Study on Quality Characteristics and Feasibility Analysis of Hail-proof Plastic Bagging of 5000 Mu in Gansu

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Abstract. The effects of bagging of bare fruits, plastic bagging, hail-proof plastic bagging and bagging on the quality of red Fuji apples in different periods were studied. Red Fuji apples in Qingyang City of Gansu Province were used as test materials to determine the fruit quality indices of bagged and bagged apples in different periods, such as light consistency, color, and fruit firmness, total sugar, reducing sugar, sucrose and total acid. With the postponement of bagging period, apple fruit surface smoothness, color and hardness gradually decreased, while total sugar, reducing sugar and sucrose content gradually increased. With the delay of bagging time, the smoothness of apples decreases. Total sugars, reducing sugars and sucrose had the same growth and decline pattern as those of fruits without bagging, but their contents were always lower than those of the control. Hail-proof Apple plastic suction bagging has been proved by a lot of research and experiments that this kind of apple bagging has the characteristics of low price, fast bagging speed and reusability. It can also prevent and control diseases, insects, birds, rats, bees and other harmful effects on fruits and reduce fruit rust. It can also avoid friction between branches and leaves, prevent sunburn and reduce hail. At the same time, bagging efficiency is fast, improving work efficiency, reducing environmental pollution and reducing the workload of fruit growers.

1. Introduction

Apple bagging is a supporting technology to improve the appearance quality of commodities. It must be based on the comprehensive management of orchards, and the results and benefits can be reflected [1-2]. Firstly, it can make the peel delicate and bright, and the fruit dots are sparse, which can significantly improve the appearance quality. Secondly, it can promote the rapid increase of anthocyanins in red fruits, enlarging the coloring area by about 30%, and the color is uniform, bright and beautiful. Thirdly, it can effectively reduce the residue and pollution of pesticides and dust on fruits. Fourth, it can prevent and control diseases, insects, birds, mice, bees and other harmful effects on fruit, reduce fruit rust. Fifth, it can avoid friction between branches and leaves, prevent sunburn and reduce mechanical damage such
as hail. Therefore, fruit bagging is still the most direct and effective technology in the production of pollution-free green fruits [3-4].

In order to overcome the shortcomings of the prior art, the present invention provides fruit bagging, and completes one apple bagging in 2 seconds, which is 6 times faster than the current bagging technology. This project won the first prize of Gansu Banking Cup College Student Innovation and Entrepreneurship Competition in 2017, and was recognized by the society. It won the patent right of venture capital fund of enterprises in Gansu Province. Gansu Science and Technology Department and Baiyinke Key Investment Co., Ltd. invested 500,000 yuan. The apple bagging is made of environmental protection materials. The product is suction moulding [5-6]. It can be industrialized, mass production, high efficiency and low production cost. It can prevent small hail with a diameter of 0.5 cm, reduce the loss of natural disasters and increase farmers’ economic income. It is a project for the benefit of the people. Mass entrepreneurship, innovation, the realization of the Chinese nation's take-off, based on agricultural projects, continue to innovate and develop China's apple bagging industry, after the project matures, the initial out of the country, the Chinese manufactured fruit bagging market to the world, to meet the needs of world economic integration [7].

Lanzhou University of technology, Lanzhou Industry and Equipment Co. Ltd Zhang Wanjun. ET, at researchers [8-22] have several methods of Apple bagging. In May 2018, a production contract was signed with Qingyang Aokai Food Co., Ltd. The hail-proof apple box invented by myself was invested 500,000 yuan to carry out a five-year experiment. In 2018, the hail-proof apple box was extended to more than 5,000 Mu orchards in five provinces and was fully recognized by the majority of fruit growers [23-24]. This paper mainly introduces Study on Quality Characteristics and Feasibility Analysis of Hail-proof Plastic Bagging of 5000 Mu in Gansu. Hail-proof Plastic Bagging efficiency [25-26] is fast, improving work efficiency, reducing environmental pollution and reducing the workload of fruit growers.

