

ASPECT OF BIOLOGY AND THE NUTRITIONAL PROFILE OF *Panulirus regius* FROM THE MAKOKO FISH LANDING SITE, LAGOS LAGOON, NIGERIA

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ABSTRACT

Panulirus regius is an edible marine crustacean known for its spiny exoskeleton and its economic significance in most parts of the world due to the high market demand among other benefits. Studies on aspects of biology and nutrient composition were conducted from the Makoko fish market of the Lagos Lagoon. The species were collected monthly between November, 2023 and July, 2024. The total length, standard length and body weight ranged between 11.4 – 27.0 cm, 9.0 – 24.0 cm and 25.5 – 453.1 g respectively. The length-weight relationship showed negative allometric growth ($b < 3$) while the correlation coefficient (r) showed a strong positive correlation (0.9271), indicating that as the length increases, the weight of the organism also increases. The species exhibited evidence of cannibalistic or tendencies of consuming their own shed shells (exuvia), as lobster shells were the major items observed in the stomach contents. There was no significant difference ($P > 0.05$) in the sex ratio, with males slightly more abundant than females (1:0.9). The findings on the proximate composition revealed that *P. regius* is rich in protein with significant differences ($P < 0.05$) in the various nutritional parameters for the dry and wet seasons. The mineral composition showed that the species is rich in sodium, potassium and calcium which are essential for growth, nerve and muscle function, and the development of strong bones and teeth across all age groups. However, there is a need for continued research to explore the underlying mechanisms for the seasonal variations and to ensure optimal conditions are maintained for the health and sustainability of lobster populations.

Keywords: Length-weight relationship, Mineral composition, Morphometric, Proximate composition, Spiny lobster

INTRODUCTION

Panulirus regius, commonly known as the royal spiny lobster, belongs to the family Palinuridae within the order Decapoda and one of the largest and most diverse orders of crustaceans. The order Decapoda includes all shrimp, crabs, and lobsters, characterized by having ten legs (5 pairs of thoracic appendages). They are edible, marine crustaceans known for their lack of large claws and their spiny exoskeleton (Phillips and Booth, 2019).

Beyond its importance as a major fisheries commodity in West African waters, particularly in Nigeria, the genus *Panulirus* is of considerable interest to biologists owing to its high biodiversity and wide geographic distribution (Freitas *et al.*, 2007; Lawal-Are *et al.*, 2018). They are mostly found in crevices/caves in coral reefs and rocky substrates. They are nocturnal creatures, emerging at night to forage for food. They reproduce in spring and summer, with females carrying bright orange eggs on their tails. They are carnivores, feeding on molluscs, crustaceans, small fish and other invertebrates but can also be found to consume plant life especially algae (Freitas *et al.*, 2007). The species is known for its migratory behavior, particularly during the reproductive season, when individuals move to shallower waters for breeding (Pollock, 1995). As a protein-rich crustacean, the royal spiny lobster has become a popular delicacy in many dishes and an economically valuable seafood, commanding high prices in most restaurants (Freitas *et al.*, 2007; Haryono *et al.*, 2018). The potential use of *Panulirus regius* is encouraged by the fact that it can be

used for different purposes. Lobster species, in general, can be used to prepare diet supplements, to obtain chitin, and as a source of astaxanthin for aquaculture. They are rich sources of essential minerals and vitamins, including copper, selenium, zinc, phosphorus, magnesium, vitamin B₁₂, and vitamin E (Freitas *et al.*, 2007; García-López *et al.*, 2016; Varisco *et al.*, 2020). The report of Yuan *et al.* (2001) suggest that consuming lobsters could decrease the risk of myocardial infarction by over 50%.

Although, several studies on lobsters have been reported by Floreto *et al.* (2000); Ayanda *et al.* (2018); Haryono *et al.* (2018) and Moruf *et al.* (2021) but there is still dearth of information on the biology and the nutritional composition of *Panulirus regius* from Lagos Lagoon. Therefore, this work seeks to address this lacuna by determining some aspects of biology as well as the proximate composition and mineral analysis of royal spiny lobster (*Panulirus regius*) from the Makoko fish landing site of Lagos Lagoon, Nigeria.

