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Morphological Traits and Biochemical Composition of a Discard Species Crested Hairtail, *Tentoriceps cristatus* (Kluzinger, 1884) from Indian Waters

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A B S T R A C T

Crested hairtail, *Tentoriceps cristatus* (Kluzinger, 1884) belonging to the Family Trichiuridae is one among the 15 species reported from the Indian coast. Except *Trichiurus lepturus* and *Lepturacanthus savala* other hairtails are not exploited commercially or considered as trash fishes. Present study is the first report of occurrence of crested hairtail along southwest and southeast coast of India. Morphological characters, morphometric measurements and meristic counts of the species were presented. Results of the morphological characters were concurrent with the specimens reported from Red sea, South China Sea and Jeju Island. The proximate composition of crested hairtail revealed richness in protein content (16.43 ± 0.516). The protein evaluation indicated 51% of essential amino acids and 49% of non-essential amino acids. Fatty acid composition recorded 46.15% of Poly unsaturated fatty acid (PUFA). Docosahexaenoic acid (22:6n-3, DHA), was the dominant one in PUFA, followed by eicosapentaenoic acid (20:5n-3, EPA) with 32.71%. Lower lipid quality indices of crested hairtail make them a potential food addictive and therapeutic ingredient against cardiovascular diseases.

***Key words*:** Trichiuridae, Crested hairtail, Biochemical composition, Fish nutrition, Proximate composition

Hair tail fishes (Family Trichiuridae) are considered as major contributor to the pelagic fishery elsewhere in the world. Hairtail occupy more than 5.27% of Indian marine fish landings during 2020. Large head hairtail, *Trichiurus lepturus* and savalai hairtail *Lepturacanthus savala*, occupy more than 90% of hairtail landings of India [1]. Both are rich in polyunsaturated fatty acids (PUFAs) of the n-3 series, such as docosahexaenoic acid (22:6n-3, DHA) and eicosapentaenoic acid (20:5n-3, EPA) [2]. Both are having high economic value and their nutritional component are well studied [3-6].

The crested hairtail, *Tentoriceps cristatus*, Kuzinger (1884) is a monotypic genus in the Family Trichiuridae, inhabiting at a depth range of 50 – 250 m. This species is known to distribute in the Indo-West Pacific Ocean including East China Sea, Japan, Philippines, North Australia, South China Sea, East China Sea, Tasman Sea, Philippines, and southern Japan [7]. In addition to its benthopelagic nature, it is available mainly as a by-catch of bottom trawls. In India, they were recorded as juvenile large head hairtail and mainly thrown overboard as trash fish or used as raw material for fishmeal industries. However, till date crested hairtails are not reported from Indian waters. Lack of information on its morphological characters, nutritional quality and their suitability for human consumption can be attributed as a major reason for non-utilization of these fishes.

Un-utilization of by catch and trash fishes causes major ecological and economic problem to the fishery. Information on biochemical composition of trash fishes will provide substantial contributions to recommended nutrient intake for human health [8]. Attempts were made in India to study the biochemical composition of by-catch species such as *Diaphus watasei*, *Neoepinnula orientalis*, *Chlorophthalmus corniger*, *Diaphus effulgens and Diaphus hudsoni* [9-10]. However, no attempt has been made to understand the morphological traits and proximate composition of crested haitail. Hence, present study illustrated the morphological traits and presented the biochemical composition of crested haitail.

MATERIALS AND METHODS

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Morphological traits

Crested hairtail specimens were collected from by-catch of trawlers operating from Sakthikulanagara, Kollam, (west coast of India) and Tuticorin (east coast of India). Specimens were brought to the laboratory in an iced styrofoam box and identified by using standard references [11]. Morphometric measurements in centimeter (cm) and meristic counts of fourty specimens were carried out following [12-13].

Biochemical composition

Crested hairtail samples around 1.3kg were filleted, skinned and homogenized for further nutritional analysis. The proximate composition of the samples was carried out following the procedure of Association of Official Analytical Chemists (AOAC) [14]. The moisture content of the sample was determined using AOAC.950:46.2019, 21st edition. Total ash determination was conducted according to AOAC.938.08.2019, 21st edition and the fat content was done by AOAC.991.36.2019, 21st edition. The protein content was determined using AOAC.2001.11.2019, 21st edition. The results were expressed in percentage (%).

