Growth, Feed utilization and Survival rate of Basa (*Pangasius* sp.) Juvenile under Different Environmental Conditions

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Abstract: Study examined the responses of juvenile Pangasius to different levels of temperature, salinity, pH, interaction between temperature and salinity. Examining the effects of temperature levels (28°C, 30°C and 32°C) showed that Pangasius had better growth performance and feed utilization in lowest temperature level (28°C). Different temperature levels didn't affect the survival rate. Investigating the effects of three water salinities (5, 10 and 15 ppt) showed that Pangasius growth performance and feed utilization were significantly higher at 5ppt than 10 and 15ppt respectively. Survival rate didn't differ significantly between different salinities. Pangasius fingerlings showed significantly higher growth performance in the higher pH level while the best feed conversion ratio was recorded in pH 8. No significant differences on the survival rate % were resulted from different pH levels. Significantly higher growth performance in terms of final weight, average weight gain, specific growth rate %, and weight gain % were noted in 26º C/5 ppt and 32°C/5 ppt as compared with 26°C/15 ppt and 32°C/15ppt. The interaction between 32°C and 5 ppt showed the best feed utilization with significantly differences from other interaction treatments. In all experimental treatments survival rate didn't decrease than 96.6% without any significant differences. Results of the study revealed that Pangasius can acclimate relatively easily to different environmental conditions without extreme effects on performance and survival.

Keywords: Pangasius, Temperature, Salinity, pH. Growth performance, feed utilization, survival rate

INTRODUCTION

Pangasius catfish considered in many countries as one of the most successful aquaculture species due to its relative ease in culture, high-market demand, and suitability to local climate conditions (Rahman, 2005; Rahman and Ali, 2012). Production of *Pangasius* could theoretically reduce poverty for millions of low-income people by creating better employment opportunities through development of activities with backward and forward linkages to the market chain. *Pangasius* are cultured both intensively with commercial feeds, semi-intensively (with limited feed), and in extensive (no feed) polyculture with it ability for both tilapia and carp (Ahmed *et al.,* 2010). High disease resistance, along with high stocking density with greater production rates (up to 120 fish/m^2 , average 40 tons/ha; (FAO, 2010), led to the suggestion that *Pangasius* is an ideal cultivar for increasing aquaculture production in Egypt, particularly in regions unfamiliar with farming other species, as well as reducing the burden of population growth. Introducing *Pangasius* aquaculture to the Egyptian coastal regions, in which water resources are largely underutilized, may significantly enhance the dietary consumption of protein for low-income families, as well as provide new sources of income and employment.

Temperature plays an important role in the life of most ectotherms with their body temperature essentially following temperature of surrounding environment (Wootton, 2011) .Some studies found out *Pangasius* sp. may be tolerant to salinity (David, 1962). Recently, juveniles of *Pangasius* catfish are reported to tolerate salinities up to 13 ppt without significant mortality (Castaneda *et al.,* 2010). The pH of water affects the normal physiological functions of aquatic organisms, including the exchange of ions with the water and respiration (Alabaster and Lloyd, 1980).

Better understanding of growth performance, feed utilization, and survival rate under different levels of salinity, temperature, and pH, can benefit *Pangasius* catfish culture dissemination. The aim of this study is to focus on determining the optimum salinity, temperature, pH, and interaction between temperature and salinity ranges for *Pangasius* catfish to assess the feasibility of its culture in Egypt.

MATERIALS AND METHODS

Experimental fish

Healthy and active specimens of juvenile *pangasius* with a total length mean of 1±0.2 cm and body weight mean of 1.75±0.2 g. were bought from a private fish hatchery which located in Alexandria, Egypt. Experimental fish were maintained in Plastic tanks (55 L) at 24±0.5°C under natural light regime for a period of 14 days as an adaptation period before starting the experiments. The study was carried out in the wet laboratory of the Fish Farming & Technology Institute, Suez Canal University, Ismailia, Egypt.

