NUTRITIONAL ASSESSMENT OF CERTAIN DRY FISHES CONSUMED BY THE TRIBAL PEOPLE OF TRIPURA, INDIA

Biplab De[1], Samir Ranjan Das[2], Raja Chakraborty[3], Kaushik Choudhury[1], Pratap Kalita[3]
Saikat Sen[1,*]
[1]Regional Institute of Pharmaceutical Science And Technology, Abhoynagar, Agartala, Tripura-799005, India
[2]Noagao High School, Kamalpur, Tripura, India
[3]Department of Pharmacy, Assam down town University, Panikhaiti, Guwahati, Assam – 781026, India
*E-mail: saikat.pharm@rediffmail.com

Abstract
Nutritional amenities attainable from the raw dry fishes of different traditional communities of Tripura are very exigent in health care system. Consumption of dry fishes by the tribal denomination of Tripura is demotic. The main aim of the present investigation was to evaluate the nutritional value of certain dry fishes consumed by the tribal people of Tripura, India, and to determine the change in nutritional component after 120 days of storage. Dry fish of five different freshwater small indigenous fish species i.e. mola (Ambylpharyngodon mola), dhela (Osteobrama cotio cotio), chapila (Gudusia chapra), punti (Puntius sofora) and tengra (Mystus vittatus) were selected in this study. Different parameters like proximate composition, protein fraction, profiling of amino acid and mineral composition were analyzed immediately after collection of dry fishes and after storage of 120 days. Results showed that the dry fishes are a good source of protein and minerals. Highest protein content (68.36 % DM) was observed in chapila, whereas punti sample contains highest fat (8.92 % DM) and carbohydrate (18.86 % DM) after collection. The current work pretended a miniature change in proximate composition on post-storage. Moisture content was increased on post-storage than pre-storage due to the absorption of moisture during the storage period. A slight increase in mineral composition was observed in dry fish sample after storage. Moreover individual protein fraction quantity and amino acid profile decreased due to denaturation of protein after 120 days of storage

Keywords: Dry fish, Tripura, Proximate composition, Amino acid, Minerals, Storage

Received: 18.09.2019 Reviewed: 04.11.2019 Accepted: 09.12.2019

1. INTRODUCTION

Fish and different products of fish have been related to the socio-economic existence of the different ethnic groups of Northeast India from ancient time (Kakati and Goswami, 2013). It was estimated that about 16% of animal proteins consumed by the people around the globe are derived from fishes, and more than 1 billion people depend on fish as a foremost source of protein from animals. People of the region eat fish regularly which is one of the main sources of animal protein. Besides protein, dried fishes are the good source of different nutritional compounds (Muzaddadi, 2013; Ullah *et al.,* 2016). Different preparation of dry fish is popular in this region. Though, previously it was believed that people from poor socio-economic class like labourers, people working in estates plantations, and coal mines are the main consumer of dry fish (Vijayan and Surendran, 2012). But in recent time dry fish gain its popularity among all section of people. Fish drying is an ancient practice among the different ethnic communities of Northeast India. There are high demand traditionally prepared dry fishes in several local markets of this region (Ullah *et al.,* 2016). Drying, smoking, salting, curing are the common process involved in the preparation of dry fishes and to store them for a longer period of time. Dried fish considered as a source of low-cost dietary protein and used by the people as a substitute for fresh fish (Ullah *et al.,* 2016). A wide variety of freshwater fish species are available in the eight states of this region. Dry fish when preserved properly can consume all around the year. During monsoon time, there is an abundance of different types of freshwater fish that caught from the rivers and big ponds. In recent time, a number of researchers are going

as the popularity of dried fishes is increasing (Ullah *et al.,* 2016).

Tripura is small, hilly state located in the North-eastern region of India. It lies between longitudes 91°09' and 92°20' E & latitudes 22°56' and 24°32' N. Tripura is the third smallest state of India with a total area of 10,492 km². This is a land of different ethnic community and Bengali people. There are about 19 ethnic communities (i.e. Tripuri, Jamatia, Reang, Noatia, Chakma, Bhil, Bhutia, Chaimal, Garo, Halam, Khasia, Kuki, Lepcha, Lushai Mag, Munda, Kaur, Orang, Santhal, and Uchai) lives in Tripura (Sen *et al.,* 2011). Dry fish is equally popular among Bengali and tribal people.

