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ZOOLOGY

Effect of feeding semi-moist diet as a practical strategy to reduce feed costs in tilapia juvenile production

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ABSTRACT. Tilapia (*Oreochromis niloticus*) is one of the species with the greatest increase in production worldwide. However, the continuous increase in the price of ingredients, and consequently in the diet costs may limit the expansion of the sector. Several alternatives to reduce feed costs are currently under study, as the use of practical press-pellet semi-moist diet that can be manufactured on farm. This study evaluates five levels of replacement (0, 25, 50, 75, and 100%) of a commercial diet by a practical (press-pellet semi-moist) diet and its effect on zootechnical performance, carcass proximate composition, as well as somatic and economic indexes in tilapia juveniles (9.48 g). After 56 days, survival and condition factor did not differ significantly between treatments. Final weight, daily weight gain, feed conversion, and specific growth rate had a negative linear effect as the practical diet increased, while carcass yield had a positive linear effect. Carcass crude protein content was higher in fish fed with 100% practical diet, while crude lipid had the lowest content in this same treatment. As for economic indexes, the estimated cost of feeding decreased as a function of the practical diet inclusion, with a final saving of US$ 8.68 per thousand of juveniles produced (100% replacement).

Keywords: nutrition; feed costs; nursery; feed technology; *Oreochromis niloticus*.

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Introduction

Aquaculture is an important activity that generates income and high-quality animal protein. In 2018, world aquaculture production was 82.1 million tons, corresponding to an increase of 6.82% in relation to 2016 (Food and Agriculture Organization of the United Nations [FAO], 2020). Fish farming contributed with 66.12% of the total produced. Among fish, Nile tilapia (*Oreochromis niloticus*) is the third most produced species, with approximately 4,525 thousand tons fished in 2018, representing 8.3% of the total volume of fish, with an increase of 12.45% in relation to the 2016 production (Food and Agriculture Organization of the United Nations [FAO], 2018). Of this total volume produced, Brazil contributes with 432,149 tons, making it the 4th largest producer of this species in the world, behind only China, Indonesia and Egypt (Peixe BR, 2020). In Brazil, tilapia represents 57% of production, where the largest producing states are Paraná, São Paulo, Minas Gerais Santa Catarina and Mato Grosso do Sul, in descending order (Peixe BR, 2020).

Currently, one of the main challenges in aquaculture is the associated high cost of feed, as certain ingredients such as soybeans and corn are high demand commodities that are widely used to feed poultry, swine, and cattle. In parallel, the fish feeding can represent up to 75% of the final production cost (Schulter & Vieira Filho, 2017), and could represent an issue in remote locations with limited access to formulated feeds (Meyer et al., 2019).

In this sense, press-pellet semi-moist diets produced on-farm could be an alternative to commercial diets due to the lower costs, generally cheaper than conventional extruded feed (Aaqillah-Amr et al., 2021). Moreover, ingredients from agro-industrial by-products available locally could also be used (Lima et al., 2011; Munguti et al., 2021). However, these diets may present some limitations such as lower water stability compared to extruded diets, as well as storage and limited shelf life, which end up directly influencing the quality of the diet (Aaqillah-Amr et al., 2021).

Although these alternatives are mostly tested in laboratory scale (Twahirwa, Wu, Ye, Zhou, 2021; Zehra& Khan, 2021), some authors report commercial applications in countries such as Kenya and Vietnam (Munguti et al., 2021). However, more research is still needed to evaluate the productive performance of fish submitted to these diets, and the impact on the economic performance at scale.

Nursery phase has become popular in fish farming, and enables a series of advantages for farmers such as a reduction in growing time, better use of the available area and water, increased biosecurity, easier management of the initial feeding, as well as compensatory weight gain after the transfer to the grow-out ponds (Little, Bhujel, & Pham, 2003; Vicente, Owatari, Mouriño, Silva, & Vieira, 2020).

Therefore, the present study evaluated the replacement of different levels of commercial diet with a press-pellet semi-moist diet on the zootechnical performance, carcass proximate composition, somatic indexes, and economic feasibility in a tilapia (*O. niloticus*) juveniles' culture during nursery phase.

