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PROXIMATE COMPOSITION AND SEASONAL VARIATION IN SELECTED *Scomberomorus guttatus* AND *Sardinella longiceps* - FINFISHES WERE DETERMINED IN NAGAPATTINAM COAST, SOUTH INDIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The finfishes *Scomberomorus guttatus* and *Sardinella longiceps* are economically important, so selected for dissimilar sizes, proximate concern to and gross energy in relation to dissimilar seasons, size and sex groups with the vision of assessing the nutritive values like carbohydrates, proteins, lipids, energy, ash, and their % contributions, males (M), females (F) and Indeterminates (IM) selected for these studies. In results, the *S. longiceps* in summer season showed highest amount of crude protein was observed (4-7 cm; 73.21%) from IM followed by in summer IM showed (11-13 cm; 72.79%), carbohydrate crude content was noticed from F (17-19 cm; 4.85%) in summer followed by in post-monsoon showed (17-19 cm; 4.55%) F. Lipid content maximum amount was observed in F (17-19 cm; 22.43%) summer followed by same size F (20.03%), in pre-monsoon highest ash content was in M (11-13 cm; 4.38%) observed followed by same season in IM (8-10 cm; 4.27%), highest energy was noticed summer in F (17-19 cm; 21.45%) followed by same F in post-monsoon showed (17-19 cm; 20.25%). In *S. guttatus* the highest amount of crude protein was observed (4-8 cm; 73.13%) in pre-

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monsoon IM followed by same season IM showed (9-12 cm; 73.02%), carbohydrate content was noticed from F (21-24 cm; 3.92%) in pre-monsoon, followed by same F showed (21-24 cm; 3.85%). The lipid content was observed from F in pre-monsoon (21-24 cm; 20.01%) followed by same season in M was obtained (17-20 cm; 19.02%), highest ash content was expressed in IM (9-12 cm; 5.12%) monsoon followed by same season IM (4-8 cm; 5.11%), highest energy content was noticed in pre-monsoon in M (21-24 cm; 19.95 MJ/kg) followed by same season F showed (21-24 cm; 19.55 MJ/kg), concluded that selected finfishes are nutritionally important.

Keywords: Ash content; carbohydrate; proximate; protein; lipids.

1. INTRODUCTION

Nutrients are play important role for the growth, development and maintenance of healthy body and physical activities. Nutrition is fundamentally necessary for maintaining life. A careful selection and blending of a variety of foods is required to achieve the nutrients [1,2]. 60–70% of total calories in a balanced diet should come from carbs, particularly starch, 10–12% from proteins, and 20–25% from fat. Additionally, additional nutrients like dietary fibre, antioxidants, and phytochemicals support favourable health outcomes [1,3]. Chronic undernutrition linked to poor dietary fat intake is a significant issue in India with regard to nutrition [4,5].

Everybody agrees that fish is a fantastic resource of nutrition for millions of people. It is regarded as a treatment for dietary inadequacies. As a result, the consumption of fish is fast rising in many nations. It has been proposed that the aquaculture of finfish can serve as a vector for the introduction of non-native and powerfully invasive species, either through unintentional escapes of non-native farmed fish or by serving as a vehicle for hitchhiking species [6]. Some of the biggest and most vital fisheries in the world are those for demersal finfish species [6,7].

Despite the fact that fish farming introductions may blend into natural ecosystems, Fleming et al. (2000) believed that escaped farmed fish have a high mortality rate in the wild [8,9]. The proximate composition, mineral composition and amino acid profile of edible muscle tissue were examined by Chandrasekhar and Deosthale [10] in fifteen marine fish species (seer, hilsa, anchovy, pomfret black, mullet, pomfret white, Jew fish, mackerel, pink perch, conger eel, trevally, threadfins, lesser sardine, Bombay duck.

