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Comparison of length-weight relationship, condition factor and dressing percentage of the Asian seabass (*Lates calcarifer*) across the natural habitats in Bangladesh

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ABSTRACT

Length-weight relationship and condition factor are important population parameters in fisheries management as they provide valuable information about growth and fitness in an aquatic habitat. A study was conducted to analyze different phenotypic traits including length-weight relationship, condition factor and relative condition factor and dressing percentage in order to identify variability in population traits and health conditions of Asian seabass (*Lates calcarifer*) in six natural habitats across Bangladesh. Samples were collected from the coastal rivers of Satkhira, Khulna, Bagerhat, Patuakhali, Bhola and Cox's Bazar region. The total length and wet weight of the samples ranged between 20.57 to 40.33cm and 120 to 630g, respectively. Strong positive correlations (0.759-0.955) were found between the length and weight of all the stocks. All the stocks showed negative allometric growth (b<3). The highest value of slope b was observed in Patuakhali (2.99) indicating the faster growth rate and Satkhira was the lowest (2.12). The highest condition factor (1.09 ± 0.13) was observed in Satkhira, while the lowest (0.93±0.09) was found in Cox's Bazar. The relative condition factor (K_n) was highest (1.13±0.39) in Bhola, whereas the lowest (0.935± 0.10) was in Cox's Bazar. Stocks of Satkhira and Bhola had relative condition factors greater than 1, which indicated that the observed weight of the fish stocks was more than expected. The highest value of dressing percentage was observed in Satkhira (59.48±2.2) and significant differences (P<0.05) were found among all the stocks. This study will pave the way of helping in proper conservation and management of this species in Bangladesh.

INTRODUCTION

The Asian seabass (*Lates calcarifer*) is known as Barramundi or *Bhetki* that is an important food fish in the many parts of the world including Bangladesh (**Nelson, 2006; Vij *et al*., 2014**). It is commercially valuable both for aquaculture and capture fisheries (**Irmawati *et al*., 2020**). It is being more attractive commodity to both large and small-scale aquaculture enterprises for its high market demand, excellent taste and nutritional value (**Pervin *et al*., 2012; Yenmak *et al*., 2018**). In addition, it is noted that this species represents 10% of all seafood production as significant fishery commodity (**Yenmak *et al*., 2018**).

The production of this fish has increased during the recent years. It has been increased interest in seabass for induced breeding (partial), polyculture with tilapia in ponds and experimental cage culture in the coastal waters of Cox's Bazar, thus it would contribute to economy in Bangladesh (**AftabUddin *et al*., 2021**). These types of products are also exported to many countries of the world (**Food and Agriculture Organization, 2017**). Value addition is one of the approaches expected to increase profitability of the seabass farming and processing industries (**Department of Fisheries, 2016**). There has been an increasing interest in the present era, in investigating its growth mechanism including production traits, yield as well as nutritional needs in association with its morphological, physiological and biological variations, mainly to increase the production of marketable size and high-quality filet (**Gjedrem, 1997; Kause *et al*., 2002; Thodesen *et al*., 2012; Irmawati *et al*., 2020**).

Several studies have been done comparing growth performance and filet percentage for different fish strains using body weight, volume measurements as well as body shape, for example, Nile tilapia *Oreochromis niloticus* (**Rutten *et al*., 2004; Rutten *et al*., 2005; Peterman and Phelps, 2012**), striped bass *Morone* spp. (**Bosworth *et al*., 1998**), common carp *Cyrpinus carpio* (**Cibert *et al*., 1999**) and catfish, *Ictalurus* spp (**Bosworth *et al*., 2001; Argue *et al*., 2003**). There is a scarcity of information regarding on phenotypic variability of Asian seabass stocks in Bangladesh.

Therefore, the present study is undertaken to analyze different phenotypic traits including growth performance, dressing percentage and health condition of *L. calcarifer*. This study would be a practical approach to fish farmers for selecting the brood fish as a candidate by observing phenotypic traits; that is important for proper conservation and management of this species in Bangladesh.

