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Proximate composition, mineral content and fatty acid profile of two marine fishes from Cameroonian coast: *Pseudotolithus typus* (Bleeker, 1863) and *Pseudotolithus elongatus* (Bowdich, 1825)

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ABSTRACT

Background: Knowledge of chemical composition of fish from Cameroon is poor. The genera *Pseudotolithus* are nutritionally and economically important in Cameroon. Thus the knowledge on their chemical composition could help in functional food elaboration.
Purpose: In this study, Proximate composition, fatty acid profiles and mineral composition were determined in two fish species, Pseudotolithus typus and Pseudotolithus elongatus from Cameroonian coasts.
Basic procedure: AOAC standard method was used. Fatty acids were identified by GC/MS as N-acylpyrolidides. Mineral compositions were determined by atomic absorption spectrophotometry for Ca, Na, K, Mg, Fe, Zn, Cu, Mn, and by UV spectrophotometry for phosphorus (P).
Main finding: Results indicated that chemical composition was not similar in the two fish species. Results also showed that water is the main constituent in the edible parts and in the bones with 76.17% to 78.24% and 51.21% to 55.28% respectively. Pseudotolithus typus and Pseudotolithus elongatus were good sources of proteins with 16.17% and 13.4% respectively. All the fish analyzed for fat were lean with fat contents less than 0.5%. These species of fish were poor in ω6PUFA and were rich in ω3PUFA with about one third of total fatty acids. The main ω3 fatty acids were eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). The most abundant main elements were the potassium in the edible parts (1.39%) and calcium in the bones (18.26%). The most abundant trace elements were Zn and Fe in the edible parts and in the bones.
Principal conclusion: The Na/K ratio values and ω3 fatty acids contents suggest that consumption of these two fish species could be recommended to prevent cardiovascular diseases.

1. Introduction

Cameroon is a country of central Africa, situated in the heart of the gulf of guinea, with 402 km of coasts approximately. In Cameroon, fish production has been estimated to be nearly 180,000 tones/year [18]. Marine fish are widely used as food in the littoral region. The demand for fish on the market has increased due to an increase in population and their perceived nutritional values by the local populations. The nutritional and medicinal values of fish products depend on their proteins, lipids, minerals and vitamins. Fish proteins have high biological values because they are characterized by the presence of essential amino acids in good proportions [22,43,46,47]. Fishes are also richest sources of ω3 polyunsaturated fatty acids [2]. Many studies have shown that eicosapentaenoic acid (EPA or 20:5ω3) and docosahexaenoic acid (DHA or 22:6ω3) are present in important amounts in fish tissues [30,40]. These polyunsaturated fatty acids have been shown to play a vital role in human nutrition [45]. They also have curative and preventive effects on many human diseases such as cardiovascular diseases, cancers, rheumatoid arthritis, and inflammation [12,39]. Minerals play an important role in maintaining body functions because they maintain acid–base balance, and help bond formation (hemoglobin formation) [14]. They also control the water balance in the body, help bones formation and teeth structure, and catalyze many metabolic reactions [27]. The importance of minerals as food ingredients is not only their nutritional and physiological roles, but they also contribute to food flavor and also activate or inhibit enzyme-catalyzed and other metabolic reactions, and they affect the texture of food [16]. Fish muscle and bones serve as good sources of essential minerals [15,31]. Fish minerals are mainly stocked in the skeleton and essentially in the vertebra with about 65%.

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Unfortunately, bones and heads are discarded parts of fish. Fish's bones were analyzed for their content in minerals and for a potential valorization of sub products from fish's flesh processing. More to that, there are people who eat both bones and flesh during their meal. Knowledge of chemical composition of fish from Cameroon is very limited. There are few reports on the genera *Pseudotolithus* genera which are economically and nutritionally important in Cameroon [18]. The aim of this study was to evaluate the nutritive value of two fish species belonging to the genera *Pseudotolihus*: *P. typus* and *P. elongatus* which are important product of fishery [28] from Cameroonians coasts and to compare the two species of fish in terms of their proximate composition, mineral composition and fatty acid profiles.

2. Materials and methods

2.1. Materials

The two fish species *Pseudotolithus typus* and *Pseudotolithus elongatus* were chosen and purchased fresh on the boats as soon as they arrived in the Douala fishing seaport in July 2014. The fish samples were put in icebox containing ice with a fish/ice ratio of 1:2, (*w*/w) and transported to the Laboratory of Foods Sciences and Nutrition at the Faculty of Sciences of the University of Douala, Cameroon. The average weight and length of the fish used in this study were: 293.14 ± 12.13 g and 31.68 ± 2.41 cm; 176.46 ± 4.96 g and 29.96 ± 1.56 cm for *P. typus*, and *P. elongatus* respectively, which are sizes above those consumed in many households.

