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Effect of different tank colour on early growth and survival of *Clarias magur* (Hamilton, 1822)

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Abstract
In the present study, the effect of different background colour of hatching tubs on larval growth and survival of magur, *Clarias magur* were investigated. The significant results showed that the length, Body weight gain, percentage weight gain, specific growth rate and protein efficiency ratio was significantly affected by background of tubs colour, which was higher in the T_3 (black colour tubs) than that of the tubs (p<0.05). The highest feed intake was observed in magur larvae reared in the T_3 (black colour tubs), followed by that of the T_2 (blue colour tubs) and the lowest was in fish in the T_1 (white colour tubs). The lowest feed conversion ratio was found in Black followed by blue and highest in white colour tubs was significantly difference (p<0.05) between each other. The tubs colour did not significantly affect survival among all the treatments (p>0.05) by the tubs that had background colour with highest survival in the (T_3) black tubs (100±0.00) and (T_1) white tubs (100±0.00) in hatching tub up to 10 dph and (98.04±1.96) in rearing system up to experimental period. In conclusion, the black colour tubs was optimum for rearing *Clarias magur* larvae based on the growth and survival performance.

Keywords: *Clarias magur*, early life-stage, growth matrix, survival, larvae skin colour

1. Introduction

The *Clarias magur* (Hamilton, 1822) popularly known as Magur, is an air-breathing indigenous catfish. Magur is in high demand throughout India and commands high market value. As Magur is considered to be sturdy, coexist with the IMCs, and it is a bottom feeder which helps to keep the pond bottom clean and importantly Magur fetches a better market value due to high consumer preference (Mahapatra, Sardar & Datta, 2010) [18]. There is an ambiguity in naming species of *Clarias* available from India. A group of scientists named them as *Clarias batrachus* (Linnaeus, 1758) while, others named as *Clarias magur* (Hamilton, 1822). Sometimes these two names are used interchangeably. The declining production of fish from natural water bodies becomes a real challenge to aquaculture to provide fish protein to the increased human population. Hence, utilization of freshwater bodies with species diversification along with simple and low-cost techniques may be the fore-runner activities for the enhanced fish production in future times. *Clarias magur*, one of the representative species of catfish species, is a coveted fish with high market demand deserving its potential culture under aquaculture policies of the country.

Food quality and quantity are also important to determine the optimum conditions for growth and survival of larvae. For any successful aquaculture enterprise, the adequate quantity of quality fish seed is the pre-requisite to maximize the productivity and increasing production level in the country (Basavaraja, 1994) [3].

The production of quality seed depends on various external and internal factors which regulate the growth and survival of fish larvae (Faruque, Kawser, & Quddus, 2010) [10]. Several fish species prefer dark tank walls (Ostrowski, 1989; Naas, Huse, & Iglesias, 1996) [23, 21] as they promote a suitable contrast between the prey and the background colour while others prefer lighter backgrounds (Downing and Litvak, 2000; Tamazouzt, Chatain, & Fontaine, 2000; Karakatsouli, Papoutsoglou, & Manolessos, 2007) [6, 35, 13]. So, the present study was conducted to evaluate the possibility of enhanced growth and survival of *C. magur* under the larval rearing in hatching tubs as well as rearing tubs combination with different colour tubs.

2. Material and Methods

2.1 Fish

Fish used for the experiment were larvae of Magur (*Clarias magur*, Hamilton, 1822). The newly hatched larvae were collected from ICAR-Central Institute of Fisheries Education, Balabhadrapuram Kakinada Centre. The four days old larvae (4th days post hatch) were used for the experimental purpose and distributed# DP in hatching tub (white, blue and Black colour hatching tubs) for three days till the yolk sac was completely absorbed.

2.2 Experimental Setup

The experiment was conducted at Magur Hatchery facility of ICAR-Central Institute of Fisheries Education, Balabhadrapuram, Kakinada Centre, Andhra Pradesh. The experimental Indoor hatching tub (With dimension of 1.25 x 0.5x 0.2 m) were used for rearing up to a period of 10 days in three treatments group *viz*; White (T_1) background, Blue (T_2) background, and Black (T_3) background in triplicates. and The indoor tubs have flow through facilities with two outlet (diameter 0.5") at bottom of tub and water inlet facilities of common 0.5 inch PVC perforated pipe placed over the tubs at a height of. 5 ft. to facilitate water showering in each tubs with maximum water flow rate of 2 lit. /hr. The growth of larvae from hatching tubs were recorded by taking length and weight on 10th day. C. *magur* larvae of 10 dph were transfer to the rearing tub with dimension of 3x 0.6x 0.45 m in triplicates for rearing of another 50 days with respective color to the treatment group *viz*; White (T_1) background, Blue (T_2) background, and Black (T_3) background Black for evaluating their survival rate (%) along with growth parameters for 60 days. Initial stocking was maintain @ 5000 larvae/tub (3m x 0.6m x 0.45 m).

Aeration in each tank was provided with the air stone to promote a homogeneous distribution of dissolved oxygen. The tubs were siphoned 30% daily during morning hours before feeding to remove uneaten feed and fecal residues. Larvae were sampled for growth and survival on every 10 days gap.

2.3 Feeding

The *Clarias magur* larvae were completely fed *ad libitum* with live food up to 5dph. On 6th dph onward weaning started with 30% artificial commercial pelleted feed **(**Balanca 7001, CP Aquaculture Pvt. Ltd.) @ of 10% of body weight twice daily (10.00 and 17.00 Hrs.).

