

1928

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Recommended Citation

Lantz, C. W. (1928) "Temperature and Catalase Activity in Germinating Corn," *Proceedings of the Iowa Academy of Science*, 35(1), 147-149.

Available at: <https://scholarworks.uni.edu/pias/vol35/iss1/26>

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TEMPERATURE AND CATALASE ACTIVITY IN GERMINATING CORN

C. W. LANTZ

INTRODUCTION

Catalase is an enzym almost universally present in living cells and has the power of breaking hydrogen peroxide into water and molecular oxygen. The various theories as to the significance of catalase in metabolism are conflicting. Catalase has been considered by some as an enzym directly correlated with respiration, others have failed to find such a correlation. Appleman (1) working with potatoes and Burge (2) working with animal tissues concluded that here is a very close correlation between catalase activity and respiration rate. Morgulis (3) and Becht (4) working with animal tissues and Lantz (5) working with germinating corn failed to find such a close correlation with respiration. Loew (6) believed that catalase destroyed hydrogen peroxide and perhaps organic peroxides in the cells which would be injurious if allowed to accumulate. Harvey (7) found that the bluegreen alga (*Phormidium laminosum*) growing in hot springs contains no catalase. Lantz (5) found that the respiration rate in germinating corn increased greatly with an increase of temperature from 20°c. to 30°c., but the catalase activity failed to show a corresponding increase and in some cases showed no increase. This seems to indicate that the higher temperatures are unfavorable for catalase activity. Palladin (8) says "respiration increases up to about 40°c., which remains constant until death intervenes." It seemed that a study of catalase activity in germinating corn at temperatures around 40°c., might throw further light on the question.

METHOD

The method used is similar to the method described by Lantz (5). In two varieties of corn, "Johnson Co. White" and "Burpee's Golden Beauty" the corn was germinated at 30°c., and then the growing temperature of the seedlings was increased to 40°c. In order to make comparisons, since the catalase activity increases rapidly with the germination stage, the length of the radicles was taken. Selections of seedlings for testing were made according to radicle length. The results are shown in Tables I and II.

RESULTS

Table I—Effect of an Increase in Temperature on Catalase Activity in Corn (Burpee's Golden Beauty)

LOT	GERMINATION PERIOD HOURS	TEMPERATURE DEGREES C.	AVERAGE LENGTH OF RADICLE MM.	OXYGEN IN 10 MINUTES C. C.
A	48	30	15.0	29.8
	24	40	25.8	
B	48	30	15.0	43.0

Table II—Effect of an Increase in Temperature on Catalase Activity in Corn (Johnson Co. White)

LOT	GERMINATION PERIOD HOURS	TEMPERATURE DEGREES C.	AVERAGE LENGTH OF RADICLE MM.	OXYGEN IN 10 MINUTES C. C.
A	53	30	22.0	24.1
	53	30	22.0	
B	27	40	24.4	91.6
C	80	Room (18-25)	24.4	53.5

In two other strains of corn, "High Protein" and "Low Protein," the germination temperature was first at 30°c., then at 42°c., and then lowered to 30°c. The catalase activity at each 24 hour period is given for seven days. These results are shown in the graph (Fig. 1).

These results show that the catalase activity decreases in germinating corn if the temperature is increased from 30°c. to 40°c. There is less catalase activity in corn germinated for 72 hours during

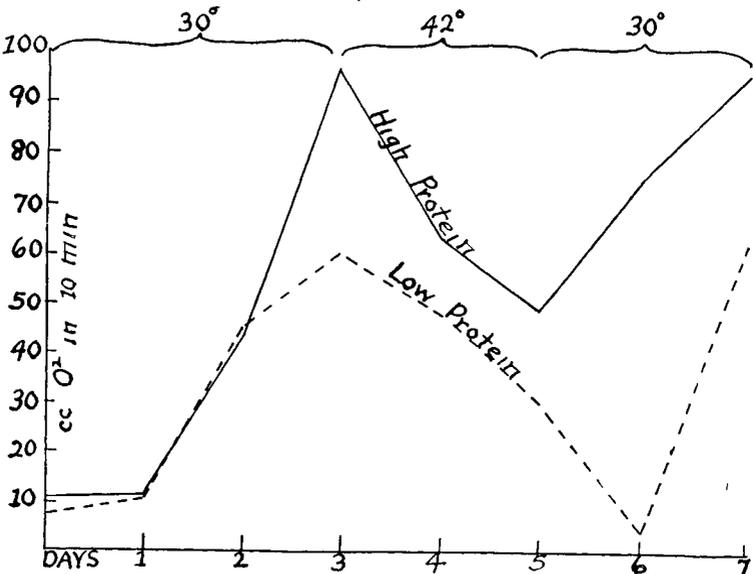


Fig. 1.

which the temperature for the first 48 hours is at 30°C., and for the last 24 hours at 40°C. than there is in corn germinated for 48 hours at 30°C. This is in spite of the fact that the radicles had increased during this last 24 hours, and at favorable temperatures there would be much more catalase activity at the later germination stage.

The graph shows markedly the effect of the high temperature on the catalase activity of these strains. The Low Protein corn was injured more than the High Protein corn and it took it longer for recovery. These results are significant when compared with Harvey's results in finding no catalase in *Phormidium laminosum* growing in hot springs at a temperature of 65°C. to 73°C.

A temperature of 40°C. is above the optimum for the growth of corn but according to Palladin's statement the respiration should not have decreased at this temperature as the seedlings were still alive and growing although the growth was checked.

Some have claimed that the role of catalase is to destroy injurious peroxides which might be formed in metabolism. Since these results indicate a decrease in catalase activity as the temperature is increased above the optimum for growth, it seems more probable that the decrease in catalase might make possible the accumulation of some injurious peroxides formed in metabolism and thus injure the seedlings. From the data given this theory seems more tenable than the theory that catalase is an enzyme directly responsible for physiological oxidation.

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