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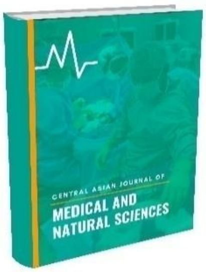

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Effects of Different Salinity Levels and Temperature on Growth Performance of Pangas Catfish, *Pangasius Hypopythalamus*

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Abstract: This study aimed to assess how salinity and temperature affect the growth productivity, survival rate, and feed conversion rate of Thai-Pangas (P. hypophthalmus) fingerlings. The fingerlings were raised in laboratory conditions for 63 days, subject to varying salinity levels of 0, 4, 7, 10, and 13 ppt, and temperatures of 24, 27, 30, 32, and 34 °C. The results showed that the fingerlings exhibited high mortality (100%) within six hours when exposed to 13 ppt salinity, while 62.5% mortality occurred at 13 ppt salinity. No deaths were observed in other treatment groups. At 30 and 32 °C with salinities of 0, 4, and 10 ppt, significantly higher specific growth rates were observed compared to 13 ppt salinity. There were no significant differences in the feed conversion rate and proximal composition among the treatment groups. The study concluded that Thai-Pangas fingerlings are suitable for salinities up to 10 ppt and water temperatures of 32 °C, with satisfactory growth rates. The species showed better adaptation to temperatures between 27 and 30 °C, while high temperatures of 34 °C and low temperatures of 24 °C were found to be stressful and unsuitable for thriving.

Key words: Pangasius Hypopythalamus.

INTRODUCTION

The world's population was estimated to be 6.92 billion in 2010, with an average annual growth rate of 1.2% (Bongaarts & Sinding, 2011). It is projected that the global population will reach ten billion by 2100. Sub-Saharan Africa experienced a significant population increase from 1950 to 2010, growing from 180 million to 831 million people, with a yearly growth rate of 108%. Less developed regions accounted for about 69.92% of the global population rise during this period, excluding the least developed nations (United Nations, 2013). The rapid population growth, along with urbanization and dietary changes, is expected to contribute to a substantial food crisis. Efforts are currently focused on increasing crop yields, enhancing livestock output, and advancing technological advancements to address this issue. Despite improvements in food productivity, it is anticipated that over 370 million people, or over 5% of the global population, will experience hunger in emerging nations by 2060 (Jackson et al., 2013).

Compared to other terrestrial sources, fish and fish products are considered an economical source of dietary protein. For more than 1.6 billion people, particularly in China and West Africa, aquatic foods make up a significant portion (20%) of their daily animal protein intake (FAO, 2014). Aquaculture plays a crucial role in improving both the economy and the health of individuals. Furthermore, the employment growth in the aquaculture sector has outpaced the population expansion globally. This industry supports the livelihoods of hundreds of millions of people and provides employment for tens of millions, making fish one of the most important food commodities worldwide. In many emerging nations, the fish sector can account for up to half of the total value of their food supplies.

The global catch fisheries produced 93.7 million tons of fish in 2011, which was the second-highest recorded amount, following the peak of 93.8 million tons in 1996. Between 2000 and 2012, the global aquaculture industry experienced significant growth, producing 66.6 million tons of food fish, with an annual growth rate of 6.2% from 32.4 million tons. In 2012, approximately 58.3 million individuals were employed full-time in the primary sector of catch fisheries and aquaculture in developing countries. Asia, at 84%, has the largest proportion of people employed in the fisheries and aquaculture sector, followed by Africa (Cochrane, 2009).

Aquaculture indeed plays a crucial role in meeting the demands of a growing global population. The rate of increase in fish production through aquaculture is outpacing the rate of population growth worldwide (FAO, 2014). In 2018, the production of aquaculture food products, which include fish, crustaceans, and mollusks, reached an estimated 82 million tons. Aquaculture has contributed significantly to the increase in per capita fish consumption, which rose from 9,000 grams in 1961 to 20,050 grams in 2018.Aquaculture food fish accounted for a record-high of over 46% of the total capture fisheries and aquaculture production in 2018, highlighting its growing importance. This industry has immense growth potential and the ability to satisfy the increasing protein requirements of a growing global population. It is projected that by 2030, aquaculture will provide 59% of the fish available for human consumption (FAO, 2018).

MATERIALS AND METHODS

3.1. Experimental Design

In the Soil and Water Testing Fish Laboratory of the Saline Water and Research Center Muzaffargarh, ten pangas fingerlings were placed in each of the 5 cleaned glass aquaria (each measuring 75 cm, 45, cm 45 cm) these cleaned glass aquaria were each filled with 72 L of tap fresh water.

During this experiment, enough aeration was maintained, and the pangas were fed twice daily until full. For 63 days, the fish were subjected to five different temperature and salinity conditions: 24°C - 1ppt, 27°C - 4ppt, 30°C - 7ppt, 32°C - 10ppt, and 34 °C - 13ppt. Temperature and salinity were gradually increased (by 1°C and 1ppt every 12 hours, respectively) from usual conditions (24 °C - ppt) to the aim temperature condition (27 - 4 ppt °C, 30 - 7 ppt °C, 32 °C - 10 ppt, and 34 °C - 13).

The salinity was maintained by introducing saline salt, and the requisite temperature usually controlled and maintained by utilizing a device thermostat (REISEA, Japan, and 300 W). On each sampling day, which corresponded to the days 7, 14, and 28 of the raising periods and functioned as the days7, 14, and 28 groups, respectively, two fish were taken from each aquarium.

3.2. Growth Performance

Fish were weighed and counted every week at varied temperatures. To gauge growth performance and feed efficiency, a variety of growth and nutrient utilisation indices, including %weight gain, weight gain, (SGR), (FCR),were assesed.

The weight of fish was measured by the using of the following formula:

$$\text{Weight gain} = \frac{\text{The Mean final weight} - \text{The Mean initial weight}}{\text{The Mean initial weight}} \text{ x } 100$$

3.2.2. Length Gain

The length of fish was measured by the using of the following formula:

