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# Effects of Salt Stress on Physiological Indexes of 'Ganmi 6' and 'Hayward' Kiwifruit Seedlings

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**Key words:** Kiwifruit; Salt stress; Antioxidant system

**Abstract:** Seedlings of two kiwifruit varieties, 'Ganmi 6' and 'Hayward', were used as experimental materials to study their tolerance to salt stress by comparing physiological indexes , The results showed that the contents of $H_2O_2$, MDA, chlorophyll and soluble protein in leaves of seedlings increased with the salt concentrations increase, accompanied with increased membrane permeability. At the same time, the activities of POD and SOD gradually increased. Furthermore, Hayward had significant higher than the Hair flower, indicating its more sensitive to salt stress.

## Introduction

The impact of soil salinization on modern agriculture has evolved into a global environmental issue [1]. At present, about 36.9 million $hm^2$ of land in China are affected by salinization, and the area affected is getting larger [2]. As a highly soluble salt, NaCl is the most important factor causing soil salinization. Soil salinity inhibits plant growth and development, leading to a significant decrease in its yield [3]. Actinidia, belonging to Actinidiaceae class, Actinidia family, is an important fruit tree resource with high nutritional value and is favored by many people [4]. A large number of research experiments show that the salt tolerance of kiwifruit is not strong, neither tolerance nor impatience ion stress [5]. Therefore, selection and breeding materials with high salt tolerance is of great significance. In the study, we compared the salt tolerance of the two kiwifruit cultivars.

## Materials and Methods

**Plant Preparation and Treatment.** 'Ganmi 6' belongs to Actinidia eriantha and Hayward belongs to Actinidia deliciosa. Seeds of Hair flower and 'Hayward' were picked in September 2016. The seeds were soaked in 5% sodium hypochlorite solution for 5 min and then placed in a Petri dish containing 0.1% Captan solution and refrigerated at 4°C for 2 months. After variable temperature treatment at 4□16h, 25 ± 1□8h for 15 days, seeds was sown into a tray with a substrate and cultured in a climatic chamber at (25 ± 2)□ with a light-dark period of 12h/12h.

When grown up to 7-8 leaves, uniform and strong seedlings of each variety were selected and divided into 4 parts equally, and transfer to the hydroponic box (40 cm × 35 cm × 15 cm) for water planting with 1/2 Hogland solution. Solution was changed every 3 days. After 5 days cultivation for adaptation, NaCl was added to cultivation solution as below: 0 (CK), 50, 100 and 150 $\mu mol \cdot L^{-1}$ of respectively. Each treatment contained 12 plants with three replicates. Treatment lasted for 4 days.

Leaf samples were harvested on 4th day. The leaves were snap-frozen in liquid nitrogen and stored at -80□ in a refrigerator.

**Determination of physiological index.** $H_2O_2$ content determination method adopts Lin Zhi-fang [6]. Relative electric conductivity, MDA and antioxidant enzymes (SOD, POD) content determination method adopted Li Hesheng [7]. The content of chlorophyll was determined by the modified method of Gao Junfeng and soluble protein content determination of the coomassie brilliant blue G-250 staining method [8,9].

**Data Analysis.** Analysis of variance was performed using the SPSS 20.0 software. Each treatment was replicated three times. Significant differences were detected using Duncan's test at the $P < 0.05$ level.

## Results and Discussion

**$H_2O_2$, MDA Content and Relative Electrical Conductivity.** When treated with NaCl, $H_2O_2$ content in leaves of two varieties had no significant difference with control when NaCl concentration below 100 mmol·L$^{-1}$, but increased significant when NaCl concentration reached to 150 mmol·L$^{-1}$, indicating 150 mmol·L$^{-1}$ NaCl induced salt stress on kiwifruit seedling. Furthermore, two varieties showed distinct different response to salt stress (150 mmol·L$^{-1}$ NaCl), $H_2O_2$ content in 'Hayward' peaked to 273.91mmol·g$^{-1}$, which was almost double of that of in 'Ganmi 6', indicating 'Hayward' was more sensitive to salt stress than Hair Flower (figure. 1A).

In 'Ganmi 6', MDA content in leaves was increased significantly with the increasing of NaCl concentration, but there was no significant difference between 100 and 150 mmol·L$^{-1}$ NaCl. In 'Hayward', MDA content at 0 mmol·L$^{-1}$ NaCl was apparent higher than that in 'Ganmi 6', but there was no significant increase when NaCl concentration increased to 50 mmol·L$^{-1}$. Afterwards, with the adding of NaCl, MDA content in 'Hayward' increased rapidly, and peaked at 150 mmol·L$^{-1}$ with 15.13μmol·g$^{-1}$FW. Under the same salt concentration, the MDA content of 'Hayward' kiwifruit was always higher than that of 'Ganmi 6' (figure. 1B).

