry with coconut water doses of 0 mL (A), 50 mL (B), 100 mL (C), and 200 mL (D) for 28 days of maintenance in a stagnant water pond.

Parameters / Treatment	Wo (g)	Wt (g)	Bo (g)	Bt (g)	ΔB (g)	JKP (g)	FCR	EP (%)	LPH (%/days)	TKH (%)
A1	2,27	5,39	68,23	145,58	77,35	102,92	1,33	75,16	2,71	90
A2	2,29	5,24	68,71	151,91	83,2	103,74	1,25	80,20	2,82	96,67

A3	2,61	5,38	78,35	140,00	61,65	118,18	1,92	52,17	2,07	86,67
B1	2,26	5,24	67,83	152,09	84,26	102,28	1,21	82,38	2,86	96,67
B2	2,77	6,03	83,00	181,01	98,01	125,26	1,28	78,25	2,79	100
B3	2,29	5,75	68,77	149,46	80,69	103,82	1,29	77,72	2,79	86,67
C1	2,00	4,55	60,00	122,85	62,85	90,56	1,44	69,40	2,57	90
C2	2,48	6,12	74,41	159,24	84,83	112,28	1,32	75,55	2,71	86,67
C3	2,57	5,46	76,95	136,55	59,6	116,18	1,95	51,30	2,07	83,33
D1	2,51	5,14	75,16	138,90	63,74	113,46	1,78	56,18	2,18	90
D2	2,16	5,00	64,75	134,88	70,13	97,74	1,39	71,75	2,61	90
D3	2,11	5,10	63,41	153,01	89,6	95,74	1,07	93,59	3,14	100

Table 2. Average values of initial body weight (Wo), final body weight (Wt), initial biomass (Bo), final biomass (Bt), difference between final and initial biomass (ΔB), amount of feed consumption (JKP), feed conversion ratio (FCR), feed efficiency (EP), daily growth rate (LPH), and survival rate (SVR) of tilapia fry with coconut water doses of 0 mL (A), 50 mL (B), 100 mL (C), and 200 mL (D) for 28 days of maintenance in stagnant water ponds.

Parameters/ Treatment	Wo (g)	Wt (g)	Bo (g)	Bt (g)	JKP (g)	FCR	EP (%)	LPH (%/days)	TKH (%)
A	2,39	5,34	71,76	145,83	108,28	1,5	69,18	2,53	91,11
B	2,44	5,67	73,20	160,85	110,45	1,26	79,45	2,81	94,45
C	2,35	5,38	70,45	139,55	106,34	1,57	65,42	2,45	86,67
D	2,26	5,08	67,77	142,26	102,31	1,41	73,84	2,64	93,33

DISCUSSION

Coconut water is one of the natural food products that is widely available throughout the world. This commodity provides nutritional content that can improve rehydration status and improve health. The treatment of a 50 mL coconut water dose in this study resulted in better daily growth rate, feed conversion ratio and harvest biomass values compared to treatments without the addition of coconut water, 100 and 200 mL. This fact is thought to be because the higher the dose of coconut water added to the feed fermentation process, the higher the acidity level of the final fermentation product. In line with this, it will cause the reduction of important nutrients contained in the feed which are very necessary to maintain basal metabolism and encourage growth. Jiang *et al*., (2023) said that the optimal fermentation duration can actually improve the nutrient value of the feed. The duration of fermentation affects the nutritional content (carbohydrates, protein, fat, water, ash, amino acids, and fatty acids), physical properties (hardness and elasticity), pH, and organoleptic properties (color, aroma, taste, and texture). In general, the longer the fermentation time, the higher the levels of carbohydrates, protein, fat, total ash content, total amino acids, total fatty acids, hardness and elasticity and the decreasing levels of organoleptic (color, aroma, taste, texture), elasticity, and water content. However, according to Afifah *et al*., (2023) the best time for mackerel sausage fermentation is 1 day compared to 2 and 3 days. One of the disadvantages of the fish feed fermentation method is that at the preparation stage, the amount of feed to be made must be adjusted to the number of fish being cultivated. This means that the duration of fish feed fermentation must be optimal and cannot be extended, in other words, the fermented fish feed product with a certain duration must be consumed by the aquaculture biota on that day.