2.2. Sample preparation

After morphometric measurement, fishes were dissected with a cleaned stainless steel knife. The heads and viscera were discarded. The edible part meaning flesh and skin which represent the parts consumed by the local population, was cut into small pieces and minced. Central vertebra was removed thoroughly. For lipids analyses, fresh edible part was used immediately. For proteins, ash and mineral analyses, the samples (edible part or clean central vertebra) were dried in an oven (Blinder, 14D-78532) at 45 °C for 48 h and were homogenized thoroughly in a food blender with stainless steels cutters.

2.3. Proximate analysis

For proximate composition, moisture content was determined using the hot air oven, by drying the sample at 105 °C ± 2 °C until a constant weight was obtained [7]. Total lipid was determined by Bligh and Dyer method using chloroform/methanol (1/1, v/v) [10]. Crude protein content was determined by converting the nitrogen content obtained by Kjeldahl's method (Nx6.25) [4,6,11]. Ash content was determined after combustion for 20 h at 550 °C [7]. Total carbohydrate was determined by subtracting the sum of fat content, protein content, ash content and moisture from 100 [35]. All analyses were carried out on three different fish.

2.4. Fatty acid analysis

The total lipids obtained were saponified by refluxing with KOH/EtOH, 2 M for 2 h. The fatty acids obtained were converted into methyl esters by reaction with methanolic hydrogen chloride (3%) under reflux for 45 min, dissolved in hexane and purified by silica gel column chromatography with hexan/diethyl ether (10:1, v/v) as eluent or by Thin Layer Chromatography (TLC) with the same eluent. N-acylpyrrolidides were prepared by direct treatment of methyl esters with pyrrolidine/acetic acid (10:1, v/v) for 2 h under reflux and purified by TLC on 0.5 mm silica gel layer, using hexane/diethyl ether (1:2, v/v) as developing solvent. GC/MS analyses of methyl esters and N-acylpyrolidides were performed on a Hewlett Packard, HP-5890 (GC) and 5989A (MS) Instrument linked to a HP 9000/345 integrator. The GC column was a DB1 (30 m × 0.32 mm × 0.25 μm). Column temperature was programmed from 170 °C to 300 °C at 3 °C/min. Carrier gas was helium. The detector and injector temperatures were at 250 °C.

2.5. Mineral analysis

Some main minerals (Ca, Na, K, P, Mg) and some trace minerals (Fe, Cu, Mn, Zn) were analyzed in the edible parts and bones of the two fish species. For mineral analysis accurately weighted ash samples were treated with nitric acid (HNO_3), $HClO_4$ and deionized water [37]. Mineral content of the digested samples was determined by flame atomic absorption spectrophotometry using a BUCK Scientific 200 A apparatus for Ca, Na, K, Mg, Fe, Zn, Cu, and Mn [4,9] and by spectrophotometric colorimetric method using a UV spectrophotometer for phosphorus [29].

2.6. Statistical analysis

All the results expressed are the mean of three measurements. Data were presented as mean ± standard deviation. To test the differences between species, one way ANOVA was performed. Significance was established at $P < 0.05$. Statistical analyses were performed using SPSS 16.0 for windows (SPSS, Chicago, IL, USA).

2.7. Results and discussion

2.7.1. Proximate composition

The average weight and length (total length) of the samples used in this study, 293.14 ± 12.13 g and 31.68 ± 2.41 cm; 176.46 ± 4.96 g and 29.96 ± 1.56 cm for *P. typus*, and *P. elongatus* respectively, show that the fishes were of adult size. The average length at first maturity for the *Pseudotolithus* is approximately 23 cm; [13]. Table 1 gives the moisture, fat, protein, ash and carbohydrate contents of the edible parts and eventually bone of the two fish species.

Table 1 shows that the biochemical composition of fish varies between species and tissues. The levels of moisture were higher in the edible parts (78.24 ± 0.23% and 76.17 ± 1.11%) than in the bones (55.28 ± 0.58% and 51.21 ± 1.11%) respectively for *P. elongatus* and *P. typus*. These results showed that water is the main constituent of fishes. Moisture content in fish was reported to be between 70 and 80% of the total weight [2]. The moisture contents in the bones of *P. typus* and *P. elongatus* were similar to the values found by Toppe et al. [47] in bones of some Norwegian fishes (52%–54%), Ondo-Azi et al. [34] in the edidle parts of *P. typus* from Gabon (78%) and differed to those found by Akpambang [3] in *P. senegalensis* (68%) and by Anene et al. [5] in *P. elongatus* from Nigeria (72%).

