

Influence of sulphur dioxide on chlorophyll content and catalase activity in some chosen lichen species

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Abstract

The influence of SO_2 on changes in catalase activity and in chlorophyll content were investigated under laboratory conditions in several lichen species and in maize. In all the plants examined the chlorophyll content and catalase activity decreased after treatment with SO_2 as compared with that in the control plants.

INTRODUCTION

Industrialization and urbanization are inevitably associated with the emission into the atmosphere of enormous quantities of substances noxious to living organisms. In industrialized regions and large conurbations, and even in the neighbourhood of single industrial establishments various forms of damage to the vegetation may be seen, caused by some components of the air contamination (Godzik and Piskornik, 1969; Piskornik and Godzik, 1970).

It has been established in field observations of many years duration and laboratory investigations that plants belonging to different taxonomic groups, and even within the same species, do not react identically to air pollution. Some of them are more susceptible while others less, and still others may be resistant to these noxious substances (Brzywczy-Kunińska, 1964; Rydzak and Piórecki, 1971; Börtitz and Ranft, 1972 and others).

Lichens are considered to be organisms particularly sensitive to sulphur dioxide. More than a hundred years ago in 1866 the famous botanist Nylander (quoted by Barkman, 1958) wrote that lichens are a reliable indicator of air purity.

Numerous authors speak of a "lichen desert" around industrial centres (Barkman, 1958; Saunders, 1970; Le Blanc and Sloover 1970; Kirschbaum, Klee and Steubing; 1971, Rydzak and Piórecki, 1971 and others).

The first measurable plant reactions to air pollution are changes in the intensity of certain physiological processes. Particularly sensitive are in this respect photosyn-

thesis and respiration, and they can serve as criteria in the assay of the noxiousness of the air contaminants (Piskornik and Godzik, 1970; Rao and Le Blanc, 1966; Saunders, 1970; Börtitz and Ranft, 1972 and others).

The commonest and also most frequently studied phytotoxic compound is sulphur dioxide. Most physiological investigations on the influence of air pollution on plants concern SO_2 .

In view of the particularly high susceptibility of lichens to air pollution and the expectation connected with this fact that these plants may serve as indicators of the range of occurrence of pollution (Saunders, 1970), it was decided to investigate under laboratory conditions the influence of SO_2 on catalase activity and chlorophyll content in several lichen species and in maize as a representative of higher plants.

MATERIAL AND METHODS

The material consisted of lichen thalli: from among the epiphytic ones — *Parmelia furfuracea* (L.) Ach., *P. physodea* (L.) Ach., *Evernia prunastri* (L.) Ach. and *Ramalina fraxinea* (L.) Ach. collected from roadside trees in the Masurian Lake District and among the species growing on the ground — *Cetraria islandica* (L.) Ach. and *Cladonia rangiferina* (L.) Web. from the pine forest in the forest district Molenda near Łódź. As representative of higher plants *Zea mays* L. was tested.

The lichen thalli after thorough cleaning were placed on Petri dishes in the chambers. Maize (*Zea mays*) caryopses were soaked in water and then put into pots with soil. When the seedlings reached a length of 15 cm after about 20 days, they were placed in the chambers together with the lichen thalli. The chambers of 1 m³ volume (an experimental and a control one) were illuminated with fluorescent tubes. Room temperature was maintained in the chambers and moisture of about 90 per cent. Illumination of about 4 000 to 5 000 lux was applied.

An atmosphere containing a definite SO_2 concentration in the chamber was produced by introducing 3 times during 24 h into the chamber a dose of sodium sulphite which in the air-tight chamber was treated with conc. sulphuric acid. The plants tested were subjected to the action of sulphur dioxide in a concentration of 10 mg SO_2/m^3 of air for 6 days.

The chlorophyll content was determined by the method of Bruinsma (1963) and catalase activity by the manganometric method described by Pleszkov (1968).

The results are shown on graphs. They represent means from 20 replications. The dashed horizontal line (100%) on the graphs denotes the results of control experiments.

RESULTS AND DISCUSSION

I. Influence of SO_2 on chlorophyll content

The results are shown in Fig. 1. In all the plants examined a decrease in chlorophyll content was observed as compared to that in control plants. In lichens the chlo-

rophyll content was as low as 70—50 per cent as compared to the control values. The greatest deficit was noted in *Parmelia furfuracea*, reaching about 50 per cent. The smallest differences were observed in maize (a decrease in chlorophyll of about 6%).

It is known that one of the effects of exposure to SO_2 is the loss of green colour in plants (Thomas, 1961; Berge, 1963; Garber, 1967, quoted by Saunders, 1970). Pearsson and Skye (l. c.) found that exposure of the *Parmelia sulcata* thallus to the action of gaseous SO_2 produces a loss of chlorophyll. These results have been confirmed for other species of lichens by Rac and Le Blanc (1966). These investigators report that chlorophyll under the influence of SO_2 is converted to phaeophytin a.

