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Effects of Different Selenium Concentrations on the Photosynthetic Pigment Content in *Solanum alatum*

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Abstract: A pot experiment was carried out to study effects of different selenium concentrations (0, 5, 10, 25, 50, 75, 100 mg/kg) on the photosynthetic pigment content in *Solanum alatum*. The results showed that all concentrations of selenium inhibited the chlorophyll *a*, chlorophyll *b* and carotenoid contents in *S. alatum*. The selenium concentrations order of *S. alatum* chlorophyll *a* and chlorophyll *b* contents from large to small were both ranked: 0, 10, 5, 25, 50, 75 and 100 mg/kg. Compared with the 0 mg/kg, only the selenium concentration of 10 mg/kg had little effect on the photosynthetic pigment contents of *S. alatum*. These results indicated that high concentrations of selenium stress have significant inhibitory the effects on the photosynthetic pigment contents in *S. alatum*, which were not conducive to the growth of *S. alatum*, but *S. alatum* could grow normally at a selenium concentration of 10 mg/kg.

Introduction

Selenium (Se) is an essential trace element in human life activities and plays a key role in immune regulation, antioxidant defense system and thyroid hormone metabolism [1]. Deficiency of Se can cause the lipid peroxidase reaction to increase and metabolic disorders, easily causing damage to the myocardial arterioles and capillaries [2]. However, Se is a typical dual-function element. When the Se content is too high, it can cause poisoning to the human body and have a significant impact on the skin, nerves, and respiratory system [3]. Therefore, it is of great significance to find a safe and efficient source of Se. Studies have found that organic Se was safer and more easily absorbed by humans and animals than inorganic Se [4]. As a producer in the ecosystem, plants play an important role in the chemical cycle of Se, and are the main carriers for converting inorganic Se into organic Se. Rosenfeld and Beath divide plants into three types: primary Se accumulator, secondary Se accumulator and Non-Se accumulator based on their ability to accumulate Se [5]. In order to reduce the diseases caused by low Se and to repair Se contaminated soil, it is important to screen more Se-resistant plants. The study found that low Se can promote the photosynthesis of plant leaves, but high concentrations of Se have a significant inhibitory effect on chlorophyll and carotenoids content of plants [6-7]. Photosynthesis is the basis of plant growth and development, which determines whether plants can grow normally. *Solanum alatum* is a variant of *Solanum* with a long history of food and medicinal use, which has a high nutritional content and high medicinal value [8]. Zeng et al. studied the effects of cadmium stress on physiological and biochemical characteristics of *S. alatum* seedlings and found that cadmium stress increased the content of malondialdehyde while inhibiting the root length and chlorophyll contents [9]. However, the effects of Se on photosynthesis of *S. alatum* have not yet been reported. Therefore, in order to screen more Se sources, *S. alatum* was used as the material to study the effects of different concentrations of Se on *S. alatum* chlorophyll and carotenoid contents.

Materials and Methods

Materials collection. The seeds of *S. alatum* were collected from the farmland of Chengdu Campus

of Sichuan Agricultural University. In March 2018, the *S. alatum* seeds were sown in 25°C climate chamber. Unpolluted soil was collected from the farmland of Chengdu Campus of Sichuan Agricultural University.

Experimental Design. The experiment was conducted in Chengdu Campus of Sichuan Agricultural University from April to May 2018. In March 2018, the unpolluted soil was air-dried and passed through a 5-mm sieve. 3 kg air-dried soil was weighed into each plastic pot (15 cm high, 18 cm in diameter), soaking uniformly Na_2SeO_3 by 0, 5, 10, 25, 50, 75 and 100 mg/kg respectively and balanced for 4 weeks. In April 2018, the same growing *S. alatum* with two real leaves were transplanted into the pots. Four *S. alatum* were planted in each pot. Five replicates per treatment and all pots were watered each day to keep the soil moisture about 80%. The distance between pots was 15 cm, and the pot position exchanged aperiodically to weaken the impact of the marginal effects. After 40 days, the upper mature leaves of *S. alatum* were collected to determine the photosynthetic pigment (chlorophyll a, chlorophyll b and carotenoid) contents [10].

Statistical Analyses. Statistical analyses were conducted using statistical software of SPSS 17.0. Data were analyzed by one-way ANOVA with least significant difference at 5% confidence level.

