Effect of molasses addition at different C:N ratios on growth and survival rate of spotted scat (*Scatophagus argus*) fingerling in biofloc system

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DOI: 10.29322/IJSRP.8.5.2018.p7759
http://dx.doi.org/10.29322/IJSRP.8.5.2018.p7759

Abstract- Study was conducted to evaluate effect of C:N ratio on growth and survival rate of spotted scat fingerlings in biofloc system. Spotted scat with initial size of 0.149±0.03 g was reared in 100 L tank at salinity of 5 ppt. Experiment includes 4 treatments with C:N ratios: (i) no molasses addition (control), (ii) C:N=10, (iii) C:N=15, (iv) C:N=20. Each treatment was triplicated, and experiment lasted for 45 days. Spotted scat was reared at density of 500 ind/m^3 and molasses was supplied every 3 days. Treatment with C:N=15 has the highest floc volume (7.33±2.08 ml/L) and total bacteria (650±122×10^4 CFU/mL), the lowest *Vibrio* rate (0.21±0.07%). Fish reared at C:N=15 has highest average weight (0.97 g/ind), growth rate in weight (0.020 g/day, 4.07 %/day), survival rate (86.0±2.00%), biomass (416±35.5 g/m^3), it was also the lowest FCR (1.39±0.15) and they all differed significantly with the other treatments ($p<0.05$).

Index Terms- *Scatophagus argus*, biofloc, spotted scat, molasses, C:N ratio, growth, survival rate

I. INTRODUCTION

Marine fish farming in Viet Nam has been developing in recent year. Popular species are being cultured including *Serranidae*, *Lates calcarifer*, *Pseudapocryptes elongates*, *Rachycentron canadum*, *Scatophagus argus* and *Liza subvirdis*. Recently, *Scatophagus argus* becomes potential species for commercial aquaculture with high commercial value. *Scatophagus argus* is omnivorous and distributes naturally in coastal areas in a wide range of salinity. Beside monoculture, spotted scat can be reared in cage culture, integrated or polyculture with other species e.g. black tiger shrimp (*Penaeus monodon*) in mangrove shrimp culture and extensive culture. This contributes to diversification of farming species and model, creates job and income for farmer and contribute to the sustainability of aquaculture development. Researches on spotted scat are mainly focused on classification, biological and reproductive aspects. Issues in spotted scat rearing currently are identified as small fingerling size, slow growth and survival rate which interfere grow-out culture of this species, especially in cage and polyculture models. Previous studies indicated that main reasons reducing survival rate and growth were due to rearing technique and water quality, therefore development of new culture system which has high biosecurity and friendly to environment become essential. Biofloc technology is applied popularly in marine aquaculture, where C:N ratio in environment is adjusted accordantly to rearing species through addition of carbon source. In this kind of technique, toxic inorganic nitrogen could be converted to biomass of benefit heterotrophic bacteria, simultaneously floc particle could be good feed for fish (Avnimelech, 1999). In addition, floc particle with appropriate size contains essential nutrition which is suitable to omnivorous characteristic of spotted scat. Recent researches illustrate that molasses is effective carbon source for floc formation, due to short chain glucose which is easy to dissolve and be quickly hydrolyzed by heterotrophic bacteria. Currently, there is no information about using molasses with effective C:N ratio for spotted scat fingerling rearing in biofloc system. The application of biofloc in rearing spotted scat fingerling could create natural food with suitable size for fingerlings in the present models. Thus, the study entitled "Effect of molasses addition at different C:N ratio on growth and survival rate of Spotted scat (*Scatophagus argus*) fingerling" was carried out to determine the optimal C:N ratio for best growth and survival rate.

II. METHODS

2.1 Experiment design

Experiment was conducted in 120 L tanks contained 100 L of brackish water 5‰. The experiment was randomly designed and included four treatments i.e. control treatment (no molasses

addition), C:N=10, C:N=15 and C:N=20. Each treatment was triplicated. Molasses was supplied for every 3 days. Spotted scat was bought from Ca Mau province where fish was collected from nature by farmer and then transported to experimental hatchery at The College of Aquaculture and Fisheries, Can Tho University.

The stocking density was 500 individuals/m^3. The initial fish size was 15.1±1.39 mm in length and 0.149±0.03 g in weight. The experiment lasted for 45 days.

2.2 Experiment management

Spotted scat fingerlings were fed by commercial feed containing 56% crude protein, 8% crude lipid, 1.4% fiber, 13% total ash, 8% moisture, and 300 µm in particle size. The feeding frequency was four times per day (6 am, 10 am, 2 pm and 6 pm), the feeding rate is about 15% fish weight in all treatments. During rearing, tanks were aerated continuously to ensure enough oxygen and suspension of floc. Sodium bicarbonate was supplied whenever total alkalinity decreased during experiment to ensure the level around 150 ppm. Salinity of rearing tanks was maintained at 5 ppt.