Amino acid analysis

HPLC pre-column derivatization method was used for extracting the amino acids and the amino acid profile was determined using an Agilent Poroshell HPHC-C18 Column [15]. All the results were expressed in gram Amino acid/ 100gram sample. The Tryptophan was assayed using the AOAC 2015 methods and expressed as g% [16].

Fatty acid analysis

The fatty acid profile was analyzed using AOAC 2005 method and results were expressed in % of fatty acid in terms of total fatty acid [16]. Lipid quality indices such as Atherogenic index (AI) and Thrombogenicity index (TI), were calculated following Ulbricht and Southgate [17]. Atherogenic index (the relationship between the sum of the main saturated fatty acids and that of the main classes of unsaturated fatty acid) was estimated using the following formula:

$$AI = [12:0+ (4 \times 14:0) + 16:0] / [(PUFA n^{-6}+n^{-3}) + 18:1 + \text{Other MUFA}]$$

Thrombogenicity index (the relationship between the pro-thrombogenetic (saturated) and the anti-thrombogenetic fatty acids) was estimated using the following formula:

$$TI = [14:0 + 16:0 + 18:0] / [0.5 \times 18:1 + 0.5 \times \text{other MUFA} + 0.5 \times n^{-6}\ PUFA + 3 \times n^{-3}\ PUFA + (n^{-3}\ PUFA/n^{-6}\ PUFA)]$$

Cholesterolemic index (h/H) was calculated following Santos-Silva *et al.* [18].

$$(h/H) = [C18:1n\text{-}9+C18:2n^{-6}+C18:3n^{-3}++C18:3n^{-6}C20:2n^{-6}+C20:3n^{-6}++C20:4n^{-6}+C20:5n^{-3}+C22:6n^{-3}] / [C12:0+ +C14:0\ C16:0]$$

Samples were run in triplicate and results were expressed as mean ± standard deviation. One-way ANOVA followed by Tukey's test [19] was performed to understand the statistical significance of the results.

RESULTS AND DISCUSSION

Morphological characters

Crested haitail body is scale less, compressed, elongated, ribbon like and tapering to a point (Fig 1). Head large, upper profile deep convex, ridge-like and trenchant; and form a continuous curve from snout to origin of dorsal fin. A high leaf-like curved crest spring from the dorsal origin over interorbital and snout (Fig 2). Free margin of subopercle is convex shaped and acutely elliptical posterior end of opercle reaching to middle of pectoral base.

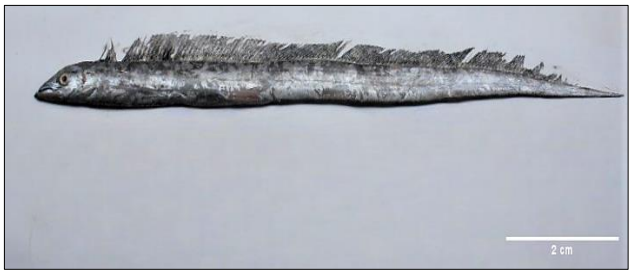

Fig 1 *Tentoriceps cristatus* (Kluzinger, 1884)

Eyes somewhat large and are situated slightly ahead of the middle part. Interorbital space is convex. One Nostril, positioned in front of eye on each side of the head and its posterior margin hardened. Mouth large, slightly oblique and lower jaw projected over the upper jaw. 3-7+7-10 small spinous gill rakers present on the first arch. A cartilaginous protuberance is present at lower jaw symphysis. The Posterior end of the upper jaw is reaching beyond the anterior part of the eye. Upper jaw is with 3 barbless fangs in front and 13 canines on the lateral side. The lower jaw is with 10-13 small pointed teeth on both sides and palatine usually smooth. Vomer and tongue are toothless. Lateral line descends gradually backward and runs a little above the lower third of the body. Caudal fin absent. Pelvic fin with 12 soft rays and dorsal fin with V spines and 114-144 soft rays. Pectoral fin small and not reaching lateral line. Pelvic fin modified into a scale-like process, rounded and inserted below 10-12th dorsal fin. Anal fin starts below 45th to 49th soft dorsal fin ray and represented by a scale like spine preceded by a rudimentary spine. Body silvery white becoming silvery grey with dark cloud like patches after death. Tip of jaws, dorsal fin base and anal base black. Dorsal fin dark with a dark patch between 17-20th dorsal fin rays.

