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RESEARCH PAPER

Fish Food and Community Health: An Assessment of the Contribution of Capture Fisheries to Nutritional Needs of Households in Nigeria

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Abstract

Capture fisheries has been a major source of animal protein to households in Nigeria especially among low income households and riverine rural communities. This study evaluated the potential contribution of captured fishes to meeting the recommended nutrient intakes (RNIs) of various population groups in consumer households. Results of nutritional composition of *Clarias gariepinus, Synodontis schall* and *Tilapia zillii* indicate that the fish species are good sources of animal protein (15.87 – 17.64%), fish oil (1.74 – 6.53%) and micronutrients (1.54 – 8.24 mg/100g). The low per capita consumption of fish as food in Nigeria (8.39 kg) has led to the poor contribution (≤ 25%) of these fishes to the average daily recommended nutrient intake (RNI) of calcium, iron, and zinc in adults, pregnant and lactating women (PLW) and children. Estimations of RNI showed increasing percentage contribution with increasing per capita consumption of fish among various population groups. The need for increased fish consumption among the various population groups in Nigeria (>30 kg per capita); investments in community based aquaculture of commercial fish species and dietary inclusion of other food sources with good quantities of nutrients are recommended to ameliorate malnutrition and undernutrition especially among the vulnerable group of consumers.

Introduction

Globally, the consumption of fish is highly recommended in resolving human nutrient deficiencies especially in rural areas and low income economies, as fish is largely acknowledged as one of the healthiest, affordable and accessible source of animal protein. In Nigeria, the importance of fish in the sustainability of animal protein supply cannot be over emphasized as fish is an irreplaceable animal-source food which accounts for about 40% of the total animal protein consumed by its citizens, and more than 60% of the total protein intake in adults (Egun and Oboh, 2022; Egun et al., 2022; Falola et al., 2022). Increasing cost of other sources of animal protein has resulted in an increasing demand and consumption of capture fishes from tropical freshwater bodies particularly among rural riverine communities and low income households in Nigeria. This has also provided economic gains for individuals' engaged in artisanal fishery. Also, several national health authorities have recommended the human consumption of freshwater fish species such as tilapia and catfish as source foods for high quality protein, important micronutrients (calcium, iron and zinc), and dietary source of low saturated fat (polyunsaturated omega-3fatty acids) (EFSA, 2018; USDA and HHS, 2020).

In Nigeria, diet analysis of rural and low income households in communities located close to water bodies, indicate higher reliance on fish meat relative to other animal- source foods (Dauda and Yakubu, 2013; Byrd *et al.,* 2021). Despite the assortment of fishes in freshwater bodies in Nigeria, the increasing concerns on underlying malnutrition in tropical neglected rural riverine and coastal communities which predominantly rely on fisheries resources as source of animal protein and essential minerals (Onyeneho et al., 2016; Ugwu and Uneke, 2020; Uzobo, 2020; Amaihunwa et al., 2022); and the contribution of artisanal small-scale fisheries to over 80 per cent of Nigeria's total domestic fish production (Nigerian Tribune, 2021) have raised concerns on fish food quality, the quantity of fish consumed and nutrient availability in fish meat.

The significant contribution of capture fisheries to attaining the global sustainable development goals of zero hunger (SDG 2), good health and wellbeing (SDG 3) of rural households and socio-economically disadvantaged households in Nigeria has necessitated studies on fishes' nutritional composition to determine their suitability in meeting nutritional needs of consumers (Oboh *et al.,* 2019; Egun et al., 2022). Therefore, the aim of this study is to assess the nutritional composition of commercial fish species from selected inland freshwater bodies in the tropics of Nigeria, and evaluate their potential contribution to meeting the recommended nutrient intakes (RNIs) for various population groups in neglected rural riverine households and commercial consumers.