Material and methods

The experiment was conducted at the Aquaculture Laboratory - LAQ, of *Universidade do Estado de Santa Catarina* (UDESC), Laguna city, Santa Catarina State, Brazil (28°28'13.9" S; 48°46'41.9" W). Nile tilapia (*O. niloticus*) fingerlings from a commercial fish farm were acclimated in 1,000 L circular tanks, where they were housed for 20 days and fed a commercial diet until reaching a weight of 9.48 ± 0.64 g. (Ethics approval, CEUA/n°1951121121).

The experiment was carried-out in five independent recirculation systems (RAS), each with three circular plastic tanks with 200 L of useful volume. These tanks were connected to a 150 L tank (macrocosm) equipped with a mechanical (Bidin®-based) bag filter, biological filter (tile pieces), one thermostat-heaters (300 W), and a submerged pump (80 W, 3500 L h^{-1}) for water circulation in each system. The clear-water RAS system was selected as a model aiming to avoid interferences of external/non-controlled food sources. Water temperature was maintained at 28°C. Tanks were aerated through a porous stone coupled to a radial compressor (2 hp).

Five treatments and three replications were used in a completely randomized design, with 20 fish per experimental unit (density of 100 fish m^{-3}). The treatments consisted of five levels of replacement of the commercial diet by the practical (semi-moist) diet: 0, 25, 50, 75, and 100%. This experimental design simulates an easy and practical application on the farm, carried-out at farm level without the drying phase.

The practical diet was produced in the Laboratory of Nutrition of Aquatic Organisms (LANOA) of UDESC/Laguna. Table 1 shows the diet formulation and composition. The semi-moist diets were formulated based on the requirements for tilapia in the initial phase according to Furuya, (2010). After grinding, weighing, and mixing the ingredients (Fracalossi & Cyrino, 2012), the dough was pelletized (~4 mm pellets) and stored in a freezer (-20ºC). The commercial diet (Table 1) was obtained from a local supplier and kept at room temperature.

The initial feeding rate was 8% of the biomass, which was gradually reduced to 3.5% at the end of the experiment. For both treatments, the amount of feed was based on dry matter, offered four times a day (8:00 am, 11:00 am, 2:00 pm, and 5:00 pm). The first meals of the day were provided with the practical press-pellet diet. For example, in the 50% replacement treatment, the practical diet was provided at 8:00 am and 11:00 am, and the commercial diet was provided at 2:00 pm, and 5:00 pm.

Dissolved oxygen (DO), temperature (YSI, 55 Dissolved Oxygen Instrument, Yellow Spring, OH, USA), and pH (AGPTEK®, It5-150310, China) were monitored daily. The levels of total ammoniacal nitrogen (TAN), nitrite, nitrate, and orthophosphate were measured every two weeks using a photocolorimeter (ALFAKIT model AT 100P, Florianópolis, Santa Catarina State, Brazil). Alkalinity was measured every two weeks by volumetric titration using a commercial kit (ALFAKIT).

The overall average values recorded for DO, temperature, pH, orthophosphate, alkalinity (CaCO3), TAN, nitrite, and nitrate were 5.8 ± 0.20 mg L^{-1}, 28.9 ± 0.15°C, 6.9 ± 0.05, 6.24 ± 0.86 mg L^{-1}, 91.6 ± 6.89 mg L^{-1}, 0.20 ± 0.04 mg L^{-1}, 0.04 ± 0.01 mg L^{-1}, and 1.08 ± 0.22 mg L^{-1}, respectively. The recorded water quality parameters were within optimal levels for tilapia (Arana, 2004; El-Sayed, 2006; Kubitza, 2011).

The experiment lasted 56 days. At the end of the experiment, for the evaluation of somatic indexes, the fish were previously submitted to a 24-hour fast to avoid stomach and intestine weights interference. Three fish per experimental unit were killed, totaling 45 fish (or nine per treatment). From the data obtained, the following organosomatic indices were calculated: CY = carcass yield (total weight – gutted weight), HSI = hepatosomatic index (liver weight/fish weight) * 100, VFI = visceral fat index (visceral fat/fish weight) * 100, DSI = digestive somatic index (digestive tract weight/fish weight) * 100. Proximate composition (dry matter, crude protein, and ash) of fish carcass were analyzed according to the methodology proposed by AOAC (1999). Finally, for lipid content determination, we used Bligh and Dyer (1959) method.