The study on amino acids revealed that fish had a homogeneous relative concentration of all the main amino acids, with the exception of lysine, which is the only one present [11,12]. Additionally, different fish regions have diverse amino acid quantify. The fatty acid composition of the muscles of *Merluccius capensis, M. paradoxus,* and *M. australis* has been documented [13,14]. The wild sea bass contained liver and white muscles are more extremely unsaturated fatty acids (n-3) than those of farmed sea bass; according to Krajnovic-Ozretic et al. [15] the fatty acids and lipids of two pelagic cottoid fish species (*Comephorus* spp). The systematic, biochemistry, and toxicology of Tetraodontid fishes found in Nagapattinam and nearby coastal waters were examined by Senthilkumar [16], Thavaselvi et al. [17].

Alasalvar et al. [18] looked into the fatty acid makeup of both domesticated and wild sea bass (*Dicentrarchus labrax*). The mineral nutrition of fish has been studied rather thoroughly, and studies by Watanabe et al. [19], Sri Devi et al. [20] highlight some of the accomplishments. The content of trace minerals in wild and farmed sea bass (*Dicentrarchus labrax*) was compared by Alasalvar et al. [18]. Sardines that had been solar dried were examined for their nutritional value, nutrient digestibility, and nitrogen balance in sheep [21,22].

Sardinella longiceps commonly known as Indian oil sardine, species of ray-finned fish, greatest important commercial fishes in India [23]. The Indian oil sardine is one of the more regionally limited species of *Sardinella* and can be found in the northern regions of the Indian Ocean. These fish feed on phytoplankton and zooplankton [24]. Fish was determined to be less seasonal than reliant on on water conditions unswervingly before and after the monsoon season. The peak period for commercial catch is June and July, fish only spawn once during the spawning season [25].

Scomberomorus guttatus commonly known as popularly (spotted) seer fish or Indo-Pacific king mackerel is a sea fish, Seer fish is a delicacy in numerous regions of India [26]. In Tamil Nadu and Andhra Pradesh, its Vanjaram and Shermai, usually the costliest variety available [27]. The distribution of these species are two species in East Pacific waters, four species in the West Atlantic, one in East Atlantic waters, and eleven species in the Indo-West Pacific waters [28]. The habitat of this fish covering the edge of the continental slope to coastal waters and coastal waters, in salinity and in slightly turbid waters [29],

Indo-Pacific king mackerel is often found in coastal waters, at depths between 15-80 meters [30].

In order to evaluate the nutritional values, variations in crude protein, carbohydrate, lipid, ash, and cross energy content profiles, as well as their percentage contributions, *Sardinella longiceps* and *Scomberomorus guttatus* were chosen as the intermediate species based on a number of economic and biologically significant parameters. Indeterminates, Male and female individuals were chosen based on different sizes, proximate compositions, and gross energy in relation to various seasons, sex, and size groups.

2. MATERIALS AND METHODS

2.1 Collection and Preparation of Samples

The collected finfishes, *Sardinella longiceps* and *Scomberomorus guttatus* were on a regular basis during four seasons in Nagapattinam coastal (monsoon, pre-monsoon, post-monsoon, and summer) for a year, between July 2018 to June 2019. Fishes were study through observation of the eye brightness, colour of gills, and muscles textures, based on size different parameters like male (M), female (F) and intermedians (IM) are separately focused for our studies. Intermedians are can't identify as male of female those are kept as intermedians, for the intention of identification of fishes and the publications [31] and Fischer and Bianchi [32] were taken; dorsolateral epaxial white muscle portion was taken, about 2 cm behind the head, followed by samples being dried at 60°C for 24 h in an oven. They were packed in sealed polyethylene covers and reserved in desiccators, dried samples were delicately powdered and used in supplementary investigation (sizes of selected fishes already reported in Elangovan et al. [33]).

2.2 Proximate Composition

The approximate composition of the dried muscle tissue, counting its carbohydrate content, was assessed; to determine its moisture content (1 g), fresh tissue was oven dried for 24 hours at a constant temperature (105°C) [34], under lab conditions are the experiments were done.

2.3 Crude Protein Content

By multiplying the N content of the dried samples, crude protein was calculated. The Kjeldahl technique of the AOAC was used to determine nitrogen concentration [35].

