Wt = average fish weight at the end of research period (grams)
Wo = average fish weight at early research period (grams)

7. Total Ammonia Nitrogen (TAN). Nitrite (NO_2^-). and Nitrate (NO_3^-).

Values of TAN nitrite and nitrate were obtained through measuring using spektrofotometer. Comparison of absorban values from samples and standard multiply with using liquid concentration. TAN concentration. nitrite and nitrate were obtained by using formula according to APHA (1989) :

TAN (mg/l) = (Cst x As)/Ast

where : Cst = concentration of liquid standard
Ast = absorban values of standard liquid
As = absorban values of sample liquid.

Formerly Research

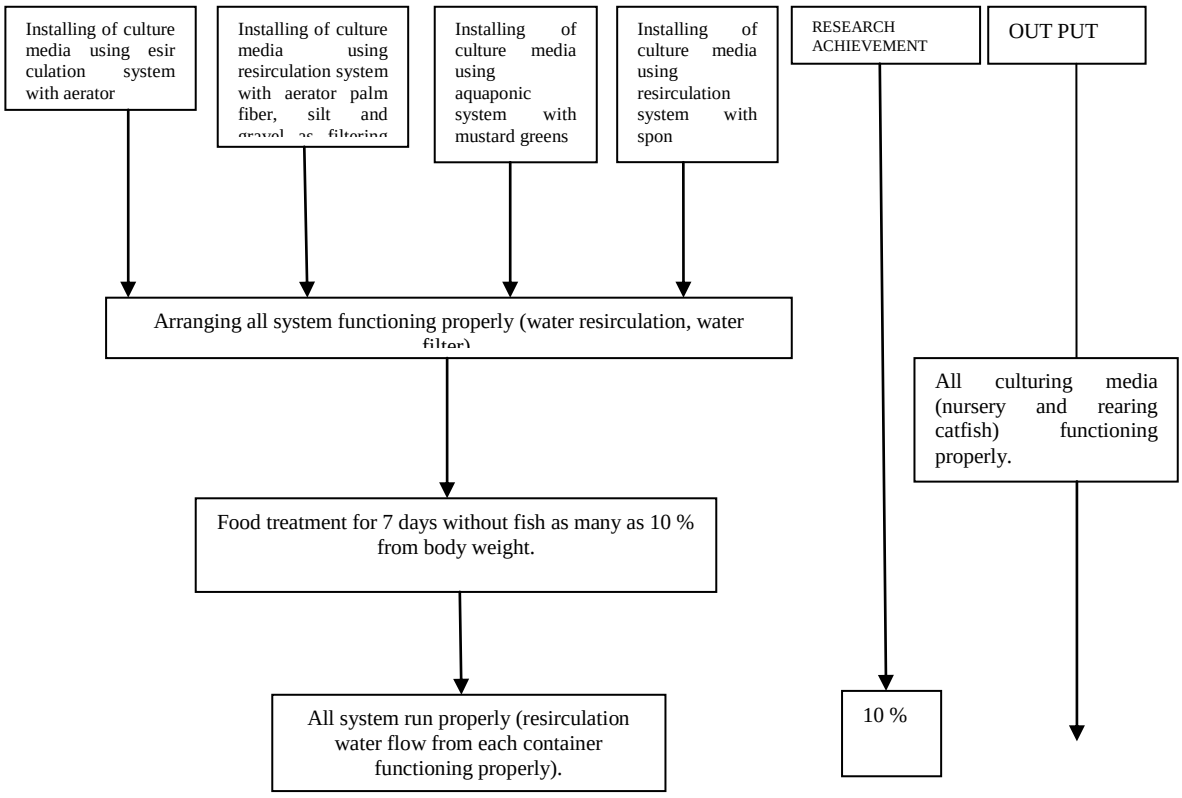
Closed resirculation system using various filter materials and aquaponic system separated with culture fish media to isolate organic disposal wastes as long as fish culture period. Containers for fish culture media made of aquarium with size of (60 x 40 x 40) cm^3 with capacity of 48 litres of water and completed with water pump with power of 20 watts. Filtering materials (gravel. silt and palm fiber) and mustard greens which were completed with carcoal and sterofoam for growing media of mustard greens made of glasses with size of (90 x13.5 x 20) cm^3 and capacity of 24 litres water volume. Furthermore. water in filter aquarium as well as mustard greens media will flow again through PVC pipes (diameter of 2.5 cm) to the fish growing containers. Research was conducted for 7 days without fish in aquarium to establish all system run well. Fish meal was given as many as 10% from fish body weight (only once for 7 days).