The next thing that is also important and relevant to explain is the potential combination of coconut water doses above 50 mL and molasses as prebiotics is suspected to be antagonistic, resulting in limited production of certain enzymes by lactic acid bacteria and probiotics, both those deliberately added to the feed fermentation process, namely in the form of EM4 and microbiota in the intestine to hydrolyze and utilize both types of prebiotics. Each individual tilapia seed in each treatment group in this study is suspected to have different composition and biodiversity of microbiota in its intestines. This condition has the potential to cause differences in the values of the main growth performance parameters between replications, namely feed utilization efficiency, feed conversion ratio and daily growth rate, the indications are especially visible in the treatment without the addition of coconut water, coconut water doses of 100 mL and 200 mL. The balance of the composition and biodiversity of the intestinal microbiota of fish is greatly influenced by the type and quality of feed consumed, which will then have an impact on the efficiency of the digestion process and optimum absorption of feed nutrients, and ultimately will determine the improvement of fish growth performance. Several genera of probiotics and lactic acid bacteria that are commonly used in the feed fermentation process, namely Bacillus, Enterococcus, Lactobacillus, Saccharomyces, and Aspergillus, and the use of different microorganisms in the fermentation process produces different effects (Dawood and Koshio 2019; Yang *et al*., 2021). Bacillus and Aspergillus are generally used for protein and carbohydrate fermentation because they have high secretion and activity of protease and amylase digestive enzymes (Suprayogi *et al*., 2022). Chi and Cho (2016) found that Bacillus subtilis is able to maintain stability during the fermentation process while ensuring increased digestion, absorption and bioavailability of soybean meal flour during digestive metabolism. Enterococcus and Lactobacillus are generally used for carbohydrate fermentation, converting carbohydrates into lactic acid, and helping to break down some proteins and fibers (Graham *et al*., 2020). Lactobacillus plays an important role in the sensory, nutritional, and sanitation aspects of various fermented products, and produces various aromatic compounds that provide flavor (Pogacic *et al*. 2015; Zhang and Vadlani 2015). Saccharomyces (yeast) is a eukaryotic single-cell microorganism that can convert carbohydrates into carbon dioxide and alcohol (Yang *et al*., 2021), often used in biomass production, because it can quickly utilize various carbon sources and produce large amounts of protein (Kurcz *et al*., 2018).

Coconut water contains several active biological compounds such as proteins, amino acids, fatty acids, minerals, vitamins, and phenolic compounds. The results of the study by Shayanthavi *et al*., (2024) revealed that the bioactive compound content of young coconut water is highly dependent on the variety, including the King variety which has a significantly higher total sugar content (63.58 mg/mL) compared to the Ran thembili variety (43.80 mg/mL). In addition, both varieties have high total antioxidant activity and phenolic levels.

The latest discovery of nutritional content, especially antioxidant properties and arginine, indicates good potential in improving carbohydrate metabolism, absorption, bioavailability and use of glucose by body cells. Antioxidants and arginine are able to optimize the conversion of blood glucose, glycated hemoglobin, serum creatinine, blood urea, albumin, albumin/globulin ratio, enzymes that play a crucial role in the role and function of the liver as a central organ of metabolism, lipid profile, antioxidant status, and lipid peroxidation without significant hepatocellular damage. Arginine increases nitric oxide synthase activity in the liver and arginine levels in plasma. The arginine-nitric oxide system can maintain blood glucose homeostasis, improve insulin sensitivity, prevent and reduce oxidative stress (Azra *et al*., 2023).