Experimental design

After the adaptation period four experiments were conducted in order to investigate the effect of temperature, salinity, pH, and interaction between salinity and temperature on the growth performance, feed utilization, and survival of juvenile *pangasius*.

Experiment I: Temperature

Twenty juvenile pangasius (1.75±0.3) g were stocked equally in nine cleaned plastic tanks each filled with 50 L of dechlorinated tap water Fish in the different tanks were maintained at three different water temperatures 28, 30 and 32°C (3 treatments with 3 replicates) for 30 days. To acclimatize the fish to high temperature, temperature was gradually increased (1°C per 12 h) from normal temperature (28°C) to the target temperature conditions (30 and 32°C). The proposed temperature (s) was maintained using electrical heaters (model RS308-C, RS Electrical, Guangdong, China).

Experiment II: Salinity

Twenty juvenile pangasius (1.75±0.2) g were stocked in each of nine cleaned Plastic tanks filled with 50 L of dechlorinated tap water mixed with marine water from Suez Canal. Fish were exposed to three different levels of water salinity; 5, 10 and 15 ppt for 30 days. In order to acclimatize the fish to different levels of salinity, salinity was gradually increased by mixing fresh water with marine water. Every experimental salinity level has three replicates. The salinity of each experimental unit was increased by 1 ppt every 18 hrs until each treatment has reached the proposed water salinities (5, 10, and 15 ppt).

Experiment III: pH

Ten juvenile pangasius (5±0.4) g were stocked in each of the nine cleaned Plastic tanks. The fish were exposed to three different levels of pH; 6, 8 and 9 for 30 days. To acclimatize the fish to different levels of pH, the acidic treatment tanks were supplemented with HCL to adjust the water pH to 6 while for the alkaline treatment tanks were supplemented with NaOH to adjust the water pH at 8 and 9.

Experiment IV: Interaction between salinity and temperature

Ten juvenile pangasius (5±0.45) g were stocked in each of twelve cleaned Plastic tank filled with 50 L of dechlorinated tap water mixed with marine water. The fish were exposed to two different levels of salinity and two different levels of temperature as follows: (26°C/5 ppt), (26°C/15 ppt), (32°C/5 ppt), and (32°C/15 ppt) for 30 days. The required temperature was maintained by using electrical heaters while the target salinities were achieved by water mixing with marine water.

Feeding:

Fish were fed with floating fish feed (40% protein) which introduced from Koudijs Feeds/Egypt at a feeding rate of 5% from body weight (bw)/day. Feed was applied twice daily at 09:00 and 14:00 h. The feeds were dispersed by hand broadcasting over the water.

Table (1) represents the chemical analysis of the experimental feed. Dry matter was determined after drying the samples in an oven (CMKO model ESM-4420, Guangdong, China) (105°C) for constant weight. Ash was determined by incineration at 550°C for 24 h in muffle (LAC model Ht60B). Crude protein was determined by micro-Kjeldhal method with 6.25 nitrogen to protein conversion factor (using VELP, Model UDK 129, Tecator, Höganäs, Sweden), total lipids extraction by Soxhlet method with diethyl ether (40–60°C) and crude fiber extraction with H_2SO_4 and NaOH, analyses were performed on the diet.

Table (1): Chemical analysis of experimental feed

Feed type	Particle size (mm)	Crude protein (%)	fat (%)	fiber	Ash	Digestible energy (MJ/kg)	Phosphorus (%)
Pellet	1.0	39.8	7.9	6.2	5.7	15.5	1

Water quality parameters

Dissolved oxygen (mg/L) was measured by a DO meter (model AD 630 Company, Adwa Instrument, Guangdong, China). Water pH was measured by a direct reading digital pH meter (Adwa, AD8000, Texas, USA). Temperature was measured by thermometer (model RS308-C, RS Electrical, Guangdong, China). Ammonia was measured by test kits (Hanna Instruments). Ammonia levels were maintained below the 0.04 mg/L threshold impacting fish growth (Stone and Thomforde, 2004). Dissolved oxygen was also maintained higher than 5 mg/l during the experimental period with using an air blower (4 horse power).