Materials and Methods

Study Locations

In this study, captured fish species were collected from three (3) tropical inland freshwater bodies which have assortment of fish species and transverses through several rural communities in Edo State Nigeria. The freshwater bodies are Ikpoba reservoir (Latitudes 006˚22'50'' N and 006˚22'43'' N and Longitudes 05˚38'36'' E and 05˚38'46'' E) in Benin City (Figure 1), Siluko River (Latitudes 06˚32'22.5'' N and 06˚31'59.7'' N and Longitudes 005˚09'32.5'' E and 005˚09'20.8'' E) (Figure 2) and Owan River (Latitudes 006^{0} 45' 36.5" N to 006^{0} 45' 52.8" N and Longitudes 05^{0} 45' 40.6" E to 05^{0} 46' 21.8" E) (Figure 3) in Southern Nigeria. The fish species – *Clarias gariepinus, Synodontis schall* and *Tilapia zillii* were selected for this study based consumers' preference and commercial value to the artisanal fishing households and fish marketers in the region. Also, these fish species accounted for over 70 percent of animal protein consumed by households in rural riverine communities in the tropics of Nigeria.

Sample Collection

Selected fish species were collected quarterly from January 2019 to December 2019; and from September 2021 to December 2022 from artisanal fish landing sites at the various study locations. The fish samples were properly identified using taxonomic guides of Idodo-Umeh (2003), and taken to a national referenced laboratory - Owena River Basin Authority/ University of Benin Analytical laboratory for analysis.

Analytical Methods

In the laboratory, fish samples were thoroughly washed with distilled water and drained under folds of filter paper. The fish samples were dissected and fish fillets were collected along the lateral line. The fillet samples were homogenised and subsamples of the homogenate were taken for respective nutritional composition analysis. The analytical methods used for

Figure 1. Sectional map of Benin City showing Ikpoba reservoir and sampling Stations. Inset maps: (A) Nigeria (B) Edo State.