Main Research

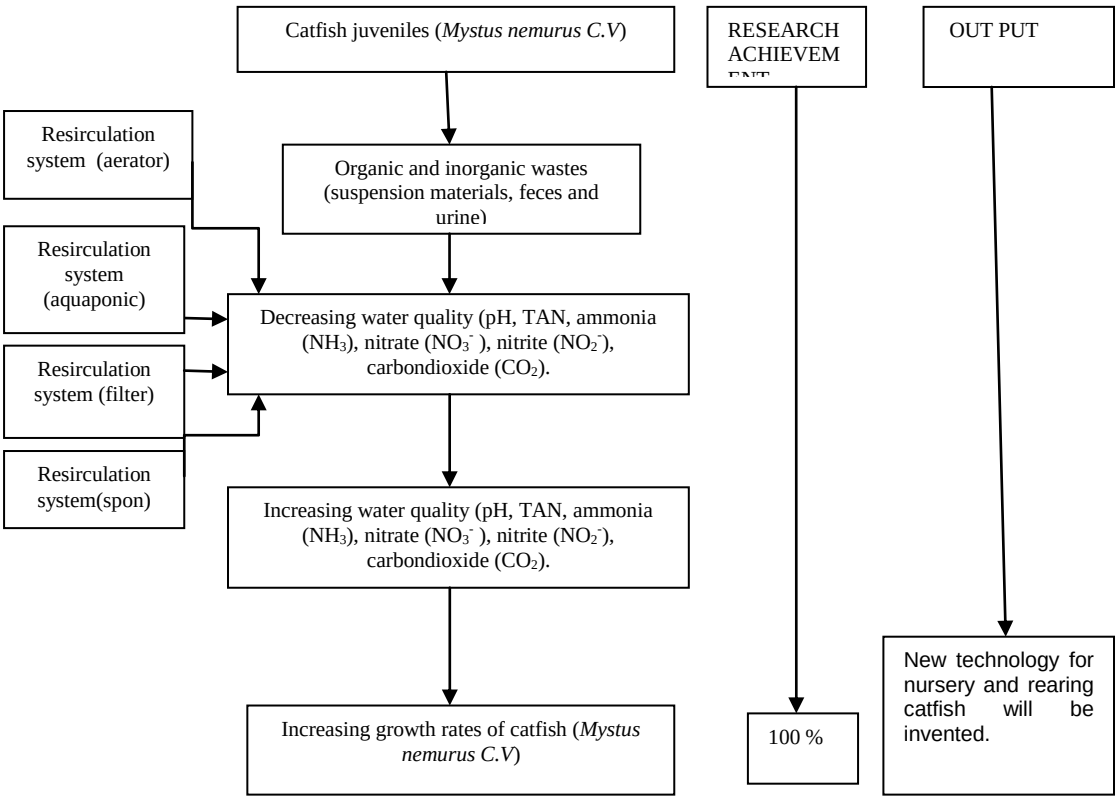
Main research was conducted after formerly research was completely finish. Main research was conducted after all culture media were functioning.

Biological parameters were measured as long as research period such as daily growth rates. biomass. feed efficiency. survival rates (SR). feed conversion ratio (FCR). and physical as well as chemical parameters consists of TAN fluctuation. NH_3. NO_2^-. NO_3^-. dissolved oxygen (DO). temperature. carbondioxide (CO_2) and pH.

1. Formerly Research



2. Main Research



Data Analysis

All data were analized using variance analysis) such as daily growth rates. biomass. feed efficiency. survival rates. feed conversion ratio (FCR). If data analysis were different. the data would be analized again using Newman Keuls test. Water quality parameters were analized descriptively in form of graphs and figures.

RESULTS

Formely Research

Water quality parameters (temperature. dissolved oxygen. carbondioxide. pH. ammonia. nitrite. and nitrate) at the prior research are presented on Table 1.

Table 1. Water quality parameters at the formerly research

Parameters	Unit	Treatments			
		P_0	P_1	P_2	P_3
Temperature	^{0}C	29	29	29	29
pH	-	5	5	5	5
DO	mg/L	3.80	3.90	3.90	3.80
CO_2	mg/L	9.98	9.98	8.89	10.18
NH_3	mg/L	0.02	0.02	0.02	0.02
NO_2	mg/L	0.05	0.04	0.04	0.05
NO_3	mg/L	0.06	0.05	0.04	0.05

Based on Table 1. it could be concluded that at the formerly research along 7 days. all systems of the research facilities run properly especially water flow from all containers (aquarium) monitored at formerly research period showed was predicted that the fish were not placed in l was only used for bacteria growth.