Aim of the study was to evaluate nutritional content, protein fraction and amino acid profile in five different small indigenous dry fish commonly consumed in Tripura, India, and to determine the change in various nutritional contents when stored for a long time.

2. MATERIALS AND METHODS

2.1. Sample collection

Dry fish of five different freshwater small indigenous fish species were selected in this study. People of Tripura like these dried fishes because of their abundance, taste and low cost. Dry fish species includes mola (*Ambylpharyngodon mola*), dhela (*Osteobrama cotio cotio*), chapila (*Gudusia chapra*), punti (*Puntius sofora*) and tengra *(Mystus vittatus).*

Dry fish sample of mola, dhela, chapila, punti, and tentra were collected from the Maharahgong Bazaar, Tripura, India. The collected specimens were stored in airtight container in dry and cool place for further experiment.

2.2. Proximate analysis

After morphometric examination, fishes were cleaned and dissected with a cleaned stainless steel knife. Whole dry fish was taken for measurement of different parameters as people of Tripura cook entire dry fish and consumed as a whole. Samples were analyzed for proximate composition. For proximate composition, moisture content, protein content, ash value, fat content, and carbohydrate content was estimated immediately after collection and after120 days of the first estimation. During 120 days of storing period, the dry fishes were stored in natural condition.

2.3. Moisture content estimation

Moisture was estimated by drying the dry fish sample at +105˚C in an oven. Sample was placed in a cleaned aluminum dish and then the sample was kept in a controlled oven and was dried at 105˚C till the constant weight was obtained (Siddique and Mahbuba, 2011). Moisture content was estimated using the following formula,

% of moisture = (weight of the sample – weight of the dried sample)/weight of the sample × 100

2.4. Estimation of protein content

Protein content was determined using the conventional micro-Kjeldahl method. Crude protein content in the dry fish was estimated by converting the nitrogen content obtained by Kjeldahl's method using the following equation (Latifa *et al.,* 2014),

% of protein = % of total N_2 x 6.25

2.5. Estimation of fat

Fat content was estimated using Soxhlet method. About 1-2 g of sample was kept in a thimble and placed in extraction apparatus. Few boiling chips were added into the extraction apparatus and dried for 2 h at 103°C. The jar was cooled at room temperature (20°C) and weight was taken. Extraction thimble was placed in extraction jars and fat was extracted using 140 ml of the diethyl ether. The % fat was calculated using standard formula (Hassan *et al.,* 2014).

2.6. Ash value estimation

A 5 g dry fish sample was weighed into an empty preweighed crucible and kept in a muffle furnace which was then ignited at 550°C for 12 hr. The furnace was turned off to cool and then the sample was weighted again.

The ash content was calculated as follows (Hassan *et al.,* 2014; Jim *et al.,* 2017),

% Ash = (Weight of crucible plus sample after ashing – Empty weight of crucible) / weight of the sample before adding x 100

2.7. Carbohydrate content estimation

The percentage of carbohydrate was determined by simply subtracts the total percentage of moisture, protein, fat and ash from 100. The following equation was used to estimate the amount of carbohydrate (Siddique *et al.,* 2012),

Carbohydrate (%) = 100 – (% moisture + % protein + % fat + % ash)

2.8. Protein fraction determination

Each species of the dry fish sample was oven dried in an electric oven at between 70-80°C until the sample had constant weight. From each composite sample, 2.0g was measured and taken as an analytical sample. For the determination of protein fraction, the muscles from each species were encased carefully. Protein fraction was determined by Hashimoto et al. (1979) (Hashimoto *et al.,* 1979). All the operations were performed at 3-4°C as for as possible. The protein fraction obtained after fractionation was determined by the Kjeldahl method.

2.9. Amino acid profiling

Dried samples of mola, dhela, chapila, punti, tengra were again oven dried and ground into powder with a homogenizer. From the dried powder, amino acid analysis was done following the methods of Bidlingmeger et al. (1994) using a column from Waters Corporation (Bidlingmeyer *et al.,* 1984).

2.10. Mineral composition assessment

For determination of macro and micronutrients contents, of dried fish samples were digested with concentrated nitric acid. The digested sample composition was determined using Perkin Elme 2380 Atomic Absorption Spectrophotometer following modified method of Cresser and Parson (1979) (Cressre *et al.,* 1979).