Figure 3.1: Map of Fisheries SWARC laboratory muzaffargarh

Figure 3.2: ***P. hypopthalmus*** **physical appearance**

Figure 3.3: Fish feed in aquarium

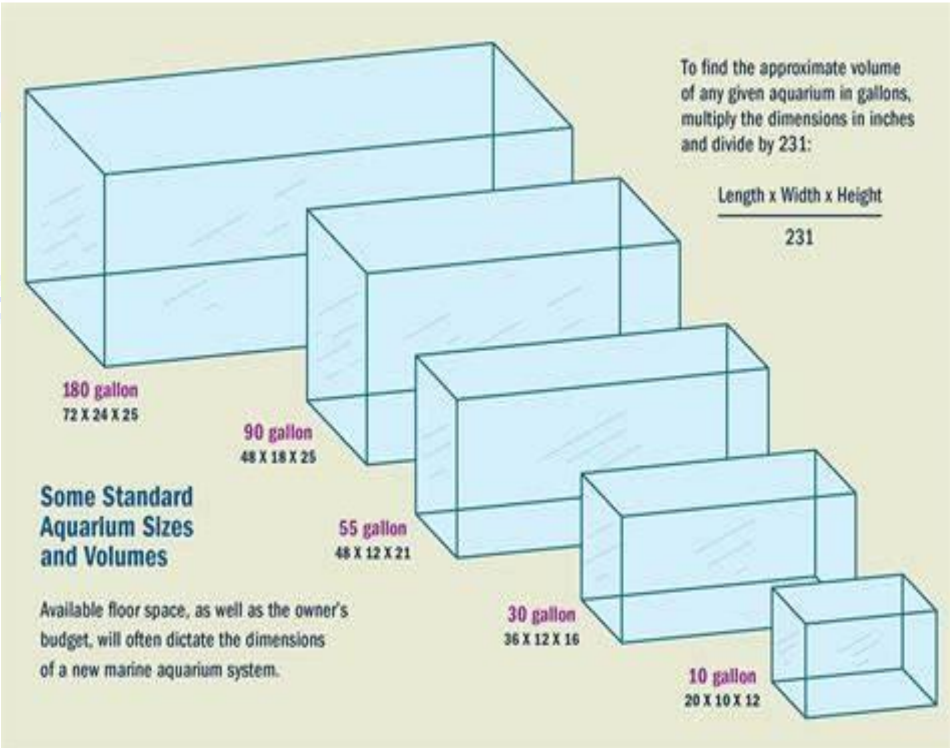

Figure 3.4: ***P. hypopthalmus*** **aquarium**

Figure 3.5: Experimental conditions of *P.hypothalamus* in aquarium

Figure 3.6: *p.hypothalamus* in aquarium

Figure 3.6: ***P. hypopthalmus*****weight measurement**

Figure 3.7: ***P. hypopthalmus*** **feed**

Figure 3.8: ***P. hypopthalmus*** **length measurement**

Figure 3.9: ***P. hypopthalmus*****death due to high salanity**

3.2.1. Weight gain

$$\text{Length gain}= \frac{\text{Mean final length} - \text{Mean initial length}}{\text{Mean initial length}} \text{ x } 100$$

3.2.3. Survival Rate

The fish survival rate can be calculted at end of experiment was measured by the using below formula:

Survival rate = No. of fish harvested – No. of fish stocked

$$\text{Survival rate} = \frac{\text{numbers . of fish harvested}}{\text{number of fish stocked}} \text{ x } 100$$

3.2.4. Food Conversion Ratio (FCR)

Food conversion ratio (FCR) was calculated by using following formula:

$$\text{FCR} = \frac{\text{Dry amount of feed(kg)}}{\text{Weight gain (kg)}}$$

The immediate change in fish weight represents the particular growth rate. The following formula will be used to determine the specific growth rate (SGR):

$$\text{Specific Growth Rate (SGR)} = \frac{\text{In Final Mean Weight} - \text{In Initial Mean Weight}}{\text{Length of Feeding Trial (days)}}$$

3.3. Water Quality Assessment

During this expirement, DO (mg/L), pH, and total alkalinity (mg/L) were among the water quality characteristics that were measured. A portable pH meter and a (DO) meter (Model DO5509, Lutron, made in Taiwan) were used to detect the amount of dissolved oxygen (mg/L) and the pH(Model RI 02895, HANNA Instruments Co.). Using phenolphthalein chemical specific amount of indicator and 0.0227 N NaOH titrant free CO_2 (mg/L) was measured and total alkalinity (mg/L) was determined using the specific titrimetric method with methyl orange indicator and 0.02 N H_2SO_4 titrant.

3.4. Statistical Analysis

(ANOVA) was used to detect the statistically significant differences in data ($P<0.05$)..

3.10: Water quality assessment meter

3.11: Orange indicator and 0.02 N H_2SO_4 titration meter

Figure 3.12: Waterproof portable E.C/T.D. S/Salinity Meter - HI – 9142.

Figure 3.13: DO Meter (Model DO5509, Lutron, made in Taiwan).

RESULTS

Salinity, Temperature and their interface (TxS) had a considerable impact on specific fish, including WG, DWG, LG, and SGR, but only minimally on the survival rate. However, there was no evidence of a TxS interaction for either the average daily food intake (FI) or the percentage of food used for growth. However, each of these variables was affected by the environment in its own way (T for FI; T and S for FCR).All treatments had similar survival rates, with the exception of the 34°C-13 ppt therapy, which had a roughly 50–60% lower survival rate ($P < 0.05$). Temperature had an impact on WG, but the varying salinity levels had a differen impact on how this effect was distributed. The WG was substantially higher in the 30 °C-10 ppt treatment compared to all other treatments (P 0.05).

Although there were some trend which are related with growth characteristics related to high temperature and the pattern of high (TxS) interaction discovered with weight gain was also noted with (LG),(DWG), and (SGR) with the 34°C-13 ppt.

Although there was no evidence of any significant relationships, temperature and salinity independently affected feed intake and FCR estimations for consumption and utilization of food. Low saline levels were typically related to the best FCR estimations, but moderate temperature (30° C) seemed to have a detrimental effect on food conversion efficiency. The temperature was a direct impact on food consumption; the greater the temperature, the more food was consumed daily.

In comparison to all other treatments, the observed survival rate in the 340C-13 ppt therapy was lower (P 0.05). All other treatments had similar fish survival rates, with the exception that the 34^{0}C-13 ppt treatment had lower fish survival than the others. Fish WG increased significantly with increasing temperature and decreasing salinity, from the lowest level of salanity and temprature observed at 34^{0} C-13 ppt to the greatest value in the 270 C-7 ppt treatment. Then, WG significantly dropped from 300C-7ppt to 320C-10ppt by roughly 20–25%. While the effect was less pronounced for LG, the similar trend was typically observed for DWG and SGR.

Because all actions were tested at 63 days, the statistical meaning of differences betweenSGR, DWG, and LG trials typically reflects that noted in the weightgain analysis. Performance across these indicators was generally improved at temperatures of 30 ^{0}C-7 ppt and higher compared to the lowest treatment temperature (24^{0}C-0ppt). Fish housed at 24^{0}C had worse DWG and SGR than fish kept at the other temperatures, even though fish in the 30^{0}C group had the highest levels of both (P 0.05). The amount of food consumed each day varied significantly between treatments, with the highest level, being seen at 34 ^{0}C. FCR values did not vary between 27 ^{0}C and 32 ^{0}C treatments, although all were superior to what was observed in the 24 ^{0}C group.

The measured water quality values were as follows: 27.23±0.02 °C for the temperature, 8.33±0.05 mg/L for the DO, and, 8.05 0.03 for the pH. For the observed water quality metrics over the course of the trial, no appreciable fluctuation was discovered. Fish biological processes including development, reproduction, and other biological activities are greatly influenced by aquatic temperature. Fish metabolism and aquatic temperature are tightly correlated. Warm water fish culture is good for water temperatures between 26.06 and 31.9^{o}C. The temperature in the current experiment was discovered to be (27.23±0.02) °C, which was within acceptable limits throughout the experiment. Another major component that significantly affects a reservoir's productivity is dissolved oxygen (DO). The overall DO for this experiment was 8.33±0.05 mg/L. It was suggested that for fish culture to be successful, oxygen levels should be at least 3 mg/L. The current result indicated that pangas culture is appropriate. pH, or the concentration of hydrogen ions, is a crucial element in fish biology. pH levels between 6.4 to 8.3 are typically ideal for fish growth. The ideal pH range is 6.5 to 8.5, while aquatic organisms prefer a range of 7.5 to 8.0. In the current experiment, the overall pH value was (8.05±0.03), which was appropriate for pangas culture.

Therefore, the result of this expirement indicate that pangas can be cultivate at a salinity of 10 ppt and temperature of 32 ^{o}C without suffering any adverse effects on life.Salinity promotes pangas' survival and growth: From the starting day of the experiment through the end of 63 days, the survival rate of pangas fingerlings was measured. No mortality was noted during the cultural time of period for salinities of 0, 6, 7, 10, and 13 ppt and for temperatures of 24, 27, 30, and 34^{o}C, but noted 86-4, 97%

Table 4.1: Growth responses of *P. hypophthalmus* fry in different temperature and salinity conditions.