MATERIALS AND METHODS

Brief description of the study area

The field survey and sample collection for this study were carried out at Makoko fish landing site of the Lagos Lagoon. Makoko, situated at longitude 3°23'39"E and latitude 6°29'44"N, is approximately 1.53 miles from the University of Lagos (Akinwunmi *et al.*, 2025) as presented in Figure 1. Makoko is one of three small communities along the Lagos mainland coast in Lagos State, Nigeria. Its waterfront area is predominantly

inhabited by the Egun people, who migrated from Badagry and the Republic of Benin, with fishing serving as their primary occupation. The community's water body is influenced by tidal influx from the open sea and exhibits brackish conditions, or nearly fresh particularly during the rainy season. As a result, fisheries resources harvested from this water body comprise both marine and freshwater species. The site is characterized by a sandy

substratum, while water turbidity remains high due to intense and ongoing anthropogenic activities. Makoko Market functions as an important landing point for fisheries resources from Lagos Lagoon and surrounding offshore waters, attracting substantial patronage from fishermen, wholesalers, retailers, and consumers (Akinwunmi *et al.*, 2023).

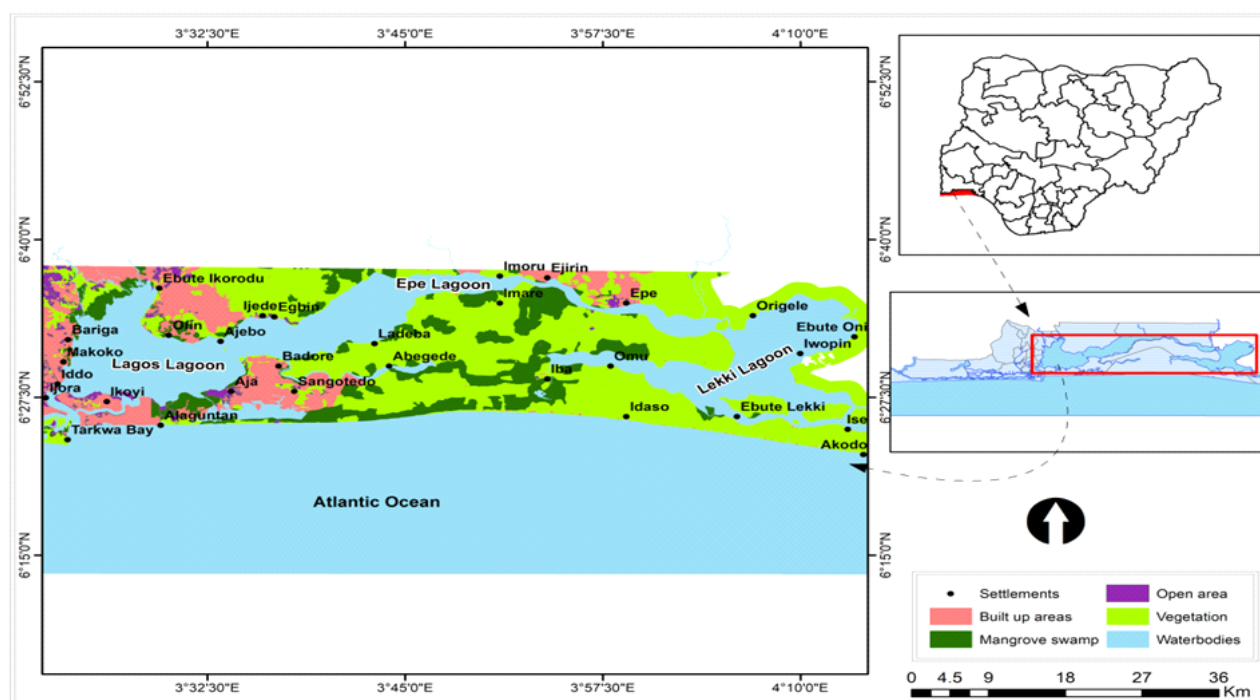


Fig. 1: Map of Lagos Lagoon showing Makoko sampling site.

Samples collection

A total of 120 (one hundred and twenty) *P. regius* were collected monthly from Makoko fish landing site of the Lagos Lagoon for 9 months (November, 2023 – July, 2024). The samples were stored in an ice chest and transported to the Department of Fisheries and Aquaculture, where they were immediately transferred to a freezer maintained at -20°C to minimize post-mortem decomposition prior to further analysis.