Pavalakumar *et al*., (2024) isolated and characterized four species of indigenous lactic acid bacteria from naturally fermented young green coconut water: Lactiplantibacillus plantarum CWJ3, Lacticaseibacillus casei CWM15, Lacticaseibacillus paracasei CWKu14, and Lacticaseibacillus rhamnosus CWKu-12. Notably, among these isolates, Lactiplantibacillus plantarum CWJ3 showed remarkable acid tolerance, with the highest survival rate of 37.34% at pH 2.0 after 1 hour, indicating its higher resistance to gastric acid conditions. However, all strains showed strong resistance to bile salts, phenol, and NaCl, with survival rates exceeding 80% at certain concentrations. Their optimal growth at 37 °C and survival at 20 °C and 45 °C indicated their adaptability to various environmental conditions. In addition, all strains showed sustained survival in artificial saliva and artificial gastrointestinal fluid, with Lactiplantibacillus plantarum CWJ3 showing a significantly higher survival rate (70.66%) in artificial gastric fluid compared to other strains. Adhesion properties were of great importance, especially in Lacticaseibacillus rhamnosus CWKu-12, which showed the highest hydrophobicity, coaggregation with pathogens, and autoaggregation, among the strains. Production of exopolysaccharides, especially by Lactiplantibacillus plantarum CWJ3, increased its potential for intestinal colonization and biofilm formation. Various in vitro antioxidant tests using spectrophotometric methods revealed significant activity of Lactiplantibacillus plantarum CWJ3, while antimicrobial testing emphasized the ability to resist certain foodborne pathogens. Safety assessments confirmed the absence of biogenic amine production, hemolytic, DNase, and gelatinase activities, and the ability to hydrolyze bile salts. Furthermore, this non-dairy probiotic showed characteristics comparable to those of dairy-derived probiotics, indicating its potential suitability in the development of probiotic-rich food products and novel functional products.

CONCLUSION

Providing fermented feed based on green coconut water with the lowest and highest doses did not provide optimum results on the growth of tilapia seeds. Providing fermented feed that showed optimum results on the growth performance of tilapia seeds was providing fermented feed with a dose of 50 mL of green coconut water (treatment B).

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REFERENCES

Abd El-latif, A., Abd El-Gawad, E., & Emam, M. (2015) Effect of Dietary Fructooligosaccharide Supplementation on Feed Utilization and Growth Performance of Nile Tilapia (*Oreochromis niloticus*) Fngerlings. *Egypt J Aquac, 5*(3), 1–16. https://doi.org/10.21608/ eja.2019.46730

Afifah, D. N., Sari, I. R., Prastifani, N. T., Fulyani, F., Anjani, G., Widyastuti, N., Hastuti, V. N. (2023). Effect of Fermentation Time on Nutrition Content, Physical Properties, pH, Amino Acids, Fatty Acids Composition and Organoleptics on Fermented Mackerel Sausage (*Rastrelliger kanagurta* Cuvier) Characteristics. *International Journal of Food Studies*, p57. 10.7455/ijfs/12.1.2023.a4

Azra, J. M., Setiawan, B., Nasution, Z., Sulaeman, A., Estuningsih, S. (2023). Nutritional Content and Benefits of Coconut Water for the Diabetes Metabolism: a Narrative Review. *Amerta Nutrition, 7* (2), 317-325 https://doi.org/10.20473/amnt.v7i2.2023.317-325

Chi, C.H., Cho, S. J. (2016). Improvement of Bioactivity of Soybean Meal by Solid-State Fermentation With *Bacillus Amyloliquefaciens* Versus *Lactobacillus* spp. and *Saccharomyces cerevisiae*. *LWT-Food Sci Technol, 68*, 619e25. https:// doi.org/10.1016/j.lwt.2015.12.002.

Cnaani, A., & Hulata, G. (2011). Improving Salinity Tolerance in Tilapias: Past Experience and Future Prospects. *Isr. J. Aquacult. Bamidgeh,* 63. https://doi.org/10.46989/ 001c.20590.

Direktorat Jenderal Perikanan Budidaya. (2024). *Rencana strategis Direktorat Jenderal Perikanan Budidaya tahun 2020-2024.* Jakarta: Kementerian Kelautan Perikanan, Direktorat Jenderal Perikanan Budidaya.