Measurements

Fish were counted and weighed at 15 and 30 days after exposure to different conditions including temperature, salinity, pH, and temperature salinity interaction. Growth performance and feed efficiency were determined by evaluating number of growth parameters and feed utilization as described in (s) (Bandyopadhyay and Das Mohapatra, 2009; Fagbenro and Arowosoge, 1991; Wang *et al.,* 2009). Survival rate % of each experimental unit was estimated according the following formula:-

1. Weight gain (g) = final weight (g) initial weight (g)
2. Specific growth rate (%) = $\frac{\text{Ln final weight (g)-Ln initial weight (g)}}{\text{Number of days}} \times 100$
3. Length gain = mean final fish length (cm) – mean initial fish length (cm).
4. Feed conversion ratio (FCR) = Feed given (dry weight)/Body weight gain (wet weight)
5. Protein efficiency ratio (PER) = $\frac{\text{final weight (g) - initial weight (g)}}{\text{Protein content of feed (\%)}}$
6. Condition factor (CF) = average weight × average length $^{-3}$×100
7. Average daily weight gain (ADG) = final weight (g) - initial weight (g)
8. Survival (%) = $\frac{\text{Number of fish survived at the end of experiment}}{\text{Initial number of fish stocked}} \times 100$

Statistical analysis

One-way analysis of variance (ANOVA) was followed by Duncan's new multiple range test to assess statistically significant differences among the different temperature, salinity, and pH conditions. Statistical significance was set at $P < 0.05$. Statistical analyses were performed using SPSS Version 14.0 for Windows (SPSS Inc., Chicago, IL). As for the salinity and temperature interaction experiment differences measured by two way ANOVA (SPSS 11.5 software) followed by Duncan's new multiple range test.

RESULTS

Growth and survival of *Pangasius* juveniles under different levels of water temperature

No significant differences were found in final length and final condition factor. Temperature level of 28°C showed the highest final weight with 10.7 g, weight gain with 8.95 g., average daily weight gain (0.3 g. per/day), and specific growth rate % (6.03%). Growth parameters of pangasius fingerlings reared in 28°C were all significantly (P<0.05) higher than those exposed to 30°C and 32°C. Survival rate observed under 28°C was lower than those under 30°C and 32°C treatments but without significant differences (Table 2).

Ficke *et al.* (2007) stated that each species of fish has an optimal temperature range for growth performance; for warm water fish or fish in tropical regions in general, optimal temperature for growth ranges generally from 20 to 32°C. In the current study, pangasius showed optimal response to temperatures level of 28°C. Experimental fish which exposed to water temperature level of 30 and 32°C respectively, showed a low growth performance, suggesting that thermal stress was becoming significant at these temperature and that some energy was now being diverted to coping with stress. It is not sure to determine however, whether the decline in growth rate in higher temperatures was due to temperature stress or to the associated DO level. Lefevre *et al.* (2014) reported that hypoxic conditions can inhibit growth of pangasius catfish by reducing appetite; reducing assimilation efficiency (*i.e.* increasing FCR); and a shift in energy balance due to the requirement for increased surfacing activity for air breathing.

Table (2): Growth performance parameters for *Pangasius* juveniles reared under different levels of temperature for 30 days

Temperature/ treatment	28°C	30°C	32°C	S.E.
Initial individual weight "g"	1.75	1.75	1.75	
Initial individual length "cm"	5.80	5.80	5.89	
Initial condition factor "g\cm3"	.90	.90	.85	
Final weight "g"	10.70a	9.1100b	9.0600b	0.44
Final length "cm"	11.17	10.73	10.67	0.63
Final condition factor "g\cm^3"	0.77	0.74	0.75	0.104
Weight gain	8.95a	7.36b	7.31b	0.44
Average daily weight gain	0.30a	0.24b	0.24b	0.013
Specific growth rate %	6.03a	5.49b	5.48b	0.15
Survival rate 30 days %	96.67	98.33	98.33	2.36

Means in the same row that do not share the same letter are significantly different (Duncan,P<0.05).