Laboratory Analysis

The lobsters were removed from the freezer, allowed to thaw and a towel was used to remove excess moisture from their body. The meristic, morphometric, length-weight relationship, condition factor, food and feeding analysis, reproductive biology were done according to the works of Akinwunmi and Moruf (2021); Akinwunmi *et al.* (2021). While the mineral (Ca, K, Na, Mg, Zn, Cu, P and Fe) and proximate composition (moisture, crude protein, crude fat, crude fibre, total ash and nitrogen free extract)

of the species were done using standard methods (Akinwunmi *et al.*, 2023).

Statistical Data Analysis

Data were analyzed using Microsoft Excel 2021. Proximate and mineral composition data were subjected to descriptive statistical analysis and analysis of variance (ANOVA) using SPSS for Windows (version 16). Differences among means were considered significant at $p < 0.05$ and further distinguished with Duncan's Multiple Range Test (Zar, 1998).

RESULTS

The result of the morphometric studies of the lobster species are summarized in Table 1. The total length ranged from 11.40 – 27.00 cm and the standard length ranged from 9.00 – 24.00 cm. The total weight ranged between 25.5 – 453.10 g.

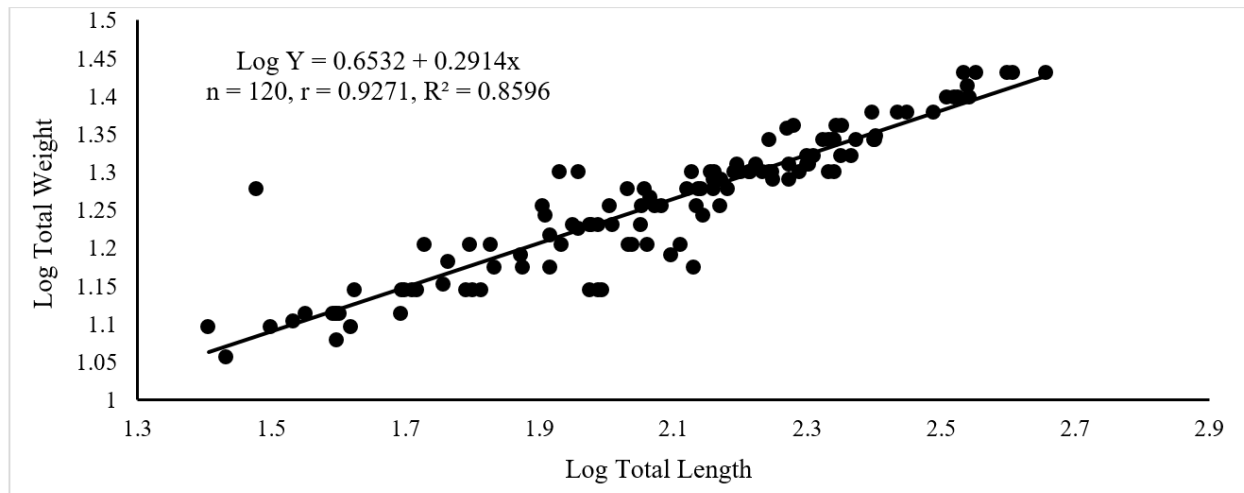
Table 1: Morphometric characteristics of *Panulirus regius* in Lagos Lagoon, Nigeria

Morphometric characters	Mean and ranges		
	Female	Male	Combined sexes
Total length (cm)	19.42 ± 0.54 (12.5 – 27.0)	17.89 ± 0.45 (11.4 – 27.0)	18.60 ± 0.35 (11.4 – 27.0)
Total weight (g)	165.87 ± 13.33 (25.5 – 403.1)	133.59 ± 10.47 (27.0 – 453.1)	148.65 ± 8.46 (25.5 – 453.1)
Standard length (cm)	16.11 ± 0.48 (9.0 – 24.0)	14.87 ± 0.40 (9.0 – 23.0)	15.45 ± 0.31 (9.0 – 24.0)

Range are shown in brackets; values are expressed as mean ± SEM

Length -Weight relationship of *P. regius*

The relationship between the length-weight of *P. regius* was determined and the graph for the log transformed values is presented in Figure 2

**Fig. 2:** Relationship between Log total length and Log weight of *Panulirus regius* from Lagos Lagoon (Nov., 2023 – July, 2024)

Condition factor

The differences in the condition factor by sex and size of *P. regius* from the Lagos Lagoon is shown in Table 2. The K values ranged from 1.6 – 2.4 (female), 1.2 – 2.7 (male) and 1.7 – 2.5 (combined sexes) with a mean value that ranged between 2.0 and 2.1. The lowest and highest mean K-value was 1.2 and 2.7 respectively and these values were observed in the male species.

