

THE OXYGEN UPTAKE AND THE CARBONDIOXIDE OUTPUT OF
THE PECTORAL MUSCLE FIBRES OF THE FOWL, PIGEON
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The rate of respiration is essentially the index of the metabolic activity and its determination is therefore of prime importance in understanding the various chemical and physiological changes that take place in organisms and the component parts of them. Investigations on these lines have been carried out by numerous workers with the result that an ocean of literature has now accumulated. Yet our knowledge of the chemistry of the oxidative processes in a living system is far from complete. In the words of Heilbrunn (1952), "What the chemistry of vital oxidative processes has shown is that the living cell is the scene of a tremendously complex series of reactions capable of producing energy. How this energy is harnessed is something for the future to determine."

The vertebrate skeletal muscle has been an object of much investigation since Fletcher and Hopkins published their work on the lactic acid production in muscle in 1907. The skeletal muscles of some mammals,

pigeon and the frog have been extensively studied and more recently the pigeon breast muscle in particular by Krebs and Szent-Gyorgyi. The presence of myoglobin, and oxygen storage system in muscles such as of the pigeon breast has also added to the importance of this material for such studies.

In the previous chapter the role of fat as the chief fuel in long and sustained muscular activity in the bird and bat has been pointed out. The presence of a high amount of fat in the pigeon and bat breast muscle which also contains myoglobin unlike that of the fowl, seems to indicate a close relationship between the presence of fat and myoglobin, and sustained muscular activity. It was therefore thought desirable to study the rate of oxygen consumption and carbon dioxide output of the breast muscle fibres of these three animals in the first instance.

Materials and Methods:

The material chosen for experiment consisted of the pectoralis major muscle of the pigeon (*Columba livia*), domestic fowl (*Gallus domesticus*) and a bat (*Rousettus lechinaulti*). The animal was pithed and a fairly large

piece of the pectoralis major muscle was cut out and immediately put into cold saline solution (9 gm. of Sodium chloride; 0.24 gm. of Calcium chloride; 0.42 gm. of Potassium chloride and 1.0 gm. of Sodium bicarbonate in 1 liter of glass redistilled water). A small piece of the muscle was then cut out and transferred into a petridish kept on ice and by means of a pair of pin-point probes, the muscle fibres were carefully teased out in about half an hour taking special care not to injure the fibres as far as possible. The teased out material was momentarily drained on a filter paper and was weighed on a torsion balance. About 100 mg. of the wet tissue was transferred into the Warburg reaction flasks.

The standard Warburg technique as given in Hawk (1949) and umbreit (1951) was used to measure the oxygen consumption and the carbondioxide output at 38^o C. The muscle tissue was suspended in 2 ml. of the above mentioned solution buffered with phosphate at pH 7.4 . Other solutions containing in addition either Magnesium sulphate or Magnesium chloride were also tried but did not prove useful as the oxygen uptake was found to be inhibited. Each flask containing the tissue was then filled with oxygen gas by passing a slow stream of the

gas. 0.3 ml of 10 % Potassium hydroxide was kept in the centre well of the reaction flask for the absorption of the carbondioxide produced. In the determination of the carbondioxide output no alkali was placed in the centre well.

After the temperature equilibration of the bath the contents of the reaction flask were allowed to mix freely and reequilibrate by starting the shaking mechanism and then readings were taken for 1 hour at an interval of every fifteen minutes. The pH. was checked at the end of each run but the changes in pH were negligible. After obtaining the rate of oxygen uptake and carbondioxide output the respiratory quotients were calculated.

Results:

Oxygen uptake and carbondioxide output of the breast muscle fibres of fowl, pigeon and bat.

Animal	O ₂ uptake	CO ₂ Output	R.Q.
Fowl	2.40 - 3.00	2.20 - 3.00	0.90 - 1.00
Pigeon	5.61 - 6.52	5.20 - 7.10	0.90 - 1.10
Bat	3.38 - 4.35	7.42- 10.40	1.83 - 2.60

Vide fig. 13

Discussion:

The values obtained for the oxygen consumption of the pigeon breast muscle fibres are higher than that of the bat fibres while that for the fowl breast muscle fibres are the lowest. With regard to the carbondioxide output the bat fibres show the highest values while the fowl fibres are the lowest. The Respiratory Quotient of the fowl and pigeon fibres are more or less one while that of the bat is as high as 2.6. Such a high figure is indicative of the tremendous amount of anaerobic respiration in the bat breast muscle. Heilbrunn (1952)

reports that in men during strenuous athletic effort the R.Q. may rise to a value of two.

Szent-Gyorgyi working on minced pigeon-breast muscle found that it respire at a very rapid rate producing little or no lactic acid and that the respiratory quotient is one, thereby denoting that the fuel oxidized was carbohydrate (Baldwin, 1953). The figures obtained by me for the oxygen consumption and the carbondioxide output for the pigeon breast muscle are rather low compared to those of Barron and Tahmisian (1948) because in my work teased out fibres were used instead of the minced muscle and about half an hour is taken for the process of teasing out. Szent-Gyorgyi had also shown that the minced pigeon breast muscle respire at a very high rate in the beginning but falls off with time. This explains for the low figures obtained in my work.

Higher values for oxygen uptake and carbondioxide output obtained for the pigeon and the bat breast muscle fibres over those of the fowl, clearly indicates that the former two are metabolically (physiologically) more evolved than that of the latter. Of the two again the bat breast muscle which is also different histologically, from that of the pigeon as already pointed out,

has a higher physiological and evolutionary status than the latter. I have not come across any such metabolic work on the bat breast muscle and from the present study it has become evident that the bat breast muscle should be a good material for such of those studies as have been done on the pigeon breast muscle.

The rate of oxygen uptake and carbon dioxide output of the breast muscle fibres of the fowl, pigeon and bat.

SCALE
1 DIVISION = 0.5"
= 1 ml/mg/hr.

▨ OXYGEN
■ CARBONDIOXIDE

Fig. 13

