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FILLETING ATTRIBUTES, LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR OF SOME LOCAL FISH SPECIES COLLECTED FROM YANBU FISH MARKET (RED SEA COAST, SAUDI ARABIA)

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ABSTRACT: Analyzing the filleting attributes of fish, are essential for evaluating the commercial viability of fish products. This study assesses the filleting attributes, length-weight relationships, and condition factors of three commercially important fish species (*Lethrinus nebulosus*, *Epinephelus tauvina*, and *Plectorhinchus gaterinus*) from the Yanbu fish market in Saudi Arabian Red Sea coast. Fillet production results indicated a decreasing trend in edible portions among these species, with *Lethrinus nebulosus* yielding the most, followed by *Plectorhinchus gaterinus* and *Epinephelus tauvina*. Fish with smaller heads and medium-sized skeletons produced higher edible fillet yields. Linear regression analysis revealed no significant differences, establishing a linear correlation between net edible weight and fillet yield. The length-weight relationship analyses for *Lethrinus nebulosus*, *Plectorhinchus gaterinus*, and *Epinephelus tauvina* indicated positive allometric growth. Condition factor analysis showed that *Lethrinus nebulosus* had the lowest mean condition factor (1.05±0.05), while *Epinephelus tauvina* had the highest (1.67±0.15). A robust association between weight and fillet yield components was also observed. These findings enhance our understanding of the biological and economic characteristics of these species along the Yanbu coastline, supporting fisheries management and postharvest research in line with conservation and restoration efforts.

Keywords: Condition factor, Edible weight, Filleting yield, Fish products, Postharvest characteristics.

INTRODUCTION

The study of fish filleting attributes including the length-weight relationship (LWR) and condition factor (K), is critical to assessing the viability of commercial fish products (Rasyadi, et al., 2023). These parameters help determine the health and growth rates of fish, offering insights for fisheries management and postharvest processing (Akintola, et al., 2022). For instance, evaluating the weight-to-length ratio provides key indicators for the economic viability of fish species as food sources and assesses their role in sustaining industries related to postharvest technology, including canning and processing sectors (Sulieman, et al., 2011; Ikape and Solomon, 2018; Tahany et al., 2022).

The length-weight relationship research is a common way to study fish in order to see how body weight composition and they are. It is useful for managing fisheries in the flied of postharvest technology and fish handling. Many authors have studied how the length and weight of tropical fish are related, and how healthy they are (Zafar et al., 2002; Hossain et al., 2006; Muchlisin et al., 2010; Khillare and Khandare, 2020) while the condition factor shows how healthy and heavy a fish is based on its environment and biology.

Accordingly, the weight to length ratio of a fish may vary depending on the species and location (Blackwell et al., 2000; Fernandes, et al., 2020). The condition factor (K) is a tool used in fisheries science to assess the health and nutrition of fish. It assists them in monitoring the amount of food the fish are consuming, their age, and their rate of growth (Getso et al., 2017).

Fisheries in the Red Sea region, specifically along the Yanbu coast of Saudi Arabia, provide substantial protein resources and support industries that contribute to the national economy. In Saudi Arabia, traditional fishing methods account for a significant portion of the national fish catch, including the Red Sea region, where fish species such as grouper, snapper, and emperors are abundant (total catch from marine fisheries in Saudi Arabia, 2022). However, limited research has focused on the processing attributes, length-weight relationships, and condition factors of local fish species in this area, particularly those sold in the Yanbu fish market.

This research aims to fill this gap by analyzing the processing attributes, length-weight relationships and condition factors of selected fish species, contributing to a better understanding of the health and viability of these commercially valuable fish.

Citation: Adam Sulieman HM and Habeeb TH (2025). Filleting attributes, length-weight relationship and condition factor of some local fish species collected from Yanbu fish market (Red Sea coast, Saudi Arabia). *Online J. Anim. Feed Res*., 15(2): 98-107. DOI: https://dx.doi.org/10.51227/ojafr.2025.12

MATERIALS AND METHODS

Sampling site

The studied commercial fish samples were purchased from Yanbu Fish Market at Yanbu City near to Red Sea coast, Saudi Arabia/al-Madinah/Yanbu/Yanbu Al-Bahr (Al-Balad) located at 24°04'11.7"N 38°03'13.4"E.