Temperature (°C)	**24**	**27**	**30**	**32**	**34**
Salinity (ppt)	**0**	**4**	**7**	**10**	**13**
Initial BW (g)	8.20±0.03	9.26±0.05	8.11±0.02	7.31±0.02	7.96±0.01
Final BW (g)	21.07±0.01	25.28±0.03	24.22±0.01	19.88±0.06	17.89±0.02
Weight gain (g)	12.87±0.04	16.02±0.02	16.11±0.05	12.57±0.04	9.93±0.03
SGR (%)	1.49±0.03	1.59±0.03	1.73±0.04	1.58±0.02	1.28±0.06
FCR	1.25±0.06	1.50±0.07	1.55±0.03	1.54±0.01	1.05±0.01
Survival (%)	100.00±0.02	100.00±0.02	100.00±	100.00±0.01	40.00±0.02

Table 4.2: Physico-chemical attributes of the Pangasius test media.

Ecological factors	**24°C**	**27°C**	**30°C**	**32°C**	**34°C**	**Mean**
Salinity (ppt)	**0**	**4**	**7**	**10**	**13**	

Ph	7.90±1.22	8.04±1.15	8.14±1.05	8.06±0.89	7.94±0.68	
DO (mg/L)	4.94±1.32	4.72±0.72	4.54±0.74	4.34±0.93	3.58±0.92	4.25±1.12
NH3 (mg/L)	0.11±0.06	0.08±0.05	0.07±0.04	0.04±0.03	0.04±0.03	0.07±0.05

Table 4.3: Survival rate (%) (Mean± SEM) of pangas fingerlings in different salinity (ppt) and temperature (^oC) at 63 days rearing period.

Salinity (ppt)	**Temperature (^oC)**	**Survival rate (%) in different duration**			
		0 day	21 day	42 day	63 day
0	24	100	100	100	100
4	27	100	100	100	100
7	30	100	100	100	100
10	32	100	100	100	100
13	34	100	70	40	30

Means in the same column with different superscripts are significantly different at P<0.05.

mortality rate for the salinity varietyamong 10 and 5 ppt.One metric used to examine fish growth is the specific growth rate (SGR). The SGR rate was discovered for salinities of 0, 4, 7, 10, and 13 ppt and temperatures of 24, 27, 30, and 34 ℃ on days 21, 42, and 63. Additionally, SGR was discovered on day 63 at salinity levels of 7 ppt and a maximum temperature of 30^{o}C.During this experiment the lowest specific growth rate wasnoted at on day 20 at 13 ppt. 0 and 4 ppt salinity indicated a moderate SGR.

These conditions are also crucial for a healthy spawn, and a change in any one of these factors can have a detrimental effect on effective reproduction.The results of this study show that pangas growth and survival are unaffected by salinities up to 10 ppt, but that growth was considerably reduced at salinities of 13ppt and higher. Most animals have a particular growth rate during a specific time theirlife cycle. Each fish requires optimum temperature, dissolved oxygen, and salinity for maximum growth and survival. Similar FCR was seen in the current study's 63-day rearing period across all treatments.. This is dependable with the consequences of another study in which salinities ranged up to 5ppt. Salinity had no discernible which showed that pike silverside and black nose silverside fishes only experienced reduced growth and survival at salinities of 10ppt and above and could withstand impact on the FCR in the pangas of the current investigation.

By modifying the energy expenditure for osmotic and ionic management and by reducing feeding rate, salinity directly affectsurvival rate and mortality of fish .Like other environmental elements unique to aquatic settings, salinity has sparked several studies on its impact on fish growth. Salinity may exert stress on aquaculture environments The amount of feed consumed and how well it is assimilated and converted into body tissues determines how well fish grow.The growth rate and food average daily gain was noted at a salinity of 13ppt and a temperature of 34^{o}C.. Salinity was found to have an Impact on average daily gain (ADG), which was negatively correlated with rising salinity. The complex process of growth isAfter 63 days of upbringing, a substantial difference in average daily increase was noticed. The highest amount of average daily gain was noted at salinities of 7 and10ppt and

Table 4.4: Specific growth rate (%) (Mean ± SEM) of pangas fingerlings in different salinity (ppt) and temperature (^oC)at 63 days rearing period.

Salinity (ppt)	(^oC)	SGR %		
		21 days	42 days	63 days
0	24	1.68	1.33	1.12
4	27	1.79	1.42	1.18
7	30	1.94	1.57	1.32
10	32	1.75	1.46	1.25
13	34	1.42	1.16	0.98

Means in the same column with different superscripts are significantly different at $P<0.05$.

Table 4.5: Feed alteration ratio FCR (mean±SEM) of pangas fingerlings in different salinity (ppt) at 63-dayraising period.

Salinity (ppt)	Temperature (^oC)	FCR %		
		21 days	42 days	63 days
0	24	2.75 ± 0.10	2.82 ± 0.04	2.54 ± 0.01
4	27	2.43 ± 0.17	2.70 ± 0.03	2.49 ± 0.01
7	30	2.69 ± 0.08	2.59 ± 0.03	2.48 ± 0.01
10	32	2.48 ± 0.12	2.57 ± 0.03	2.48 ± 0.13
13	34	2.36 ± 0.05	2.45 ± 0.01	2.4 1± 0.01

Table 4.6: The growth rate of Pangasius at 0 ppt and 24 ^0C

Weeks	Early W (g)	Last W (g)	W G (g)	Initial L (cm)	Final L (cm)	L G (cm)	SGR (%)	FCR	Survival (%)
1st Week	8.2	9.47	1.27	6.83	7.81	0.98	2.05	2.07	100
2nd Week	9.47	10.78	1.31	7.81	8.83	1.02	1.85	2.08	100
3rd Week	10.78	12.13	1.35	8.83	9.89	1.06	1.68	2.03	100
4th Week	12.13	13.52	1.39	9.89	10.99	1.1	1.54	2.1	100
5th Week	13.52	14.95	1.43	10.99	12.13	1.14	1.43	2.11	100
6th Week	14.95	16.42	1.47	12.13	13.31	1.18	1.33	2.12	100
7th Week	16.42	17.93	1.51	13.31	14.53	1.22	1.25	2.1	100
8th Week	17.93	19.48	1.55	14.53	15.79	1.26	1.18	2.09	100
9th Week	19.48	21.07	1.59	15.79	17.09	1.3	1.12	2.11	100
Median	13.52	14.95	1.43	10.99	12.13	1.14	1.43	2.1	100
St. Dv	3.863	3.972	0.109	3.06	3.179	0.109	0.316	0.027	100