Protein contents in the edible parts of these two fish species were 13.4 ± 0.36% and 16.17 ± 0.31% respectively in *P. elongatus* and *P. typus*. These values showed that the two fish species contained high levels of proteins, and can be used as an animal proteins source. The high protein content in *P. typus* (˜15%) showed that this fish belong to the high protein fish category [19,48]. Significant differences

Table 1
Proximate composition of *P. typus* and *P. elongates.*

	P. typus n = 3		*P. elongatus* n = 3	
	Edible part	Bones*	Edible part	Bones*
Moisture (%)	76.17 ± 0.57^{a}	51.21 ± 1.11^{b}	78.24 ± 0.23^{a}	55.28 ± 0.58^{b}
Fat (%)	0.46 ± 0.05	nd**	0.36 ± 0.06	nd**
Protein (%)	16.17 ± 0.31	nd**	13.4 ± 0.36	nd**
Ash (%)	7.28 ± 0.25^{a}	39.30 ± 0.44^{bc}	7.17 ± 0.21^{a}	45.54 ± 0.35^{bd}
Carbohydrates	0.19	nd**	0.83	nd**

For the same line the values with the same letter are not significantly different ($P < 0.05$).
* Bones mean in this study the central vertebra.
** Not determined.

($P < 0.05$) in protein content were observed between the two species. The protein content of P. elongates was similar to those reported in another specie from Malaysia: *Channa striatus* [26]. Reports for Nigerian *P. elongatus* were different for our results and were higher than ours showing 18.2% of protein [1]. Cameroonian maritime waters are less productive than southern and northern oceanic waters. This is due to smaller or absent upwelling phenomena, caused by offshore islands that disturb the flood of cold waters towards the coast. This could explain the differences in the proximate compositions found between Cameroonian species and those from Nigeria and Gabon. The differences observed between the two species can be explained through their habitats: *P. typus* lives at shoreline and to about 150 m depth, while *P. elongatus* lives near the coasts and in the estuaries.

Both species analyzed for fat content were lean in fat (<2%) according to the Ackman classification [2]. Fat contents were 0.46 ± 0.05 and 0.36 ± 0.06 in *P. typus* and *P. elongatus* respectively. No significant difference ($P < 0.05$) in fat contents was observed between the two fish species.

The levels of ash were higher in the bones (39.30 ± 0.44% and 45.54 ± 0.35%) than in the edible parts (7.28 ± 0.25% and 7.17 ± 0.21) in *P. typus* and *P. elongatus* respectively. The differences were significant ($P < 0.05$) among the ash contents in the bones of the two species. Similar results were reported in the fillets of *Cynoglossus senegalensis* from Nigeria with 7.7% occurring in this species [23].

Carbohydrate values were low (0.9% and 0.83% in *P. typus* and *P. elongatus* respectively) compared to other nutrients. These values were less than those reported by [5] in *P. elongatus* of Nigeria (2.49%).

Proximate composition varies between *P. typus* and *P. elongates*. The chemical composition varies greatly from one species and one individual to another depending on diet, sex, age, environment and season [32,34,36].

2.8. Mineral content

Table 2 gives the mineral content (main and trace elements) in the edible part and bones of *P. typus* and *P. Elongatus*.

2.9. Main elements

The levels of macroelements Ca, P, Mg, and Na were higher in the bones of the two fish species than in the edible parts. However, the levels of potassium (K) were higher in edible parts. Among the main elements, the most abundant were potassium in the edible part (1.39 ± 0.07) and calcium in the bones (18.26 ± 1.57). Lower concentrations of Na and higher of K were observed and makes ours fishes a good meal for human health, especially in the case of cardiovascular disease prevention, the Na/K ratio in food should be less than 1 as shown in Table 2 [38,44].

Table 2
Main and trace elements contents in the edible part and bones of the two fish species.

