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Proximate Analysis of the Flesh and Anatomical Weight Composition of Skipjack Tuna (*Katsuwonus pelamis*)

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ABSTRACT

Skipjack tuna (K. pelamis) *was assessed for its proximate and anatomical compositions with a view to establishing its nutritive and technological usefulness. Analysis of the muscle revealed that it contained between 69·0% and 72·6% moisture, 1·59% and 2·57% lipid, 22·4% and 25·5% protein, 1·53% and 2·42% ash and 0·87% and 3·21% salt.*

The mean percentage yields of trunk, head and viscera were 69·7%, 23·0% and 7·03%, respectively. On average, a total waste yield (head plus viscera) of about 30% was obtained. The technological implications of this analysis on the development of tuna fisheries in Nigeria are discussed.

INTRODUCTION

Nigeria claims territorial waters of 30 nautical miles off-shore and an Exclusive Economic Zone (EEZ) of 200 nautical miles. Development of the fisheries in Nigeria's EEZ has been hampered by lack of information

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on the species and the proximate composition of the fishes in this zone. However, a study of published (Wise & Ajayi, 1981) and unpublished data and information leads to the assertion that there is a reasonable possibility of developing a profitable tuna fishery for Skipjack. This is based on the fact that catches of Skipjack tuna are large and increasing and it is estimated (Wise & Ajayi, 1981) that they have not yet approached the maximum sustainable level. It is also known that profitable catches are now being made off the Nigerian Coast by Ghana-based and other foreign vessels.

Apart from the work by Tahiri-Zagret (1968), Talabi *et al.* (1980), Banjo (1979) and Emokpae (1983), information on the proximate composition of the pelagic fisheries resources of the East Central Atlantic region is scanty. Specifically, there appears to be no information on the chemical characteristics of Skipjack tuna in Nigeria's Exclusive Economic Zone. Therefore, in order to formulate a rational policy for the development and utilization of this resource, some knowledge of the proximate composition and weight (based on anatomical fractions) composition must be established.

This study was carried out with a view to obtaining some preliminary information on the proximate and weight compositions of Skipjack tuna within Nigeria's EEZ. It is hoped that the data generated will provide basic information on the utilization potential of this resource, either as a nutritive or as an industrial biomaterial.

MATERIALS AND METHODS

Skipjack tuna (*Katsuwonus pelamis*) were caught by a Japanese chartered boat (*Fukuichi Maru No. 78*) equipped with adequate 'pole and line' facilities for tuna fishing and storage facilities. The fish were caught off the Nigerian Coastal waters (Nigeria's EEZ). Seven trips (from April, 1982 to January, 1983) were made, each trip lasting for a period of one month or more. The catches were brine-frozen and stored in fish holds until they were landed. From the landings of each month, samples for analyses were collected according to the procedure of Miyake & Hayasi (1978) (International Commission for the Conservation of Atlantic Tunas). The fishes were cleaned with jets of fresh clean tap water and the gutted fish were used for chemical analyses after being finely minced and thoroughly mixed together.

Proximate composition and salt content

Moisture and ash were determined by the method of the AOAC (1970). Lipid was determined by the method of Bligh & Dyer (1959). Nitrogen was determined by the micro-Kjeldahl method. Protein was then obtained by multiplying the nitrogen by a factor of 6·25. Salt was determined by the silver nitrate method described by the AOAC (1970).

Determination of weight composition

Fish samples ranging between 1·30 kg and 2·00 kg were used for the weight composition studies. The fishes were cleaned and separated into three main anatomical parts—the head, the viscera and the enviscerated trunk. The weight of each separated part was then determined as a percentage of the whole weight of the fish.

RESULTS AND DISCUSSION

The average percentage proximate composition of the muscle of Skipjack tuna caught between May, 1982 and January, 1983 is presented in Table 1.

Average moisture content was 71·3 ± 1·3%. The highest moisture content was obtained in November with a level of 72·6%. Table 1 also shows an increase in moisture content from May to July. It decreased gradually to 71·9% in August and 71·6% in September. Lipid content

TABLE 1
Proximate Composition and Salt Content of Skipjack Tuna[a]

Month	*Moisture* (%)	*Lipid* (%)	*Protein* (%)	*Ash* (%)	*Salt* (%)
May (1982)	69·0	1·59	24·0	2·18	3·21
June	71·5	1·68	22·7	2·09	2·64
July	72·5	1·75	22·4	2·42	1·43
August	71·9	1·81	23·4	2·30	1·42
September	71·6	2·57	22·7	1·53	0·87
November	72·6	1·88	25·5	1·95	1·02
January (1983)	70·1	1·90	25·5	1·96	1·42
Mean	71·3 ± 1·3	1·88 ± 0·32	23·7 ± 1·3	2·06 ± 0·29	1·72 ± 0·87

