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Nutritive Evaluation of Trash Fishes in Tuticorin (India)

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Abstract: The non commercial fishes called by catch forms a significant quantity of the total marine fish landings particularly in the landing areas of Tuticorin coast. By catch of marine fishes generally consists of edible and inedible sea food species. Among the inedible fishes bulk catches of juvenile fishes, low value fishes and fishes unacceptable for human consumption were also included and these were commonly referred to as trash fishes. Totally 42 dominant species from trash fishes were identified and studied for their proximate composition like moisture, protein, lipid, carbohydrate, ash and mineral composition includes Zinc, Iron, Calcium, Magnesium, Potassium, Sodium, Manganese, Copper and these parameters were analyzed spectrometrically by atomic absorption techniques. The result of the current study explained that the overall nutritional composition of each trash fish categories were above 15% in inedible trash fish which proves that the trash fishes are of good nutritional value and it is acceptable for development of value added products.

Key words: Trash Fishes · Proximate Composition · Minerals

INTRODUCTION

Fish and shellfish are important source of income for people in south eastern Asia [1]. During 2009 - 2010, marine fish production in India was about 3.9 million tons [2]. On a global scale, fish and fish products are the most important source of protein in the human diet [3]. Seafood comprises of all the ten essential amino acids in desirable quantity for human consumption. Fish is also a vitamin and mineral rich food [4, 5]. All these properties bring the fish flesh to be in the same class as chicken protein and are superior to milk, beef protein and egg albumen [6].

In general, the biochemical composition of the whole body indicates the fish quality. Therefore, proximate biochemical composition of a species helps to assess its nutritional and edible value in terms of energy units compared to other species. Variation of biochemical composition of fish flesh may occur within the same species depending upon the fishing ground, fishing season, age, sex of the individual and reproductive status. The spawning cycle and food supply are the main factors responsible for this variation [7].

Conventional trawlers are poor selective fishing gears and so retain large quantities of the non-target species [8]. The commercial marine fish catch from these trawlers generally consists of edible fishes and inedible species. The collection of inedible low value fishes and juveniles of commercially important fishes are referred to trash fishes and locally known as ‘Kalasal’. These trash fishes where caught as 50% of total catch generally lacking economic value but rich in nutritional value are often not utilized properly discarded as waste [9-11].

According to FAO [12] the global trend has been towards a proper and better utilization of non-commercial fishes. Trash fishes are widely used in coastal areas either directly or indirectly for human consumption and unhygenically dried and used as poultry feed [13]. Trash fishes that are freshly prepared and carefully managed can be a very good and inexpensive, source of food for culturing aquatic animals. Sadly, this is not in practical due to its unknown nutritional components [14]. The nutritional values of the discarded fishes are very important to initiate proper use of these trash fishes in a desirable way [15]. Hence, understanding the nutritional

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value of trash fish is very important [16]. Although several studies have dealt with the proximate biochemical components of many commercially important fishes [17-33], work on similar lines was very limited in trash fishes [34]. The overall objective of the present study is to determine the nutritive value of low value trash fish species found dominant in Tuticorin Fishing harbour, the major landing area of Tuticorin coast, in order to assess the variability of the biochemical composition of protein, lipids, moisture, ash, carbohydrate and mineral composition. The information on the proximate composition of these dominant trash fishes is considered to be very essential for the product development from these low valued non-commercial trash fishes.

MATERIALS AND METHODS

Sample Collection: Fresh trash fishes were collected from the landing areas of Tuticorin fishing harbour during the study period of August 2010 to July 2011. Trash fishes of different size ranging from 2.0-35 cm were collected immediately after the landing. The collected samples were kept in ice and transported to the laboratory in polystyrene boxes to sustain freshness. In the laboratory, the fish samples were thoroughly washed and rinsed with de-ionized water to remove the adhering contaminants and then drained under fold of filter paper and individual species were identified. Fishes were classified into three categories namely juveniles of commercially important species, low valued species and species unacceptable for human consumption. Then the fin fish samples were gutted, washed and dried in an oven at 60°C. Meanwhile the shell fish samples were also cleaned and dried in an oven at 60°C. The dried fish samples were powdered and stored in an air tight container as stock sample for proximate composition analysis.