2.4 Crude Carbohydrate Content

The dried sample's total carbohydrate content was calculated spectrophotometrically using Dubois et al [36] phenol sulphuric acid technique.

2.5 Crude Lipid Content

The dried sample tissue's lipid content was gravimetrically calculated using Folch et al. [37] chloroform-methanol extraction technique. By incinerating 1 g of dried material for 6 hours at 550°C in a Muffle furnace,

2.6 Crude Ash Content

The ash content was calculated gravimetrically and the findings are given as a percentage [34,38].

2.7 Total Crude Gross Energy

Analysis of gross energy Mega Joule per kilogramme (MJ/kg) is the unit used to express the gross energy of a dry sample measured with an adiabatic bomb calorimeter (Parr Model 124) standard used (benzoic acid).

2.8 Statistical Analysis

The DMRT (Duncan's Multiple Range Test) was applied combination with the ANOVA (One-way Analysis of Variance) to calculate the noteworthy differences in resource allocation between different management groups by using SPSS (Statistical Package for the Social Sciences) (Version 16.0) level (5%) enclose. Values are displayed with a level of consequence ($P<0.05$) [39].

3. RESULTS

3.1 Proximate Composition

We report the seasonal fluctuations in the finfishes' proximate composition and gross energy contents. For each species, the value on the graph corresponds to the average of three duplicate samples. It was quite challenging to compare the monthly variations because the nutritional composition of the two species varied greatly. It was simpler to find the seasonal average values by adding up the monthly numbers, size of selected species already reported by same research groups [33], same size of male and female selected for accurate comparison of this study.

3.2 Proximate Composition Variations and Gross Energy of *Sardinella longiceps*

The proximate composition variations and gross energy noticed in *S. longiceps* are depicted, crude protein values fluctuated between 68.33 and 73.21%, the highest in amount of crude protein was obtained in

IM (4-7 cm; 73.21%) showed in summer followed by same IM showed (72.22%) in post-monsoon, in IM lowest amount was obtained (70.05%) in monsoon. Among the size groups in both sexes, in between M highest amount of protein content was noticed (72.11%) in summer followed by (71.02%) same season, the lowest amount was noticed (68.33%) in pre-monsoon. In between F the highest amount (71.08%) of crude protein was noticed in the summer season followed by in monsoon it's showed (71.02%), fewest amount was obtained in pre-monsoon (69.85%) (Table 1).

Carbohydrate values varied between 2.11 and 4.85%. Both the size groups; in F the uppermost amount (4.85%) was noticed (17-19 cm) in summer followed by same size F in post-monsoon showed (4.55%), cheapest amount was obtained from pre-monsoon (2.61%; 11-13 cm). Among the males the highest carbohydrate content was observed in summer (4.44%; 17-19 cm) followed by post-monsoon it showed (4.35%; 17-19 cm), the lowest amount of carbohydrate of males noticed in monsoon it showed (2.22%; 11-13 cm). Among the IM the highest amount was noticed from summer it showed (2.89%; 8-10 cm) followed by in post monsoon it showed (2.75%; 8-10 cm), the lowest amount of carbohydrate was noticed (2.11; 4-7 cm) in pre-monsoon (Table 2).

The crude lipid content varied between 11.48 and 22.43%. Both the size groups; in F the uppermost amount (22.43%) was noticed (17-19 cm) in summer followed by same size F in post-monsoon showed (20.03%), the cheapest amount was obtained from pre-monsoon (13.65%; 11-13 cm). Among the males the highest lipid content was observed in summer (22.56%; 17-19 cm) followed by same size group (17-19 cm) in monsoon it showed (19.96%), the lowest amount was noticed in pre-monsoon it showed (11.48%; 11-13 cm). Between the IM the highest amount was noticed in summer it showed (15.23%; 8-10 cm) followed by in same season it showed (15.11%; 4-7 cm), the lowest amount of crude lipid was noticed (11.56%) in pre-monsoon (4-7 cm) (Table 3).