Molasses with carbon content of 35.48%, carbohydrate content of 52%, moisture of 26.52% was incubated 24 hours by warm water at 40ºC before supplying into rearing tanks with volume ratio of 1 molasses and 3 water. Before stocking into rearing tanks, floc was created from each treatment. The ratio between molasses and feed to reach required C:N ratio was calculated based on assuming 50% nitrogen from feed eaten by fish excreting into water environment (Avnimelech, 1999). From this basis, the formula of the ratio in weight between carbon source and feed can be given as follow:

$$\frac{\Delta CH}{\Delta F} = \frac{[CN \times \%P(F) \times \%N(P)] - \%C_F}{\%C_{CH}}$$

Where:

ΔCH: weight of carbon source

ΔF: weight of feed

CN: C:N ratio need to be required

%P(F): protein content in feed

%N(P): nitrogen content in protein (15.5%)

$\%C_F$: carbon content in feed (50%)

$\%C_{CH}$: carbon content in carbon source

During rearing time, there was no water exchange, floc volume from each treatment was maintained at level of < 15 mL/L (Avnimelech, 2015).

2.3 Measurement and calculation parameters

Temperature and pH were measured every 3 days (7h and 14h) by thermometer and pH meter (HANA, USA). TAN and NO_2^- were measured every 5 days and alkalinity was measured every 10 days by test-kit sera.

Floc volume (FVI) was collected every 7 days by measuring 1 L water sample into “Imhoff cone“ and settling in 30 minutes, sediment was recorded in volume by mL/L unit.

Floc particle size was collected every 7 days by measuring randomly length and width of 10 floc particles per tank through microscope at 40 times magnitude.

Water sample was collected to analyze total heterotrophic bacteria at 15^{th}, 30^{th}, 45^{th} and total *Vibrio* bacteria at 30^{th}, 45^{th}.

Initial fish sample was weighed and measured length randomly 30 individuals for all treatments. At the end of experiment, all fish were weighed and measured length individually then the total number of fish was counted in every tank to determine growth and survival rate.

Growth rate, survival rate, coefficient of variation and floc volume were determined basing on the following formulas:

Daily weight gain: DWG (g/day)=($W_t - W_0$)/t

Specific growth rate of weight: SGR (%/day)=100*($LnW_t - LnW_0$)/t

Daily length gain: DLG (mm/ngày)=($L_t - L_0$)/t

Specific growth rate of length: SGR (%/day)=100*($LnL_t - LnL_0$)/t

(Where W_0 is initial weight, W_t is final weight, L_0 is initial length, L_t is final length, t is culture period (day).

Survival rate (%)=(number of harvest fish/ number of stocking)*100

Coefficient of variation (CV)= $\frac{S}{X}$*100

(Where S is standard deviation, X is average weight of fish).

Vibrio bacteria rate (%):=$\frac{V}{H}$*100

(Where V is average density of *Vibrio* bacteria and H is average density of total bacteria in each tank from periods of sample collection).

Biofloc volume (FVI): = $V_{floc}/V_{collection}$

(Where V_{floc} is biofloc volume (ml) and $V_{collection}$ is collected sample volume (L)).

Floc particle size (mm): $L=\frac{1}{10}*\frac{A}{G}$

Where: A is the number of lines measured on the ruler of the glass, G is magnification degree.

2.4 Data analysis

Mean and standard deviation of collected data were calculated in Microsoft Excel 2010. The difference in variants between treatments was determined according to one-way ANOVA and following by DUNCAN test using SPSS 16.0, significant difference was set at 95%.

III. RESULTS AND DISCUSSION

3.1 Water quality parameters

3.1.1 Temperature and pH

Temperature in morning and afternoon between treatments ranged from 26.4-27.0 ºC (Table 1).

Table 1. Temperature and pH between treatments

Treatments	Temperature (ºC)		pH	
	AM	PM	AM	PM
Control	26.4±0.04	26.9±0.05	8.28±0.01	8.29±0.02
C:N=10:1	26.5±0.14	27.0±0.24	8.26±0.02	8.27±0.03
C:N=15:1	26.5±0.06	26.9±0.07	8.20±0.07	8.20±0.05
C:N=20:1	26.6±0.12	27.0±0.23	8.23±0.03	8.25±0.06

Spotted scat fingerlings were reared in experimental hatchery with cover at rainy season and cold weather, so temperature is relatively low and stabilize. Boyd (1998) revealed that optimal temperature for growth of tropical aquatic species ranged 25-32 ºC, Krishna and Van Loosdrecht (1999) stated that floc could be well aggregated at temperature up to 30-35ºC, according to Diep (2012) the temperature could be 24-26ºC.

pH varied from 8.20-8.29 in morning and afternoon, since fish was reared in cover condition leading to limitation from the effect of raining and light, which directly and indirectly cause fluctuation in pH due to the development of algae. Boyd (1998) stated that suitable pH range for best growth of fish and crustacean was 6-9, according to Diep (2012) floc is well formed at pH range of 7.2-8.2. Temperature and pH in this experiment are in suitable range for fish growth and floc formation.