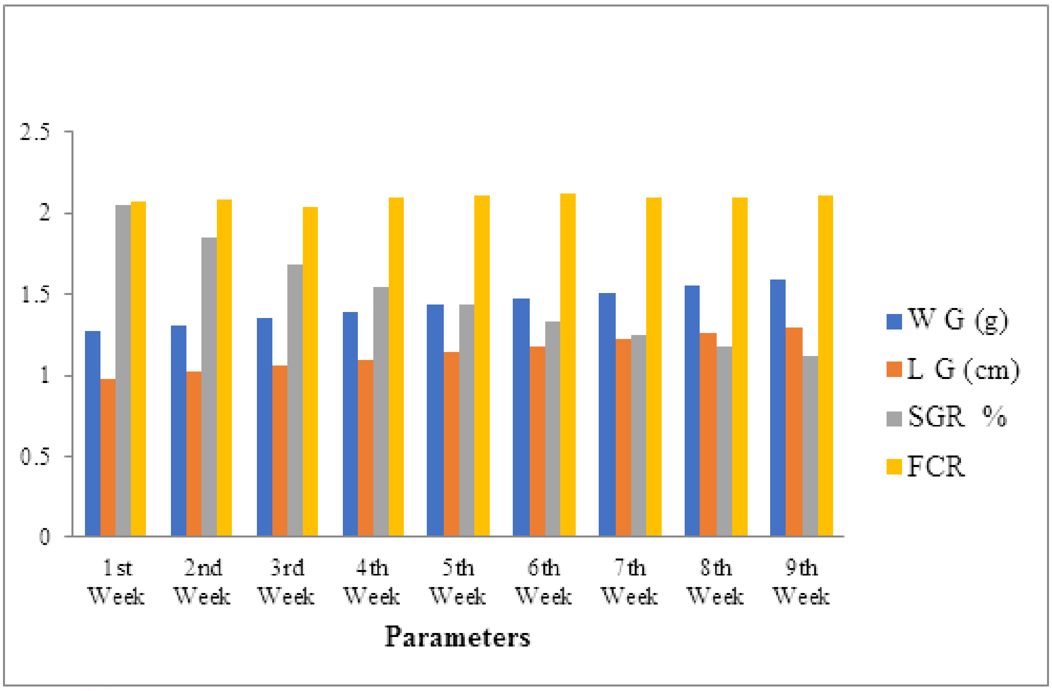

Figure 4.1: Effects of chronic exposure to different salinities and temperatures on growth performance in *P. Hypothalamus*

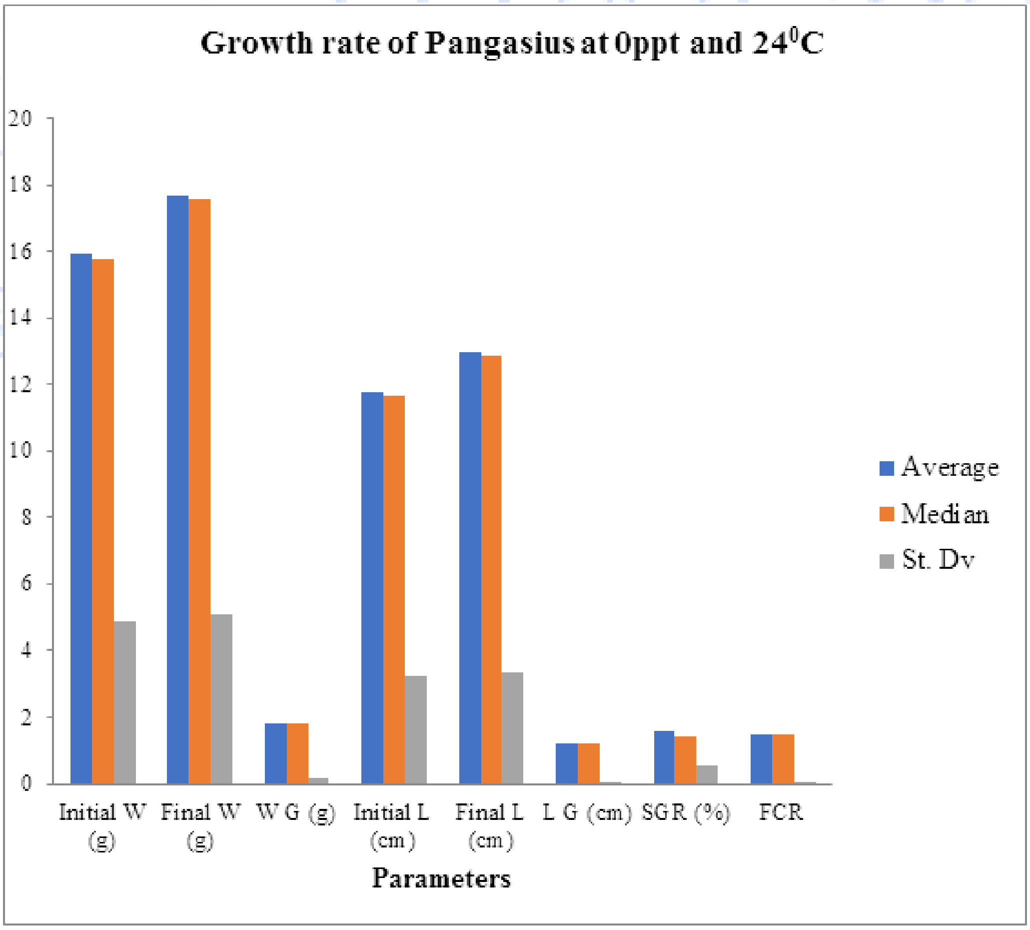

Figure No. 4.2: Column graph showing growth responses of *P. hypothalamus at* salinity (0 ppt) and temperature (24^0C).

Table 4.7: ANOVA on SGR of Pangasius

SOV	Df	SS	MS	F	P
Week	8	0.758	0.095	1.800**	0.000
Treat	4	21.090	5.272	100.141**	0.000
Error	32	1.685	0.053		
Total	44	23.532			

Table 4.8: The growth rate of Pangasius at 4 ppt and 27 ^{0}C.

Weeks	Initial W (g)	Final W (g)	W G (g)	Initial L (cm)	Final L (cm)	L G (cm)	SGR %	FCR	Survival (%)
1st Week	9.26	10.08	1.54	7.17	8.25	1.08	1.21	1.48	100
2nd Week	10.08	12.4	1.6	8.25	9.36	1.11	2.95	1.52	100
3rd Week	12.4	14.06	1.66	9.36	10.5	1.14	1.79	1.5	100
4th Week	14.06	15.78	1.72	10.5	11.67	1.17	1.64	1.51	100
5th Week	15.78	17.56	1.78	11.67	12.87	1.2	1.52	1.5	100
6th Week	17.56	19.4	1.84	12.87	14.1	1.23	1.42	1.49	100
7th Week	19.4	21.3	1.9	14.1	15.36	1.26	1.33	1.51	100
8th Week	21.3	23.26	1.96	15.36	16.65	1.29	1.25	1.5	100
9th Week	23.26	25.28	2.02	16.65	17.97	1.32	1.18	1.49	100
Average	15.9	17.68	1.78	11.77	12.97	1.2	1.587	1.5	100
Median	15.78	17.56	1.78	11.67	12.87	1.2	1.42	1.5	100
St. Dv	4.898	5.090	0.164	3.246	3.328	0.082	0.550	0.012	100

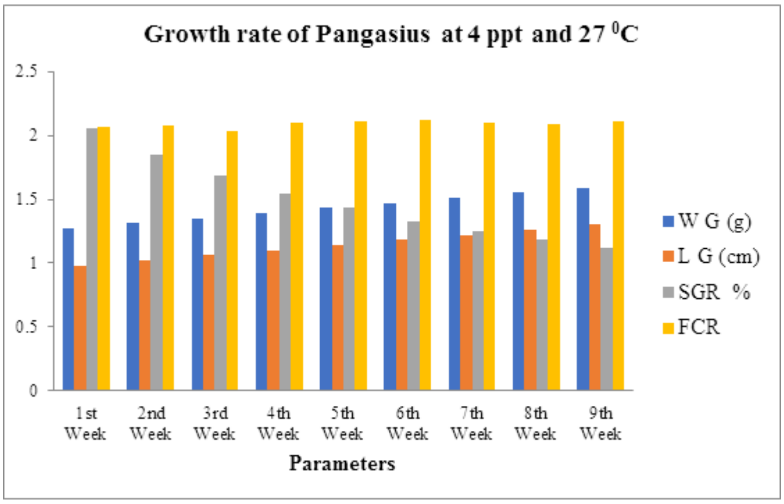

Figure 4.3: Effects of chronic exposure to different salinities and temperatures on growth performance in *P. hypothalamus*

