Effects of Ca(OH)$_2$ on Three Dietary Nutrients in Jujube Fruits

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Abstract. For the prevention and control of jujube disease, the improvement of jujube quality and the improvement of dietary nutrients. The changes of three dietary nutrients in Huping jujube were studied under different Ca (OH)$_2$ concentrations. The results showed that: 1. Low concentration of Ca(OH)$_2$ solution could significantly increase the content of VC and protein in Huping jujube pulp, and the content of VC and protein in Huping jujube pulp showed a downward trend with the increase of solution concentration; 2. Medium concentration of Ca(OH)$_2$ solution could significantly increase the total dietary fiber in Huping jujube pulp and concentration is too high or too low results are not satisfactory.

Keywords: Jujube, Ca(OH)$_2$, Dietary Nutrients

1. Introduction

Huping jujube, a special product of Taigu, Shanxi Province, is a national geographical indication product of China [1]. It gets its name because of its big bottom, small top, thin middle waist and red glaze shape [2]. For a long time, affected by various biological and non biological factors, taigu huping jujube production area appeared various disease and insect symptoms, which reduced the quality of jujube fruit. Especially since 2004, a new disease of jujube fruit was found in the jujube area of South Central Shanxi Province. The researchers named it "jujube black top disease". Its symptoms are jujube fruit near mature stage, the top is black, wrinkled, and the flesh is bitter, which makes jujube fruit black Loss of economic value [3]. In Taigu jujube area, the occurrence area of "jujube black top disease" is wide, the harm is heavy and the loss is big, which is a big threat to the development of Shanxi jujube industry. It is found that "jujube black top disease" is a non infectious disease, and the atmospheric fluorine concentration is one of the main causes of "jujube black top disease" [4]. However, high concentration of Ca (OH)$_2$ has the best control effect on "jujube black top disease", which is worth popularizing [5]. In addition, a large number of studies have also shown that the effect of calcium nutrition on fruit growth and development is greater than that of nitrogen, phosphorus, potassium and magnesium [6] and closely related to fruit quality and mineral nutrition [7]. However, the effects of Ca (OH)$_2$ on the dietary nutrients of Huping jujube fruit have not been systematically studied and reported. In this experiment, taigu Huping jujube was taken as the research object, and the changes of three kinds of dietary nutrient elements of Huping jujube fruit were studied under different
Ca(OH)$_2$ concentrations, which provided theoretical basis for disease prevention and control of taigu Huping jujube fruit, quality improvement of jujube fruit and improvement of dietary nutrient elements.

2. Materials and Methods

2.1. Test Site and Experimental Materials
The experimental base is located in the jujube resource garden of Fruit Research Institute of Shanxi Academy of Agricultural Sciences. Located in the southwest of Taigu County. It belongs to Loess Plateau, hilly platform and temperate continental climate. The experimental soil belongs to carbonate cinnamon soil, which is alkaline, with low humus content and medium soil fertility. In the experiment, jujube was selected as Huping jujube, about 10 years old.

2.2. Test Method
Starting from 2017, 27 jujube trees with good and consistent growth were selected in jujube garden and divided into 9 groups, with 3 trees in each group as repetition. At the end of July, jujube fruit began to expand, and 8 kinds of Ca(OH)$_2$ solutions with different concentration gradients were sprayed on each group of jujube trees, and water was used as control. The method of solution preparation and dilution is as follows: first prepare saturated solution of Ca(OH)$_2$ (concentration is 0.165%), then prepare 8 kinds of Ca(OH)$_2$ solutions with different concentration gradients according to 50-300 times of dilution concentration. See Table 1 for concentration gradient and spraying time. After ripening, 10 jujube fruits of similar size will be randomly picked from each tree. After picking, they will be put into ice box for cold storage and preservation immediately. After picking, they will be taken back to the laboratory for index determination.

Table 1. Concentration gradient and spraying time of Ca(OH)$_2$ solution

| Calcium preparations | concentration | Processing number | Spraying time   |
|----------------------|---------------|-------------------|----------------|
| Ca(OH)$_2$          | 50 times      | A1                |               |
|                     | 100 times     | A2                |               |
|                     | 150 times     | A3                |               |
|                     | 200 times     | A4                | 2017.07.22    |
|                     | 225 times     | A5                | 2017.08.02    |
|                     | 250 times     | A6                | 2017.08.13    |
|                     | 275 times     | A7                |               |
|                     | 300 times     | A8                |               |
|                     | water         | CK                |               |

2.3. Determination Method
VC was determined by 2,6-dichlorophenol indophenol titration.
Determination of protein content by Kjeldahl method
Dietary fiber was determined by enzyme weight method.