2.4 Evaluation of larvae growth, survival and water quality

Clarias magur larvae were sampled (rearing on 10th, 20th, 30th, 40th, 50th and 60th days of culture to assess their growth performance (length, weight). Ten larvae from each experimental tank were randomly sampled. Four different parameter were considered for growth measurement i.e. percentage gain in weight, feed conversion ratio, feed efficiency ratio, specific growth rate, protein efficiency ratio and survival rate. At the end of the experiment, all the tubs were dewatered and number of animal in each experimental tubs was counted.

$$\text{Percent gain in weight} = \frac{\text{Final weight (mg)} - \text{Initial weight (mg)}}{\text{Initial weight (mg)}} \text{ x } 100$$

$$\text{Food conversion ratio} = \frac{\text{Dry Weight of food given (mg)}}{\text{Wet Weight gain of fish (mg)}}$$

$$\text{Food efficiency ratio} = \frac{\text{Wet Weight gain of fish (mg)}}{\text{Dry weight of food given (mg)}}$$

$$\text{Specific growth rate (\%)} = \frac{\text{ln Final Weight (mg)} - \text{ln Initial Weight (mg)}}{\text{Number of Days}} \text{ x } 100$$

$$\text{Protein efficiency ratio} = \frac{\text{Net weight gain (mg)}}{\text{protein in feed (\%)}}$$

$$\text{Survival (\%)} = \frac{\text{Total number of harvested}}{\text{Total number of stocked}} \text{ x } 100$$

2.5 Analysis of fish skin Colour Intensity

Colour intensity of the fishes was analyzed every week following Raymond (1992) by using colour difference meter equipment (Hunter colour lab, USA). The instrument measures colour parameters in terms of CIE L* (Luminosity), a* (red-purple to bluish green), b*(yellow to blue), h° (hue angle) and C* (Chroma).

2.6 Water quality Parameters

Through-out the rearing period dissolve oxygen, pH and water temperature were recorded *in situ*, whereas total alkalinity, total hardness and dissolve inorganic nutrients (ammonia nitrogen, nitrite - nitrogen) were analyzed in laboratory by following standard protocols, APHA, (2005) [1].

2.7 Statistical analysis

The data recorded for evaluation of different treatments were statistically analysed using SPSS 16 Version for analysis of variance (ANOVA) order to test the significance at chosen level of significance (p=0.05). The analysis were further test with Duncan Multiple Range Test if treatments mean were statistically significant.

3. Results

3.1 Water quality

The range and mean values of selected water quality parameters (i.e. water temperature, pH, Dissolve oxygen, alkalinity, hardness, ammonia and nitrite nitrogen) are presented in Table 1. It would be seen from this table (1), that water quality parameters remained more or less same in all the treatments. Further, the levels of selected water quality parameters, remained congenial for the growth and survival of magur larvae. As such in all the treatment water temperature ranges between 23.33 – 25.67 ^{0}C, pH value were recorded within the range of 7.50 – 8.00, dissolved oxygen 4.53 – 5.75 mg/l, total hardness was found to be 85.00 – 93.00 mg/l., total alkalinity was found to be 84.67 – 98.33 mg/l, ammonia values were recorded within the range of 0.0010 – 0.0073 and nitrite-N in water was found to be negligible, throughout the experimental period and the values were within the recommended range for rearing of *Clarias magur* larvae. (Table 1).

3.2 Clarias magur larvae growth

The mean value of length in different treatments are presented in Table 2. The highest length was recorded in T_3 with 56.97±0.84 mm followed by T_2 and T_1 with respective length of 54.67±0.38 and 54.47±0.49 mm. It is obvious from the results (Table 2) that the rearing tubs colour affected the length of magur larva. The highest length (56.97±0.84 mm) was in T_3 with black colour tubs and comparatively low (54.67±0.38mm) in T_2 with Blue colour tubs and 54.47±0.49 mm in T_1 with White colour tubs. In T_3 highly significant ($p < 0.05$) length was noticed. However, the length gain in T_1 and T_2 are non-significant.

The body weight gain a growth pattern in different treatments because of a varying colour wavelength of tubs. The body weight gain in T_3, T_2 and T_1 was 1571±16.7, 1091±9.53 and 1030±14.7 mg respectively. The gain in total body weight was highest in treatments (T_3) with black colour tubs. Treatment T_1 with white colour and T_2 with Blue colour had lower growth gain as compared to black colour tubs. The gain in body weight was highly significant between various treatments (p<0.05).

The percent gain in weight in different treatments has been shown in Table 2. A significant (p<0.05) effect of rearing tubs colour on percent weight gain was noticed. As such the highest percentage weight gain was observed in T_3 (1988±6.64%) with black colour tubs which was followed by T_2 (1485±30.6%) and T_1 (1347±32.2%).

The food conversion ratio was found to be lowest (1.79±0.012) in T_3 (Black colour tubs) followed by T_2 (1.95±0.092) and T_1 (1.97±0.023). A low FCR indicates better conversion of food into flesh. The better FCR (1.79±0.012) was recorded in T_3 (Black colour tubs) indicating better utilization of consumed food as compared to other treatments. The mean FCR value were significantly different (p<0.05) between treatments except for T_2 and T_3.

3.1.1.

3.1.2.

Feed efficiency ratio values in different treatments were significantly different (p<0.05) between treatments. The highest FER was recorded in treatment T_3 (0.56±0.006) followed by T_2 (0.51±0.003%) and T_1 (0.56±0.006).

Specific growth rate was highest (5.07±0.003%) in T_3 (with Black colour tubs) followed by T_2 with Blue colour tubs (4.61±0.032) and T_1 with White colour tubs (4.45±0.038). The mean values of SGR were highly significant at 5% level (p< 0.05) in treatments as compared to control (Table 2).

The Protein efficiency ratio values have differed with the varying colour wavelength of tubs in treatments. The respective values of PER in T_3, T_2 and T_1 were 44.90±0.46, 31.20±0.28 and 29.43±0.4. The increase in PER was high in treatments T_3 (with black colour tubs) followed by treatment T_1 (with white colour) and T_2 (with Blue colour). The PER values were highly significant between treatments (p <0.05).

