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COMMUNITY METABOLISM, P/R RATIO AND PHOTOSYNTHETIC EFFICIENCY OF A BRACKISHWATER FARM

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ABSTRACT

Productivity level of a brackishwater fish culture farm consisting of 25 ponds, with a water spread area of 2.5 ha was studied. Gross community photosynthesis of the farm was found to be 46.32 Kcal/m^2/day, which is equivalent to the release of 13.23 of O_2/m^2/day, or the fixing of 4.10 gc/m^2/day. Respiratory demand of the farm was estimated to be 44.66 kcal/m^2/day, which is equivalent to the uptake of 12.76 g O_2/m^2/day or the utilization of 3.95 gC/m^2/day. Photosynthetic efficiency of the farm was high at 2.26%. The P/R ratio was 1.04, showing eutrophic nature.

INTRODUCTION

Several prawn and fish farms are being established along the coastline of India for the development of brackishwater aquaculture in the country. In order to utilize the waterbody effectively, several factors are to be considered and monitored regularly and one of the most important aspects is to study the productivity of the farm. However, there is very limited information regarding this factor. Welch (1952) pointed out the lacunae in the knowledge on this aspect. Cole (1979) mentioned the importance of studying community metabolism and Odum (1956) developed the idea of determining the P/R ratio in order to define a community type and also the concepts of autotrophy and heterotrophy.

Earlier studies related to brackishwater fish farms are by

Dwivedi *et al.* (1977), who studied the diurnal variation of abiotic and biotic parameters of a pond whereas, Jayanand Reddy (1985) focussed on the photosynthesis, respiration and gross photosynthesis.

In the present account, the well established culture ponds of the brackishwater fish farm, Kakinada were selected to study the community metabolism, P/R ratio and photosynthetic efficiency on an average.

DESCRIPTION OF THE SITE

The study was conducted at the CIFE's Brackishwater Fish Farm at Kakinada (Lat. 16° 50' 4" North and long. 82° 15' 45" East; elevation 0.87 m above MSL) in the East Godavari district of Andhra Pradesh. The farm has a total area of 7.5 ha with a total waterspread area of 3.2 ha enclosing 36 ponds of varying dimensions (Fig.I) Pond No.1 to 25 were selected for the present study. Other ponds were omitted as they were not in use for culture. Of these ponds 4,5,22 and 23 were stocked with prawns @ 10000/ha while the other twenty one ponds were stocked with *Chanos chanos* @ 5000-7500/ha.

The main source of water supply to these ponds is the feeder canal, connected to the backwaters of Kakinada Bay, at the northern side of the farm.

MATERIALS AND METHODS

Community metabolism and P/R ratio were estimated following the mentioned of McConnel (1962, as outlined by Lind 1979). Samples were collected from all the ponds at 1700 hrs. on 13.1.88 and at 0500 hrs and 1700 hrs on 14.1.1988. Two samples were collected from each pond, one just below the surface and the second sample from a depth of 60-70 cm (euphotic zone).

Water temperature and DO concentration were measured *in situ* using a battery operated portable water quality analyser (Elico model PE 132).

Cole (1979) suggested multiplication of the volume of the water body of the weight in grams of O_2 per cubic meter produced within it to reveal the total production and then dividing the total oxygen by the surface area. This is equivalent to multiplying the weight in grams of O_2 per cubic meter by the mean depth (Z)

of the water body to get the depth productivity figure for the entire water body. Following this procedure, all values in grams per cubic meter were multiplied by the corresponding mean depth to express the production and respiration values in grams of oxygen per square meter per day.

Community respiration, gross community photosynthesis and the P/R ratio were calculated by the method of Lind (1979). Following the method outlined by Cole (1979) all the oxygen data were converted into carbon values by multiplying with a conversion factor of 0.375 and dividing the product by the customary photosynthetic quotient of 1.2 (Strickland, 1960; Cole, 1979). An oxycaloric coefficient of 3.5 was used, as suggested by Cole (1979) to convert the oxygen data into caloric energy units.