Feed utilization of *Pangasius* juveniles under different levels of water temperature

Daily feed intake was significantly different among treatments, with the lowest feed intake at 28°C with 11.5 g, best feed conversion ratio (FCR) was found at 28°C with 1.28 and Protein efficiency ratio was significantly highest at 28°C treatments with 2.16. Generally, feed utilization was significantly better at 28°C treatment from those at 30 and 32°C treatments °C as shown in (Table 3).

Table (3): Feed utilization of Pangasius under different levels of water temperature

Temperature/treatment	28°C	30°C	32°C	S. E.
Feed intake(g)	11.5 b	15.29a	15.84a	0.59
Feed conversion raito	1.28b	2.08a	2.18a	0.13
Protein efficiency raito	2.16a	1.34b	1.29b	0.08

Means in the same row that do not share the same letter are significantly different (Duncan,P<0.05).

Fish in 28°C treatment consumed lowest amount of feed as compared with other treatments. These results suggest that increased water temperatures of 30 and 32^{o} C results in a stress response and that most of the energy derived from the increased feed intake was being directed to dealing with stress rather than to growth (Portner, 2011). Nguyen *et al*. (2015) found similar results as he reported that low temperature affect growth of pangasius more significantly with individuals in these conditions not only consuming approximately half the amount of food compared with the treatment with the highest temperature (32°C), but also with showing a much differ FCR value than in all other treatments.

Growth and survival of *Pangasius* juveniles under different levels of water salinity

No significant differences were noted in final length at the end of experiment. Final condition factor didn't differ significantly between 5 ppt (0.7) g\cm^3 and 10 ppt (0.71) while 15 ppt treatment showed significantly lower final condition factor (0.56 g\cm$^{3)}$. Water salinity level of 5 ppt showed significantly highest final weight with 7.367 g, weight gain (5.62 g.), average daily weight gain (0.19 g.) and Specific growth rate % with 4.79. Water salinity of 10 ppt followed the 5ppt treatment in all growth parameters with a significantly differences from those which of 15 ppt as shown in (Table 4).

Table (4): Growth performance parameters of *Pangasius* juveniles reared under different levels of water salinity for 30 days

Salinity/ treatment	5 ppt	10 ppt	15 ppt	S.E.
Initial weight "g"	1.75	1.75	1.75	
Initial length "cm"	5.86	5.88	5.81	
Initial condition factor "g\cm^3"	.85	.85	.90	
Final weight "g"	7.37a	6.53b	4.93c	0.11
Final lenght "cm"	9.93	9.67	9.57	0.35
Final condition factor "g\cm^3"	.76a	.71a	.55b	.069
Weight gain	5.62a	4.78b	3.18c	0.11
Average daily weight gain	.19a	.16b	.11c	.005
Specific growth rate %	4.79a	4.39b	3.45c	.059
Survival rate after 30 days %	100	100	96.66	1.36

Means in the same row that do not share the same letter are significantly different (Duncan,$P<0.05$).

Salinity is an important ecological factor which is more specific to native of the aquatic environment. The minerals level between body fluid and surrounding water is balanced by optimizing the salinity of rearing environment. Generally, fishes show less tolerance to salinity change of water (Bhatnagar and Devi, 2013). Partridge and Jenkins (2002) reported that fish under osmostic stress were able to survive and grow at salinities ranging from freshwater to 48 ppt, but individuals reared at 24 ppt showed better growth and the highest food intake and best FCR.. Apart from high energy demand for osmoregulation leading to effects on growth rate and metabolism. *P. hypophthalmus* fingerlings reared in 0 ppt showed better growth performance in terms of average body weight and specific growth rate than the saline water exposed fishes. The SGR% result obtained from the experiment was within the range reported in Pangasius (Ali *et al.,* 2005; Khan *et al.,* 2009). Lowest weight gain and SGR were observed at 15 ppt which clearly indicates that increase in water salinity negatively affect the growth of *P. hypophthalmus*. Iqbal *et al.* (2012) stated that salinity had a significant role in controlling the growth of Nile tilapia. Fishes reared in higher salinities exhibited low growth since salinity stress suppresses the growth of the fishes.

