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Seasonal variation of proximate composition of tuna fishes from Visakhapatnam fishing harbor, East coast of India

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Abstract
The present study was carried out to assess the proximate composition of tuna fish Kawa kawa (*Euthynnus affinis*) and frigate tuna (*Auxis thazard*) from Visakhapatnam fishing harbor, East Coast of India. These fishes inhabit coastal waters and have preference staying in relatively warm water. In the present study the proximate chemical composition and seasonal variations of moisture, protein, fat and ash in marine fishes *Euthynnus affinis* and *Auxis thazard* were recorded during three different seasons. High moisture content was observed during pre-monsoon seasons (77.01±0.16 in *E. affinis* and 79.71±0.36 in *A. thazard*), while high protein concentration was seen in monsoon season (25.16±0.10% and 23.34±0.21%) in both *E. affinis* and *A. thazard* species. Whereas high mean concentration of fat was found in post-monsoon season in the case of *E. affinis*, recording 1.37±0.16% and in monsoon season in the case of *A. thazard* (1.25±0.07%). High ash percentage was noted in pre-monsoon season in *E. affinis* (1.13±0.14%) and in post-monsoon season in *A. thazard* (1.01±0.27).

Keywords: Proximate composition**,** euthynnus affinis, auxis thazard, food and agriculture organization

1. Introduction

Fish constitutes a very important component of the diet for many people and often gives the much needed nutrient that is not provided by the cereal-based diets [1]. Nutrition has been mentioned as one of the most important reasons why consumers are attracted to seafood [2]. Seafood, especially finfish provide a major source of essential nutrients such as proteins, vitamins, fats and minerals which help in the maintenance of life to man [3]. Basically, tuna meat is considered highly nutritive owing to its content of essential amino acids, protein and fat [4]. Tuna fish is well known for its rich food value as it contains elevated levels of Omega-3 polyunsaturated fatty acids, which has many health benefits like it lowers the risk of heart diseases, reduces cholesterol levels, regulate blood pressure, prevents arteriosclerosis and there are many other health benefits. Tuna also contains minerals like phosphorous which are important for the nervous system and iodine which is conducive for balanced growth. Besides, it also contains vitamins like niacin and vitamin B12 necessary for cell growth and proper metabolism of fatty acids and cholesterol [5].

Tunas are among the largest and most specialized and economically imperative of all fishes [6]. In India, tuna fisheries are concentrated mainly on the coastal region while offshore tuna fishery resources are yet to be exploited commercially. There is a considerable increase in tuna fish exports from India from 16,627 t in 2005-2006 to 23,778 t in 2006-2007 and the tuna export realization grew from Rs 693.1 million in 2005-2006 to Rs 1303.8 million in 2006-2007. Chilled tuna is the highest unit value earning item, while larger quantities of tuna are exported in frozen form. Major form of chilled tuna exported is whole tuna, yellow fin loins and gutted tuna (MPEDA) [7]. The Indian Ocean contributes 19% of the world tuna catch [8] and they are the fourth major internationally traded fish commodity contributing 7.6% of the international fish trade in value terms [9].

The species, which contributed to tuna fisheries are *E. affinis* (51%), *A. thazard* (16%), *A. rochei* (3%), *Katsuwonus pelamis* (9%), *T. tonggol* (9%), *T. albacares* (10%) and *Sarda orientalis* (3%) [10]. The size range of the fish in the catch was; *E. affinis*, 24-60 cm, *A. thazard*, 20-54 cm, *T. albacares*, 28-90 cm, *S. orientalsis*, 36-54 cm and *A. rochei*, 22-34 cm.

Tunas are found in temperate and tropical waters and are distributed all around the world. Tuna and related species belong to six genera of the family Scombridae. A rapid progress in tuna fishery in Andhra Pradesh was visible since 2000 and Visakhapatnam has emerged as the new center for tuna fishing along the east coast of India [11]. Yellow fin tuna (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*) and little tunny or kawa kawa (*Euthynnus affinis*) are the important tuna species landed by the fishing vessels in Visakhapatnam.