The mean value of survival in different treatments are presented in Figure 1 and 2 as hatching tubs and rearing tubs respectively. The highest survival rate of (100±0.00%) was in T_1 and T_3 followed by T_2 (97±3.00%) in hatching tubs system (Figure 1). It is obvious from the figure (2) that the rearing tubs colour affected the survival rate of fish larvae. The high survival (98.04±1.96%) in T_3 with black colour tubs. A comparatively low mean survival (97.25±1.08%) in T_2 with Blue colour tubs and (94.78±1.00%) in T_1 (with White colour tubs) was noticed in the rearing system. A periodical aeration might have helped in high survival percentage in all the treatments. Black colour wave length are desired of hatching and rearing system for higher survival of *Clarias magur* larvae in the experimental period.

3.3 *Clarias magur* larvae skin colouration

3.3.1 CIE L* Colour Coordinate (Luminosity)

The data on CIE L* (Luminosity)

C. magur larvae with different colour wavelength during the experimental period are presented in Figure 3. The CIE L* (Luminosity) of magur are varied in different treatments and it was maximum in T_1 (89.32±0.09) where the fishes were reared in White colour tubs. The minimum Luminosity was found in T_3 (69.99±0.06) for the fishes reared in Black colour tubs and followed by T_2 (84.24±0.06) for in Blue colour tubs in the treatments. The statistical analysis of variance of Luminosity mean value indicates highly significant results (p<0.05) between each other.

3.3.2 CIE C* (Chroma)

The mean values of CIE C* (Chroma) of *C. magur* larvae reared in different colour tubs are presented in Figure 4. It would be seen from data (Figure 4) that CIE C* (Chroma) of experimental *C. magur* was different in varies treatment. The maximum was in T_2 (74.27±0.18) in blue colour rearing tubs. However, the minimum value of CIE C* (Chroma) was found in T_1 (36.50±0.08) where the fishes were reared in white colour tubs and T_3 (72.97±0.54) in black colour tbs. The mean values of CIE C* (Chroma) of *C. magur* larvae in descending order were in the following order:

T_2 (74.27±0.18) > T_3 (72.97±) > T_1 (36.50±0.08).

The statistical analysis of CIE C* (Chroma) colour of *C. magur* indicated significant results (p< 0.05). However, CIE C* in T_2 and T_3 were non-significant.

3.3.3 CIE a* Colour Coordinate [Green (-a) – Red (+a) Axis]

The data a CIE a* colour co-ordinate of *C. magur* with different colour tubs during the experimental period are presented in Figure 5. It is clear from data (Figures 5 to 7) that CIE a* colour co-ordinate of *C. magur* is varied in treatments. It was maximum in T_1 (69.24±0.07) and minimum CIE a* being in T_2 (-56.45±0.17) followed by T_3 (-54.55±0.02) with White, Blue and Black colour tubs. The statistical analysis of mean CIE a* colour co-ordinate of *C. magur* larvae indicated a significant difference (p<0.05) between treatments.

3.3.4 CIE b* Colour Coordinate [Blue (-b) – Yellow (+b) Axis]

The data on CIE b* colour co-ordinate of *C. magur* reared in different colour tubes are presented in Figure 6. It is clear from the data presented in Figures (5 – 7). CIE b* colour coordinate of *C. magur* varied in different treatments. It was maximum in T_3 (48.46±0.28) Black colour tubs. Whereas, the minimum CIE b* value was found in T_1 (32.08±0.02) and T_2 (48.27±0.08). The statistical analysis of variance on mean CIE b* colour coordinate values of *C. magur* indicated significant difference (p<0.05) in treatments except T_1 and T_2.

3.3.5 CIE h° (Hue Angle)

It is clear from the data presented in Figures 5 - 7 that CIE h° (hue angle) of *C. magur* varied in treatments. It was maximum in T_2 (139.47±0.04) where the fish larvae was reared in blue colour tubs. However, the minimum CIE h° was found in control T_1 (19.34±0.03) where the larvae reared white colour source and T_3 (139.38±0.37) were reared in black colour wave length. The statistical analysis of variance on CIE h° of *C. magur* indicated significant different (p < 0.05) except T_2 and T_3 between treatments.

3.4 Length weight relationship of Clarias magur larvae

The length and weight measurements of fish are related to each other. The descriptive statistics of length-weight data is presented in Table 4. Where the minimum and maximum recorded TL varies from 5.4 – 5.5 mm in T_1, 5.4 – 5.5 cm in

T_2 and 5.6 – 5.8 cm in T_3.The total weight ranged varies from 1.08 – 1.12 gm in T_1, 1.15 – 1.18 gm in T_2 and 1.62 -1.68 gm in T_3. The mean values of total length were 5.4±0.049, 5.5±0.038 and 5.7±0.086 cm in T_1, T_2 and T_3 respectively. Further, the mean total weight 1.10±0.012, 1.17±0.009 and 1.65±0.017gm in T_1, T_2 and T_3 respectively. The 'r' value showed a positive correlation and regression equation of *Clarias magur* was, T_1 (W= 0.235+-0.1793L) in White colour tubs, T_2 (W= 0.2303+-0.0933L) in Blue colour tubs and T_3 (W= 0.1939+0.5499L) in Black colour tubs. $W = aL^b$ was observed to be fit with length-weight data. The value of exponent 'b' were 1.163549 (T_1), 1.080563 (T_2) and 0.670219 (T_3) (Table 20). According to the theory of 'Cube law', if the 'b' value in length weight relationship is 3, then the growth in fish is isometric. The value of the regression co-efficient usually lies between 2.5 and 3.0 and ideal fish maintains the shape i.e. b = 3.When b<3 it can be said to have a negative algometric growth and is defined hypoallometry; instead when b>3, it shows a positive allometric growth which is defined hyperallometry.