3.1.2 TAN, NO_2^- and alkalinity

Table 2 shows that TAN content in treatments fluctuated in the range of 0.19-1.02 mg/L. The highest TAN was found in control treatment (1.02±0.06 mg/L), TAN content in treatments with molasses addition were lower than 0.21 mg/L.

Table 2. Concentration of TAN, NO_2^- and alkalinity between treatments

Treatments	TAN (mg/L)	NO_2^- (mg/L)	Alkalinity (mg/L)
Control	1.02±0.06	4.79±0.14	154±0.00
C:N=10:1	0.19±0.11	4.19±0.05	151±3.43
C:N=15:1	0.21±0.15	3.69±0.17	153±2.07
C:N=20:1	0.19±0.15	4.38±0.22	158±4.13

NO_2^- content fluctuated in the range of 3.69-4.79 mg/L, the highest NO_2^- content was found in control treatment (4.79±0.14 mg/L) and the lowest was found in treatment of C:N=15 (3.69±0.17 mg/L). NO_2^- content at first reached 5 mg/L after that decreased clearly from the day 25th, the highest decrease of NO_2^- content was in treatment C:N=15 (Figure 1). In treatments with molasses supplied, the lower TAN and NO_2^- content indicate that beside TAN absorption of heterotrophic bacteria, there was nitrification process taken place. When forming and suspending, floc will become substrate for nitrifying bacteria to grow and convert nitrogen to other forms. Boyd (1998) stated that suitable TAN content for aquaculture ranged from 0.2-2 mg/L, NO_2^- content should not exceed 10 mg/L, TAN and NO_2^- content in this experiment was in suitable range for normal growth of spotted scat.

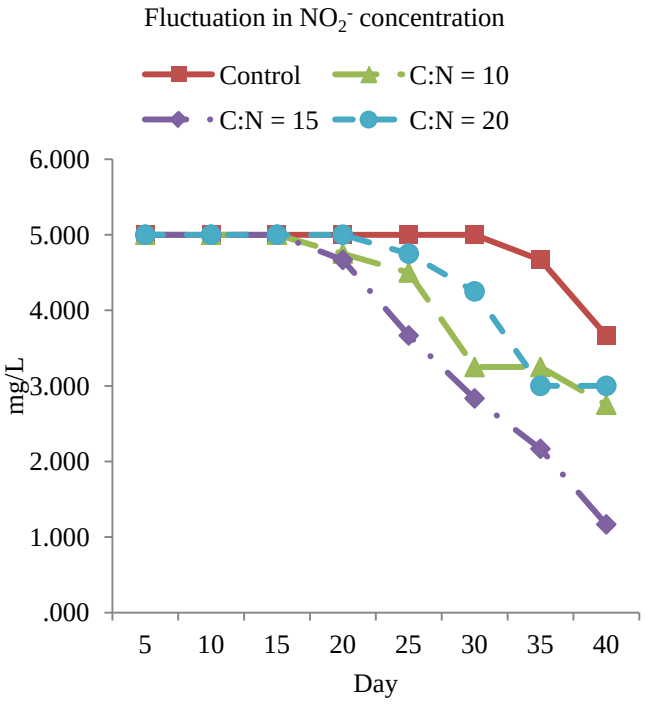


Figure 1. Fluctuation in NO_2^- concentration

3.2 Biofloc size and volume

Results about floc size in treatments with different C:N ratio are presented in Table 3.

Table 3. Floc size in treatments with different C:N ratio

Treatment	Floc size (mm)	
	Length	Width
Control	0.44±0.02 [ab]	0.30±0.02 [a]
C:N=10:1	0.44±0.02 [ab]	0.31±0.01 [a]
C:N=15:1	0.42±0.01 [a]	0.30±0.00 [a]
C:N=20:1	0.46±0.01 [b]	0.32±0.02 [a]

Floc length between treatments fluctuated in the range of 0.42-0.46 mm, the highest value was found in treatment C:N=20 (0.46 mm) and it differed significantly ($p<0.05$) with treatment C:N=15 (0.42 mm). Floc length (0.44 mm) in control treatment and C:N=10 treatment did not differ significantly ($p>0.05$) with C:N=15 and C:N=20 treatments. Width of floc was in the range of 0.30-0.32 mm and there was no significant difference ($p>0.05$) between treatments. In general, width and length of floc in treatments increased gradually by the time. In treatment C:N=15 floc length is closed to floc width. Du (2016) stated that spotted scat with the size of 3.59 g/ind was reared at different C:N ratios by molasses, floc length (0.33-0.44 mm) and floc width (0.23-0.31 mm) were relatively lower than result of this research.

