PROXIMATE, MINERAL AND MINERAL SAFETY INDEX OF *ACANTHURUS MONROVIAE* AND *LUTJANUS GOREENSIS* FISHES

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(Received on Date: 28TH October 2015 Date of Acceptance : 26th December 2015)

ABSTRACT

Two types of lagoon fish: *Acanthurus monroviae* and *Lutjanus goreensis* were used for this study. Proximate and mineral compositions were analysed for in them and the mineral safety index were then calculated from the mineral values. The proximate values were very high at 65.4-68.5 g/100 g (protein), moderate in moisture, crude fat, carbohydrate and total ash but significantly low in crude fat, carbohydrate and total ash but significantly low in crude fibre (0.80-0.90 g/100 g). The coefficient of variation percent (CV %) values were generally low at 3.22-13.6 but proximate values were generally significantly different at r =0.01. The total energy from carbohydrate, fat and protein was high and close at 1438-1442 kJ/100 g and CV % of 0.162-0.208 being mostly contributed by protein at 1112-1164 kJ/100 g (77.1-80.9 %). Utilization of 60 % of energy due to protein was high at 46.3-48.5 at CV % of 3.38. The general CV % were low (0.162-13.6) and significant difference also existed at $r_{=0.01}$. The mineral levels were high in K (392-419 mg/100 g) and P(219-269 mg/100 g); moderate in Ca (15.0-15.6 mg/100 g), Mg (27.2-36.0 mg/100 g) and Na (51.0-63.8 mg/100 g) but low to very low in Zn, Fe (low) and Co, Mn, Pb and Se (very low). The mineral CV % ranged from low to high (2.73-117), significant difference at $r_{= 0.01}$ also occurred. These mineral ratios were good: Na/K, K/Na and [K/(Ca+Mg)] with general low CV % (7.89-22.5) and being significantly different ($r_{= 0.01}$). All calculated mineral safety index were lower than the standard (hence no mineral overload), with significant difference existing at $r_{= 0.05}$.

Keywords: Proximate, minerals, *Acanthurus monroviae*, *Lutjanus goreensi*

No of Tables:11 **No of References:35**

INTRODUTION

The extreme variability of composition of different species of fish accounts to some extent for the large variety of dishes that can be made from them; unfortunately fish are all too often lumped together in one category although there is a much greater difference in composition, flavour and texture and this range is even wider when shellfish are included when compared to herring, haddock, hallbut and salmon (Murray and Burt, 2001). Fish is known for its high nutrition due to its high protein content, phospholipids and polyunsaturated fatty acids as well as the covering percentage of the essential minerals RDA/RDI (recommended daily allowance/intake) (Simopoulos, 2002). The protein content for meat and for fish is roughly comparable. The processor, the nutritionist and the consumer all have a direct interest in the composition of fish. The processor needs to know the nature of the raw material; the nutritionist wants to know what contribution fish can make to the diet and to health; and the cook must know whether a particular fish tastes good and whether it is nutritious (Murray and Burt, 2001).

The two types of lagoon fish involved in this study were *Acanthurus monroviae* and *Lutjanus goreensis*

First is: *Acanthurus monroviae* Steindachner, 1876 has a taxonomic serial no. 172286.;Taxonomic Hierarchy (Eschmeyer, 1989):Kingdom: Animalia-Animal, animaux, animals ;Subkingdom: Bilateria;Infrakingdom: Deuterostomia;Phylum: Chordata-cordés, cordado, chordates;Subphylum: Vertebrata-vertebrado, vertébrés, vertebrates;Infraphylum: Gnathostomata;Superclass: Osteichthyes-bony fishes, poissons osseux, osteíceto, peixe ósseo;Class: Actinopterygii-ray-finned fishes, spiny rayed fishes, poisson épineux, rayonnées poissons nagetires rayonnées ; Subclass : Neopterygii neoptery gians;Infraclass: Teleostei; Superorder: Acanthopterygii;Order: Perciformes-perch-like fishes; Suborder: Acanthuroidei-surgeon fishes ;Family: Acanthuridae-surgeon fishes, tangs, cirujanos, poisons-chirurgiens;Genus: *Acanthurus* Forsskål, 1775-lance fishes, surgeon fishes, tangs, doctor fishes, common surgeon fishes; Species: *Acanthurus monroviae* Stein dachner, 1876-surgeonfish

In Nigeria the fish is given various Nigerian local names. It is a rare fish of maximum 30 cm (Federal Ministry of Science and Technology, 1975).