Table 2: Variation in the Condition factor (K) by sex and size of *Panulirus regius* from Lagos Lagoon, Nigeria (Nov., 2023 – July, 2024)

SIZE GROUP	FEMALE				MALE				COMBINED SEX			
	N	TL(cm)	WT(g)	K	N	TL(cm)	WT(g)	K	N	TL(cm)	WT(g)	K
10.5-11.4	-	-	-	-	1	11.4	27.0	1.8	1	11.4	27.0	1.8
11.5-12.4	-	-	-	-	1	12.0	39.5	2.3	1	12.0	39.5	2.3
12.5-13.4	3	12.8	34.8	1.6	7	12.8	38.7	1.8	10	12.8	37.5	1.8
13.5-14.4	6	14.0	57.1	2.1	6	14.0	73.2	2.6	12	14.0	65.1	2.4
14.5-15.4	2	15.1	63.0	1.8	3	15.0	91.3	2.7	5	15.0	83.6	2.5
15.5-16.4	5	15.9	92.6	2.3	5	15.9	93.3	2.3	10	15.9	93.0	2.3
16.5-17.4	-	-	-	-	8	16.9	95.4	2.0	8	16.9	95.4	2.0
17.5-18.4	6	17.9	119.4	2.1	3	17.8	107.0	1.9	9	17.9	115.3	2.0
18.5-19.4	6	18.9	136.5	2.0	3	19.0	83.8	1.2	9	18.9	118.9	1.8

19.5-20.4	9	19.8	154.2	2.0	10	20.0	165.7	2.1	19	19.9	160.2	2.0
20.5 -21.4	1	21.0	223.0	2.4	8	20.7	193.0	2.2	9	20.7	196.4	2.2
21.5-22.4	5	22.0	222.4	2.1	4	22.1	228.3	2.1	9	22.0	225.0	2.1
22.5-23.4	2	22.9	188.5	1.6	2	23.0	222.5	1.8	4	23.0	205.5	1.7
23.5-24.4	4	24.0	277.1	2.0	-	-	-	-	4	24.0	277.1	2.0
24.5-25.4	3	25.0	337.8	2.2	1	25.0	321.0	2.1	4	25.0	333.6	2.1
25.5-26.4	-	-	-	-	1	26.0	346.5	2.0	1	26.0	346.5	2.0
26.5-27.4	4	27.0	374.0	1.9	1	27.0	453.1	2.3	5	27.0	389.8	2.0
	56			2.0	64			2.1	120			2.1

Key: N = Number, TL = Total Length in cm, WT = Total weight in g, K = Condition factor

Stomach analysis

The variety of food items observed in the stomach contents of *P. regius* is presented in Fig. 3. The result shows that the stomach contains items like fish bones,

shells, fishes, unidentified substances, sand grains, detritus were encountered. Though, shells of an organism were found to be the major food items.