Moisture: Moisture was determined by placing an accurately weighed known amount of ground sample in a pre-weighted porcelain crucible in an electric oven at 105°C for about 24 hours until constant weight was obtained. The loss of moisture was calculated as percent moisture [35].

$$\text{Moisture content (\%)} = \frac{\text{Weight of wet material} - \text{Weight of dry material}}{\text{Weight of wet material}} \times 100$$

Protein: Protein was estimated by following the method of Lowry *et al*. [36]. To a 10 mg of sample, 1 ml of 1N NaOH was added for protein extraction in water bath for 30 minutes. Thereafter, it was cooled at room temperature and neutralized with 1 ml of 1N HCL. The extracted sample was centrifuged at 2000 rpm for 10 minutes and an aliquot of the sample (1 ml) was further diluted with distilled water (1/9 v/v). From the diluted sample, 1 ml was taken and treated with 2.5 ml of mixed reagent (carbonate – tartrate – copper) and 0.5 ml of 1N Folin's reagent. After 30 minutes, sample absorbency was read at 750 nm using spectrophotometer. Bovine serum albumin was used as a standard for this analysis. The results were expressed as percentage.

$$\text{Protein\%} = X \times V \times 100/ W \times 100$$

X = Amount of protein obtained from graph, V = Volume of supernatant, W = weight of the sample

Lipid: Lipid was estimated by following the method of Folch *et al*. [37]. Ten mg of dried sample was homogenized in 10 ml of chloroform methanol mixture (2/1 v/v). The homogenate was centrifuged at 2000 rpm. The supernatant then washed with 0.9% saline solution (Kcl) to remove the non-lipid contaminants and allowed to separate. The upper phase was discarded by siphoning. The lower phase was allowed to dry in an oven and the weight was taken. The lipid content was expressed as percentage by the following formula.

$$\text{\% of Lipid} = \text{Weight of lipid (mg)} / \text{Weight of sample (mg)} \times 100$$

Carbohydrate: Total Carbohydrate was estimated by the phenol sulphuric acid method of Dubois *et al*. [38]. Sample of dried tissue (10 mg) was treated with 2 ml of 80% sulphuric acid and was allowed to digest for about 20-21 hours at room temperature. 2 ml of 5% phenol reagent followed by 5 ml of concentrated sulphuric acid were added to the digested sample and was allowed to cool. Absorbency was measured at 490 nm and the concentrations were expressed as percentage. The concentration of glucose in the sample was calculated using a standard curve.

$$\text{\% of Carbohydrate} = \text{Std value X OD of sample} / \text{weight of the sample} \times 100$$

Ash: The ash content was determined according to AOAC [39]. About 3-5g of prepared sample was taken in pre - weighed porcelain crucible and was placed in muffle furnace at 550°C for 6 hours. Then the crucibles were cooled in desiccators. The average in percentage of each sample of the remaining materials was taken as ash.

$$\text{Ash content (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

Mineral Content: Mineral content were determined quantitatively by atomic absorption spectrophotometer method [40]. The selected entire organisms were used for the analysis of minerals. 500 mg of the samples were digested with 10 ml of concentrated nitric acid over low heat on a hot plate. Caution was taken to avoid charring during the digestion process. When the solution become near dryness, added a small quantity of double distilled water along the sides of the flask and rinsed the flask. Filtered the solution through filter paper into 25 ml volumetric flask and made up the solution to 25 ml using crystal clear double distilled water. The made up samples were transferred into polythene bottles and stored for further analysis in Atomic absorption spectroscope. Blank solution was also prepared in the same way with the reagents but without the sample.

Preparation of Standard Solution: Standard stock solution was prepared as per the method summarized in the working manual of AAS (Elico – SD 164, India). The standards and the samples were directly aspirated into flame and the absorbance of the known and unknown samples were measured.

The amount of minerals in the sample was calculated as follows

$$X = C \times V / W$$

where, x = Amount of element in sample mg /100g, C = Concentration read out from AAS (g), V = Volume of solution (ml), W = Weight of sample in gram.

RESULT

Dominant trash fishes from the fishing harbour were segregated according to the known average length - weight and grouped into three categories namely juveniles of commercially important fishes, low valued species and species unaccepted for human consumption.

Juveniles of commercially important fishes are normally discarded as trash. Percentages of proximate composition (moisture, protein, lipid, carbohydrate and ash) of twenty commercially important juvenile fishes are presented in Table 1. The moisture content ranged from 71.92% (*Carangoides praeustus*) to 87.36% (*Pterocaesio chrysozona*). The percentage composition of protein ranged from 10.07 (*Portunus pelagicus*) to 23.1 (*Carangoides praeustus*). Carbohydrate was absent in 12 species whereas the gastropod (*Murex murex*) had high