2. Materials and methods

2.1. Test material

In 2015, the apple planting area of China was 38.5 million mu, Gansu Province was 4.6 million mu. According to the existing effective planting area of fruits, Qing Yang City had 118 million mu [27]. The Apple planting area was large and the demand for apple bagging was large. The plastic-absorbing apple bagging had broad market prospects. The preliminary plan of the project has been implemented for five years. At present, a preliminary agreement has been reached with Qing yang Aokai Food Co., Ltd. to produce the product for trial production. Plastic-absorbing bagging has been tested and popularized in some orchards of fruit growers, which reduces the cost without reducing the effect of bagging and is welcomed by fruit growers. The product is marketed by the combination of physical store sales and Internet platform sales. The market is initially positioned in the main apple producing township of Qing yang City. It has been extended to other apple producing areas in Gansu Province and the main apple producing areas in China since 2018. It is expected that the company will be established in 2017, and the production scale will be expanded by 2021, with sales revenue reaching 26 million yuan and annual net profit reaching about 6 million yuan.

Figure 1. Hail-proof Apple plastic suction bags.
In April 2018, the hail-proof bagging project was invested 500,000 yuan by Qingyang Aokai Food Co., Ltd. in preparation for the comparative test of new and old bagging technology in my favorite inventions column. In 2018, more than 1,000 Mu is expected to be popularized for testing.

The experiment was conducted in the trial orchard of Apple Quality Cultivation and introduction in Gansu Apple planting area of 4.6 million mu fruit tree base in 2018. The apple varieties tested were 'Red Fuji', which were fruit trees of 8-year-old fructifying period. The experiment was conducted in a completely randomized design. Five apples were used as a test plot and repeated three times. Hail-proof Apple plastic suction bags, as is shown in Fig.1.

2.2. Experimental design
In 2018-06-15 (40 days after flowering), the bagging of New Red Star apples was started. Half of the fruits with uniform size in different directions in the upper part of the tree were bagged, half of the fruits without bagging were bagged as control, and the fruit bags were three-layer fruit bags (external oil flower paper, medium-black monochrome paper and inner non-woven fabric). 2018-06-15 bagged (130 days after flowering), 2018-06-15 harvested (150 days after flowering) and shipped to the laboratory on the same day. Fruits with uniform size, no mechanical damage and relatively consistent maturity were selected for experiment. Unbagged fruits (control) and bagged fruits (bagging) were treated at room temperature and controlled atmosphere bagging at room temperature respectively. There were four treatments, namely control, control + controlled atmosphere bagging, bagging, bagging + controlled atmosphere bagging. Each treatment contained 100 fruits, which were repeated three times. Apple special spontaneous air-conditioned bag: 50 "m thick, specifications for 85 cm * 75 cm, purchased from Qingyang Aokai Food Co., Ltd. Ten fruits were randomly selected from different treatments every one week to determine each index. The pulp was minced and blended well. The fruits were frozen with liquid nitrogen and placed in a low-temperature refrigerator at 80 for reserve until the fruits lost their commercial value. The fruits were stored for 6 weeks. Effect of Apple Bagging, as is shown in Fig.2.

![Figure 2. Effect of Apple Bagging.](image)

3. Design of apple bagging test

3.1. Coloring area, chlorosis area, smoothness, brightness and fruit dot size

The evaluators were 3 trained food sensory quality evaluators. The evaluation process is carried out in the sensory evaluation laboratory. Before evaluation, each evaluator will be explained the evaluation content, evaluation criteria and evaluation methods, and then the numbered samples to be evaluated will be sent to the evaluator with the same container for evaluation. Finally, the evaluation form will be filled out and signed. Collect and analyze the evaluation results of each evaluator.

3.2. Fruit Hardness

GY-B fruit hardness tester was used to measure 8 times on both sides and back of apple, and the average value was obtained.
3.3. Total Sugar, Reduced Sugar and Sucrose
The content of total sugar and reducing sugar (glucometer) was determined by Filin Reagent Titration Method n21. The average value was obtained after three repetitions. According to the total sugar, reducing sugar and correlation coefficient, the formula is: sucrose content= (total sugar-reducing sugar)*0.96.

