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# COMPARATIVE STUDIES ON NUTRITIONAL VALUE OF NORMAL AND TUMOR TISSUE, SARDINELLA LONGICEPS (VALENCIENNES, 1847) FROM NAGAPATTINUM SOUTHEAST COAST OF INDIA

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## ABSTRACT

Fish are at present in high demand in food markets, they are widely consumed in many parts of the world because they posses high protein content, saturated fat and also contain omega fatty acids known to support good health. The present study deals with biochemical composition of common fish,*Sardinella longiceps*. The proximate composition of protein, carbohydrate, lipid, amino acids and fatty acids were studied. The results of proximate composition in *S. longiceps* showed the percentage of protein was high in the normal and tumor infected fish tissue (29.15 &18.93%), followed by the carbohydrate (5.81 & 2.42 %) and lipid (15.61 & 9.28 %). The percentage compositions of essential and non-essential amino acids are presented in normal tissue and tumor infected tissue were found to be as 46.09 % & 41.47 % and 37.23% & 40.63%. In the analysis, the fatty acid profile by gas chromatography revealed the presence of higher amount of PUFA (Linolenic acid 32.74 %) in normal tissue. The details of the vitamins detected in *S. longiceps*tissue. Among them, vitamin A was found in higher levels (91.16 mg/gm) at normal tissue. In the present study, totally 5 macro minerals and 2 trace minerals were reported. The *S. longiceps* normal and infected tissue contributed maximum sodium (289.6 mg/gm) and Potassium (166.5 mg/gm) of minerals. The result shows that marine fish (*S. longiceps*) tissue is a valuable food recipe for human consumption, due to its high quality protein and well-balanced amino acids fatty acids and vitamins and minerals.

**Key words:** Marine fish, *S. longiceps*, proximate composition, amino acids, fatty acids, vitamins and minerals.

## INTRODUCTION

The knowledge on biochemical composition of any edible organisms is extremely important since the nutritive value is reflected in its biochemical contents [1]. A new species should be recommended for human consumption only after assessing the nutritive value of the species with regards to its nutritional qualities [2]. The demand for protein rich food is increasing, especially in developing countries, stimulating the exploration of unexploited or non-traditional resources. Marine fish are commercially valuable species and easy to cultivate in coastal areas. Marine fish are important for marine ecology and human diet, since it is an important source of nutrients. Consumption of marine fish provides an inexpensive source of protein with a high biological value, essential minerals and vitamins. Additionally, the fish muscle contains little saturated fat and significant amount of Vitamin C. Fish is also a good source of minerals such as calcium, potassium, zinc, iron, phosphorus and copper.

Protein is the essential substance of life and accordingly exists in the largest quantity of all nutrients as a component of the living beings. The ratio of carbohydrate was less when compare to the other nutrients such as proteins and lipids in animal tissues, especially in aquatic animals [3]. Lipids are the major sources of metabolic energy and essential materials for the formation of cell and tissue membranes [4]. Fish proteins are rich in essential amino acids (EAA). They are required for the maintenance of growth, reproduction and synthesis of vitamins. Aquatic animal fats are good sources of essential fatty acids that are not synthesized in the human body. Fatty acids in fish oil have a very distinctive character compared to fatty acids from other sources. They consist not only essential fatty acids, but also a significant source of omega-3 fatty acids-especially eicosapentaenoic acid (EPA, C20:5n3) and docosahexanoic acid (DHA, C22:6n3). These fatty acids play a vital role in human nutrition, disease prevention and health promotion [5]. Vitamins are organic compounds representing a minor fraction in the day today life. Fish is a good dietary source of vitamin B complex, Niacinamide and Folic acid. Fish is a good source of vitamins A and D; fatty fish have higher level of vitamins than the lean fish. Vitamin content may be considerably influenced by methods of handling, storage and preparation of sea food [6]. Seafood includes the following important macro minerals: Ca, P, Mg and the electrolytes (Na and K). Trace minerals present in marine organisms are Mn, Fe, Co, Cu, Zn, Ni, Mo and Cr (essential), Al, Ti, V and Ag (non-essential) and Pb and Cd (toxic). Marine organisms are good sources of I, Ca and P which ranged from 70 to 80% in the skeleton of fishes.

As the world population is growing, the per capita consumption of seafood is also increasing rapidly. Because of health consciousness, the modern day man is interested in taking seafood more in view of its nutritional superiority than all other sources of food accessible to him. There remain no considerable comparative studies on normal and infected tumor fish with regard to their nutritive value. Hence, the present work was planned to study the proximate composition of *S. longiceps* through estimating their major biochemical components such as total protein, carbohydrate and lipid content in the whole body tissue apart from the amino acids, fatty acids profile, vitamins and minerals content.