[a] Average of duplicate analysis.

varied between 1·59 % in May and 2·57 % in September with an average of 1·88 ± 0·32 %. There appeared to be an increase in the lipid content with a corresponding decrease in moisture content of the muscle between August and September. The increase in lipid content with a corresponding decrease in moisture content within this period depicts a change in the body composition similar to that reported for sexually matured fish and, according to Brown (1957), these changes are likely to be associated with preparation for reproductive activities. There appear to be no studies on the reproductive biology of Skipjack tuna in Nigeria's EEZ, but, from the present study, it seems that there was accumulation of lipid in the muscle between August and September. The changes in lipid content within this period may therefore be associated with changes occurring in body composition during the period of changes in body physiological activities (spawning) of this species, in accordance with the views of Brown (1957).

The generally low lipid content in the muscle offers two major advantages. In one sense, it may render the fish muscle less prone to oxidative rancidity and, in another, it augurs well for the possibilities of developing a low lipid protein concentrate.

Protein content showed a decreasing trend from 24·0 % in May to 22·4 % in July. The average for the muscle was, however, 23·7 ± 1·3 %. Tuna muscle showed the highest protein content between November and January. The average protein content obtained in this study is higher than the range of values (18·9–20·8) reported for the flesh of Skipjack tuna from India by Chinnamma (1975).

Generally, there was no pronounced seasonal fluctuation in the protein content of the muscle. This confirmed the reports of earlier workers (Gerking 1955; Lagler *et al.*, 1962; Emokpae, 1983) that the protein content of fish muscle changes very little with season.

Table 2 compares the protein content of tuna (22·4–25·5 %) with that of other marine fish species. It is evident that tuna muscle is rich in protein and every effort should be made to ensure that its component parts are fed to humans either directly or indirectly as a means of helping to alleviate the protein shortage in the diets of Nigeria's peasant population.

Salt content varied between 0·87 % and 3·21 % with an average of 1·72 ± 0·87 %. Salt is normally not a constituent of marine fish species. The salt content of tuna and the variation observed in this study appeared to be related to the absorption of salt into the tissue during brine preservation on board rather than to changes in oceanographic conditions of salinity.

TABLE 2
Protein Content of Skipjack Tuna Muscle Compared with Other Marine Species

Species	*Range of protein* (%)	*Source*
Katsuwonus pelamis (Skipjack tuna)	22·4–25·5	Present study
Trichurus lepturus	18·5–22·6	Emokpae (1980)
Brachydeuterus auritus (Big eye)	18·4–19·0	Emokpae (1980)
Pseudotolithus typus (Croaker)	19·1–20·4	Emokpae (1980)
Carcharias taurus (Shark)	23·8–29·0	Emokpae (1980)

Data related to the weight composition (anatomical measurements) of whole Skipjack tuna are presented in Table 3. The average weight of eviscerated trunk varied between 0·952 kg and 1·43 kg, corresponding to relative percentages of 70·9% and 75·3%, respectively. The average weight of the head varied between 0·281 kg and 0·408 kg, representing 20·6% and 24·9%, respectively. The proportion of the viscera to the whole body weight varied between 4·93% and 10·4% with an average of 7·03%. On the whole, if the head and the viscera were to be regarded as wastes, then the yield of wastes varied between 27·4% and 31·8%, representing an average of 30·0% of the total weight of the fish. The importance of the anatomical (weight) composition analysis lies in its

TABLE 3
Average Anatomical Compositions of Skipjack Tuna

Month	*Average body weight (kg)*	*Average weight of trunk (kg)*	*Average weight of head (kg)*	*Per cent of head to average body weight*	*Weight of viscera (kg)*	*Per cent of viscera to body weight*	*Percentage total wastes*
May (1982)	1·422	1·075	0·319	22·43	0·070	4·93	27·36
June (1982)	1·767	1·349	0·418	23·66	0·106	6·00	29·66
July (1982)	1·741	1·311	0·410	23·5	0·104	5·974	29·52
August (1982)	1·828	1·373	0·455	24·89	0·127	6·95	31·84
September (1982)	1·895	1·427	0·468	24·70	0·128	6·76	31·41
November (1982)	1·343	0·952	0·281	20·92	0·110	8·19	29·11
January (1983)	1·387	1·101	0·286	20·62	0·144	10·38	31·00
Average for the survey period	1·626	1·230	0·337	22·980	0·113	7·030	30·01