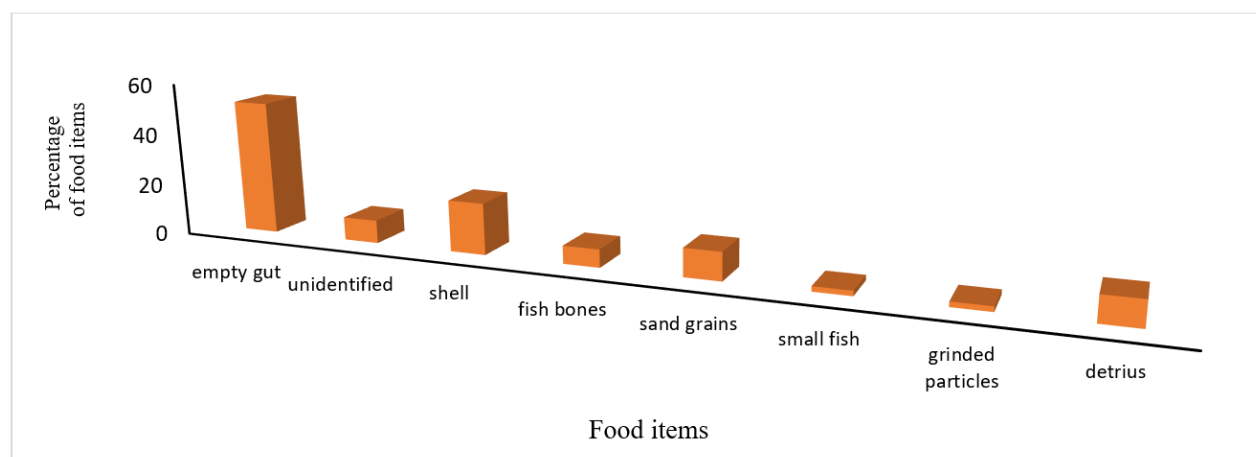


Fig. 3: Frequency of Occurrence distribution of food items in the stomach of *P. regius* from Lagos Lagoon

Reproductive Biology

Sex Ratio

Out of the one hundred and twenty (120) specimens of *Panulirus regius* that were examined, 64 (53.3%) were

found to be males and 56 (46.7%) were females, yielding a sex ratio of 1:0.9 (male: female). The result shows that the number of males was higher than females as shown in Fig. 4.

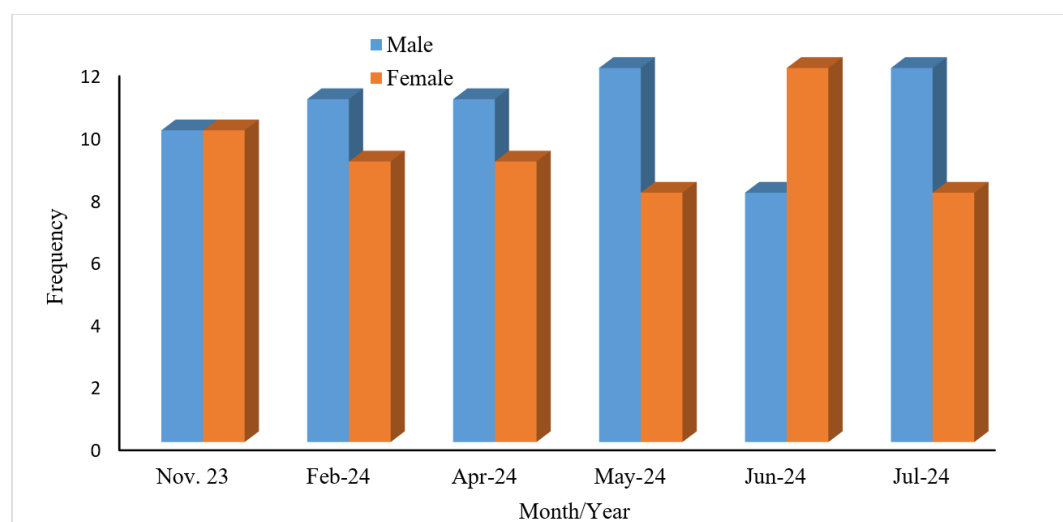


Fig. 4: Sex ratio of *P. regius* from Lagos Lagoon

Proximate Composition

The proximate composition of *P. regius* for the dry and wet seasons is shown in Table 3. The analysis done during the dry season shows no significant difference ($P > 0.05$) in the moisture, protein, fat, fibre and ash while the Nitrogen Free Extract (NFE) differs significantly ($P < 0.05$) from the other parameters. Meanwhile, there is no

significant difference ($P > 0.05$) in the moisture, protein and fat content of the species collected in the wet season which differs significantly ($P < 0.05$) from the fibre, ash and NFE contents of the same season. The proximate composition of the species is higher for the dry season compared to the wet season.