Second fish is:

Lutjanus goreensis Valenciennes, 1830.

Synonym: *Lutjanus guineensis* Bleeker, 1863

Family: Lutjanidae

Genus: *Lutjanus* -red snapper

Species: *Lutjanus goreensis* Valenciennes, 1830 -red snapper

FAO names: English Gorean snapper; French (Vivaneau de Gore); Spanish Pargo de Gorea.

Its environments are marine; freshwater; brackish; reef-associated; depth range 0-

50 m. Tropical; 34 °N-17 °S, 27° W-14 °E. Physical characteristics: max length: 80.0 cm TL male/ unsexed; common length: 50.0 cm TL male/unsexed. Morphometrics: dorsal spines (total):10; dorsal soft rays (total): 14; anal spines:3; anal soft rays: 8. Head pointed, dorsal profile of forehead steep. Preorbital bone broad, maxilla extending to about mid-eye level. Pectoral fins of adult not reaching level of anus. Scale rows on back parallel to lateral line. Scale rows on cheek 5 or 6. Presence of narrow blue band or row of broken spots below eye. Small specimens from shallow water mainly brownish. In distribution; eastern atlantic: mainly between Senegal and the Republic of Congo; also from Cape Verde. Adults occur on rocky bottoms and in the vicinity of coral reefs. Young are frequently encountered in coastal waters, particularly estuaries and sometimes in rivers. They feed mainly on fishes and bottom-dwelling invertebrates. It is commonly seen in markets, usually fresh. It is caught with hand lines, traps and gillnets (Allen, 1985). Work already published on these two types of fish is on the investigation of the lipids compositions (fatty acids, phopholipids and sterols) of their muscle (Adeyeye, 2015a). The main aim of the present report was the determination of proximate and mineral compositions and the calculation of the mineral safety index (of appropriate minerals) of the two fish types. There is paucity of information on chemical composition of the two fish types from literature. This report might improve information on the food composition table of the fishes.

MATERIALS AND METHODS

Wet samples of the fishes were collected from fish trawlers from the Lagos lagoon, the samples were brought to the laboratory under ice cover. The samples were identified in the Department of Zoology of the Ekiti State University, Ado-Ekiti. The samples were opened up in the laboratory; oven-dried till constant weight; fins, bones and viscera were removed and further oven-dried at 55 °C until constant weight. The cooled dried samples were ground using mortar and pestle into fine powder. Two fish samples (of each type) were used for this exercise and the ground portions were kept in plastic containers in the laboratory freezer pending analyses.

The micro-Kjeldahl method (Pearson, 1976) was followed to determine the crude protein. The crude fat was extracted with chloroform/methanol (2:1 v/v) mixture using Soxhlet extraction apparatus (AOAC, 2005). Moisture, ash and crude fibre determination followed AOAC (2005) methods while carbohydrate was determined by difference. The calorific values in kilojoule (kJ) and kilocalorie (kcal) were calculated by multiplying the crude fat, protein and carbohydrate by Atwater factor of (kJ/kcal) 37/9, 17/4 and 17/4 respectively. Determinations were in duplicate. The minerals were analysed from the solution obtained by first dry ashing the samples at 550 °C. The filtered solutions were used to determine Na, K, Ca, Mg, Zn, Fe, Mn, Cu, Pb, Co and Se by means of atomic absorption spectrophotometer (Buck Scientific Model- 200 A/210, Norwalk, Connecticut 06855) and phosphorus was determined colorimterically by Spectronic 20 (Gallenkamp, UK) using the phosphovanado molybdate method (AOAC, 2005). All chemicals used were of British Drug House (BDH, London, UK) analytical grade. The detection limits for the metals in aqueous solution had been determined previously using the methods of Varian Techtron (1975). The optimal analytical range was 0.1-0.5 absorbance units with coefficients of variation from 0.9 %-2.21 %. Ratios of Ca/P, Na/K, K/Na, Ca/Mg, and the milliequivalent ratio [K/(Ca +Mg)] were all calculated (Hathcock, 1985); also calculated was the mineral safety index (MSI) (Hathcock, 1985) of Na, Mg, P, Ca, Fe, Se, Zn and Cu using the formula:

Calculated MSI = MSI/RAI x Research data result

where MSI = mineral safety index table (standard); RAI = recommended adult intake.

The statistical analyses carried out included determination of mean, standard deviation (SD), coefficient of variation in per cent (CV %). The linear correlation coefficient (Pearson r), variance (r_{xy}^2) and regression coefficient (R_{xy}) were calculated whilst r_{xy} was subjected to the Table (critical) value of r $_{= 0.01}$ to see if significant differences existed in the values of the proximate and mineral compositions as well as in the mineral safety index results (Oloyo, 2001). Further calculated for the three major determinations were coefficient of alienation (C_A) and index of forecasting efficiency (IFE) (Chase, 1976) using the following formulae:

$C_A = \sqrt{1-(rxy)2}$, IFE = $(1 - \sqrt{1-(rxy)2})$ x 100

RESULTS AND DISCUSSION

Table 1 shows the proximate values of *Acanthurus monroviae* (M_{22}) and *Lutjanus goreensis* (M_{33}) on dry weight basis. Results of major significance were (g/100 g dry weight): protein (65.4-68.5) with CV % of 3.22; moisture (11.5-13.2) with CV % of 9.88 and total ash (8.58-9.10) with CV % of 4.16. Moderate proximate values came from (g/100 g): crude fat (5.15-6.25, CV % = 13.6) and carbohydrate (4.95-5.80, CV % = 11.2) but very low in fibre at 0.80-0.90 g/100 g (CV % = 8.32). All CV % levels were generally low at 3.22-13.6.The calculation of the organic matter (OM) gave values of (g/100 g): 91. 42 (M_{22}) and 90.9 (M_{33}) with CV % (0.403). These values were higher than the literature values in *Callinectes latimanus* (71.4 g/100 g) (a lagoon crab-shellfish) (Adeyeye et al., 2014), the values reported for four fresh water finfishes of *Mormyrops delicious* (86.4 g/100 g), *Bagrus bayad* (75.0 g/100 g), *Synodontis budgetti* (84.0 g/100 g) and *Hemischronis fasciatus* (76.0 g/100 g) (Abdullahi and Abolude, 2002), close to the OM value in trunk fish (91.07 g/100 g) (Adeyeye and Adamu, 2005) but lower than the OM in ostrich muscles (98.97 g/100 g) (Sales and Hayes, 1996). The crude fat when subjected to fatty acid values [crude fat x 0.70; Paul and Southgate (1978)] gave values of 4.38 g/100 g (M_{22} and 3.61 g/100 g (M_{33}) and a ratio of muscle to muscle as 1.21:1.00 (total fatty acids) *A. monroviae* and *L. goreensis* respectively. The crude fat of values of 5.15-6.25 g/100 g was close to the value of 7.48 g/100 g of the skin of *Pellanula afzeliusi* (Adeyeye and Oyarekua, 2011) and the value of 7.40 g/100 g in the skin of barracuda fish (Adeyeye et al., 2012); also the total calculated FA values range of 3.61-4.38 g/100 g were also close to the value in the skin of *P. afzeliusi* (5.23 g/100g) (Adeyeye and Oyarekua, 2011) and skin of barracuda (5.18 g/100 g) (Adeyeye et al, 2012). Both the crude fat and total FAs results were close with each parameter having low values of CV % (13.6) in each case. The low values of the crude fat in the muscle shows that both fish samples are white fish, that is fish in which the fat is confined mainly to the liver (Adeyeye, 2015a). The crude fat content gave an indication that the samples would

