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Estimation of Fillet/Food Calorie Ratio as an Index of Energy Assimilation in Some of the Marinewater Fishes from Saudi Arabia

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ABSTRACT. The energy values in the fillet and gut content of some predominantly carnivorous fishes were determined in order to derive a parameter for expressing the biomass in terms of energy units. The energy values of the nutrients in the fillet/food, determined by Organic Carbon and Karzinkin Tarkovaskaya Methods for five species, were in order; *Scomberomorus commerson* (13534.97/6405.50 and 15409.96/6874.72 J gm^{-1}); *Epinephelus tauvina* (12636.44/6462.66 and 13864.16/6702.22 J gm^{-1}); *Alepes djeddaba* (10931.29/6466.71 and 12529.99/6727.13 J gm^{-1}); *Valamugil seheti* (10758.89/6068.03 and 1197.04/6604 J gm^{-1}) and *Lethrinus harak* (7602.53/5034.98 and 10278.65/6202.57 J gm^{-1}) respectively. The implications of the results obtained by the method used, have been indicated and the ratio between the energetic values of food and fillet have been given. Consistency of the results obtained in each fish clearly indicate the reliability of the method used.

Energy transformation between the organism and circuits of energy in nature are of fundamental interest in ecological studies of terrestrial, limnic, marine and global ecosystems (Odum 1971 and Brey *et al.* 1988). It is widely accepted that the biomass of animals can be expressed in terms of their calorific value are very well known. Similarly, energy budget and balances for other ecological parameters can be computed in terms of calories; thus, the calorie is becoming a generally accepted ecological unit since it gives a better comparison of energetic processes than number of biomass. The description of energy content and energy flow is one of the problem in the fish bioenergetic scheme, while the total dietary energy can be determined relatively easily, this is of little value in predicting of the amount of energy available for metabolism and growth. In energy flow studies, caloric content of the organism is an important parameter and is used for converting the total biomass of the population into units of energy (Vijayaragavan *et al.* 1975 Jafri and Shamsi 1983). This approach can be applied for the determination of the organic carbon content of ingested food and expressing this in terms of energy units in its natural environment. This covers the main feeding cycle which is chacracterised by various morphological and behavioural adaptations in the animals. In natural environment the bioenergetics concept has been applied to estimate growth and processess controlling the production of fish populations (Webb 1978). This concept of estimating growth by energy consumption has been applied to several other fishes such as, yellow perch, *Perca flavescens* (Salmon and Bradfield 1972); brown trout, *Salmo trutta* (Elliot 1976a, 1976b) and large mouth bass, *Micropterus salmoides* (Niimi and Beamish 1974). But variations in the energy content due to season, taxonomic group, developmental and reproductive stages, food condition and the environmental factors strognly influence the result of the measurements (Slobodkin and Richman 1961, Qasim *et al.* 1975, Griffith 1977, Jana and Pal 1980 and Norrbin and Bamstedt 1984).

Studies on the caloric content of aquatic organisms from different environments have so far been limited (Qasim and Jacob 1972, Foltz and Norden 1977, Jafri and Shamsi 1983 and Pauly 1986). The aim of this study is to obtain a valid conversion factor from weight-to-enery which is useful for general estimations of energy content and energy flow in aquatic ecosystem. When combined with diet and behavioural data it helps to assess habitat quality and interpret the use of various habitats by different species (Driver 1981). Hence, the present communication gives working instructions for the analysis of caloric value in fillet and stomach contents of some of the selected marine-fish for expressing the energy assimilation and conversion efficiency.

Materials and Methods

Freshly collected marine fish specimens, *Scomberomorus commerson* (Scobridae), *Epinephelus tauvina* (Serranidae), *Alepes djeddaba* (Carangidae), *Valamugil seheti* (Mugilidae) and *Lethrinus harak* (Lethrinidae) were taken from Saudi Fisheries Agency. The stomachs were carefully removed, emtied into bowl and pooled for analysis. Stomach contents were examined under the microscope for different identifiable food items, and then dried in an oven at a 60-70° C for 24.0 hrs. Then the fish from which the content had been removed were macerated in an electric grinder and dried at the same temperature. The dried sample was homogenised into a fine powder using pestle and mortat and stored in properly stopped specimen tubes in a desiccator until analysed. The caloric values of both the samples (fillet and food) were estimated by the method of organic carbon (Qasim and Jacob 1972) and Karzinkin and Tarkovaskaya (1964). The same methods were also utilized earlier by Jafri and Shamsi (1983).