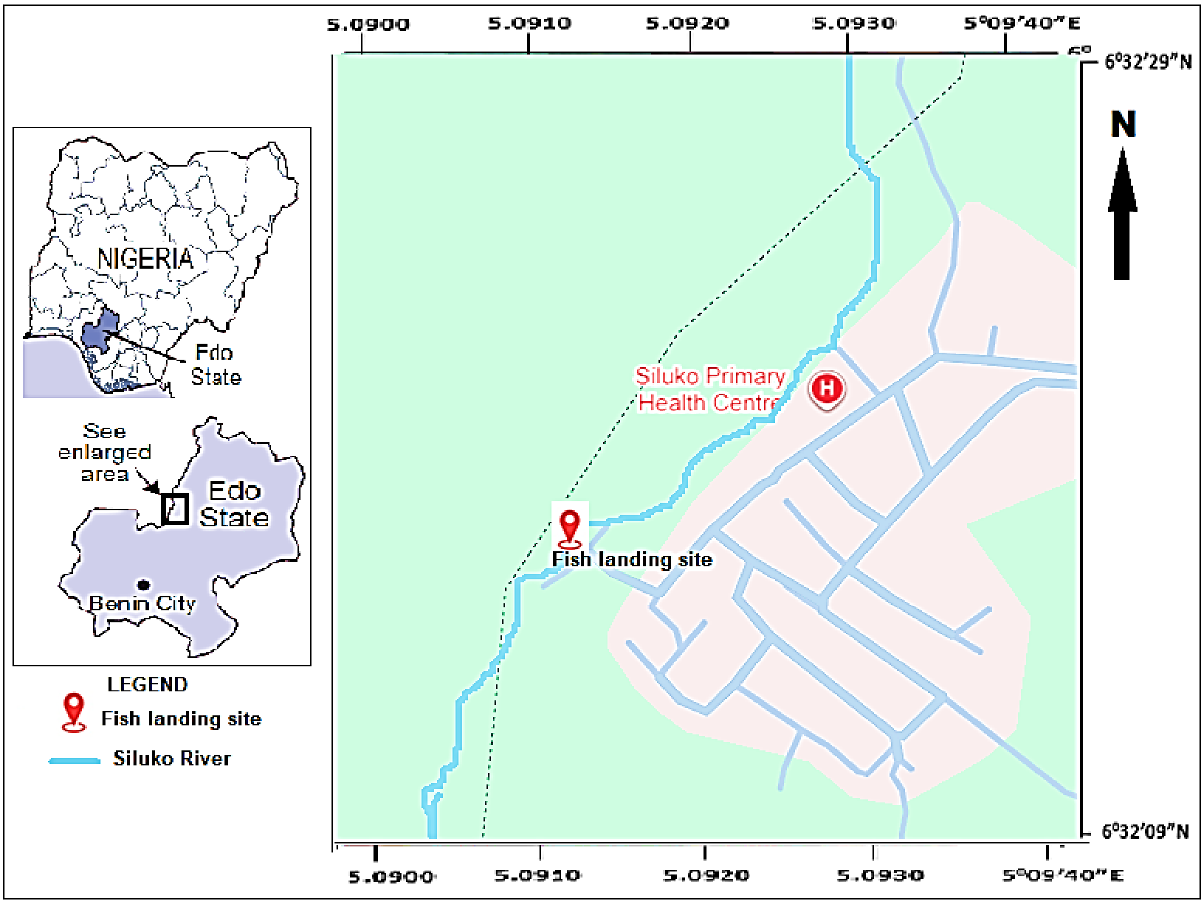

Figure 2. Map of Siluko River with fish landing site in Siluko Town, Edo State. Insert maps: (A) Nigeria (B) Edo State.