Fulton's conditioning factor (K) or Ponderal Index was also calculated. That indicate the degree of wellbeing, robustness, fatness in numerical terms. From this study, the K values were 0.683276 (T_1), 0.723651 (T_2) and 1.024914 (T_3). These values also indicated an increased fat deposition into the body due to adaptability and high feeding activity of fish.

The calculation of coefficient of correlation (r) along with regression (R^2) equation for total length and Total weight are presented in (Table 5). The values of coefficient of correlation (r) were 0.499398 (T_1), 0.723651 (T_2) and 0.1.024914 (T_3). Form (Table 4) it is evident that the Total length value was maximum in T_3 (5.6 – 5.8 cm) and Total weight value was maximum in (1.62 – 1.68 gm) with Black colour tubs.

4. Discussion

In this study, the water quality parameter in different treatments was within the normal range prescribed for the rearing of fish larvae by (Boyd, 1979) [4]. It is also evident from Table 1 that all the water quality parameters studies in the present experiment were within the permissible ranges as observed by other works for hatchery (Mustapha, Okafor, Olaoti, & Olyelakin, 2012 and Sahoo, Giri, Chandra, & Sahu, 2010) [20, 28]. The DO concentration (4.53 -5.75 mg/l) recorded in this study was within the ranges as suggested by Nwipie, Erondu, & Zabbey, (2015) for *Clarias gariepinus*. The optimum pH (7.67 – 8.00) reported by Swingle (1967) [34] and Ammonia (0.0010 – 0.0073) by Paramanik, Ferosekhan, & Sahoo (2014) [25] for *Clarias batrachus*. The highest length (56.97±0.84 mm) was in T_3 with black colour tubs and comparatively low length (54.67±0.38) was in both T_2 and T_1 with Blue colour (54.47±0.49 mm) and White colour tubs. The growth, survival and feeding performance of fish recorded in the present study suggest that the responses to colour tubs are similar to those recorded by McLean, Cotter, Thain, & King (2008) [29] and Naas *et al.* (1996) [21] in Black colour tubs. Paramanik, *et al*, (2014) [25] have suggested that in dark colour tank *Clarias batrachus* performance was better. The gain in total body weight was highest in treatments (T_3) with black colour tubs. Treatment T_1 with white colour and T_2 with Blue colour had lower growth gain as compared to black colour tubs. Many culturists recommend the use of black tanks for larval rearing because the larvae tend not to accumulate along the walls (Naas *et al.*, 1996), resulting in less damage due to abrasion. Black tanks resulted in increased growth and survival for turbot *Scophthalmus maximus* (Howell, 1979) and dolphin (*Coryphaena hippurus*) larvae (Ostrowski, 1989). SGR was highest (5.07±0.003%) in T_3 (with Black colour tubs) followed by T_2 with Blue colour tubs (4.61±0.032) and T_1 with White colour tubs (4.45±0.038). The mean values of SGR were highly significant at 5% level ($p<0.05$) in treatments as compared to control (Table 2). Specific growth rates and survival observed in both experiments are comparable to values previously reported for laboratory rearing of larval haddock (Laurence, 1974; Laurence, Smigielski, Halavik, & Burns, 1981; Buckley, Halavik, Smigielski & Laurence., 1987; Downing and Litvak, 1999). The larval rearing of *Clarias magur* in hatching and raring tubs had a highest survival rate of 100±0.00% in T_1 and T_3 followed by T_2 (97±3.00). (Figure 1). It is obvious from the figure (2) that the rearing tubs colour affected the survival rate of fish larvae. The higher mean survival (98.04±1.96%) was in T_3 with black colour tubs. A comparatively low survival (97.25±1.08%) in T_2 with Blue colour tubs and (94.78±1.00%) in T_1 (with White colour tubs). However, the survival rate was statically non-significant between treatments. Papoutsoglou, Mylonakis, Miliou, Karakatsouli, & Chadio (2000) [24] have reported similar results when common carp was reared in B, W and G tubs. Further, it has been suggested that the effect of background colour on fish performance is species specific (El Sayed and El Ghobashy 2011) [40].