3. RESULTS AND DISCUSSIONS

3.1. Analysis of proximate composition

After collection of samples of dry fishes, the proximate composition evaluations have been carried out and the findings are tabulated Table 1.

Ash and moisture content typically less in punti (0.98 ± 0.07 % DM) and mola (5.76 ± 1.01 % wt) respectively, maximum protein content found in chapila (68.36 ± 2.23 % DM).

In addition, maximum fat (8.92 ± 1.98 % DM) and carbohydrate (18.86 ± 2.08 % DM) content were observed in punti.

The experiment was repeated after 120 days to find out alteration in the proximate compositions for dry fishes after when stored in normal condition (Table 2).

Ash value and moisture content relatively increased while protein and fat content relatively decreased compare to first evaluation. High level of ash (5.93 ± 0.71 % DM), moisture (9.99 ± 2.01 % wt) and protein (66.30 ± 2.98 %DM) content have been executed in chapila after the storage of 120 days. In case of punti and tengra, fat and carbohydrate content were higher in level respectively.

In the present study, it was observed that all the dry fish sample contain high protein which may be considered as an important source of protein for the people of Tripura. The present study showed little change in the proximate composition after 120 days. Moisture content was increased after 120 days which may be due to the absorption of moisture during the storage period.

3.1. Protein fraction in dry fish sample

The different protein fraction data for different varieties of dry fishes were tabulated in Table 3 and 4. After collection of the sample, the highest percentage of sarcoplasmic protein (6.44%) found in punti, 11.15% myofibrillar protein observed in dhela. The highest level of stroma protein (1.2%) and alkali-soluble

protein (2.4%) found in chapila and punti sample. A reduced level of protein fraction has been noticed in all varieties of dry fishes after 120 days of collection compared to results found in after collection. Sarcoplasmic protein (6.30%) and alkali soluble protein (2.92%) were eminent in punti. Myofibrillar protein (11.10%) and stroma protein (1.2%) were higher in dhela and chapila respectively.

Sarcoplasmic proteins are soluble in neutral salt solutions and found in highest in punti sample. Myofibrillar protein is the highest fraction contains actin and myosin tropomysin, actomysin, which found more in Dhela sample. Stroma protein is connective tissue protein found more in Chapila sample. Alkali-soluble protein was in the range of 3% to16% (after collection), 2.33 to 16% (after storage period) in the different dry fish sample. The result showed that all dry fish sample selected for the study is a good source of different protein. Percentage of protein and individual protein fractions were decreased after 120 days of storage. The loss of crude protein in dry fish during the storage period is largely due to the formation of free drip accomplished by loss of sarcoplasmic protein and other protein tested. The alteration of protein is probably linked with decreased water holding capacity of the fish muscle during storage. But results confirmed that dry fish is remain a good source of protein after 120 days of storage.

Table 1. Proximate composition of selected dry fish (after collection)

Dry fish	Ash (% DM)	Moisture (% wt)	Protein (% DM)	Fat (% DM)	Carbohydrates (% DM)
Mola	3.40 ± 0.76	5.76 ± 1.01	67.25 ± 2.07	5.72 ± 1.22	17.87 ± 1.99
Dhela	3.06 ± 0.54	5.96 ± 0.97	66.58 ± 1.89	6.90 ± 1.30	17.50 ± 2.76
Chapila	4.54 ± 0.55	8.29 ± 1.10	68.36 ± 2.23	4.08 ± 1.29	14.73 ± 1.90
Punti	0.98 ± 0.07	6.27 ± 0.89	64.97 ± 2.20	8.92 ± 1.98	18.86 ± 2.08
Tengra	2.82 ± 0.32	6.28 ± 0.94	65.67 ± 2.33	6.80 ± 1.50	18.43 ± 2.50

% DM, g/100 g dry matter. Values are represented as mean ± standard deviation (n=3).

Table 2. Proximate composition of selected dry fish (after 120 days of collection)

Dry fish	Ash (% DM)	Moisture (% wt)	Protein (% DM)	Fat (% DM)	Carbohydrates (% DM)
Mola	3.45 ± 0.55	7.80 ± 2.11	65.20 ± 3.12	5.05 ± 1.29	18.50 ± 1.90
Dhela	3.80 ± 0.44	8.98 ± 2.90	63.56 ± 2.66	6.10 ± 1.52	17.56 ± 2.36
Chapila	5.93 ± 0.71	9.99 ± 2.01	66.30 ± 2.98	3.05 ± 1.41	14.73 ± 1.55
Punti	2.50 ± 0.57	9.58 ± 1.80	62.96 ± 3.50	6.22 ± 1.81	18.74 ± 1.98
Tengra	4.08 ± 0.62	9.70 ± 1.99	62.67 ± 3.83	4.51 ± 1.60	19.04 ± 2.01

% DM, g/100 g dry matter. Values are represented as mean ± standard deviation (n=3).