Avnimelech (2015) revealed that one of factors affecting floc size is mixing intensity of water, the suitable energy for aggregation of bacteria in floc was about 0.1-10 $W.m^3$, if the energy is higher than 100 $W.m^3$ bacteria could be in dispersed form and difficult to aggregate in floc. Wilen and Balmer (1999) cited by Avnimelech (2015) reported that at higher oxygen concentration, floc has more big size and stable structure. The increase in number, composition of zooplankton and phytoplankton by the time also contributes to change in microbial composition and increase in floc size. Biological polymers as poly-B-hydroxybutyrate (PHB) also contribute to increase in floc size, at the final of rearing, accumulation a lot of PHB was due to development of heterotrophic bacteria, caused by adhesion of feed, feces, zooplankton and phytoplankton, indirectly leading to increase in floc size.

Fluctuation in floc volume between treatments with different C:N ratios is indicated in Figure 2. In the first three weeks, there was no significant difference ($p>0.05$) in floc volume between treatments, ranged 0.15-0.68 mL/L. In the 4th week, floc volume in treatments of C:N=10, C:N=15, C:N=20 was not significantly difference ($p>0.05$), and fluctuated between 1.63-2.30 mL/L but it was significantly higher than control treatment (0.17±0.06 ml/L) ($p<0.05$). In the 5th week, floc volume in C:N=15 and C:N=20 treatments was not significant different ($p>0.05$), fluctuated between 3.53-3.87 mL/L and it was significantly higher ($p<0.05$) than that of C:N=10 (1.75±0.25 mL/L) and control treatments (0.43±0.12 mL/L).

After 6 weeks of rearing, floc volume reached the highest at C:N=15 treatment (7.33±2.08 ml/L) and it differed significantly with the other treatments ($p<0.05$). Floc volume in treatments of C:N=10 and C:N=20 were not significantly different ($p>0.05$) ranged 3.50-4.63 mL/L. The control treatment has the lowest floc volume (0.53 ml/L). Avnimelech (2015) reported that floc volume increased dramatically after 30 days and fluctuate between 2-10 mL/L, high floc volume can cause congestion of fish gill and should be maintained < 25 mL/L. Du (2016) stated spotted scat fingerling with initial size of 3.59 g after 4 months of rearing at different C:N ratios, floc volume can reach between 5-31 mL/L. Lower floc volume in this experiment can be explained as young stage of fingerling, amount of supplied feed and low molasses supplied. Increase in floc volume in combination with increase in total bacteria decreased concentration of TAN and NO_2^-. In general, floc volume in treatments was in suitable range for fingerling growth.

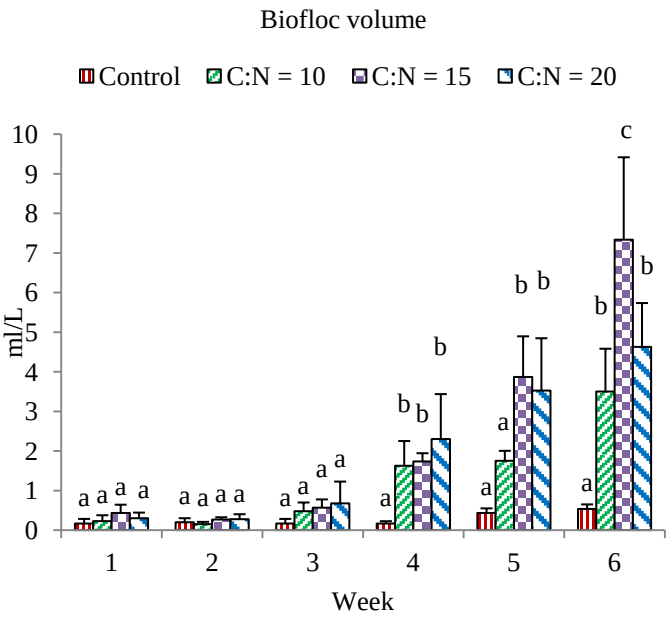


Figure 2. Fluctuation in floc volume between treatments

3.3 Fluctuation of microbial density

Total bacteria, total *Vibrio* bacteria and *Vibrio* rate of all treatments are indicated in Table 4, Table 5 and Figure 3.

Total bacteria in all treatments after 15 days of rearing was relatively low and fluctuated between (0.06-2.55)×10^4 CFU/mL. After 30 days of rearing, total bacteria in treatments of C:N=10, C:N=15, and C:N=20 were not significantly different ($p>0.05$) ranging between 39.0-48.7×10^4 CFU/mL and it was significantly higher ($p<0.05$) than control treatment (1.35±0.54×10^4 CFU/mL). After 45 days of rearing, total bacteria was the highest in treatment C:N=15 (650±122×10^4 CFU/mL), following by C:N=20 (445±87.0×10^4 CFU/mL), C:N=10 treatment (165±26.9×10^4 CFU/mL) and control treatment (15.0±2.40×10^4 CFU/mL), and there were significant differences between treatments ($p<0.05$).

