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# ENERGY DISTRIBUTION PATTERN IN THE EDIBLE AND INEDIBLE BODY PARTS OF *ETROPLUS SURATENSIS* (*BLOCH*)

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**Abstarct:** The present study was carried out to find out the energy distribution pattern in the edible and inedible body parts of *Etroplus Suratensis* (bloch). The study indicated that the mean energy density of the edible portion of immature fish was 17.47 kJ/g dry weight compared 20.20 kJ/g and 19.65 kJ/g of adult female and, ale respectively. Similarly the energy density of inedible portion of immature fish was 15.65 kJ/g while that of adult female and male were 17.49 kJ/g and 16.62 kJ/gdry weight respectively. The present investigation was carried out in the estuarine area formed by the confluence of Mulki (Shambhavi) and Pavanje rivers and both open into the Arabian sea at a point about 29 KM north of Mangalore in south India (13° 05' N; 74° 47' E).

## Introduction

The pearl spot, *Etroplus suratensis,* is an estuarine fish of commercial importance. It possesses certain requisite qualities essential for aquaculture such as good body weight, growth rate, high adaptability for food, tasty flesh and good market price (Joseph, 1980; Jayaprakash and Phil, 1980; Rattan, 1994). *Etroplus.suratensis* is a widely cultured species in the Indo-pacific region and is known to breed in confined waters (Hora and Pillay, 1962).

Being euryhaline, the species could easily be acclimatized to fresh waters indicating its suitability in pond aquaculture (Devaraj *et al,.* 1975). *E. suratensis* is also maintained as all aquarium fish because of its attractive colouration (Rattan, 1994). However, the successful culture of any endemic species depends on the efficient management of the farming system. To achieve this, information on feeding habits, digestive physiology, reproductive biology, water quality parameters, proximate analysis of body parts etc. are the prerequisites. Hence the present research was carried out with the following main objective of evaluating the pattern of energy distribution in the whole body and in edible and inedible body parts of fish at different life stages with a view to understand the possible energy mobilization pattern for reproductive and somatic growth purposes.

## MATERIALS AND METHODS

### Fish sampling site

The present investigation was carried out in the estuarine area formed by the confluence of Mulki (Shambhavi) and Pavanje rivers and both open into the Arabian sea at a point about 29 KM north of Mangalore in south India (13° 05' N; 74° 47' E). The area has been referred to as Mulki estuary, since the Mulki river is the major water source, while Pavanje river is only a tributary. The estuary is flooded with fresh water from the drainage area and the estuarine waters attain almost fresh water conditions during the south-west monsoon season (June to September).

### Collection of specimens

For the present investigation, fresh samples of *Etroplus suratensis* (sample size 40-60 individuals per month) caught from the estuary using cast net at depths ranging from 1.5-4.0 m as well as fresh fish purchased from landing centre formed the material for the present study. A total of 1256 specimens was examined, of which 578 were female, 334 male and 344 sex- indeteminates. The size range of the fish varied from 5.20 cm to 23.50 cm TL. Fish were transported to the laboratory in live condition in tin metal (Galvanized-iron) containers filled with the very waters from which fish were caught. Only live specimens were used for physiological studies.

### Energy estimation

Energy content of the dried samples of the :whole body of fish, liver, gonad, muscle, skin, fins, head, visceral organs etc., were measured in different stages of maturity using an autobomb automatic adiabatic bomb calorimeter (Model: Gallenkamp, CBA-305, UK make). The energy values of the tissue are expressed as *kJ/g* dry matter. Energy values of the whole body of fish belonging to the three stages of maturity namely, immature (Stage I wil;h < 10 cm TL), maturing (Stage II in the size range of 10-15 cm TL) and mature (Stage III,IV, V & VI with size > 15 cm TL) were, however, detennined in different months of the year.

## Results and Discussion

### Profile of body energy

The whole body energy density (kJ/g dry matter) of *E. suratensis* in immature (< 10 cm TL) maturing ( 10 -15 cm TL) and mature (> 15 cm TL ) groups of either sex caught from wild were estimated during different months and the same is presented in Table 3.