3.4. Treatment of bagging and picking bags in different periods
The bagging period was divided into four treatments: May 20, May 30, June 9 and June 19. Each bagging was carried out at 10:00-12:00. Three trees with identical trees, good growth and basically identical fruits were selected as experimental trees for each treatment. Each tree selected 15 fruits from four directions of southeast, northwest, and each set of trees marked the date of bagging with a label card. The bagging period is October 1, and the harvesting date is October 17. Apple Bagging Tools, as is shown in Fig.1.

![Apple Bagging Tools](image)

**Figure 3. Apple Bagging Tools.**

The bagging period was divided into eight treatments: September 11, September 16, September 21, September 26, October 1, October 6, October 11 and October 16, each time was 10:00-11:00. Three trees with identical trees, good growth and almost identical fruits were selected as experimental trees for each treatment. Fifteen fruits were selected from four directions of southeast, northwest and northwest for each tree. Fifteen bagged fruits and fifteen unpacked fruits were taken from four directions of three trees for quality determination. Fruit harvesting was determined 15 days after bagging.

4. Analysis and comparison

4.1. Analytical Charts of Coloring and Decoloring of Different Apple Bags
The early bagging fruit had thin and thick pericarp and was sensitive to light stimulation. Bagging at different stages has a profound impact on the formation of internal quality of fruits. Bagging has a greenhouse effect on fruits. Fruits have a high respiratory intensity under high temperature and increase the consumption of carbohydrates. Analytical Charts of Coloring and Decoloring of Different Apple Bags, as is shown in Fig.4
As you can see from Fig. 4, fruits have a high respiratory intensity under high temperature and increase the consumption of carbohydrates.

4.2. Effects of Coloring and Decolorization on Appearance Index of Red Fuji Apple

Colority and chlorosis are also important indicators affecting the appearance quality of apples. With the delay of bagging time, the colority and chlorosis of bagged apples first increased and then decreased, which were better than those of non-bagged apples before October 6. After October 6, the colority and chlorosis began to decline, and were lower than those of non-bagged apples. It is concluded that early or late bagging will reduce the quality of apple color and chlorosis. Comparison of Colouring and Greening of Bagged and Unbagged Apple in the Simultaneous Period, as is shown in Fig.4.

**Figure 4.** Analytical Charts of Coloring and Decolouring of Different Apple Bags.

**Figure 5.** Comparison of Colouring and Greening of Bagged and Unbagged Apple in the Simultaneous Period.
4.3. Hardness analysis
Fruit firmness represents the strength of pulp resistance to pressure. With the growth and development of apples, fruit firmness will gradually decrease. The results showed that the earlier the bagging time was, the smaller the fruit firmness was, and the firmness of bagged fruit was significantly lower than that of unpacked fruit. Hardness analysis, as is shown in Fig.6.

![Graph](image_url)

**Figure 6.** Hardness Analysis Charts of Different Apple Bags.

4.4. Sugar and calcium analysis
Sugar and calcium content directly affect the flavor quality of apples, which are important factors affecting fruit quality. The results showed that the earlier the bagging time was, the lower the contents of total sugar, reducing sugar, sucrose and total acid in apples were, and they were significantly lower than those in the control group, indicating that the bagging microenvironment was not conducive to the synthesis of apple sugar and acid. Analysis Charts of Calcium Content and Sugar Content in Different Apple Bags, as is shown in Fig.7.

![Graph](image_url)

**Figure 7.** Analysis Charts of Calcium Content and Sugar Content in Different Apple Bags.
5. Experts carry out on-site apple bagging guidance
This year, on June 20, experts from Qingyang Academy of Agricultural Sciences and Gou Xiaoping, associate professor of Longdong University, Dr. Zhang Wanjun, senior engineer and senior economist of Qingyang Xinyuan Engineering Co., Ltd. gave guidance to fruit growers on apple bagging technology. Different apple bagging experiments, as is shown in Fig. 8. Experts carry out on-site apple bagging guidance, as is shown in Fig. 9.

