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Proximate Composition, Nutritive value and share of Protein to the diet of Coastal population from four neritic tunas occurring along north western Indian EEZ

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ABSTRACT
Four Important neritic tunas viz. Thunnus tonggol (Longtail tuna), Euthynnus affinis (Little tuna/Kawakawa), Auxis thazard (Frigate tuna) and Auxis rochei (Bullet tuna) were chosen for evaluating the proximate composition and their nutritive value/ Caloric values occurring along North-western Indian EEZ. Percentage of moisture content in these species observed was 71%, 72%, 70% and 74.3% respectively. The degree of protein content was more or less same in T. tonggol and A. thazard (23%) whereas, in case of E. affinis and A. rochei it was between 21-22%. Lipid content in all the four species ranged between 3.1-5.5%. Glycogen value observed to be 0.4% for T. tonggol and 0.3% for E. affinis, A. thazard and A. rochei. The Ash content range among the four species was between 1.2-1.4%. The range of total Caloric values derived was between 1.49-1.82 kcal. Total protein contributed by neritic tunas to the diet of coastal population under study is low during 2015 (69x10^9 kcal) when compared to the year 2014 (75x10^9 kcal).
Keywords: *North-western Indian EEZ, neritic tunas, proximate composition, caloric value, protein content, coastal population*

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INTRODUCTİON

Among the eight species representing in India, occurring in both neritic and oceanic realms, the longtail tuna, *Thunnus tonggol*, the little tuna/Kawakawa, *Euthynnus affinis*, the frigate tuna, *Auxis thazard* and Bullet tuna, *Auxis rochei* are the important neritic tuna species exploited during 2015 was 53,241 tonnes. Tunas are large pelagic fishery resources contributing to the tune of 78,470 t forming 2.23% of the total fish landings of India (CMFRI, 2016). The North-west coast of India covering two maritime states i.e., Gujarat and Maharashtra lies between Lat. 18°N to 23°N. The landings of neritic tunas in Gujarat have shown that *T. tonggol* (54.3%) was the dominant species followed by *E. affinis* (26.8%) and *Auxis spp.* (6.9%). Whereas, in case of Maharashtra, the dominant species was *E. affinis* (55.31%) followed by *T. tonggol* (31.6%) and *Auxis spp.* (4.7%). The coastal tunas form important components of the catches by gill nets and purse seines operated in the North-western Indian EEZ. Fish is considered as rich protein diet. Tuna is an important food fish and its meat is highly nutritious and known for its protein, fat and amino acid contents (Chinnamma, 1975). Nearly 80 nation's fishermen harvest tuna from the world oceans. The harvested tuna are consumed in many ways, i.e., raw, cooked, smoked, dried and canned. Tuna is commonly known as, "Chicken of the Sea". Presently, there is an increased awareness about healthy foods. Of which, fish has been found accepted as highly valued healthy food because of its significant nutritional qualities. Knowledge of biochemical constituents of fish is essential for adopting appropriate technology towards creating awareness or its food and value among consumers and for the development of processing industries. Nutrition has been cited as one of the primary reasons why consumers are attracted towards sea foods (Gall *et al.,* 1983). Sea food provides a good balance of protein, lipid and minerals (Edirisinghe *et al.*, 2000). The nutritive value of fish protein is ranked above casein (Haard, 1995, Snook 1984). Tissues of fish are rich sources of polyunsaturated fatty acids, which have profound implications for health and disease precautions (Uauy *et al.,* 1991). A number of environmental factors such as salinity, temperature and diet affect the biochemical composition of fish (Benitez, 1989). The chemical composition of fish varies widely between species among the individual fishes within the same species depending on age, sex, environment and season (Clucas and ward, 1996). Tuna is an excellent source of high quality protein (Gopakumar, 1997) and Omega-3 polyunsaturated fatty acids (Medina *et al.*, 1995). As per FAO (2016), global per capita fish consumption has increased to about 20 kg/year and fish providing 6.7% of all protein consumed by humans besides other fatty acids, vitamins and minerals. Fish is an exceptionally valuable food with a unique combination of high quality protein and important nutrients. Shyam (2016) reported that around 60% of the Indian population consumes fish and consumption pattern varies spatio-temporally due to different social structure. The annual per capita consumption of fish for the entire population was estimated at 5-6 kg but for the fish eating population in the coastal area was found to be 8-9 kg and this is comparatively poor with global rates. The World Health Organization (WHO, 2002) recommended that regular consumption of fish one to two portions a week with an average portion size of 150grms fish per capita which results an average consumption of 11.7 kg fish per capita. The biochemical composition also may vary from region to region. Edible fish muscle normally contains about 18% protein, 1-2% ash and the balance 80% of the wet weight of muscle is made up of lipid and water (Ackman, 1995). Analysis of biochemical composition and Caloric value/nutritional value is essential to understand the concentrations of the biochemical constituents so as to provide awareness to the consumers about the importance of the neritic tuna species under this study. The values may vary within the same species, especially protein content, which is an important component, tends to vary little in a healthy fish (Weatherly and Gill, 1987). As per the literature, the biochemical analysis of marine fishes was attempted by many researchers, among them Stansby (1962), Gopakumar and Nair (1972), Chinnamma (1975), Devadasan (1994), Gopakumar (1997) , Nair and Suseela (2000), Kris *et al.,* (2002), Siddhappaji and Prabhu, (2002), Peng *et al.,* (2013), Mahaliyana *et al.,* (2015), Rani *et al.,* (2016) and Arunkumar & Padmavathi (2017) have investigated the proximate analysis and utilisation of various marine fishes including tunas. Although, from the tropical waters attempts were made on the assessment of biochemical constituents, the information is rather scanty or inadequate. The proximate composition varies from species to species (Gopakumar,1997). Regular monitoring of changes in the biochemical composition shall enable the consumers and processing industries to understand the importance of tuna meat. Therefore, the present study has been undertaken for four neritic tuna species along the North West coast of India to derive the values of biochemical constituents, nutritional value/ Caloric value and utilization in order to make the consumer to understand the importance of the tuna species. The present analysis is attempted to know the biochemical constituents, such as moisture, protein, lipids, glycogen and ash of fish muscle tissue in the coastal tunas, viz., *Thunnus tonggol, Euthynnus affinis*, *Auxis thazard* and *Auxis rochei.* Although proximate composition of tunas has been reported earlier from South-west coast, a meager attention has been given to assess proximate composition of tunas found in North-west coast. Therefore, the present work on proximate composition of tuna will fill up the gaps existing in this aspect of tunas.