Table 3: Proximate Composition (%) of *Panulirus regius* in dry and wet season

Seasons	Moisture	Protein	Fat	Fibre	Ash	NFE
Dry	72.52±0.11 ^a	18.33±0.01 ^a	2.56±0.01 ^a	0.00±0.00 ^a	2.10±0.02 ^a	4.50±0.11 ^b
Wet	70.42±0.06 ^b	18.05±0.08 ^b	2.02±0.02 ^b	0.00±0.00 ^a	2.09±0.01 ^a	7.43±0.11 ^a

Data are presented as mean ± SEM

^{a, b} Mean values with different superscripts within a column differ significantly ($P < 0.05$)

The mineral contents of *P. regius* for the dry and wet seasons showed varied concentrations as shown in Figure 5. Sodium was the most abundant (364.51 and 355.013 mg/100g) followed by potassium (257.98 and 303.751 mg/100g) and then calcium (91.94 and 83.472 mg/100g) for the dry and wet seasons respectively.

Copper was the least abundant element in both seasons whereas magnesium and phosphorus were higher in the dry season and lower in the wet season. Conversely, zinc and iron were more abundant in the wet season and lower in the dry season.

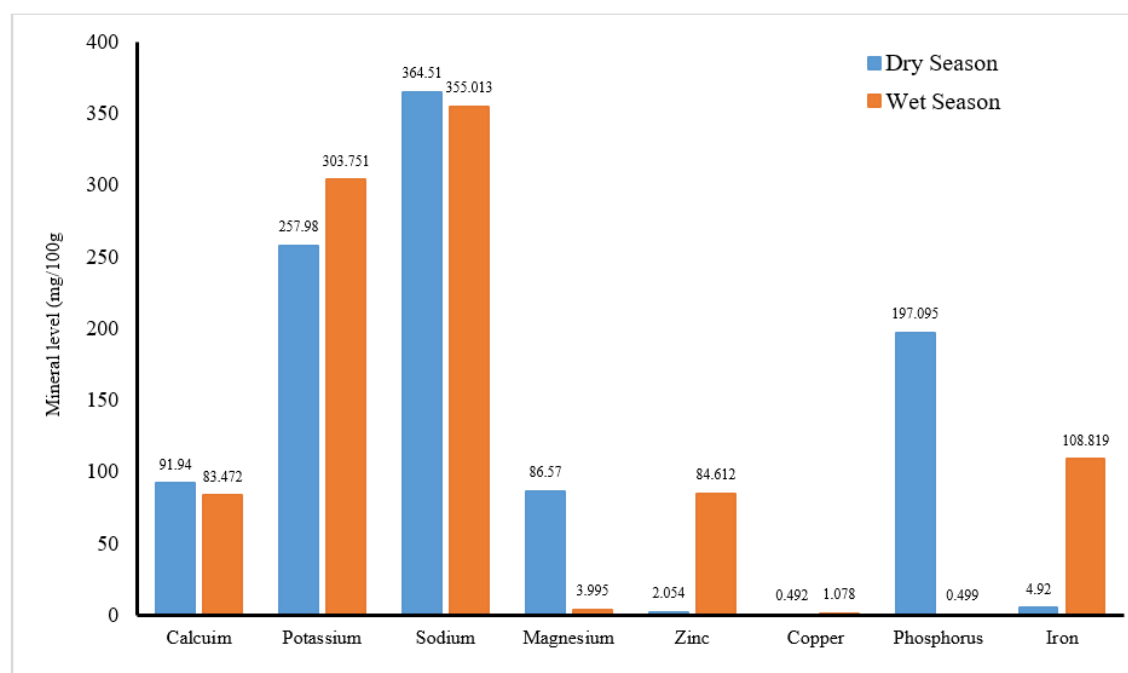


Fig. 5: Mineral contents of *P. regius* for dry and wet seasons

DISCUSSION

The result from the morphometric characters showed that the female lobster is larger based on length while the males are bigger in terms of weight. Though, it could be deduced that there is no much variation in the morphometric characters, which is an indication that the male and female species of the lobster are adapting well in the environment. This is similar to the findings of Freitas *et al.* (2007), Akinwunmi and Lawal-Are (2018) and García-Rodríguez and Pérez-Vázquez (2023). The length and weight relationship of *Panulirus regius* showed a negative allometric growth ($b < 3$) indicating that the

lobster weight increases at a slower rate, relative to length. This is in tandem with the works of Waiho *et al.* (2021) and De Boeck and Kristensen (2022) who posited an allometric growth patterns in *Panulirus polyphagus* and *Palinurus elephas* respectively. The coefficient of determination (R^2) values showed a strong positive correlation ($r = 0.9271$, $R^2 = 0.8596$) between total length and weight in the lobster species, which indicate an increase in length resulting to an increase in weight of the organism which is similar to the report of Lawal-Are and Adefule (2017).