MATERIALS AND METHODS

1. Study area, sample collection and period:

The experiment was carried out in six different coastal locations of Bangladesh (Fig. 1) from January 2020 to June 2021. Samples were collected from these rivers; viz. Kholpetua river (Satkhira, 22.3155°N, 89.1115°E), Vodrariver (Khulna, 22.8456°N, 89.5403°E), Boleshwar river (Bagerhat, 22.6602°N, 89.7895°E), Meghna river (Bhola, 22.1785°N, 90.7101°E), Andharmanik river (Patuakhali, 22.3586°N, 90.3317°E) and Moheshkhali river (Cox's Bazar, 21.4272°N, 92.0058°E). The used gears depend on shapes and sizes to capture various sizes of fish species (**Paul *et al*., 2019**). This fish is captured using traditional fishing gears such as seine net (mesh size: 0.5-1.5 cm) and hook and line.

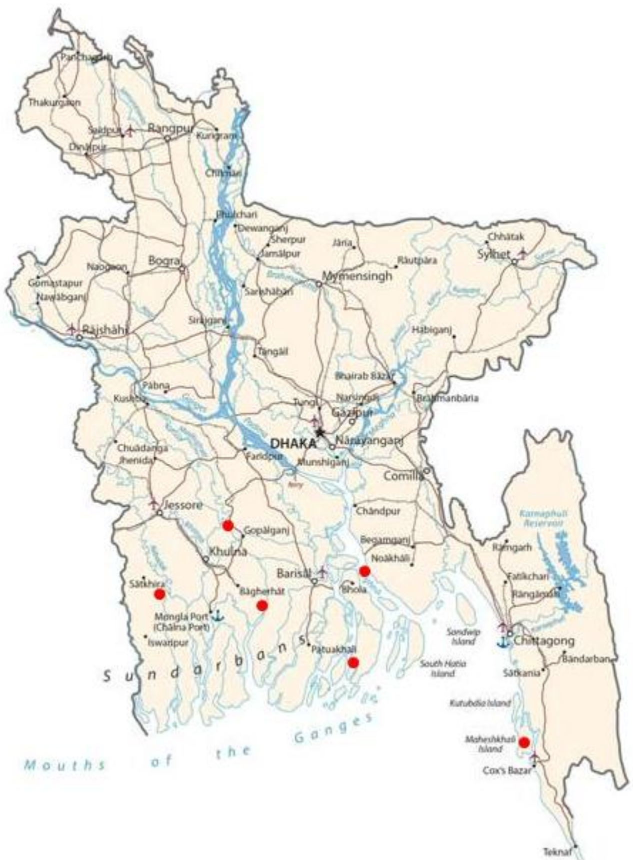

Fig. (1). Geographic map (imported from Google) showing the sampling rivers (Red circle) in the coastal area of Bangladesh

2. **Length-weight relationship:**

A total of 180 specimens, 30 from each of the areas were analyzed. Length-weight relationship was estimated by the equation: W= aL^b (**Le Cren, 1951**). Which was further expressed logarithmically as Log W= log a +b log L. Where W= weight of the fish in grams, L= length of the fish in centimeters, a= regression intercept, b= regression slope. The 95% confidence limits of a and b were estimated. The correlation coefficient 'r' and standard deviation (SD) between total length and body weight were calculated with the help of Microsoft Office Excel. The test was conducted at Fish Biology Laboratory of Fisheries and Marine Resource Technology Discipline of Khulna University.

3. **Condition Factor:**

The Relative Condition Factor ($K_n=\frac{W}{a\times L^b}$) expression analysis shows that the condition (K) and weight (W) should be directly proportionate. As a result, the higher weight of the population of the same length, the higher their condition factor (**Bolger and Connoly, 1989**). To calculate the condition factor, we used the following formula: K= $\frac{W\times 100}{L^3}$(**King, 1996**). Where, K= condition factor, W= weight of fish in g, L= total length of fish in cm, 10^3= the factor takes the condition factor near unity. Fulton (K) and relative (K_n) conditions factor equation: $K=\frac{W\times100}{L^3}$ and $K_n=\frac{W}{a\times L^b}$.

