EFFECT OF PHYSIOLOGICAL CONDITION OF ASCARIDS ON THEIR SURVIVAL TIME IN AN ATMOSPHERE OF OXYGEN

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A number of authors have shown the value of oxygen in the treatment of ascaridosis [1, 3, and others]. N. P. Kravets found that ascarids died after an hour of exposure to oxygen, as compared with a survival time of up to 10 hours in air [2]. H. Laser [7] and A. I. Krotov [5] have shown that the metabolism of ascarids is to a certain extent an aerobic one. In the presence of excess of oxygen they are, however, unable to dispose of the hydrogen peroxide accumulating as a result of respiratory processes, owing to their low catalase activity. The accumulation of hydrogen peroxide appears to cause their death when they are exposed to an atmosphere of oxygen.

EXPERIMENTAL METHODS

We determined the catalase activity of swine ascarids by Bach's manganometric and gasometric methods (1937), and we studied their survival time in an oxygen atmosphere under various conditions. The catalase activity varied for each batch of ascarids received from the slaughter house, for which reason it was estimated as a separate control for each series of experiments. The catalase activity index was taken as being the number of milligrams of hydrogen peroxide decomposed in 1 hour by the catalase present in 1 ml of body-cavity fluid or ascarid muscle brei, at 20°.

Each determination was done in triplicate, and only those values which did not differ by more than 0.1% were taken as trustworthy. In all, we performed 450 manganometric and 35 gasometric estimations of catalase activity, of which 50% were controls. The student K. Kats performed some of the experiments.

The catalase activity index of ascarids varied for different batches, values of from 300 to 2050 being found. Catalase activity could not be found in certain batches of ascarids, and such batches were not taken for further experimentation.

EXPERIMENTAL RESULTS

It appeared from a large number of experiments that the catalase activity of the body-cavity fluid of ascarids did not differ significantly from that of the muscles, and we therefore based the bulk of our experiments involving determination of catalase activity on body-cavity fluid. The catalase activity did not appear to vary according to the age or the sex of the ascarids. The activity fell progressively with duration of storage of the worms, and for this reason we used freshly collected ascarids in all our experiments. When the ascarids were kept under anaerobic conditions we were unable to find any catalase activity; this appeared only a certain time after they were placed in salt solution in equilibrium with atmospheric air. The supply of nutrients significantly affected the catalase activity. When the ascarids were placed in saline solution without nutrients the catalase activity index had a mean value of 272, as compared with 850 for material from the same batch kept in saline containing glucose and proteins.

When the ascarids were subjected to periodic electrical stimulation for 30 minutes their catalase activity

fell to zero. It is known that the activity of ascarids is greatly diminished when they are immersed in chloral hydrate solution, whereas in piperazine or santonin solutions contraction of the body alternates with its relaxation, for the first few hours. Determination of catalase activity of ascarids while stimulated or inhibited by these substances gave the following results.

TABLE 1

Changes in Catalase Activity of Ascarids Kept Under Various Conditions

Duration of exposure of ascarids to the given solutions, in hours	Catalase activity index of the ascarids	
	piperazine (1:1000)	santonin (1:10,000)
0	1870	1250
1	240	0
2	0	0
3	0	0
20	850	680

In an inhibited state, caused by immersion in 0.1% chloral hydrate solution for 20 hours, the catalase activity index rose to values 72-83% above the normal. In a stimulated state, resulting from exposure to 0.01% santonin for 2-5 hours, the catalase activity index fell to zero in all cases. The same effect was found after exposure to 0.1% piperazine. The value of the catalase activity index again rose after prolonged exposure to santonin or piperazine (Table 1). This may be ascribed to the state of depression of activity which succeeds that of excitation of ascarids in such cases [6, 7].

Lowering of catalase activity was also found when the ascarids had been exposed to the action of a number of other anthelminthics, in particular, chenopodium oil, heptylresorcinol, and thymol.

Maintenance of the ascarids in methylene blue solution (1:10,000) for a day also resulted in the catalase activity index falling to zero, and it again rose after 2-3 days. It is known that, at certain concentrations, methylene blue causes intensification of aerobic metabolism of helminths, but at high concentrations it inhibits it. The survival time of ascarids exposed to an atmosphere of oxygen also depends on their physiological condition (Table 2). They were considered to be dead when they ceased to respond to electrical stimulation. Oxygen was passed at a uniform rate into the ascardiograph tube containing Locke's solution in which the ascarids were immersed. The state of the nematodes was registered on a kymograph [4].

TABLE 2

Relation Between Survival Time of Ascarids Exposed to the Action of Oxygen and Their Physiological Condition

Physiological condition of ascarids	Time in minutes elapsing before response to electrical stimulation is abolished
Normal – Locke's solution	45 – 55
Inhibition – 1% chloral hydrate	70 – 90
Excitation:	
electrical	15 – 30
santonin	30 – 40
piperazine	35 – 42

Our experiments permit the drawing of the following conclusions:

1. The intensity of aerobic respiration of ascarids varies according to their physiological condition, as was shown from determinations of their catalase activity and survival time when exposed to an atmosphere of oxygen.

2. Inhibition of motor activity of ascarids leads to a rise in catalase activity and in survival time in an atmosphere of oxygen. Conversely, catalase activity falls under conditions of stimulation, and the ascarids die sooner when exposed to oxygen.

3. The effectiveness of oxygen therapy for ascaridosis can be enhanced by preliminary administration (2-3 hours earlier) of small doses of piperazine or santonin.

SUMMARY

The ascaricidal effect of oxygen is related to accumulation of hydrogen peroxide formed as an aerobic metabolite under conditions of low catalase activity. Stimulation of motor activity of the ascarids by immersion in santonin or piperazine solutions or by galvanic current abolishes catalase activity, and thus shortens

survival time during exposure to oxygen. Conversely, abolition of motor activity by immersion in chloral hydrate solutions raises catalase activity, and prolongs survival time. Preliminary administration of small doses of santonin or piperazine should enhance the effectiveness of oxygen therapy for ascaridosis.

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