Main Research

Besides water quality parameters were recorded as long as main research period. absolute fish growth rates. absolute length growth rates. daily growth rates and survival rates were also recorded as explain below.

Water Quality

Observation results of temperature, pH, dissolved oxygen (DO), carbon dioxide (CO_2), ammonia (NH_3), nitrite (NO_2^-) and nitrate (NO_3^-) as long as research period could be seen on Table 2.

Table 2. Average of water quality as long as research period

Parameters	Unit	Treatment			
		P_0	P_1	P_2	P_3
Temperature	^{0}C	29 – 31	29 - 31	29 – 31	2 9 – 31
pH	-	5 – 6	5 - 6	5 – 6	5 – 6
DO	mg/L	3.80 - 4.50	4.10 - 4.80	3.90 - 4.90	4.50 - 4.90
CO_2	mg/L	15.98 - 17.97	9.98 - 11.98	7.99 - 11.98	11.18 - 13.98
NH_3	mg/L	0.02 - 0.09	0.02 - 0.08	0.02 - 0.07	0.02 - 0.09
NO_2	mg/L	5.02 - 0.05	4.40 - 0.04	2.43 - 0.02	4.60 - 0.05
NO_3	mg/L	6.87 - 0.06	5.99 - 0.05	4.32 - 0.04	6.06 - 0.05

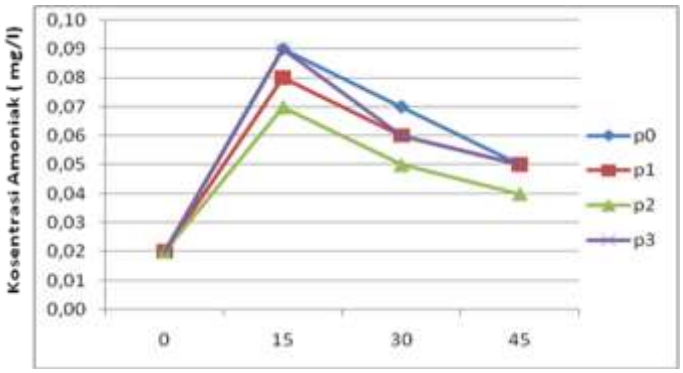
From the above table, it seems that as long as research period, water temperature was recorded around 29-31 ^{0}C and it is appropriate to support fish growth. According to Boyd (1982) suitable difference water temperature for living organisms is not more than 10 ^{0}C and range temperature for tropic organisms is around 25-32 ^{0}C.

pH at all treatments were recorded around 5 – 6. It means that pH can support catfish growth and survival. According to Daelami (2001), low pH and high pH could affect negatively fish life. Generally, fish could grow well in the waters with neutral water pH. Ideally, the good pH range can support fish growth in aquaculture environment is around 5-9 (Syafriadiman *et al.* 2005).

Dissolved oxygen (DO) recorded at treatment P_3 (4.50-4.90 mg/L) and then P_1 (4.10-4.80 mg/L), P_2 (3.90-4.90 mg/L) and P_0 (3.80-4.50 mg/L) respectively. All dissolved oxygen recorded at all treatments appropriate to support growing catfish. According to Syafriadiman *et al* (2005) ideal dissolved oxygen to support fish development should be more than 5 mg/L. In the research, dissolved oxygen was increasing slightly because function of resirculation system. Lesmana (2001) stated that resirculation system has a function to maintain biological parameters, water temperature and oxygen distribution as well as toxic methabolic prevention.

The highest carbondioxide (CO_2) concentration was achieved at treatment P_0 (15.98-17.97 mg/L) and then P_3 (11.18-13.98 mg/L), P_1 (9.98-11.98 mg/L) as well as P_2 (7.99-11.98 mg/L). High CO_2 concentration at treatment P_0 caused by waste disposal from methabolic waste disposal. so that uneaten food and methabolic wastes as material suspension were not filtering. CO_2 content at all treatments was still in the save range concentration for fish development. Kasry (2002) stated that CO_2 concentration in the water body produced from decomposing of organic materials. The highest CO_2 concentration should not more than 12 mg/L and the lowest CO_2 concentration 2 mg/L.