Table 3. The protein fraction of dried fishes (after collection)

Dry fish	Sarcoplasmic protein %	Myofibrillar protein %	Stroma protein %	Alkali soluble protein %
Mola	2.80 (20.0)	8.82 (63.0)	0.28 (0.2)	1.40 (10.0)
Dhela	4.2 (25.0)	11.15 (66.0)	0.10 (0.6)	1.20 (7.15)
Chapila	2.8 (20.0)	9.01 (64.0)	2.4 (10.0)	0.42 (3.0)
Punti	6.44 (34.0)	8.21 (43.0)	0.57 (3.0)	3.03 (16.0)
Tengra	5.40 (33.0)	10.05 (63.0)	0.20 (0.8)	0.90 (6.15)

*values in brackets expressed percentage of total protein.

Table 4. The protein fraction of dried fishes (after 120 days of collection)

Dry fish	Sarcoplasmic protein %	Myofibrillar protein %	Stroma protein %	Alkali soluble protein %
Mola	2.70 (20.0)	8.72 (66.0)	0.25 (1.9)	1.32 (10.0)
Dhela	4.0 (23.0)	11.10 (66.0)	0.5 (3.0)	1.12 (6.60)
Chapila	2.5 (19.0)	8.87 (68.0)	1.2 (9.32)	0.30 (2.33)
Punti	6.30 (35.0)	8.20 (45.0)	0.51 (2.84)	2.92 (16.0)
Tengra	5.12 (31.0)	9.29 (61.0)	0.15 (0.93)	0.85 (5.30)

*values in brackets expressed percentage of total protein.

3.3. Profiling of amino acid

Both types of protein/amino acids (essential and non-essential) were investigated in all varieties of dry fishes (Table 5). Glutamic acid found to be in higher concentration in all varieties of dry fishes whereas the level of cysteine was comparatively less. In case of dhela the glutamic (6.96 ± 0.12 g/100g protein) level was high and cysteine (0.20 ± 0.03 g/100g protein) was less in mola. After 120 days of collection of dry fishes, again the amino acids levels were measured and data were constructed in Table no 6. In this stage also, the glutamic acid concentration was higher in all samples of dry fishes and level of cysteine was less. The maximum level of glutamic acid found to be in punti (6.72 ± 0.34 g/100g) and less in dhela (5.23 ± 0.16 g/100g). Decline level of cysteine has been noticed in dhela (0.12 ± 0.07 g/100g).

The present result showed that the dry fish samples are also the good source of different amino acid. Although drying process may cause protein denaturation.

3.4. Mineral composition in dry fish

Mineral compositions are also analyzed after the collection of the samples (Table 7). Maximum potassium content found in Dhela (921.41 ± 8.83 mg/100g). Magnesium (122.32 ± 3.13 mg/100g) and calcium (229.31 ± 4.67 mg/100g) content was high in mola. Content of copper (5.83 ± 0.43 mg/100g) and manganese (6.02 ± 0.72 mg/100g) were found more in tengra, while iron (42.11 ± 2.01 mg/100g) and zinc (17.77 ± 0.98 mg/100g) content was more in chapila. Among all the minerals, K level was high compared to others and level of Cu was less. After 120 days of storage, mineral compositions were further evaluated (Table 8). Contents of mineral were increased in the dry fish sample after 120 days of storing. Level of potassium and calcium were comparatively high in the dhela dry fish. Magnesium, iron, zinc found more in chapila, Cupper and manganese content is comparatively more in tengra.