## MATERIALS AND METHODS

The marine normal and tumor infected fish*S. longiceps* were collected from the Nagapattinum (Lat. $11^0$ 15' N Long. $79^0$ 46' E) Southeast coast of India.*S. longiceps* is purely marine and estuarine habited. They were brought to the laboratory, the animal body was removed and tissue were dried at 55 ºC in an oven and used for biochemical analysis. The proximate compositions of the experimental samples were determined by using standard methods; *viz*., protein [7], carbohydrate [8] and lipid [9]. The experimental fish samples were dried at 55ºC for 24 hours in an oven and the dried samples were finely ground for estimating the amino acids in the HPLC (Merck Hitachi L-7400) following the method of [10]. For fatty acid analysis, the samples (body tissue) were homogenized with chloroform: methanol (2:1 v/v) mixture and the samples were extracted using the method of [11]. After the fat was extracted, it was esterified with 1% $H_2SO_4$ and fatty acid methyl esters were prepared by following the procedure of [12]. Identification and quantification of fatty acids were done using Gas chromatography (Hewlett Packard 5890 model). The vitamins were estimated the fat soluble vitamins A, D, E and K and the water soluble vitamins $B_1$, $B_2$, $B_6$, $B_{12}$ and C were analysed in the HPLC (Merk Hitachi L-74000) following the method described by [13]. The folic acid was estimated by following the calorimetric procedure of [14]. The pyridoxine, panthothenic acid and vitamin $B_{12}$ were estimated by following methods suggested in USP NF 2000 Asian edition. The minerals were estimated soft tissue *S. longiceps*by following the method of [15].

## RESULTS

The proximate composition (%) such as protein, carbohydrate and lipid contents of*S. longiceps*tissue (normal and non- infected) arepresented. The results of the present study revealed that the protein composition were high (29.15 &18.93%), followed by carbohydrate (5.81 & 2.42 %) and lipid (15.61 & 9.28 %). The percentage compositions of essential and non-essential amino acids are presented in normal tissue (Table 1). The total essential amino acids were found to be as 46.09 % and non-essential amino acids were 41.47 %. Among the essential amino acids Phenylalanine were found high as 11.64 % on dry matter basis in fish tissue and the non-essential amino acids Glutamate were found maximum as 8.15 % (Table1). The percentage compositions of essential (37.23%) and non-essential amino acids (40.63%) are presented in tumor infected tissue (Table 2). Among the essential and non essential amino acidsThreonine &Aspartate were found high as 8.47 &9.96 % on dry matter basis in fish infected tissue (Table 2).


Normal Fish


Infected fish

**Figure 1:** Showed the normal and tumor infected fish

| EAA | % of amino acids | NEAA | % of amino acids |
|---|---|---|---|
| Phenylalanine | 12.64 | Glycine | 6. 87 |
| Lysine | 5.14 | Serine | 9. 16 |
| Histidine | 4.65 | Glutamic acid | 3.95 |
| Methionine | 6.72 | Cystine | 2.63 |
| Arginine | 1.81 | Glutamate | 5.23 |
| Leucine | 6.27 | Alanine | 1.62 |
| Threonine | 4.25 | Proline | 0.48 |
| Isolucine | 2.94 | Aspartate | 3.82 |
| Valine | 1.83 | Tyrosin | 5. 95 |
| Tryptophan | 0.65 | Aspertic acid | 1.76 |

**Table 1.** Essential and non essential amino acids of normal tissue

| EAA | % of amino acids | NEAA | % of amino acids |
|---|---|---|---|
| Phenylalanine | 2.77 | Glycine | 3.53 |
| Lysine | 5.82 | Serine | 6.14 |
| Histidine | 6.03 | Glutamic acid | 5.63 |
| Methionine | 2.19 | Cystine | 4.75 |
| Arginine | 0.12 | Glutamate | 3.15 |
| Leucine | 3.58 | Alanine | 0.83 |
| Threonine | 8.47 | Proline | 1.85 |
| Isolucine | 4.45 | Aspartate | 9.96 |
| Valine | 3.52 | Tyrosin | 1.77 |
| Tryptophan | 0.28 | Aspertic acid | 3.02 |