Table 1: Proximate composition (g/100 g edible portion) of *Acanthurus monroviae* (M_{22}) and *Lutjanus goreensis* (M_{33}) on dry weight basis

Parameter	**M_{22}**	**M_{33}**	**Mean**	**SD**	**CV %**
Crude fat	6.25	5.15	5.70	0.778	13.6
Crude protein	65.4	68.5	66.9	2.16	3.22
Carbohydrate	5.80	4.95	5.38	0.601	11.2
Total ash	8.58	9.10	8.84	0.368	4.16
Crude fibre	0.80	0.90	0.850	0.071	8.32
Moisture	13.2	11.5	12.3	1.22	9.88

Table 2: Statistical analysis of the results from Table 1

Statistics	***A. monroviae***		***L. goreensis***
r_{xy}		0.9993	
r_{xy}^2		0.9986	
R_{xy}		-0.9642	
Mean	16.7		16.7
SD	24.2		25.6
CV %	145		154
C_A		0.0377	
IFE		0.9623	
Remark		*	

r_{xy} = correlation coefficient; R_{xy} = regression coefficient; C_A = coefficient of alienation; IFE = index of forecasting efficiency; * = results significantly different at n-2 (df) and $r_{=0.01}$.

Table 3: Proportion of percentage energy contribution from fat, protein and carbohydrate to total energy

Parameter	M_{22}	M_{33}	Mean	SD	CV %
Total energy					
(E in kJ/100 g)	1442	1438	1440	2.33	0.162
(E in kcal/100 g)	341	340	341	0.707	0.208
PEF % (E in kJ/100 g)	16.0 (231)	13.2 (191)	14.6	1.97	13.5
(E in kcal/100 g)	16.5 (56.3)	13.6(46.4)	15.1	2.05	13.6
PEP % (E in kJ/100 g)	77.1 (1112)	80.9 (1164)	79.0	2.67	3.38
(E in kcal/100 g)	76.7(262)	80.5 (274)	78.6	2.69	3.42
PEC % (E in kJ/100 g)	6.84 (98.6)	5.85(84.2)	6.34	0.699	11.0
(E in kcal/100 g)	6.80 (23.2)	5.82 (19.8)	6.31	0.693	11.0
UEDP %	46.3	48.5	47.4	1.60	3.38

PEF = proportion of total energy due to fat.;PEP = proportion of total energy due to protein.;PEC = proportion of total energy due to carbohydrate.;UEDP = utilization of 60 % of PEP %.

Table 4: Statistical analysis of the results from Table 3

Statistics	*A. monroviae*		*L. goreensis*
r_{xy}		0.9994	
r_{xy}^2		0.9988	
R_{xy}		-2.58	
Mean	36.6		37.1
SD	31.9		34.6
CV %	87.1		93.2
C_A		0.0012	
IFE		0.9988	
Remark		*	

Table 5: Mineral composition (mg/100 g dw) of *Acanthurus monroviae* (M_{22}) and *Lutjanus goreensis* (M_{33})

Parameter	**M_{22}**	**M_{33}**	**Mean**	**SD**	**CV %**
Fe	0.376	0.684	0.530	0.218	41.1
Cu	0.005	0.001	0.003	0.003	110
Co	0.0007	0.0011	0.0009	0.0003	31.4
Mn	0.009	0.0008	0.005	0.006	117
Zn	0.615	0.432	0.524	0.130	24.8
Pb	0.0003	0.0005	0.0004	0.0001	35.4
Ca	15.6	15.0	15.3	0.417	2.73
Mg	27.2	36.0	31.6	6.25	19.8
K	392	419	405	18.6	4.59
Na	51.0	63.8	57.4	7.58	13.2
P	269	219	244	34.9	14.3
Se	0.012	0.048	0.030	0.025	83.0

Table 6: Statistical analysis of the results from Table 5

Statistics	***A. monroviae***		***L. goreensis***
r_{xy}		0.9907	
r_{xy}^2		0.9815	
R_{xy}		0.5176	
Mean	63.0		62.8
SD	129		128
CV %	204		204
C_A		0.1359	
IFE		0.8641	
Remark		*	