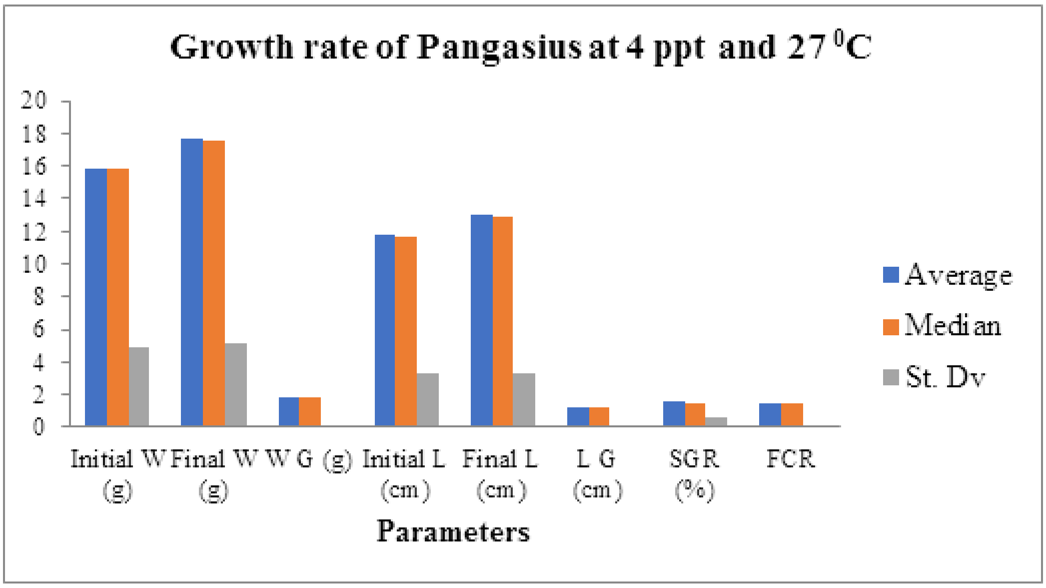

Figure No. 4.4: Column graph showing growth responses of *P. hypothalamus at* salinity (4 ppt) and temperature (27^{0}C).

temperatures of 30 ^{o}C and 32 ^{o}C, respectively. The very low amount ofinfluenced by a variety of influences, including the properties of food intake, predators, and exterior environmental factors like photo-period, salinity and their interactions. Intaking process of pangas are nevertheless governed by a number of internal elements, including those relating to the endocrine system, and external influences, like salinity. Very important environmental factors impacting fish survival, fish growth, and allocation in both marine and fresh water habitats have been demonstrated to be salinity. Salanity effects the fish survival rate and nutrition quality have barely been studied. In order to determine the maximum amount of salinity that pangas may withstand without compromising life and proximate composition, the current investigation was carried out.

According to the summary of SGR table, supplier 2's mean growth performance is at a low of 1, and supplier 3's is at a high of 1, 4922. The means of our sample differ. We must, however, ascertain whether our statistics are consistent with the idea that the population means are not equal. The variations we observe in our samples could be the result of erroneous random sampling. The p-value in the ANOVA table is 0.000. We reject the null hypothesis since this value is below our significance level of 0.05. We may conclude that the three populations' means are not equal based on the strength of the evidence in our sample data.

According to the summary table, supplier 3's mean growth performance is lowest at 3.05 and supplier 1's is highest at 6.07. The means of our sample differ. We must, however, ascertain whether our statistics are consistent with the idea that the population means are not equal. The variations we observe in our samples could be the result of erroneous random sampling. The p-value for the ANOVA table is 0.025. We reject the null hypothesis since this value is below our significance level of 0.05. Our sample data offer compelling justification for drawing the conclusion that the three populations' means are not equal.

The summary table shows that supplier 2's mean growth performance is lowest at 1.48 and supplier 1's is highest at 1.79. The means of our sample differ. We must, however, ascertain whether our statistics are consistent with the idea that the population means are not equal. The variations we observe in our samples could be the result of erroneous random sampling. The p-value in the ANOVA table is 0.051. We reject the null hypothesis since this value is below our significance level of 0.05. The statistics from our sample are convincing enough to support the conclusion that the three populations' means are not equal.

According to the summary table, supplier 3's mean growth performance was 1.37, whereas supplier 1's was 1.583. The means of our sample differ. We must, however, ascertain whether our statistics are consistent with the idea that the population means are not equal. The variations we observe in our samples could be the result of erroneous random sampling. The p-value in the ANOVA table is 0.056. We reject the null hypothesis since this value is below our significance level of 0.05. The statistics from our sample are convincing enough to support the conclusion that the three populations' means are not equal.

According to the summary table, supplier 2's mean growth performance is lowest at 1.077778 and supplier 3's is highest at 1.278889. The means of our sample differ. We must, however, ascertain whether our statistics are consistent with the idea that the population means are not equal. The variations we observe in our samples could be the result of erroneous random sampling. The p-value in the ANOVA table is 0.04958. We reject the null hypothesis since this value is below our significance level of 0.05. The statistics from our sample are convincing enough to support the conclusion that the three populations' means are not equal.

Table 4.9: The growth rate of Pangasius at 7 ppt and 30 ^oC.

Weeks	Initial W (g)	Final W (g)	W G (g)	Initial L (cm)	Final L (cm)	L G (cm)	SGR (%)	FCR	Survival (%)
1st Week	8.11	9.14	1.43	2.1	3.42	1.32	1.7	1.51	100
2nd Week	9.14	11.06	1.52	3.42	4.77	1.36	2.72	1.54	100
3rd Week	11.06	12.67	1.61	4.77	6.15	1.4	1.94	1.57	100
4th Week	12.67	14.37	1.7	6.15	7.56	1.44	1.79	1.53	100
5th Week	14.37	16.16	1.79	7.56	9	1.48	1.67	1.55	100
6th Week	16.16	18.04	1.88	9	10.47	1.52	1.57	1.55	100
7th Week	18.04	20.01	1.97	10.47	11.97	1.56	1.48	1.54	100
8th Week	20.01	22.07	2.06	11.97	13.5	1.6	1.39	1.58	100
9th Week	22.07	24.22	2.15	13.5	15.06	1.64	1.32	1.57	100
Average	14.625	16.415	1.79	7.66	9.1	1.48	1.731	1.548	100
Median	14.37	16.16	1.79	7.56	9	1.48	1.67	1.55	100
St. Dv	4.842	5.103	0.246	3.903	3.985	0.109	0.418	0.022	100

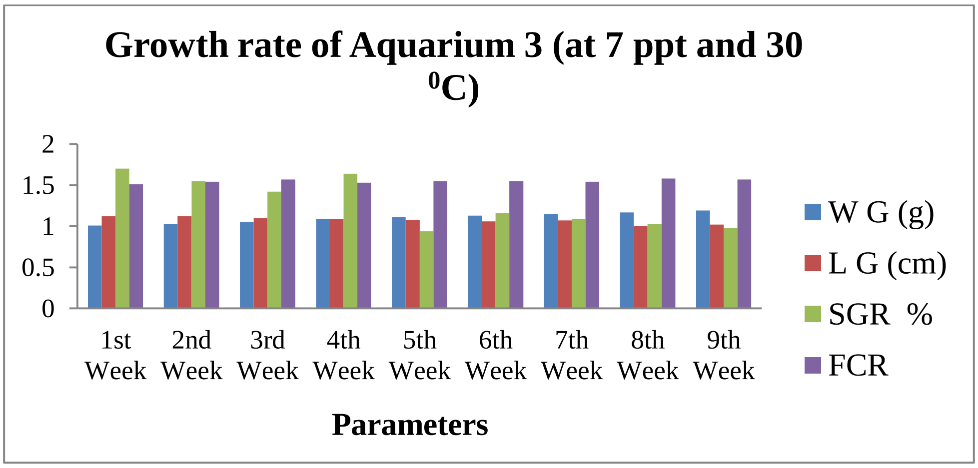

Figure 4.5: Effects of chronic exposure to different salinities and temperatures on growth performance in *P. hypothalamus.*