When C:N ratio increased to 15, floc volume reached highest value and NO_2^- content reduced to lowest value at the end of rearing. Heterotrophic bacteria absorbed toxic substances as NH_4^+ and NO_2^- and converted into biomass leading to increase in bacteria density and floc volume. Avnimelech (2015) stated that total bacteria in biofloc system fluctuated between 100×10^4 and 1000×10^4 CFU/mL, Anderson (1993) cited by Ngan and Hiep (2010) reported that in clear water, total bacteria was lower than 10^3 CFU/mL. If total bacteria exceed 10^7 CFU/mL, it will be harmful to cultured shrimp, fish. Total bacteria in this experiment was in suitable range for growth of spotted scat.

Table 4. Fluctuation in total bacteria (×10^4 CFU/mL) between treatments by the time

Treatments	15 days	30 days	45 days
Control	0.06±0.03 [a]	1.35±0.54 [a]	15.0±2.40 [a]
C:N = 10	1.04±0.26 [a]	43.0±4.58 [b]	165±26.9 [b]
C:N = 15	2.55±1.07 [b]	48.7±4.51 [b]	650±122 [c]
C:N = 20	2.28±0.58 [b]	39.0±11.1 [b]	445±87.0 [d]

After 30 days of rearing, total *Vibrio* bacteria was lowest in treatment C:N=15 (6.43±1.63×10^3 CFU/mL), it did not differ significantly with treatment C:N=10 (8.47±1.33×10^3 CFU/mL) ($p>0.05$) but it was significantly lower than treatment C:N=20 (11.7±2.61×10^3 CFU/mL) and control treatment (12.8±1.51×10^3 CFU/mL) ($p<0.05$). After 45 days of rearing, total *Vibrio* bacteria in treatments of C:N=10, C:N=15, and C:N=20 did not differed significantly ($p>0.05$), in range of 1.37 to 5.07×10^3 CFU/mL, but total *Vibrio* bacteria in these treatments were significantly lower than control treatment (11.4±2.44×10^3 CFU/mL) ($p<0.05$).

In general, when C:N ratio increased, total *Vibrio* bacteria decreased. Tao *et al*. (2017) reported that *Penaeus monodon* reared up to the stage PL-15, the highest total *Vibrio* bacteria was found in control treatment (72±0.4×10^3 CFU/mL), and decreased dramatically to 5±0.2×10^3 CFU/mL in treatment C:N=30. Souza *et al*. (2014) reported *Farfantepenaeus brasiliensis* can reach high survival rate of 80-88% when total *Vibrio* bacteria of 2×10^3 CFU/mL in treatment supplied with molasses. Ngan *et al*. (2008) reported that total *Vibrio* bacteria which is lower than 6.5×10^3 CFU/mL did not cause effect to cultured shrimp. The result indicates that total *Vibrio* bacteria in this experiment does not cause effect to growth of spotted scat.

Table 5. Fluctuation in total *Vibrio* bacteria (×10^3 CFU/mL) between treatments by the time

Treatment	30 days	45 days
Control	12.8±1.51 [a]	11.4±2.44 [a]
C:N = 10	8.47±1.33 [bc]	5.07±2.23 [b]
C:N = 15	6.43±1.63 [c]	2.87±1.86 [b]
C:N = 20	11.7±2.61 [ab]	1.37±0.45 [b]

The highest *Vibrio* rate was found in control treatment (22.5±5.18%) and it was significantly higher than that of C:N=10, C:N=15, C:N=20 treatments. White leg shrimp (0.37 g/ind) reared in biofloc system at C:N=15, after 45 days of rearing, *Vibrio* rate ranged 0.04-1.88% (Viet *et al*., 2017). *Bacillus* bacteria can produce anti-microbial substances which is able to kill *Vibrio harveyi* (Hasting and Nealson, 1981 cited in Ngan and Hiep, 2010). Result shows that suitable C:N ratio can facilitate development of benefit bacteria and inhibit the development of *Vibrio* bacteria.