Table 1: Nutritional value of commercially important juvenile trash fish species

	Proximate composition (%)				
Species	Moisture	Protein	Lipid	Carbohydrate	Ash
Leiognathus equlus	74.06±1.37	19.06±0.99	3.58±0.45	-	2.3±0.39
Sardinella albella	76.48±1.50	20.2±0.72	1.9±0.1	-	1.42±0.12
Pellona dichela	75.92±1.35	21.2±0.99	1.6±0.2	-	1.28±0.15
Saurida tumbil	79.2±1.01	19.40±1.21	0.13±0.02	-	1.27±0.32
Acanthurus leucosternon	77.21±1.91	21.03±0.95	0.66±0.36	-	1.1±0.40
Pterocaesio chrysozona	87.36±1.79	11.0±1	0.7±0.05	0.01±0.009	0.93±0.18
Poecilopsetta colorata	77.69±1.53	19.0±2	2.3±0.15	-	1.01±0.01
Upeneus vittatus	76.60±1.63	21.0±1	0.39±0.04	-	2.01±0.01
Lutjanus lutjanus	73.95±1.10	19.6±1.44	4.1±0.35	1.0±0.5	1.35±0.13
Stolephorus indicus	77.22±0.94	21.2±0.76	0.28±0.03	-	1.3±0.51
Carangoides praeustus	71.92±1.57	23.1±1.73	3.9±0.36	0.002±0.001	1.07±0.12
Himantura bleekeri	83.12±1.67	14.6±0.52	0.88±0.55	-	1.4±0.45
Liza parsia	78.5±2.68	19.7±0.79	0.9±0.13	-	1.2±0.14
Portunus Pelagius	83.53±1.75	10.0±0.92	2.6±0.52	0.1±0.13	3.7±0.1
Sepilla inermis	77.59±2.60	20.1±0.81	0.35±0.07	0.77±0.02	1.16±0.15
Octopus vulgaris	78.07±2.58	17.9±1.15	1.3±0.44	-	2.1±0.04
Loligo duvaucelli	79.81±0.01	17.0±0.23	0.99±0.14	0.21±0.07	1.98±0.03
Pinctata radiata	78.4±1.54	18.2±0.72	1.2±0.39	-	2.2±0.08
Chichorus virginicus	79.79±1.56	16.3±0.65	2.1±0.85	2.11±0.67	1.7±0.48
Meurex meurex	82.77±2.66	10.1±0.85	1.22±0.42	4.45±0.49	1.46±0.50

Table 2: Nutritional value of Low valued trash fish species

Species	Proximate composition (%) Moisture	Protein	Lipid	Carbohydrate	Ash
Arothron hispidus	75.90±1.24	20.2±1.19	1.7±0.18	0.003±0.003	2.19±0.55
Plotosus lineatus	85.77±1.35	11.2±0.72	0.3±0.14	0.021±0.001	0.7±0.18
Lactoria cornuta	73.0±2.73	11.74±0.82	1.08±0.24	-	1.11±0.05
Cookeoleus jappanicus	79.44±1.25	17.1±0.97	2.2±0.11	-	1.26±0.45
Trichiurus lepturus	74.79±1.67	19.3±0.75	4.2±0.15	0.02±0.01	1.69±0.53
Fistularia commersonii	80.06±1.78	17.8±0.43	0.76±0.28	-	0.38±0.02
Abalistus stellatus	76.25±1.39	18.8±1.31	3.7±0.28	0.001±0	1.24±0.23
Pellona dayi	70.41±1.22	16.9±1.87	0.8±0.48	-	0.98±0.03
Saurdia undosquamis	72.60±1.67	10.4±0.76	1.03±0.02	-	1.53±0.03
Atule mate	80.22±1.10	18.3±1.51	3.0±0.5	0.34±0.22	3.3±0.60
Upeneus sulphureus	78.11±2.30	12.2±1.71	2.92±0.21	-	2.0±0.45

Table 3: Nutritional value of trash fish Species unaccepted for human consumption

Species name	Proximate composition (%) Moisture	Protein	Lipid	Carbohydrate	Ash
Dipterygonotus balteatus	81.31±1.61	16.4±0.87	0.8±0.18	-	1.49±0.21
Bleekeria viridianguilla	79.64±1.48	17.9±1.01	1.5±0.5	-	0.96±0.10
Halichoeres dussumieri	81.44±0.41	10.2±0.83	2.68±0.74	-	3.11±0.16
Brakyptorosis serrulata	73.66±1.16	13.2±0.65	1.97±0.05	-	2.12±0.82
Pteros volitans	71.24±2.59	14.2±0.81	0.7±0.26	-	1.96±0.63
Apoleichthus taprobanensis	73.26±0.11	18.3±0.79	1.8±0.39	-	2.60±0.55
Echensis naucrates	80.7±1.53	16.2±1.05	1.3±0.23	-	1.8±0.57
Dactyloptena orientalis	79.3±1.47	18.0±1	1.7±0.32	-	1.0±0.5
Amphiprion sebae	83.4±1.41	12.0±1.08	0.92±0.18	-	2.14±0.83
Leiognathus bindus	75.0±1	12.4±0.82	2.4±0.52	-	1.11±0.12
Fisularia villosa	83.0±2	14.5±1.02	2.5±0.5	-	2.0±1

