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# AEROBIC AND ANAEROBIC PRODUCTION OF LACTIC ACID BY THE FILARIAL WORM, *DRACUNCULUS INSIGNIS**

BY

ERNEST BUEDING AND JOSÉ OLIVER-GONZÁLEZ

*From the Department of Pharmacology, School of Medicine, Western Reserve University, Cleveland, Ohio, and the Department of Medical Zoology, School of Tropical Medicine, San Juan, Puerto Rico*

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In the course of a recent investigation of the metabolism of the filarial worm, *Litomosoides carinii*, it was found that under anaerobic conditions this organism converts 80 per cent of the total carbohydrate utilized to *l*-(+)-lactic acid (Bueding, 1949). Aerobically only 30 to 45 per cent of the metabolized glucose can be accounted for by the production of lactic acid. When the respiration of these filariae was inhibited by low concentrations of cyanine dyes, a compensatory increase in the production of lactic acid from glucose occurred. In view of these observations, it appeared of interest to compare the metabolic characteristics of *L. carinii* with those of another tissue nematode, *Dracunculus insignis* (Leidy, 1858), which has been described in detail recently by Chandler (1942).

## EXPERIMENTAL

The worms were dissected from the subcutaneous tissue of the hind and forelegs of infested racoons (*Procyon lotor lotor*)† and were placed in the basic filarial medium described previously (Bueding, 1949). The initial glucose concentration of the medium was 0.0045 M. After several washings in this medium, the worms were blotted with No. 50 Whatman filter-paper, weighed on a torsion balance, and transferred to Warburg micro-respirometer vessels. Seven to eleven mg. of worms were placed into 0.8 ml. of medium contained in each vessel. Incubation was carried out at 37.5° C. for two hours. The oxygen uptake and rates of glucose utilization and lactic acid production were measured by the same methods as those used in the study of the metabolism of *L. carinii* (Bueding, 1949).

## RESULTS

The results of two typical experiments are recorded in Table I. They can be summarized as follows: The rates of glucose utilization and lactic acid pro-

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TABLE I

OXYGEN UPTAKE AND RATE OF GLYCOLYSIS OF THE TISSUE NEMATODE, *Dracunculus insignis*

| Experiment | Atmosphere | Molar concentration of cyanine dye* | $Q_{O_2}$† | $Q_G$‡ | $Q_L$§ |
|---|---|---|---|---|---|
| 1 | Air | — | 0.65 | 24.6 | 30.8 |
| | ,, | — | 0.51 | 22.8 | 27.0 |
| | Nitrogen | — | — | 24.3 | 29.9 |
| 2 | Air | — | 0.52 | 21.6 | 24.3 |
| | ,, | $5.2\times10^{-7}$ | 0.09 | 22.2 | 24.7 |

*[1-amyl-2 : 5-dimethylpyrrol-(3)]—[1 : 6-dimethylquinoline-(2)]-dimethine cyanine chloride. † $\mu$l. oxygen taken u per mg. (wet weight) per hour. ‡ $\mu$g. glucose removed per mg. (wet weight) per hour. § $\mu$g. lactic acid formed per mg. (wet weight) per hour.

duction were found to be approximately the same under aerobic and anaerobic conditions. Low concentrations (1 : 5,000,000) of a cyanine dye inhibited markedly the respiration of the worms, but did not affect their rate of glycolysis. Since lactic acid production was greater than could be accounted for by the removal of glucose from the medium, the organisms must have formed lactic acid from endogenous sources as well as from glucose available in the medium. The rate of respiration of *D. insignis* was about three to four times lower than that of *L. carinii.*

## Discussion

As with *L. carinii,* the main end-product of the anaerobic carbohydrate metabolism of *D. insignis* appears to be lactic acid, and the respiration of both worms is strongly inhibited by a cyanine dye. However, whereas anaerobiosis and inhibition of the oxygen uptake by cyanine dyes resulted in a compensatory increase in the rate of glycolysis of *L. carinii,* glucose utilization and lactic acid production of *D. insignis* were not affected by the presence or absence of respiratory metabolism. In this respect, the carbohydrate metabolism of *D. insignis* is identical with that of *Schistosoma mansoni,* but differs basically from that of *L. carinii.* In contrast to the latter organism, inhibition by cyanine dyes of the respiratory metabolism of *S. mansoni* does not result in the death of the trematodes or in a compensatory increase in their rate of glycolysis (Bueding, Peters, and Welch, 1947 ; Bueding and Oliver-González, 1948). Therefore, *S. mansoni* requires little or no oxidative metabolism for survival. Possibly the same is true for the tissue nematode, *D. insignis.* It is conceivable that the physiological characteristics of another tissue nematode, *Wuchereria bancrofti,* are similar to those of *D. insignis* and of *S. mansoni,* and that they differ in this respect from those of *L. carinii,* in which inhibition of the respiratory metabolism by the cyanines is followed by the death of the worms. Such differences could adequately explain why a cyanine dye possessing high chemotherapeutic activity against *L. carinii* (Peters *et al.,* 1949) had no effect in the treatment of human filariasis produced by *W. bancrofti* (Santiago-Stevenson *et al.*).

The metabolic differences between the two closely related tissue nematodes, *L. carinii* and *D. insignis,* on one hand, and the biochemical similarities between the latter nematode and the trematode, *S. mansoni,* on the other, indicate that

among parasitic invertebrates two morphologically related organisms do not necessarily have the same metabolic characteristics and, consequently, may not be sensitive to the same type of chemotherapeutic agents.

## SUMMARY

In contrast to the filarial worm, *Litomosoides carinii,* respiratory metabolism of *Dracunculus insignis* has no effect on its rate of glycolysis. The significance of this metabolic difference is discussed.

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