The available literature on the tune fish shows a very healthy composition of nutritional constituents. Majority of the tuna species have the protein content range in between 15 and 30% [12]. Tuna is also low in fat and calories and therefore, is a great substitute for meats and dairy products that are higher in saturated fats and trans-fatty acids. Like most animal foods, seafood proteins have excellent nutritive value. Fish protein contains all the essential amino acids and it is easily and highly digestible [13]. In terms of nutritive value, fish protein ranks above casein [14, 15]. However, these values contrast noticeably within and between species, size, sexual condition, feeding season and physical activity. Protein content, which is important component, tends to vary little in healthy fish [16].

Body composition is a good indicator of the physiological condition of a fish but it is relatively time consuming to measure. Proximate body composition includes the analysis of water, fat, protein and ash contents of fish. Carbohydrates and non-protein compounds are obtainable in negligible amount and are generally ignored for routine analysis [17]. The complexity of the composition of tuna meat is more intricate and a detailed fundamental knowledge on the properties of protein is needed in order to develop/stabilize different products.

Work done on the biochemical composition of tuna is comparatively inadequate, especially from tropical waters. The percentage of water in the body is a good indicator of its relative contents of energy, proteins and lipids. The lower the percentage of water the greater would be the lipids and protein contents and higher would be the energy compactness of the fish [18].

The present study deals with seasonal variation in the biochemical composition of two tuna fish species *Euthynnus affinis* and *Auxis thazard*. Proximate chemical composition (Moisture, protein, fat and ash) in muscle tissue was studied with respect to different season's viz., Pre-monsoon (March, April, May and June), Monsoon (July, August, September and October) and Post-monsoon (November, December, January and February). These values would be useful references for consumers in order to choose the fish based on their nutritional contents.

2. Materials and Methods

E. affinis and *A. thazard* were collected in fresh condition biweekly from fishing boats operating from north-east coast of Visakhapatnam, Andhra Pradesh during the period July 2014 – June 2015. To prepare the sample for determination of proximate composition, fishes were washed with running tap water and the excess water was removed with blotting paper. After initial rinsing with seawater, the samples were sealed in polyethylene bags and kept frozen at -20 °C until further analyses.

The moisture content was determined using the oven drying method described in AOAC [19], Kjeldahl method was used to determine the crude protein content of the samples [20]. Acid hydrolysis method [19] was used to determine the total fat content of the samples. The total ash content of each sample was measured using Pearson's method [21]. This method involves oxidation of all organic matter by incineration in a furnace at a specified temperature (550 ºC) for about 5h. All of the chemicals used in this work were high purity GR grade. The data generated from the results of the present study were presented as mean ± standard error (SE) and statistically analyzed by one-way ANOVA using MS- Excel to determine the variations among the mean concentrations of moisture, protein, fat and ash of two tuna species, *E. affinis* and *A. thazard* during different seasons at 1% or 5% significance level.

3. Results

The proximate chemical composition and seasonal variations of moisture, protein, fat and ash in the edible part of marine water fishes *E. affinis* and *A. thazard* were recorded during three seasons (July 2014 – June 2015) from fishing harbour, Visakhapatnam were furnished in Tables 1 and fig. 1-4 respectively. It was observed that the proportions of the components of meat showed variations with the change of season.

3.1 Moisture: Moisture forms the major component of proximate composition. Table-1 and fig. 1 shows the moisture values of *E. affinis* and *A. thazard*. The moisture values ranged from 73.19 - 77.36% in case of *E. affinis* and 74.36 – 80.19% in *A. thazard*. High values of moisture content were observed in the month of June 2015 in both species, however, low values were noted in the month of October 2014 in *E. affinis* and in the month of July 2014 in *A. thazard*. The total mean value of moisture content is 75.38±0.46 in *E. affinis* and 77.04±0.62 in *A. thazard*. Seasonal wise rise in moisture content was observed in both species recording 73.53±0.21 in *E. affinis* and 74.87±0.18 in *A. thazard* during monsoon, 75.61±0.52 in *E. affinis* and 76.55±0.34 in *A. thazard* during post-monsoon and 77.01±0.16 in *E. affinis* and 79.71±0.36 in *A. thazard* during pre-monsoon season (Table 2 & 3, fig. 1). Statistically significant value between the two species was noted as $P = 0.041$.