4. Relative Condition Factor:

The ratio between the measured weight (g) and the theoretically expected weight (g) for a given length (cm) is known as the relative condition factor (K_n) (**Le Cren, 1951**). As a result, the relative condition factor (K_n) demonstrates a relative growth increase in terms of predicted value (**Verani and colleagues, 1997 and Romagosa *et al*., 2001**). The relative condition factor of fish stocks (K_n=1.0) for a certain length indicates that the observed value of the weight (W) of the stocks equals the theoretically expected weight (aL^b) (**Ranzani-paiva *et al*., 2001**). If the K_n<1.0 that indicates that the observed weight of a fish is much less than the expected weight whereas, (K_n>1.0) means the observed weight of a fish is much more than the expected (**Basak and Hadiuzzaman, 2019**).

RESULTS

1. Overall length-weight relationship:

The overall length-weight relationship of studied fish, *L. calcarifer* is presented in Fig 2. The length-weight relationship was found strong and positive (r=0.93). The regression equation was estimated as log weight (g) = -1.485 + 2.648 log length (cm). The regression slope was observed as b=2.65 which was less than 3 indicated negative allometric growth patterns. The coefficient of regression (R^2) was obtained 0.86.

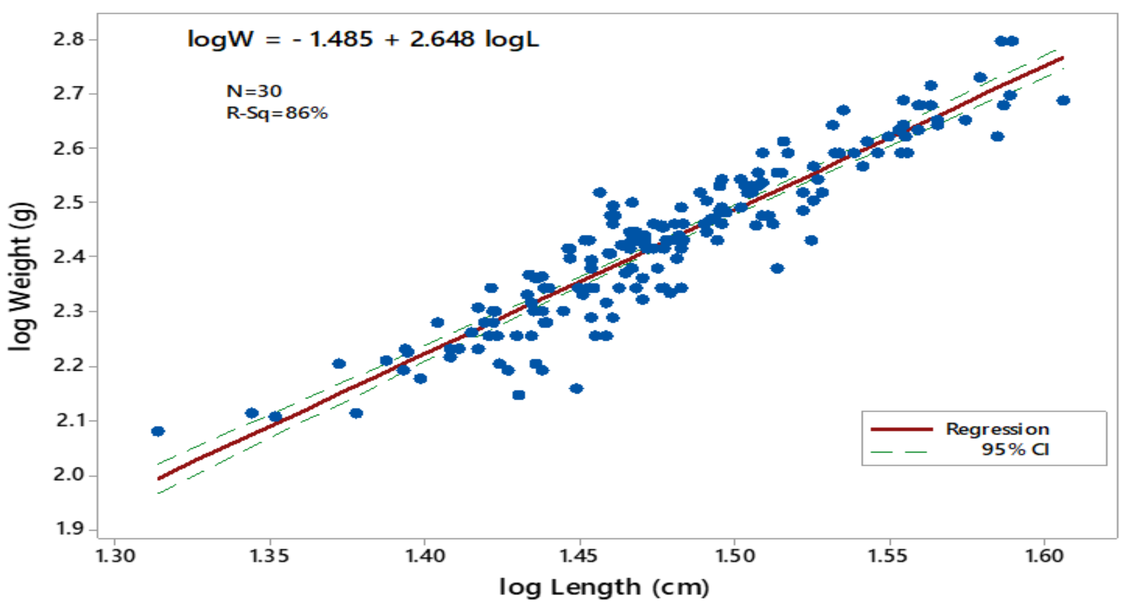

Fig. (2). Overall length-weight relationship of *L. calcarifer* collected from six locations across the coastal region of Bangladesh.