Experimental fish species

A total of 60 individuals, belonging to three families, were procured for this research. These families include, Lethrinidae, Serranidae and Haemulidae, representing three species, namely, *Lethrinus nebulosus* (Emperors or scavengers), Epinephelus tauvina, Local name (Arabian grouper or greasy rockcod) and *Plectorhinchus gaterinus.*

Experimental trial

A total of 60 fish samples were utilized, 20 individuals regarding each species. Fish samples were purchased from Yanbu Fish Market and put in to sterile polythene bags and taken in icebox and transported to the Taibah University, College of Science, Department of Biology laboratory where data were processed: Their total and standard length were recorded (in cm) using measuring tape meter and total body weights were recorded in grams using an electronic weighing balance. The samples were then filleted, eviscerated, beheaded using a sharpen knives. The weight of viscera, fillets, heads, and skeletons (skeleton) were weighed separately using weighing balance. A pooled mean of these weights was calculated and used to estimate the percentage of each part of the dress out-fillets, head, gut and skeleton relative to the weight of whole fish and recorded the findings in Table 1.

Length-weight relationship

The equation W=aLb was used to calculate the relationship between the length and weight of the fish samples. In this study, used the least-square method to find the values of constant a and b. Values transformed the data using logarithms and used the formula: log W= log a + b log L.

Which, W is the fish's body weight in grams, L is the total length in centimeters, a is the intercept of the regression curve and b is the regression coefficient.

Condition factor

Fulton's condition factor (K) measures the health condition of the fish by using the formula $K=100W/L^3$, where W is the weight and L is the length of the fish. W represents weight in grams and L represents total length in centimeters. The condition factor was figured out using a formula created by Fagbuaro et al. (2018).

Statistical analysis

Statistical analysis is containing numbers and data to study and understand information; In this study, the statistical method ANOVA and software SPSS version 17 to analyze the data were used. Followed by Duncan multiple range tests, and the difference between species was investigated by independent sample T-test Correlations between body size (weight and length and Condition factor) and edible and inedible parts comparing with condition factor were analyzed by Pearson's coefficient for linear regression (r). The differences were considered significant at $P<0.05$ and $P<0.01$. All data were recorded as mean±Standard error.

RESULTS

Length-weight relationship

The length-weight relationships (LWR) of the studied fish species from the Yanbu Fish Market are presented in Tables 2 and Figures 7-9. The 95% confidence interval values of the exponent 'b' in the relationship varied among investigated fish (*Lethrinus nebulosus:* 0.93, *Plectorhinchus gaterinus*: 1.09 and *Epinephelus tauvina:* 1.34). Analysis of studied fish species statistically showed that all the species exhibited positive allometric growth pattern. Their 'b' values were less than 3. There was correlation between the length and the weight of all the studied fish species.

Filleting yield composition

The study found that the fish's filleting yield composition, body parts, and amount of meat varied a lot. The *Lethrinus nebulosus* had the highest fillet percentage (37.4%), followed by *Plectorhinchus gaterinus* (36.5%) and *Epinephelus tauvina* has the lowest fillet (34.2%). While in the case of inedible parts all studied fish species were recorded a high percentage showed (59.2%, 61.1% and 61.7% respectively) as presented in Table 1, Figures 1-6 and 16, 17. There was strong correlation between weight and their filleting yield components Tables 4-7.

Condition factor (K)

The mean condition factors (K) of all studied species are shown in Table 3, and Figures 10-15. The results exhibited variability in the condition factor for studied samples. As shown in the Figure 17, the condition factor for the 3 species recorded range between 1.05 and 1.67. *Lethrinus nebulosus,* had (1.05±0.05), *Plectorhinchus gaterinus* (1.24±0.06) and *Epinephelus tauvina* (1.67±0.15). The study revealed a negative correlation between condition factor and total length, while a positive correlation was observed between condition factor and total body weight across all examined fish (Tables 4–7). Additionally, it highlighted variations in the condition factor in relation to total length among the three studied fish from Yanbu Fish Market, as shown in Figures 10–18.

Table 1 - Average (%) Body weight composition and filleting yield of three fish type procured from Yanbu Fish Market

Fish species	Total body (g)	Total length (cm)	Standard length (cm)	Head %	Viscera %	Fin %	Skeleton %	Fillet %	Skin %	Edible parts %	Inedible parts %
Lethrinus nebulosus	299.0±24.06[a]	29.47±1.44[a]	24.43±0.52[a]	28.08±0.052[a]	4.97±0.067	2.17±0.23	13.43±0.40[c]	37.44±0.40[a]	10.80±0.77[a]	37.44±0.40[a]	59.27±0.97
Epinephelus tauvina	245.57±23.1[b]	24.75±0.87[b]	20.63±0.77[b]	23.28±1.04[b]	4.76±0.90	1.97±0.08	21.82±0.59[b]	34.30±1.17[b]	8.63±0.92[b]	34.29±1.17[b]	61.77±0.54
Plectorhinchus gaterinus	340.73±14.09[a]	30.40±0.46[a]	25.70±0.47[a]	25.01±0.17[b]	6.03±0.54	1.61±0.21	16.00±0.62[a]	36.59±0.92[a]	11.87±0.72[a]	36.37±0.92[a]	61.19±1.20
P-value	0.008**	0.001**	0.001**	0.006**	0.401	0.130	0.0001**	0.041*	0.002**	0.405	0.173