Tank background colour has also been found to affect fish skin pigmentation (Karakatsouli *et al.*, 2007) [13]. In the present study, *Clarias magur* larvae seemed to prefer a black environment, similar to dark blue and black for yellow catfish, *Pelteobagrus fulvidraco* (Raghavan, Xiao, Wu, Dong, Yun, & Shou, 2013) [27]; yellow environment was rainbow trout (Ustundag and Rad 2015) [35] and Nile tilapia, *Oreochromis niloticus* (Luchiari, Duarte, Freire,& Nissinen, 2007) [17], while red was better for zebrafish, *Danio rerio* (Spence and Smith 2008) [31]; blue for barramundi (Ullmann, Gallagher, Hart, Barnes, Smullen, Collin, & Temple, 2011); white for goldfish (Eslamloo, Akhavan, Eslamifar, & Henry, 2015) [9]; green for grouper, *Epinephelus coioides* (Zhang, Guo, Ma, Jiang, Wu, Li, & Qin, 2015) [38] and Atlantic cod (Sierra-Flores, Davie, Grant, Carboni, Atack, & Migaud, 2016) [30]; and white and blue for turbot, *Scophthalmus maximus* (Li, Chi, Tian, Meng, Zheng, Gao, & Liu, 2016) [16]. In addition, a clear difference in body colour was observed for *Clarias magur* larvae, as almost black coloured fish was noticed from the Black tubs. Naas *et al*. (1996) [21] stated that black tanks seemed to be the best system to provide an illusion of natural conditions. Papoutsoglou *et al*. (2000) [24] have indicated no differences in the body weight of scaled carp in response to black, green and white backgrounds. Duray, Estudillo, & Alpasan (1996) [7] also found that grouper larvae could be reared in both tan and black tanks. However, tank background colour affected the growth and survival of Eurasian perch (*Perca fluviatilis*) larvae (Jentoft, Øxnevad, Aastveit, & Andersen 2006) [12], and spotted sand bass *Paralabrax maculatofasciatus* (Peña, Dumas, Trasviña, García, & Pliego-Corteéz 2005) [26]. Pale rearing in the light-coloured tubs (blue and white), which is similar to the findings of other studies (Marchesan, Spoto, Verginella, & Ferrero, 2005 [19]; Strand, Alana¨ra, Staffan, & Magnhagen, 2007) [33]. This indicated that the capacity of magur larvae to change the body colour in accordance with tanks might reduce the problem of conspicuousness and reduce a potential source of stress (Strand *et al*., 2007) [33]. Staffan (2004) [32] has noted that in green and blue coloured tanks fish moved more freely because they were more free and comfortable in these environments. The mean values of total length were 5.4±0.049, 5.5±0.038 and 5.7±0.086 cm in T_1, T_2 and T_3 respectively. Further, the mean total weight were 1.10±0.012, 1.17±0.009 and 1.65±0.017gm in T_1, T_2 and T_3 respectively (Table 4). The 'r' value showed a positive correlation and regression equation of *Clarias magur* was, T_1 (W= 0.235+-0.1793L) in White colour tubs, T_2 (W= 0.2303+-0.0933L) in Blue colour tubs and T_3 (W= 0.1939+0.5499L) in Black colour tubs. $W = aL^b$ was found to be fit with length-weight data. The value of exponent 'b' were 1.163549 (T_1), 1.080563 (T_2) and 0.670219 (T_3) (Table 05). These results are comparable with the findings of other researchers. Allometric growth was also reported by Bala, Lawal, Bolorunduro, Oniye, Abdullahi, & Bichi (2009) [2] for *Clarias magur* with a 'b' value of 1.1635, 1.0805 and 0.6702 with White (T_1), Blue (T_2) and Black (T_3) respectively. Fulton's condition factor (K) represents the health condition or well-being of fish. The fish having value of more than 1 in condition factor are said to be good in health condition (Nash, 2006 and Singh, 2017).In the present study, the value of 'K' were 0.683276 (T_1), 0.7157 (T_2) and 1.024914 (T_3). The T_3 of *C. magur* was found to be more than 1 which indicated the good health condition of fish in the present study (Table 5). These values also indicated an increased fat deposition into the body due to adaptability and high feeding activity of fish. From the overall result of present study it is concluded that the black colour (T_3) was found the most effective in obtaining higher growth and survival performance of *Clarias magur* larvae.

Table 1: Range and Average values (± Standard error) of selected water quality parameters during the experimental period

Parameters	Treatments					
	T_1		T_2		T_3	
	Range	Mean ±SE	Range	Mean ±SE	Range	Mean ±SE
Temperature (^{0}C)	24.00 – 24.83	(24.37±0.13)	24.33 – 24.83	(24.63±0.08)	23.33 – 25.67	(24.87±0.45)
pH	7.67 – 8.00	(7.86±0.06)	7.50 – 7.50	(7.72±0.08)	7.77 – 8.00	(7.90±0.04)
Dissolved oxygen (mg/l)	4.80 – 5.33	(5.15±0.10)	4.81 – 5.73	(5.32±0.16)	4.53 – 5.75	(5.06±0.20)
Total Alkalinity (mg/l)	84.67 – 97.53	(92.00±2.33)	86.67 – 94.00	(90.00±1.22)	86.88 – 98.33	(94.00±1.91)
Hardness (mg/l)	90.00 – 91.67	(91.00±0.41)	85.00 – 92.33	(89.00±1.20)	86.67 – 93.00	(89.00±1.13)
Ammonia – nitrogen (mg/l)	0.0010 – 0.0063	(0.0034±0.0009)	0.0007 – 0.0073	(0.0041±0.0011)	0.0013 – 0.0070	(0.0042±0.0010)
Nitrite – nitrogen (mg/l)	ND	ND	ND	ND	ND	ND

T_1 – White colour tubs, T_2 – Blue colour tubs and T_3 – Black colour tubs ND – not detectable

Table 2: Effect of different tubs colour on growth performance of *Clarias magur* larvae during 60 days rearing trial

Treatments	Growth parameters						
	Length	Body weight gain	Percent weight gain	FCR	FER	SGR	PER
T_1	54.47±0.49^a	1030±14.7^a	1347±32.2^a	1.97±0.0238^a	0.50±0.007^a	4.45±0.038^a	29.43±0.41^a
T_2	54.67±0.38^a	1091±9.53^b	1485±30.6^b	1.95±0.0092^b	0.51±0.003^b	4.61±0.032^b	31.20±0.28^b
T_3	56.97±0.84^b	1571±16.7^c	1988±6.64^c	1.79±0.012^c	0.56±0.006^c	5.07±0.003^c	44.90±0.46^c
p- value (0.05)	0.0464	0.00000	0.00001	0.00026	0.00028	0.00001	0.0000

Note: data are express as Mean ±SE. Mean bearing different superscripts column wise on right hand side along a particular treatments are significantly (p<0.05) different from each other

Table 3: Colouration parameter of L*a*b* and L* C* h^0 value of experimental fish (*Clarias magur*) larval rearing in White, Blue and Black colour tubs.