The relative electric conductivity (REC) of the two varieties both showed an upward trend with the increasing of NaCl concentration. REC of the 'Ganmi 6' was always lower than that of the 'Hayward' under different salt concentrations. Both kiwifruit cultivars peaked at the salt stress of 150 mmol·L$^{-1}$, but the maximum conductivity of the salt concentration, the MDA content of 'Hayward' kiwifruit was always higher than that of 'Ganmi 6' varieties was 47.61%, far lower than 93.66% of the 'Hayward' (figure. 1C).

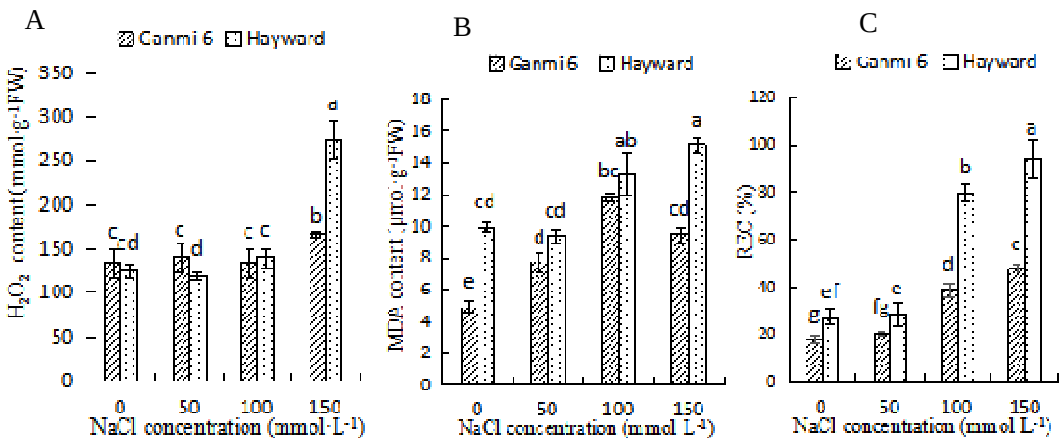


Figure.1 $H_2O_2$ (A), MDA content (B) and REC (C) in two kiwifruit varieties under salt treatments

**Chlorophyll Content and Soluble Protein Content.** The chlorophyll content reached the highest under the NaCl stress of 50 mmol·L$^{-1}$. With the increasing of NaCl concentration, the chlorophyll content in leaves of 'Hayward' decreased firstly and then increased. The chlorophyll content was decreased after the NaCl concentration was 100 mmol·L$^{-1}$. Under the stress of 50 mmol·L$^{-1}$ NaCl, there was no significant change in the chlorophyll content. Under the same salt stress, the chlorophyll content in 'Hayward' kiwifruit seedlings was significantly higher than that in salt concentration, the MDA content of 'Hayward' kiwifruit was always higher than that of 'Ganmi 6' varieties and the differences were significant at the concentration of 100 mmol·L$^{-1}$ and 150 mmol·L$^{-1}$, which increased by 63.64%, 72.22% respectively(figure. 2A). The soluble protein content in the 'Ganmi 6' kiwifruit did not vary greatly with the increasing of NaCl concentration, fluctuating between 5 and 6 mg·g$^{-1}$. The soluble proteins content under 100 mmol·L$^{-1}$ and 150 mmol·L$^{-1}$ NaCl stress were basically unchanged. There was no significant difference in the soluble protein content between the seedlings treated with 50 mmol·L$^{-1}$ NaCl and control treatment. The soluble protein content in the 'Hayward' kiwifruit increased gradually, reaching the highest at 100 mmol·L$^{-1}$, and then decreased. The maximum content reached 6.39 mg·g$^{-1}$(Figure. 2B).