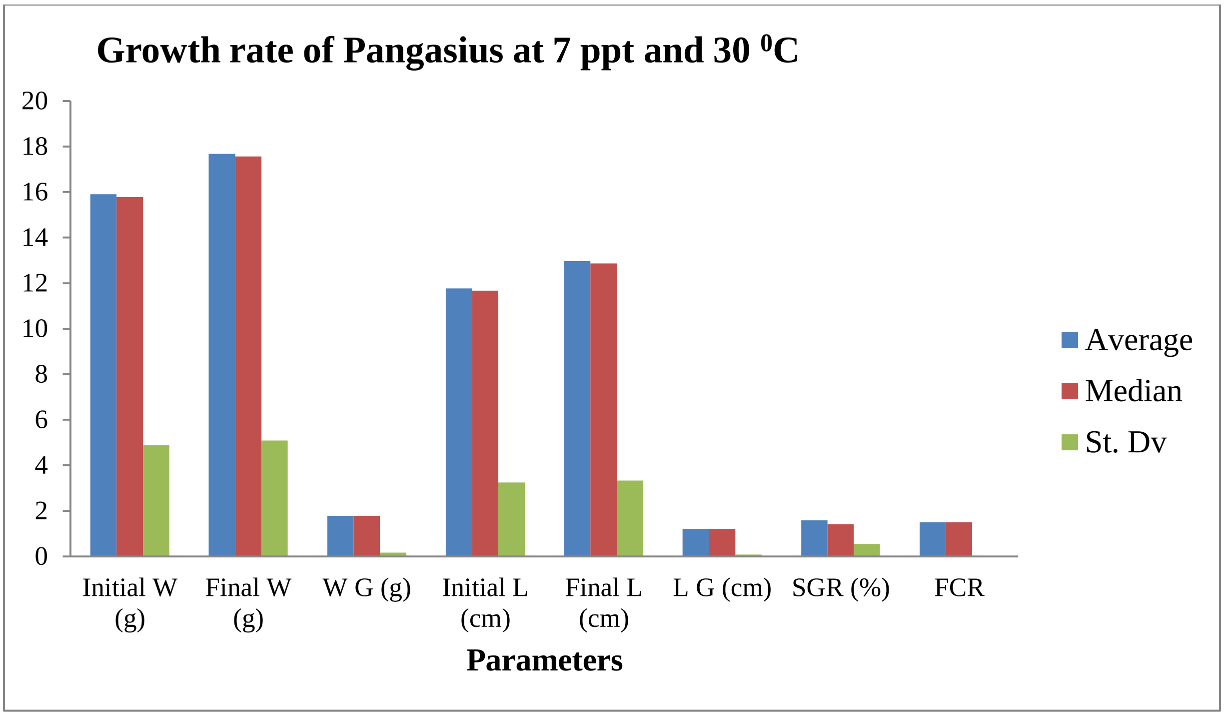

Figure No. 4.6: Column graph showing growth responses of *P. hypothalamus at* salinity (7 ppt) and temperature (30^{0}C).

Table 4.10: ANOVA on bodylength of Pangasius.

SOV	Df	SS	MS	F	P
Week	8	0.815	0.102	5961.844**	0.000
Treat	4	1.183	0.296	6.947**	0.000
Error	32	0.470	0.015	20.150**	0.000
Total	44	2.467			

Table 4.14: Growth rate of Pangasiusat 10ppt and 32 ^{0}C.

Weeks	Initial W (g)	Final W (g)	W G (g)	Initial L (cm)	Final L (cm)	L G (cm)	SGR %	FCR	Survival (%)
1st Week	7.31	8.43	1.12	2.01	3.26	1.25	2.03	1.51	100
2nd Week	8.43	9.62	1.19	3.26	4.53	1.28	1.88	1.54	100
3rd Week	9.62	10.88	1.26	4.53	5.82	1.31	1.75	1.57	100
4th Week	10.88	12.21	1.33	5.82	7.13	1.34	1.64	1.53	100
5th Week	12.21	13.61	1.4	7.13	8.46	1.37	1.55	1.55	100
6th Week	13.61	15.08	1.47	8.46	9.81	1.4	1.46	1.55	100
7th Week	15.08	16.61	1.53	9.81	11.18	1.43	1.38	1.54	100

8th Week	16.61	18.21	1.6	11.18	12.57	1.46	1.31	1.58	100
9th Week	18.21	19.88	1.67	12.57	13.98	1.49	1.25	1.57	100
Average	12.44	13.836	1.396	7.196	8.526	1.37	1.583	1.54	100
Median	12.21	13.61	1.4	7.13	8.46	1.37	1.55	1.55	100
St.Dev	3.739	3.926	0.187	3.615	3.670	0.082	0.265	0.022	100

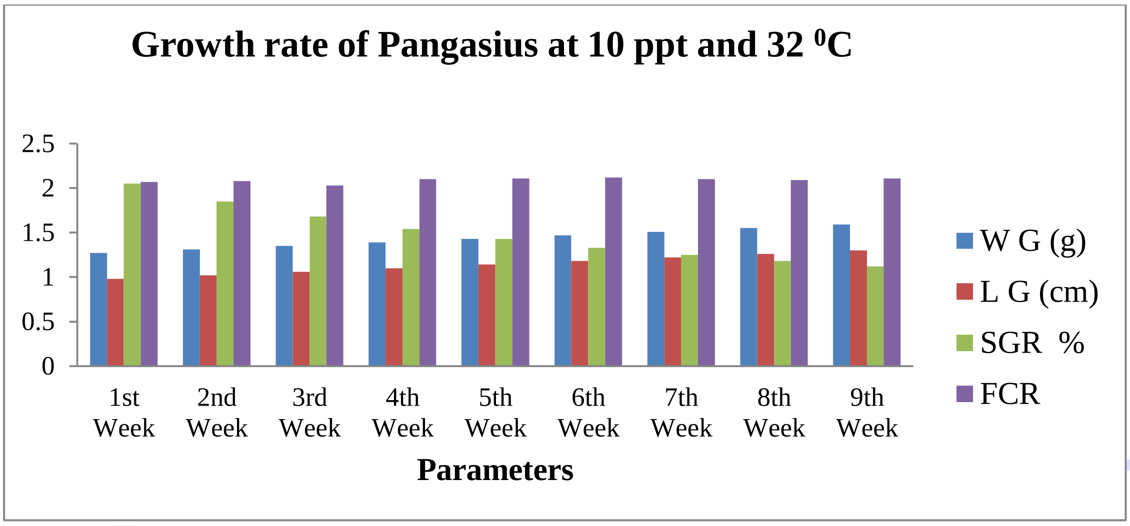

Figure 4.7: Effects of chronic exposure to different salinities and temperatures on growth performance in *P. hypothalamus.*