The crude ash content varied between 2.75 and 4.38%. Both the size groups; in M the uppermost amount (4.38%) was noticed (11-13 cm) in monsoon followed by in pre-monsoon it showed (3.85%; 14-16 cm), the cheapest amount was crude ash obtained from summer (3.06%; 14-16 cm). Among the F the highest crude ash content was observed in pre-monsoon (4.21%; 11-13 cm) followed by same size group (11-13 cm) in post-monsoon it showed (3.65%), the lowest amount was noticed in summer it showed (2.75%; 17-19 cm). Between the IM the highest amount was noticed in pre-monsoon it showed (4.27%; 8-10 cm) followed by in same season it showed (4.24%; 4-7 cm), the lowest amount of crude ash was noticed (3.08%) in summer (4-7 cm) (Table 4).

Table 1. Crude protein content variations in *Sardinella longiceps* in relation to sex, size, season and groups (Dry weight % basis)

Species	Indeterminates (cm)		Males and Females (cm)					
			Males	Males	Males	Females	Females	Females
Sardinella longiceps	4-7	8-10	11-13	14-16	17-19	11-13	14-16	17-19
Monsoon	71.22	70.05	70.69	69.21	68.55	70.35	71.02	70.39
Pre-monsoon	70.44	70.23	70.21	70.18	68.33	70.66	70.95	69.85
Post-monsoon	72.22	70.33	70.15	70.21	69.33	70.44	70.86	70.75
Summer	73.21	72.21	72.11	71.05	71.02	72.79	71.08	70.89

Table 2. Crude carbohydrate content variations in *Sardinella longiceps* in relation to sex, size, season and groups (Dry weight % basis)

Species	Indeterminates (cm)		Males and Females (cm)					
			Males	Males	Males	Females	Females	Females
Sardinella longiceps	4-7	8-10	11-13	14-16	17-19	11-13	14-16	17-19
Monsoon	2.15	2.19	2.22	3.25	3.35	2.65	3.17	3.33
Pre-monsoon	2.11	2.16	2.26	3.23	3.33	2.61	3.05	3.28
Post-monsoon	2.55	2.75	2.64	2.86	4.35	2.81	3.94	4.55
Summer	2.35	2.89	2.95	3.12	4.44	3.01	4.03	4.85

Table 3. Crude lipid content variations in *Sardinella longiceps* in relation to sex, size, season and groups (Dry weight % basis)

Species	Indeterminates (cm)		Males and Females (cm)					
			Males	Males	Males	Females	Females	Females
Sardinella longiceps	4-7	8-10	11-13	14-16	17-19	11-13	14-16	17-19
Monsoon	14.55	15.02	14.96	16.55	19.57	16.05	18.76	19.95
Pre-monsoon	11.56	11.66	11.48	14.52	16.58	13.65	16.05	17.02
Post-monsoon	15.09	15.01	15.12	17.75	19.96	17.71	18.57	20.03
Summer	15.11	15.23	15.35	19.55	22.56	18.02	19.88	22.43

Table 4. Crude ash content variations in *Sardinella longiceps* in relation to sex, size, season and groups (Dry weight % basis)

Species	Indeterminates (cm)		Males and Females (cm)					
			Males	Males	Males	Females	Females	Females
Sardinella longiceps	4-7	8-10	11-13	14-16	17-19	11-13	14-16	17-19
Monsoon	3.25	3.18	3.14	3.45	3.55	3.36	3.41	3.31
Pre-monsoon	4.24	4.27	4.38	3.85	3.35	4.21	3.45	3.41
Post-monsoon	3.25	3.23	3.21	3.18	2.87	3.65	3.61	2.85
Summer	3.11	3.08	3.07	3.06	2.89	3.08	2.89	2.75