3.2 Protein: The protein values of *E. affinis* and *A. thazard* is presented in Table 1. The concentration of protein values ranged from 19.98 to 25.42% in *E. affinis* and 18.27 to 23.86% in *A. thazard* respectively. In *E. affinis* high protein content was observed during the month of July 2014 and low accumulation of protein content was seen during the month of June 2015 (Fig. 2), whereas in the case of *A. thazard* high protein concentration was observed in the month of July 2014 and less protein content was observed in the month of March 2015. Slight seasonal fluctuations in protein concentration was noted in both species of tunas recording 25.16±0.10% and 23.34±0.21% in monsoon season 22.50±0.22% and 21.34±0.35% in post-monsoon season and 20.54±0.31% and 18.86±0.30% in pre-monsoon season (Table 2 & 3; Fig. 2). It is evident from the data that high protein content was found in *E. affinis* during all the three seasons. No significance ($P>0.05$) was observed in between the seasons.

3.3 Fat: The data on total mean fat values in *E. affinis and A. thazard* is given in Table 1. More fat content was found in the month of March 2015 and less fat content was observed in the month of January 2015 in *E. affinis,* on the other hand high fat percentage was found in the month of January 2015 and less percentage was found in the month of September 2014 in case of *A. thazard* (Fig. 3) respectively. High mean fat values were found in post-monsoon season (1.37±0.16%), followed by monsoon (0.75±0.11%) and pre-monsoon seasons (0.68±0.01) in the case of *E. affinis,* whereas high fat concentration was noted in monsoon season (1.25±0.07%) followed by post-monsoon season (1.17±0.05%) and pre-monsoon seasons (0.69±0.19) in *A. thazard* I (Table 2 & 3). In comparison of two species, *A. thazard* accumulated more fat content in monsoon and post-monsoon and less content was observed in pre-monsoon season than *E. affinis* (Table 4, Fig. 3). No significant difference (P>0.05) was observed in the two species and between the species during the study period.

3.4 Ash: The mean ash value for twelve months is shown in the Table 1. Highest mean value of ash was found in the month of March 2015 and low content of ash was found in the month January 2015 in *E. affinis* and high mean ash content was found in the month of January 2015 and low ash value was observed in the month of September 2014 in *A. thazard* (Fig. 4). The data on season wise ash composition in, *E. affinis* showed high ash percentage in pre-monsoon season (1.13±0.14%) followed by monsoon season (1.00±0.02%) and post-monsoon season (0.96±0.13%) (Table 2), whereas in *A. thazard* high percentage was noted in post-monsoon season (1.01±0.27%) followed by pre-monsoon season (0.86±0.20%) and monsoon season (0.77±0.19%) (Table 3). The total mean concentration of ash content was accumulated more in *E. affinis* when compared to *A. thazard*. Season wise data of the two species indicated more ash percentage in monsoon and pre-monsoon season and less percentage was found in post-monsoon season in *E. affinis* (Table 4) respectively. No significant difference (P>0.05) was observed in the two species and between the species.

4. Discussion

According to FAO [22] moisture and lipid contents in fish fillets are inversely related and their sum is approximately 80% with other components accounting for the remaining 20%. This inverse relationship has also been reported in marine fishes such as, *Pseudosciaena aeneas* and *Johnius carutta* [23], *Mullus barbatus* [24]. In the present study moisture was inversely related to lipid content. Fish protein contains all essential amino acids which are easy to digest. The protein digested and assimilated is mostly incorporated in the muscles of the fish [25]. Ali [26] has reported that protein content, which is a vital constituent of living cells, tends to vary relatively little in healthy fish unless drawn upon during particular demands of reproduction or during food deprivation periods. Tuna contains high amount of protein, (27%) and also rich in essential amino acids [27]. In the present study, the protein content of monsoon season is comparable with Nurjanah [28]. Matsumoto [29] has stated that protein content of skipjack was 21.45%, and that of *Thunnus tonggol* 21.8% [30] Generally, fish had a high protein content until 20% [31] The protein levels of *E. affinis* was comparable with the protein values reported by Ali [32] where an increase was noted from March reaching peak levels in September where maximum numbers of mature fishes were found. Decline in protein content was noticed from October (spawning period) to February, coinciding with post-spawning period. Such depletion in muscle-protein during spawning period has been reported in many fishes [27]. Selvaraj [33] has reported depletion in muscle protein in *Ilisha melastoma*, *and* noted that it might be due to the fact that the build-up of gonad is often accomplished at the expense of body proteins. According to Dabhade *et al* [25] muscle protein started declining gradually during spawning and post-spawning phases in *Channa gachua*. This decline of muscle protein was attributed to its transfer into ovaries to meet energy requirement of fish during spawning and post spawning phases.