Average ± Standard error. * denoted is significant at the 0.05 level. ** denoted is significant at the 0.01 level. Sample size = 60. The values in the table represent the mean ± SE. P-values indicate the significance of differences calculated from the test comparing the means of the studied fish species. Different superscript letters indicate statistically significant differences between fish species (Tukey's test, $p < 0.05$). Values sharing the same letter within a column are **not** significantly different.

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Table 3 - Condition factor regression analysis of three fish species collected from Yanbu Fish Market

Fish species	TW+SE	SL+SE	95% CI for b	R^2	K+SE	Condition factor Equation	KP
Lethrinus nebulosus	299.00+24.06	29.47+1.44	0.935-1.167	0.413	1.05+0.05	K= 1.85-0.3* (TL)	(-)
						K= 0.74+1.03*(TW)	(+)
Epinephelus tauvina	245.57+23.17	24.75+0.87	1.346-1.991	0.323	1.67+0.15	K=4.14-0.10 *(TL)	(-)
						K=0.83+3.6*(TW)	(+)
Plectorhinchus gaterinus	340.73+14.09	30.40+0.46	1.098-1.379	0.518	1.24+0.06	K=4.39-0.10*(TL)	(-)
						K=0.38+2.5*(TW)	(+)

K: Condition factor; TL: Total length; TW: Total weight; SE: Standard error; SL: Standard length; KP: condition factor pattern; R^2 : correlation coefficient, Sample size : 60

Table 4 - Correlation of the Body weight composition of *Lethrinus nebulosus* collected from Fish Yanbu Market

Parameters	Edible part	Inedible part	Total Weight	Head	Viscera	Fin	Skeleton	Skin
Edible part								
Inedible part	0.591**							
TL	-0.057	0.324						
Head	0.542*	0.763**	0.397					
Viscera	0.448*	0.644**	0.044	0.410				
Fin	0.502*	0.243	-0.369	0.169	0.703**			
Skeleton	0.053	0.145	-0.019	0.051	-0.297	-0.423		
Skin	-0.345	-0.248	-0.086	-0.657**	-0.063	-0.165	-0.331	
Total Weight	-0.234	-0.102	0.638**	0.029	-0.238	-0.405	-0.125	0.082

*: Correlation is significant at the 0.05 level (2-tailed). **: Correlation is significant at the 0.01 level (2-tailed).

Table 5 - Correlation of the Body weight composition of *Epinephelus tauvina* collected from Fish Yanbu Market

Parameters	Head	Vesera	Fin	Skeleton	Skin	Total weight	Total length	Edible part
Head								
Vesera	-0.812**							
Fin	0.203	-0.187						
Skeleton	0.385	-0.581**	0.276					
Skin	-0.595**	0.846**	-0.292	-0.723**				
Total weight	0.657**	-0.812**	0.142	0.370	-0.712**			
Total length	0.320	-0.085	-0.039	-0.178	0.113	0.409		
Edible part	0.388	-0.489*	0.250	0.414	-0.374	0.533*	0.290	
Inedible part	-0.457*	0.316	-0.376	-0.390	0.376	-0.246	-0.321	-0.458*

*: Correlation is significant at the 0.05 level (2-tailed). **: Correlation is significant at the 0.01 level (2-tailed).

Table 6 - Correlation of the Body weight composition of *Plectorhinchus gaterinus* fish collected from Fish Yanbu Market

Parameters	Total Weight	Edible part	Inedible part	Total Length	Head	Vesera	Fin	Skeleton
Total weight (TW)								
Edible part	-0.560**							
Inedible part	0.329	-0.557**						
Total Length	0.191	0.253	-0.485*					
Head	0.376	-0.458*	0.878**	-0.605**				
Vesera	-0.593**	0.605**	-0.714**	0.310	-.812**			
Fin	-0.085	0.494*	-0.325	0.210	-0.349	0.466*		
Skeleton	0.528*	-0.399	0.576**	0.102	0.482*	-0.743**	-0.240	
Skin	0.109	-0.505*	0.479*	-0.171	0.213	-0.287	-0.319	0.117

*: Correlation is significant at the 0.05 level (2-tailed). **: Correlation is significant at the 0.01 level (2-tailed).