From the dried sample 25 mg was placed in round bottom flask containing 3 ml of 5 % potassium iodate and 20 ml of conc. H_2SO_4. The flask was connected to a reflux condenser and heated for one hour on an electric heating mantle. Oxidation commences immediately on heating and releases the free iodine. The intensity of the colour appearing is directly proportional to the amount if organic matter present in the sample. After cooling, the sample was diluted by 50 ml of distilled water. Free liberated made the solution pinkish orange. This solution was again heated until the colour and smell of iodine disappeared. The content was made to 250 ml with 10 ml of 10% potassium iodide and the sample was kept in the dark for 15 minutes. This solution was treated against a 0.1 N solution of sodium thiosulphate using starch as an indicator. For the blank, all the details described above were followed.

Calculations:

Oxygen used by the sample is determined from the difference between the amount of thiosulphate consumed for the titration of the blank and that of the sample.

Amount of thiosulphate consumed by blank = a
Amount of thiosulphate consumed by the sample = b
Amount of oxygen used by the sample = a-b x 0.6667.

(1 ml of 0.1 N thiosulphate corresponds to 3.567 mg of potassium iodate and 1 mg of this solution corresponds to 0.1869 mg of oxygen, hence, 3.567 x 0.1869 = 0.6667.

Weight of the sample = A

$$\text{Oxygen consumed by one gram of sample} = \frac{a-b \times 0.6667 \times 1000}{A}$$

$$\text{Joules/g. dry weight of sample} = \frac{(a-b) \times 0.6667 \times 1000 \times 3.38}{A}$$

3.38 is the oxycaloric coefficient given by Vinber *et al.* (1934).

Organic Carbon

The samples were taken in the same way as above and lumped together in bowls containing melting ice. The total quantity was then shaken thoroughly and three of the sub samples were taken for quantitative analysis and examined under the microscope. Moistened samples as described and the dried sample (50 mg) were placed in a hard glass boiling tube and 30 ml chromic acid was added and coverd with aluminium foil. The sample was heated till completely digested and cooled. After cooling the sample was diluted with distilled water and titrated against 0.2 N ferrous ammonium sulphate using ferrous-phenanthroline ($C_{14}H_8$ $N_2.H_2O$) as an indicator until a brick red colour appeared. Blanks were also run accordingly without sample.

In this method 1 ml of 0.2 N ferrous ammonium sulphate is equivalent to 0.6 ml of carbon. If the titration value of the blank is (X) and for the sample is (Y), then (X-Y) is the volume of ferrous ammonium sulphate which is equivalent to chromic acid reacted. If up to 10 ml of chromic acid is used for the blank instead of the usual 30 ml, the titration values should be multiplied by 6 and 3 respectively.

Results

Data pertaining to the total average energy in terms of Joules/gm. dry weight and the fillet/food energy ratio of the samples are tabulated in Table 1. The present investigation reveals that energy values obtained in the method of Karzinkin Tarkovaskaya (1964) are a little higher than the organic carbon. However, the relative effectiveness of both the methods were determined by calculating the correlations coefficients which are highly significant ($P<0.001$). This indicates that the methods applied here are equally efficient in measuring the energy values in fillet as well as in the ingested food. Table 2 shows the values of correlation coefficient between fillet and food of both the methods used. It indicates that the methods could be applied for both the estimations with reasonable accuracy. The assimilation of energy nutrients in the body and the food of the two methods applied for the five specimens increases in order: (*S. commerson* > *E. tauvina* > *A. djeddaba* > *V. seheti* > *L. harak*) respectively.