2. Variation in length-weight relationship among the locations:

Length-weight relationship of *L. calcarifer* collected from six locations across the coastal region of Bangladesh is illustrated in Figure 3.The linear regression equation's fitness was determined using the coefficient of determination (R^2). Except for Satkhira's R^2 (0.55), all positive R^2 values from all stocks from six locations demonstrated a strong relationship. Correlation coefficient (r) was high (0.955) in Cox's Bazar and whereas low (0.759) in Satkhira. The highest R^2 value was found in Bhola (0.94) and the lowest value in Satkhira (0.55). In contrast Patuakhali (2.99) had the highest value of b while Satkhira had the lowest value of b (2.123). The values of a, b and R² are shown in the Table 1.

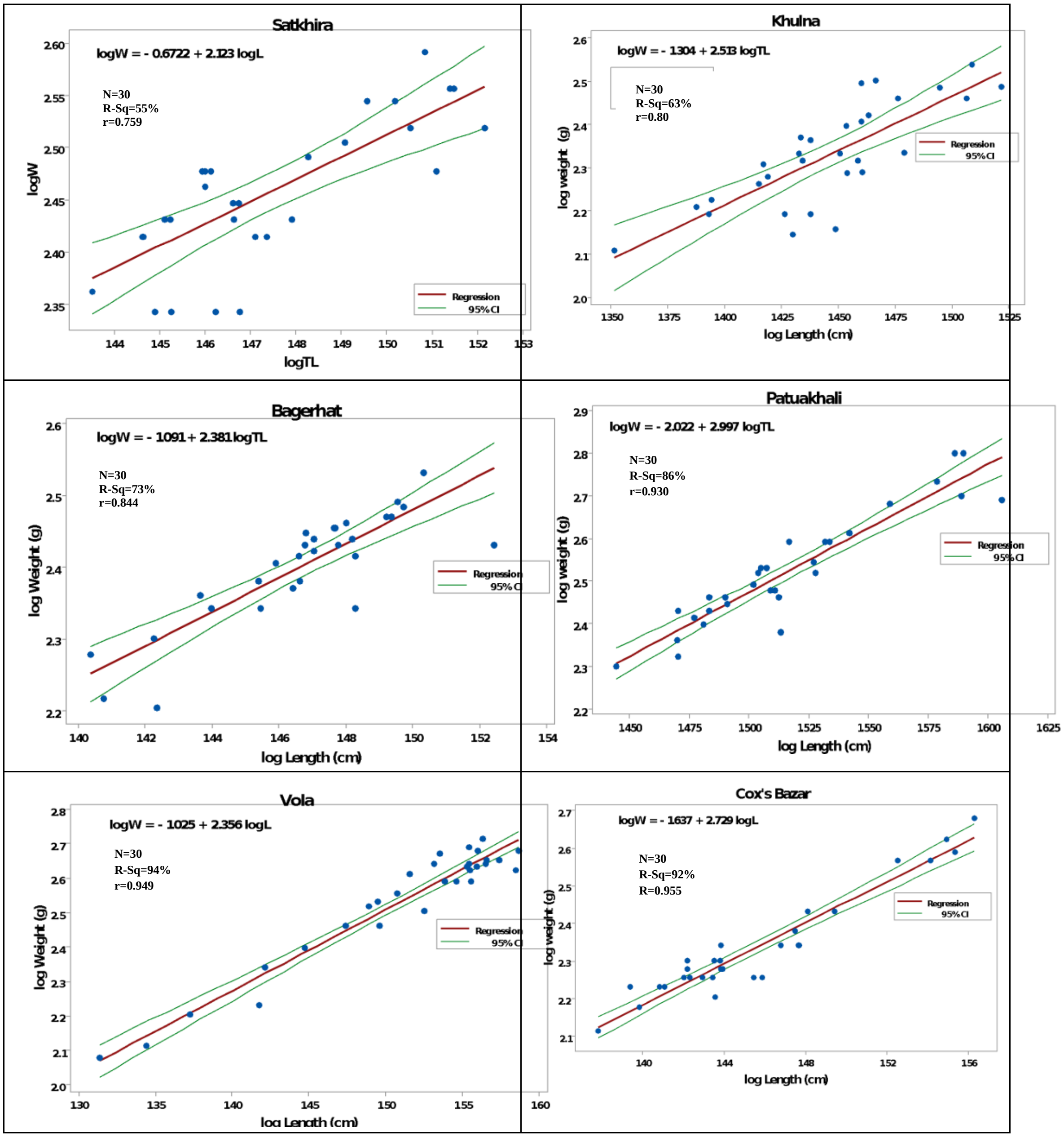

Fig. (3). Length-weight relationship of *L. calcarifer* collected from six locations across the coastal region of Bangladesh

Table 1. Total length-weight relationship, coefficient of regression and regression equations from the different stocks

Location	River	a	b	Equation Log W= a +b log L	R^2
Satkhira	Kholpetua	-0.6722	2.123	Log W = 2.123log L –0.6722	0.55
Khulna	Vodra	-1.304	2.513	Log W = 2.513log L -1.304	0.63