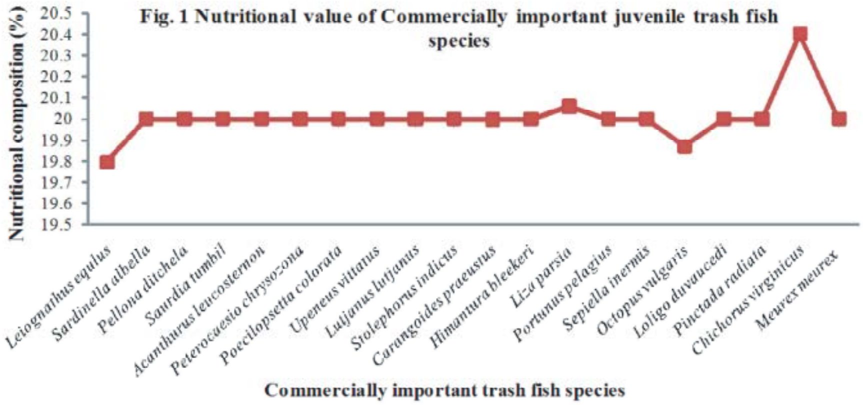
(4.45%) and *Pterocaesio chrysozona* had low (0.01%) amount of carbohydrate respectively. The percentage composition of Lipid was high (3.9) in *Carangoides praeusts* and low (0.13) in *Saurida tumbil.* Ash content ranged from 0.93% (*Pterocaesio chrysozona*) to 3.7% (*Portunus pelagicus*).

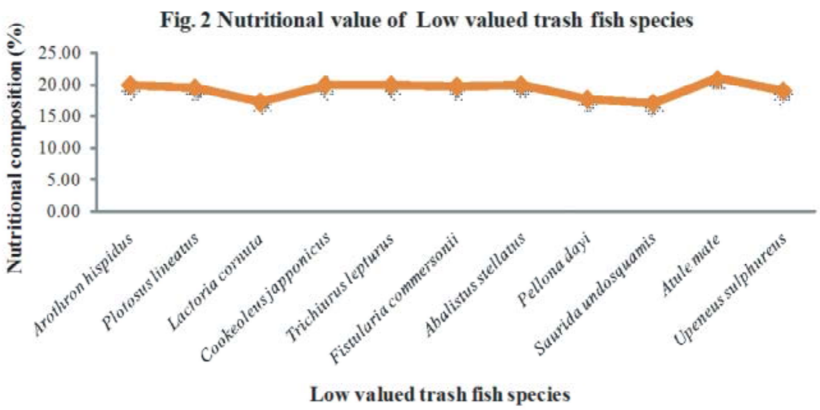
Low valued trash fish constitutes of about 11 species and their nutritional values were analyzed and the results are presented in Table 2. Protein content was with a range of about 10.4% (*Saurida undosquamis*) to 20.2% (*Arothron hispidus*). The moisture content ranged from 70.41% (*Pellona dayi)* to 85.77% (*Plotosus lineatus*). Highest range of lipid and ash content was observed to about 4.2% (*Trichiurus lepturus*) and 3.3% (*Atule mate*) and lowest range was observed in *Plotosus lineatus* and *Fistularia commersonii* respectively. Carbohydrate was absent in 6 species of low valued trash fishes and in the rest of the fishes it ranged from 0.001 (*Abalistus stellatus*) to 0.34% (*Atule mate*).

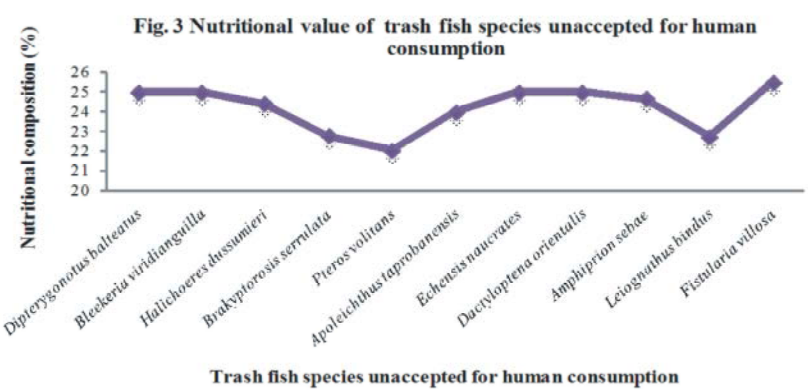
The results of proximate compositions of 11 species of trash fishes unaccepted for human consumptions are presented in Table 3. Carbohydrate was not present in all the 11 species. Highest level of protein, ash, lipid and moisture recorded to about 18.30% (*Apoleichthus taprobanensis*), 3.11% (*Halichoeres dussumieri*), 2.68 (*Halichoeres dussumieri*) and 83.4% (*Amphiprion sebae*) respectively. Lowest level of protein, ash, lipid and moisture recorded to about 10.29 (*Halichoeres dussumieri*), 0.96% (*Bleekeria viridianguilla*), 0.7% (*Pteros volitans*) and 71.24% (*Pteros volitans*) respectively.