Table 7: Calculated mineral ratios of *Acanthurus monroviae* (M_{22}) and *Lutjanus goreensis* (M_{33})

Parameter	**Standard**	**M_{22}**	**M_{33}**	**Mean**	**SD**	**CV %**
Na/K	0.60	0.130	0.153	0.141	0.016	11.3
K/Na	5.0	7.69	6.56	7.12	0.801	11.2
Ca/P	≥0.5	0.058	0.068	0.063	0.007	11.6
Ca/Mg	1.0	0.574	0.416	0.495	0.111	22.5
[K/(Ca + Mg)]	2.2	18.4	16.4	17.4	1.37	7.89

Table 8: Statistical analysis of the results from Table 7

Statistics	***A. monroviae***		***L. goreensis***
r_{xy}		0.9998	
r_{xy}^2		0.9996	
R_{xy}		-0.0610	
Mean	5.36		4.72
SD	7.95		7.09
CV%	148		150
C_A		0.0004	
IFE		0.9996	
Remark		*	

Table 9: Mineral safety index (MSI) of Na, Mg, P, Ca, Fe, Se, Zn, Cu of *Acanthurus monroviae* (M_{22}) and *Lutjanus goreensis* (M_{33})

Mineral	RAI	TV of MSI	M_{22}			M_{33}		
			CV	D	%D	CV	D	%D
Na	500 mg	4.80	0.490	4.31	89.8	0.613	4.19	87.2
Mg	400 mg	15.0	1.02	14.0	93.2	1.35	13.6	91.0
P	1200mg	10.0	2.24	7.76	77.6	1.83	8.17	81.7
Ca	1200mg	10.0	0.130	9.87	98.7	0.125	9.88	98.8
Fe	15mg	6.70	0.168	6.53	97.5	0.305	6.39	95.4
Se	0.070mg	14.0	2.48	11.5	82.3	9.52	4.48	32.0
Zn	15mg	33.0	1.35	31.6	95.9	0.950	32.1	97.1
Cu	3mg	33.0	0.053	32.9	99.8	0.007	33.0	100

CV = calculated value; TV = Table value; D = difference; RAI= recommended adult intake. No MSI standard for K, Mn, Co and Pb.

Table 10: Descriptive statistics in mineral safety index values of *Acanthurus monroviae* (M_{22}) and *Lutjanus goreensis* (M_{33})

Mineral	M_{22}	M_{33}	Mean	SD	CV %
Na	0.490	0.613	0.551	0.087	15.8
Mg	1.02	1.35	1.18	0.235	19.8
P	2.24	1.83	2.03	0.291	14.3
Ca	0.130	0.125	0.127	0.003	2.73
Fe	0.168	0.305	0.237	0.097	41.1
Se	2.48	9.52	6.00	4.98	83.0
Zn	1.35	0.950	1.15	0.286	24.8
Cu	0.053	0.007	0.030	0.033	110

Table 11: Statistical analysis of the results from Table 10

Statistics	*A. monroviae*		*L. goreensis*
r_{xy}		0.7592	
r_{xy}^2		0.5763	
R_{xy}		-0.6445	
Mean	0.9913		1.84
SD	0.9602		3.17
CV %	96.9		172
C_A		0.6509	
IFE		0.3491	
Remark		*	

* = results significantly different at n-2 (df) and $r_{=0.05}$.