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Table 7 - Correlation of the Body length and condition factor of three fish species (*Lethrinus nebulosus*, *Epinephelus tauvina* and *Plectorhinchus gaterinus* collected from Fish Yanbu Market

Parameters	Total weight	Condition factor
Total length		
Total weight	0.638**	
Condition Factor	-0.376	0.445*

*: Correlation is significant at the 0.05 level. **: Correlation is significant at the 0.01 level.

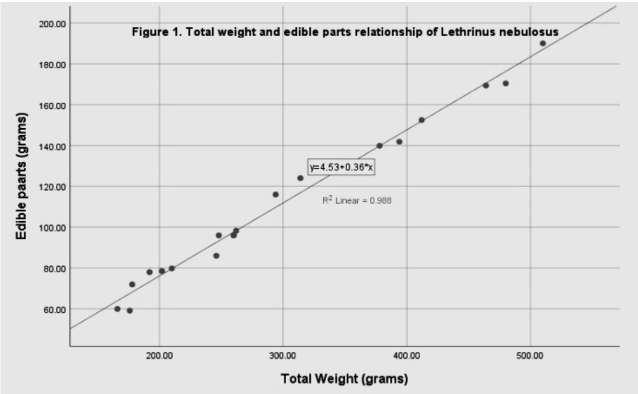


Figure 1 - Total weight and edible parts relationship of *Lethrinus nebulosus.*

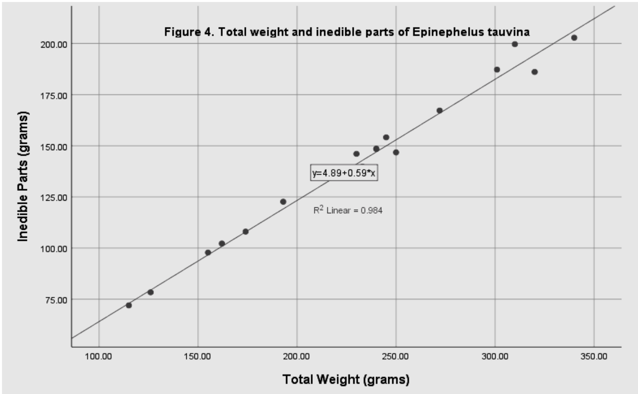


Figure 4 - Total weight and inedible parts relationship of *Epinephelus tauvina*.

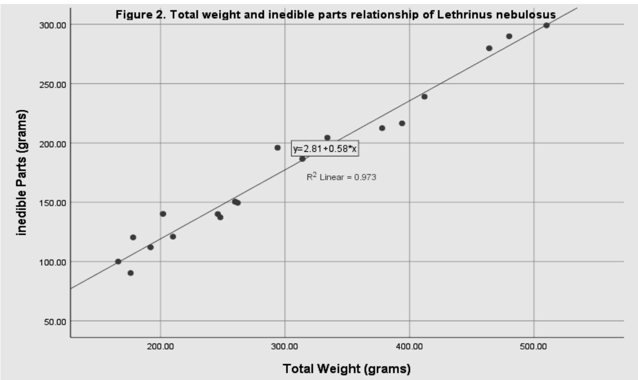


Figure 2 - Total weight and inedible parts relationship of *Lethrinus nebulosus.*

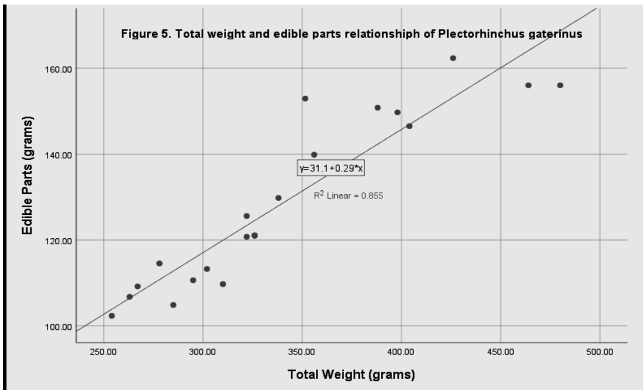


Figure 5 - Total weight and edible parts relationship of *Plectorhinchus gaterinus.*

