Analysis of Changes of POD Activity of Indoor Plants under the Stress of Benzene Pollution

M Lu, L F Zhang, D H Li, J H Lu, X M Zhao
Shandong Jianzhu University, Jinan 250101, China
lumin@sdjzu.edu.cn

Abstract. Benzene is the main pollutant of indoor chemical pollution, which is severely threatening the human-being’s daily life. To find a reasonable and safety method to control the indoor benzene pollution has become an urgent issue. The activity of peroxidase in plants is an important basis of judging the resistance ability of plants to benzene pollution stress. The study made 8 kinds of shade tolerant foliage-plants live under benzene stress. The results show that both of the benzene and the plant species and the collaboration of them have an significant effect on plant POD activity, the resistance capability of Sansevieria trifasciata is the best, with Scindapsus aurea least.

1. Introduction
Nowadays, with the situation that indoor chemical pollution has a severe form, nearly half of the world's population is under serious indoor chemical pollution stress, indoor chemical pollution has been ranked one of the five major environmental factors that affect public health. Using plants to absorb and purify chemical pollution indoor is a method to repair and purify which is green, economy and sustainable with no secondary pollution. It is gradually recognized as an important method to purify and repair chemical pollution indoor[1,2,3]. Peroxidase (POD) is a kind of oxidoreductase, when self-regulation in plants can be resistant to external stress, the enhanced activity of POD in plants could enhance the metabolism, while the stress is beyond the scope of the toleration, which plants cannot acheive, the activity of POD below the normal level[4,5,6]. The activity of peroxidase in plants is an important basis for judging the resistance ability of plants to benzene pollution stress[7,8]. The study made 8 kinds of shade tolerant foliage-plants live under benzene stress. The effect of plant species and benzene were judged by the change of POD in plants. The research provides scientific basis and theoretical support for the development of the ecological rehabilitation technology for indoor chemical pollution.

2. Materials and methods

2.1. Materials
8 kinds of indoor shade-tolerant plant were selected as the research objects. (As shown in table 1) The test plants were identical in the amount, type and flowerpot materials and specifications of the culture medium, and the same test plants have consistent specification. All the test plants grew well. In the process of benzene pollution stress, the basin soil, flowerpot and the upper plant were isolated by plastic film, so as to avoid the influence of plant root system and culture medium quality on the experimental results. Wash and dry the leaves of the plants before each experiment.
Table 1. Plant species.

| No. | Plant species                    |
|-----|----------------------------------|
| X1  | *Chlorophytum comosum*           |
| X2  | *Chlorophytum capense var. variegatum* |
| X3  | *Calathea insignis*              |
| X4  | *Scindapsus aureus*              |
| X5  | *Sansevieria trifasciata*        |
| X6  | *Spathiphyllum floribundum*      |
| X7  | *Kalanchoe blossfeldiana*        |
| X8  | *Podocarpus nagi*                |

2.2. Experimental method

Experiment takes enclosed space devices designed by Wolverton as the reference\textsuperscript{[9]}\textsuperscript{[9]}. The experiment sets 3 benzene concentration gradient of 25.00 mg/m\textsuperscript{3}, 50.00 mg/m\textsuperscript{3} and 100.00 mg/m\textsuperscript{3} with 3 replications. 8 kinds of experimental plants are divided randomly by every three kinds of plants as one group, a set of each experiment fume gas for 24 h. After fume gas, people sample three plant groups which show the characteristics have no clear suffer. POD activity was determined by method of guaiaco\textsuperscript{[10]}, using the phosphate solution ph value of 6.0 as the buffer. The experiment data is dealt with variance analysis, multiple comparisons and significant difference text with SPSS.

3. Results and discussion

The change of the activity of POD in 8 kinds of shade tolerant foliage-plants after the benzene stress in different concentrations with 24 h is showed in table 2.

Table 2. The change of the activity of POD under different concentrations of benzene stress.

| Concentrations | 25.00mg·m\textsuperscript{3} | 50.00mg·m\textsuperscript{3} | 100mg·m\textsuperscript{3} |
|----------------|-------------------------------|-------------------------------|-------------------------------|
| Plant species  | Comparision Treatment Rate of | Comparision Treatment Rate of | Comparision Treatment Rate of |
|                | change (u·g\textsuperscript{-1}FW) (%) | change (u·g\textsuperscript{-1}FW) (%) | change (u·g\textsuperscript{-1}FW) (%) |
| X1             | 120.8000 130.2000 7.78 | 133.2000 140.0000 11.11 | 116.5000 144.1000 23.69 |
| X2             | 196.2000 218.9000 11.57 | 197.4000 230.6000 16.82 | 210.8000 284.0000 34.72 |
| X3             | 780.5700 900.5000 15.36 | 783.4000 943.3000 20.41 | 796.2000 1119.1000 40.56 |
| X4             | 780.0000 941.2000 20.67 | 789.0000 1009.0000 27.88 | 793.5000 1261.2000 58.94 |
| X5             | 111.0000 112.4000 1.26 | 107.8000 111.3000 3.25 | 104.3000 111.5000 6.90 |
| X6             | 4015.8000 4225.8000 5.23 | 4339.2000 4647.8000 7.11 | 4215.6000 4859.0000 15.26 |
| X7             | 170.0000 174.5000 2.65 | 165.2000 171.3000 3.69 | 170.2000 184.2000 8.23 |
| X8             | 531.2000 557.2000 4.89 | 542.6000 573.3000 5.66 | 540.5000 608.8000 12.64 |

Data shows that the activity of POD of 8 kinds of shade tolerant foliage-plants shows a inceasing trend. The two factors, plant species and benzene concentrations, are used to make two-factor variance analysis with SPSS.(See table 3)