Survival rate under low salinity conditions (5 ppt) were better than those at higher salinity treatments but without statistical significant differences. This may result from increased resistance of fish to disease under low salinity condition or better prevention of fungal and bacterial contamination of the culture water (Aihua and Buchmann, 2001).

Feed utilization

Water salinity level of 5 ppt treatment was the highest in feed intake with 11.2 g. while feed conversion ratio was the lowest (1.99) with significantly differences from the result of 10ppt and 15ppt. Protein efficiency ratio was lowest at 15 ppt treatment with 1.05 and was significantly differ from the result of 5 ppt and 10 ppt as shown in (Table 5)

Table (5): Feed utilization of Pangasius under different levels of water salinity

Salinity/treatment	5	10	15	S.E.
Feed intake	11.2b	9.8a	8.4a	0.0
Feed conversion raito	1.99b	2.05a	2.64a	.060
Protein efficiency raito	1.39a	1.36a	1.05b	.030

Means in the same row that do not share the same letter are significantly different (Duncan,P<0.05).

Feed conversion ratio (FCR) measurements were similar with the normal levels achieved in the pangasius catfish industry in the south of Vietnam (Bosma *et al.,* 2009), approximately 1.9–2.6 g/g. In some freshwater fishes, faster growth rates can be achieved at slightly raised salinities compared with 0ppt conditions (Boeuf and Payan, 2001). In the current study, growth performance of the pangasius reared in 5 ppt salinity was significantly different with 10 and 15 ppt treatments.

Pangasius catfish, like most teleosts, can limit ion and water exchange using barriers at the skin surface via scales and a mucus layer (Evans, 2011)when they live in their natural environments. There is, however, an associated cost for this because they must use energy for osmoregulation to maintain their osmotic balance. The 10 and 15ppt treatments were both hyperosmotic to fish, and growth rates and survival rates were reduced as a consequence as fish obviously were stressed, and so energy was diverted from growth to osmoregulation. This would include producing a reduced volume of isotonic urine, a mechanism that has a high energy cost (Evans, 2011; McCormick, 2001; and Varsamos *et al.,* 2005).

Growth and survival of *Pangasius* fingerlings under different levels of water pH

No significant differences were noted in final length and surivival rate at the end of experiment. Fish which reared under pH 9 showed the highest final weight with 14.33 g, weight gain (9.33 g), final condition index with 0.75 g\cm^3, average daily weight gain (0.310 per/day, specific growth rate with 3.5. All growth parameters were higher and statistically differ from the results of pH levels of 8 and 6. No mortalities were recorded in different pH treatments (Table 6).

Table (6): Growth performance parameters of *Pangasius* juvenile under different levels of water pH for 30 days

pH/ treatment	6	8	9	S. E.
Initial weight "g"	5	5	5	
Initial length "cm"	8.86	8.84	8.77	
Initial condition factor "g\cm^3"	0.72	0.72	0.74	
Final weight "g"	12.03b	12.60b	14.33a	0.24
Final lenght "cm"	12.20	12.25	12.39	0.082
Final condition factor "g\cm^3"	0.66b	0.69b	0.75a	0.011
Weight gain	7.03b	7.60b	9.33a	0.24
Average daily weight gain	.23b	.25b	.31a	.009
Specific growth rate %	2.93c	3.08b	3.51a	.060
Survival rate after 30 days %	100	100	100	

Means in the same row that do not share the same letter are significantly different (Duncan,P<0.05).