Discussion

Comparison of food intake in the field and bioenergetics of fish in the laboratory are a potentially useful approaches to understanding the relation between fish growth and food abundance and availability (Mills and Forney 1981). It is of obvious importance to measure the relationship between food intake and growth; if the growth is poor, the food may be appropriate for the animal. It would be important to know whether the ratio in the fish species of the same group and in the same species has changed monthly depending upon the quality of food consumed

Table 1. Total average energy in terms of Jouls/gm dry weight and the fillet/food energy ratio in some of marinewater fish species

Species	Total Specimens used for analysis	General composition of ingested food	Organic Carbon Method			Karzinkin Tarkovaskaya Method		
			Fillet	Food	Ratio	Fillet	Food	Ratio
1. *S. commerson*	22	Small fishes	13534.97 ±31.814	6405.50 ±160.90	2.11	15409.96 ±32.64	6874.72 ±33.13	2.24
2. *E. tauvina*	28	Bottom living crustaceans and small fishes	12836.44 ±104.36	6462.66 ±52.43	1.98	13864.16 ±27.35	6702.22 ±54.63	2.06
3. *A. djedabba*	30	Small fishes and crustaceans	10931.29 ±33.58	6466.71 ±22.69	1.69	12529.99 ±44.09	6727.13 ±30.84	1.86
4. *V. seheti*	40	Small organisms and crustaceans	10758.89 ±47.17	60.68.03 ±34.76	1.77	11970.04 ±25.08	6604.54 ±29.06	1.81
5. *L. harak*	30	Small fishes and crustaceans	7602.53 ±33.78	5054.98 ±29.28	1.50	10278.65 ±37.32	6201.57 ±28.66	1.66

Table 2. Correlation coefficient between caloric value of fillet and food in the two different methods

Methods used	Value of correlation coefficient	Significance
1. Organic carbon	0.987	$P < 0.001$
2. Karzinkin Tarkovaskaya	1.00	$P < 0.001$

which has to be determined after seeing the assimilation by the body or whether it is influenced by some other biological factors such as maturity, spawning and growth. This hypothesis can be correlated with the work of Qasim *et al.* (1975) and Jafri and Shamsi (1983). The variation in the energy content values might also be due to highly differing amount of food materials in the gut of species of various feeding habits of the fish. This hypothesis is in concordant with the work of Brey *et al.* (1988).

The values of organic carbon obtained very often differ widely in all species probably because of incomplete oxidation of protein for which a correlation becomes necessary. This is concordant with the work of Hughes (1969). It can be concluded that the energetic value of a fish is certainly the consequence of the main constituents of its body such as, protein, lipid and corbohydrates and the ratio of these organic components determines the energy content per unit of body mass if inorganic matter is ignored (Brey *et al.* 1988), so the fish undergoes energy changes of its soma in different stages of maturity because there is considerable drain of the energy reserves due to sexual maturation which is comparatively greater in females (Jana and Pal 1980).

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تقدير نسبة السعرات الحرارية في العضلات والطعام كمؤشر لطاقة التمثيل الغذائي في بعض الأسماك البحرية في المملكة العربية السعودية

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في هذه الدراسة تم قياس قيم الطاقة الموجودة في العضلات وبقايا محتويات الأمعاء من الطعام في خمسة أنواع من الأسماك البحرية آكلات اللحوم في المملكة العربية السعودية وهي :

١- *Scomberomorus commerson*
٢- *Epinephelus tauvina*
٣- *Alepes djeddaba*
٤- *Valamugil seheti*
٥- *Lethrinus harak*

تم اختيار طريقتين لتقدير الطاقة وهما طريقتا :

١- طريقة الكربون العضوي (Organic Carbon)
٢- طريقة كارزنكين تاركوفاسكيا (Karzinkin Tarkovaskaya)

وقد تبين من الدراسة أن كميات السعرات الحرارية المقدرة بالطريقة الثانية (K.T.) كانت أعلى بقليل من تلك التي قدرت بالطريقة الأولى (O.C.) – طريقة الكربون العضوي وعند حساب مؤشرات العلاقة بين الطريقتين كان الفرق غير معنوي إحصائياً . وبالتالي فأنه يمكن استخدام أي من الطريقتين في تقديرات الطاقة دون فرق ظاهر .

اتضح من الدراسة كذلك أن تمثيل الطاقة في العضلات والطعام حسب قياسهما بالطريقتين ووجد أن قيم الطاقة قد تدرجت بإزدياد مضطرد على النحو التالي :

S. commerson ثــم *E. tauvina* ثــم *A. djeddaba* ثــم *V. seheti* ثــم *L. harak* .

وقد أشار البحث كذلك إلى أهمية تقديرات الطاقة في دراسات النظم البيئية .