Overall, nutrient composition of each species in trash fish categories were graphically represented based on the average (100%) nutrient composition of the each trash fish species Nurnadia *et al*. [33] and are illustrated in Figs. 1, 2 and 3. All the trash fishes are highly rich in nutritional composition (>20%) and are viable in utility for any type of product development with good quality management.

Table 4 depicts the mineral contents of trash fish species of all the three categories varied from each other. Mineral contents such as Zinc, Calcium, Iron, Potassium, Magnesium, Sodium, Silica, Manganese and Copper were analyzed in each species. The total Zinc (Zn) content







Figs. 1-3: Overall Nutritional value of trash fish species categories

present in the trash fish species ranged from 10.06 mg (*Pellona dayi*) to 41.2 mg (*F. commersonii*). Iron (Fe) is a micro element and it is present in small quantity and it was about 14.26 mg (*P. Volitans*) to 62.4 mg (*L. equlus)*. Calcium (Ca) is one of the most important elements for the formation of bone and it is bound partly with proteins and myosin. Calcium content of the trash fish species ranged from 23.6 mg (*P. Dayi*) to 96.1 mg (*L. equlus*). The magnesium (Mg) content ranged from 7.9 mg (*Pinctada radiata*) to 61.33 mg (*C. praeustus*). Potassium (K) content ranged from 13.3 mg (*L. duvaucelli*) to 64.8 mg (*L. lutjanus*). Sodium (Na) content ranged from 10.4 mg (*S. tumbil*) to 77.5 mg (*Portunus pelagicus*). Highest and lowest ranges of Selenium (Si) were found to be 1.2 mg and 0.01 mg respectively. Manganese ranged from 1.11 mg (*D. balteatus*) to 7.9 mg (C. *Japonicus*). Copper composition was in the range of 1.0 mg (*U. sulphurous, A. taprobanensis, A. sebae)* to 9.8 mg (*C. virginicus*).

Two way ANOVA result for nutritional value of commercially important juvenile trash fish showed a significant deviation ($p<0.05$) between parameters and not significant value was recorded ($p>0.05$) between fish

Table 4: Mineral content of trash fish categories (mg/kg)

	Mineral content of commercially important trash fish species (mg/kg)								
Species	Zn	Fe	Ca	Mg	K	Na	Si	Mn	Cu
L. *equlus*	27.0	62.4	96.1	41.1	59.0	54.3	0.004	3.6	4.0
S. *albella*	19.3	32.2	43.7	29.8	39.0	37.9	0.4	3.2	1.7
P. *ditchela*	11.8	31.2	62.5	25.1	50.0	37.5	0.02	5.0	4.4
S. *tumbil*	18.0	25.2	57.2	23.5	42.8	10.4	0.02	5.6	4.0
A. *leucosteron*	22.6	41.7	48.3	37.8	43.0	47.5	0.01	4.23	2.9
P. *chrysozona*	24.2	31.6	52.2	30.2	35.6	33.5	0.01	3.2	2.0
P. *colorata*	21.6	37.4	48.2	32.2	42.2	41.4	0.06	4.0	2.6
U. *vittatus*	17.2	41.5	48.0	35.11	46.4	44.2	BDL	3.2	2.0
L. *lutjanus*	22.3	41.9	78.4	36.2	64.8	52.8	0.002	5.0	3.9
S. *indicus*	24.6	40.4	63.3	31.1	52.2	50.5	BDL	3.8	0.2
C. *praeustus*	26.8	52.1	82.1	61.33	64.10	59.2	0.03	6.9	2.8
H. *bleekeri*	20.6	26.6	46.1	23.2	36.4	34.2	0.5	5.6	2.0
L. *parsia*	18.2	30.3	45.1	26.7	40.0	37.4	0.02	6.0	2.9
P. *pelagius*	37.8	55.0	79.0	54.98	63.5	77.5	BDL	3.9	5.8
S. *inermis*	20.0	29.9	40.1	22.2	26.0	35.3	0.2	3.5	8.7
O. *vulgaris*	31.2	27.5	48.5	34.0	21.4	36.3	BDL	2.4	3.0
L. *duvaucelli*	22.2	26.5	42.5	29.5	13.3	30.0	BDL	4.0	4.8
P. *radiata*	15.1	28.4	49.5	7.9	23.6	30.5	BDL	5.5	4.11
C.*virginicus*	24.3	40.2	56.2	38.2	36.9	42.9	0.2	6.9	9.8
M. *meurex*	24.6	30.6	48.1	30.0	47.0	37.20	0.1	5.0	6.5
	Mineral content of Low valued trash fish species (mg/kg)								
Species	Zn	Fe	Ca	Mg	K	Na	Si	Mn	Cu
A. *hispidus*	28.3	30.8	43.1	30.0	40.8	39.4	BDL	4.6	3.8
P. *lineatus*	13.8	27.3	50.0	21.9	47.2	32.5	BDL	3.2	1.9
L. *cornuta*	12.0	16.8	38.91	17.1	46.0	32.0	0.006	2.0	1.01
C. *japonicus*	22.1	27.0	40.7	25.2	38.2	36.4	0.08	7.9	4.8
T. *lepturus*	31.9	40.7	72.1	36.2	80.0	48.4	0.07	2.0	3.4
F. *commersonii*	41.2	26.2	51.4	22.8	48.0	35.2	0.2	6.0	5.1
A. *stellatus*	17.2	31.5	58.0	30.1	41.0	34.2	0.4	6.2	3.0
P. *dayi*	10.06	14.8	23.6	27.2	40.04	25.8	0.06	1.64	2.25
S. *undosquamis*	19.24	32.8	46.4	25.0	35.08	25.60	0.08	2.55	3.06
A. *mate*	22.11	39.6	58.2	40.8	29.0	51.44	1.2	5.29	1.76
U. *sulphureus*	15.0	24.5	30.0	20.28	24.0	22.20	0.90	3.25	1.0
	Mineral content of trash fish Species unaccepted for human consumption								
Species	Zn	Fe	Ca	Mg	K	Na	Si	Mn	Cu
D. *balteatus*	19.8	31.6	46.1	23.6	40.0	33.4	BDL	1.11	1.6
B. *viridianguilla*	22.7	28.6	41.3	27.5	32.2	30.5	BDL	3.8	0.2
H. *dussumieri*	24.0	24.63	36.0	36.0	29.30	26.8	0.21	2.0	1.14
B. *serrulata*	16.1	33.28	51.24	19.26	33.17	31.2	0.003	3.14	1.08
P. *volitans*	18.3	14.26	23.91	25.85	33.26	28.2	BDL	1.96	2.03
A. *taprobanensis*	25.2	25.0	34.21	31.19	25.60	19.44	0.01	2.78	1.0
E. *naucrates*	25.0	32.8	47.9	27.6	44.4	37.5	0.1	3.0	4.2
D. *orientalis*	15.4	19.2	41.6	25.0	36.2	30.9	0.01	3.2	3.0
A. *sebae*	14.26	17.6	30.0	27.21	30.0	27.78	0.010	4.04	1.0
L. *bindus*	21.77	35.50	32.94	25.0	26.8	32.99	0.01	2.36	2.68
F. *villosa*	23.68	21.78	29.87	25.06	36.11	40.60	0.001	2.14	1.15