be good for people avoiding animal protein with high level of fat.The protein content of 65.4-68.5 g/100 g was much higher than the literature values of some shellfishes: *Callinectes pallidus* (24.38 %), *Cardisoma armatum* (23.94 %) (Elegbede and Fashina-Bombatta, 2013); *Callinectes latimanus* (19.1 g/100 g) (Adeyeye et al, 2014); protein values were g/100 g: 32.5 (whole body), 24.8 (flesh) and 24.2 (exoskeleton) from the male body of *Sudananautes africanus africanus* (Adeyeye and Kenni, 2008); 17.2 (whole body), 18.3 (endoskeleton) and 19.1 (exoskeleton) from the body of *Pandalus borealis* (Adeyeye, 2015b), however falling within the group of 18.40-87.57 g/100 g from various parts of male and female West African fresh water crab *S. africanus africanus* (Adeyeye, 2002). The ash level of 8.58-9.10 g/100 g would only result in average levels of minerals in the samples. The very high level of protein might have resulted in the moderate levels of crude fat, carbohydrate and ash. The very low level of crude fibre was close to that of *C. latimanus* where fibre was not detected. In Table 2 is depicted the statistical evaluation of the results in Table 1. Both correlation coefficient (r_{xy}) and variance or coefficient of determination (r_{xy}^2) were high at respective values of 0.9993 and 0.9982. The regression coefficient showed that for every one unit of increase in the proximate value of *A. monroviae*, there was a corresponding decrease of -0.9642 in *L. goreensis*. Both samples had a total mean value of 16.7 g/100 g each with close standard deviation (SD) but slightly different but high CV % (145-154) showing the spread of the proximate values. The coefficient of alienation or non-relationship (C_A) was low at 0.0377 (3.77 %) but high index of forecasting efficiency (IFE) with a value of 0.9623 (96.23 %). The IFE is a value for the reduction of error in the prediction of relationship between *A. monroviae* and *L. goreensis*. This meant 100-96.23 =3.77 % (error of prediction); the prediction here was easy because the error was just 3.77 %. The IFE showed that *A. monroviae* can carry out all the biochemical functions of *L. goreensis* and vice versa. Significant differences existed in the results at $r_{=0.01}$.

In Table 3, we have the proportion of percentage energy contributed by fat, protein and carbohydrate to total metabolizable energy. Total metabolizable energy range was 1438-1442 kJ/100 g (1.438-1.442 MJ) or 340-341 kcal/100 g with both kJ and kcal values being very close with CV % range of 0.162-0.208. The energy values were higher than in *C. latimanus* (1142 kJ/100 g) (Adeyeye et al, 2014); close to 1.61-1.71 MJ /100 g from eight organs of guinea-fowl (Adeyeye and Adesina, 2014) but lower than in sheep lean meat (2.06 MJ/100 g) and lean pork (2.29 MJ/100 g) (Fornias, 1996). The energy obtained was also within the range of 1.3-1.6 MJ/100 g obtained from cereals (Paul and Southgate, 1978) showing the samples to be good sources of energy. Protein contributed the highest energy values (1112-1164 kJ/100 g or 77.1-80.9 %) with PEF % > PEC %. The daily energy requirement for an adult is between 2500-3000 kcal depending on his physiological state while that of infants is 740 kcal (Bingham, 1978). This meant that 733-880 g (adults) and 220 g (infants) of *A. monroviae* would be needed for full energy production whereas 735-882 g (adults) and 221 g (infants) of *L. goreensis* would supply total energy requirement. These weights were lower than from *C. latimanus* (915 g, adults minimum) and (271 g, infants) (Adeyeye *et al*, 2014); 786-944 g (muscle) and 761-913 (skin) of turkey to meet adults requirement but 233 g (muscle) and 325 g (skin) in infants (Adeyeye and Ayejuyo, 2007) but close to the values for guinea-fowl organs: 649-733 g (adult man) and 192 g (infants) (Adeyeye and Adesina, 2014). The utilizable energy due to protein (UEDP %) was high at a range of 46.3-48.5 (assuming 60 % of protein energy utilization). This is higher than the recommended safe level of 8 % for adult man who requires about 55 g protein per day with 60 % utilization. From literature, UEDP % was 56.4 (turkey muscle), 40.0 (skin of turkey) (Adeyeye and Ayejuyo, 2007) whereas values were 12.1-28.8 % (female and male exoskeletion), 12.5-23.5 % (female and male flesh) and 13.8-17.9 % (female and male whole body) of *S. africanus africanus* (Adeyeye et al, 2010). The UEDP % of 46.3-48.5 might be far more than enough to prevent energy malnutrition in children and adult fed solely on the samples as the main sources of protein. The samples may also be used to fortify or supplement protein deficient cereal products. The PEF % value of 13.2-16.0 is generally low and below the recommended level of 30 % (NACNE, 1983) and 35 % (COMA, 1984) for total fat intake, this could be very useful for people wishing to adopt the guidelines for a healthy diet. The statistics in Table 4 showed that the percentage energy distributions had high values of r_{xy}, r_{xy}^2, high negative R_{xy} (-2.58), close mean and CV %, very low C_A but very high IFE with overall results being significantly different at $r_{=0.01}$.