Fats are the primary energy storage material in fish [27, 34, 35]. Lipid content is a good index of future survival in some species [36] and a strong indicator of reproductive potential in some fish stocks [37]. In the present study both species recorded high protein content and contained considerable levels of fat. The higher fat content in some species of fish is of nutritional value as that support protective effect against coronary heart disease due to the presence of marine omega-3 fatty acids [38]. In this study, the fat content was relatively lower than blue fin tuna *Thunnus orientalis* (2.06 ± 0.57) of Peng *et al* [39] study.

Ash is a measure of the mineral content of any food including fish [40]. The concentration of minerals and trace elements that contribute for the total ash contents are known to vary in fish depending on their feeding behavior, increasing weight or length of fish [41] season, environment, ecosystem and migration even within the same area [42, 43, 44]. The ash content changes with the time of storage due to absorbance of moisture and loss of protein [45]. Smaller sized fish species show higher ash content due to the higher bone to flesh ratio [46]. In the present study, ash percentage was accumulated more in pre-monsoon season followed by monsoon season and post-monsoon season in *E. affinis* whereas ash percentage was found to be more in post-monsoon season followed by pre-monsoon season and monsoon season of *A. thazard*. Overall, the mean concentration of ash percentage was accumulated more in *E. affinis* and less in *A. thazard*. The ash content of two tuna species on wet basis was (1.03±0.06 of *E. affinis* and 0.88±0.12 of *A. thazard*). This result was not much different from Matsumoto [30] was 1.27%, the low ash content shown in *E. lineatus* was 1.4% [30].

5. Conclusion

The present study provides information on seasonal variation of proximate composition of two tuna species. The results indicated that the fish resources analyzed contain high protein content, and hence can be exploited commercially for meeting protein requirements.

Table 1: Seasonal data on proximate composition on *E. affinis* and *A. thazard*

Seasons	Month and Year	Moisture		Protein		Fat		Ash	
		E. affinis	***A. thazard***	***E. affinis***	***A. thazard***	***E. affinis***	***A. thazard***	***E. affinis***	***A. thazard***
Monsoon season	14-Jul	73.26	74.36	25.42	23.86	0.56	1.24	1.05	0.62
	14-Aug	73.55	75.19	25.01	23.47	0.65	1.43	0.99	0.82
	14-Sep	74.13	75.08	25.22	23.19	0.72	1.26	0.92	0.35
	14-Oct	73.19	74.83	24.98	22.83	1.08	1.08	1.03	1.27
Post-monsoon	14-Nov	76.18	77.13	22.68	21.64	0.64	1.24	0.96	0.62

season	14-Dec	75.98	75.86	21.97	22.08	0.67	1.03	0.83	0.48
	15-Jan	76.21	77.17	22.33	20.43	0.69	1.11	0.71	1.64
	15-Feb	74.05	76.03	23.03	21.21	0.71	1.29	1.34	1.29
Pre-monsoon season	15-Mar	77.19	80.19	20.16	18.27	1.32	1.24	1.41	0.62
	15-Apr	76.65	79.82	21.39	19.43	1.05	0.46	0.95	0.82
	15-May	76.83	78.64	20.64	18.39	1.83	0.67	0.81	1.46
	15-Jun	77.36	80.19	19.98	19.34	1.27	0.38	1.36	0.54

Table 2: Mean value of *Euthynnus affinis* proximate composition in seasonal variation