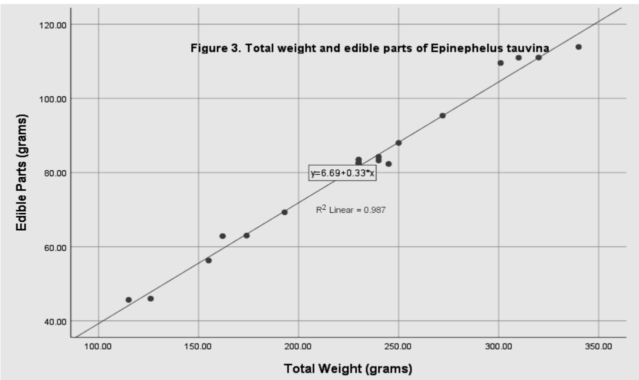


Figure 3 - Total weight and edible parts relationship of *Epinephelus tauvina.*

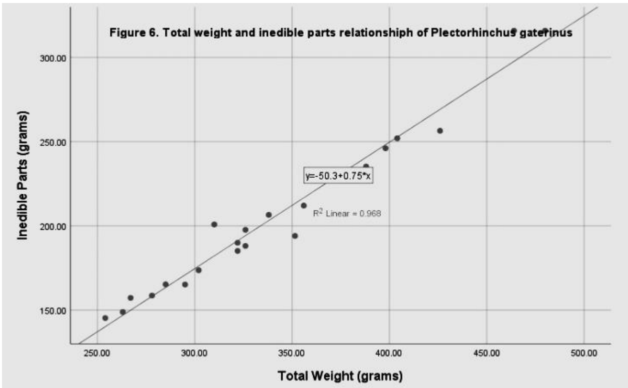


Figure 6 - Total weight and inedible parts relationship of *Plectorhinchus gaterinus*.

1. Variations of weight parameters with total weight of three studied fish from Yanbu fish Market

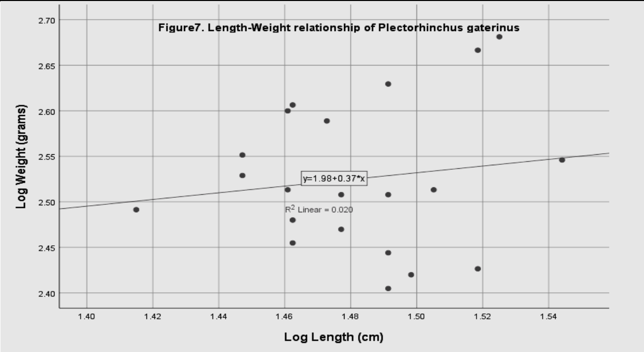


Figure 7 - Length-weight relationship of *Plectorhinchus gaterinus*.

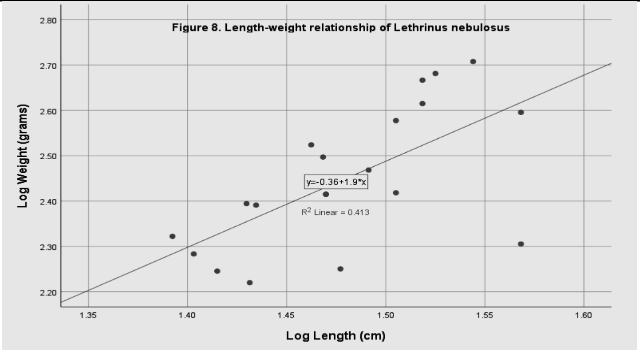


Figure 8 - Length-weight relationship of *Lethrinus nebulosus*.

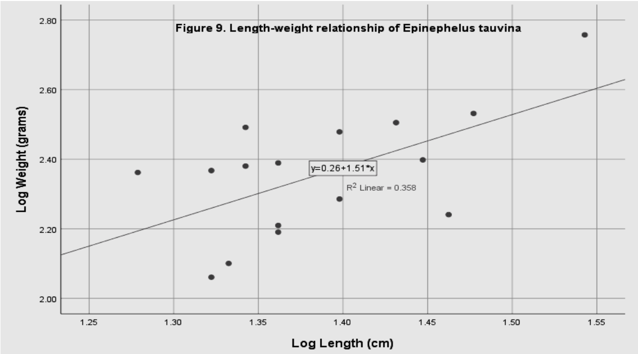


Figure 9 - Length-weight relationship of *Epinephelus tauvina*.

2. Variations of length- weight relationship (LWR) of three fish species collected from Yanbu fish Market

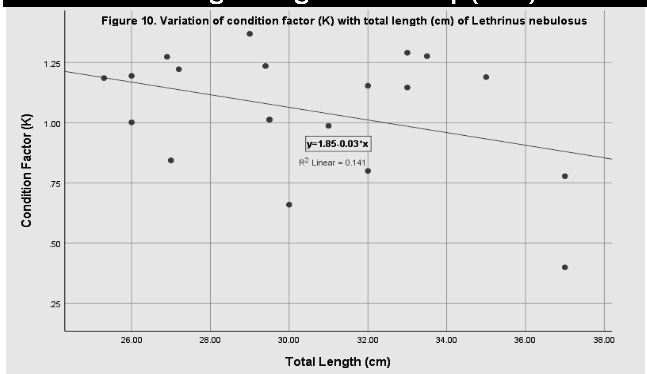


Figure 10 - Variation of condition factor (K) with total length (cm) of *Lethrinus nebulosus*.