TABLE 4
Average Yield of Wastes (Monthly) of Skipjack Tuna (In Metric Tonnes)

Month	*Total catch (metric tonnes) of Skipjack*	*Total yield of wastes (metric tonnes)*	*Per cent wastes (head + viscera)*
May (1982)	49·995	13·679	27·36
June (1982)	37·196	11·032	29·66
July (1982)	39·514	11·665	29·52
August (1982)	73·435	23·382	31·84
September (1982)	92·391	29·020	31·41
November (1982)	55·891	16·270	29·11
January (1983)	51·500	15·965	31·00
Total	399·992	121·013	—
Average	57·132	17·288	30·01

prediction of the meatiness and amount of wastes that can be generated and converted into other by-products (fish meal). The value obtained in this study for the eviscerated trunk is higher than those previously reported for *Trichiurus lepturus*, *Cynoglossus browni* and *Pseudotolithus typus* by Emokpae (1983). The high proportion of the trunk relative to the total body weight reveals that Skipjack tuna is a meaty fish and therefore offers more in terms of consumption. This property can also be utilized in developing other tuna-based industries (tuna canning, mincing and smoking) in Nigeria.

A comparison of the total catch and total yield of wastes is presented in Table 4. A total of 399·92 metric tonnes were caught by the tuna boat throughout the survey period. This thus represented a total waste yield of 121·01 tonnes.

On a proportionality basis, this means that Skipjack tuna has the potential to generate a minimum of about 300 kg of wastes for every 1 metric tonne of fish dressed during any processing operation. Assuming, therefore, a conversion ratio of 5:1 for fish waste to fish meal, it means that 75 kg of fish meal could be obtained as a by-product during the processing of 1 metric tonne of tuna, either for canning, smoking or mincing. This is significant in that it will entice many industrialists into the tuna fishery and hence enhance the development and exploitation of the tuna fisheries resources in Nigeria's exclusive economic zone. It will also help to reduce, to some extent, the problem of scarcity and the widespread rise in price of imported fish meal.

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REFERENCES

AOAC (1970). *Official methods of analysis* (12th edn), (Horwitz, N. (Ed.)), Washington, DC.

Banjo, A. O. (1979). Composition and properties of shark liver oil and liver residue. *J. Fd. Technol.* **14**, 107–13.

Bligh, E. & Dyer, W. J. (1959). A rapid method of total lipid extraction and purification. *Canadian J. Biochem. and Physiology*, **37**, 911–17.

Brown, M. E. (Ed.) (1957). *The physiology of fishes*. Vol. 1. Academic Press, New York.

Chinnamma, A. G. (1975). Biochemical differences between the dark and white meat of tuna and changes in quality during freezing and storage. *Fish Tech.* **12**(1), 70–74.

Emokpae, A. O. (1980). *Chemical composition of Nigerian marine species of fish and shrimps*. Annual Report, Nigerian Institute for Ocean. & Mar. Res., 30–2.

Emokpae, A. O. (1983). Preliminary studies on the chemical and weight composition of some commercially important species of fish caught in the Nigerian inshore waters. *J. Fd. Technol.*, **18**, 271–83.

Gerking, S. D. (1955). Influence of rate of feeding on body composition and protein metabolism of bluegill sunfish. *Physiol. Zool.* **2**, 267–82.

Lagler, K. F., Bardach, J. E. & Miller, R. R. (1962). *Icthyology*. John Wiley and Sons, New York.

Miyake, M. & Hayasi, S. (1978). *Field manual for statistics and sampling of Atlantic tunas and tuna-like species*. (2nd ed.), International Commission for the Conservation of Atlantic Tunas, Madrid, Spain.

Tahiri-Sagret, M. (1968). Studies on the nutritional and chemical composition of fish. *University of Abidjan: Journal of the Faculty of Science*, **4**, 49–70.

Talabi, S. O. (1982). *Lipid stability of developed fish meat analogues from mince of* Trachurus trachurus. PhD Thesis, University of Ife, Nigeria.

Talabi, S. O., Fetuga, B. L. & Ologhobo, A. (1980). Utilization of Big-eye for fish meal and fish protein concentrate production. A preliminary biochemical and nutritional evaluation. *Adv. in Fish Sci. and Tech.* (Connell, J. J. (Ed)), Fishing News Books Ltd, UK, 335–8.

Wise, J. P. & Ajayi, T. O. (1981). Feasibility study for development of a Nigerian tuna fishery. Occasional Paper No. 32 Nigerian Institute of Oceanographic and Marine Research.