It is known that appreciable shifts in the tissue compartments, water, fat and protein frequently accompany changes in the dietary, nutritional status and age of an animal (Cowgill, 1958). Water is indispensable for the efficient utilization and conservation of food within the body (Snively and Wessner, 1954), this is because the water content of the body changes with the type of diet (White House Conferences, 1932). This important connection of water with other food substances is the fact that the biochemical basis for this relationship arises from the fact that the water deficit created by protein metabolism is about seven times that for equivalent calories of carbohydrate or fat. Hence, in young children an increase in calories from carbohydrate causes hydration; whereas an increase in calories from proteins causes dehydration (Pratt and Snyderman, 1953). The increased output of ketones and acids which accompanies a shift to high-fat diets is associated with increased water loss which can be offset by an increase in carbohydrate intake. Protein quality also influences the degree of tissue hydration. Grams of water needed for complete metabolism of 100 calories of some food substances had been given by Albanese (1959). Food material (protein, starch and fat) all have performed water of 0.00 in each case; gained by oxidation: 10.3 (protein), 13.9 (starch) and 11.9 (fat); lost in dissipating heat: 60.0 for each of the food material; lost in excreting end products (1 calorie of protein requires 30 ml of water for the excretion of the urea and sulphate formed from it, 1 g of ash requires 65 ml of water for its excretion): 300 (protein), both 0.00 in starch and fat; deficit: 350 (protein), 46 (starch) and 48 (fat). From Table 3, 262 kcal/100 g energy from *A. monroviae* protein would require 786 ml of water for complete metabolism whereas *L. goreensis* protein of 274 kcal/100 g energy would require 822 ml of water for complete metabolism. Hence, whereas *A. monroviae* would have water deficit of 917, *L. goreensis* would have water deficit of 959 ml (since 100 Calories have a water deficit of 250 ml). This means that a lot of water (just below one litre) would always be needed for consumption in taking the diet containing these fishes, although water deficit in *A. monroviae* < water deficit in *L. goreensis*.

In Table 5, minerals of major significant levels were only P (219-269 mg/100 g) and K (392-419 mg/100 g); those of moderate values were Ca, Mg and Na, those of low values were Fe and Zn whereas those with values of < 1.0 mg/100 g each were Cu, Co, Mn, Zn, Pb and Se. These minerals: Fe, Cu, Co, Mn, Zn, and Se would have to be sourced from other protein (animal) sources when these fish samples serve as the main source of animal protein. The very low level of Pb (0.0003 - 0.0005 mg/100 g in the samples could be) cheering but that it was detected could be due to onset of pollution. The values of Ca, Mg and Na were just to add to other major sources of the mentioned minerals. If the amount of Ca is adequate in the diet, Fe is utilized to better advantage; this is an instance of 'sparing action' (Fleck, 1976) but both minerals were low in the samples.

Phosphorus is always found with Ca in the body, both contributing to the supportive structures of the body. It is present in cells and in the blood as soluble phosphate ion, as well as in lipids, proteins, carbohydrates and energy transfer enzymes (NAS, 1974). Phosphorus is an essential component in nucleic acids and the nucleoproteins responsible for cell division, reproduction and the transmission of hereditary traits (Hegsted, 1973). Potassium is primarily an intracellular cation, in large part this cation is bound to protein and with sodium influences osmotic pressure and contributes to normal pH equilibrium (Sandstead, 1967). Plants and animal tissues are rich sources of potassium, thus a dietary lack is seldom found. The mineral values in Table 5 were subjected to statistical analysis as shown in Table 6. The r_{xy} was positively high and significant at $r_{=0.01}$; these other values were high: r_{xy}^2, R_{xy} (0.5176), mean, SD, CV % and IFE putting the samples into a position of where each can perform the biochemical functions of the other.