Table 1. Formulation and composition of practical press-pellet semi-moist and commercial diets utilized for Nile tilapia (*Oreochromis niloticus*) juveniles in a 55 days culture period.

Ingredient	Practical diet (%)	Commercial diet (%)	Cost of ingredients US $ kg of feed^{-1}
Soybean meal	50.47	-	0.20
Ground corn	18.10	-	0.05
Wheat bran	15.00	-	0.04
Fish meal	10.00	-	0.07
Soy oil	1.00	-	0.01
DL-Methionine	0.21	-	0.01
Premix	0.80	-	0.10
Vitamin C	0.10	-	0.06
Salt	0.30	-	0.01
Dicalcium phosphate	3.00	-	0.07
Antioxidant	0.02	-	0.01
Binder	1.00	-	0.13
Nutritional composition			
Dry matter (%) †	64.97±0.60	90.23±0.28	
Crude protein (%) †	34.08±2.10	32.73±1.83	
Gross energy (Kcal kg^{-1})	3990.62 ‡	4000 §	
Crude lipid (%)	5.75±0.67	10.55±0.21	
Crude fiber (%)	4.41 ‡	6.00 §	
Minerals (%) †	10.13±0.30	11.10±0.07	
Total calcium (%)	1.82 ‡	1.2 §	
Total phosphorus (%)	0.84 ‡	0.6 §	

† Analyzed according to the methodology proposed by Association of Official Agricultural Chemists [AOAC] (1999); ‡ Based on values cited by Rostagno et al. (2011); § Warranty levels by the company; Analyzed according to the methodology proposed by Bligh and Dyer (1959).

The data for Final individual weight (g), Weight gain (g day^{-1}), FCR = Apparent feed conversion ratio, SGR = Specific growth rate (%), CF = condition factor, Survival (%), organosomatic indices and proximate composition of the carcass were analyzed for normality and homogeneity of variances. Results that presented normal distribution were evaluated by linear and quadratic regression analyses. For the variables that did not show effect in at least one of the regression analyses, analysis of variance (one-way ANOVA) was applied. When a significant difference was detected ($p < 0.05$), the Tukey test was performed. Data were evaluated at a significance level of 5%.

For the economic evaluation, the feed costs for the production of one thousand juveniles was calculated according to Sousa, Pinho, Rombenso, Mello, and Emerenciano (2019). The average values of FCR, feed offered, and survival from each treatment were considered and extrapolated to 1000 individuals, simulating a commercial juvenile's operation, adapted from Sousa et al. (2019). In addition, the feed costs of each experimental treatment were also calculated, considering the price of the commercial feed. The price of the practical press-pellet diet was calculated using the average individual prices of each ingredient utilized in the diet formulation (Table 1). The final cost was added with 10% of this value due to the estimated expense for labor and electricity (Sousa et al., 2019).

Results

Zootechnical parameters

Table 2 describes the results of the zootechnical parameters. The increase in the inclusion of the practical press-pellet diet led to a decreasing linear effect ($p < 0.01$) for the FW, DWG and SGR. For the feed conversion (FCR), an increasing linear effect ($p < 0.01$) occurred as a function of the greater inclusion of the practical diet. On the other hand, the condition factor (CF) and survival did not differ between treatments, and a survival rate of 100% was recorded in all treatments.

Table 2. Zootechnical performance for different levels of inclusion of a practical press-pellet diet for *Oreochromis niloticus* juveniles in a 55 days culture period.

Parameter	Levels of inclusion of a practical diet (%)					CV%	p (L)	p (Q)
	0	25	50	75	100			
Final individual Weight (g)	64.74	66.30	64.15	61.77	61.57	2.45	<0.01	0.28
Weight gain (g day^{-1})	1.00	1.03	0.99	0.95	0.95	2.87	<0.01	0.27
FCR	1.31	1.28	1.34	1.40	1.39	3.20	<0.01	0.79
SGR (%)	3.49	3.54	3.48	3.41	3.40	1.31	<0.01	0.24
CF	1.96	1.87	1.89	1.95	1.85	3.41	0.28	0.91
Survival (%)	100.00	100.00	100.00	100.00	100.00	0.00	0.99	0.99

CV: Coefficient of variation; L: linear effect; Q: quadratic effect. Final individual weight = 65.91 – 0.044X², R² 0.71; Weight gain = 1.02 – 0.001X², R² 0.78; Apparent feed conversion ratio (FCR) = 1.29 + 0.001X², R² 0.78; Specific growth rate (SGR) = 3.52 – 0.001X², R² 0.69. CF = condition factor.