**Table 2:** Essential and non essential amino acids of tumor infected tissue

In *S. longiceps,* 7 different fatty acids were found in normal tissue; they are three saturated fatty acids (36.67), one monounsaturated fatty acids (14.84) and three polyunsaturated fatty acids (43.48). Among the PUFA Linolenic acid were the major acids (Table.3). The percentage availability of SFA, MUFA and PUFA content was 27.09, 9.48 & 43.11 % in infected tissue (Table.4). In Linolenic acid was the major acids found.

| S. No | Fatty acids | Carbon atom (n) | % of fatty acids |
|---|---|---|---|
| **Saturated Fatty Acids** | | | |
| 1 | Palmitic acid | C16:0 | 22.54 |
| 2 | Margaric acid | C17:0 | 3.61 |
| 3 | Stearic acid | C18:0 | 10.52 |
| **Total** | | | **36.67** |
| **Mono Unsaturated Fatty Acids** | | | |
| 4 | Oleic acid | C18:1 | 14.84 |
| **Total** | | | **14.84** |
| **Poly Unsaturated Fatty Acids** | | | |
| 5 | Linolenic acid | C18:3 | 32.74 |
| 6 | Alpha Linolenic acid | C18:3 | 2.43 |
| 7 | Stearidonic or Moroctic acid | C18:4 | 8.31 |
| **Total** | | | **43.48** |

**Table 3:** Fatty acid profile of normal

| S. No | Fatty acids | Carbon atom (n) | % of fatty acids |
|---|---|---|---|
| **Saturated Fatty Acids** | | | |
| **1** | Palmitic acid | C16:0 | 16.45 |
| **2** | Margaric acid | C17:0 | 3.08 |
| **3** | Stearic acid | C18:0 | 8.37 |
| **Total** | | | **27.09** |
| **Mono Unsaturated Fatty Acids** | | | |
| **4** | Oleic acid | C18:1 | 9.48 |
| **Total** | | | **9.48** |
| **Poly Unsaturated Fatty Acids** | | | |
| **5** | Linolenic acid | C18:3 | 26.58 |
| **6** | Alpha Linolenic acid | C18:3 | 7.72 |
| **7** | Stearidonic or Moroctic acid | C18:4 | 5.81 |
| **Total** | | | **43.11** |

**Table 4:** Fatty acid profile of infected fish

The details of the vitamins detected in normal and infected tissueare presented in Table 5. Among them, vitamin A were found in higher levels, whereas vitamin BE were noticed as lower levels in normal tissue (0.17) and vitamin A was high in infected tissue.

| S. No | Vitamins | Normal | Infected |
|---|---|---|---|
| **1** | Retinol (A) | 91.16 | 38.1 |
| **2** | Calciferol (D) | 5.89 | 2.18 |
| **3** | Tocopherol (E) | 0.17 | 0.11 |
| **4** | Vitamin (K) | 5.48 | 0.58 |
| **5** | Pyridoxin (B6) | 2.56 | 0.54 |
| **6** | Cobalamin (B12) | 4.08 | 9.74 |
| **7** | Vitamin (C) | 6. 23 | 2.86 |

**Table 5:**Vitamin content of *S. longiceps*(mg/g of the sample)

The quantity of minerals present in the tissue samples (Table.6). Totally, 5 macro minerals and 2 trace minerals were detected. Among the macro minerals, sodium (289.6), potassium (166.5 mg/g) and copper (2.56 mg/g) were observed at higher and lower levels in normal tissue, whereas other macro-minerals magnesium and calcium were in negligible level. The trace minerals such as iron (3.07 mg/g) and zinc (0.24 mg/g) were also detected. The macro minerals, Potassium (102.7 mg/g) were observed at

higher levels in infected tissue.

| S. No | Minerals | Normal | Infected |
|---|---|---|---|
| | **Macro** | | |
| **1** | Calcium | 35.9 | 56.47 |
| **2** | Sodium | 289.6 | 89.64 |
| **3** | Potassium | 166.5 | 142.7 |
| **4** | Copper | 2.56 | 8.45 |
| **5** | Magnesium | 21.6 | 35.25 |
| **Trace** | | | |
| **6** | Iron | 3.07 | 8.23 |
| **7** | Zinc | 0.24 | 0.37 |

**Table 6:**Minerals content of *S. longiceps*(mg/g of the sample)

## DISCUSSION

Fish is a major source of animal protein and it also contains vitamins. Fish is widely consumed in many parts of the world by humans because it has high protein content, low saturated fat and also contains omega fatty acids known to support good health. Marine foods are very rich sources of mineral components. The total content of minerals in the raw flesh of marine fish and invertebrates is in the range of 0.6–1.5% wet weight. Mineral components such assodium, potassium, magnesium, calcium, iron, phosphorus and iodine are important for human nutrition [16]. Hence, the present work was planned to study the proximate composition of *S. longiceps* through estimating their major biochemical components such as total protein, carbohydrate and lipid content in the whole body tissue apart from the amino acids, fatty acids profile, vitamins and minerals content.