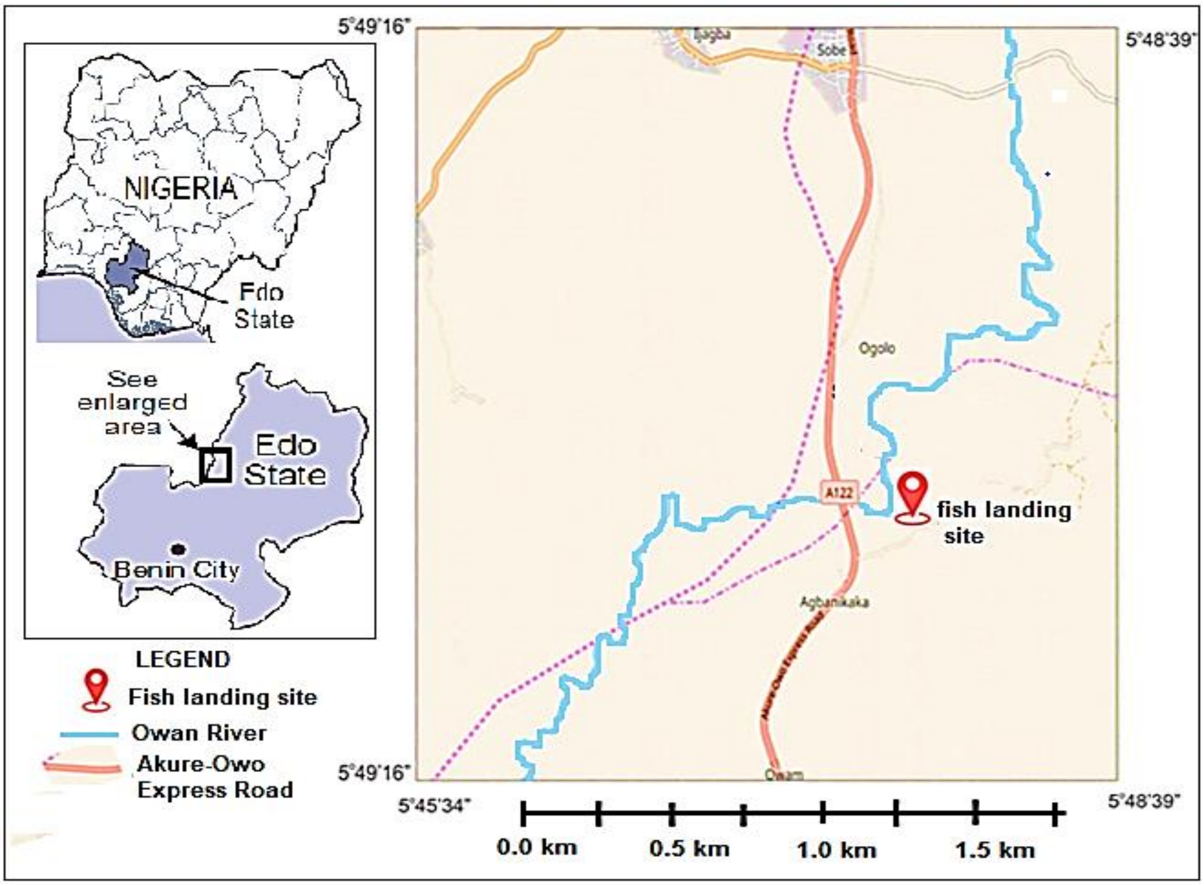

Figure 3. Map of Owan River with fish landing site in Owan Community, Edo State. Insert maps: (A) Nigeria (B) Edo State.

the determination of the nutritional composition of fish samples are summarized in Table 1. Analytical procedures were carried out in triplicates to guarantee result consistency.

Estimation of Potential Contribution to Recommended Nutrient Intakes (RNI)

The potential contribution of each fish species to daily RNI was calculated as described by Egun and Oboh (2022) in reference to the average RNI values for each nutrient as recommended for pregnant and lactating women (PLW), adults/ adolescents (8 years and above) and children (1 – 3 years). In this study, potential contribution to recommended nutrient intake (RNI) will be estimated based on

a. contribution from an assumed standard portion of fish which is the per capita consumption of fish as food in Nigeria. According to the Food and Agriculture Organization (FAO) of the United Nations, in year 2021 the per capita consumption of fish in Nigeria was 8.39 kg, which is equivalent to 23g portion per day (FAOSTAT, 2023).
b. contribution from assumed standard portion of fish based on global average per capita fish consumption of 20.3 kg, which is equivalent to 55.62g portion per day (FAO, 2018).
c. contribution from an estimated portion of fish based on the dietary composition survey of rural households in this study area. This showed an estimated fish consumption of 600g (adults), pregnant and nursing women (800g), and 300g (children) per day. As households involved in fishing activities recorded higher values.

The potential contribution to potential nutrient intake is estimated as:

$$N_{SP} = \frac{N_A \times S_P}{100}$$

$$\% \, RNI_i = \frac{(N_{SP} \times 0.7)}{RNI_i} \times 100$$

Where N_A is the amount of nutrient (mg/100g)

S_P is the assumed standard portion of source food (fish) per day.

N_{SP} is the nutrient amount in a standard portion.

RNI_i is the daily Recommended Nutrient Intake for nutrient *i* (Table 2)

% RNI_i is the percentage contribution to daily RNI from an assumed standard portion.

According to Nalan et al. (2004), food processing methods decreases the amount of nutrient in fish available to consumers. In this study, nutrient bioavailability percentage of 70% (70% of N_{SP}) in fish meat was assumed in estimating the percentage contribution to RNI as the fishes are consumed after undergoing at least one form of food processing. The mean requirement of ≥25% of the RNI of age and sex specific groups for each nutrient was adopted (FAO/WHO/UNU, 1985)

Data Analysis

All statistical analysis was computed Statistical Package for Social Sciences (SPSS) version 21. At every sampling visitation, three (3) specimen of each species were collected from the various study locations. In this study, analytical results are presented as the pooled means ± SD per 100 g of each fish species from the various locations, as preliminary data analysis using ANOVA (p<0.05) showed no significant variation with study locations.

Table 1. Analytical methods used for nutrient composition analysis of fish samples

Analyte	Units	Method reference
Proximate components		
Moisture	g/100g	Oven drying (Bolawa *et al.*, 2011).
Protein	g/100g	Block digestion (AOAC, 2010)
Fat	g/100g	Acid hydrolysis (AOAC, 2010)
Ash	g/100g	Direct method (AOAC, 2010)
Minerals		
Calcium	mg/100g	Acid Digest, ICP OES (APA et al., 2012)
Iron	mg/100g	Acid Digest, ICP OES (APA et al., 2012)
zinc	mg/100g	Acid Digest, ICP OES (APA et al., 2012)

Table 2. Recommended Daily Dietary Allowance (RDA) of the Food and Nutrition Board (Published by the National Academy of Science, Washington DC, USA)