The mean body energy density of immature fish was 18.00 kJ/g. Among maturing fish female and male had 17.31and 16.92 kJ/g respectively. Mature fish showed 18.73 kJ/g for female and 17.75 kJ/g for male. Generally the body energy values of fish in all the three groups did not show much variation except during June to October (monsoon season) during which time mature fish had registered a high of 20 kJ/g and above. Comparatively higher values of body energy were also noticed during January. A sudden fall in the values of body energy in either sex may be noticed during February and March only to rise again in April month. Female in general, had higher body energy than male thought the period of study. Significant difference ($P < 0.05$) was noticed in the energy values due to maturity stages, but there was no significant variation due to months and sexes .The variation of whole body energy of *E. suratensis* at different lengths. The lowest body energy of juvenile fish ( 7.00 cm TL ) was 13.02 kJ/g which increased subsequently as fish grew in length. The highest energy value recorded in female was 21.61 kJ/g at 13.00 cm size group, while the lowest (11.24 kJ/g) in 16.70 cm size group. Similarly the highest body energy value (21.62 kJ/g) in 14.50 cm TL.

### Proportion of edible and inedible body parts of *E.suratensis* and their energy content

The proportion of different body parts of *E.suratensis* catogerizzed as edible and inedible in immature and mature fish are provided in Table 1. Immature fish has 56.49 % edible and 43.51% of inedible parts in their body. However in the mature fish, male exhibited a higher proportion of edible body arts (61.92%) compared to female (53.92%).

### Energy distribution in different body parts of *E.suratensis*

The percentage distribution of energy in different body parts of fish are given in Table 2.The percentage of energy distribution of different body parts of fish showed that among immature fish, muscle contributed a maximum of 43.64 % while head and visceral organs shared 24.99 % and 12.10 % respectively. The share of energy by skin was 10.27% and that of scale was 4.61%. Fins contributed the least energy (4.38%).Similarly in case of adults also muscle ranked first with female showing 40.59% amd male 50.18 %. The second highest energy containing organ was head (female with 31.84% and male with 24.43%) followed by fins in female (9.3%) and skin in male (9.66%). The least energy containing body part in female was scales (5.00%) while in male it was visceral organs (4.11%).

**Proportion of edible and inedible body parts of *E. suratensis* and their energy content**

While selecting a species for aquaculture it is desirable to select a species which contains more edible body parts (i.e., after the removal of viscera, fluids, head, scales, fins etc.). Fish flesh comprises approximately 60% of body weight of fish, varying considerably from species to species (Pigott and Tucker, 1990).

In the present study, *E.suratensis* has been found to possess a high proportion of its body in the form of muscle comparable with those of popular food fishes. As can be seen from the Table 1, immature pearl spot has muscle comprising 47.62% and mature male and female with 55.34% and 47.09% of the body weight respectively. According to Jobling (1995) gold fish, *Carassius auratus* possesses 40%, salmonids about 60% and scombrids as high as 70% muscle content of body weight. As is generally known, higher the- muscle content in fish greater is the demand for it in the market even though taste does play a crucial role.

However, it is not just the muscle portion alone that is edible in fish. There are other organs/tissues which are also edible. For instance, liver, gonad etc., depending on their size. Skin, however, is usually consumed along with the underlying muscle tissue after the removal of scales.

Thus, in the present study, even if liver and gonad tissues are discarded along with the other visceral organs, as inedible (as often is the case mostly on account of their small size) the edible portion (muscle tissue plus the overlying adhering skin) in immature fish, yet, amounts to an impressive 56.49%, while in mature male and female the values of edible portion are 61.92% and 53.29% respectively. Thus, it may be stated that *E. suratensis* is a meaty fish whose edible portion showing variation with the size of fish and hence, the maturity condition.

The high proportion of edible body parts in mature male compared to female may be due to the higher portion of visceral organs in female (6.91 %) than in male (3.96%). Miller (1974) reported a value of 47.9% dress-out weight for *Sarotherodon hornorum* and 5.3% for S. *mossambicus.* Edwardson (1976) found out the edible portion (filleted) of S. *mossambicus* to be at 38%. According to Hickling (1963) the edible portion of S. *mossambicus* varied with the size of the fish and accordingly fish weighing 450g, 700g and 2000g yielded 24%, 27% and 46% of its body weight as edible portion indicating that bigger the fish higher the proportion of edible parts in fish. Edwardson (1976) reported that carp had 53% and trout