The ratios of some of the minerals are shown Table 7. The Ca/P values ranged from 0.058-0.063 which were lower than 0.5 required minimum ratio for favourable Ca absorption in the intestine for bone formation (Nieman *et al*, 1992). The Ca/P ratio is reported to have some effects on Ca in the blood of many animals (Adeyeye and Faleye, 2007); therefore for better Ca/P ratio, more Ca would have to be consumed from other food sources. The Na/K was low and good at values of 0.130-0.153 being much less than 0.60 which is the ratio that favours none enhancement of high blood pressure disease in man (Nieman *et al,* 1992). The K/Na level of 6.56-7.69 was better than the standard of 5.0, hence optimal health would be maintained. The expected value of Ca/Mg is 1.0 but the values here ranged from 0.416-0.574, both Ca and Mg would need adjustment for good health to be attained. The [K/(Ca + Mg)] values of 16.4 to 18.4 were much greater than 2.2; the high values of milliequivalent were due to low Ca and Mg and high level of K. The results in Table 8, gave high and significant value for r_{xy}, high value for r_{xy}^2, low negative value for R_{xy} (-0.0610), low levels of mean and SD but very high values for CV %. Also the C_A was very low at 0.0004 with corresponding high value for IFE (0.9996 or 99.96 %).

The mineral safety index (MSI) as calculated for the samples is in Table 9. The standard MSI for the minerals are Na (4.8), Mg (15), P(10), Ca (10), Fe (6.7), Zn (33), Cu (33) and Se (14). The explanation of the MSI can be understood as follows taking Ca as an example: the recommended adult intake (RAI) of Ca is 1,200 mg, its minimum toxic dose (MTD) is 12,000 mg or 10 times the recommended daily average (RDA) which is equivalent to MSI of Ca. This reasoning goes for the other minerals whose MSI were determined. All calculated MSI values were all lower than the standard MSI values giving positive differences as shown in Table 9. In M_{22}, the differences ranged from 4.31-32.9 and percentage range of 77.6-99.8 %; in M_{33}, differences ranged from 4.19-33.0 and percentage range of 32.0-100. The calculated MSI < standard MSI meant that non of the minerals would constitute mineral overload or become toxic to the samples consumers. Table 10 only depicts the descriptive analysis of the MSI values giving the mean, standard deviation and coefficient of variation percent values. The MSI values were highly varied between the two samples resulting in CV % that ranged from 2.73-110. The statistical analysis in Table 11 came from the results in Table 10. It could be noticed that r_{xy}, r_{xy}^2, mean, SD and IFE were much lower than the earlier values from Tables 2, 4, 6 and 8. On the other hand these values were much higher than previous values: R_{xy} (-0.6445) and C_A (0.6509). The CV % also ranged very high at 96.9-172. Result was only significant at $r_{=0.05}$ unlike others that were significant at $r_{=0.01}$. Also the prediction of relationship between the MSI values of the two fishes was difficult because reduction of error of prediction of relationship was low at 34.91 % coupled with non-relationship value of 65.09 %.

CONCLUSION

The samples of *Acanthurus monroviae* and *Lutjanus goreensis* have good nutritional properties. They were high in protein, moderate in ash, fat and cabohydrate. Source of high energy from protein that could prevent protein energy malnutrition (PEM), low level of energy from fat thereby preventing heart diseases and high energy utilization due to protein. Most minerals were either low or within the normal average intake of man. Both Na/K and K/Na values were good for human health. MSI values showed that no mineral could overload the body for any deleterious effects. It is however noted that for all the major parameters determined, significant differences existed between the values of *A. monroviae* and *L. goreensis* and with high index of forecasting efficiency value (except in MSI), it was easy to predict the relationship between the two types of fish.

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