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Fatty acid composition of horse mackerel (*Magalaspis cordyla*) and croaker (*Otolithes ruber*)

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ABSTRACT

Objective: To determine the proximate and fatty acid composition of muscle, viscera, skin and bone of marine fish's horse mackerel and croaker. **Methods:** Freshly collected fishes were dissected and their moisture, ash and protein content were estimated gravimetrically by AOAC procedure and the lipid was extracted using chloroform, methanol and water in a ratio proposed by Bligh and Dyer. Extracted lipid was injected into gas chromatography connected to BPX–70 glass column to evaluate the fatty acid composition. **Results:** All the body parts analyzed had varying moisture content in between 73%–83%. Horse mackerel contained less than 3% and croaker had above 4% of lipid in all the body parts except muscle (1.4%). Fatty acid and lipid class composition was determined for all the body parts and the dominant polyunsaturated fatty acids (PUFA) was docosahexaenoic acid (DHA). **Conclusion:** Both the fish species showed variation, in protein content, lipid content and fatty acid composition. However, croaker had more remarkable quantity of lipid than horse mackerel.

1. Introduction

Fish is a major source of animal protein and is widely consumed in many parts of the world because of its high protein content, low saturated fat *etc.* It also contains important fatty acids like long chain ω -3 polyunsaturated fatty acids (PUFA) such as, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). These fatty acids are essential for a balanced nutrition and play an imperative role in prevention and treatment of coronary artery disease, hypertension, diabetes, arthritis, other inflammatory and autoimmune disorders, and cancer^[1–3] and cannot be synthesized directly in the body, must be derived from dietary sources. The proximate and fatty acid composition of fish varies greatly from one species to another^[4,5] depending on age, sex, environment and season^[6–8], variations in the chemical composition are closely related to feed intake, migratory swimming and sexual changes in connection with

spawning. The biochemical composition of fish proves to be of great importance to the fish processing industry for the use in the techniques such as chilling, freezing, smoking or canning^[9,10].

Recently several researchers reported the proximate and fatty acid composition of several fish like skip jack tuna, channel catfish, large yellow croaker, pomfret fish, Indian feather back, bhola bhetki, threadfin bream, tuna, flounder^[6,7,11–18]. Nevertheless, the knowledge of proximate composition of two species horse mackerel (*Magalaspis cordyla*) and croaker (*Otolithes ruber*) which are very common and widely distributed in the Tamilnadu coast, were not studied. In this context, the study of proximate composition will contribute to the better utilization as an important bioresource. In addition fatty acid composition studies have also been carried out for different parts of both the fish species.

2 Materials and methods

2.1. Sample collection

Marine fishes horse mackerel (*Magalaspis cordyla*) and

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croaker (*Otolithes ruber*) were collected from Royapuram sea coast (13° 6' 26" N 80° 17' 43" E), Tamilnadu, India in March 2009. The length, breath and weight of fishes were measured as shown in Table 1.

Table 1.

Size and weight of marine fish analyzed.

	Horse mackerel	Croaker
Weight (g)	166.00±13.70	200.00±31.70
Length (cm)	25.70±1.86	26.00±2.12
Width (cm)	5.60±0.34	5.80±0.83

Values are Mean±SD, n=6.

2.2. Tissue collection

Fishes were washed with running water, blotted and dissected in aseptic conditions. Muscle, visceral mass, skin and bone were collected separately from each fish, wiped with blotting paper and weighed. All the body parts were minced separately using a grinder and stored in plastic bags at -20 °C until used.

2.3. Proximate analysis

Proximate (moisture, ash, lipid and protein) composition was determined on wet weight basis. Moisture content was determined by placing approximately 2 g of sample into a pre weighted aluminium dish^[19]. Samples were then dried in an oven at 105 °C until a constant mass was obtained. Ash content was estimated by charring the pre-dried sample in a crucible at 600 °C until a white ash was formed^[19]. The total crude protein (N×6.25) in raw material was determined using the kjeldahl method^[19]. Lipid content was determined gravimetrically using Bligh and Dyer method^[20].

2.4. Determination of structural lipids

Phospholipid content was estimated by measuring the phosphorus in the lipid using the standard method of A.O.C.S^[21]. Cholesterol was estimated according to the method of Zlatkis et al. ^[22]using the standard cholesterol for comparison.