Average Daily RNI	Population Sub - groups		
	Adults	Pregnant and lactating women (PLW)	Children
Calcium	1000 mg	1200 mg	700 mg
Iron	16 mg	18 mg	10 mg
Zinc	15 mg	20 mg	10 mg

Results and Discussion

Nutritional Composition of Fish Species

The nutritional composition of fish makes it an invaluable component of a healthy and balanced diet. Fish is ranked high among foods with high nutritional value and enormous health benefits, due to its composition of well-balanced macronutrients such as proteins, lipids and micronutrients such as vitamins and minerals (Hassanien and Al-Rashada, 2021; Jiali et al., 2022). The mean nutritional composition of *C. gariepinus, T. zillii* and *S. schall* from the various water bodies are presented in Table 3. The mean moisture content of the fillets of *C. gariepinus* (64.30%), *S. schall* (68.11%) and *T. zillii* (66.61%) were within the range of previously published reports (Gallagher et al., 1991; Egun et al., 2022). Nutritionally, the quality of fish meat is dependent on its protein content, as fish protein has high biological values characterized by the presence of good proportions of essential amino acids such as lysine, leucine, valine and arginine, and therefore suitable for supplementing diets of high carbohydrates contents (Womeni *et al.,* 2014; Salma and Nizar, 2015). The mean protein content in *C. gariepinus* (15.87%), *S. schall* (16.23%) and *T. zillii* (17.64%) indicate that the fishes are good source of dietary protein for human consumption; as protein content in fish is generally present in the range of 16 – 18% (Ninan, 2003; WHO, 2007). According to Oboh et al. (2019), fishes are important dietary source of polyunsaturated omega-3 fatty acids which the human body is unable to synthesize. The percentage lipid composition of *C. gariepinus* (6.53%), *S. schall* (3.95%) and *T. zillii* (1.74%) categorizes the fishes as fat fishes, which implies that they are good sources of fish oils (EFSA, 2005). However, based on Ackman (1989) classification of fish according to their fat content - lean fish (<2%), low fat (2 – 4%), medium fat (4 – 8%) and high fat (>8%). It can be seen that the observed variation in lipid content among the studied fish species is attributed to the lipid content in *C. gariepinus* which categorizes the fish species as medium fat. In similar studies on capture fisheries in Nigeria, higher protein content values were reported by Adewumi *et al*. (2014) in *C. gariepinus* (18.32%) and *T. zilli* (19.33%) from Osinmo reservoir. Also, Agali (2018) recorded higher protein and lipid content for *C. gariepinus* (18.20% and 8.83%) and *T. zilli* (18.50% and 7.99%) obtained from Obueyinomo River, Edo State Nigeria.

The observed variation is lipid content among the studied fishesAccording to Adewumi *et al.* (2014), the ash content of food materials is an indication of its total mineral content. Ash contents in the fillets of *C. gariepinus* (5.15%), *S. schall* (6.89%) and *T. zillii* (5.82%) indicate that the fishes are good sources of minerals such as calcium, iron and zinc. In this study, there were no observed significant difference in the nutritional composition of the fish species attributable to the influence of study locations, as the observed variation was attributed to species variation.

Fishes are good sources of micronutrients in a readily usable form. These micronutrients are essential mineral elements that are required in small quantities for the proper growth and development of the human body. In this study, the mean iron content in *C. gariepinus* (6.51 g/100g), *S. schall* (6.99 g/100g) and *T. zillii* (8.24 g/100g) were higher than iron content reported for fish and shellfish in the global FAO/INFOODS database. Zinc concentrations in *C. gariepinus* (2.58 g/100g), *S. schall* (1.54 g/100g) and *T. zillii* (1.55 g/100g); and calcium concentrations in *C. gariepinus* (4.35 g/100g), *S. schall* (2.86 g/100g) and *T. zillii* (2.45 g/100g) were within their respective reported range in fish and seafood (FAO/ INFOODS, 2016).