The effects of pH on fish and other freshwater aquatic life have been reviewed in detail (Katz, 1969; NAS, 1972; AFS, 1979; Alabaster and Lloyd, 1980). The pH of water affects the normal physiological functions of aquatic organisms, including the exchange of ions with the water and respiration. Such important physiological processes operate normally in most aquatic biota under a relatively wide pH range (e.g., 6-9 pH units). There is no definitive pH range within which all freshwater aquatic life is unharmed and outside which adverse impacts occur. The acceptable range of pH to aquatic life, particularly fish, depends on numerous other factors, including prior pH acclimatization, water temperature, dissolved oxygen concentration, and the concentrations and ratios of various cations and anions (McKee and Wolf 1963).

Wilkie and wood (1991) observed that if the pH fell below the tolerance range death would ensue as a consequence of the disturbance of the balance of sodium and chloride ion in the blood of the fish and the inhibition of ammonia excretion through the gills during high pH situations. Nevertheless, it is also reported that the relationship between growth rate and hydrogen-ion concentration is unclear and the presence of other ions such as sodium, calcium and chloride in a water body can exert a modifying effect on the growth rate. Uzoka *et al.* (2012) reported that extreme pH has a deleterious effect on the growth and survival of *Clarias gariepinus* fry, the mode of toxicity being the precipitation of mucus on the gill's epithelium or the precipitation of protein with the epithelial cells.

Feed utilization

Individuals which reared under pH level of 9 showed highest feed intake with 21.47 g and protein efficiency ratio (1.20). Feed conversion ratio (FCR) was better in pH 8 treatment with 2.36 which is significantly differ from the results of those under of 9 and 6 pH level, Table 10.

Table (7): Feed utilization of *Pangasius* juvenile under different levels of pH

pH/ treatment	6	8	9	S.E.
Feed intake	18.20b	17.87b	21.47a	0.54
Feed conversion ratio	2.70a	2.37b	2.70a	0.07
Protein efficiency ratio	1.03b	1.13b	1.21a	0.04

Means in the same row that do not share the same letter are significantly different (Duncan,P<0.05).

Feed conversion ratio of tilapia increased as pH levels differ than the pH 7. This may be due to a decrease in feed consumption at low pH. Scott *et al.* (2005) reported that FCR achieved at pH 9 was significantly higher (P≤0.05) than that achieved in pH 7 and 8 being 3.3, 2.7 and 2.9, respectively. Ivoke *et al.* (2007) reported better FCR, FE and PER at pH 7.0 to 7.5 in hybrid catfish, they were efficiently utilizing the given feed for somatic growth. Sapkale *et al.* (2013) reported better FCR at pH 7.5 in common carp (*Cyprinus carpio*). Acidic pH induced reduction in feeding and corresponding growth. Beamish (1972) and D'Cruz *et al.* (1998) which explain the lower feed utilization at pH level of 6 at the present study.

Growth and survival of *Pangasius* juvenile under different levels of interaction between water temperature and salinity

Final weight of fishes which reared under the temperature and salinity levels of 32°C/5 ppt (19.6 g) was highest than 26°C/5 ppt (19.3 g) which in turns higher than 32°C/15 ppt (18.2 g) and 26°C/15 ppt (12.3 g). No statically significant differences were noted between 26°C/5 ppt and 32°C/5 ppt. As for the weight gain individuals reared under the temperature and salinity of 32°C/5 ppt showed the highest value (14.57 g) followed with 26°C/5 ppt with 14.27 g which is higher than 32°C/15 ppt (13.23 g) and 26°C/15 ppt (7.3 g). Average daily weight gain was highest also under 32°C/5 ppt (0.49 per/day) followed by 26°C/5 ppt with 0.48 per/day which was higher than 32°C/15 ppt (0.44 per/day) and 26°C/15 ppt (0.24 per/day). Specific growth% rate % was best under 32°C/5 ppt with 4.55% followed 26°C/5 ppt with 4.49% which higher than 32°C/15 ppt (4.31%) and 26°C/15 ppt (3%). No significant differences in survival rate % were recorded among treatments after 30 days (Table 8).