II. Influence of SO_2 on catalase activity

The results are shown in Fig. 2. In all the plants exposed to the action of SO_2 a depression of catalase activity was observed. Inhibition was stronger as compared

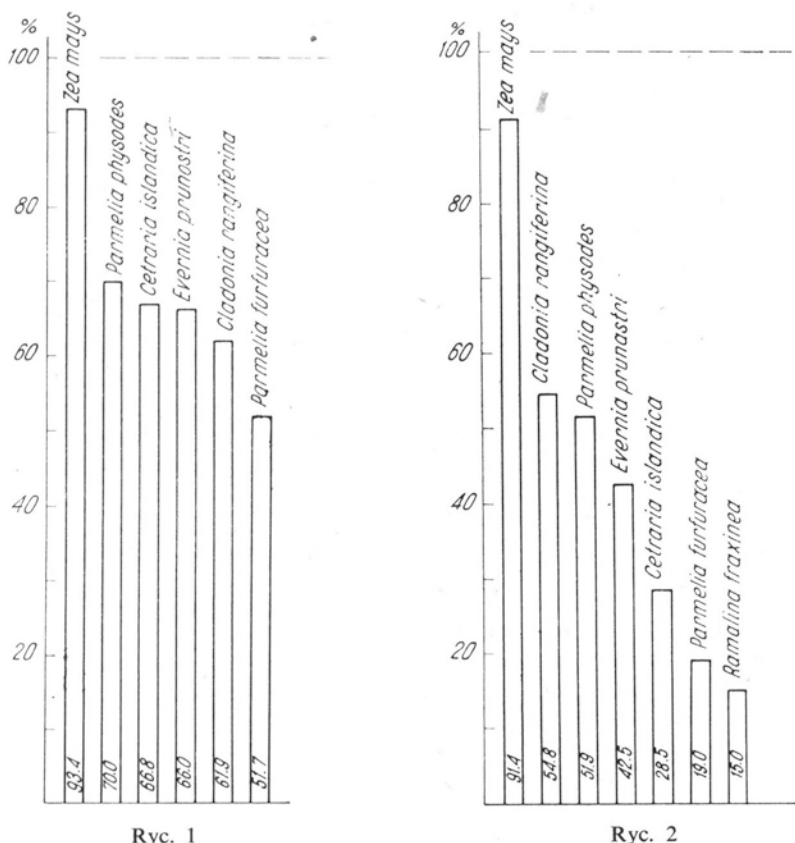


Fig. 1. Influence of SO_2 on chlorophyll content in: 1. *Zea mays*, 2. *Parmelia physodes*, 3. *Cetraria islandica*, 4. *Evernia prunastri*, 5. *Cladonia rangiferina*, 6. *Parmelia furfuracea*

Fig. 2. Influence of SO_2 on catalase activity: 1. *Zea mays*, 2. *Parmelia physodes*, 3. *Evernia prunastri*, 4. *Cladonia rangiferina*, 5. *Parmelia furfuracea*, 6. *Ramalina fraxinea*

with the control plants in lichens, whereas in maize catalase activity decreased by barely 9 per cent. Among the lichen species studied rather wide differences were noted: catalase activity in *Ramalina fraxinea* decreased by as much as 85 per cent, and in *Parmelia physodes* by 48 per cent. Mikołajewski and Suslova (1967) also describe catalase activity inhibition by SO_2 in higher plants.

The present results confirm the suggestion of numerous lichenologists that lichens are highly sensitive to air pollution, particularly by SO_2 .

Many authors in studies concerning the occurrence and distribution of lichens in cities and industrial centres point to the different extent of susceptibility of the particular species. The investigations of Skye (1968) are worth quoting. He distinguished 5 zones around Stockholm according to the occurrence in them of various lichen species. This author found a distinct correlation between SO_2 concentration and the presence of the particular species. Similar relations between industrialization and the distribution of epiphytes in Montreal are described by Le Blanc and Sloover (1970) and in Frankfurt by Kirschbaum, Klee and Steubing (1971).

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Wpływ S_2O na zawartość chlorofilu i aktywność katalazy u wybranych gatunków porostów

Streszczenie

Kilka wybranych gatunków porostów a z roślin wyższych *Zea mays* poddano działaniu SO_2 o stężeniu 10 mg/m^3 przez okres 6 dni w warunkach laboratoryjnych. Inne warunki t.j. temperatura, wilgotność i światło były jednakowe w obu komorach (kontrolnej i doświadczalnej). Następnie u tych roślin badano zawartość chlorofilu oraz aktywność katalazy.

1. U wszystkich badanych roślin stwierdzono obniżenie zawartości chlorofilu i obniżenie aktywności katalazy w stosunku do roślin kontrolnych.

2. W plechach porostów obniżenie zawartości chlorofilu było bardzo znaczne i wynosiło od 30 do 48%, natomiast z *Zea mays* zaledwie 6%.

3. W plechach porostów obniżenie aktywności badanego enzymu było bardzo znaczne i mieściło się w granicach od 48 do 86, a u *Zea mays* wynosiło zaledwie 9%.