Dawood, M. A., Koshio, S. (2019). Application of Fermentation Strategy in Aquafeed for Sustainable Aquaculture. *Rev Aquacult, 2019*. https://doi.org/10.1111/raq.12368.

Dewi, R. R. S. P. S., Setyawan, P., Tahapari, E., Robisalmi, A., & Listiyowati, N., (2012). Nutritive Composition of Red Tilapia Reared in Freshwater and Brackish Water. *Indonesia Aquac. J, 7*, 19–27. https://doi.org/10.15578/iaj.7.1.2012.19-27.

Graham, K., Stack, H., & Rea, R. (2020). Safety, Beneficial and Technological Properties of Enterococci for Use in Functional Food Applicationsea Review. *Crit Rev Food Sci Nutr, 60*(22), 3836e61. https://doi.org/10.1080/10408398.2019.1709800.

Jiang, W., Jia, X., Xie, N., Wen, C., Ma, S., Jiang, G., Li, X., Chi, C., Zhang, D., & Liu, W. (2023). Aquafeed Fermentation Improves Dietary Nutritional Quality and Benefits Feeding Behavior, Meat Flavor, and Intestinal Microbiota of Chinese Mitten Crab (*Eriocheir sinensis*). *Animal Nutrition, 14*,1-19. https://doi.org/10.1016/j.aninu.2023.04.002

Kultz, D. (2015). Physiological Mechanisms Used by Fish to Cope With Salinity Stress. *J. Exp. Biol, 218*(12), 1907–1914. https://doi.org/10.1242/jeb.118695.

Kurcz, A., Bła_ zejak, S., Kot, A.M., Bzducha-Wrobel, A., & Kieliszek, M. (2018). Application of Industrial Wastes for the Production of Microbial Single-Cell Protein by Fodder Yeast *Candida Utilis*. *Waste Biomass Valorization, 9*(1), 57e64. https:// doi.org/10.1007/s12649-016-9782-z.

MAO, Eweedah, N. M., Moustafa, E., & Shahin, M. G. (2019). Effects of Feeding Regimen of Dietary *F*on the Growth Performance, Intestinal Morphometry and Blood Profle of Nile Tilapia (*Oreochromis niloticus*). *Aquacult Nutr, 25*(5), 1063–1072. https://doi.org/10.1111/anu.12923

Pavalakumar, D., Undugoda, L. J. S., & Gunathunga, C. J. (2024). Evaluating the Probiotic Profile, Antioxidant Properties, and Safety of Indigenous *Lactobacillus* spp. Inhabiting

Fermented Green Tender Coconut Water. *Probiotics & Antimicro. Prot.* https://doi.org/10.1007/s12602-024-10352-x

Pogacic, T., Maillard, M-B., Leclerc, A., Herve, C., Chuat, V., Yee, A. L., Valence, F., Thierry, A. (2015). A Methodological Approach to Screen Diverse Cheese-Related Bacteria for Their Ability to Produce Aroma Compounds. *Food Microbiol, 46*, 145e53. https:// doi.org/10.1016/j.fm.2014.07.018.

Poolsawat, L., Li, X., Yang, H., & Yang, P. (2020) The Potentials of Fructooligosaccharide on Growth, Feed Utilization, Immune and Antioxidant Parameters, Microbial Community and Disease Resistance of Tilapia (*Oreochromis niloticus* × *O. aureus*). *Aquacult Res, 51*(11), 4430–4442. https://doi.org/10.1111/are.14786

Rovely, F. C., Nuhman N., & Rosana, N. (2024). Air Kelapa Sebagai Salah Satu Bahan Probiotik yang Dicampurkan pada Pakan Terhadap Pertumbuhan dan Kelangsungan Hidup Benih Ikan Nila Hitam (*Oreochromis niloticus*). *Samakia: Jurnal Ilmu Perikanan, 15*(2), 172-181. http://dx.doi.org/10.35316/jsapi.v15i2.5547

Selim, K. M., & Reda, R. M. (2015) Beta-Glucans and Mannan Oligosaccharides Enhance Growth and Immunity in Nile Tilapia. *Lat Am J Aquat Res, 77*(1), 22–30. https://doi.org/10.1080/15222 055.2014.951812.