Treatments	Tubs colour	Observations				
		L	A	b	C	h^0
T_1	White	89.32±0.09^a	69.24±0.07^a	32.08±0.02^a	36.50±0.08^a	19.34±0.03^a
T_2	Blue	84.24±0.06^b	56.45±0.17^b	48.27±0.08^b	74.27±0.18^b	139.47±0.04^b
T_3	Black	69.99±0.06^c	-54.55±0.02^c	48.46±0.28^b	72.97±0.54^b	139.38±0.37^b
p- value (0.05)		0.000	0.000	0.000	0.000	0.000

Note: data are express as Mean ±SE. Mean bearing different superscripts column wise on right hand side along a particular treatments are significantly (p<0.05) different from each other

Table 4: Length weight relationship of *Clarias magur* larvae in different colour rearing tubs

Treatment	Length (cm)			Weight (gm)		
	Min	Max	Mean ±SE	Min	Max	Mean ±SE
T1	5.4	5.5	5.4±0.049	1.08	1.12	1.10±0.012
T2	5.4	5.5	5.5±0.038	1.15	1.18	1.17±0.009
T3	5.6	5.8	5.7±0.086	1.62	1.68	1.65±0.017

Table 5: Length weight relationship equation, r, R^2, a value, b value and K value of *Clarias magur* larvae in different colour rearing tubs

Treatment	Regration equation	R	R^2	a	b	K value
T_1	W=0.235+-0.1793L	0.499398	0.9988	0.153169	1.163549	0.683276
T_2	W=0.2303+-0.0933L	0.49900	0.9980	0.185975	1.080563	0.723651
T_3	W=0.1939+0.5499L	0.468685	0.9373	0.515545	0.670219	1.024914

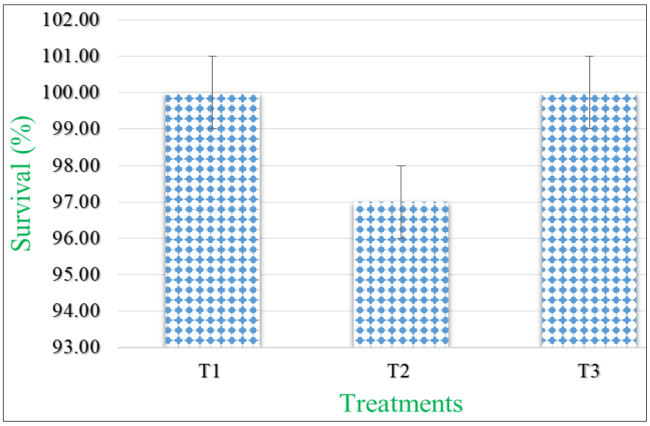

Fig 1: Effect of different colour on Hatchery survival of *C. magur* larvae

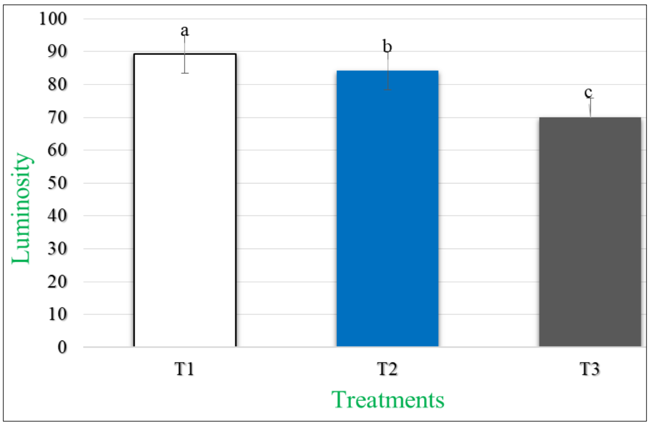

Fig 3: Colouration parameter: L* (Luminosity) value of experimental *Clarias magur* rearing with different colour tubs

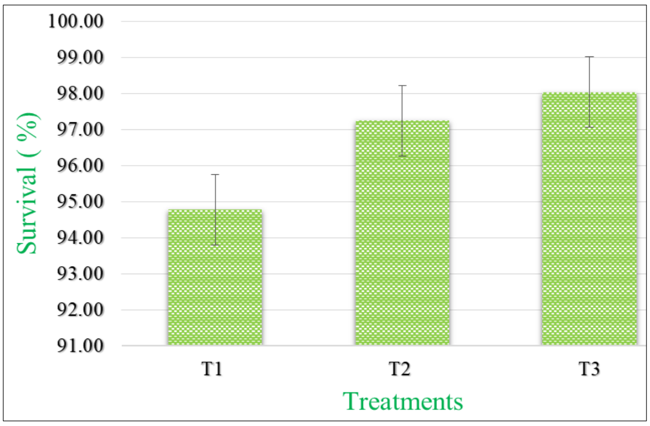

Fig 2: Effect of different colour on rearing survival of *C. magur* larvae

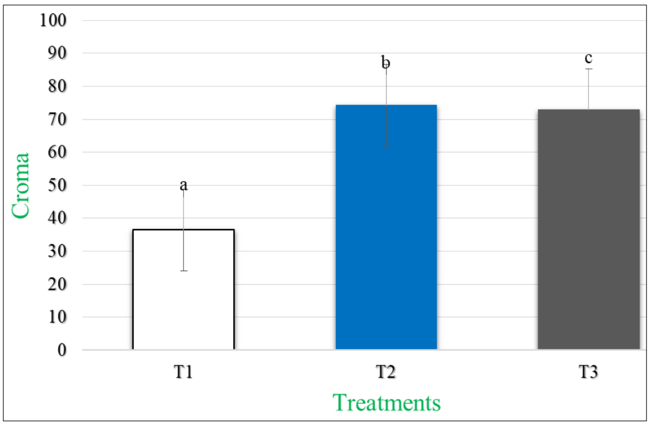

Fig 4: Colouration parameter: C* (Chroma) value of experimental *Clarias magur* rearing with different colour tubs