Table 3. The variance analysis of the rates of change of POD activity under different benzene concentrations.

| Source          | Df (Degree of freedom) | SS(Sum of squares of deviations) | MS(Mean square) | F(Mean square ratio) | P(Significance level) |
|-----------------|------------------------|----------------------------------|-----------------|----------------------|----------------------|
| Concentrations  | 2                      | 0.363                            | 0.181           | 2877.641**           | 0.000                |
| Plant species   | 7                      | 0.805                            | 0.115           | 1823.565**           | 0.000                |
| Plant species*  | 14                     | 0.161                            | 0.011           | 182.080**            | 0.000                |
As can be seen in Table 3, the impact on POD activity of plant species and benzene concentration and the synergistic effect reaches an extremely significant level. In comparison, the impact of benzene concentration on POD activity is more significant.

3.1. Results and analysis of the rates of change of POD activity in shade tolerant foliage-plants under the stress of 25.00 mg/m³ benzene concentration

Different rates of change of POD activity in shade tolerant foliage-plants under the stress of 25.00 mg/m³ benzene concentration is dealt with multiple comparison by SPSS. (See: Table 4)

Table 4. Results of the rates of change of POD activity in shade tolerant foliage-plants under the stress of 25.00 mg/m³ benzene concentration.

| Plant species | X̄ 1 | X̄ 2 | X̄ 3 | X̄ 4 | X̄ 5 | X̄ 6 | X̄ 7 | X̄ 8 |
|---------------|-----|-----|-----|-----|-----|-----|-----|-----|
| X4            | 0.2067 | 0.194067** | 0.180200** | 0.157733 | 0.154367** | 0.128867* | 0.090967** | 0.053033** |
| X3            | 0.1536 | 0.141033** | 0.127167** | 0.104700** | 0.101333** | 0.075833* | 0.037900** | 0.037900** |
| X2            | 0.1157 | 0.103100** | 0.089233** | 0.066767** | 0.063400** | 0.037933** | 0.037900** | 0.037900** |
| X1            | 0.0778 | 0.065200** | 0.051333** | 0.028867** | 0.025500** | 0.025500** | 0.025500** | 0.025500** |
| X6            | 0.0523 | 0.039700** | 0.025833** | 0.003367** | 0.003367** | 0.003367** | 0.003367** | 0.003367** |
| X8            | 0.0489 | 0.036333** | 0.022467** | 0.022467** | 0.022467** | 0.022467** | 0.022467** | 0.022467** |
| X7            | 0.0265 | 0.013867 | 0.013867 | 0.013867 | 0.013867 | 0.013867 | 0.013867 | 0.013867 |
| X5            | 0.0126 | 0.0126 | 0.0126 | 0.0126 | 0.0126 | 0.0126 | 0.0126 | 0.0126 |

LSD₀.₀₁₀=0.012218  LSD₀.₀₀₁=0.016834

Data shows that under the benzene pollution stress with the concentration of 25.00 mg/m³, POD activity of 8 kinds of shade tolerant foliage-plants increased. Except X7 and X5, the rates of change of...
POD activity between all plants have reached extremely significant level about. The rate of change in X5 (*Sansevieria trifasciata*) about POD is the least, means the resistance capability is the best, while the resistance capability of X4 (*Scindapsus aureum*) is the least.

### 3.3. Results and analysis of the rates of change of POD activity in shade tolerant foliage-plants under the stress of 100.00 mg/m³ benzene concentration

Different rates of change of POD activity in shade tolerant foliage-plants under the stress of 100.00 mg/m³ benzene concentration is dealt with multiple comparison by SPSS. (See: Table 6)

Table 6. Results of the rates of change of POD activity in shade tolerant foliage-plants under the stress of 100.00 mg/m³ benzene concentration.

| Plant species | X1   | X1-X2 | X1-X3 | X1-X4 | X1-X5 | X1-X6 | X1-X7 | X1-X8 | X1-X9 |
|---------------|------|-------|-------|-------|-------|-------|-------|-------|-------|
| X4            | 0.5894| 0.520367**| 0.507133**| 0.463033**| 0.436767**| 0.352500* | 0.242167**| 0.183833**|
| X3            | 0.4056| 0.336533**| 0.323300**| 0.279200**| 0.252933**| 0.168667* | 0.058333**|
| X2            | 0.3472| 0.278200**| 0.264967**| 0.220867**| 0.194600**| 0.110333**|
| X1            | 0.2369| 0.167867**| 0.154633**| 0.110533**| 0.084267**|
| X6            | 0.1526| 0.083600**| 0.070367**| 0.026267**|
| X7            | 0.1264| 0.057300**| 0.044100**|
| X8            | 0.0823| 0.013233|
| X5            | 0.0690|         |

Data shows that under the benzene pollution stress with the concentration of 100.00 mg/m³, POD activity of 8 kinds of shade tolerant foliage-plants increased. Except X7 and X5, the rates of change of POD activity between all plants have reached extremely significant level about. The rate of change in X5 (*Sansevieria trifasciata*) about POD is the least, means the resistance capability is the best, while the resistance capability of X4 (*Scindapsus aureum*) is the least.

### 4. Conclusions

The experimental results indicate:

1. The impact on POD activity of plant species and benzene concentration and the synergistic effect reaches an extremely significant level, and the impact of benzene concentration on POD activity is more significant.

2. According to the overall effect of rates of change of POD activity under different benzene concentrations, the resistance capability of *Sansevieria trifasciata* (X5) is the best, *Kalanchoe blossfeldiana* (X7) comes second, with *Scindapsus aureum* (X4) the least.

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