Bagerhat	Boleshwar	-1.091	2.381	Log W = 2.381log L–1.091	0.73
Patuakhali	Andharmanik	-2.022	2.997	Log W = 2.997log L –2.022	0.86
Bhola	Meghna	-1.025	2.356	Log W = 2.356logL –1.025	0.94
Cox's Bazar	Moheshkhali	-1.637	2.729	Log W = 2.729logL –1.637	0.92

3. Condition factor:

3.1. Fulton's Condition factor (K)

The fig. 4 shows the comparison among the different stocks of *L. calcarifer* in respect of their condition factor. Highly significant differences among the stocks were obtained for condition factor ($F_{(5,174)}$ =6.18, p<0.05) by the One-way ANOVA analysis. The Fulton's condition factor (K) was obtained as 0.998 ± 0.119 (mean ± SD) in an average of 6 stocks in total, ranging from 0.93 to 1.09; while the relative condition factor (K_n) among the stocks was estimated as 1.01±0.16 (mean ± SD) in total, ranging from 0.93 minimum to 1.14 maximum (Table 2). The highest Condition factor was found in Satkhira stock (1.09 ± 0.13) while the lowest was found in Cox's Bazar (0.93±0.08) whereas, K of the stock from Cox's Bazar, Satkhira and Bhola were significantly different from other locations.

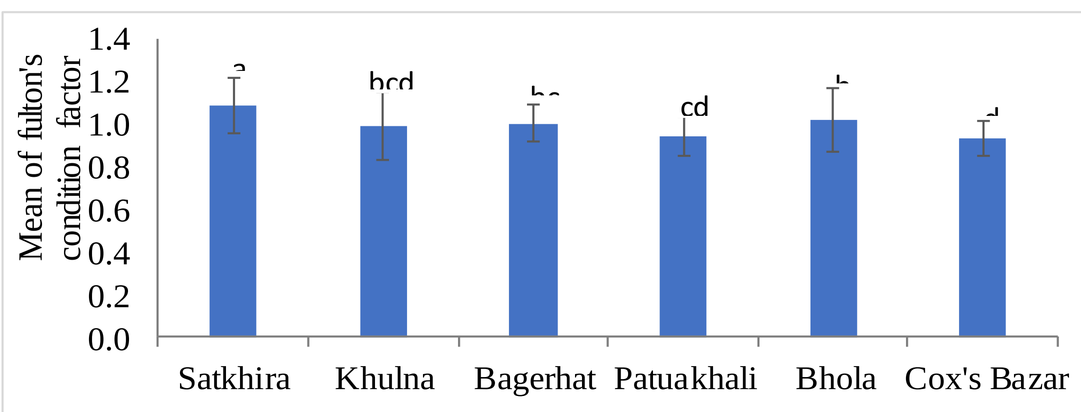

Fig. (4). Comparison of condition factor among *L. calcarifer* collected from six locations across the coastal region of Bangladesh