Biochemical components such as protein, carbohydrates and lipids are essential for body growth and maintenance. Protein is essential for the sustenance of life and exists in largest quantity of all nutrients as a component of the human body [17]. The present investigation revealed that the maximum level of protein content in normal and infected tissue is 29.15 &18.93 %. Similarly,[18] reported that the protein (%) 19.41 ± 1.44, 19.11 ± 1.63 and 17.86 ± 1.14 is the major biochemical component in the *Atherina boyeri*, *Atherina lagunae* and *Atherina* sp. [19] estimated maximum level of (17.9%) of protein in *Gadus macrocephalus.* Agreeing to the above the normal and tumor infected of *S. longiceps* in the present study also exhibited variations in protein content in tissue. In the present study the percentage of carbohydrates in the body tissue of 5.81 & 2.42 %. [20] reported that the carbohydrate 2.12-4.82%, 1.14-3.92%, 2.14-4.75% and 1.55-5.48% is the major biochemical component in the *Sardinella longicephs, Rastrelliger kanagurta, Lates calcarifer* and*Epinephelus tauvina.* In *S. longiceps,* generally the carbohydrate content was

found to be low as it is high when compared to other fish. The lipids are highly efficient as source of energy, in that they contain more than twice the energy of carbohydrate and proteins. Spawning in oil sardine is prolonged and fishes with gravid gonads were observed throughout the year [21]. In the present study lipid content of tissue were15.61 & 9.28 %. [22] Who studied to lipid composition in the lantern fish *Benthosema Pterotum* found that for protein fat 3.4%. [23] reported that the lipids constituents from the ovary of *S. niger* at maturation III and IV stage is high value 11.83 ± 1.00 &16.33 ± 1.04 %.Lipids comprise only (20%) dry weight of their ovaries [24]. In the present study, the high lipid values were observed in normal tissue.

Biological value of protein is obviously reflected upon its essential amino acids concentration. In general, the finfishes have a balanced distribution of all essential amino acids required for an adult per day. The percentage compositions of essential and non-essential amino acids are presented in normal tissue. The total essential amino acids were found to be as 46.09 % and non-essential amino acids were 41.47 %. Among the essential amino acids Phenylalanine were found high as 11.64 % on dry matter basis in fish tissue and the non-essential amino acids Glutamate were found maximum as 8.15 %. The percentage compositions of essential (37.23%) and non-essential amino acids (40.63%) are presented in tumor infected tissue. Among the essential and non essential amino acidsThreonine &Aspartate were found high as 8.47 &9.96 % on dry matter basis in fish infected tissue. [20] reported that the *R. Kanagurtta, L. Calcorifer, E.tauvina* was essential amino acids and non essential amino acids 50.24 & 42.5, 52.72 & 42.46 and 48.44 & 44.87%. [25] analysed amino acid and fatty acid nutritional quality of muscles of Pampus sp and they reported that Pomfret protein contained a high amount of glutamic acid. [26] reported that the higher amount of glutamic acid in all their four species (*Clupea harengus, Scomber scombrus, Trachurus trachurus and Urophycis tenuis*) studied. [27] reported that the higher amount of EAA and NEAA in *Myrophis platyphynchus* in which the amino acids range from 47.28% and 52.72%. Leucine is generally high in fish protein [28] relatively low values were reported in Indian shark, Silver belly and sole.In the present study, fish value of Phenylalanine was noticed high in normal tissue and low value in infected tissue. The result revealed in this study showed that moonfish,*S. longiceps* tissue is a potential source for food value due to high quality protein, as well as balanced essential amino acids.