Gross energy fluctuated between 15.02 and 21.45 MJ/kg, the maximum amount was obtained in F (17-19 cm; 21.45 MJ/kg) in summer followed by in same season it showed (20.02 MJ/kg; 14-16 cm), the lowest amount (11-13 cm; 17.43 MJ/kg) values were found during pre-monsoon. Among the male sexes, the high value was recorded during pre-monsoon (17-19 cm; 20.07 MJ/kg) followed by same size group in summer it showed (17-19 cm; 20.04 MJ/kg) and the low value during post-monsoon (11-13 cm; 16.34 MJ/kg). In between IM the uppermost content of cross energy obtained (8-10 cm; 16.75 MJ/kg) in post-monsoon followed by in summer showed (8-10 cm; 16.55 MJ/kg), lowest from (8-10 cm; 15.01 MJ/kg) in monsoon. Higher and lower size groups showed high and low values respectively. F showed higher values than M in most of the size groups during all the four seasons (Table 5).

3.3 Variations in Proximate Composition and Gross Energy of *Scomberomorus guttatus*

Crude protein values fluctuated between 68.15 and 73.13%. Both the size groups of females (21-24 cm) showed uppermost value (79.05%) during monsoon followed by pre-monsoon (72.85%; 17-20 cm) it was observed, the lowest content in monsoon (69.25%; 21-24 cm) was noticed. In intermediates high values pre-monsoon (73.13%; 4-8 cm) followed by same season (73.02%; 9-12 cm), fewest content was examined in summer (72.05%; 4-8 cm). Along with the size groups in both sexes, in males lofty value was recorded during pre-monsoon (13-16 cm; 72.05%) followed by same season showed (13-16 cm; 71.21%) and low value in monsoon (17-20 cm; 68.85%). Low values were noticed in superior size groups and elevated values in slighter size groups. The majority of the dimension groups in females showed superior standards than males in all the seasons (Table 6).

Carbohydrate values varied between 1.21 and 3.92%. Both the size groups; from females uppermost amount was noticed in pre-monsoon (3.92%; 21-24 cm) followed by same season showed (3.61%; 21-24 cm), lowest in monsoon (2.01%; 17-20 cm). Among the males uppermost (3.62%; 17-20 cm) followed by same season noticed (3.45%; 13-16 cm), lowest in post-monsoon season (13-16 cm; 1.61%). Intermediates uppermost in pre-monsoon showed (1.67%; 9-12 cm) followed by same season and in summer showed (1.65%; 4-8 cm) lowest in monsoon (1.21%; 9-12 cm), short values were observed in lower size groups and high values in higher size groups (Table 7).

Crude lipid showed variations from 11.05 to 20.01%, the uppermost most lipid content was obtained from pre-monsoon in females (20.01%; 21-24 cm) followed by in summer (18.05%), lowest amount was obtained in monsoon (12.25%; 17-20 cm). Among the males highest was confirmed in pre-monsoon (19.02%; 17-20 cm) followed by in summer (17.01%; 17-20 cm), lowest was in monsoon (11.05%; 13-16 cm). Between indeterminates highest (14.56%; 8-12 cm) content in pre-monsoon followed by same season showed (14.55%; 4-8 cm) lowest in monsoon (11.11%; 4-8 cm). Lower size groups exhibited low values whereas higher size groups showed high values. Nearly every one of the size groups in females showed lofty values than males throughout all the four seasons (Table 8).

Table 5. Crude cross energy content variations in *Sardinella longiceps* in relation to sex, size, season and groups (Dry weight MJ/kg basis)

Species	Indeterminates (cm)		Males and Females (cm)					
			Males	Males	Males	Females	Females	Females
Sardinella longiceps	4-7	8-10	11-13	14-16	17-19	11-13	14-16	17-19
Monsoon	15.02	15.01	18.08	19.04	19.95	17.95	19.45	19.97
Pre-monsoon	15.11	15.22	16.34	17.95	17.99	17.43	18.15	18.55
Post-monsoon	16.45	16.75	18.45	19.05	20.07	18.56	20.04	20.25
Summer	16.45	16.55	18.91	19.98	20.04	18.97	20.02	21.45

Table 6. Crude protein content variations in *Scomberomorus longiceps* in relation to sex, size, season and groups (Dry weight % basis)