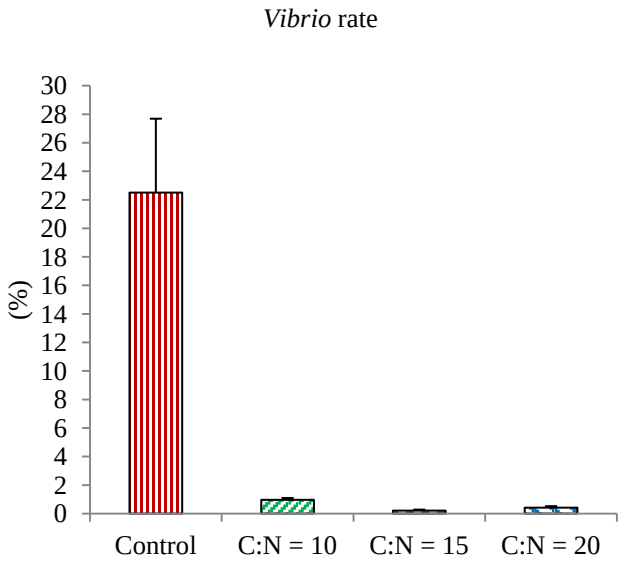


Figure 3. *Vibrio* rate between treatments

3.4 Growth performance of spotted scat between treatments

Growth in weight and length of spotted scat fingerling after 45 days of rearing in all treatments are presented in Table 6 and Table 7. The highest final weight, daily weight gain, specific growth rate in weight was found in treatment C:N=15 (0.97 g/ind, 0.020 g/day, 4.07 %/day), following by treatment of C:N=20 (0.92 g/ind, 0.018 g/day, 3.95 %/day), and treatment of C:N=10 (0.76 g/ind, 0.013 g/day, 3.53 %/day) and control treatment (0.69 g/ind, 0.010 g/day, 3.31 %/day). In general, growth of weight between two treatments C:N=15 and C:N=20 did not differ significantly ($p>0.05$) but they were significantly higher than two treatments C:N=10 and control ($p<0.05$). Khanh (2012) reported that spotted scat with initial size of 0.14 g/ind reared for 30 days at density of 500 ind/m^3 and salinity of 5‰, average weight, DWG and SGR in weight reached 0.91 g/ind, 0.026 g/day, 6.22 %/day, respectively. DWG and SGR in weight found in this experiment were lower than previous research because the rearing time was longer (up to 45 days), high mixing intensity in biofloc system, affected swimming and catching ability of spotted scat. In general, result of this research shows that spotted scat in treatment C:N=15 has best growth in weight.

Table 6. Growth in weight of spotted scat between treatments

Treatments	Final weight (g/ind)	Daily weight gain (g/day)	Specific growth rate (%/day)
Control	0.69±0.02 ^{a}	0.010±0.000 ^{a}	3.31±0.07 ^{a}
C:N=10:1	0.76±0.08 ^{a}	0.013±0.005 ^{ab}	3.53±0.22 ^{a}
C:N=15:1	0.97±0.09 ^{b}	0.020±0.000 ^{c}	4.07±0.21 ^{b}
C:N=20:1	0.92±0.08 ^{b}	0.018±0.005 ^{bc}	3.95±0.19 ^{b}

The highest final length, daily length gain and specific growth rate in length were found in treatment C:N=15 (30.7 mm/ind, 0.33 mm/day, 1.50 %/day) and the lowest ones was found in control treatment (27.0 mm/ind, 0.25 mm/day, 1.21 %/day). Growth in length between treatments C:N=15 and C:N=20 did not differ significantly ($p>0.05$) and they were significantly higher ($p<0.05$) than two treatments of C:N=10 and control.

In treatment C:N=15, total bacteria and floc volume were the highest, *Vibrio* rate and toxic substances as NH_4^+, NO_2^- reached the lowest value. Beside commercial feed, floc is also secondary feed which has high nutritional value for fish, benefit bacteria both supports in good digestion and promote immunity, the above characteristics show that in treatment C:N=15 fish absorbs feed well and reaches highest growth.

Table 7. Growth in length of spotted scat between treatments

Treatments	Final length (mm/ind)	Daily length gain (mm/day)	Specific growth rate (%/day)
Control	27.0±0.59 ^{a}	0.25±0.01 ^{a}	1.21±0.05 ^{a}
C:N=10:1	27.7±0.95 ^{a}	0.27±0.02 ^{a}	1,26±0.07 ^{a}
C:N=15:1	30.7±0.70 ^{b}	0.33±0.02 ^{b}	1.50±0.05 ^{b}
C:N=20:1	29.5±1.09 ^{b}	0.31±0.03 ^{b}	1.39±0.08 ^{b}

3.5 Survival rate, FCR and biomass of spotted scat between treatments

Table 8 shows that FCR fluctuated in the range of 1.39-2.92 between treatments, the lowest FCR was found in treatment C:N=15 (1.39±0.15) and the highest one was found in control treatment (2.92±0.18). FCR in treatments C:N=10 (2.06±0.30) and C:N=20 (1.89±0.24) did not differ significantly ($p>0.05$) but they were significantly higher to treatment C:N=15 ($p<0.05$) and significantly lower to control treatment ($p<0.05$).