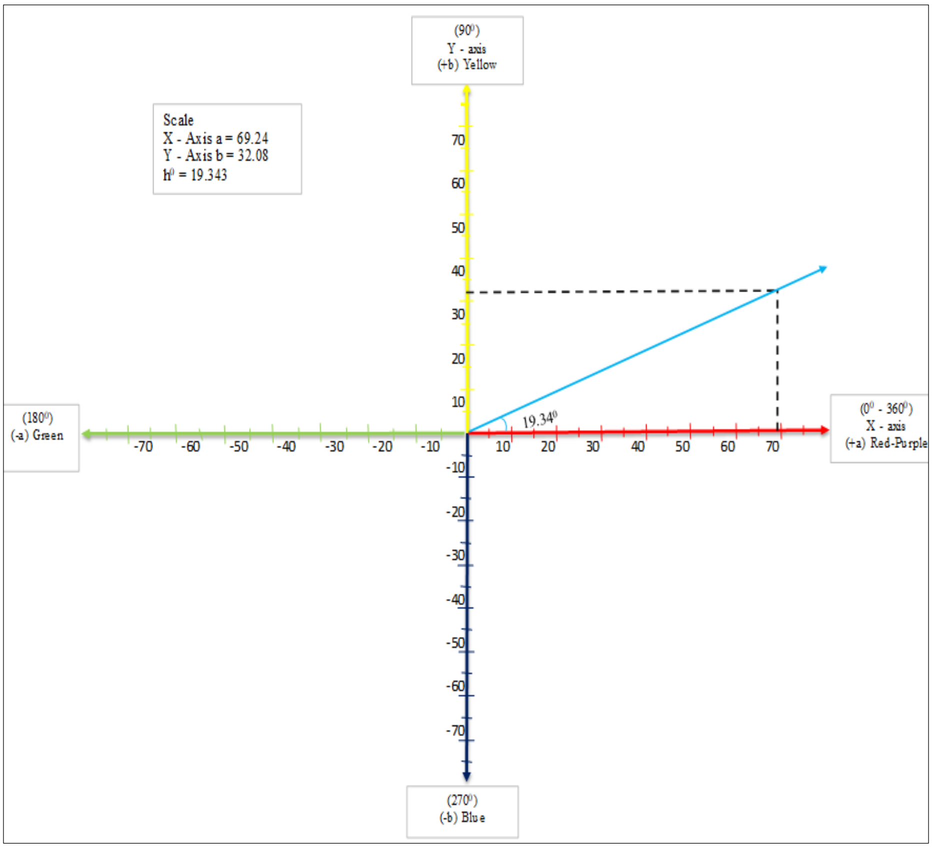

Fig 5: Showing *Clarias magur* larvae value of L*, a* and h^0 of T_1 (White colour tubs)

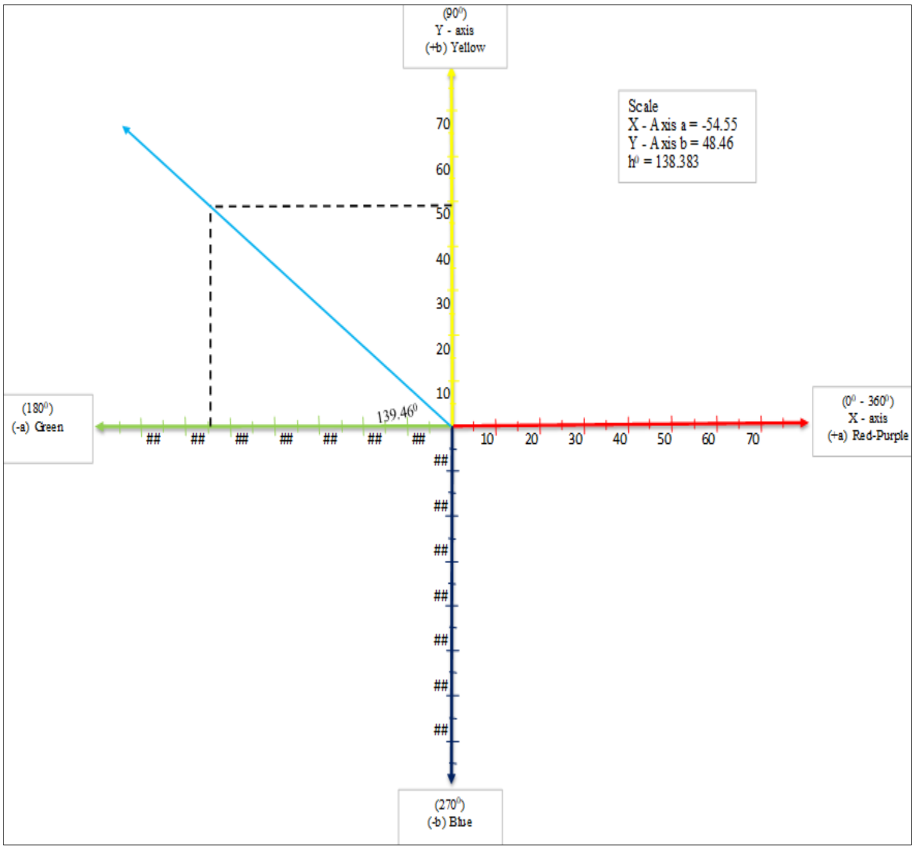

Fig 6: Showing *Clarias magur* larvae value of L*, a* and h^0 of T_2 (Blue colour tubs)