Concentration of ammonia at all treatments are almost same (0.02 - 0.09 mg/l). Ammonia concentrations since early research at all treatments were increasing until day-15 and then decreasing until final research period (day-45) (see Figure 3).



Observation period (day)

Figure 3. Fluctuation of ammonia as long as research period

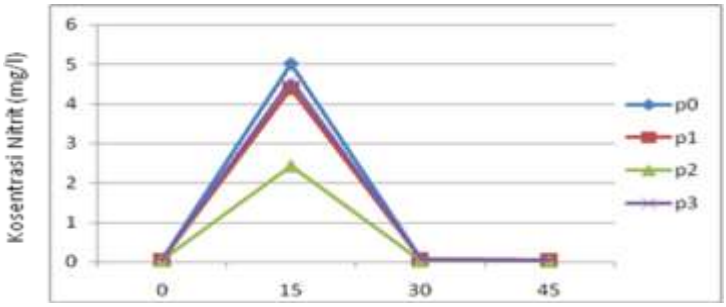
Increasing ammonia concentration was invented at treatment P_0 and P_3 as many as 0.09 mg/L and then follow by P_1 as many as 0.08 mg/L and the lowest at P_2 as many as 0.07 mg/L. The highest ammonia concentration at P_0 and P_3 caused by filter functioning effectively.

Ammonia concentration at the end of the research period was achieved at treatment P_0, P_1 and P_3 same (0.05 mg/L), while the lowest concentration was invented at treatment P_2 (0.04 mg/L). Low ammonia concentration at treatment P_2 caused by mustard green root could absorb ammonia better than the other filter materials. According to Putra and Pamukas (2011) mustard greens can decrease NH_3 concentration, because nitrogen concentration in water could utilize for growth especially nitrite and ammonium.

Ammonia concentration at all treatments was still in the save range concentration for organism life. Boyd (1979) said that ammonia concentration was safe for aquatic organism less than 1 mg/L.

Results of Variance Analysis (ANAVA) P (0.000) < 0.05 showed that different filter materials were affecting ammonia concentration in the catfish culture media. Furthermore, SNK test showed that treatment P_2 with P_3 and P_0 differ significantly between P_1 with P_0 differ.

Nitrites concentrations (NO_2) were increasing at day 15, where the highest nitrite concentration was P_0 (5.02 mg/L) and then P_3 (4.60 mg/L), P_1 (4.40 mg/L) and P_2 (2.43 mg/L). Furthermore, nitrite concentration decreasing at day 45, where nitrite concentrations at the end of research period were different. The highest nitrite concentration in the treatment P_0 (0.06 mg/L), P_3 (0.06 mg/L), P_1 (0.05 mg/L) and P_2 (0.02 mg/L).



Observation period (day)

Figure 4. Fluctuation of nitrite concentration as long as research period

Nitrite concentration as long as research period was treatment P_0 around (5.02 - 0.05mg/L) and then (P_3 4.60 - 0.05 mg/L), P_1 (4.40 - 0.04 mg/L) and P_2 (2.43 – 0.04 mg/L). Range of nitrite concentration at all treatments could tolerate fish growth. Siikavuopio and Saether (2006) stated that nitrite concentration at level 16 mg/L as lethal dose concentration, 1-5 mg/L is dangerous for fish and the save concentration should less than 1 mg/L. While Syafriadiman *et al* (2005) stated that nitrite concentration up to 2 mg/L for long time will be a toxic for fish.

Putra (2010) said that nitrite concentration without filter materials at nile culture more than ard greens (0.286 - 1.386 mg/L).

Results of Variance Analysis (ANAVA) P (0.000) < 0.05 showed that different filter materials were significantly affecting nitrite concentration in the catfish culture media. Furthermore. SNK test showed that treatment P_2 differ significantly with P_1, P_3, and P_2 differ significantly with P_0, while P_1 and P_3 differ with P_0.

Nitrate concentrations (NO_3^-) were increasing and decreasing as long as research period. The highest nitrate concentration was achieved at the second measurement (day-15) at treatment P_0 6.87 mg/L and then P_3 (6.06 mg/L), P_1 (5.99 mg/L and P_2 (4.32 mg/L). Furthermore, nitrate concentration decreasing at day 45 (Figure 5).