MATERIALS AND METHODS

Neritic tuna samples *viz.*, *Thunnus tonggol, Euthynnus affinis, Auxis thazard* and *Auxis rochei,* were collected from gill net catches from the landing center at Sassoon Dock, Mumbai. These fresh fish samples were brought to the laboratory for recording length and total weight and then the fish muscle was cut separately and weighed. The methods employed for proximate analysis are presented below:-

For moisture estimation, Oven drying method (AOAC, 1975 & 1984) has been followed by maintaining 80°C temperature for 6 hrs. Protein estimation was attempted by Lowry (1951) method. Lipids were estimated based on the Barnes (1973) method. Glycogen estimation was done by following Seifter (1980) method. Ash content was estimated based on AOAC (1975 & 1984) method.

After analysing the biochemical constituents, the energy of muscle tissue have been calculated to understand the Caloric content. The Caloric content was calculated for protein, lipids and glycogen by multiplying the concentration of various components with conversion factors 4.15 for glycogen, 9.4 for lipids and 5.65 for proteins as described by Philips (1969), Somvanshi (1976), Shamsan (2008) have been applied. The Caloric values were expressed as calorie/gram on dry weight basis.

RESULTS

The results of proximate composition of muscle tissues of *Thunnus tonggol*, *Euthynnus affinis*, *Auxis thazard* and *Auxis rochei* are presented in the Table 1.