Table (8): Growth performance parameters of *Pangasius* juvenile under different levels of interaction between water temperature and salinity for 30 days

Temperature and salinity/treatment	26 / 5	32 / 5	26 / 15	32 / 15
Initial weight "g"	5	5	5	5
Initial length "cm"	7.6	**7.8**	7.8	7.7
Initial condition factor "g\cm3"	1.04	1.05	1.05	1.09
Final weight "g"	19.3a	19.6a	12.3c	18.2b
Final length "cm"	11.86	11.43	11.73	11.62
Final condition factor "g\cm^3"	1.1	1.3	0.77	1.2
Weight gain	14.27a	14.57a	7.3c	13.23b
Average daily weight gain	0.48a	0.49a	0.24c	0.44b
Specific growth rate %	4.49a	4.55a	3c	4.31b
Survival rate after 30days	96.7	96.7	100	100

Means in the same row that do not share the same letter are significantly different (Duncan,P<0.05).

Water salinity of 5 ppt with different levels of temperature provided best conditions for growth and survival. A study of incubated pangasius catfish eggs in salinities of freshwater, 1, 3, 5, 7, 9, 11, 13, 15, 17, and 19 ppt demonstrated that embryos can develop and hatch in brackish water up to 11 ppt (Do and Tran, 2012). At this salinity (5 ppt), which is just lower than the isosmotic point (Do and Tran, 2012; Nguyen *et al.,* 2014) showed that the energy budget for ion osmoregulation declined. Relatively low salinity conditions from 2 to 10ppt provided optimal conditions with high survival rates and good growth performance for pangasius catfish fingerlings (Nguyen *et al.,* 2014).

Feed utilization

Feed intake of fish reared under 32°C/5 ppt showed the highest result (29.92g) followed 26°C/5 ppt with 24.99 g and 26°C/15 ppt (18.96 g) and 32°C/15 ppt (17.95 g). No significant difference in feed intake was noted between 32°C/15 ppt and 26°C/15 ppt. As for the feed conversion ratio 26°C/15 ppt showed the highest with 2.60 followed 32 °C/5 ppt with 1.71 which in turns higher than 26°C/5 ppt with 1.68 and with 32°C/15 ppt with 1.36 which represents best feed utilization level. Feed conversion ratio didn't differ significantly between 26°C/5 ppt and 32°C/5 ppt. Protein efficiency ratio 32°C/15 ppt showed the highest value (2.19) followed 26°C/5 ppt with 1.65 which was higher than 32 °C/5 ppt (1.62) and 26°C/15 ppt (1.06) without significant difference between 26°C/5 ppt and 32°C/5 ppt as shown in (Table 9).

Table (9): Feed utilization of *Pangasius* juvenile under different levels of interaction between water temperature and salinity for 30 days

Temperature / treatment	26 /5	32 /5	26 /15	32 /15
Feed intake	24.99b	29.92a	18.96c	17.95c
Feed conversion raito	1.68b	1.71b	2.60a	1.36c
Protein efficiency raito	1.65b	1.62b	1.06c	2.19a

Means in the same row that do not share the same letter are significantly different (Duncan,P<0.05).

At 26°C, increasing salinity level generally resulted in increased FCRs, while growth rates were decrease. The higher the salinity level, the higher the FCR values. This suggests that dealing with stress response in raised salinities requires greater energy than the stress created by higher water temperatures. German (2011) reported that feed intake by fish is not affected solely by dietary quality, but can also be influenced by temperature and other environmental factors. Salinity, temperature and the complex interaction between the two factors can affect food intake, FCR, metabolic rate and hormonal levels of fish. Boeuf and Payan (2001) also showed that the energy incited to osmoregulation is important and suggested that it needs to be considered when examining salinity and temperature interactions in fish. Here, it was apparent that under raised temperature and salinity conditions, fish consumed lower food than other treatments, and growth rates decreased accordingly.