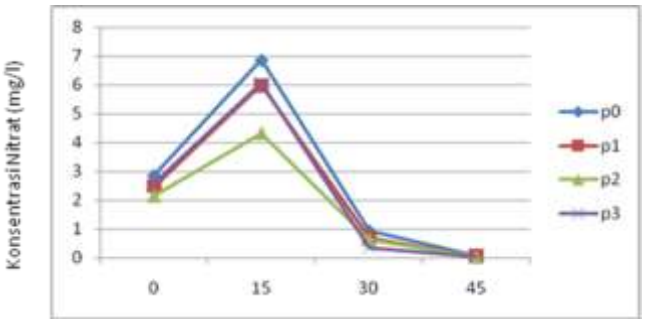


Figure 5. Fluctuation of nitrate concentration as long as research period

Nitrate as nitrogen form has function as main nutrient for algae growth. Nitrate come originally from ammonium (NH_4) enter to culture media through domestic wastes and its concentration decreasing to the outlet caused by microorganism activity in the water such as Nitrozomonas. Microbacteria oxidized ammonium become nitrate. Oxidation processing will decrease oxygen concentration especially at raining season.

The highest nitrate concentration was achieved at treatment P_0 (6.87 - 0.06 mg/L) and then P_3 (6.06 - 0.05 mg/L), P_1 (5.99 – 0.05 mg/L) as well as P_2 (4.32 - 0.04 mg/L). The highest nitrate concentration at treatment P_0 (0.06 mg/L), P_3 (0.05 mg/L) and P_2 (0.04 mg/L). Low nitrate concentration at P_2 caused by mustard greens using nitrates for the growth. According to Putra and Pamukas (2011), mustard greens could utilized nitrate (NO_3) and ammonium (NH_4) for the growth. At the early mustard greens growth, they utilized nitrates more so that nitrate concentration decreasing.

Results of Variance Analysis (ANAVA) P (0.000) < 0.05 showed that different filter materials were significantly affecting nitrate concentration in the catfish culture media. Furthermore, SNK test showed that treatment P_2 differ significantly with P_1, P_3, and P_2 differ with P_0, while P_1 and P_3 differ significantly toward P_0.

Average Growth Rates and Absolute Growth Rates of Catfish Juveniles

Result from measuring of average growth rates at all treatments as long as research period could be seen in Table 3.

Table 3. Average growth rates of catfish juvenile (*Mystus nemurus C.V*) as long as research period

Treatment	Observation day- (gram)			
	0	15	30	45
P_0	2.83	3.53	3.91	5.95
P_1	2.73	3.87	4.84	6.49
P_2	2.83	4.52	5.66	6.85
P_3	2.77	3.87	4.69	6.37

Average growth rates of fish as long as research period was increasing of each treatment. The highest catfish growth rates was achieved at treatment P_2 (6.85 grams) and then follow by [illegible].95 grams) respectively. It could be concluded [illegible] utilize fish meal better than the others. beside

that the fish appetite in the treatment was higher than the other fish treatments. Furthermore, water quality in the treatment was better than with the other treatments. Wilburn and Owen (1964) stated that fish growth is affected by water quality, fish meal quality and quantity and fish age.

Absolute growth rates of catfish as long as research period could be seen on Table 4.

Table 4. Absolute growth rates of catfish *(Mystus Nemurus C.V)* as long as resrach period

Repetition	Treatment (gram)			
	P_0	P_1	P_2	P_3
1	2.96	3.54	3.96	3.64
2	3.12	3.48	4.02	3.66
3	3.26	4.26	4.06	3.5
Total	**9.34**	**11.28**	**12.04**	**10.8**
Average (Std.dev)	**3.11± 0.15[a]**	**3.76± 0.43[b]**	**4.01±0.05[b]**	**3.60±0.08[b]**

Average absolute growth rates of fish as long as research period was increasing of each treatment. The highest catfish growth rates was achieved at treatment P_2 (4.01 grams) and then follow by treatment P_1 (3.76 grams), P_3 (3.60 grams) and P_0 (3.11 grams) respectively. It could be concluded that at treatment P_2, the fish in the treatment could utilize fish meal better than the others. besides that the fish appetite in the treatment was higher than the other fish treatments.

Fish growth means fish body alteration in weight and length along with times difference. In order to reach better growth, the fish should obtain fish meal in good nutrition as long as culture period. Fish growth affected by internal and external factors such as genetic, sex, age, water quality, food as well stocking density (Effendi, 2003).

Results of Variance Analysis (ANAVA) P (0.009) < 0.05 showed that different filter materials gave different effect on absolute growth weight of catfish. Furthermore, SNK test showed that treatment P_0 differ significantly with P_1, P_2, and P_3, while among other treatments were not different. It could be concluded that different filter materials were not affect significantly absolute growth weight of catfish.