3.2.Relative condition Factor (K_n)

The figure 5 shows the comparison among 6 stocks of *L. Calcarifer* in respect of their relative condition factor (K_n). The ANOVA analysis revealed that there were highly significant differences among different stocks for relative condition factor ($F_{(5,174)}$ =4.05, $p<0.05$). The highest condition factor was found in Bhola stock (1.14 ± 0.39) whereas, the lowest was found in Cox's Bazar (0.935±0.10) (Table 2). Relative condition factor (K_n) of the stock from Cox's Bazar and Bhola were significantly different from other locations.

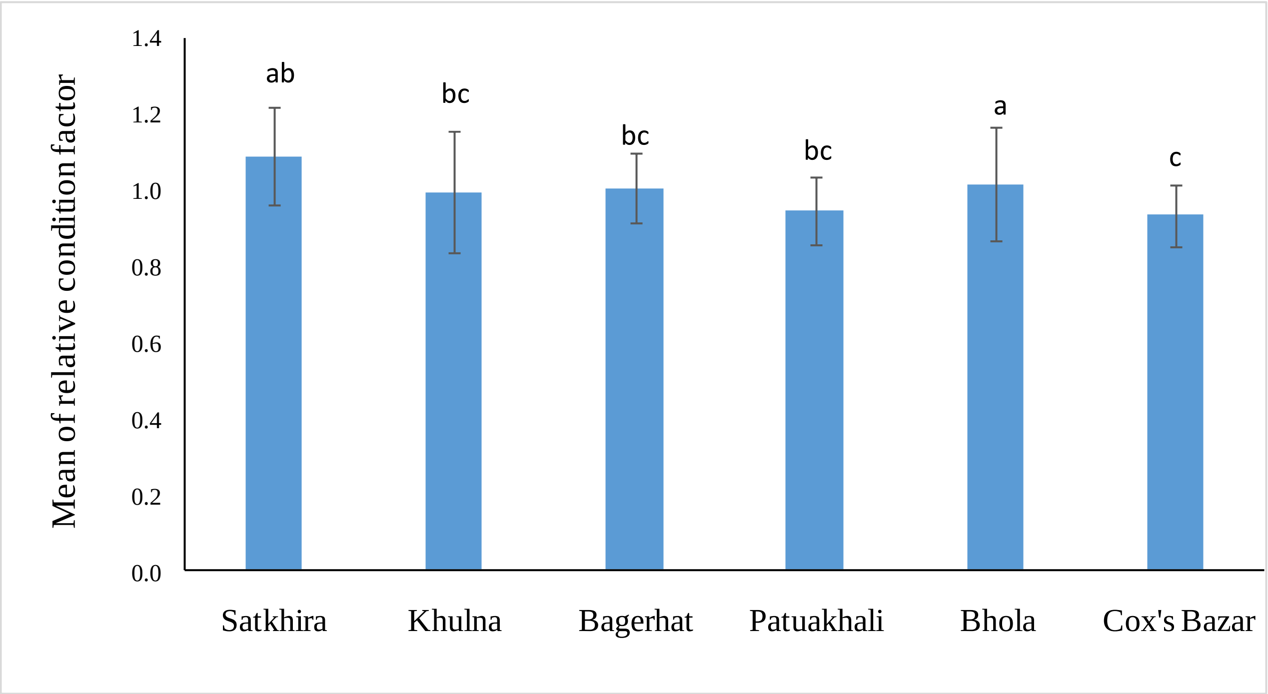

Fig. (5). Comparison of relative condition factor among *L. calcarifer* collected from six locations across the coastal region of Bangladesh

3.3. Dressing percentage

Fig. 6 shows the comparison among 6 stocks of *L. calcarifer* in respect of their dressing percentage. The ANOVA analysis revealed that, there were highly significant differences among the stocks for dressing percentage ($F_{(5,174)}$ = 24.19, $p<0.05$). The highest dressing percentage was found in Satkhira stock (59.48 ± 2.2) while the lowest was found in Cox's Bazar (54.59±1.5) (Table 2). Dressing percentage of the stock from Satkhira, Cox's Bazar and Patuakhali were found significantly different from other locations.