Species	Indeterminates (cm)		Males and Females (cm)					
			Males	Males	Males	Females	Females	Females
Scomberomorus guttatus	4-8	9-12	13-16	13-16	17-20	17-20	21-24	21-24
Monsoon	72.43	72.22	69.04	69.01	68.85	70.85	79.05	69.25
Pre-monsoon	73.13	73.02	72.04	71.21	70.07	72.85	72.55	71.65
Post-monsoon	72.55	72.75	69.11	68.15	69.31	69.85	69.45	70.05
Summer	72.05	72.20	70.11	69.65	70.03	70.65	71.55	71.45

Table 7. Crude carbohydrate content variations in *Scomberomorus guttatus* in relation to sex, size, season and groups (Dry weight % basis)

Species	Indeterminates (cm)		Males and Females (cm)					
			Males	Males	Males	Females	Females	Females
Scomberomorus guttatus	4-8	9-12	13-16	13-16	17-20	17-20	21-24	21-24
Monsoon	1.25	1.21	1.45	2.22	2.51	2.01	2.23	2.51
Pre-monsoon	1.65	1.67	2.36	3.45	3.62	3.22	3.61	3.92
Post-monsoon	1.55	1.63	1.61	2.56	3.11	2.42	2.58	3.33
Summer	1.52	1.65	2.35	3.27	3.12	2.65	3.25	3.85

Table 8. Crude lipid content variations in *Scomberomorus guttatus* in relation to sex, size, season and groups (Dry weight % basis)

Species	Indeterminates (cm)		Males and Females (cm)					
			Males	Males	Males	Females	Females	Females
Scomberomorus guttatus	4-8	9-12	13-16	13-16	17-20	17-20	21-24	21-24
Monsoon	11.11	12.22	11.05	12.55	13.55	12.25	13.79	14.51
Pre-monsoon	14.55	14.56	14.75	14.52	19.02	16.21	17.75	20.01
Post-monsoon	12.55	12.59	12.56	13.55	14.01	14.00	14.02	14.55
Summer	12.35	12.45	14.01	13.85	17.01	14.92	15.02	18.05

Ash content ranged between 3.02 and 5.11%, elevated values noticed from indeterminates groups (9-12 cm; 5.12%) in monsoon followed by same season showed (5.11%; 4-8 cm), and low values (4.83%; 4-8 cm) summer. Among males ash content high (5.09%; 13-16 cm) in monsoon followed by same season and post-monsoon showed (4.85%; 13-16 cm) the fewest was in summer (3.11%; 17-20 cm).

Among the female size groups maximum (17-20 cm; 4.95%) in monsoon followed by post-monsoon (4.79%; 17-20 cm) and minimum in summer (21-24 cm; 3.02%) values were recorded. High values were noticed in lower size groups while low values were observed in higher size groups (Table 9).

Table 9. Crude ash content variations in *Scomberomorus guttatus* in relation to sex, size, season and groups (Dry weight % basis)

Species	Indeterminates (cm)		Males and Females (cm)					
			Males	Males	Males	Females	Females	Females
Scomberomorus guttatus	4-8	9-12	13-16	13-16	17-20	17-20	21-24	21-24
Monsoon	5.11	5.12	5.09	4.85	4.25	4.95	4.29	4.02
Pre-monsoon	5.04	5.01	4.39	4.29	3.85	4.41	3.89	3.84
Post-monsoon	4.97	4.89	4.85	4.25	3.75	4.79	3.98	3.79
Summer	4.87	4.83	4.15	4.07	3.11	4.09	3.45	3.02

Table 10. Crude cross energy content variations in *Scomberomorus guttatus* in relation to sex, size, season and groups (Dry weight MJ/kg basis)

Species	Indeterminates (cm)		Males and Females (cm)					
			Males	Males	Males	Females	Females	Females
Scomberomorus guttatus	4-8	9-12	13-16	13-16	17-20	17-20	21-24	21-24
Monsoon	14.05	14.02	14.02	17.02	17.87	16.02	17.55	18.95
Pre-monsoon	15.05	15.12	15.02	17.95	19.92	17.43	18.55	19.55
Post-monsoon	14.95	14.92	15.02	17.55	18.03	16.52	17.04	17.89
Summer	15.02	15.01	15.11	17.54	18.86	17.02	18.02	18.87