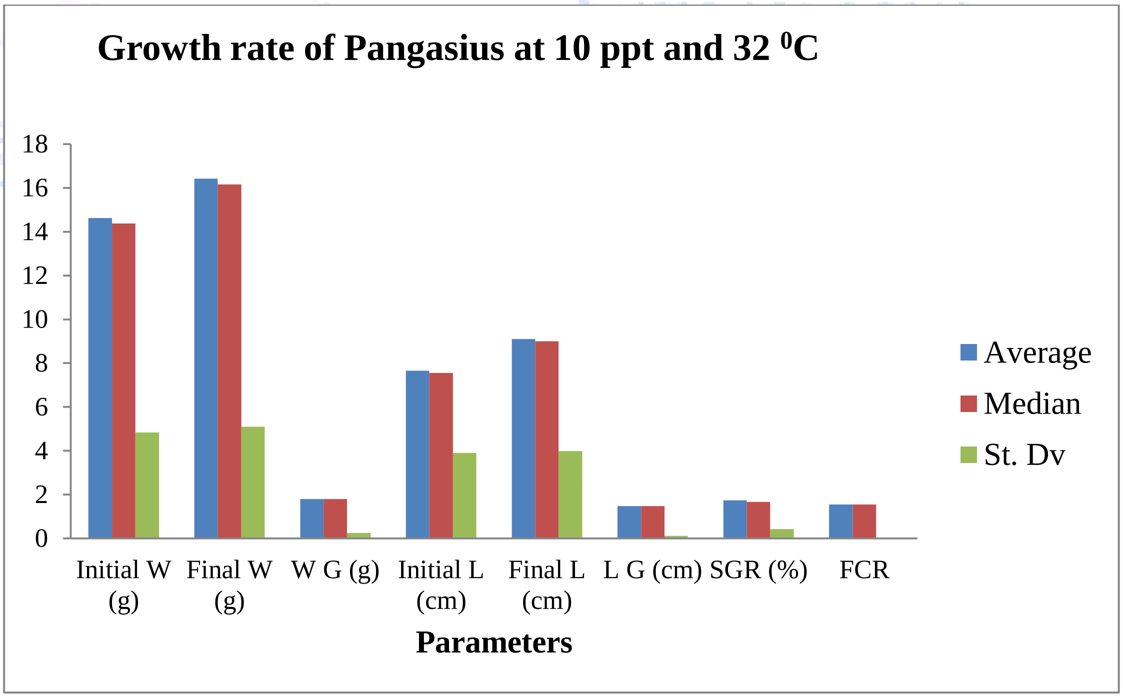

Figure No. 4.8: Column graph showing growth responses of *P. hypothalamus at* salinity (10ppt) and temperature (32^{0}C).

Table 4.15: ANOVA on weight gain in Pangasius.

SOV	df	SS	MS	F	P
Week	8	2.306	0.288	56.727	0.000
Treat	4	5.327	1.332	262.128	0.000
Erorr	32	0.163	0.005		
Total	44	7.795			

Table 4.16: Growth rate of Pangasius at 13ppt and 34 ^{0}C.

Weeks	Initial W (g)	Final W (g)	W G (g)	Initial L (cm)	Final L (cm)	L G (cm)	SGR (%)	FCR	Survival (%)
1st Week	7.96	8.97	1.01	2.07	3.19	1.12	1.7	1.51	100
2nd Week	8.97	10	1.03	3.19	4.32	1.12	1.55	1.54	100
3rd Week	10	11.05	1.05	4.32	5.46	1.1	1.42	1.57	50
4th Week	11.05	12.4	1.09	5.46	6.61	1.09	1.64	1.53	50
5th Week	12.4	13.25	1.11	6.61	7.77	1.08	0.94	1.55	50
6th Week	13.25	14.38	1.13	7.77	8.94	1.06	1.16	1.55	50
7th Week	14.38	15.53	1.15	8.94	10.13	1.07	1.09	1.54	40
8th Week	15.53	16.7	1.17	10.13	11.33	1.004	1.03	1.58	40
9th Week	16.7	17.89	1.19	11.33	12.54	1.02	0.98	1.57	0
Average	12.248	13.352	1.103	6.646	7.81	1.073	1.278	1.548	100
Median	12.4	13.25	1.11	6.61	7.77	1.08	1.16	1.55	100
St. Dv	2.991	3.046	0.063	3.168	3.199	0.040	0.299	0.022	100

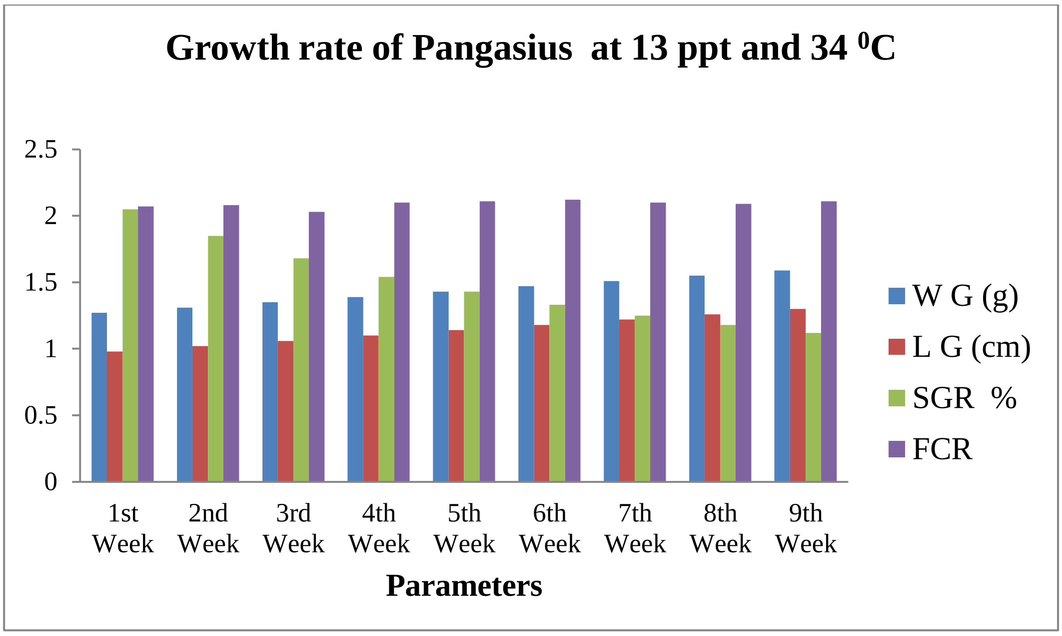

Figure 4.9: Effects of chronic exposure to different salinities and temperatures on growth performance in *P. hypothalamus*