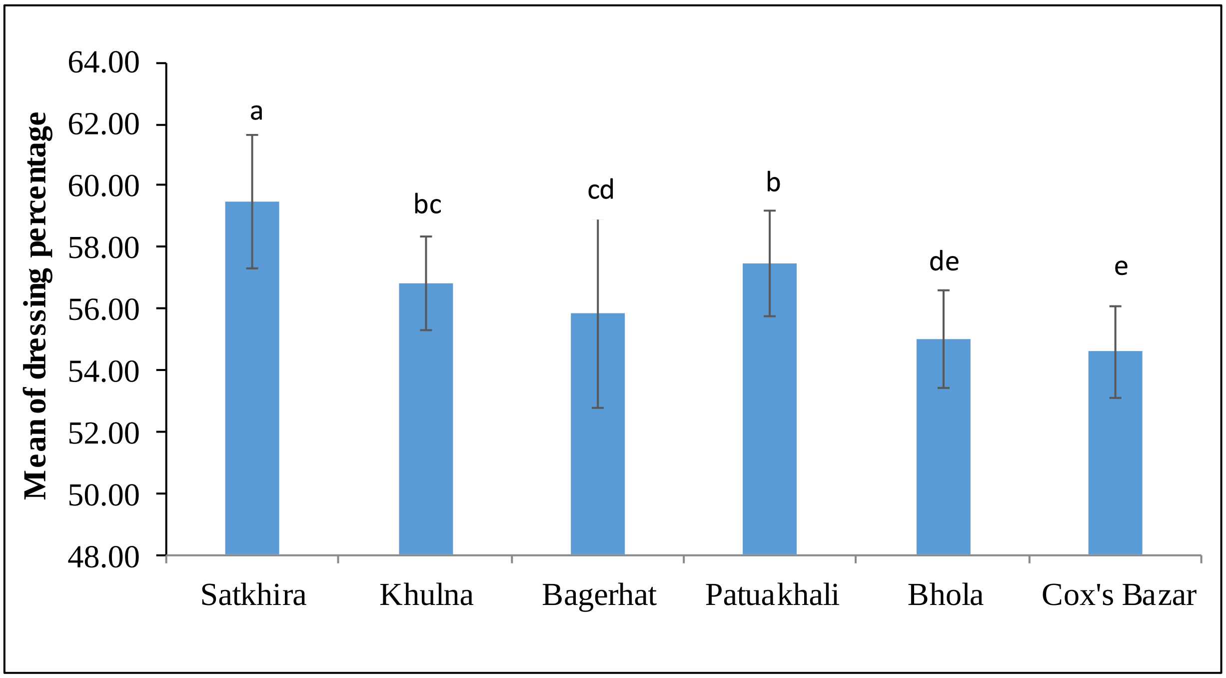

Fig. (6). Comparison dressing percentage among *L. calcarifer* collected from six locations across the coastal regions of Bangladesh

Table 2. Descriptive statistic of W, L, Condition factors (K), Relative condition factors (K_n), Dressing percentage (D %) of *L. calcarifer*

Locations	(K) (mean±SD)	K_n (mean±SD)	D% (mean±SD)	W (mean±SD)	L (mean±SD)	W (Max, Min)	TL (Max, Min)
Satkhira	1.09 ±0.13	1.06 ± 0.12	59.48± 2.2	290.3 ±46.37	29.85±1.7	390,220	33.23, 27.25
Khulna	0.99±0.16	0.99 ± 0.19	56.83 ± 1.5	221.03±60.2	28.01±2.4	345,128	33.24, 22.46
Bagerhat	1.01 ±0.09	0.98 ± 0.09	55.85 ± 3.1	256.3±42.18	29.37±1.8	340,160	33.44, 25.33
Patuakhali	0.95 ±0.09	0.98 ± 0.12	57.46 ± 1.6	351 ±114.93	33.03±3.2	630,200	40.32,27.81
Bhola	1.02 ±0.15	1.14 ± 0.39	55.01 ± 1.6	364 ±113.18	32.75±4.9	520,120	38.6, 20.57
Cox's Bazar	0.93 ±0.08	0.93 ± 0.10	54.59± 1.5	229.66±87.3	28.76±3.4	480,130	36.55, 23.87