Gross energy values fluctuated between 14.02 and 19.55 MJ/kg, among males maximum amount was obtained (19.92 MJ/kg; 17-20 cm) in monsoon followed by in pre-monsoon (18.87%; 17-20 cm) and minimum values (14.02 MJ/kg; 13-16 cm) in monsoon. Between females maximum amount was obtained in monsoon (19.55 MJ/kg; 21-24 cm) followed by in summer (18.87%; 21-24 cm) and minimum values (16.02 MJ/kg; 17-20 cm) in monsoon. Indeterminates uppermost (15.12 MJ/kg; 9-12 cm) in pre-monsoon followed by same season (15.05 MJ/kg; 4-8 cm) lowest in monsoon (14.02 MJ/kg; 9-12 cm), Higher and lower size groups showed high and low values respectively. Females showed higher values than males in most of the size groups during all the seasons (Table 10).

4. DISCUSSION

4.1 Continuing Variations in Proximate Composition and Gross Energy

Based on different parameters finfishes male, females and intermedians (can't identify male or female) selected for this study, from this study we confirmed lot of variations based on environmental factors, light, temperature, pH, etc., Spectacular continuing in proximate composition variations have been recognized in an assortment of forage species e.g., herring, Pacific cod *Gadus macrocephalus* and capelin [40,41]. Solun et al. [42] suggested that the variation in proximate components within a species is related to the time of a year, Ke et al. [43], Hariprasath et al. [44] observed that white muscle of mackerel showed the principal recurring difference in fat contented. Investigate the climate effects in lipid content variation, Krzynowek [45] reported that the fat contented of some fish species strength contrast through roughly (10%) according to the season. Agreeing to the above the males and females of *S. longiceps* and *S. guttatus* in the present study also demonstrated significant seasonal variations in lipid content Krzynowek [45].

The body fat percentage is recognized to based on the life energy intake and cycle stage of the animals [46] and temperature advanced periods are characterized through faster augmentation rates and bulky intakes [47]. Abdelmovleri et al. [48] found high protein and lipid and low water content in *Sardina pilchardus* during summer. He also noted that the calorific value of sardine was very high during summer. The results of the in attendance study are in close conformity with the above.

Fat content in fishes varied in relation to size and season [49]. Nair and Suseela [50] observed the maximum lipid content in oil sardine between October and December and the least from April to June in the Indian waters. The lipid total content of sardines from the sea of Hyuga-Nada diverse between 1.8 and 7.2%, it was lowly in February and uppermost from July to September [51]. Wide variation (12.14 - 22.11%) in lipid content was observed in *S. longiceps* presently. In both the sexes high values were noticed

during summer and low values during pre-monsoon in Nagapattinam coast.

Sivashanthini [52] experiential that the in *Gerres abbreviatus* muscle lipid declined throughout monsoon to augment over during summer and post-monsoon in *G. filamentosus*, the muscle lipid was maximum during pre-monsoon and it declined considerably during monsoon and post-monsoon to augment again throughout summer in Nagapattinam waters. In contrast to the above, most of the size groups in both sexes of *E. malabaricus* in the present study showed higher lipid content during post-monsoon and lower values during summer.

Ash contented also showed recurrent variations, during autumn (March to April), ash contents decreased (44%) in fishes, coinciding with a drop in water content. An augment in water comfortable was observed in March and it is in accordance with Love's proposal [53] that the water content necessity augment to a dangerous assessment previous to minerals can be excreted and mobilized. Noteworthy seasonal variations were observed presently in both the sexes of *S. fimbriata* and *L. argentimaculatus* with respect to ash content [54].

The higher and lower lipid and gross energy values were recorded during post-monsoon and summer respectively in both the sexes of *E. malabaricus* presently. Fish allocating the majority of their power to somatic enlargement or imitation in mechanism and summer have got to shift to increasing lipid storage to survive during winter [55,56].