Fig 2 Head profile of the *Tentoriceps cristatus*

Morphometric and meristic count

The proportion of different morphological measurements in respect of total length/head and meristic counts are furnished in (Table 1). As shown in (Table 1), head length, eye diameter, gill rakers count and pectoral fin rays count matches with [20-21]. The morphological characters and meristic counts were concurrent with earlier workers [20-21]. Crested head and leaf like reduced pelvic fin of *T. cristatus* are significantly differentiating them from other commercially important hairtails like *T. lepturus* and *L. savala*.

Table 1 Body proportions of *Tentoriceps cristatus* were reported from different localities as a percentage of total length and head length in cm

S. No	Morphological / Meristic characters	Length range in % (in total length) *Tentoriceps cristatus*					Mean length in % (in total length)
		Kluzinger (1884)	Senta (1975)	Nakamura and Parin (1993)	Kim *et al.* (2014)	Present study	
1.	No of specimens	9	50	1	1	39	-
2.	Total length	41.8	-	80	61.9	45.6-77.9	
3.	Head length	-	(8.8-10.6)	9.2	9.1	9.42-13.93 (7.18-10.62)	10.90 (9.24)
4.	Body depth	(20-24)	(17.2-24.1)	4.8	4.3	4.44-7.02 (14.25-22.25)	5.38 (18.85)
5.	Pre anal length	-	-	30.8	33.4	33.79-45.18 (2.21-2.96)	37.25 (2.69)
6.	Pre anal fin length	-	(2.5-2.9)	-	-	35.56-46.71 (2.14-2.81)	38.48 (2.61)
7.	Pre pectoral length	-	-	9.2	8.1	8.70-12.77 (7.83-11.49)	10.38 (9.68)
8.	Length of dorsal fin base	-	-	-	-	77.92-104.82 (0.95-1.28)	86.57 (1.16)
		Range in head length (in head length)					
9.	Eye diameter	-	(5.1-6.1)	13.7	15	14.29-19.40 (5.15-7)	16.61 (6.04)
10.	Snout length	-	(2.5-2.9)	-	40.6	28.99-50.79 (1.97-3.45)	34.09 (2.96)
11.	Pre orbital length	-	-	36.8	-	36.21-47.14 (2.12-2.76)	41.76 (2.40)
12.	Inter orbital length	-	-	-	11.1	10.14-15.19 (6.18-9.86)	12.27 (8.21)
13.	Pectoral fin length	-	(4.5 -6.4)	-	-	15.38-35.9 (2.79-6.5)	20.63 (4.95)
		Meristic counts					
14.	Gill rakers		2-6+7-11		3+9	3-7+7-10	4 +8
15.	No. of pelvic fin ray	I	I		I	I	I
16.	No. of pectoral fin rays		11		11	12	12
18.	No. of dorsal fin rays	120	126-144	V+126-144	V+131	V+114-V+144	V+129

Table 2 Proximate composition of *Tentoriceps cristatus*

Parameters (%)	*Tentoriceps cristatus* (Present study)	*Trichiurus lepturus* (Mohanty *et al.* 2016) West Bengal	*Lepturacanthus savala* (Akhade *et al.* 2012) India
Moisture	80.99±0.347	75.5	76.82
Ash	1.4±0.03	1.6	3.35
Fat	1.45±0.27	3.4	2.08
Protein	16.43±0.516	17.9	17.75

Values were reported as mean ± standard deviation of three triplicates
One-way ANOVA followed by Tukey's test showed there is no significant difference

Table 3 Amino acid composition of *Tentoriceps cristatus*

Parameters (g amino acid / 100 g sample)	*Tentoriceps cristatus* Present study	*Trichiurus lepturus* (Attia 2016) Egypt	*Lepturacanthus savala* (Nazeer and Deeptha 2013) Chennai
L- Histidine	1.57 ± 0.065	3.73	7.85
L- Threonine	2.95 ± 0.156	4.33	3.09
L- Arginine	0.69 ± 0.179	6.13	13.38
L- Valine	0.4 ± 0.077	5.26	2.81
L- Methionine	0.68 ± 0.03	2.15	4.32
L- Phenylalanine	0.73 ± 0.045	4.29	15.36
L- Isoleucine	0.99 ± 0.153	4.35	3.01
L-Leucine	1.04 ± 0.01	8.52	1.57
L- Lysine	0.62 ± 0.119	9.35	13.51
Tryptophan g%	0.04 ± 0.056	ND	1.09
L- Aspartic acid	0.77 ± 0.127	9.81	2.79
L- Glutamic acid	0.34 ± 0.047	14.83	4.56
L- Serine	0.6 ± 0.09	3.87	0.94
Glycine	0.92 ± 0.175	5.37	0.6
L- Alanine	1.31 ± 0.066	6.15	1.06
L- Tyrosine	2.01 ± 0.083	3.47	16.09
L- Cystine	0.33 ± 0.02	0.6	2.96
L- Proline	0.088 ± 0.006	2.89	5.01