Results and Discussion

Chlorophyll a content in *S. alatum*. For the content of chlorophyll a, except the Se concentration of 10 mg/kg had no significant effect on the chlorophyll a content of *S. alatum*, other Se concentrations all significantly reduced the chlorophyll a content of *S. alatum* (Figure 1). And when the Se concentration started at 10 mg/kg, the content of *S. alatum* chlorophyll a decreased with increasing Se concentration. In all treatments, the Se concentration of 100 mg/kg resulted in the lowest chlorophyll a content of the *S. alatum* ($P < 0.05$).

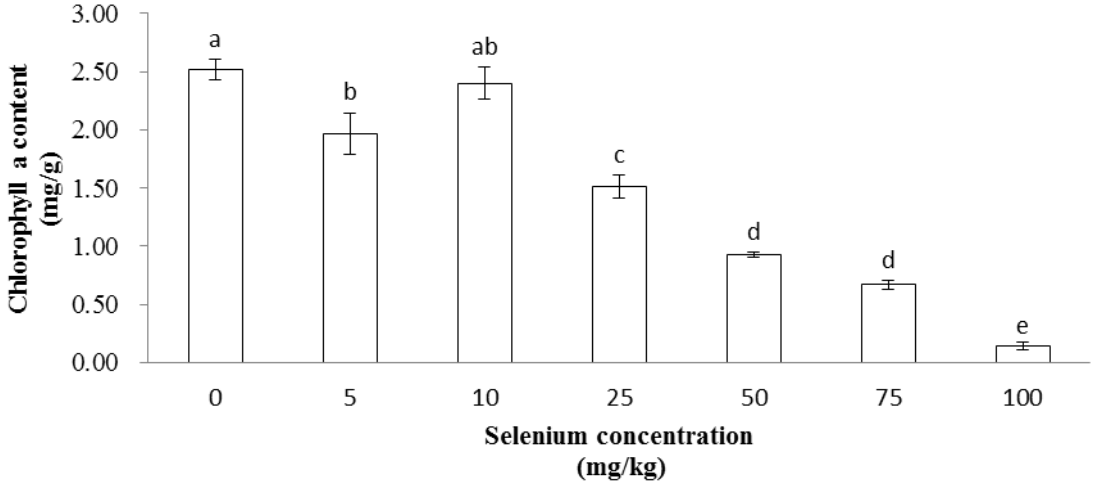

Figure 1 Chlorophyll a content in *S. alatum*

Means with the same letter within each column are not significantly different at $p < 0.05$.

Chlorophyll b content in *S. alatum*. For the content of chlorophyll b, except the Se concentration of 10 mg/kg had no significant effect on the chlorophyll b content of *S. alatum*, other Se concentrations all significantly reduced the chlorophyll b content of *S. alatum* (Figure 2). And when the Se concentration started at 10 mg/kg, the content of *S. alatum* chlorophyll b decreased with increasing Se concentration. In all treatments, the Se concentration of 100 mg/kg resulted in the lowest chlorophyll b content of the *S. alatum* ($P < 0.05$).

Carotenoid content in *S. alatum*. For the content of carotenoid, except the Se concentration of 10 mg/kg had no significant effect on the carotenoid content of *S. alatum*, other Se concentrations all significantly reduced the carotenoid content of *S. alatum* (Figure 3). The Se concentrations order of *S. alatum* carotenoid content from large to small was ranked: 0 mg/kg, 10 mg/kg, 25 mg/kg, 5 mg/kg, 50 mg/kg, 75 mg/kg and 100 mg/kg. Among all treatments, the Se concentration of 100

mg/kg resulted in the lowest carotenoid content of the *S. alatum* ($P < 0.05$).