	P. typus		*P. elongatus*	
	Edible part	Bones*	Edible part	Bones*
Ca (%)	0.19 ± 0.10^a	18.26 ± 1.57^a	0.42 ± 0.25^a	17.43 ± 1.21
Mg (%)	0.12 ± 0.02	0.22 ± 0.02^a	0.13 ± 0.01	0.33 ± 0.01^a
K (%)	1.39 ± 0.07	0.51 ± 0.02^a	1.37 ± 0.09	0.72 ± 0.02^a
P (%)	0.70 ± 0.19^a	7.72 ± 0.35^a	1.12 ± 0.05^a	9.38 ± 0.40^a
Na (%)	0.27 ± 0.00^a	0.40 ± 0.01	0.31 ± 0.01^a	0.39 ± 0.01
Na/K ratio	0.19 ± 0.00	0.78 ± 0.5	0.23 ± 0.11	0.54 ± 0.5
Ca/P ratio	0.26 ± 0.09	2.37 ± 0.27	0.63 ± 0.01	1.75 ± 0.04
Zn (μg/g)	12.49 ± 0.80^a	36.05 ± 1.87^a	14.70 ± 2.62	34.32 ± 0.50^a
Cu (μg/g)	0.53 ± 042	2.74 ± 0.86	0.75 ± 0.12	2.64 ± 0.25
Mn (μg/g)	1.34 ± 0.03	27.53 ± 4.21^a	1.37 ± 0.05	15.21 ± 0.24
Fe (μg/g)	18.93 ± 2.93	34.24 ± 11.4	24.02 ± 4.3	36.94 ± 8.21

Values affected with letter [a] are significantly different ($p < 0.05$).
* Bones mean in this study the central vertebra.

Statistical analyses of results by ANOVA showed significant differences among the levels of Ca, P and Na in the edible parts of the fish studied. There were significant differences between the Ca, Mg, K, and P contents in the bones and no significant differences among the levels of Mg and K in the edible parts of the two fish species and no significant differences among the levels of Na in the bones.

The calcium and phosphorus contents were no similar in all the samples.

The Ca/P ratio gave different values. It was less than 1 in the edible parts with the highest in *P. elongatus* (0.63 ± 0.01) and more than 1 in the bones with the highest value in *P. typus* (2.37 ± 0.27). Generally, the mineral bones matrix contains similar levels of the main structural minerals, Ca and P [25,44,47]. The Ca/P ratio in food should be about 1 [8].

2.10. Trace elements

Trace elements are higher in bones than in the edible parts in the two fish species. Among the microelements, the most abundant were the Zn and Fe in the edible part and in the bones.

The level of Cu and Zn found in the edible parts of *P. elongatus* is lower than those reported by Ogundiran and Ojo in *P. elongatus* of Nigeria [33].

The microelements can be harmful in high concentrations. The concentrations of Cu, Zn, Mn and Fe in ours fishes are lower than the toxic levels described by FAO/WHO, [17]. The microelements are not only toxic but also essential for human nutrition [20].

2.11. Fatty acid profiles

The fatty acid profiles are presented in Table 3.

Thirty eight fatty acids were identified in the two fish species as N-acyl pyrolidides, with 33.8 ± 0.23% saturated fatty acids (SFA), 32.43 ± 0.27% monounsaturated fatty acids (MUFA), and 33.41 ± 0.23% polyunsaturated fatty acids (PUFA) in *P. typus* and 50.93 ± 0.45% SFA, 18.9 ± 0.33% MUFA and 29.57 ± 0.54% PUFA in *P. elongatus*. The SFA were higher in *P. elongatus* than in *P. typus*. The MUFA and PUFA were higher in *P. typus* than in *P. elongatus*. There were significant differences ($P < 0.05$) between SFA and MUFA, and no signification differences ($P > 0.05$) among the PUFA in the two fish species. The results showed significant differences among SFA, MUFA and PUFA in *P. elongatus*. All the polyunsaturated fatty acids belonged to ω3 and ω6 series. The content found for ω3 PUFA ranged from 22.9 ± 0.2 for *P. elongatus* to 28.8 ± 0.26% for *P. typus*. These two species of fish were poor in ω6PUFA with about 5%, and were rich in ω3PUFA with about one quarter and one third of total fatty acids percentage in *P. elongatus* and *P. typus* respectively. This characterizes the marine fish species which have high percentages of ω3PUFA and less of ω6PUFA compared to fresh water fish which have high percentages of ω6 and less of ω3PUFA [21,41]. The most abundant ω3PUFA were eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) with 10.47 ± 0.15% and 9.17 ± 0.70% for EPA, 7.47 ± 0.15% and 6.2 ± 0.62% for DHA. Another important result obtained was the high levels of the PUFA/SFA ratio at 0.99 and 0.58 in *P. typus* and *P. elongatus* respectively, and the ω3/ω6 ratio 6.24 and 3.44 in P. *typus* and *P. elongatus* respectively ranging in the ideal ratio [24]. These findings make these two fish species or their oils important to prevent or to fight against cardiovascular diseases [12,39,42].