In this study micronutrient such as Zn, Cu, Mn etc content was determined using the whole fish sample and observed that dry fish sample contain a good amount of minerals which may beneficial for health. It was observed that slide increase in the mineral composition in the dry fish sample after storage. During natural storage, different oils are applied on the dry fish to prevent denaturation and increase the storage duration. Therefore it is possible that mineral present in those oil may penetrate into the dry fish sample and thus the quantity of minerals in the sample was increased after 120 days of storage

Table 5. Amino acid profile of dry fishes (after collection)

Amino acids	Mola	Punti	Chapila	Dhela	Tengra
Aspartic acid	3.49 ± 0.12	2.80 ± 0.09	3.53 ± 0.14	3.78 ± 0.09	3.54 ± 0.10
Glutamic acid	6.20 ± 0.18	5.76 ± 0.13	6.72 ± 0.18	6.96 ± 0.12	5.92 ± 0.12
Serine	1.32 ± 0.07	1.30 ± 0.16	1.43 ± 0.10	1.40 ± 0.10	1.40 ± 0.10
Glycine	2.47 ± 0.09	3.22 ± 0.12	3.22 ± 0.17	2.99 ± 0.16	3.18 ± 0.19
Histidine	1.18 ± 0.05	1.11 ± 0.10	1.08 ± 0.19	1.03 ± 0.11	1.10 ± 0.10
Arginine	2.74 ± 0.09	2.71 ± 0.12	3.17 ± 0.17	3.20 ± 0.18	3.10 ± 0.13
Threonine	1.76 ± 0.13	1.68 ± 0.12	1.93 ± 0.18	1.87 ± 0.17	1.50 ± 0.16
Alanine	2.68 ± 0.12	2.88 ± 0.18	3.03 ± 0.10	2.93 ± 0.19	2.65 ± 0.17
Proline	2.01 ± 0.12	2.31 ± 0.16	2.30 ± 0.16	2.25 ± 0.15	2.40 ± 0.13
Tyrosine	1.67 ± 0.14	1.60 ± 0.10	1.81 ± 0.17	1.84 ± 0.16	1.65 ± 0.16
Valine	2.38 ± 0.10	2.24 ± 0.16	2.64 ± 0.18	2.50 ± 0.15	2.42 ± 0.17
Methionine	1.28 ± 0.10	1.22 ± 0.09	1.49 ± 0.10	1.46 ± 0.10	1.44 ± 0.13
Cysteine	0.20 ± 0.03	0.24 ± 0.04	0.26 ± 0.03	0.31 ± 0.08	0.25 ± 0.05
Isoleucine	2.19 ± 0.12	2.02 ± 0.11	2.31 ± 0.12	2.35 ± 0.12	2.20 ± 0.12
Leucine	3.26 ± 0.10	3.00 ± 0.11	3.48 ± 0.18	3.51 ± 0.15	3.40 ± 0.12
Phenylalanine	1.87 ± 0.08	1.85 ± 0.09	2.13 ± 0.15	2.07 ± 0.18	1.90 ± 0.10
Lysine	3.64 ± 0.16	3.36 ± 0.15	4.10 ± 0.18	4.13 ± 0.19	3.90 ± 0.15

*values are expressed as 'g/100g protein'. Results are represented as mean ± standard deviation (n=3).

Table 6. Amino acid profile of dry fishes (after 120 days of collection)

Amino acids	Mola	Punti	Chapila	Dhela	Tengra
Aspartic acid	3.40 ± 0.17	3.65 ± 0.20	3.42 ± 0.19	2.15 ± 0.19	3.42 ± 0.17
Glutamic acid	6.10 ± 0.31	6.72 ± 0.34	5.67 ± 0.16	5.23 ± 0.16	5.75 ± 0.26
Serine	1.25 ± 0.12	1.30 ± 0.17	1.40 ± 0.17	1.20 ± 0.12	1.32 ± 0.12
Glycine	2.40 ± 0.22	2.60 ± 0.23	3.01 ± 0.14	3.12 ± 0.18	3.08 ± 0.18
Histidine	1.08 ± 0.18	0.92 ± 0.10	0.95 ± 0.12	1.01 ± 0.10	1.10 ± 0.10
Arginine	2.05 ± 0.19	3.01 ± 0.22	3.01 ± 0.25	2.60 ± 0.17	3.01 ± 0.19
Threonine	1.65 ± 0.19	1.72 ± 0.13	1.65 ± 0.18	1.45 ± 0.14	1.44 ± 0.15
Alanine	2.42 ± 0.25	2.91 ± 0.28	2.92 ± 0.14	2.88 ± 0.18	2.15 ± 0.17
Proline	1.92 ± 0.17	2.20 ± 0.18	2.01 ± 0.18	2.30 ± 0.15	2.35 ± 0.18
Tyrosine	1.44 ± 0.14	1.74 ± 0.14	1.75 ± 0.19	1.51 ± 0.12	1.42 ± 0.15
Valine	2.21 ± 0.18	2.60 ± 0.17	2.56 ± 0.23	2.21 ± 0.24	2.31 ± 0.17
Methionine	1.11 ± 0.13	1.35 ± 0.15	1.40 ± 0.16	1.12 ± 0.19	1.30 ± 0.12
Cysteine	0.15 ± 0.10	0.25 ± 0.25	0.15 ± 0.17	0.12 ± 0.07	0.16 ± 0.05
Isoleucine	2.01 ± 0.22	2.11 ± 0.27	2.01 ± 0.22	2.00 ± 0.21	2.12 ± 0.17
Leucine	3.10 ± 0.12	3.35 ± 0.28	3.14 ± 0.27	2.90 ± 0.23	3.18 ± 0.18
Phenylalanine	1.75 ± 0.10	2.01 ± 0.17	2.01 ± 0.23	1.75 ± 0.11	1.15 ± 0.11
Lysine	3.42 ± 0.31	3.95 ± 0.28	3.92 ± 0.29	3.21 ± 0.26	3.75 ± 0.18