![Figure 8. Different apple bagging experiments.](image)

6. Comparison of different apple bagging
The early bagging fruit had thin and thick pericarp and was sensitive to light stimulation. Bagging at different stages has a profound impact on the formation of internal quality of fruits. Bagging has a greenhouse effect on fruits. Fruits have a high respiratory intensity under high temperature and increase the consumption of carbohydrates.

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The fruit is bagged. Firstly, it can make the peel delicate and bright, and significantly improve the appearance quality. Secondly, it can increase the anthocyanin content of red fruits, and the color is gorgeous and beautiful. Thirdly, it can reduce the residues and pollution caused by pesticides and dust. Fourth, it can prevent and control diseases, insects, birds, rats, bees and other hazards, reduce fruit rust.

![Figure 9. Experts carry out on-site apple bagging guidance.](image)

7. Discussion
On the premise that bagging can greatly promote the comprehensive quality of Red Fuji apple, bagging of fruit, plastic bags and hail-proof plastic bags in different periods were studied. The effect of Bagging on apple quality to determine the best bagging and bagging date of apple is of great guiding significance.
to production practice. We found that the absolute content and relative ratio of different pigments in the peel were important factors determining the color of the peel.

Consulting some experts in many related fields and our actual experiments found that the early bagging fruits had faster coloring speed, which might be related to the thin and thick peel of the early bagging fruits and the sensitivity to light stimulation. Bagging at different stages has a profound impact on the formation of internal quality of fruits. Bagging has a greenhouse effect on fruits. Fruits have a high respiratory intensity under high temperature and increase the consumption of carbohydrates.

In addition, the shading effect of fruit bags greatly weakens the photosynthetic capacity of fruits, which is not conducive to the accumulation of organic substances such as sugar and acid. The earlier bagging, the more obvious this effect. With the delay of bagging period, the total sugar, soluble sugar and sucrose content of bagged apples tended to increase, which was consistent with Wang Shaomin's research results. We considered that early bagging, low colority of fruit, poor brightness, large fruit dots and poor greening of fruit surface; late bagging, bright fruit surface, but not conducive to the accumulation of sugar substances. The results are basically the same. In addition, the effects of bagging and bagging on the growth, development and quality of Red Fuji apple, as well as the local climate and cultivation level, should be considered comprehensively in determining the bagging period. In addition, hail-proof Apple plastic suction bags have been proved by a lot of research and experiments that the bags are cheap, fast and reusable. They can also prevent and control diseases, insects, birds, rats, bees and other hazards to fruits and reduce fruit rust. They can also avoid friction between branches and leaves, prevent sunburn and reduce ice. At the same time, the bag picking efficiency is fast, the work efficiency is improved, the environmental pollution is reduced, and the workload of fruit growers is reduced. This bagging method is feasible, can produce strong economic and social benefits, and has been recognized by the majority of fruit growers.

8. Conclusion
The advantage of this method is that two different thresholds are used to detect the strong edge and the weak edge, and only when the weak edge relates to the strong edge, the weak edge is included in the output image. Therefore, this method is not easy to be filled with noise, and it is easy to detect the real weak edge. Prewitt has better effect on image processing with gradation and more noise.

The fruit is bagged. Firstly, it can make the peel delicate and bright, and significantly improve the appearance quality. Secondly, it can increase the anthocyanin content of red fruits, and the color is gorgeous and beautiful. Thirdly, it can reduce the residues and pollution caused by pesticides and dust. Fourth, it can prevent and control diseases, insects, birds, rats, bees and other hazards, reduce fruit rust. With the delay of bagging time, the apple's smoothness decreased. The Apple bagged from October 1 to October 6 had the best coloring and chlorosis effect, and the apple bagged on October 6 had the highest total sugar, reducing sugar and sucrose content, lower total acid content and good taste. Therefore, the time of picking bags is ideal around October 6.

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