Average Growth Length and Absolute Growth Length of Catfish Juveniles

The average growth length of catfish juveniles as long as research period could be seen on Table 5.

Table 5. Average growth length of catfish (*Mystus nemurus C.V*) as long as research period.

Treatments	Observation day- (cm)			
	0	15	30	45
P_0	4.77	7.67	8.30	9.57
P_1	4.73	7.93	8.63	9.77
P_2	4.80	8.30	8.60	9.98
P_3	4.77	7.87	8.60	9.73

Average growth length of fish as long as research period was increasing of each treatment. The highest catfish length was achieved at treatment P_2 (9.98 cm), and then follow by treatment P_1 (9.77 cm), P_3 (9.73 cm) and P_0 (9.57 cm) respectively. It showed that both fish weight and fish length were increasing. While absolute growth length of fish could be seen on Table 6.

Table 6. Absolute growth length of catfish (*Mystus nemurus C.V*) as long as research period.

Repetition	Treatment (cm)			
	P_0	P_1	P_2	P_3
1	5.20	5.20	5.14	
2	4.90	4.70	5.10	4.90
3	4.30	5.20	5.30	4.90
	15.10	**15.54**	**14.9**	
	5.03± 0.28	**5.10±0.10**	**4.9**	

Absolute growth length of fish as long as research period were P_2 (5.10 cm), P_1 (5.03 cm), P_3 (4.97 cm) and P_0 (4.80 cm) respectively .

Results of Variance Analysis (ANAVA) P (0.466) > 0.05 showed that different filter materials were not gave different effect toward absolute growth length of catfish.

Daily Growth Rates of Catfish Juveniles

Daily growth rates were different at each treatment as shown on Table 7.

Table 7. Daily growth rates of catfish (*Mystus nemurus C.V*) as long research period.

Repetition	Treatment (%)			
	P_0	P_1	P_2	P_3
1	1.60	1.77	1.87	1.95
2	1.58	1.80	1.98	1.81
3	1.76	2.21	2.04	1.80
Total	**1.65**	**1.92**	**1.96**	**1.85**
Average (Std.dev)	**1.65± 0.98**	**1.92± 0.24**	**1.96±0.86**	**1.85±0.83**

Average daily growth rates of catfish was achieved from the best of P_2 (1.96 %) and then P_1 (1.92 %), P_3 (1.85%) and the lowest of P_0 (1.65%).

Result of variance analysis (ANAVA) P (0.106) > 0.05 showed that different filter materials gave different effect toward daily growth rates of catfish.

Survival Rates of Catfish

Survival rates of catfish as long research period were around 66.67- 93.33 % (Table 8).

Table 8. Survival rates of catfish (*Mystus nemurus C.V*) as long as research period.

Repetition	Treatment (%)			
	P_0	P_1	P_2	P_3
1	66.67	80	93.33	66.67
2	73.33	66.67	86.67	86.67
3	80	93.33	93.33	80
Total	**73.33**	**80**	**91.11**	**78**
Average (Std.dev)	**73.33± 0.06**	**80± 0.13**	**91.11±0.03**	**78±0.10**

The highest survival rates of catfish was achieved by treatment P_2 91.11%, while the lowest survival rates was achieved by treatment P_0 (73.33 %) (Table 8). Catfish mortality as long as research period caused by canibalism characteristic of the fish. At treatment P_0 and P_3, mortality predicted by bad water quality especially high ammonia concentration at day-15 of 0.09 mg/L.

Survival rates are comparison between life fish at the research period with total fish number at the formerly research period. In aquaculture activities. fish mortality as an indicator of fish culture successful (Tang. 2000).

Result of variance analysis (ANAVA) P (0.184) > 0.05 showed that different filter materials were not gave different effect toward survival rates of catfish.

CONCLUSION

Rearing of catfish juveniles (*Mystus nemurus C.V*) at resirculation system using various filter materials gave positively effect toward decreasing ammonia, nitrite and nitrate concentration at fish culture media. The best result was achieved at treatment P_2 (aquaponic system with mustard greens) with concentration of NH_3 (0.02 - 0.07 mg/L), NO_2 (2.43 - 0.02 mg/L), NO_3 (4.32 - 0.04 mg/L). But those treatments did not have effect toward absolute length growth rates, daily growth rates, as well as survival rates respectively. At treatment P_2, absolute growth rates, daily growth rates and survival rates were about 4.01 grams, 1.96 % and 91.11 % respectively.

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