Fish Species Contribution to Recommended Nutrient Intake (RNI)

The European Food Safety Authority (EFSA) averred that a food source is regarded as a relevant source of mineral if it provides 15% of RNI, and a significant source if providing 30% (EFSA, 2011). The evaluation of the contribution of the mineral contents in the captured fish species to providing the RNI for calcium, iron and zinc to adults, pregnant and lactating women (PLW) and children are presented in Tables 4 to 6. Table 4 shows that the mineral contents on the fish species did not meet the ≥25% of the RNI of calcium, iron and zinc in adults, PLW and children from the per capita consumption of fish in Nigeria. This could significantly contribute to the prevalence of iron deficiency anemia (IDA) among preschool children (<5 years) in rural areas and from low income households in various parts of the country (Akodu *et al.,* 2016; Ogunsakin et al., 2020; Obasohan et al., 2022; Osei et al., 2024); and in women of reproductive age in Nigeria (Kareem et al., 2022). High prevalence of zinc deficiency

Table 3. Analytical values of the proximate and mineral composition of the fish species.

	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	Iron (mg/100g)	Zinc (mg/100g)	Calcium (mg/100g)
C. gariepinus	64.30±4.40[a]	15.87±0.69[a]	6.53±0.58[b]	5.15±0.52[a]	6.51±1.43[a]	2.58±0.67[a]	4.35±1.18[a]
S. schall	68.11±2.87[a]	16.23±0.99[a]	3.95±0.45[a]	6.89±0.09[a]	6.99±1.30[a]	1.54±0.69[a]	2.86±0.47[a]
T. zillii	66.61±4.96[a]	17.64±3.05[a]	1.74±0.56[a]	5.82±1.30[a]	8.24±1.13[a]	1.55±0.45[a]	2.45±0.39[a]

Note: Values are presented as pooled means ± standard deviations (SD) of the fish species analyzed from the various study locations, and expressed as the nutrient content per 100g raw edible sample. In each column, similar superscript indicates no significant difference (p > 0.05), while dissimilar superscript indicates significant difference (p<0.05).

has been reported in children aged below 5 years (Ibeawuchi et al., 2017; Dembedza et al., 2023; John et al., 2024); adults (Awobusuyi *et al.,* 2014; Amadi and Aleme, 2020) and pregnant women (Olayiwola et al., 2022; Abdurrahman et al., 2024) in Nigeria. Low dietary calcium intake among children especially from poor households have been linked to reported incidences of rickets (Okonofua *et al.,* 1991; Oginni *et al.,* 2004) and stunted growth; as 32% of children under age 5 were found to be stunted (Nutrition International, 2024). Maternal calcium homeostasis is vital to the provision of adequate calcium for fetal skeletal mineralization during pregnancy and through breast milk during infancy (Ettinger *et al.,* 2014). Reported high prevalence of IDA and zinc deficiency in PLW especially in rural communities, has been linked with adverse foetal and maternal outcomes (Okafor *et al*., 2016; Ajepe *et al*., 2020; Ugwu and Uneke, 2020). Also, higher systolic blood pressure in pregnant women have been significantly associated with the prevalence of hypocalcaemia among pregnant women in sub-Sahara Africa (Ajong *et al.,* 2019).

The low per capita consumption of fish in Nigeria in comparison with the world's average fish consumption of 20.3 kg per capita (FAO, 2018) has been identified to contribute to the food and nutrition insecurity especially among the vulnerable population groups in Nigeria (Bradley et al., 2020; Egun et al., 2022).

Table 4. Potential contribution of fishes to average daily Recommended Nutritional Intake (RNI) (%) from a standard portion (per capita) consumed

	Calcium (mg/100g)			Iron (mg/100g)			Zinc (mg/100g)		
	Adults	PLW	Children	Adults	PLW	Children	Adults	PLW	Children
Average daily RNI	1000	1200	700	16	18	10	15	20	10
C. gariepinus	1.00 (0.07%)	1.00 (0.06%)	1.00 (0.10%)	1.50 (6.56%)	1.50 (5.83%)	1.50 (10.5%)	0.60 (2.800%)	0.60 (2.10%)	0.60 (4.20%)
S. schall	0.66 (0.05%)	0.66 (0.04%)	0.66 (0.07%)	1.61 (7.04%)	1.61 (6.26%)	1.61 (11.27%)	0.35 (1.63%)	0.35 (1.23%)	0.35 (2.45%)
T. zillii	0.56 (0.04%)	0.56 (0.03%)	0.56 (0.06%)	1.90 (8.31%)	1.90 (7.39%)	1.90 (13.30%)	0.36 (1.68%)	0.36 (1.26%)	0.36 (2.52%)

* Standard portion is equivalent to 23g portion per day (FAOSTAT, 2023).