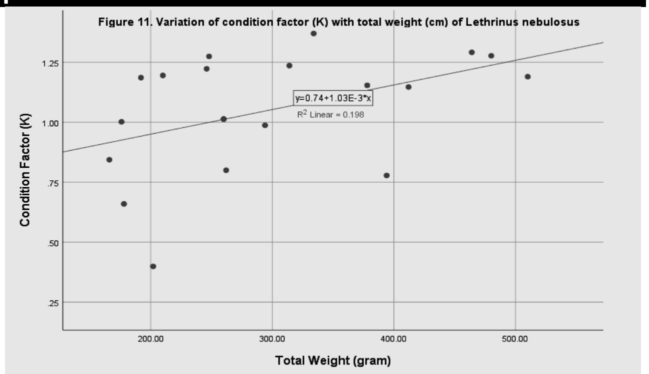


Figure 11 - Variation of condition factor (K) of total weight (g) *Lethrinus nebulosus*.

3. Variations of condition factor (K) with total length (cm) of three studied fish from Yanbu fish Market

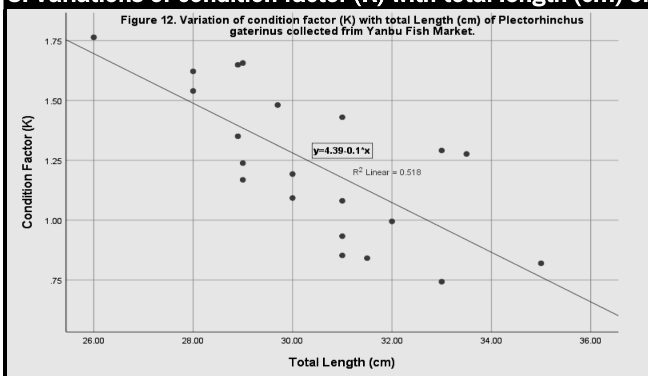


Figure 12 - Variation of condition factor (K) with total length (cm) of *Plectorhinchus gaterinus* collected from Yanbu Fish Market.

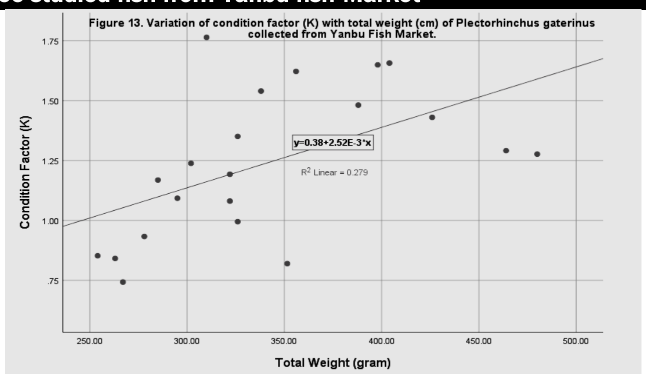


Figure 13 - Variation of condition factor (K) with total weight (grams) of *Plectorhinchus gaterinus* collected from Yanbu Fish Market.

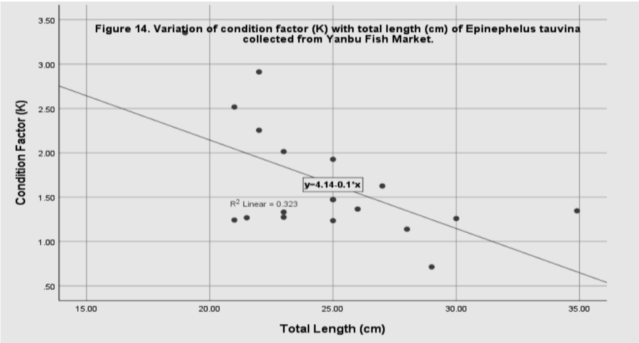


Figure 14 - Variation of condition factor (K) with total length (cm) *Epinephelus tauvina* collected from Yanbu Fish Market.