The photosynthetic efficiency F was calculated by the method given by Natarajan and Pathak (1983) using the formula,

$$F = \frac{n}{n-1} \times 100$$

where n = energy in primary producers
n-1 = visible solar energy

The visible solar energy for the study area was assumed to be 2050 Kcal/m^2/day, based on the data for Nagarjunsagar reservoir as given by Natarajan and Pathak (1983) as the present study area also falls under the same latitude (16°N) as that of Nagarjunsagar.

RESULTS AND DISCUSSION

The highest level of photosynthetic production observed during the present study was 17.37 g O_2/m^2/day which is equivalent to 5.38 g C/m^2/day or 60.80 Kcal/m^2/day, the lowest observed was 7.27 g O_2/m^2/day equivalent to 2.25 g C/m^2/day or 25 Kcal/m^2/day. The mean value was 13.23 g O_2/m^2/day equivalent to 4.10 g C/m^2/ day or 46.32 Kcal/m^2/day.

Talling *et. al.* (1973) suggested that the highest level of gross production possible was 17.8 g C/m^2/day (=47 g O_2/M^2/day) but this rate of production must be extremely rare according

to Cole (1979). However, the production per square meter in a shallow, eutrophic pond may be intense but surpassed by that in a deep oligotrophic lake with marked light penetration, because the water column is short in the pond (Cole, 1979). But the present study is at variance from this point of view, in that the mean value of oxygen produced per square metre per day in these ponds viz. 13.23 g is greater than those reported for some freshwater reservoirs, viz., 1.003 g for Rihand, 1.619 g for Nagarjunsagar, 2.38 g for Bhavani sagar, and 3.178 for Govindsagar (Natarajan and Pathak, 1983). Such a high production could be due to higher amounts of salts and inorganic carbon (Talling *et al.* 1973; Cole, 1979).).

Jayanand and Reddy (1985) reported gross photosynthesis of 766.333,589.875 and 847.000 mgC/cm^3/hour respectively from ponds 3, 15 and 23 from the same farm; respiration at the three ponds was reported to be respectively 176.458, 196.625 and 342.834 mgC/cm^3/hr. The gross production rates when converted to g C/m^2/day works out to be less than those of the present study for the same ponds, and may reflect on the method used for the study.

Odum (1956) developed the idea of a grass primary production/total/diel respiration or P/R proportion to define community type. Based on the data on P/R ratios from the present study, ponds 4 and 13 can be termed oligotrophic (P/R equals unity). Ponds 2(0.96), 5(0.98), 17(0.94), 21(0.64), 23(0.79) and 24(0.82) can be termed heterotrophic as the P/R values are less than one, of these ponds 2,5 and 17, however, have values very near to 1.0. All the other ponds have P/R values above 1.0 and can be categorised as autotrophic. However, only a long-term study can tell something about the ecosystems nature and a seasonal study is therefore needed to draw final conclusions in this regard.

The overall P/R values for the farm, for the 25, ponds, worked out to be 1.104 on an average. Thus the farm as a whole can be classified as autotrophic.

The magnitude of energy fixation ranged between 25.45 and 60.80 Kcal/m^2/day with an average of 46.32 Kcal/m^2/day (Table-1) as gross community photosynthesis; this production rate is much higher than 3.80 Kcal/m^2/day reported for Rihand reservoir and 11.69 Kcal/m^2/day as observed for Govindsagar reservoir

(Natarajan and Pathak, 1983).

Community respiration in terms of energy ranged between 27.5 and 58.63 Kcal/m^2/day, with an average of 44.66 Kcal/m^2/day (Table-1); this accounts for 96.42% of the energy fixed by the autotrophs. The very high respiratory demand of the community in the present study can be attributed to the high stocking density of prawns and fishes in these ponds.

The photosynthetic efficiency of the farm under study was found to be 2.26%, which is considerably higher than 0.202 to 0.682% as reported for certain reservoirs by Natarajan and Pathak (1983).

Thus the study of some aspects of the bioenergetics of the Brackishwater Fish Farm, Kakinada, conducted for specific days show the farm to be eutrophic and autotrophic in nature. However, weekly variations in community metabolism are likely to occur. Therefore a continuous study between the stocking and harvesting periods is essential to draw precise conclusions on the trophic nature of the farm.

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