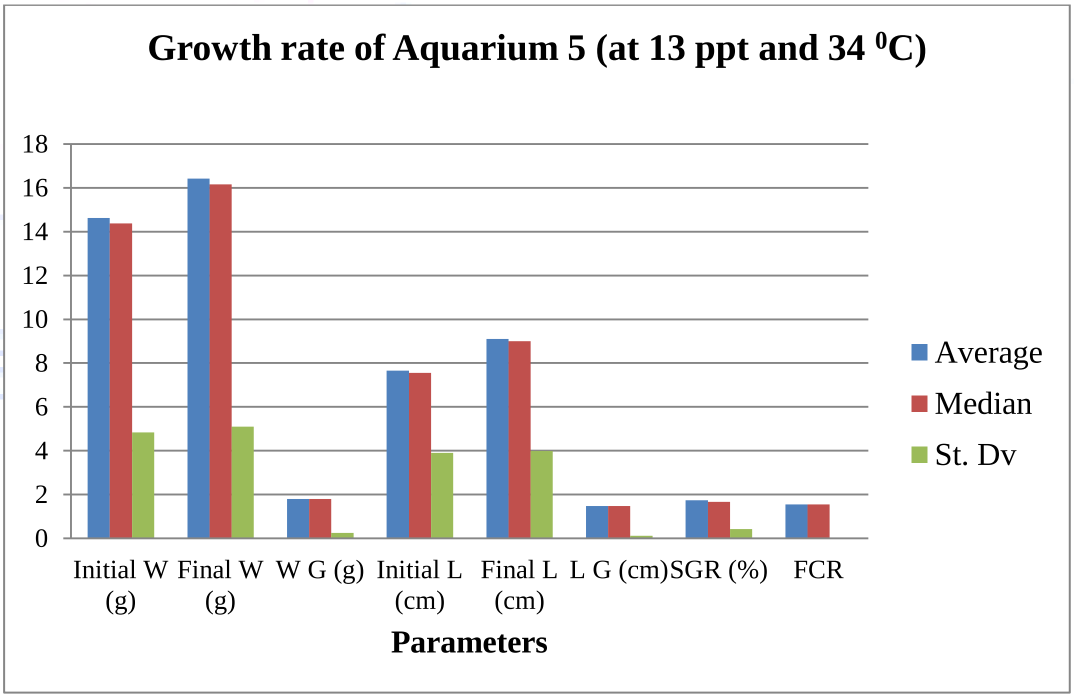

Figure No. 4.10: Column graph showing growth responses of *P. hypothalamus at* salinity (13ppt) and temperature (34^0C).

Table 4.17: Length Table

SOV	Df	SS	MS	F	P
Week	8	0.815	0.102	5961.844**	0.000
Treat	4	1.183	0.296	6.947**	0.000
Error	32	0.470	0.015	20.150**	0.000
Total	44	2.467			

DISCUSSION

The complex process of growth is influenced by the effects of food intake and predators, as well as photoperiod, temperature. In universal, the brain interacts with messages from the peripheral environment to control food intake, such as sensory information and blood-borne signals (hormone and nutrient molecules).When stocked at 20% salinity, all fish perished within 6 hours, whereas with 14% salinity, about 50% died in the same time. The result of this experiment shows that pangas can be cultivated at a salinity of 12ppt without dangerous effects on the life of *P. hypothalamus*. Salinity promotes pangas survival and growth: From the beginning of the trial through the end of 63 days, the survival rate of pangas fingerlings was measured. No death was seen for salinities of 0, 4, 7, 10, or 13 ppt during the cultural era, while discovered 86–97% mortality at salinities of 15-5ppt.

SGR rate decrease and more slowly as the organism advances in age. The maximum specific growth rate is at 8ppt salinity was also discovered on day 63.During this experiment the lowest SGR was 14ppt on day 20, and moderate SGR was seen at salinities of 12% and below. The specific growth rate is one statistic used to assess fish growth. The SGR rate was found for salinities of 0 and 2% at 21, 42, and 63 days. This is consistent with the results of another research, which showed that pike silverside and black nose silverside fishes can survive and thrive at salinities of up to 5% and at salinities of 10% and higher. Most animals have an SGR at a crucial point in their life cycles, which frequently decreases with ageing and even approaches zero in certain species (Foresberg et al., 1996)

After a 60-day raising period, a substantial difference in the regular daily increase was noticed. At 2% salinity and 0% salinity, the average daily increases were highest, while at 14% salinity, it was lowest. Salinity was found to have an impact on average daily gain (ADG), which was negatively correlated with rising salinity. At salinities of 6% and higher, the condition factor was significantly reduced over the course of 20 days, while at salinities of 12 and 14%, it was significantly reduced over the course of 40 days. Nevertheless, it was discovered that the fish could sustain the condition factor at day 60 under all salinity circumstances. In the 60-day rearing period of the current investigation, same FCR was seen for all treatments.Three freshwater euryhaline species had well SGR and FCR at 3 or 9pptsalinity than they did at 0 or 1% salinity, which is in contrast to the findings of the current study. Salinity had no more acute effect on the FCR in the pangas. FCR in pangas in this inquiry was similar to earlier findings in different type of species.

The measured water quality values were as follows: 27.23 0.02 °C for the temperature, 8.33±0.05 mg/L for the DO, and 8.05±0.03 for the pH. For the observed water quality metrics over the course of the trial, no appreciable fluctuation was discovered. Fish biological processes, including development, reproduction, andmany important other biological activities, are affected by water temperature (Harvell et al., 2002). Fish metabolism and water temperature are tightly correlated. Warm water fish culture is good for water temperatures between 26.06 and 31.97 °C. The temperature in the current experiment was discovered to be (27.23±0.02) °C, which was within acceptable limits throughout the experiment. Another critical element that significantly affects a reservoir's productivity is dissolved oxygen (DO). The overall DO for this experiment was 8.33±0.05 mg/L. Fish culture to be successful, oxygen levels should be at least 3 mg/L (Ha et al., 2009). The current result indicated that pangas culture is appropriate. pH, or the concentration of hydrogen ions, is a crucial element in fish biology. pH levels between 6.4 to 8.3 are typically ideal for fish growth (Graham et al., 2011) . The ideal pH range is 6.5 to 8.5, while aquatic organisms prefer a range of 7.5 to 8.0.

Climate change can decrease host comparative sensitivity andalso increased pathogenattacking load, and decrease disease ratio of transmission and also decrease survival rates through effects on relative illness levels, changes in the average water temperature may also have an indirect impact on the tra catfish sector (Kumar et al., 2018). Paradoxically, the results of this experiment shows that, while at increase in water temperature may indirectly decrease survival by heartening disease, any similar rise in salinity level may instead counteract this effect. Although difference in salinitylevels and temperature that are within permissible restrictions may not directly affect survival rates, they may do so indirectly by changing the virulence of the illness.This is due to the fact that by cultivating catfish in a very low saline surroundings that is harmful to catfish diseases (up to 10%), many of the major catfish diseases can be eliminated somewhat than freshwater 0% where catfish diseases grow (Fiess et al., 20070. One of the major factors that is anticipated to have an impact on how the sector develops in the future is diseases that affect farmed*P. hypothalmus*.

In the current study, it was found that salinity, temperature, and perhaps their interactions all had a substantial impact on the survival of tra catfish when kept in a lab setting. Compared to all lower salinity treatments, the survival rates of *P. hypothalmus*were negatively impacted when the salinity reached 18%.Furthermore, an increase in salinity above 10% did not lead to an increase in food intake because the amount of food ingested among treatments did not differ significantly, but FCR values increased. Fish growth rate, FCR values, and *P. hypothalmus*weight gain did suffer when salinity levels exceeded 10%. The iso-osmotic pressure point, which is expectedto be around 9ppt was increased by external ambient osmotic pressure, catfish needed to consume more food and the energy/matter it contains to deal with the osmotic challenge; this strategy was not intended to promote weight gain but rather osmoregulation and protein synthesis in the gills (Imsland et al., 2001).

This showed that pike silverside and black nose silverside fishes only experienced compact growth and survival rate at salinities of 10ppt and above and could withstand salinities of up to 5. Most animals have a certain development rate in their life cycle, which normally diminishes with advance age pattern and even reaches zero in some animals (Hieu et al., 2021). Each fish requires a optimum temperature, dissolved oxygen, or salinity for maximum growth and survival (Goda et al., 2019). These conditions are also crucial for a healthy spawn, and a change in any one of these factors can have a detrimental effect on effective reproduction (Lin et al., 2003). The results of the current study show that salinities up to 4% do not effect pangas development and survival, but salinities above 8% dramatically reduce growth. Similar FCR was seen in the current study's 60-day rearing period across all treatments. In contrast to the results of the current study, three freshwater euryhaline species had better SGR and FCR at 3 or 9% salinity compared to 0 or 1% salinity. Salinity had no discernible impact on the FCR in the pangas of the current investigation. FCR in pangas in this study, however, was comparable to prior findings in various fishes (Doolgindachabaporn, 1995).

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