70% of its body weight as edible portion. The calorific content of the entire animal is an important variable to be determined in energy flow studies, for its knowledge makes it possible to express dry weights in terms of energy units. Hence, much effort has been made earlier to measure the calorific content of the diet and tissues of many organisms (Slobodkin and Richman, 1961; Paine and Vadas, 1969; Cummins and Wuycheck, 1971; Jain, 1991 and Jobling, 1995). Biochemical constituents of animals are known to vary with seasons, size of animals, stage of maturity and the availability of food. These in turn affect the caloric content of the animal (Wootton, 1974; Wootton and Evans. 1976; Wootton1979; Hunter and Long, 1981, and Jain, 1991). Jobling, (1995) reported that a deposition of 19 lipid (38 kJ*)* leads to a weight increase of 1g, whereas deposition of 19 protein (24 kJ*)* also leads to the deposition of3-4g water. Therefore, changes in weight alone may not always give an accurate reflection of growth in terms of energy gain. Hence, estimation of energy values of fish body can provide the accurate nutritional status of fish.

The distribution / contribution of energy in different body parts of *E. suratensis* showed that muscle tissue contained the maximum energy compared to other body parts. Evidently this must be due to the fact that nutrient rich muscle tissue comprise more than 50% of the body weight of fish. The second highest energy containing organ is the head which may be attributed to the higher biochemical composition compared to other parts such as fins, scales, skin and visceral organs.

There is paucity of information on bio-energetic studies of Indian fish species. As far as the energy density of edible and inedible parts of *E. suratensis* are concerned immature fish registered a mean value of 17.47 kJ/g in edible parts and 15.65 kJ/g in inedible parts as against 17.49 kJ/g and 18.73 kJ/g in mature female and 19.65 kJ/g and 16.62 kJ/g in mature male respectively. The lower energy value in inedible body parts of immature fish may be due to the lower energy content of visceral organs probably due to the less developed gonad and liver tissues. In contrast, the energy values of inedible body parts of mature fish were high (26.21 kJ/g in female and 24.91 kJ/g in male) possibly due to the well developed gonad and other organs of high energy value for example liver (27.37 kJ/g each in both sexes) and ovary (21.80 kJ/g).

Pigott and Tucker (1990) reported that a low-fat white fish contains about 80 kcal per 100 g edible portion (raw), medium fat about 100 kcal/l00 g and high fat fish between 150 to 225 kcal II 00 g (1 calorie = 4.184 *J).* According to them, chinook salmon contributes 222 kcal /100 g, pink salmon only 119 kcal and mackerel yielding 191 kcal/ 100 g.

In the present study, a mature *E. suratensis* is found to contain a very low fat and high protein content Therefore, it may be considered as an ideal low calorie and protein rich source of food. Wootton (1979) has calculated a mean value of ripe ovaries of 50 teleost species at 23.48 kJ/g dry weight. In the present study also, ripe ovaries of pearl spot have been found to contain almost similar value (21.80 kJ/g dry matter). Stickleback eggs also are reported to contain almost a similar value (22.6 kJ/g) (Wootton, 1974).

Ursin (1979) suggested that the production of testicular tissue in fish may be energetically more costlier than ovarian tissue production which was questioned by Wootton (1979). He opined that in view of the lesser amount of production of testicular tissue, as noticed in stickle back, energy costs associated with maturation of testes are probably negligible (74.9 kl),when compared to ovaries production (1122 kJ*).* Jobling (1995) reported that though generally males produce lesser amount of testicular tissue (usually < 3-5% Gonado-somatic index (GSI) when compared to ovaries (about 20% or more) males often indulge actively in courtship, breeding territory defense, egg guarding / parental care, energetic costs of reproduction is likely to be same in both sexes.

However, in fishes with longer spawning season oocytes may develop in small batches and spawning events may occur several times in a year, in which case the ovaries of such fishes seldom exceed 5 -10% of the to1a}'fish body weight. Jobling (1995) states that the measurement of size of overy alone will not give true reflection of annual energy investment. Wootton (1979) could not measure the energy content of testes of stickle back as the quantity of sperm produced by it was very less. **In** the present study also a similar problem was encountered. Hence, measurement of energy of testes could not be made. However, the studies on other species indicate that energy content of the testes is similar or lower than that of ovaries in the same species. In pike *(Esox lucins)* energy content of testes was 22.60 kJ/g dry weight and that ovaries was 24.69 kJ/g, both measured just prior to spawning. The head of pearl spot contained considerable energy ranging from 17.47 kJ/g in immature to 18.68 kJ/g and 16.49 kJ/g in mature female and male respectively. Similarly, other parts of inedible portion also contain considerable energy in them which may be effectively used in feed formulation / manure preparation