2.12. Conclusion

There was a lack of information about the chemical composition of *Pseudotolithus typus* and *Pseudotolithus elongatus* from Cameroonian coasts. In the present study, the nutritional values of both species were evaluated. This study shows that the investigated fish species are good sources of many major nutrients and essential elements. They

Table 3
Fatty acid profiles of the edible parts of the two fish species studied.

N°	Fatty acids (%)	*P. typus* n = 3	*P. elongatus* n = 3
01	12:0	–	0.9 ± 0.1
02	13:0	0.47 ± 0.06	1.77 ± 0.25
03	4,8,12–13:0	0.63 ± 0.12	–
04	14:0	0.57 ± 0.21	6.07 ± 0.15
05	ai-15:0	–	0.47 ± 0.06
06	15:0	2.67 ± 0.15	1.3 ± 0.61
07	n.i.	–	0.3 ± 0
08	16:1ω11	1.10 ± 0.10	–
09	16:1ω9	0.43 ± 0.06	–
10	16:1ω7	6.33 ± 0.49	2.57 ± 0.50
11	16:0	6.50 ± 0.46	13.87 ± 1.43
12	17:1ω8	–	0.33 ± 0.06
13	ai-17:0	–	1.03 ± 0.21
14	i-17:0	–	0.67 ± 0.15
15	17:0	4.50 ± 0.50	5.1 ± 0.56
16	18:3ω3	5.30 ± 0.20	5.93 ± 0.81
17	18:2ω6	0.31 ± 0.01	1.37 ± 0.42
18	18:1ω9	5.53 ± 0.32	9.3 ± 0.79
19	18:1ω7	5.20 ± 0.40	4.7 ± 0.61
20	18:1ω5	10.60 ± 1.00	–
21	18:0	5.07 ± 0.40	13.2 ± 2.07
22	ai-19:0	2.47 ± 0.06	–
23	19:0	0.10 ± 0.00	1.1 ± 0.1
24	20:4ω6	1.83 ± 0.35	1.6 ± 0.17
25	20:5ω3	10.47 ± 0.15	9.17 ± 0.70
26	20:2ω6	1.30 ± 0.20	3.7 ± 0.72
27	20:1ω11	0.39 ± 0.01	1.3 ± 0.2
28	20:1ω9	2.30 ± 0.20	0.23 ± 0.06
39	20:0	2.00 ± 0.10	1.13 ± 0.25
30	21:0	–	0.8 ± 0.2
31	22:6ω3	7.47 ± 0.15	6.2 ± 0.61
32	22:5ω3	5.57 ± 0.60	1.6 ± 0.36
33	22:4ω6	1.17 ± 0.21	–
34	22:1ω13	0.27 ± 0.06	–
35	22:0	6.80 ± 0.66	1.67 ± 0.55
36	23:0	–	0.37 ± 0.15
37	24:1ω15	0.27 ± 0.06	0.47 ± 0.06
38	24:0	2.03 ± 0.06	1.5 ± 0.3
39	% Total FA	99.64 ± 0.24	99.7 ± 0.43
40	% ΣSFA	$33.8 \pm 0.23^{a*}$	$50.93 \pm 0.45^{a\#}$
41	% ΣMUFA	32.43 ± 0.27^{b}	$18.9 \pm 0.33^{b\#}$
42	% ΣPUFA	33.41 ± 0.23^{b}	$29.57 \pm 0.54^{c\#}$
43	% ΣFAω3	$28.8 \pm 0.26^{*}$	$22.9 \pm 0.2^{\#}$
44	% ΣFAω6	$4.61 \pm 0.26^{*}$	$6.67 \pm 0.32^{\#}$
45	% ΣFAω3 + % ΣFAω6	33.41 ± 0.23	29.57 ± 0.54
46	% ΣFAω3 / % ΣFAω6	6.24 ± 1.03	3.44 ± 0.62
47	% ΣFAω6 / % ΣFAω3	0.16 ± 0.26	0.29 ± 0.26
48	% ΣPUFA / % ΣSFA	0.99	0.58

ai = anteiso; i = iso.
For the same line the values with the same symbol are not significantly different.
For the same column the values with the same letter are not significantly different.

are rich in proteins and in ω3 polyunsaturated fatty acids including high percentage of eicosapentaenoic acid and docosahexaenoic acid. These species can be recommended for human consumption and health.

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Conflicts of interest

None.

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