Setyawan, P., Aththar, M. H. F., Imron, I., Gunadi, B., Haryadi, J., Bastiaansen, J. W. M., Camara, M. D., & Komen, H. (2022). Genetic Parameters and Genotype by Environment Interaction in A Unique Indonesian Hybrid Tilapia Strain Selected for Production in Brackish Water Pond Culture. *Aquaculture, 561*, 738626. https://doi.org/10.1016/j.aquaculture.2022.738626

Shayanthavi, S., Kapilan, R., Wickramasinghe, I. (2024). Comprehensive Analysis of Physicochemical, Nutritional, and Antioxidant Properties of Various Forms And Varieties Of Tender Coconut (*Cocos Nucifera* L.) Water in Northern Sri Lanka S. *Food Chemistry Advances, 4*, 100645. https://doi.org/10.1016/j.focha.2024.100645

Suprayogi, W. P. S., Ratriyanto, A., Akhirini, N., Hadi, R. F., Setyono, W., & Irawan, A. (2022) Changes in Nutritional and Antinutritional Aspects of Soybean Meals by Mechanical and Solid-State Fermentation Treatments with *Bacillus subtilis* and *Aspergillus oryzae*. *Bioresource Technology Reports, 17*: 100925. https://doi.org/10.1016/ j.biteb.2021.100925.

Tiengtam, N., Khempaka, S., Paengkoum, P., & Boonanuntanasarn, S. (2015) Effects of Inulin and Jerusalem Artichoke (*Helianthus tuberosus*) as Prebiotic Ingredients in the Diet of Juvenile Nile Tilapia (*Oreochromis niloticus*). *Animal Feed Sci Technol, 207*:120–129. https://doi.org/10.1016/j.anifeedsci.2015.05.008

Van Doan, H., Hoseinifar, S. H., Khanongnuch, C., & Kanpiengjai, A. (2018) Host-Associated Probiotics Boosted Mucosal and Serum Immunity, Disease Resistance and Growth Performance of Nile Tilapia (*Oreochromis niloticus*). *Aquaculture, 491*, 94–100. https://doi.org/10.1016/j.aquaculture.2018.03.019

Wael, G., Nouh, M. F. M., & Salah, M. A. (2009) Pathological Evaluation to the Effect of Some Probiotics on the Health and Immune Status of Nile Tilapia (*Oreochromis niloticus*). *Egypt J Comp Path Clinic Path, 22* (2), 233–249.

Widanarni., & Tanbiyaskur. (2015) Application of Probiotic, Prebiotic and Synbiotic for the Control of *Streptococcosis* in Tilapia *Oreochromis niloticus*. *Pakistan J Biol Sci, 18*(2), 59–66. https:// doi.org/10.3923/pjbs.2015.59.66

Yang, L. J., Zeng, X. F., & Qiao, S. Y. (2021). Advances in Research on Solid-State Fermented Feed and Its Utilization: The Pioneer of Private Customization for Intestinal Microorganisms. *Animal j.aninu, 2021.06.002. Nutrition*, *7*(4), 905e16.

Zahran, E., Awadin, W., Risha, E., * Khaled, A. A. (2019) Dietary Supplementation of *Chlorella Vulgaris* Ameliorates Chronic Sodium Arsenite Toxicity in Nile Tilapia

Oreochromis Niloticus as Revealed by Histopathological, Biochemical and Immune Gene Expression Analysis. *Fish Sci, 85*(1), 199–215. https://doi.org/10. 1007/s12562-018-1274-6

Zhang, Y. X., & Vadlani, P. V. (2015). Lactic Acid Production from Biomass-Derived Sugars Via Co-Fermentation of *Lactobacillus brevis* and *Lactobacillus plantarum*. *J Biosci Bioeng, 119*(6), 694e9. https://doi.org/10.1016/j.jbiosc.2014.10.027.