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**Table 1:** Proportion of edible and inedible body parts and their energy profile in *Etroplus susratensis*

| | Immature | | | Mature | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Maturity stages | | | | Female | | | Male | | |
| | Wet weigh t(g) | Percent body wet weight (%) | Energy content(kJ/g dry wt.) | Wet weigh t(g) | Percent body wet weight(%) | Energy content(kJ/g dry wt.) | Wet weigh t(g) | Percent body wet weight(%) | Energy content(kJ/g dry wt.) |
| **A. INEDIBLE PORTION** | | | | | | | | | |
| Head | 3.7 | 24.50 | 17.47 | 35.73 | 24.28 | 18.68 | 30.93 | 19.83 | 16.49 |
| Pectoral fins | 0.06 | 0.40 | | 0.87 | 0.59 | | 0.70 | 0.44 | |
| Pelvic fins | 0.03 | 0.20 | 0 | 0.80 | 0.54 | | 9.07 | 0.69 | |
| Dorsal fins | 0.21 | 1.39 | 11.24* | 3.66 | 2.49 | 12.80* | 3.80 | 2.44 | 12.28* |
| Anal fins | 0.10 | 0.66 | | 3.00 | 2.04 | | 2.07 | 1.33 | |
| Caudal fins | 0.10 | 0.66 | | 2.20 | 1.50 | | 2.27 | 1.44 | |
| Scales | 0.27 | 1.79 | 17.47 | 8.13 | 5.52 | 12.28 | 8.07 | 5.17 | 12.80 |
| Visceral organs | 1.60 | 10.60 | 16.43 | 10.17 | 6.91 | 26.21 | 6.17 | 3.96 | 24.91 |
| Vertebral column | 0.50 | 3.31 | | 4.17 | 2.83 | -- | 4.35 | 2.79 | -- |
| Total in edible | 6.57 | 43.51 | 15.65 | 68.73 | 46.70 | 17.49 | 59.43 | 38.09 | 16.62 |
| **B. EDIBLE PORTION** | | | | | | | | | |
| Muscle(free of bones) | 7.19 | 47.62 | 19.55 | 69.30 | 47.09 | 20.59 | 86.33 | 55.34 | 19.50 |
| Skin | 1.34 | 8.87 | 15.9 | 9.13 | 6.20 | 19.81 | 10.27 | 6.58 | 19.79 |
| Total edible | 8.53 | 56.49 | 17.47 | 78.43 | 53.29 | 20.20 | 96.60 | 61.92 | 19.65 |
| **C.WHOLE BODY** | 15.10 | -- | 18.00 | 147.17 | -- | 18.73 | 156.00 | -- | 17.75 |

**Table 2:** Energy distribution pattern (%) in different body parts of *E.suratensis*

| Body parts of the fish | Wet weight(g) | Moisture(%) | Dry matter(g) | Energy density(kJ/g dry matter) | Total energy(kJ) | % of energy distribution |
|---|---|---|---|---|---|---|
| **Immature** | | | | | | |
| **Head** | 3.91 | 73.51 | 1.03 | 17.47 | 17.99 | 24.99 |
| **Fins** | 0.529 | 47.44 | 0.28 | 11.24 | 3.15 | 4.38 |
| **Scales** | 0.303 | 35.20 | 0.19 | 17.47 | 3.32 | 4.61 |
| **Skin** | 1.481 | 67.70 | 0.48 | 15.39 | 7.39 | 10.27 |
| **Visceral organs** | 1.807<br>1.807 | 70.56<br>70.56 | 0.53<br>0.53 | 16.43<br>16.43 | 8.71<br>8.71 | 12.10<br>12.10 |
| **Muscles** | 7.62 | 79.25 | 1.58 | 19.55 | 31.41 | 43.64 |
| **Mature- Females** | | | | | | |
| **Head** | 52.00 | 68.81 | 16.22 | 18.68 | 302.99 | 31.84 |
| **Fins** | 15.80 | 53.73 | 7.31 | 12.80 | 93.57 | 9.83 |
| **Scales** | 12.40 | 68.75 | 3.88 | 12.88 | 47.65 | 5.00 |
| **Skin** | 11.60 | 74.62 | 2.74 | 19.81 | 58.24 | 6.12 |
| **Visceral organs** | 10.00 | 75.99 | 2.40 | 26.21 | 62.90 | 6.61 |
| **Muscles** | 93.00 | 79.83 | 18.76 | 20.59 | 386.27 | 40.59 |
| **Mature- Females** | | | | | | |
| **Head** | 32.80 | 66.04 | 11.14 | 16.49 | 183.70 | 24.43 |
| **Fins** | 8.00 | 49.64 | 4.03 | 12.28 | 49.49 | 6.58 |
| **Scales** | 7.00 | 57.73 | 2.96 | 12.80 | 37.89 | 5.04 |
| **Skin** | 12.20 | 69.93 | 3.67 | 19.79 | 72.63 | 9.66 |
| **Visceral organs** | 5.50 | 77.46 | 1.24 | 24.91 | 30.89 | 4.11 |
| **Muscles** | 85.90 | 77.47 | 19.35 | 19.50 | 377.33 | 50.18 |