*values are expressed as 'g/100g protein'. Results are expressed as Mean±SD (n=3)

Table 7. Mineral composition of dry fish (mg/100g) (after collection)

Dry Fish	K	Mg	Ca	Zn	Cu	Mn	Fe
Mola	632.11 ± 7.22	122.32 ± 3.13	229.31 ± 4.67	16.22 ± 0.60	2.65 ± 0.23	4.20 ± 0.50	34.62 ± 1.75
Dhela	921.41 ± 8.83	110.28 ± 3.52	142.42 ± 3.13	13.50 ± 0.64	2.81 ± 0.37	4.04 ± 0.62	39.50 ± 1.88
Chapila	865.42 ± 7.19	121.20 ± 3.21	132.62 ± 3.02	17.77 ± 0.98	1.92 ± 0.22	4.70 ± 0.43	42.11 ± 2.01
Punti	652.60 ± 7.40	119.25 ± 2.63	121.08 ± 2.52	11.34 ± 0.72	3.98 ± 0.38	5.68 ± 0.65	32.62 ± 1.45
Tengra	830.39 ± 9.03	100.01 ± 2.22	120.91 ± 3.28	11.97 ± 0.55	5.83 ± 0.43	6.02 ± 0.72	33.03 ± 1.10

Results are expressed as Mean±SD (n=3)

Table 8. Mineral composition of dry fish (mg/100g) (after 120 days collection)

Dry Fish	K	Mg	Ca	Zn	Cu	Mn	Fe
Mola	649.10 ± 9.34	151.20 ± 5.11	256.32 ± 6.88	18.20 ± 1.01	3.51 ± 0.93	4.99 ± 1.02	44.21 ± 2.99
Dhela	999.91 ± 9.03	140.80 ± 4.99	162.29 ± 5.38	17.51 ± 1.20	3.88 ± 0.77	4.88 ± 1.10	51.22 ± 2.98
Chapila	903.40± 8.92	147.28 ± 4.29	150.21 ± 4.28	20.70 ± 1.18	2.60 ± 0.83	5.57 ± 0.98	60.13 ± 2.77
Punti	702.62 ± 7.88	130.20 ± 3.69	141.33 ± 3.88	14.43 ± 1.22	4.55 ± 0.83	6.38 ± 1.12	45.22 ± 3.01
Tengra	879.30 ± 9.93	133.17 ± 4.25	143.91 ± 3.81	14.75 ± 1.50	6.37 ± 0.92	6.89 ± 1.20	50.01 ± 2.11

Results are expressed as Mean±SD (n=3)

A number of previous investigations have also suggested that dry fishes are a good source of protein, amino acid and minerals (Ullah et al. 2016; Ullah *et al.,* 2016; Ako and Salihu, 2004). Our study also showed similar results and confirms that dry fish is an importance source of protein, amino acid and minerals.

4. CONCLUSIONS

In this study, the nutritional assessment of certain dry fishes consumed by the tribal people of Tripura, India has been estimated. Our findings revealed that consumption of dry fishes by tribal people of the different ethnic community of Tripura has a significant nutritional and medicinal value in their daily health care system.

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