Biomass ranged between 233-416 g/m^3 and similar trend was found as FCR. The highest biomass was found in treatment C:N=15 (416±35.5 g/m^3) and the lowest one was found in control treatment (233±9.80 g/m^3). Du (2016) reported that FCR was between 1.64-3.46 in grow-out culture of spotted scat in different C:N ratios. Ni *et al.* (2013) reported spotted scat with initial size of 0.49 g/ind after 2 months of rearing, FCR ranged between 2.6-2.83.

Table 8. FCR and biomass of spotted scat between treatments

Treatment	FCR	Biomass (g/m^3)
Control	2.92±0.18 ^{a}	233±9.80 ^{a}
C:N=10:1	2.06±0.30 ^{b}	307±37.7 ^{b}
C:N=15:1	1.39±0.15 ^{c}	416±35.5 ^{c}
C:N=20:1	1.89±0.24 ^{b}	321±23.6 ^{b}

Figure 4 shows that after 30 days of culture, there was no significant difference in survival rate between treatments ($p>0.05$), ranged 88.7-95.3%. After 45 days of culture, survival rate in treatments C:N=10 (80.8±3.77%**)** and C:N=15 (86.0±2.00%) was not significantly different ($p>0.05$) and it was significantly higher than control treatment (68.0±2.00%) and C:N=20 (70.4±5.76%) ($p<0.05$). Khanh (2012) reported that spotted scat reared after 30 days reached survival rate between 55.1-92.8% at salinity between 0-30‰.

In general, total bacteria and floc volume were higher in treatments which molasses supplied, total *Vibrio* bacteria and

toxic substances were very low, fish absorbs feed and grows well leading to high survival rate, increased biomass and lower FCR in comparison with control treatment. In treatment C:N=20 molasses is supplied with higher amount so it can directly affect to fish's health, leading to lower survival rate compared to treatments C:N=10 and C:N=15. C:N=15 treatment has highest survival rate and biomass, lowest FCR.

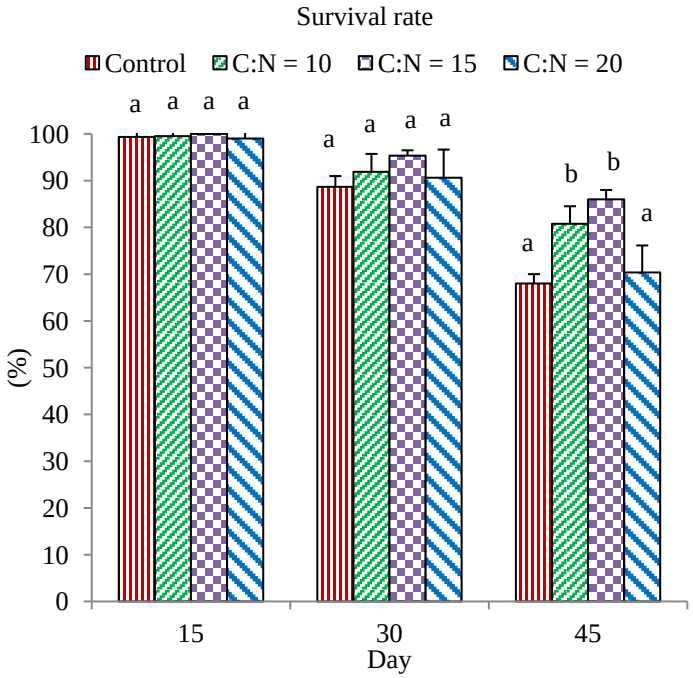


Figure 4: Survival rate of spotted scat between treatments by the time

3.6 Coefficient of variation of spotted scat

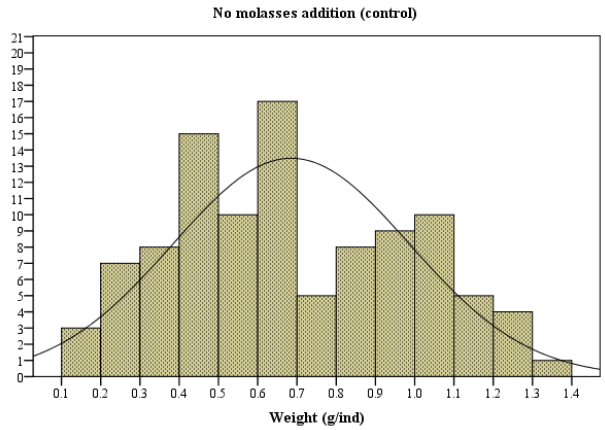
Coefficient of variation (CV) reflects degree of variation of individual weight to average value, the higher the CV the higher the variation in fish's weight. Table 9 indicates that after 45 days of rearing the CV from all treatments ranged 0.36-0.44, the highest CV was found in control treatment (0.44) and the lowest CV was found in treatment C:N=15 (0.36). There was no significant difference between treatments ($p>0.05$). Khanh (2012) reported spotted scat reared after 30 days reached the CV between 0.38-0.49.

