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

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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 aureun* 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 showen 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.

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Table 1. Plant species.

No.	Plant species
X1	*Chlorophytum comosum*
X2	*Chlorophytum capense* var. *variegatum*
X3	*Calathea insignis*
X4	*Scindapsus aureun*
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[9].The experiment sets 3 benzene concentratrion gradient of 25.00 mg/m^3, 50.00 mg/m^3 and 100.00 mg/m^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[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^{-3}			50.00mg·m^{-3}			100mg·m^{-3}		
Plant species	Comparision	Treatment	Rate of change	Comparision	Treatment	Rate of change	Comparision	Treatment	Rate of change
	(u·g-1FW)		(%)	(u·g-1FW)		(%)	(u·g-1FW)		(%)
X1	120.8000	130.2000	7.78	133.2000	148.0000	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

Concentrations			
Error	48	0.003	6.305E-5
Total	71	1.331	
R-Sq=99.8%			

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/m^3 benzene concentration

Different rates of change of POD activity in shade tolerant foliage-plants under the stress of 25.00 mg/m^3 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/m^3 benzene concentration.

Plant species	$\bar{x}_i$	$\bar{x}_i - \bar{x}_5$	$\bar{x}_i - \bar{x}_7$	$\bar{x}_i - \bar{x}_8$	$\bar{x}_i - \bar{x}_6$	$\bar{x}_i - \bar{x}_1$	$\bar{x}_i - \bar{x}_2$	$\bar{x}_i - \bar{x}_3$
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**	0.037933**	
X2	0.1157	0.103100**	0.089233**	0.066767**	0.063400**	0.037900**		
X1	0.0778	0.065200**	0.051333**	0.028867**	0.025500**			
X6	0.0523	0.039700**	0.025833**	0.003367**				
X8	0.0489	0.036333**	0.022467**					
X7	0.0265	0.013867						
X5	0.0126							
$LSD_\alpha=t_{\alpha(dfe)}S_{\bar{x}_i-\bar{x}_j}$		$LSD_{0.05}$=0.014759		$LSD_{0.01}$=0.020335				

Data shows that under the benzene pollution stress with the concentration of 25.00 mg/m^3,POD activity of 8 kinds of shade tolerant foliage-plants increased, X4, X3, X2, X1, X6and X8 and all the plants have reached extremely significant level about the rates of change of POD activity. The rate of change in X5 (*Sansevieria trifasciata*) about POD is the least, means the resistance capability is the best, while X4 (*Scindapsus aureun*) least.

3.2. Results and analysis of the rates of change of POD activity in shade tolerant foliage-plants under the stress of 50.00 mg/m^3 benzene concentration

Different rates of change of POD activity in shade tolerant foliage-plants under the stress of 50.00 mg/m^3 benzene concentration is dealt with multiple comparison by SPSS.(See:Table 5)

Table 5. Results of the rates of change of POD activity in shade tolerant foliage-plants under the stress of 50.00 mg/m^3 benzene concentration.

Plant species	$\bar{x}_i$	$\bar{x}_i - \bar{x}_5$	$\bar{x}_i - \bar{x}_7$	$\bar{x}_i - \bar{x}_8$	$\bar{x}_i - \bar{x}_6$	$\bar{x}_i - \bar{x}_1$	$\bar{x}_i - \bar{x}_2$	$\bar{x}_i - \bar{x}_3$
X4	0.2788	0.246367**	0.241900**	0.222267**	0.207700**	0.167733**	0.110633**	0.074733**
X3	0.2041	0.171633**	0.167167**	0.147533**	0.132967**	0.093000**	0.035900**	
X2	0.1682	0.135733**	0.131267**	0.111633**	0.097067**	0.057100**		
X1	0.1111	0.078633**	0.074167**	0.054533**	0.039967**			
X6	0.0711	0.038667**	0.034200**	0.014567**				
X8	0.0566	0.024100**	0.019633**					
X7	0.0369	0.004467						
X5	0.0325							
$LSD_\alpha=t_{\alpha(dfe)}S_{\bar{x}_i-\bar{x}_j}$		$LSD_{0.05}$=0.012218		$LSD_{0.01}$=0.016834				

Data shows that under the benzene pollution stress with the concentration of 50.00 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 aureun)* 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	$\bar{X}_i$	$\bar{X}_i - \bar{X}_5$	$\bar{X}_i - \bar{X}_7$	$\bar{X}_i - \bar{X}_8$	$\bar{X}_i - \bar{X}_6$	$\bar{X}_i - \bar{X}_1$	$\bar{X}_i - \bar{X}_2$	$\bar{X}_i - \bar{X}_3$
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**				
X8	0.1264	0.057300**	0.044100**					
X7	0.0823	0.013233						
X5	0.0690							
$LSD_\alpha = t_{\alpha(df_e)} S_{\bar{X}_i - \bar{X}_j}$		$LSD_{0.05}$=0.014131		$LSD_{0.01}$=0.019469				

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 aureun)* 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 aureun* (X4) the least.

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