Values were reported as mean ± standard deviation of three triplicates. ND – Not Detected
One-way ANOVA followed by Tukey's test showed there is no significant difference

Proximate composition analysis

The proximate composition of the species (Table 2) recorded a moisture content of 81%, a protein content of 16.4% and an ash content of 1.4%. Proximate composition is comparable to the large head hairtail (*Trichiurus lepturus*) inhabiting in similar ecosystem of crested hairtail [22]. The lipid content on other hand seems to be lower (1.5%) than lipid content (3.4%) of large head hairtail [22]. Species composition of crested hairtail was closer to the composition of large head hairtail than savalai hairtail. Species with protein content of more than 15% contribute around 40 to 50% of the daily protein requirement (Daily value % (%DV)) of humans [23]. Hence,

crested hairtail can be considered as protein rich food. The lipid content indicates that the species comes under the lean fish category (<2%).

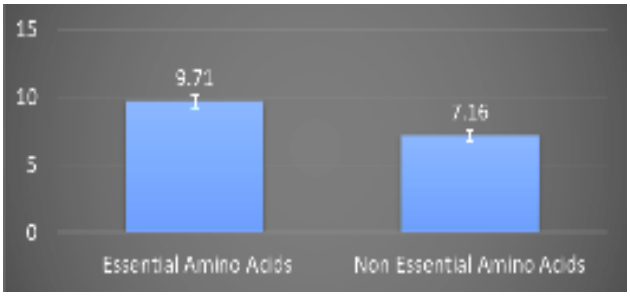

Fig 3 Percentage amino acid composition of crested hairtail

Amino acid profile

The evaluation of the amino acids of crested hairtail revealed that the protein is rich in both essential amino acids (EAA) and non-essential amino acids (NEAA) (Table 3). The EAA and NEAA constituted around 51% and 49% of the total amino acids respectively (Fig 3). The EAA/NEAA ratio in the case of the evaluated species was reported to be 1.03, which indicates the balanced nature of the protein. The quality of a dietary protein could be assessed by its essential to the nonessential amino acid ratio [24]. Romano *et al*. [25] reported that an EAA/NEAA ratio of at least >1, efficiently enhances the health of malnourished human beings of different ages. The dominant amino acids found in the sample were L-Glutamic acid (18.3%) followed by L-Lysine (12.5%). L-Glutamic acid plays a crucial role in amino acid metabolism and detoxification of toxic peroxides and polyglutamate folate cofactors [26].

Lysine is an EAA that is comprehensively necessary for optimal growth and its shortage leads to immunodeficiency issues [27]. The presence of these significant amino acids at considerable levels indicates the nutritional superiority of the fish protein. Fish protein is considered to be contributing towards 17% of the global animal protein supply and 7% of total protein for human consumption [28].

In recent times, another amino acid classification, which is functional amino acids (FAAs), has been popularly used. They are amino acids such as Arginine, cysteine, leucine, methionine, tryptophan, tyrosine, aspartate, glutamic acid, glycine, proline, and taurine [29]. FAA of crested hairtail constituted around 55% of the total amino acid profile. FAA plays an active role in key metabolic activities regulating health, survival, growth, development, lactation, and reproduction of the organisms [30].

Fatty acid profile

Fish is a rich source of high quality and easily digestible proteins and unsaturated fats, particularly long chain omega-3 fatty acids, which play important roles in human health [31]. The fatty acid profile of the lipid source generally indicates the presence of Saturated Fatty Acids (SFA), Mono Unsaturated Fatty Acids (MUFA) and Poly Unsaturated Fatty Acids (PUFA). The fatty acid analysis of the species indicated a distribution pattern of PUFA>SFA>MUFA (Table 4).