Organosomatic indexes

Table 3 shows the results of the organosomatic indexes. DSI, VFI and HSI presented a similar trend as per growth performance parameters, with a decreasing linear effect ($p < 0.01$) as the practical press-pellet diet inclusion increases. However, the carcass yield (CY) presented an opposite trend with an increasing linear effect ($p < 0.01$) with the inclusion of the practical diet, with a maximum value of 90.88%.

Table 3. Somatic indexes for different levels of inclusion of a practical press-pellet diet for *Oreochromis niloticus* juveniles in a 55 days culture period.

Parameter	Levels of inclusion of a practical feed (%)					CV (%)	p (L)	p (Q)
	0	25	50	75	100			
CY	86.68	87.96	89.09	88.96	90.88	1.53	<0.01	0.28
HSI	2.30	1.91	1.91	1.75	0.42	17.81	<0.01	<0.01
VFI	1.78	1.57	1.09	0.64	0.21	34.52	<0.01	0.61
DSI	5.47	5.35	3.88	3.58	3.66	12.90	<0.01	0.23

CY = Carcass yield; HSI = Hepatosomatic index; VFI = Visceral fat index; DSI = Digestive somatic index; CY = 0.86 + 0.001X, R² 0.84; HSI = 1.23+0.004X – 0.001X², R² 0.88; VFI= 0.02 – 0.001X, R² 0.98; DSI= 0.05- 0.001X, R² 0.82.

Proximate composition

For carcass crude protein content, treatments with some level of inclusion of the practical feed did not differ and all of them showed higher values than the treatment containing 100% of commercial feed. As for lipids, the treatments containing 100 and 75% inclusion of the practical feed displayed similar results, but inferior to the other treatments. The treatments did not influence mineral matter content (Table 4).

Table 4. Proximate composition of the carcass (whole fish) of *Oreochromis niloticus* juveniles fed a practical press-pellet diet at different levels of inclusion in a 55-days culture period.

Parameter (%)	Levels of inclusion of a practical diet (%)					P
	0	25	50	75	100	
CP	15.66±0.73^{a}	17.03±0.98^{b}	18.75±1.51^{b}	18.77±0.55^{b}	17.84±0.32^{b}	0.009
LIP	8.79±0.97^{a}	7.99±0.27^{a}	7.97±0.28^{a}	5.27±0.64^{b}	4.90±1.29^{b}	0.001
DM	26.35±1.23^{b}	30.85±1.64^{a}	30.65±0.33^{a}	27.94±1.83^{ab}	27.67±0.73^{ab}	0.005
MM	4.02±1.44	4.27±0.32	4.92±0.49	4.86±0.73	4.84±0.43	NS

CP: crude protein; Lip: crude lipid; DM: dry matter; MM: mineral matter, NS: not significant. Means with different letters on the same line differ statistically by the Tukey test ($p < 0.05$).

Economic evaluation

For the economic analyses, Table 5 describes the feed costs for the production of one thousand individuals. The cost of the diets were US$ 0.95 kg^{-1} and US$ 0.83 kg^{-1}, for the commercial feed (local quotation) and the practical press-pellet (estimation based on the ingredients and related expenses), respectively. Savings increased as a function of the inclusion of the practical diet in the daily ration. Thus, the treatment using 100% of practical press-pellet diet accounted for the lowest cost (US$ 60.12 per thousand of fish^{-1}), with a saving of US$ 8.68 per thousand of fish produced.

Table 5. Economic analysis considering the feed costs to produce one thousand individuals according to the different inclusion levels of the practical press-pellet semi-moist diet (0, 25, 50, 75, and 100%) for tilapia *Oreochromis niloticus* juveniles in a 55 days culture period.