Table 5. Potential contribution of fishes to average daily Recommended Nutritional Intake (RNI) (%) from assumed portion based on global average per capita fish consumption

	Calcium (mg/100g)			Iron (mg/100g)			Zinc (mg/100g)		
	Adults	PLW	Children	Adults	PLW	Children	Adults	PLW	Children
Average daily RNI	1000	1200	700	16	18	10	15	20	10
C. gariepinus	2.42 (0.17%)	2.42 (0.14%)	2.42 (0.24%)	3.62 (15.83%)	3.62 (14.07%)	**3.62 (25.34%)**	1.44 (6.72%)	1.44 (5.04%)	1.44 (10.08%)
S. schall	1.54 (0.11%)	1.54 (0.09%)	1.54 (0.15%)	3.89 (17.01%)	3.89 (15.12%)	**3.89 (27.23%)**	0.86 (4.01%)	0.86 (3.01%)	0.86 (6.02%)
T. zillii	1.36 (0.10%)	1.36 (0.08%)	1.36 (0.14%)	4.58 (20.03%)	4.58 (17.81%)	**4.58 (32.06%)**	0.86 (4.01%)	0.86 (3.01%)	0.86 (6.02%)

*Assumed portion here refers to the standard portion of fish based on global average per capita fish consumption of 20.3 kg, which is equivalent to 55.62g portion per day (FAO, 2018).

Table 6. Potential contribution of fishes to average daily Recommended Nutritional Intake (RNI) (%) from assumed portions consumed by various groups in the study area

	Calcium (mg/100g)			Iron (mg/100g)			Zinc (mg/100g)		
	Adults	PLW	Children	Adults	PLW	Children	Adults	PLW	Children
Average daily RNI	1000	1200	700	16	18	10	15	20	10
C. gariepinus	26.10 (1.83%)	34.80 (2.03%)	13.05 (1.30%)	**39.06 (170.88%)**	**52.08 (202.53%)**	**19.53 (136.50%)**	**15.48 (72.24%)**	**20.64 (72.24%)**	**7.74 (54.18%)**
S. schall	17.16 (1.20%)	22.88 (1.33%)	8.58 (0.86%)	**41.94 (183.49%)**	**55.92 (217.46%)**	**20.97 (146.79%)**	**9.24 (43.12%)**	**12.32 (43.12%)**	**4.62 (32.34%)**
T. zillii	14.70 (1.03%)	19.16 (1.12%)	7.35 (0.75%)	**49.44 (216.30%)**	**65.92 (256.36%)**	**24.72 (173.04%)**	**9.30 (43.40%)**	**12.40 (43.40%)**	**4.65 (32.55%)**

*Assumed portion here refers to the estimated daily amount of fish consumed by the population sub groups in the study area - adults (600g), pregnant and nursing women (800g), and children (300g).

An estimation of the contribution of the studied fish species to the average daily RNI (%) of the population groups from an assumed portion of 20.3 kg per capita based on global average per capita fish consumption, indicate that the mineral content in the fish species only meet ≥ 25% of the RNI of iron in children (Table 5).

Also, bDietary composition survey of rural households in the study locations and involved in fishing activities, showed an increase in the quantity of fish consumed daily by the various population groups - adults (600g), pregnant and nursing women (800g), and children (300g). Estimation of the contribution of the fish species to RNI, indicated that the mineral contents in the fish species met the ≥ 25% of the RNI of iron and zinc in adults, PLW and children. While the calcium content in the fish species did not meet the ≥ 25% of the RNI of calcium in adults, PLW and children (Table 6). This is a public health concern as the various population groups are predisposed to ailments associated with hypocalcaemia even with increased fish consumption. These evaluations of fish nutrient contribution to RNI further give credence to the assertion on the need for food quality based on the amount of nutrients available to the consumers than food quantity in resolving nutritional deficiencies.