2.5. Fatty acid analysis

The lipids were extracted according to the method of Bligh and Dyer^[20], the methyl esters of the fatty acids were prepared according to the technique described by Metcalfe et al^[23]. The total fatty acid composition was determined by Gas Chromatography (Chemito, 8610). The GC was

connected with a glass column (25 m×0.22 mm i.d.) packed with BPX-70 supported on chromosorb-WHP (100/200 mesh) of HP make. The oven, injector and detector temperatures were maintained at 160 °C, 250 °C and 260 °C, respectively. Nitrogen was used as the carrier gas (flow rate 35 mL/min). The fatty acid esters peaks were identified and calibrated with standard methyl esters.

2.6 Statistical analysis

All the analyses were repeated three times, and the results are presented as mean±SD for triplicate samples.

3. Results

The study includes the determination of proximate, structural lipid and fatty acid composition of horse mackerel and croaker fish species. The proximate composition of different body parts was documented in Table 2. The moisture content of these species ranged in between 73%–83% with some variations in different body parts. The horse mackerel muscle and croaker viscera has recorded high moisture content. On other hand, ash content was also estimated from all the body parts and the percentage was in between 1.4% to 2.6% in muscle, viscera and skin of both the fish species. But, bone showed a high content of ash with a maximum percentage of 10.5% in horse mackerel and 11.4% in croaker, which may be because of rich mineral content. Current observations were also drawn interest in finding the percentage of protein and lipid content. Skin and muscle of the both the species had more protein compared than remaining parts. Where, the relative lipid content varied from one species to the other, but horse mackerel and croaker showed the lipid values to be below 4.8% in the present study. Croaker possess a good percentage of lipid than horse mackerel, which was found to be better when compared with other parts and bone being waste part this can be used for production of fish oil which will have both environmental and medical significance.

Distributions of lipid fractions in different parts of two fish species were examined and their structural lipid pattern was estimated. The lipid fractions in all the parts varied and their distribution of phospholipids and cholesterol are presented in Table 3. Cholesterol was the dominant class of lipids among all body parts and varied between 9–26 %. Phospholipids were very less in all the body parts, may be because of their habit and habitat. Both horse mackerel and croaker are carnivorous and it is very well known that dietary lipids play an important role in energy production of

Table 2.

Proximate composition (%w/w) of various body parts of horse mackerel and croaker.

(%)	Muscle		Visceral mass		Skin		Bone	
	HM	CK	HM	CK	HM	CK	HM	CK
Moisture	80.4±0.7	83.8±1.1	83.6±1.7	81.2±2.5	83.5±0.6	79.5±1.5	73.7±0.4	75.3±2.0
Ash	1.7±2.8	2.1±0.8	2.6±1.7	1.4±0.4	1.5±0.2	1.4±1.1	12.5±2.2	11.4±2.3
Protein	16.5±0.7	12.7±1.9	11.7±0.5	13.1±2.2	13.0±3.6	14.3±2.5	10.8±4.8	8.9±2.5
Lipid	1.4±0.3	1.4±0.3	2.5±0.3	4.3±2.1	2.0±0.1	4.8±1.2	3.0±0.1	4.5±0.5

Values are mean±SD, n=3. HM: horse mackerel; CK: croaker.

Table 3.

Structural lipid composition (%w/w) of various body parts of horse mackerel and croaker.

(%)	Muscle		Visceral mass		Skin		Bone	
	HM	CK	HM	CK	HM	CK	HM	CK
Phospholipid	1.47±0.7	2.36±1.1	1.27±0.1	1.98±2.5	0.91±0.4	1.74±1.5	0.11±0.05	0.21±2.0
Cholesterol	9.19±2.8	11.21±5.8	17.45±1.7	26.40±3.4	9.81±0.2	15.76±3.1	7.60±2.2	14.13±2.3

Values are mean±SD, n=3. HM: horse mackerel; CK: croaker.

Table 4.

Fatty acid composition (%w/w) of various body parts of horse mackerel and croaker.

Fatty acid (%)	Muscle		Visceral mass		Skin		Bone		
	HM	CK	HM	CK	HM	CK	HM	CK	
Myristic	14:0	9.0	1.6	0.6	3.0	0.9	1.3	2.3	1.2
Palmitic	16:0	23.3	28.9	32.7	24.8	25.8	45.4	25.3	25.9
Stearic	18:0	8.5	8.9	9.7	13.1	12.3	8.0	8.2	8.1
Palmitolic	16:1	9.1	16.4	9.3	2.0	1.3	16.2	4.8	5.1
Oleic	18:1	14.8	18.5	27.7	26.0	29.4	19.0	19.1	19.7
Linoleic	18:2	1.6	3.0	9.5	12.1	15.4	0.9	5.8	5.9
Linolenic	18:3	0.3	–	–	0.1	–	–	–	–
Arachidic	20:4	0.2	0.3	–	0.5	–	–	–	–
EPA	20:5	10.6	5.0	3.2	4.7	0.9	1.4	5.5	5.8
DHA	22:6	10.2	11.0	6.9	7.9	13.5	7.5	12.7	15.4

Values are mean±SD, n=3. HM: horse mackerel; CK: croaker.

carnivorous fish rather than herbivorous.