**Table 3:** Body energy content (kJ/g dry matter.) of *E suratensis* in different stages of maturity

| Maturity stages | IMMATURE | | MATURING | | | | MATURE | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | UNSEXED | | FEMALE | | MALE | | FEMALE | | MALE | |
| MONTHS | MEAN | SE | MEAN | SE | MEAN | SE | MEAN | SE | MEAN | SE |
| **Oct '97** | 18.60 | 0.09 | 17.80 | 0.08 | 17.50 | 0.14 | 18.97 | 0.09 | 18.43 | 0.11 |
| **Nov.** | 17.97 | 0.07 | 16.46 | 0.06 | 16.91 | 0.03 | 19.13 | 0.14 | 17.60 | 0.10 |
| **Dec.** | 18.16 | 0.14 | 16.73 | 0.02 | 17.20 | 0.11 | 17.28 | 0.06 | 18.53 | 0.19 |
| **Jan.'98** | 18.25 | 0.02 | 17.42 | 0.10 | 18.23 | 0.13 | 18.63 | 0.06 | 19.45 | 0.23 |
| **Feb.** | 17.6 | 0.11 | 16.84 | 0.05 | 17.85 | 0.05 | 16.80 | 0.05 | 18.31 | 0.12 |
| **Mar.** | 16.75 | 0.13 | 17.14 | 0.05 | 16.42 | 0.10 | 17.43 | 0.11 | 16.43 | 0.11 |
| **Apr.** | 17.98 | 0.07 | 18.02 | 0.03 | 17.26 | 0.07 | 19.53 | 0.04 | 17.83 | 0.06 |
| **May** | 17.44 | 0.10 | 15.04 | 0.08 | 18.43 | 0.10 | 18.55 | 0.13 | 15.43 | 0.11 |
| **Jun.** | 18.25 | 0.05 | 16.89 | 0.02 | 17.65 | 0.14 | 21.90 | 0.02 | 18.22 | 0.05 |
| **JuI.** | 16.63 | 0.08 | 17.64 | 0.10 | 17.44 | 0.10 | 18.29 | 0.08 | 15.10 | 0.05 |
| **Aug.** | 20.46 | 0.29 | 17.83 | 0.07 | 17.55 | 0.07 | 21.60 | 0.11 | 17.49 | 0.17 |
| **Sep.** | 18.52 | 0.13 | 15.36 | 0.05 | 17.44 | 0.10 | 20.29 | 0.05 | 19.56 | 0.13 |
| **Oct.** | 19.07 | 0.06 | 18.01 | 0.07 | 16.08 | 0.10 | 20.56 | 0.14 | 18.30 | 0.07 |
| **Nov.** | 17.63 | 0.08 | 17.18 | 0.28 | 17.18 | 0.28 | 18.48 | 0.15 | 17.90 | 0.02 |
| **Dec.** | 17.86 | 0.05 | 16.83 | 0.07 | 15.88 | 0.04 | 17.94 | 0.13 | 18.23 | 0.06 |
| **Jan.'99** | 18.48 | 0.13 | 16.44 | 0.11 | 17.01 | 0.09 | 18.51 | 0.06 | 19.58 | 0.08 |
| **Feb.** | 17.47 | 0.07 | 18.55 | 0.07 | 16.07 | 0.08 | 16.42 | 0.10 | 17.50 | 0.13 |
| **Mar.** | 16.57 | 0.08 | 17.10 | 0.11 | 17.56 | 0.06 | 17.18 | 0.08 | 16.07 | 0.17 |

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