As per the above derived results, it was observed that variations exist in the proximate composition of neritic tunas.

a) **Moisture:** The degree of percentage of moisture content can be read as *Auxis rochei (*74.3%), *E. affinis* (72%), *T. tonggol* (71%) and *A. thazard* (70%). As per the observation, except the species *Auxis rochei*, no significant variations in moisture content has been reported in other 3 species of coastal tunas.

b) **Protein:** The degree of protein content in the muscle was recorded as 21.0% (*A. rochei*) 22.0% (*E. affinis*), 23.0% (*A. thazard*) and 23.2% (*T. tonggol*). In all the species, value of protein in the muscles ranged from 21.0 to 23.2%. From the nutritional point of view, protein is the most important constituent of the fish.

c) **Lipids:** The distribution of lipids within the body of a fish is not always uniform. The Different tissues vary in their lipid content and their composition. In the present study the lipid content of the muscle samples varied between 3.1 to 5.5%. The degree of lipid content in the muscle samples of these species can be put as *A. rochei* (3.1%), *T. tonggol* (4.2%), *E. affnis* (4.4%) and *A. thazard* (5.5%).

d) **Glycogen:** Glycogen plays a vital role in muscular action and acts as immediate source of energy and also associated with the feeding and spawning of the fishes. The glycogen values obtained for *Thunnus tonggol* was 0.4%, and for *Euthynnus affinis, Auxis thazard* and *Auxis rochei* the value was similar (0.3%).

e) **Ash:** A large number of minerals are present in ash content of fish. Most of the minerals present in sea water are also present in the fish muscles. The study of ash content of fish is to have an idea of the minerals contained in the fish. The important minerals present in fish are sodium, potassium, calcium, phosphorus and magnesium. Elements of special nutritional significance present in fish are iodine and fluoride. The present study of ash could give an idea of the percentage of mineral content of coastal tunas. The Ash content of the species studied can be in the order of *A. rochei* (1.2), *Auxis thazard* (1.2), *E. affinis* (1.3) and *T. tonggol* (1.4). The species *A. thazard* and *A. rochei* have got similar contents. In all the species studied no much significant variation is reported in the ash contents.

The Caloric value/ Nutritive value

Based on the analysed values of the biochemical constituents, the energy values of the muscles have been calculated to understand the caloric content. The caloric value/ nutritive values in the present study are represented in Table 2.

As per the table 2, *T. tonggol* is showing highest caloric value in the protein content (1.31 kcal/gm) followed by *A. thazard* (1.30 kcal/gm), *E. affinis* (1.24 kcal/gm) and *A. rochei* (1.18 kcal/gm) whereas, the caloric value for lipid content is more in *A. thazard* (5.17 kcal/gm) followed by *E. affinis* (4.14 kcal/gm), *T. tonggol* (3.95 kcal/gm) and *A. rochei* (2.91 kcal/gm). The caloric value in the glycogen content was found to be highest in *T. tonggol* (1.7 kcal/gm) whereas *E. affinis, A. thazard* and *A. rochei* have the similar caloric content i.e. 1.2 kcal/gm in glycogen. The total caloric value found to be highest in *A. thazard* (1.83 kcal/gm) followed by *T. tonggol* (1.72 kcal/gm), *E. affinis* (1.67 kcal/gm) and *A. rochei* (1.49 kcal/gm).

Share of Protein to the diet of coastal population

The neritic tuna production in India during the year 2015 was 53,241 t, of which, the *E. affinis* contribution was 35,858 t followed by *T. tonggol* 9,207 t and *Auxis spp.* 8,176 t (Fig.1). As per the caloric values derived for different biochemical components, the total protein contributed by the neritic tunas under study estimated as 69×10^9 kcal. This value is low when compared to the year 2014 (75×10^9 kcal). During the year 2015, the *E. affinis* contribution towards meeting protein requirement is estimated as 46×10^9 kcal followed by *T. tonggol* 12×10^9 kcal. and A*uxis spp.* 10×10^9 kcal. In the North West coast of India, the contribution of neritic tunas was 17304 t. From this region 22×10^9 kcal protein was produced. The neritic tunas from the state of Gujarat were 14,814 t and the total protein values derived was 19×10^9 kcal wherein, the species *T. tonggol* stands with the highest protein values (73×10^8 kcal) followed by *E. affinis* (36×10^8 kcal) and A*uxis spp.* (9×10^8 kcal). The contribution of Maharashtra was 2490 t and the protein values derived was 32×10^8 kcal. of which, the *E. affinis* was dominated in protein contribution (19×10^8 kcal) and was followed by *T. tonggol* (11×10^8 kcal.) and *Auxis spp*. (1×10^8 kcal.). Comparatively, in the northwest coast of India, Gujarat is meeting more protein requirement than the state of Maharashtra as for as neritic tuna species are concerned (Fig. 2 & 3).