The distribution of saturated fatty acids (SFA), monounsaturated fatty acids (MUFA) and PUFA in the different parts of horse mackerel and croaker are shown in Table 4. Among the saturated fatty acids, the 16:0 fatty acids was the dominant one, the croaker skin contained more fatty acids than remaining parts and followed by horse mackerel viscera and croaker muscle. The fatty acid 18:1 oleic acid was the dominant monounsaturated fatty acid, while DHA was the dominant polyunsaturated acid. More specifically, the bone of horse mackerel and croaker showed good percentage of eicosapentaenoic acid and docosahexaenoic acid.

4. Discussion

Study on distribution of biochemical composition of fish body parts is very rare; most of the literature on fishes was confined to muscle. Since, it is the only useful part in consumable fish. But, study on other body parts like viscera, skin and bone enlightens us for converting these waste parts into commercially important medicinal or pharmaceutical products. In this contest current study was conducted in bringing out sufficient data on all the body parts of two marine fishes. Generally the moisture content in marine fishes varies from 70% to 80%, fishes like *Mugil cephalus* (79.1%) and *Harpodon nehereus* (89.8%) had more moisture content. Other marine fishes like *Scomberomorus guttatus* (70%), *Hilsa hilsa* (72%) and *Sparus aurata* (63.5%)[24]. showed more are less similar results like horse mackerel and croaker. And these fishes showed 2.6%–1.4% of ash, which is very high when compared with the fresh water clam (0.3%), eel (0.4%) and large yellow croaker (2.5)[11,12]. The protein content has been observed about 8% to 21% in marine fishes

and 13% to 17% in fresh water fishes[25]. Skin, muscle, bone and viscera of horse mackerel and croaker values for protein content were proven to be in good concentration. Further, the findings were in the line of *Macrourus berglax* (16%) and *Centroscyllium fabricii* (17%)[12]. The croakers' visceral mass and skin showed high lipid content which is very high than pomfret (1%)[13], bhola bhetki (1%)[14] and *Nibea soldado* (1.5%)[15]. On the other hand, the lipid content is same as in *Alepocephalus bairdii* (3%) and *A. agassizii* (3.6%)[19]. The maximum cholesterol level is present in croaker muscle followed by viscera, bone and skin but in horse mackerel viscera had more cholesterol than remaining and these results were in line of pomfret and bhola bhetki[13,15], but compared to the results of Nazeer *et al*[16], the percentage of cholesterol was very less.

The results demonstrated that a significant part of the fatty acids in these fish species were PUFA, which varied from 0.9% to 21% of lipid content among the different body parts examined, which was very high than *Nemipterus japonicus* (1.6%)[16]. The result matches, with rainbow trout, which has been considered to be nutritionally important species since they have a relatively high content of n–3 fatty acids. Previous studies have also demonstrated a beneficial role of lean fish, as well as medium fish consumption, in the prevention of cardiovascular diseases [26,27]. The fish species in the present study, *viz.*, croaker is a medium fish and horse mackerel a lean fish. In marine fish, PUFA comprise mainly n–3 fatty acids; EPA and DHA[18]. However, the ratio of EPA versus DHA varies among species; in the present study the difference is observed between body parts. When considered the edible part of the fish, muscle showed more or less same percentage of EPA (10.6%) and DHA (10.2%) in horse mackerel and comparatively more DHA (11.7%) than EPA (6.2%) in croaker. Thus, fish species with a high content of n–3 fatty acids in the muscle is not necessarily a good

source of DHA. High ratio of PUFA in the tissues of Baltic sprat^[28], goldfish^[29], salem and sand smelt^[30] has been previously reported. The marine fishes are well known to possess abundant amount of highly unsaturated acids to maintain homeostasis of the body, fluid and osmoregulation in sea water^[18].

Sea food origin proteins and fatty acids play a major role in the human diet. Current investigations reveal the presence of high quality protein and lipid with a well-balanced composition of essential fatty acids in horse mackerel and croaker. The proportions of *n*-3 PUFAs (especially EPA and DHA) were high in both the fish species. We conclude that horse mackerel and croaker are good sources of EPA and DHA.

Conflict of interest statement

We declare that we have no conflict of interest.

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