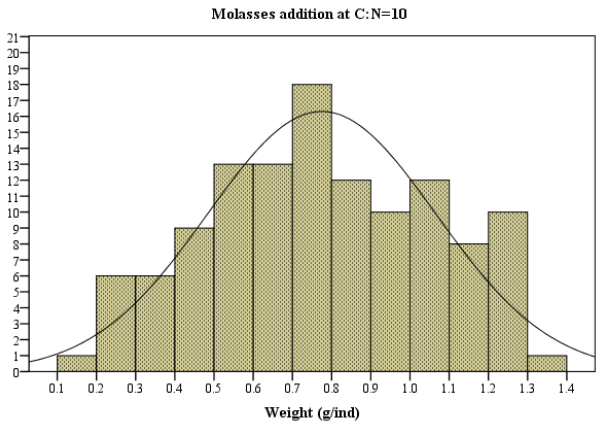
Figure 5 indicates frequency of size groups of fish in treatments supplied with different C:N ratios, size of fish in all treatments was in normal distribution. Fish's size in control treatment ranged between 0.11-1.31 g/ind, the most abundant size was 0.6-0.7 g/ind, the following group was in 0.4-0.5 g/ind.

Table 9. Coefficient of variation of spotted scat between treatments

Treatment	Coefficient of variation (CV)
Control	0.44±0.04 [a]
C:N=10:1	0.40±0.08 [a]
C:N=15:1	0,36±0.02 [a]
C:N=20:1	0.42±0.04 [a]

In treatment C:N=10, fish's size was in the range of 0.17-1.34 g/ind, the most abundant size was 0.7-0.8 g/ind, and size group of 1.1-1.3 g/ind in this treatment was higher than control treatment. In treatment C:N=15, the lowest size of fish was 0.3 g/ind, fish group with size between 0.8-0.9 g/ind was the most abundant size. Moreover, there were also fish size up to 1.7-2 g/ind and fish'size of 1.3-1.6 g/ind also occupy the highest quantity. In treatment C:N=20 the lowest size of fish was 0.2 g/ind, the biggest size of fish of 2 g/ind was low quantity, fish group which has the most quantity was in size of 0.8-0.9 g/ind,. Generally, in treatment C:N=15, big size group accounted for large quantity, fish size fluctuated narrowly so CV was lower than the other treatments.





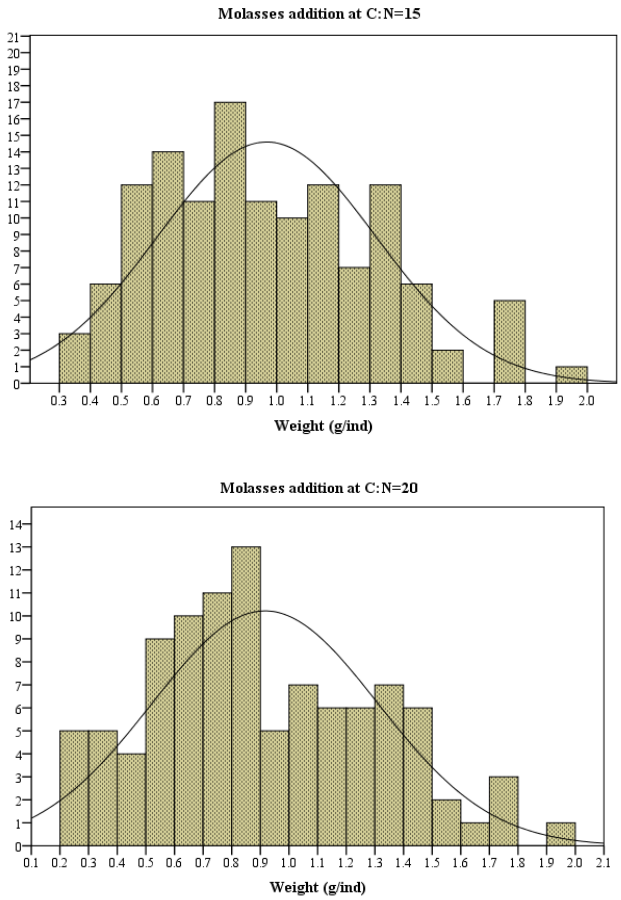


Figure 5. Frequency of different size groups of spotted scat between treatments after 45 days of rearing

IV. CONCLUSION

Supplementation molasses at C:N=15 into biofloc system for rearing of spotted scat prove the best condition for fingerling development. In rearing this condition, spotted scat has the highest growth rate, biomass and survival rate. Thus, application in on-farm condition should be done to promote this technique in rearing of spotted scat fingerlings.

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