Practical diet inclusion (%)	Initial weight (g)[1]	Final weight (g)[2]	Feed conversion[3]	Cost per kg of diet (U$$)	Feed offered (kg thousand fish^{-1})[4]	Total feed cost per thousand fish (U$$ thousand fish^{-1})[5]
0	9.46	64.74	1.31	0.95	72.42	68.80
25	9.46	66.37	1.28	0.92	72.84	67.01
50	9.46	64.15	1.34	0.89	73.28	65.22
75	9.46	61.77	1.40	0.86	73.23	62.98
100	9.46	61.57	1.39	0.83	72.43	60.12

[1]Initial weight of individuals at the beginning of the experiment; [2]average final weight of treatments after the 55th day experimental period; [3]average feed conversion calculated for the treatments (total feed offered / biomass gain); [4]average total feed consumption considering one thousand fish; [5]total feed cost to obtain the final weight in each treatment for one thousand individuals (feed consumption for one thousand fish x feed cost).

Discussion

Zootechnical performance parameters

This preliminary study compared different feeding strategies using a commercial diet and a practical semi-moist diet with a simple low-cost processing technique that could easily be adopted in tilapia farms, especially the ones with logistics issues. Many factors impact the diet performance, such as selection of the ingredients (Köprücü & Özdemir, 2005), quality and digestibility (Maina et al., 2002), nutritional requirement levels such as proteins (Ma, Li, Li, & Leng, 2015) and lipids (Ma, Li, Li, & Leng, 2016), among others. The other important factor related to those feeds is the type of processing, e.g., extrusion, press-pellet, microencapsulated or powder-based diets, which could directly affect the fish performance.

In this context, Ma et al. (2015) showed similar zootechnical performance results for tilapia fed press-pellet diet with 31% CP level and extruded diet with 28% CP level. On the other hand, *Paralichthys olivaceus* flounder fed with extruded diets presented results of final weight, feed conversion, specific growth rate and protein efficiency rate much higher than fish fed with wet and semi-moist isoprotein diets (Kim & Shin, 2006). The authors highlighted the benefits of the extrusion process in the feed, which increases the availability and digestibility of dietary nutrients. The higher levels of 'bioavailable' starch, digestibility coefficients and potential nutrient use in extruded commercial diets may contributed to the present results (Gao et al., 2019; Welker et al., 2018).

The effects of extrusion can improve the nutrient digestion and absorption, as fish fed extruded diets showed greater digestive enzymatic activity and a greater amount of total plasma free amino acids (Fracalossi & Cyrino, 2012; Kanmani et al., 2018). Controversially, the wet or semi-moist diets might negatively impact the water quality parameters, as a result of reduced pellet stability and rapid leaching (Kim & Shin, 2006).

Several other authors have reported better zootechnical performance results for fish fed with extruded diets compared to press-pellet (Furuya, Souza, Furuya, Hayashi, & Ribeiro, 1998; Signor et al., 2011) and wet diets (Dias et al., 2017). Iglesias, Pérez, and de laVega (2007), when comparing a fish waste-based semi-moist diet with an extruded commercial diet for tilapia, did not obtain significant differences for FCR, survival and protein efficiency rate, however, higher final individual weights were observed. In this study, the levels of inclusion of practical diet in the daily ration did not influence survival, which was of 100% in all treatments.

Other authors reported similar survival values for the species in production system comparison's studies: BFT vs RAS, Luo et al. (2014); or nutrition studies evaluating alternative feed ingredients such as fish waste silage (Carvalho, Pires, Veloso, Silva, Carvalho, 2006); mango waste meal (Lima et al., 2011); and pizzeria by-product (Sousa et al., 2019). For the final individual weight, WG and SGR, the values decreased as a function of the practical diet increase in the daily ration; however, an inverse effect was observed for the FCR.

It was observed a decrease in tilapia juveniles (4g) performance as a function of fish meal replacement by soybean meal (0, 25, 50, 75, and 100%) (Lin & Luo 2011). The lower growth and high FCR were mainly attributed to the potential increased levels of antinutritional factors, which may negatively impact the fish performance. The same trend was observed by Shiau, Kwok, Hwang, Chen, and Lee (1989), where replacement levels above 67% reduced the zootechnical performance, and increased the FCR in tilapia juveniles (4.47g) culture.

It was observed a decrease in the growth of *O. niloticus* for formulated diets containing 50 and 100% soybean (Koumi, Atse, & Kouame, 2009). In addition, increased levels of soybean meal could also negatively impact the feed palatability, and dietary amino acid profile, as well as may contain nondigestible oligosaccharides and protease inhibitors that can impair the fish growth (Fracalossi & Cyrino, 2012).