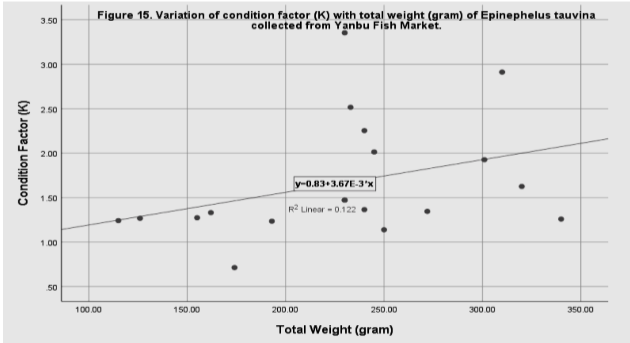
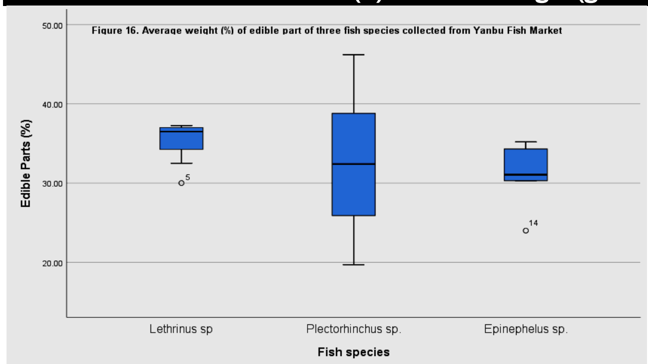
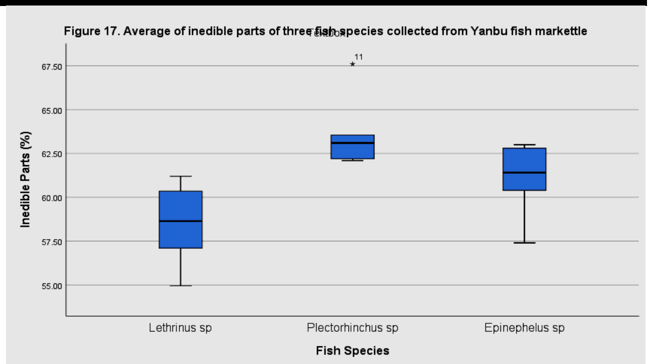


Figure 15 - Variation of condition factor (K) with total weight (g) *Epinephelus tauvina* collected from Yanbu Fish Market.

4. Variations of condition factor (K) with total weight (grams) of three studied fish from Yanbu fish Market





Figures 16 and 17 - Average of edible and inedible of three fish species collected from Yanbu fish market

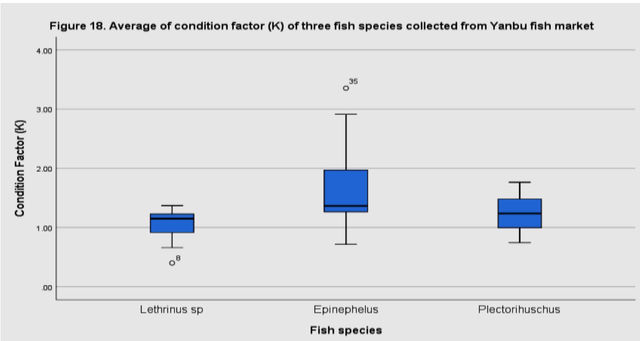


Figure 18 - Average of condition factor (K) of three fish species collected from Yanbu fish market

DISCUSSION

Length-weight relationship

The length-weight relationship (LWR) and condition factor (K) are essential for evaluating fish health and postharvest quality (Jayasankar et al., 2024; Moutopoulos and Stergiou, 2002). While Fetouh and El-Far (2023), stressed the importance of LWR in modeling aquatic ecosystems This study's findings indicate that allometric growth patterns for fish in the Yanbu region differ from documented LWR ranges in tropical species, which typically exhibit 'b' values between 2.5 and 3.5 (Pauly, 1997; Rosemonde, et al., 2019). The positive allometric growth observed implies that Yanbu's environmental conditions may limit fish weight gain relative to length increases, possibly due to unique habitat variables like salinity or food availability. The length-weight relationship (LWR) of the fish species analyzed in this study, specifically *Lethrinus nebulosus, Plectorhinchus gaterinus, and Epinephelus tauvina,* revealed a significant positive correlation. All species exhibited positive allometric growth patterns with 'b' values less than three, suggesting that the weight of these fish increases more slowly compared to their length.

This result aligns with the work of Jayasankar et al. (2024), and Moutopoulos and Stergiou (2002); who noted that LWR is valuable for fish population studies, as it reflects environmental conditions affecting growth. The values observed for each species (*Lethrinus nebulosus*: 0.93, *Plectorhinchus gaterinus*: 1.09, and *Epinephrine tauvina:* 1.34), suggest that the growth patterns of fish species vary based on specific environmental and genetic factors (Hossain et al., 2006; Muchlisin et al., 2010; Famoofo and Abdul, 2020).