Ecological parameters similar to rainfall, light, temperature, periodicity, upwelling, thermocline, etc. are recognized to significantly power the spawning of pelagic fishes like mackerels and sardines [57,58]. The constituents of biochemical of fish are subjected to noticeable seasonal changes outstanding to different physiological and other factors such as maturation and spawning [59]. Spawning in oil sardine is protracted and fishes with gravid gonads were experimental all over the year [60]. However, month wise analysis revealed a clear spawning period for oil sardine during June-August with peak in July in Mangalore-Malpe coast [60]. The spawning season of *S. fimbriata* in Nagapattinam waters extended from July to September. Along the west coast of India, the spawning period of *R. guttatus* corresponds with the period of the southwest monsoon. On the east coast, the origination of the spawning period is during October-November coinciding with the commencement of the northeast monsoon [61]. The spawning period of *L. argentimaculatus* is July-August with a supplementary spawning between January and March in Indian waters [61]. The spawning of *E. malabaricus* is restricted to a petite period extending from late May to early June which is completed at about the full moon [62]. In the present study, gravid gonads of sardines, mackerels, sea bass and groupers were observed during July-early September, October-early December, late July-early September and April-early May respectively.

In universal, fishes do not nourish when they are spawning, in spite of the superior nutritional demands of spawning. Their nutrient obligation is thus met through body reserves and as a consequence, the level of lipids falls steadily as spawning progresses. When lipid is drawn from muscle reserves, it is replaced through water, so that the entirety fish mass remains much the same [63]. The water pleased of muscle perceptibly rises, and this makes the flesh weak, this is the motivation for the deprived eating quality of spawning fish.

The contented moisture in muscle in all the size groups of females and males was elevated throughout spawning months and extremely short during post spawning months in all the four species studied currently. Equally, uppermost proportion of water was experiential in muscle throughout the spawning season of *Osteomugil cunnesius Mugil cephalus* and *Clarius batrachus* [64]. The moisture values low of throughout position spawning seasons have been observed in numerous other fishes through various authors [65].

In muscle tissues the crude protein contents currently studied finfishes showed a association with spawning season. Elevated protein levels were experimental in muscle during post and pre spawning months and small values during spawning season. This corresponds well with the findings of Bano [66], who also observed a fall in the protein content during spawning in *Clarius batrachus*. High protein content of muscle during post and pre spawning months further suggests the accumulation of muscle protein to meet the nitrogen demands of the body [67].

In all the four species depletion of protein coincided with depletion of fat which confirmed gonad development and spawning. Further, depletion of the carbohydrate reserve was also noticed with depletion of other constituents. In fishes, depletion of glycogen from muscle was observed during spawning [68]. Fluctuation in carbohydrate perhaps may be due to the functional state of the animal. Glycogen in the muscle is probable to be distorted due to assorted reasons such as implement, food item and starvation [69] etc. The method of assassination, quantity of stressed and implement earlier to bereavement as well as property

temperature after death strength also influence the carbohydrate contented [70].

The of *Osteomugil cunnesins* and *O. speigleri* body power reserves were exhausted throughout spawning and the speed of recuperation after spawning speckled significantly in moreover sex [59]. In the nearby learning, the utmost calorific principles were experiential during post spawning months and towering principles throughout pre spawning months. Throughout spawning months, nevertheless, the calorific comfortable was small and it was endorsed to storage of liveliness reserves happening first in the weight in post spawning months and consequently receiving transferred to gonads[71-73].

5. CONCLUSION

The universally fishes accepted as a nutrition wealthy resources for millions, it's measured as a preparation to situate accurate deficiencies in nutritionally. Consumption fish is consequently escalating speedily in numerous countries. Selected *S. longiceps,* and *S. guttatus* finfishs focused proximate composition and gross energy in relation to dissimilar sex, seasons and size groups with the observation of nutritive values assessed, concluded that selected finfishes are highly nutrition for human societies.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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