Resolving Nutrient Deficiency - The Way Forward

Freshwater fish species have been described as wholesome foodstuffs (Steffens, 2006), and its consumption highly recommended by various nutritional health authorities. This study has raised concerns on two major aspects – the nutritional quality of capture fisheries and the quantity of fish meat consumed in meeting the daily recommended nutrient intake of various population groups. Concerning the quantity of fish meat consumed, this study has shown that increased per capita consumption of fish will result in an increase in the amount of nutrients available to the consumers (Table 6). However, increase in per capita consumption of fish comes at a concurrent ecological cost of overfishing of inland freshwater bodies. On the issue of nutritional quality of capture fisheries, increasing pollution of inland freshwater ecosystems in Nigeria has been reported to influence the decrease in the nutritional quality of fish meat (Fanuel et al., 2017; Egun, 2021) and safety of fish food (Egun et al., 2023). In resolving these concerns, the following approaches are recommended:

1. Increased public health awareness and campaigns on the need for dietary diversity and inclusion of other food sources with good quantities of nutrients such as calcium, iron and zinc particularly in neglected rural riverine communities which rely chiefly on fish species as sources of animal protein and dietary nutrients. This will address the shortfall in the nutrient availability to consumers from the fish species, and improve the overall health status of the various population groups.
2. Increase in fish production through adequate investments in aquaculture. This will notably contribute to resolving the supply-demand gap occasioned by the increasing demand for fish and alleviate food and nutrition insecurity among households in Nigeria. Increase in fish production through aquaculture particularly for freshwater species will reduce capture fishing pressure on inland water bodies, and guarantees the rejuvenation and sustainability of aquatic ecosystems. Also, the practice of aquaculture allows for the monitoring of fish development, thereby ensuring that good quality fish meat is made available to consumers.
3. The sustainability of inland capture fisheries is dependent on water quality. As the decline in fish catch, ichthyofauna composition and diversity has been attributed to deteriorating water quality (Tawari-Fufeyin and Ekaye, 2007). The nutritional and socio-economic contribution of inland capture fisheries to nutrition security and economy, necessitates the need for the protection of the aquatic ecosystems against further deterioration in water quality. Government and relevant agencies should as a matter of urgency commence full implementation and enforcement of compliance to pollution laws/ regulations in order to safeguard the aquatic ecosystems in Nigeria. This will improve the quantity of fish catch and nutritional quality of fish meat.

Conclusion

Nigeria is currently faced with the burden of undernutrition occasioned by deficiencies in protein and micronutrients such as calcium, iron, and zinc. This study has assessed the contribution of capture fisheries to the daily required nutritional intake (RNI) of various population groups in Nigeria. Study findings showed that the fillets of *C. gariepinus*, *S. schall* and *T. zillii* from the various water bodies are good sources of animal protein, fish oil and micronutrients. However, the low per capita consumption of fish in Nigeria has led to the poor contribution of these fishes to the RNI of calcium, iron and zinc in adults, pregnant and lactating women (PLW) and children. The need for dietary diversity and inclusion other food sources with good quantities of nutrients, increased investment in aquaculture practices to resolving the supply-demand gap for fish; and the enforcement of pollution abatement policies/ practices to safeguard inland freshwater bodies were simultaneously recommended approaches to guaranteeing the sustainable supply of good quality and safe fish food to consumers, and resolving micronutrients deficiencies among various population groups especially in rural households in Nigeria.

Ethical Statement

This study did not require ethical approval. As adopted methodologies were approved standard methods.

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Author Contribution

First Author: Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Writing - original draft, review and editing; Second Author: Conceptualization, Investigation, Methodology, Writing -review and editing; Data Curation, Formal Analysis, Investigation, Methodology, Visualization and Writing - original draft; Third Author: Formal Analysis, Investigation, Writing -review and editing; and Fourth Author: Formal Analysis, Investigation, Writing - review and editing.

Conflict of Interest

The authors declare that they have no known competing financial or non-financial, professional, or personal conflicts that could have appeared to influence the work reported in this paper.

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