DISCUSSION

Utilisation of fish caught from the sea would reflect on status of fish production to meet protein demand of the people. The fisheries sector in India helps to improve socio-economic condition of the fishing community as well as generates employment and meets the need of the fishing industry in supplying sea food to domestic and export markets. Diversification of fishing activities, processing technologies has lead to the introduction of new products and their promotion of marketing for exports besides the domestic consumption in India. Presently in India, tuna and tuna like fishes are processed in traditional way as well as by using advanced techniques to make products in various forms *viz.* (a) fresh (b) tuna meal in which the whole fillet is cooked, dried and powdered, which is used in cattle and poultry feeds (c) tuna wafers (d) tuna fingers (e) tuna cutlet (f) tuna chutney powder (g) tuna flakes (h) tuna meat pickle. Quantitatively, protein is the second major component in the muscle of fish. Protein content of most tuna species ranges between 15-30% (Bykov, 1983). Protein content of tuna species were reported to be around 27% (Gopakumar, 1997; Stansby 1962; Love.1970). A little variation of protein content in particular species can occur seasonally (Clucas and Ward, 1996). Protein content in fish ranges between 13.8-25.2% (Spinelli and Dassow, 1982). The values obtained for protein in the present study are in the range of 21-23% and these are well within the range of above researchers. Tuna can be used as a good protein source due to its high protein digestibility (Linder, 1985). In general, the moisture content of fish varies between 28-90%. The water content varies due to growth, maturity, spawning, feeding and starvation. High moisture content in fishes is associated with low content of fat (Clucas and Ward, 1996). Determination of moisture content in tuna is an important factor when comes to various processing techniques such as smoking, drying etc. The moisture content is to be reduced to a particular level to prevent the degradation of the processed tuna (Mumthaz *et al.*, 1999). The moisture content range of 71-74% was observed in the present analysis and these values are close to the values of Rani *et al.*, (2016) from the south west coast of India. Though moisture content is not so important from the nutritional point of view but it plays a crucial role in understanding the texture of food material. The moisture content decides the spoilage of fish. The range of values derived for the proximate composition, in the present study for moisture, protein, fat and ash are supported by the works of Stansby (1961) from world oceans and Nair & Suseela (2000) from Indian waters.

CONCLUSION:

The bio-chemical constituents and nutritive values required to be analysed from time to time as drastic changes are taking place in the marine environment due to dumping of pollutants into the sea and bioaccumulation of toxic metals which may result in variation of bio-chemical constituents of the aquatic living resources. The present analysis would provide the knowledge of the bio-chemical constituents and the nutritive values of four neritic tunas occurring in the North-western Indian EEZ and also provides information on the share of protein from the neritic tunas and as per the analysis 69×10^9 kcal proteins per annum was found to meet the diet of coastal population of the region.