This relationship had avital role in fisheries biology because it allows estimation of average weight of the fish of a given length group (Kırankaya, 2014). The findings of this study revealed that the growth pattern of the studied fish species in the Yanbu Fish Market registered as positive allometric, because the b-values ranged from 1.51 to 1.98. This means that the studied fishes do not grow symmetrically as reported by PRASAD and VERMA (2023) or the fish becomes thinner with increase in length as mentioned by Gusau et al. (2021). Notable among them includes the results of Kaushik (2004) and in commercial fish landings in central market, and also in an investigation of some morphometric parameters of fish species of Lower Nun River in Niger Delta (Abowei, 2010; David et al., 2025). Also, Usman (2012), observed allometric growth pattern in Kontagora Reservoir, while Rosemonde et al. (2019) and Suleiman et al. (2021) made similar findings in an evaluation of length-weight relationship of fish species of Ebonyi River. Also, the same findings were observed by Sulaiman et al. (2022), and Usman (2012), which these results agreed with the findings of the present study. However, the b-values recorded for all the species in the present study is below the documented values of 2.5 to 3.5 for tropical fish species (Pauly, 1997; Rosemonde et al., 2019).

Filleting yield composition

The filleting yield of each species showed notable differences. *Lethrinus nebulosus* recorded the highest fillet percentage (37.4%), followed by *Plectorhinchus gaterinus* (36.5%), and *Epinephelus tauvina* with the lowest yield (34.2%). However, non-edible parts constituted a high percentage, exceeding 59% for all species. These findings correspond with other studies indicating that fish species with higher proportions of head and skeleton yield less edible fillet, a factor that affects their commercial value (Di Blase and Marchisio, 1991; Shehawy, et al., 2016). The correlation between body weight and filleting yield suggests that species with a higher condition factor may yield better fillets relative to their body structure. The filleting yield results further emphasize the impact of fish body composition on commercial yield. The higher percentage of inedible parts in the analyzed fish species presents a potential loss for fisheries, as consumers typically discard these components. The study suggests the utilization of these inedible portions for fish silage or meal production, a sustainable alternative practiced in other regions with similar high-nutrient waste products (FAO, 2010; Report of the FAO/CECAF 2020; Fisheries statistics: Saudi Arabia 2016–2021, 2023).

Condition factor (K)

The condition factor (K) results for the three fish species ranged between 1.05 and 1.67, reflecting variations in health and nutritional status. *Lethrinus nebulosus* had a mean K value of 1.05±0.05, *Plectorhinchus gaterinus* recorded 1.23±0.06, and *Epinephelus tauvina* had the highest at 1.67±0.15. The K values align with findings by Ahmed et al. (2011), Kumolu-Joh and Ndimele (2011) and it is contrary with Usman (2012).

Shalloof et al. (2024) noted that higher condition factors are indicators of better nutritional status and growth rates in fish populations. Additionally, these findings reveal a negative correlation between condition factor and total length and a positive correlation with total body weight, implying that growth rates may impact the physiological state of fish over time. This result of Figures 9, 12, and 14 are not the same as the one found by Oniye et al. (2006), Ayoade and Ikulala (2007) and Kırankaya (2014). Finally, the condition factor observed among the fish species reflects their adaptation to local environmental factors, with variations in K values suggesting differential access to nutrients and feeding habits. High K values generally indicate robust health and favorable growth conditions, as noted by Ayoade and Ikulala (2007) and Rosemonde et al. (2019) who associated condition factors with environmental quality. For the Yanbu fish market, improving fish yield through selective handling or habitat management could increase the commercial value of species with lower K values, thus enhancing their marketability and nutritional value for consumers.

CONCLUSION

In conclusion, the fish species in this study showed a clear relationship among their lengths and weights. Also, the study revealed that the edible and inedible parts of studied fish, was a result of its structural body and processing skills. Fish with small heads and skeletons produces high fillet (edible) and it is suggested to use the parts of fish that people don't eat to make fish silage or fish meal in different fishing industries and poultry meal.

DECLARATIONS

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Data availability
The original data supporting this study are included in the article, is available upon reasonable request to the corresponding author.

Author contribution
Prof. Hassan Sulieman contributed to the study design and experiment scheduling, while Talaat Hassan conducted the data analysis. All authors reviewed the analyzed data and approved the final manuscript draft.

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The present research work does not contain any studies performed on animal/human subjects by any of the authors.

Consent to publish
All authors agree to the publication of this manuscript.

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The authors have not declared any competing interest.

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