Table 5: Two way ANOVA of three group fishes from result between nutritive value and trash fish species

Source of Variation	SS	df	MS	F	P-value	Remarks
Commercially important juvenile trash fish						
Between species	1.096	19	0.058	0.008	1.000	NS
Between parameters	89667.674	4	22416.918	2930.844	0.000	*
Total	90250.065	99				
Low valued trash fish						
Between species	79.911	10	7.991	1.198	0.321	NS
Between parameters	47578.912	4	11894.728	1783.534	0.000	*
Total	47925.590	54				
Unaccepted for human consumption						
Between species	54.093	10	5.409	0.763	0.662	NS
Between parameters	44313.385	3	14771.128	2082.532	0.000	*
Total	44580.265	43				

"*"- Significant at 5% level, "NS" – Not significant

Table 6: Two way ANOVA of three group fishes from result between minerals and trash fish species

Source of Variation	SS	df	MS	F	P-value	Remarks
Commercially important trash fish						
Between species	7954.160	19	418.64	6.837	8.8E-13	*
Between parameters	64768.902	8	8096.113	132.222	1.8E-64	*
Total	82030.186	179				
Low valued trash fish						
Between species	2764.518	10	276.4518	5.403	4.5E-06	*
Between parameters	26542.677	8	3317.835	64.845	8.8E-32	*
Total	33400.452	98				
Unaccepted for human consumption						
Between species	479.825	10	47.98251	2.195	2.6E-02	*
Between parameters	18939.204	8	2367.401	108.278	1.2E-39	*
Total	21168.15796	98				

"*"- Significant at 5% level, "NS" – Not significant

species. Result of nutritive value of low valued trash fish showed a significant deviation ($p<0.05$) between parameters and not significant value was recorded ($p>0.05$) between fish species. Nutritional value of trash fish species of unaccepted for human consumption showed a significant deviation ($p<0.05$) between parameters and not significant value was recorded ($p>0.05$) between fish species (Table 5).

Two way ANOVA result for three group of fishes such as nutritional value of commercially important juvenile trash fish, low valued trash fish and species unaccepted for human consumption showed a significant deviation ($p<0.05$) between minerals and between fish species (Table 6).