Hence, the linear decrease in fish performance in the present study observed in treatments with high levels of practical diet inclusion could also be attributed to the higher levels of soybean meal in the diet formulation (50.47%). More research efforts are needed to elucidate the combined effect of low-cost processing techniques and increased levels of soybean in the formulation.

Organosomatic indexes and proximate composition

Carcass yield linearly increased with the inclusion of the practical diet ($p < 0.01$). This outcome aligned with the lower levels of visceral fat (VSI), as well as lower DSI and HSI, potentially indicating a good nutritional balance of the practical press-pellet diet. Nutritional composition revealed that either commercial and practical diet presented similar crude protein and energy content, however, with different crude lipid levels (~6 and ~10%, respectively), which may have impacted the organosomatic indexes and also the carcass proximate composition.

Higher dietary lipid increase the liver metabolism and, consequently, the organ size (National Research Council [NRC], 2011). In this sense, the higher amount of lipids in carcasses from fish fed 100% commercial diet was probably due to the (i) higher dietary crude lipid content (Meurer et al., 2002). Nonetheless, the (ii) higher 'bioavailable' starch as a result of the extrusion process in commercial diets, may contribute to lipid deposition (Welker et al., 2018). Kanmani et al. (2018) have also reported an increase in these parameters when comparing extruded and pelletized diets.

The results of CY, carcass crude protein and crude lipid from our study corroborated with those found by Souza and Hayashi (2003). The authors evaluated different inclusion levels of cottonseed meal in (~37 g) tilapia and obtained similar CY, of ~85%. Interestingly, our results also corroborate with larger size tilapia (300 and 500 g) with CY between 89.90% and 91.31%, and carcass crude protein levels ~16%, while lipid varied from 5.03 to 5.80% (Souza & Maranhão, 2001).

In our study, we obtained 90.88% carcass yield with 100% of practical feed and 86.68% carcass yield with the control treatment (100% commercial feed). In contrast to the present study, which showed a negative linear effect for HSI as a function of the practical diet inclusion, Lin and Luo (2011) did not detect any statistical difference for HSI in tilapia fed diets containing different percentages of inclusion of soybean meal (0, 25, 50, 75, and 100%).

Future research efforts could elucidate the effect of different feed processing techniques and formulations on the carcass yield and proximate composition, as the quality of the final product (e.g. low lipid carcasses) will directly impact the consumer's acceptance (Pinho & Emerenciano, 2021).

Economic analysis

In the present study, the total feed costs to produce one thousand tilapia juveniles (62-65 g) decreased as a function of the practical diet inclusion. Similar economic outcomes were observed by Sousa et al. (2019), Carvalho, Baracat, and Sgarbieri (2006), and Furuya et al. (1998). These studies evaluated the pizzeria by-product, fish silage and press-pellet diets, respectively, and found economic advantages when replacing conventional by alternatives approaches in tilapia culture, however with a concomitant fish growth impair.

In a direct comparison within our study, the treatment with 100% replacement of commercial diet by the practical press-pellet diet represents a saving of US$ 8.68, or 12.6%, per thousand of fish produced. Extrapolating to a production of 1 million individuals (small-medium commercial scale), the adoption of 100% practical press-pellet diet would result in feed cost savings of US$ 8,680 during 55 days (experimental period) or US$ 52,080 annually, considering suitable temperature conditions. It is important to mention that zootechnical performance decrease as a function of the practical diet inclusion, from 64.7 to 61.6 g of individual final weight (Table 2). This difference represents 4.8%, and once the nursery phase is concluded and the fish is transferred to traditional systems (e.g., earthen ponds), such difference would likely be compensated due to the compensatory growth *a posteriori*, as described in different tilapia studies (Abdel-Tawwab, Ahmad, Khattab, & Shalaby, 2010; Liu, Deng, Verdegem, Ye, & Zhu, 2019)

Conclusion

The adoption of alternative feeding strategies could represent major savings, especially in remote locations. In our experimental conditions, economic and fish quality benefits (higher carcass yield, protein content, and lower lipid deposition) were identified when the practical press-pellet diet was adopted in tilapia

O. niloticus nursery. However, this strategy needs to be carefully evaluated and customized to the different culture conditions, as it can impair the fish growth and feed efficiency. Further studies are also encouraged to test the practical press-pellet diets during the grow-out phase.

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