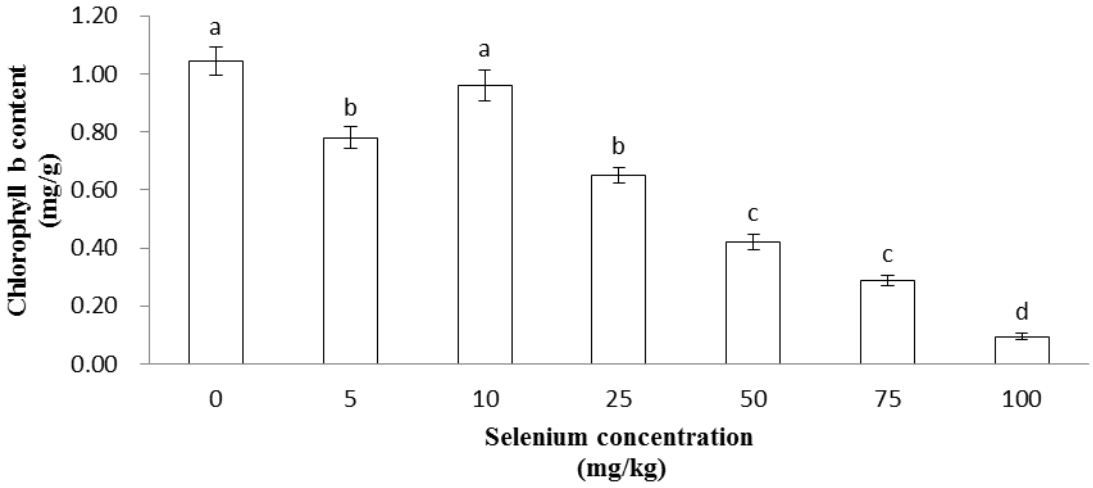

Figure 2 Chlorophyll b content in *S. alatum*

Means with the same letter within each column are not significantly different at $p < 0.05$.

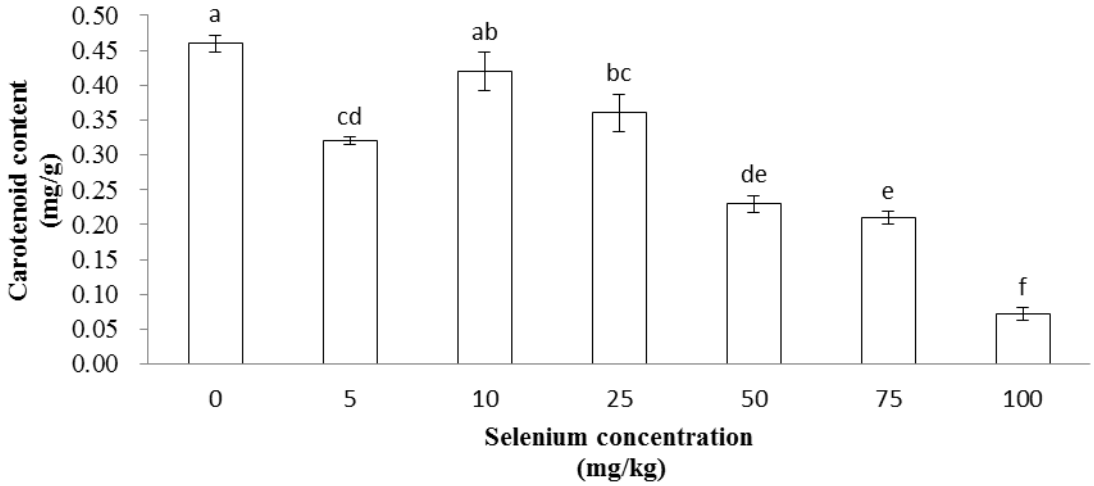

Figure 3 Carotenoid content in *S. alatum*

Means with the same letter within each column are not significantly different at $p < 0.05$.

Conclusions

This study showed that different concentrations of selenium stress have different effects on the photosynthetic pigment contents of *S. alatum*. For *S. alatum* chlorophyll a and chlorophyll b contents, the selenium concentrations order of *S. alatum* chlorophyll a and chlorophyll b contents from large to small were both ranked: 0 mg/kg, 10 mg/kg, 5 mg/kg, 25 mg/kg, 50 mg/kg, 75 mg/kg and 100 mg/kg. Compared with the 0 mg/kg, only the selenium concentration of 10 mg/kg had little effect on the chlorophyll a, chlorophyll b and carotenoid contents of *S. alatum*, other Se concentrations all significantly reduced the photosynthetic pigment contents of *S. alatum*. These results indicated that high concentrations of selenium stress have a significant inhibitory effect on the photosynthetic pigment contents of *S. alatum*, which were not conducive to the growth of *S. alatum*. And only the concentration of 10 mg/kg of selenium had little effect on the photosynthetic pigment contents of *S. alatum*. Therefore, *S. alatum* could grow normally under selenium stress of 10 mg/kg.

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