DISCUSSION

In this study, we found dissimilarity in terms of growth among the six different stocks from different geological locations in Bangladesh and significant correlations between length and weight relationship among six stocks of *L. calcarifer*. All the stocks showed negative allometric growth (b<3) where stocks of Patuakhali had the highest value (2.99) and Satkhira showed the lowest value (2.123). The study is fully agreed with the results of variations in slope b that are influenced by sample size, life stages and environmental factors (**Pauly, 1984 and Kleanthids *et al*., 1999**).

Additionally, several studies have reported the same growth pattern in *Channa punctata* (**Ali *et al*., 2002; Haniffa *et al*., 2006**) in *Channa marulius* (**Dua and Kumar, 2006; Rathod *et al*., 2011**) and in *Channa striatus* (**Khan *et al*., 2011**). The stocks of Patuakhali revealed the highest value of b indicating the faster growth rate (**Datta *et al*., 2013**) than the remaining 5 stocks. As condition factor (K) of a fish expresses its physical and biological situations in response with feeding conditions, parasite infections, and physiological parameters (**Le Cren, 1951**). Therefore, it is definited that the stocks with the highest value of (K) are in better physiological and biological condition than others. In case of the present study, highest value (1.09 ± 0.13) of K was found in the stocks of Satkhira whereas the lowest value (0.934±0.08) was found in the stock of Cox's Bazar (0.934±0.08). As a result, we may conclude that the physiological and biological conditions of the stocks obtained from Satkhira were superior to the remaining stocks. This could be due to a favorable habitat, the availability of food, or the fact that they are at a younger stage of their life cycle.

The relative condition factor (K_n) demonstrates whether the relative growth increase in terms of predicted value or not (**Verani and colleagues, 1997; Romagosa *et al*., 2001**). We found that, $K_n > 1.0$ in the stocks of the Satkhira and Bhola indicating the observed weight of the fish stocks were more than the expected value. It can be described that, the species were in the nourished state due to improve feeding conditions or the passage of a spawning or pre-spawning period (**Basak and Hadiuzzaman, 2019**). The remaining stocks also showed the value of K_n nearly close to the 1.0 indicating their improved nourished state as well as better health condition. Differences in dressing percentage of a fish species usually depends on the various stages of maturation (**Safner *et al*., 2001**). The fishes having the higher dressing percentage, it possesses the highest market demand as well as consumer value in terms of fish processing or fish filet production (**Hough, 1993; Safner *et al*., 2001; Vallod, 1995**). The study revealed that the highest dressing percentage in the stocks of Satkhira and the significant differences ($p<0.05$) had been observed among all the stocks where the stocks of Satkhira, Patuakhali and Cox's Bazar showed the individuality in terms of dressing percentage. The study would allow the message to fish farmers, that the seabass species from Satkhira is the best candidate for culturable among the others studied areas.

CONCLUSION

In conclusion, this study showed a clear variation of phenotypic traits of *L. calcarifer* in different stocks of Satkhira, Khulna, Bagerhat, Patuakhali, Bhola and Cox's Bazar. There was a significant correlation between length and weight relationship among the six stocks whereas all the stocks showed negative allometric growth ($b<3$). The findings of the study indicating a superior physiological and biological state of studied fish in Satkhira than others. Therefore, it is expected that the study will pave the way of helping in proper conservation and management of this species in Bangladesh.

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