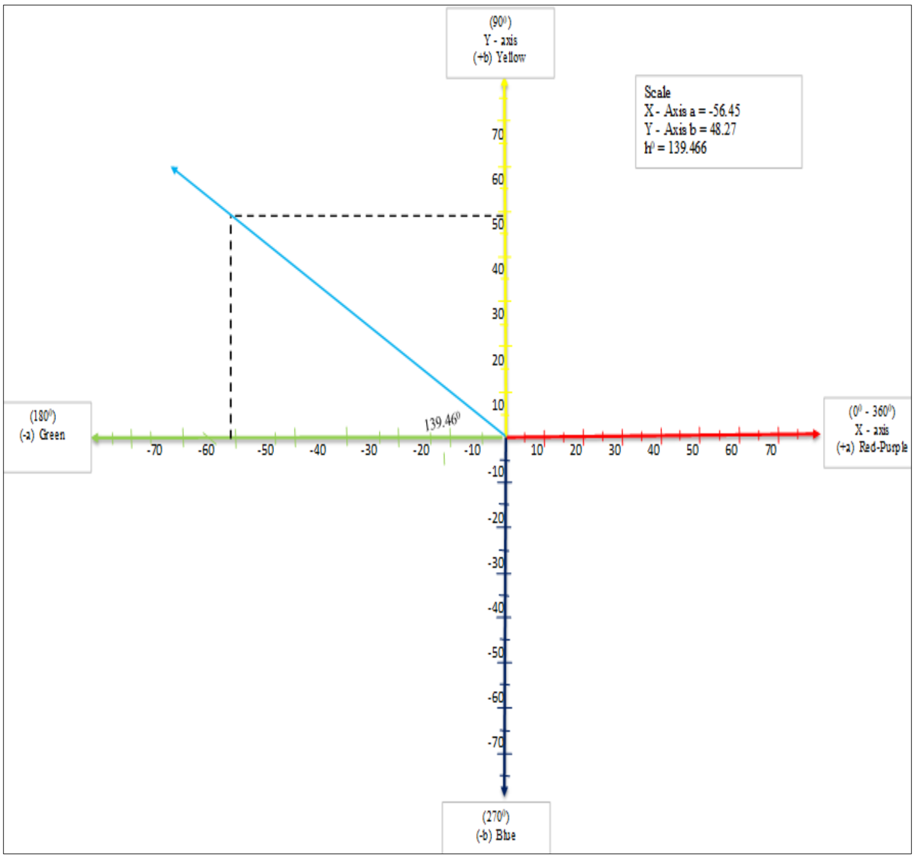

Fig 7: Showing *Clarias magur* larvae value of L*, a* and h^0 of T_3 (Black colour tubs)

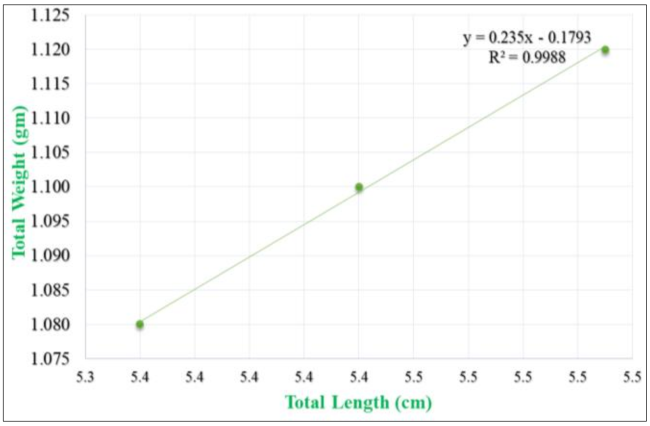

Fig 8: Length weight (linear) relationship of *Clarias magur* larvae in white colour rearing tubs

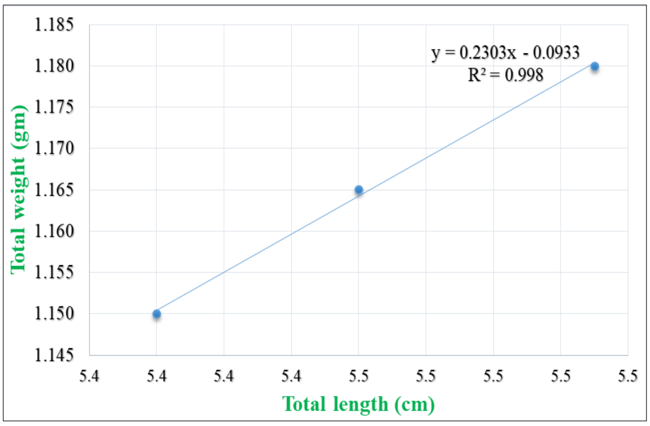

Fig 9: Length weight (linear) relationship of *Clarias magur* larvae in Blue colour rearing tubs

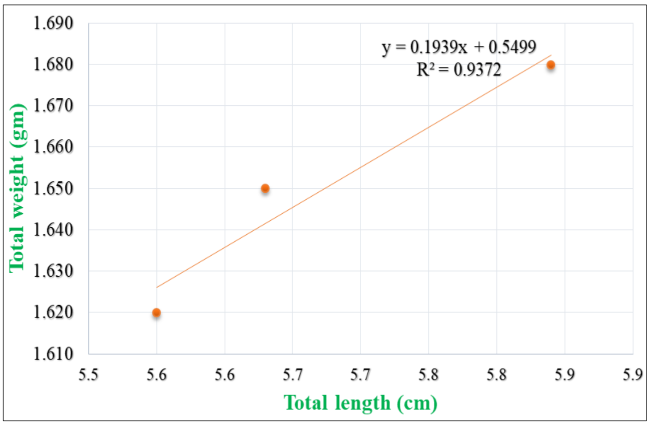

Fig 10: Length weight (linear) relationship of *Clarias magur* larvae in Black colour rearing tubs

Conclusion

This study clearly showed that the *Clarias magur* larvae obtaining higher growth and survival performance were significantly improved by rearing the magur larvae in black colour tubs based on the specific experimental conditions. This application can therefore be used to improve the culture performance of *Clarias magur* and increase the productivity of fish in the aquaculture industry, therefore, further studies could also investigate the chronic effects of background colours on magur growth, stress, and immune reactions to confirm this study.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Ethical approval

All applicable international, national, and/or institutional guidelines for the care and use of animals were followed by the authors.

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