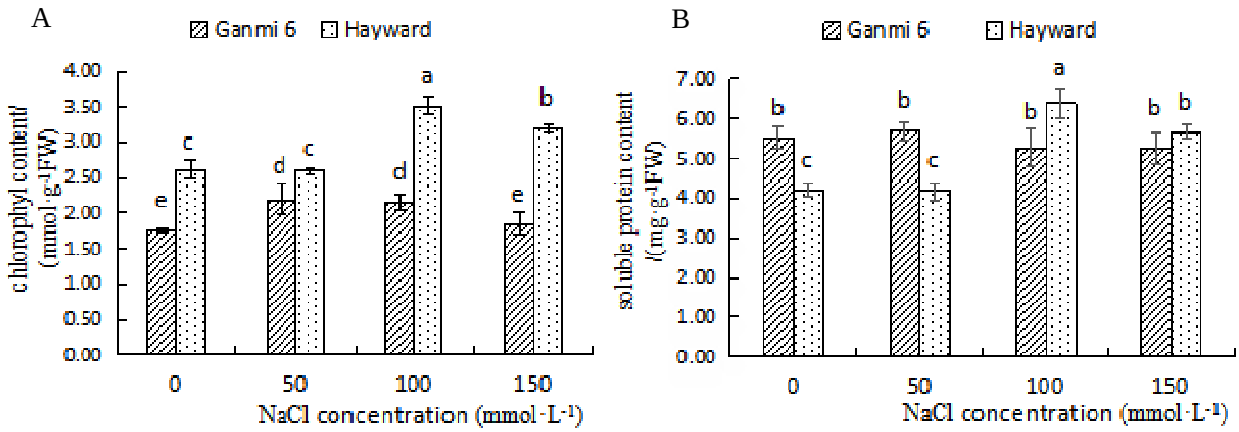


Figure.2 Chlorophyll contents (A) and soluble protein content (B) treatment in two kiwifruit varieties under salt

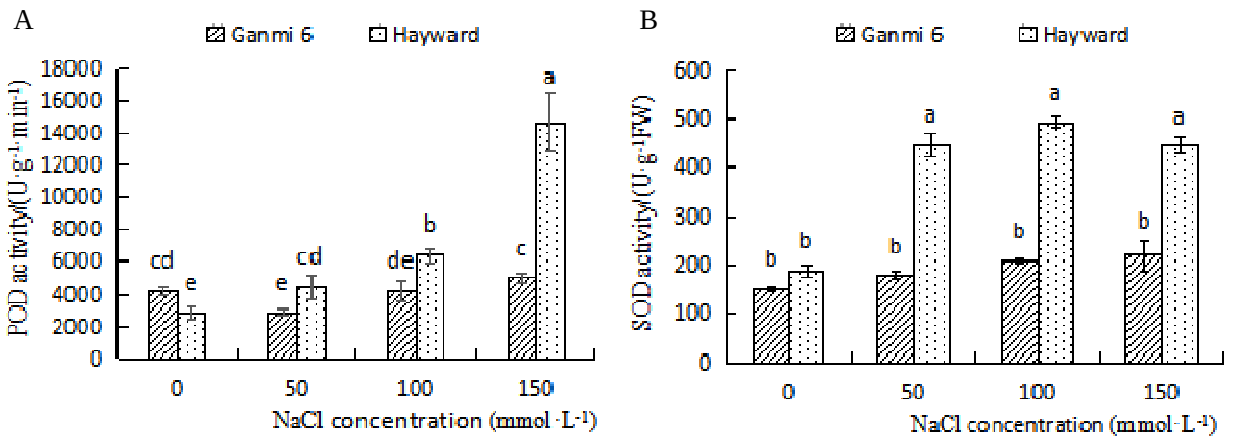


Figure.3 POD (A) and SOD Activity (B) in two kiwifruit varieties under salt

**POD Activity and SOD Activity.** When NaCl concentration was 50 mmol·L$^{-1}$, POD activity of the 'Ganmi 6' kiwifruit was slightly lower than that of control treatment, and then increased. POD

activity of 'Hayward' cultivars always increased with the increasing of NaCl concentration, and POD activity at 150 mmol·$L^{-1}$ NaCl stress was significantly higher than that under low salt stress (Figure. 3A). SOD activity of 'Hayward' increased significantly at NaCl concentration of 0-50 mmol·$L^{-1}$, reaching the maximum at 100 mmol·$L^{-1}$. SOD activities of two varieties of 'Ganmi 6' and 'Hayward' kiwifruit seedlings generally showed an upward trend as the increasing of NaCl concentration, which were higher than the control. SOD activity of 'Hayward' seedlings was significantly higher than that of 'Ganmi 6' under the same salt stress (Figure. 3B).

## Conclusions

The results of experiments showed that salt stress can inhibit the growth of kiwifruit seedlings and destroy the antioxidant system. The physiological indexes of 'Ganmi 6' and 'Hayward' kiwifruit seedlings were affected to varying degrees with the increasing of NaCl concentration. Overall, the higher the NaCl concentration, the more severe the salt stress. The content of MDA, $H_2O_2$, chlorophyll and soluble protein in leaves of two kiwifruit cultivrs increased under different concentrations of salt stress, relative conductivity was also. At the same time, the activities of POD and SOD in leaves were also increased. High-salt stress inhibited the growth of 'Ganmi 6' and 'Hayward' kiwifruit, and the salt tolerance of 'Ganmi 6' kiwifruit was significantly higher than that of 'Hayward'.

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