The overall mean values in the condition factor for the

females, males and the combined sexes of the lobster were 1 and more. This is in tandem with the work reported by Rossiter and Ansyari (2021), Szalkiewicz *et al.* (2022) and Akinwunmi *et al.* (2024) which implies that an aquatic organism could be said to be in a good condition when the K-value is equal to 1 or more. Besides, this also gave an indication of the overall well-being, adequate feeding intensity and reproductive behaviour of the species. From this study, the male lobster had higher K value compared to the females. This might be due to the fact that the female lobster recently spawned prior to samples collection. Apart from this, the morphometric characters obtained in this study showed that the males are bigger in terms of weight than the females. This conforms to the work of Situmorang *et al.* (2021) on *P. versicolor*, who reported that the mean condition factor of the males were more than that for the females for the samples collected from Tanjung Kasuari and Makbon waters.

The stomach contents analysis revealed that crustacean shells were the most abundant food item. This finding suggests that these lobsters frequently consume crustaceans, which could include both prey and conspecifics, possibly indicating cannibalistic behavior, especially during ecdysis when lobsters are more vulnerable. These results align with Amin *et al.* (2022), who observed that zooplankton (crustaceans) were the main food items for ornate spiny lobsters at early developmental stages, indicating their role as possible diets for the larvae. Though, according to Briones-Fourza *et al.* (2003), crustaceans, particularly hermit crabs and brachyurans, alongside gastropods, formed the dominant food items in all juvenile stages of *Panulirus argus* while Lawal-Are and Adefule (2017) reported worms, parts of fish, crabs, sea urchins and lobster to be found in the stomach of *Panulirus regius*.

The sex ratio analysis showed a male-biased population, with no significant difference ($P > 0.05$) in the males and females. This variation in sexes is not unusual but can stem from a variety of factors, such as habitat conditions, differences in mortality rates, fishing pressures, migration patterns, and reproductive behaviors. These findings negate the work of Lawal-Are and Adefule (2017) but corroborated the works of Freitas *et al.* (2007) and Jawahar *et al.* (2014) on *Panulirus regius* from the north-western Cape Verde Islands and *Panulirus homarus* from the South-eastern Coast of India respectively.

The findings on the proximate composition revealed significant variations ($P < 0.05$) in the various nutritional components for the dry and wet seasons. All the nutrient parameters except CHO were high during the dry compared to the wet season, though crude fibre was absent in the species in both seasons. This variation might be due to differences in food availability or nutritional intake across the seasons. The findings of Moruf *et al.* (2021) on moisture content does not support the values recorded in this study, while the result from the protein content corroborates with the findings of Akinwunmi *et al.* (2023) on some shrimp species.

The mineral composition revealed varied concentrations regardless of the seasons, which is not in tandem with the work reported by Moruf *et al.* (2021). The trend in terms of abundance in sodium, potassium and calcium in the species agrees with the work of Akinwunmi *et al.* (2023) on some shrimp species. The levels of potassium, zinc, iron and copper were higher in the wet season while calcium, sodium, magnesium and phosphorus concentrations were elevated in the dry season. The variations observed could be attributed to several factors as the availability and absorption of these minerals may be mainly influenced by seasonal changes in the environment and diet of the lobster. The observed differences highlight the need for further research to explore the underlying mechanisms driving these seasonal variations and to ensure that optimal conditions are maintained for the health and sustainability of lobster populations.

CONCLUSION

The results obtained from this study indicate that *P. regius* is a rich source of protein and essential minerals, underscoring its nutritional importance which makes it an ideal food source for maintaining human health and preventing deficiencies in individuals of all age groups.

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AUTHORS CONTRIBUTION

AMF conceptualized, designed and analyzed the generated data; GTA and TO collected the data, performed the experiment, analysed the data and wrote the original draft of the manuscript. AMF reviewed the original draft, edited and participated in writing final draft while all authors read and approved the final manuscript for submission.

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