Results of the study revealed that Pangasius can acclimate relatively easily to different environmental conditions without extreme effects on performance and survival.

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النمو، الاستفادة من الغذاء، معدل البقاء لأسماك البنجاسيوس تحت ظروف بيئية مختلفة

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أجريت الدراسة الحالية على اصبعيات الباسا لمعرفة تأثير مستويات مختلفة من درجه الحرارة (٢٨ و ٣٠ و ٣٢) ومستويات مختلفة من الملوحة (٥ و ١٠ و ١٥) جزء في الألف ومستويات مختلفة من الأس الهدروجيني (٦ و ٨ و ٩) وكذلك مستويات مختلفة من التداخل بين درجه الحرارة والملوحة ٢٦ /٣٢ و ٥ /١٥ جزء في الألف. أفضل معايير نمو كانت عند ٢٨ درجه مئوية حيث كان الوزن النهائي (١٠.٧ جرام) والزيادة في الوزن (٨.٩٥ جرام) ومتوسط زيادة الوزن اليومية (٣. ٠ جرام/ يوم). لم يكن هناك فروق معنوية بين مستويات درجه الحرارة المختلفة من ناحية معدل البقاء. أقل استهلاك غذاء كان عند ٢٨ درجة مئوية (١١.٥ جرام) بينما كان أفضل معامل تحويل غذائي (١.٢٨%) ومعدل كفاءة البروتين (٢.١٦%) عند ٢٨ درجه مئوية. مستوى الملوحة ٥ جزء في الألف كان الأفضل من حيث الوزن النهائي (٧.٣٦ جرام) والزيادة في الوزن (٥.٦١ جرام) ومتوسط زيادة الوزن اليومية (١٨. ٠جرام/يوم) ومعدل النمو النوعي (٤.٧٩ %) ويليه مستوى ملوحة ١٠ جزء في الألف ثم مستوى ملوحة الماء ١٥ جزء في الألف. لم تظهر المعاملات المختلفة لملوحة المياه فروقا معنوياً من حيث معدلات البقاء. مستوى ملوحة المياه ٥ جزء في الألف كان الأفضل معنويا من حيث استهلاك الغذاء المقدم و معامل التحويل الغذائي. مستوى الأس هيدروجيني ٩ كان أعلى معنويا من حيث الوزن النهائي (١٤.٣٣جرام) والزيادة في الوزن (٩.٣٣ جرام) ومتوسط زيادة الوزن اليومي (٣١. ٠جرام/ يوم) ومعدل النمو النوعي (٣.٥٠%) عنها عند مستوى الأس الهيدروجيني ٨ و ٦. مستوى الأس هيدروجيني ٩ كان الأعلى من حيث استهلاك الغذاء ومعدل كفاءة البروتين (٢.١٦%) بينما كان معامل التحويل الغذائي أفضل في معامله الأس الهيدروجيني ٨ (٢.٣٦%). التداخل ما بين درجات الحرارة ٢٦ أو ٣٢ مع مستوى الملوحة ٥ جزء في الألف كان له افضليه من ناحية النمو والاستفادة من الغذاء بينما لم يكن هناك أية فروق معنوية في معدل البقاء بين مستويات التداخل المختلفة بعد ١٥ يوم أو ٣٠ يوم. أوضحت النتائج الحالية أن أصبعيات البنجاسيوس سجلت معدلات نمو أعلى ومعدلات استفادة من الغذاء أفضل عند ٢٨ درجة مئوية ومستوى ملوحة ٥ جزء في الألف ومستوى أس هيدروجيني ٨ إلى ٩ والتداخل مابين درجه الحرارة والملوحة ٢٦ أو ٣٢ درجة مئوية مع ملوحة ٥ جزء في الألف.