DISCUSSION

Fishes generally contain calcium, protein, vitamins, iron and are relatively high [41]. The proximate composition of fish species greatly varies during the catching season due to physiological reasons and changes of environmental conditions [42]. Several studies have been carried out on the nutritional composition of fishes [43-50]. Ayyappan *et al*. [51] estimated protein, lipid and ash content of miscellaneous edible fish from shrimp trawlers and reported that most of the species had high lipid and low moisture contents. Kevin and Rimmer [14] reported that the nutritional status of marine trash fishes was high and it was used for the preparation of aquaculture grade Peruvian fishmeal. Ehigiator and Nwangwu [52] reported proximate composition of muscle sample of prawn *M. macrobrachion* and observed that muscle sample gave true value of nutritional status instead of other parts. In the present study also fish muscle sample were taken for the analysis. Trash fish comprises variety of species with various sizes and there was no report on nutritional status of trash fishes. Present study indicates that all the trash fishes had good nutritional profile as like consumer preference fishes. Moisture is one of the major components of all species and all types of fish [53]. In the current study, moisture content of trash fishes ranged from 70.41% to 87.36%.

The moisture content of miscellaneous trash fish had inverse relationship with lipid content. The percentage of moisture is good indicator of its relative contents of energy, proteins and lipids. Gopakumar [54] reported lower percentage of water (<90) with high content of lipid and protein contents in lantern fish (*Benthosema pterotum*).

Protein and lipid are the major nutrients in fish and their levels help to define the nutritional status of the particular organism [55, 56]. Mazumder *et al*. [53] reported protein content of commercial fishes of *sardine* (20%). Abdullahi [57] reported protein content of oyster (11%), mackerel (12%) respectively. Bhulyan *et al*. [58] reported protein content of beef (18%), lamb (16%) and pork (10%). Protein content of the trash fishes varied between 10.07% to 23.1%. Brain and Allan [59] reported that the protein content of mollusc were <11%, but in contrast in our results the protein content varied from 10 to 18%.

Lipid content of the trash fishes had wide variations and, all the fishes showed <4% lipid value and the result of the present study was slightly lower (6%) than the earlier report of Osman *et al*. [60]. Love [7] has mentioned that lipid is the most variable component in fish and was generally low, ranging between 0.13 - 3.9%. The differences in these values could be due to many factors such as fat content in fish vary according to seasons, species and geographical variations. Age variation and maturity in the same species may also contribute to the significant differences in the total lipid content [61]. According to Chilima [62] fat contributes to energy supply and assists in the proper absorption of fat soluble vitamins such as A, D, E and K in species and this suggests that the species of this study being rich sources for fat could also be good source for vitamins.

Fish contain far less carbohydrate than foods of plant origin. The small amounts present can be ignored as far as their nutritional value is concerned, but they have important consequences for fish quality during processing. The major carbohydrate in fish muscle is glycogen which is a polymer of glucose [63]. In the present study, carbohydrate range was recorded to about 0.01% to 4.49%. Anthony *et al.* [64] reported that carbohydrate content in fish is generally very low and practically considered zero. Ravichandran *et al*. [65] reported that crustacean may contain between 0.1 - 2.5% glycogen and molluscs have high glycogen content typically in the range 1 to 7%, but it can vary seasonally and declines rapidly after death especially during the stress and struggle associated with capture. Jeyasree *et al*., [63] reported similar findings in demersal fishes. Ramaiyan *et al*., [66] reported similar findings in 11 species of Clupeids. The low values of carbohydrates recorded in the present study suggest that glycogen in many marine animals does not contribute significantly to the total reserves of the body.

The ash content of the species is an indication of the mineral concentration in the organisms [67-69]. Emmanuel *et al*. [70] reported that miscellaneous trash species contain rich source of minerals. Ash content in this study ranged from 0.38% to 3.7%, this result gave an indication that the fish samples are the good sources of minerals such as calcium, potassium, zinc, iron and magnesium. Present findings show ash content of trash fish coincides with the value of ash content of commercial fishes. Mazumder *et al*. [53] stated that small indigenous finfish species had considerable range of ash content but the percentage of occurrence was low compared with crustaceans. Asuquo *et al*. [71] stated that marine species have high ash content compare to fresh water species; because they live in high salinity environment. The ash content for all the trash fish samples examined was not above the world health standard of above 5% [72].

Minerals are essential nutrients and are the components of many enzymes and metabolism and contribute to the growth of the fish [73]. Minerals serve as structural constituents of soft tissues. The macro elements like Calcium, Potassium, Sodium, Magnesium and micro minerals such as Iron, Zinc, Copper, Selenium and Manganese elements present in trash fishes. The minerals are essential in the regulation of pH, osmotic pressure, water balance, nerve impulse transmission and active transport of glucose/amino acids [73]. In the present study, macro or major minerals that are presented in fairly large quantities, micro or trace minerals which are presented in smaller quantities in all the trash fishes. Mawaddah *et al.* [7 4] reported trash fishes as waste but it is having relatively high content of calcium, proteins, vitamins, iron and minerals, so it is potential to be used as raw material for the manufacture of peptone for bacterial growth media.