In *S. longiceps,* 7 different fatty acids were found in normal tissue; they are three saturated fatty acids (SFA), one monounsaturated fatty acids (MUFA) and three polyunsaturated fatty acids (PUFA). Among the PUFA Linolenic acid were the major acids. The percentage availability of SFA, MUFA and PUFA content was 36.67, 14.84 & 43.48 % in *S. longiceps*. The percentage availability of SFA, MUFA and PUFA content was 27.09, 9.48 & 43.11 % in infected tissue. In Linolenic acid was the major acids found.[18] contributed that the total monounsaturated fatty acids (especially C16:1 and C18:1) were more abundant in*Atherina lagunae, A. boyeri* and *Atherina* sp. (36.2, 25.37 and 32.65% respectively). [29] reported that the the amount of total lipids and fatty acids both in muscle and liver, varied by months and seasons ($P<0.05$).[30] reported that the Palmitic acid showed its higher level in both species (5.78 and 3.89%) in *Dussumieria acuta* and *Sardinella brachysoma*, respectively. [31] the percentages of polyunsaturated fatty acids (PUFA) were

higher than the percentages of saturated fatty acids (SFA) and double the percentages of monounsaturated fatty acids (MUFA). [32] studied that the nutritional value of *Stolephours waitei*, *Chirocenttrus nudus* and *Pomadasys kaakan* its suitability for consumption. In which the SFA, MUFA and PUFA fatty acids range from 35.87 to 0.39%, 28.74 to 0.41% and 18.81 to 0.42% respectively. The main dominant PUFA was DHA (22:6n-3), followed by EPA (20:5n-3), AA (20:4n-6), LA (18:2n-6) and ALA (18:3n-3). These results are in agreement with studies of fatty acids composition of fishes [33]. The PUFA content in the case of marine fish ranges from 28 to 57% with C20:5 and C22:6 predominating and constituting about 50% in most cases [34]. In the present study, *S. Longiceps* showed the dominance of linolenic acid (C18:3) of polyunsaturated fatty acids in normal tissue.

Vitamins are organic chemical compounds essential for promoting growth, reproduction and maintenance of normal body health and function. [35] Fish liver oils are the richest sources of vitamin A and D, and the flesh is rich in vitamin B complex, especially niacin and B12. [6] stated that the flesh of fish and shell fish flesh in nut considered to be important sources of vitamin A while high of at fishes (e.g. eel, mackerel end menhaden) contain moderate amounts. The details of the vitamins detected in normal and infected tissue. Among them, vitamin A were found in higher levels, whereas vitamin BE were noticed as lower levels in normal tissue (0.17) and vitamin A was high in infected tissue. [20] reported that soluble vitamins A were more than D and E in *S. Longiceps*. In the present study, the vitamin A was more in *S. longiceps*normal fish tissue.

Minerals are the chemical elements, which are involved in the building of organisms and are necessary for its proper functioning. [36] explained the importance of Ca, Mg, and K in the human nutrition. The main aim of the present studies totally, 5 macro minerals and 2 trace minerals were detected. Among the macro minerals, sodium (289.6), potassium (166.5 mg/g) and copper (2.56 mg/g) were observed at higher and lower levels in normal tissue, whereas other macro-minerals magnesium and calcium were in negligible level. The trace minerals such as iron (3.07 mg/g) and zinc (0.24 mg/g) were also detected. The macro minerals, Potassium (102.7 mg/g) were observed at higher levels in infected tissue. The potassium content of raw rainbow trout was found to be 306mg/100g [37]. [21] Reported that potassium content was more in *R. kanagurta* followed by phosphorus and sodium. [38] Found the sodium content of individual species of salt water fish to range from 39 to 96 mg/100g with the average of 68mg/100g. [35] Reported that sea foods in general are excellent sources of I, Ca, P, Na, Fe, Zn and oysters are good sources of Fe and Cu. When compared to the other fish, the calcium content of raw rainbow trout was found to be 63.2mg/100g [37]. In the present study normal tissue showed higher levels of sodium and potassium. Consumption of finfishes especially *S. longiceps* tissue enriches of minerals.

In general, seafood is one of the most nutritionally balanced foods. The seafood diet helps to control weight and goes a long way towards preventing heart diseases. Studies on fatty acid composition of

commercial seafood in India are limited. This might be due to lack of awareness on benefits of these nutrients particularly from fish tissue. The nutritional values of fish are not brought to the limelight so far, so consumption of these nutrient rich fish has not attracted attention. The results of the present study provide information about the amino acids and fatty acid composition, but also suggest the consumption of this fish tissue. It is rich in amino acids (Phenylalanine), fatty acids (linolenic acid) and minerals (sodium, potassium). Further, the presence of amino acids (Phenylalanine) and fatty acids (linolenic acid) in *S. longiceps* tissue adds more value through the possibility. From the above observation it is clear that the normal tissue of *S. longiceps*with rich nutritive value can be used for alternate source as a regular sea food which supplies nutrients for the growing children, pregnant women and people suffering from malnutrition.

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