Seasons	**Moisture**	**Protein**	**Fat**	**Ash**
Monsoon	73.53±0.21	25.16±0.10	0.75±0.11	1.00±0.02
Post-Monsoon	75.61±0.52	22.50±0.22	0.68±0.01	0.96±0.13
Pre-Monsoon	77.01±0.16	20.54±0.31	1.37±0.16	1.13±0.14

Table 3: Mean value of *Auxis thazard* proximate composition in seasonal variation

Seasons	Moisture	Protein	Fat	Ash
Monsoon	74.87±0.18	23.34±0.21	1.25±0.07	0.77±0.19
Post-Monsoon	76.55±0.34	21.34±0.35	1.17±0.05	1.01±0.27
Pre-Monsoon	79.71±0.36	18.86±0.30	0.69±0.19	0.86±0.20

Table 4: Total Mean value of Proximate composition in between the two species

Species name	**Moisture**	**Protein**	**Fat**	**Ash**
Euthynnus affinis	75.38±0.46	22.73±0.58	0.93±0.11	1.03±0.06
Auxis thazard	77.04±0.62	21.18±0.57	1.04±0.09	0.88±0.12

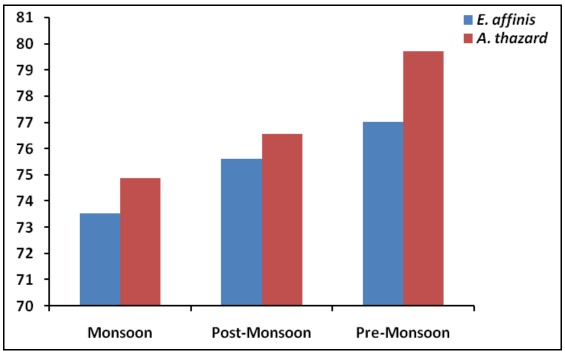

Fig 1: Seasonal variation of moisture content in Tuna species

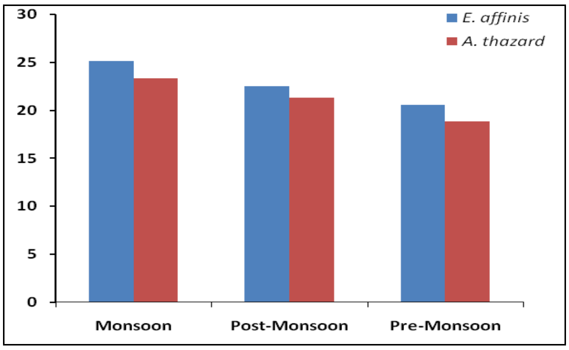

Fig 2: Seasonal variation of Protein content in Tuna species

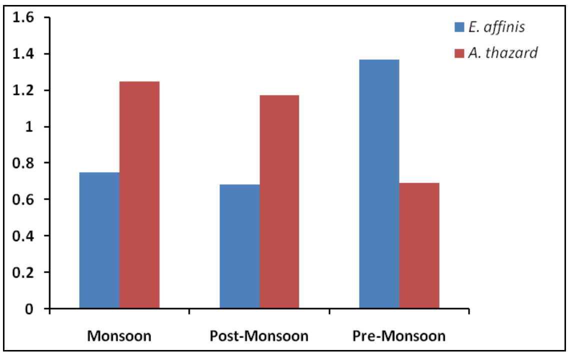

Fig 3: Seasonal variation of fat content in Tuna species

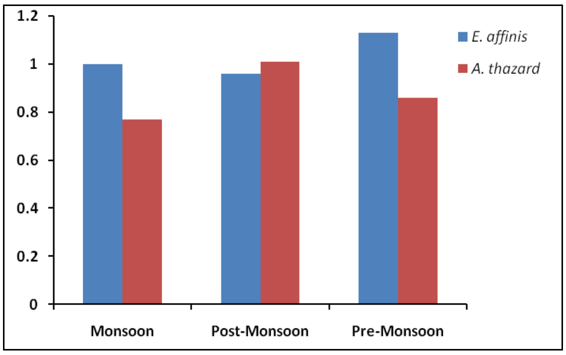

Fig 4: Seasonal variation of Ash content in Tuna species

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