Iron is an essential component of the respiratory pigments, hemoglobin. Iron was recorded as micro element because body needs it in trace amounts [75]. In the present study, trace mineral especially iron was found in high concentration in all the animals studied. Iron (Fe) is a micro element and it is present in small quantity and was estimated to about 14.26 mg to 62.4 mg. The high concentration of iron in the body may not be harm full since this mineral is known to play many useful roles in the physiological activity of the animal [76].

The potassium content of the fishes varies with the species from 13.3 mg (*L. duvaucelli*) to 64.8 mg. Stansby [43] reported that the average potassium value of commercial fishes was 300 mg%. Steffens [77] reported that the potassium content in mussels, scallops and clams were 56, 45, 80 mg% respectively. Rafia *et al*. [78] reported that the potassium content in trash fish in Karachi, Pakistan ranges between 24-45 mg/kg.

High-protein foods of fishes contain highest amount of zinc and it is easily absorbed from these sources. Zn is the less abundant metal of the fish species. Stanek *et al*. [79] reported that Zn has high tendency to accumulate in the muscle. Zn concentration in the muscle of the studied fish was lower than the permissible level (40 mg/kg) recommended by Western Australian Food and Drink regulations [80]. The high zinc content in animal may be due to high concentration of metal in the water [81].

As a co-factor or component of several key enzyme systems, manganese is essential for bone formation and muco polysaccharide synthesis, the regeneration of red blood cells, carbohydrate metabolism and the reproductive cycle [82]. The manganese content varies in trash fish muscle to about 1.1 to 7.9 mg/kg. This result is in agreement with the observations of Orent and McCollum [83] stated that fish muscle contains 0.1-10.0 mg/kg of manganese. Yilmaz [84]; Ahmed and Naim, [85] reported the similar concentration of manganese in muscle tissue of fish, while Huang [86] observed the lower Mn content in fish tissue. WHO [87] reported the tolerance limits in fish for manganese were 12 mg/kg. Lindow and Peterson [88] observed that the muscles of Herring, Pike, Salmon, Sunfish, Smelt, Shad, Trout, Mackerel, Flounder, Eel and Cod fish from red sea to be manganese free. Skinner and Peterson [89] found that the manganese content of cod fish from Lake Champlain was 6.3 mg/kg.

Calcium is a major mineral constituent of bone [90] and has specific storage depots (bone tissue). The soft bones of small fish are valuable sources of calcium. In the present study, the level of Calcium ranged to about 23.6 mg (*P. Dayi*) to 96.1 mg (*L. equlus*) and there were appreciable level of Calcium obtained from all the species ranged within the WHO limits i.e. between 19 - 881 mg/kg [87]. Sodium is the main monovalent ion of extracellular fluids; sodium ions constituting 93% of the ions (bases) found in the blood stream [91]. Sodium and chloride tie for the third most abundant minerals in the body. They are both electrolytes, like Potassium and have a close relationship with each other. Together they maintain fluid and electrolyte balance [92]. The sodium content studied is found to be in the range between 10.4 mg to 77.5 mg/kg. Stansby [43] estimated the average value of sodium (63 mg/kg) in commercial fishes. In present study, results show that trash fishes had >30% sodium content in most of the fish and crustaceans and mollusk.

The magnesium (Mg) content ranged from 7.9 mg (*Pinctada radiata*) to 61.33 mg (*C. praeustus*). Magnesium is an essential component of bone, cartilage and the crustacean exoskeleton [93, 94]. In soft tissues, magnesium observed both intra and extracellular homeostasis in fish [95] and crustaceans [96]. There is no marked variation noted in magnesium content. Stansby [43] reported that the average magnesium content in commercial fishes as 95 mg/kg. While calcium and phosphorus have specific storage depots (bone tissue), magnesium is not so easily being stored.

Selenium was identified as an essential nutrient to the body only within the last fifty years [87]. Fish is a particularly good source of the mineral selenium. Selenium is a component of some of the enzymes which reduce the risk of free radical damage. It is also necessary for the use of iodine in thyroid hormone production and for immune system function [97]. In the present study, trash fishes had selenium content, ranges between 0.01 and 0.8 mg/kg. Copper has a greater affinity than most metals [99-103]. The concentration of Cu in the muscle of the trash fishes was below the permissible level of 30 mg/kg recommended by the National Health Medical Research council [80]. In the present study, the copper content ranges between 0.2 - 9.8 mg/kg. A high value of copper concentration was reported for molluscs from various parts of the world [104-106] and is coincided with the results of the present study. Agusa *et al.* [1] reported that copper content was high in oysters, crabs and lobster but in the present study, high copper content was observed in prawn.

From the present investigation it was concluded that the overall nutritional composition of each trash fish categories were above 15% and contain important minerals which proves that the trash fishes are of good nutritional value, which can utilize in many aspects such as poultry feed, food supplements and several byproduct such as fish protein concentrate, fish fertilizer and fish meal.

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