2.4. Data analysis
Charting with Excel, analysis of variance and multiple comparisons were performed using DPS.

3. Results and Analysis

3.1. Effects of Different Concentration of Ca (OH)$_2$ On The Protein in the Pulp of Huping Jujube
The effect of different concentration of Ca(OH)$_2$ on the protein content in the pulp of huping jujube is shown in Figure 1.
Figure 1. Effect of calcium nutrition concentration on protein content in pulp of hupingzao jujube

The same letter in the graph indicates that the difference between treatments is not significant, and the difference between different letters indicates that the differ

As can be seen from the figure, compared with the control, 8 different concentrations of Ca(OH)$_2$ solution could increase the protein content in the pulp of Huping jujube in different degrees. Among them, the protein content of A8 treatment was the highest, and the protein increment was 1.7g / 100g. With the increase of solution concentration, the protein content in jujube pulp decreased with the increase of solution concentration. The protein increment of A1 treatment was the lowest, which was 0.45g / 100g. By analysis of variance and multiple comparisons, there were significant differences between different concentration treatments and the control (p < 0.01). There were no significant differences among A2, A3, A4, A5, A6 and A7 among different treatments, but there were significant differences among other treatments (p < 0.05).

3.2. Effects of Different Concentration of Ca(OH)$_2$ On VC in Huping Jujube Pulp

The effect of different concentration of Ca(OH)$_2$ on VC content in huping jujube pulp is shown in Figure 2.

Figure 2 Effect of calcium nutrition concentration on VC content in pulp of huping jujube

The same letter in the graph indicates that the difference between treatments is not significant, and the difference between different letters indicates that the differ

It can be seen from the figure that, similar to protein, 8 different concentrations of Ca(OH)$_2$ solution can increase the content of VC in jujube pulp in different degrees. Among them, the content of VC in A8 treatment was the highest, and the increment of VC was 184.43mg / 100g. With the increase of solution concentration, the content of VC in jujube pulp decreased with the increase of solution concentration. The increment of VC in A1 treatment was the lowest, which was 15.72mg/100g. By analysis of variance and multiple comparisons, there were significant differences between different concentration treatments and the control (p < 0.05). There were no significant differences among A1, A2, A2, A6 and A7 among different treatments, but there were significant differences among other treatments (p < 0.05).
3.3. Effects of Different Concentration of Ca(OH)₂ on Dietary Fiber of Huping Jujube

The effect of different concentration of Ca(OH)₂ on dietary fiber content in huping jujube pulp is shown in Figure 3.

From the figure, it can be seen that different concentrations of Ca(OH)₂ solution can increase the content of total dietary fiber in jujube pulp to a certain extent. With the increase of Ca(OH)₂ solution, the content of total dietary fiber in jujube pulp increased at first and then decreased. The largest increase of total dietary fiber content in jujube pulp was A5 treatment with Ca(OH)₂ saturated solution diluted 225g, and the increment was 5.75g / 100g, and the smallest increment was 1.26g / 100g in A7 treatment with Ca(OH)₂ saturated solution diluted 275times. Through analysis of variance and multiple comparison, the content of total dietary fiber in jujube pulp of different treatments was significantly different from that of the control (p < 0.01). Among different treatments, there were no significant differences among A1, A2, A7 and A8, and no significant differences among A3, A4 and A6, but there were extremely significant differences among other treatments (p < 0.01).

![Figure 3](image)

**Figure 3.** The effect of calcium nutrition on the content of total dietary fiber in huping jujube pulp

The same letter in the graph indicates that the difference between treatments is not significant, and the difference between different letters indicates that the difference.

4. Conclusion and Discussion

Calcium ion is one of the essential trace elements in plant life activities, which has varying degrees of effects on fruit quality and physiological and biochemical indexes [8,9]. This may be due to the fact that calcium ions play a very important role in stabilizing and regulating plant cell wall [10], cell membrane structure stability [11] and intracellular enzyme activity [12].

VC is a very important nutrient for humans. It can not only prevent various diseases such as scurvy and arteriosclerosis, but also enhance the body's absorption of iron and has obvious anti-cancer effects [13]. Therefore, people should pay attention to the intake of VC in their daily diet. In addition, the role of VC in plants is not only to provide humans with VC needed for daily diet. VC is an antioxidant that is commonly found in plants [14] and is a very important functional component in fruits. Many scholars have shown that different types of exogenous calcium fertilizer can increase fruit quality and VC content [15]. This study found that different concentrations of Ca(OH)₂ solutions can increase the VC content in jujube jujube pulp to varying degrees, and with the increase of the solution concentration, the VC content in jujube jujube pulp showed a downward trend. The findings are basically the same.

Protein is one of the three indispensable nutrients in human dietary nutrition, which plays a pivotal role in human diet. In addition, protein is the final product of gene expression and the performer of life function, which plays a very important role in life activities, especially when the external environment changes, the protein content in the plant will also change accordingly [16]. Several scholars have shown that a certain concentration of this treatment can promote the protein content of plant fruits to a certain extent [17]. This study found that 8 different concentrations of Ca(OH)₂ solutions all had different effects on the protein content of jujube jujube pulp, and the protein content of jujube jujube pulp showed a downward trend with the increase of the solution concentration. It is basically
consistent with the previous research results.

Dietary fiber is the seventh nutrient besides carbohydrate, protein, fat, vitamin, mineral and water [18]. A large number of studies have shown that dietary fiber in food has certain preventive and alleviating effects on diseases including abdominal obesity, hypertension, diabetes and so on[19]. The results showed that the content of total dietary fiber in the pulp of huping jujube was increased with the concentration of Ca(OH)$_2$. The medium concentration of Ca(OH)$_2$ solution can obviously promote the total dietary fiber in the pulp of huping jujube, but the effect is not ideal if the concentration is too high or too low.

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