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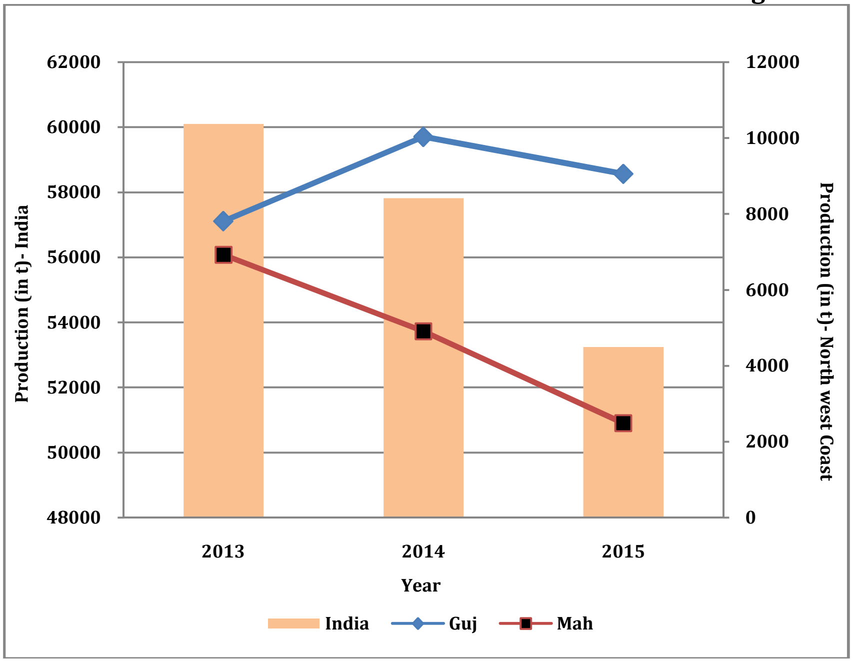
Table 1: Percentage composition of proximate analysis of Coastal tunas

Proximate composition	*Thunnus tonggol*	*Euthynnus affinis*	*Auxis thazard*	*Auxis rochei*
Moisture	71.0	72.0	70.0	74.3
Protein	23.2	22.0	23.0	21.0
Lipid	4.2	4.4	5.5	3.1
Glycogen	0.4	0.3	0.3	0.3
Ash	1.4	1.3	1.2	1.2

Table 2: Caloric value of Coastal tunas due to biochemical constituents

Proximate composition	Protein		Lipid		Glycogen		Total Caloric value
Species name	%	kcal/gm	%	kcal/gm	%	kcal/gm	kcal/gm
Thunnus tonggol	23.2	1.31	4.2	3.95	0.4	1.7	1.72
Euthynnus affinis	22.0	1.24	4.4	4.14	0.3	1.2	1.67
Auxis thazard	23.0	1.30	5.5	5.17	0.3	1.2	1.83
Auxis rochei	21.0	1.18	3.1	2.91	0.3	1.2	1.49

Fig. 1. Total Neritic Tuna Production of India Vs North West Coast during 2013-15



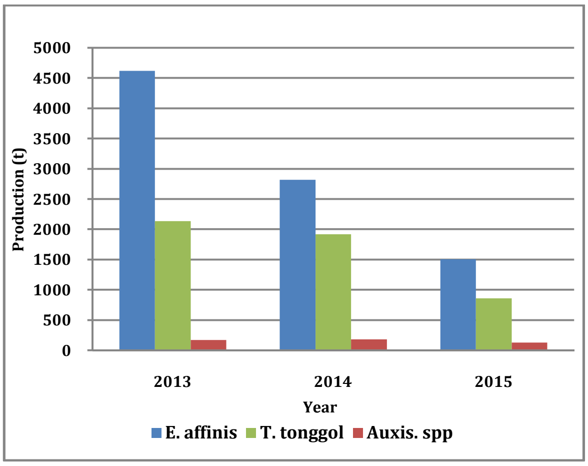


Fig. 2. Neritic tuna production (Species-wise) of Maharashtra during 2013-15

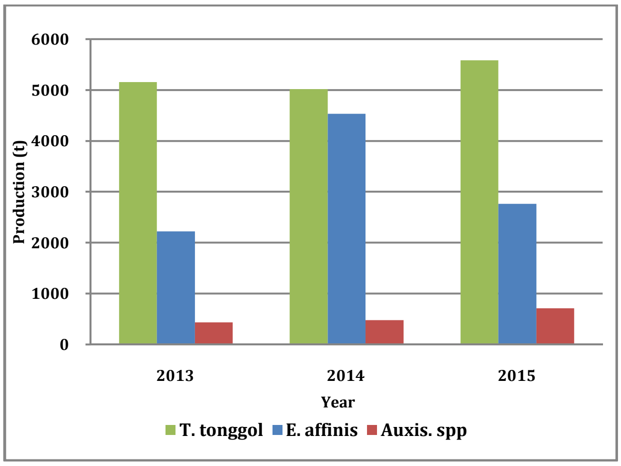


Fig. 3. Neritic tuna production (Species-wise) of Gujarat during 2013-15

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