Table 4 Fatty acid composition of *Tentoriceps cristatus*

Parameters (% of fatty acid in terms of total fatty acid)	*Tentoriceps cristatus* Present study	*Trichiurus lepturus* (Chakaraborty *et al.* 2016) Mangalore (Attia 2016) Egypt	*Lepturacanthus savala* (Ramesh *et al.*, 2015) Mumbai
C14	3.72 ± 0.407	6.3	1.95
C16	20.68 ± 0.958	23.5	17.53
C16:1	4.45 ± 0.365	5.52	0.65
C18	8.94 ± 0.291	12.1	12.48
C18:1	11.68 ± 0.19	0	12.51
C18:2	1.06 ± 0.135	1.27	1.03
C20:4	3.44 ± 0.225	2.59	4.7
C20:5	8.94 ± 0.69	5.28	5.31
C22:6	32.71 ± 0.921	14.8	25.82
Others	4.39 ± 0.617	1.83	ND

Values were reported as mean ± standard deviation of three triplicates

ND – Not Detected. One-way ANOVA followed by Tukey's test showed there is no significant difference

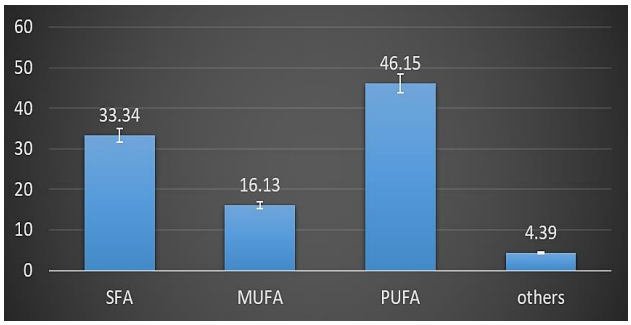

Fig 4 Percentage of fatty acid composition of crested hairtail

The total SFA content was 33.34% with Palmitic acid (C16:0) being the dominant one with a distribution pattern of C16>C18>C14 (Fig 4). The total MUFA content was reported to be 16.3% with Oleic acid (C18:1) being the major one with a distribution pattern of C18:1>C16:1. Rich lipid content in PUFA indicates the nutritional significance of the species [32]. The PUFA n6:n3 ratio was estimated as 0.11, which indicates a balanced PUFA concentration. PUFA n6:n3 ratio of <4.0 are considered nutritionally beneficial [33]. The MUFA/SFA, PUFA/MUFA and PUFA+MUFA/SFA ratios were estimated as 0.5, 2.9 and 3 respectively. According to Chang and Huang [34] low MUFA/SFA ratio and high PUFA/MUFA ratio and a PUFA + MUFA/SFA ratio below or equal to 3 are essential for maintaining low plasma and liver cholesterol levels.

Among the total fatty acid profile, PUFA contributed the most with 46.15% with Docosahexaenoic acid (DHA, C22:6) being the dominant one (32.71%) followed by eicosapentaenoic acid (EPA, C20:5). PUFA distribution pattern was of C22:6>C20:5>C20:4>C18:2. According to Garaffo *et al*. [35], DHA decreases the concentration of low-density lipoprotein cholesterol in plasma and EPA is the major fatty acid in the human diet because it is the precursor to the 3-series eicosanoids. Results indicate that n-3 PUFA levels of hairtails (*T. cristatus*, *T. lepturus* and *L. savala*) are higher than that of other marine fishes [36].

Lipid quality indices such as Thrombogenic Index (IT), Atherogenic Index (IA) and Cholesterolemic Index (h/H) were

estimated as 0.23, 0.57 and 1.03 respectively (Table 5). IT and IA values below 1 and h/H above 1 are considered to be advantageous for human nutrition [31]. Results indicate that lipid quality indices (IA, IT and h/H) of crested hairtail are lower than that of other terrestrial meats. This specifies their health potential against cardiovascular diseases [17].

Table 5 Lipid quality indices of *Tentoriceps cristatus*, *Trichiurus lepturus* and *Lepturacanthus savala*

Lipid quality indices	*Tentoriceps cristatus*	*Trichiurus lepturus*	*Lepturacanthus savala*
Index of Atherogenicity (IA)	0.23	2.6	0.58
Index of Thrombogenicity (IT)	0.57	0.46	0.32
Cholesterolemic index (h/H)	1.03	0.8	1.89

The lipid quality indices of *T. lepturus* and *L. savala* were calculated from the reference values

CONCLUSION

Hence present study confirms the presence of crested hairtail in southwest and southeast coast of India. Results of the morphological characters were concurrent with the specimens reported from Red sea, South China Sea and Jeju Island. Proximate composition analysis revealed that crested hairtail is a major source of omega-3 fatty acids. Richness of the fatty acids and the PUFA n6:n3 ratio indicates nutritional benefits of crested hairtail. Moreover, the lipid quality indices points out that this species can be considered as a potential resource for nutritional addictive's and pharmaceuticals.

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