Study on the Structure Design and Feasibility Analysis of Apple Inhaled Box Bags Based On Hailproof

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Abstract. Now the Apple bag, skilled farmer 12 s complete the whole process of an Apple bag, the process is cumbersome, the work efficiency is low. The hailproof Apple plastic box bag can effectively prevent small hailstones from injuring apples. It is a general paper bag that can not solve this technical problem. How to design and make a fast and effective Apple bag is a research topic of inquiry. In order to overcome the deficiency of the existing technology, this paper gives a kind of Apple plastic box bag that can prevent hail. 1s completes an Apple bag and the bag speed increases by 12 times. Through a lot of research and experiments, this kind of Apple bag has the characteristics of low price, fast bag, and reusable. It can also prevent and control diseases, insects, birds, rats, bees, etc. from harming the fruit and reducing fruit rust; It also avoids friction between branches and leaves, prevents sunburn, and relieves hail and other mechanical injuries. This bagging method is feasible and can produce strong economic and social benefits, and is recognized by the majority of fruit farmers.

1. Introduction
Apple bagging is a supporting technology to improve the appearance and quality of commodities. It is necessary to strengthen the integrated management of orchards on the basis of comprehensive management, and the results and benefits can be reflected [1-2]. First of all, it can promote the skin to be delicate and clean, the fruit point is small, and the appearance quality is significantly improved [3-4]. Secondly, it can promote the rapid increase of anthocyanin in red varieties, expand the coloring area of about 30 %, and the color is uniform, bright and beautiful [5-6]. Third, it can effectively reduce the residue and pollution brought by pesticides and dust to the fruit. Fourth, it can prevent and control diseases, insects, birds, rats, bees, etc. from harming the fruit and reducing fruit rust. Fifth, we can avoid friction between branches and leaves, prevent sunburn, and reduce hail and other mechanical damage. Therefore, the widely used fruit bag is still the most direct and effective technology for pollution-free green fruit production.
In order to overcome the deficiency of the existing technology, the invention provides a fruit bag and completes an Apple bag in 2 seconds, which is 6 times faster than the current bag technology. This project won the first prize of the Gansu Bank Cup College Student Innovation and Entrepreneurship Competition in 2017 and was recognized by the society. It won the patent rights and development of the venture capital funds of Gansu companies, and the Gansu Provincial Science and Technology Department and Baiyinke Keyboard Investment Co., Ltd. invested 500,000 yuan. Apple bags are made of environmental protection materials. This product can be made into a large number of industrial production, work efficiency, low production costs, can prevent 0.5 cm diameter of small models of hail, reduce the loss of natural disasters, improve farmers' economic income, is a beneficial project. Mass entrepreneurship and innovation, the realization of the Chinese nation's take-off, based on agricultural projects, continuous innovation and development of the Chinese Apple bagging industry, after the project mature, initially out of the country, will be promoted to the world's fruit bagging market, to meet the needs of world economic integration [7].

Lanzhou University of technology, Lanzhou Industry and Equipment Co. Ltd ZhangWanjun.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 the Structure Design and Feasibility Analysis of Apple Inhaled Box Bags Based on Hailproof. Hail-proof Plastic Bagging efficiency [25-26] is fast, improving work efficiency, reducing environmental pollution and reducing the workload of fruit growers. This bagging method is feasible, can produce strong economic and social benefits, and has been recognized by the majority of fruit growers.

2. Materials and methods
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, Qingyang City had 118 million mu [27]. The preliminary plan of the project has been implemented for five years. At present, a preliminary agreement has been reached with Qingyang Aokai Food Co., Ltd. to produce the product for trial production. The market is initially positioned in the main apple producing township of Qingyang 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. Hail-proof Apple plastic suction bags, as is shown in Fig.1.

Fig. 1 Hail-proof Apple plastic suction bags.
In accordance with the standard hailproof Apple suction box bag should have: outer bag requirements to reach 180mm long, 145mm wide, hydrophobic strong, resistant to wind and sun and rain, good shade, air permeability, high degree of green fruit, fast color; The paper is soft, the worm is strong, and the tension is large; The inner bag requires a length of 150mm and a width of 140mm. The wax layer is uniform, does not melt at high temperatures, has a good separation of water, and separates the internal and external bags. The process requires the adhesive to be strict and not to crack for a long time; On the side of the outer pocket, there is a thread with a length of 3 to 4 cm; On one side of the bag mouth is a half-moon tooth shape gap, with a 2-2.5 cm longitudinal incision in the center, and a 1cm long longitudinal incision and a breathable mouth in the middle and 2 corners of the outer bag. Physical structure of the Apple plastic box bag which can prevent hail, as is shown in Fig.2.

Bagging method: The bag mouth is stacked down on the wet ground in the room before the bag to soften it so that it can tighten the bag mouth. First, use the left hand to hold the fruit paper bag, the right hand to open the bag mouth, and half hold the fist to support the drum bag body, so that the two corners of the bag bottom air drain hole open. With two hands under the mouth of the bag 2 to 3cm, the bag mouth is put into the fruit downwards, so that the fruit stem is placed on the fruit paper bag along the base of the longitudinal incision, so that the young fruit is suspended in the center of the fruit paper bag. Fold the bag horizontally to the left and right, placing the side of the bag behind the folding. Squeeze the pocket into a "V" shape on the side of the longitudinal incision and tighten it to avoid pests, rain water, and potions entering the fruit bag. When bagging, the direction of force is always upward, and the fruit paper bag is avoided as much as possible. The leaves and shoots are not put into the bag. The thread is not wrapped around the stem to prevent the fruit from falling. The order of the bags is the first crown, the second crown, the first inner chamber, and the later periphery. This kind of bag has been tested. The skilled farmer 12s has completed the entire process of an Apple bag. The process is cumbersome and the work efficiency is low.

3. Structure Design Analysis of Apple Inhaled Box Bags
Diagram of the three-dimensional structure of Apple plastic box bag with anti-hail, as is shown in Fig.3.
Fig. 3 Diagram of the three-dimensional structure of Apple plastic box bag with anti-hail.

Label of Apple plastic box bags that can prevent hail: 1, groove connection surface; 2, grooves I; 3, grooves II; 4, fruit handle bayonet I; 5, equivalent surface A; 6, grooves III; 7, grooves IV; 8, grooves V; 9, convex platform I; 10, fruit handle hook A; 11, incision I; 12, convex platform II; 13, grooves VI; 14, grooves VII; 15, grooves VIII; 16, fruit handle pin II; 17, table I; 18, Semi-circular ring table I; 19, grooves nine; 20, suction molding uplift one; 21, grooves ten; 22, shading surface A; 23, fruit handle bayonet three; 24, countertop two; 25, shading surface B; 26, semicircle ring table two; 27, suction molding uplift two; 28, concave one; 29, fruit handle hanging port B; 30, incision two; 31, concave mouth two; 32, face B; 33, shading surface C; 34, fruit handle bayonet four; 35, shading surface D; 36, table three; 37, semi-circular ring table three; 38, table four; 39, semi-circular ring table four. Diagram of the three-dimensional structure of Apple plastic box bag which can prevent hail. Diagram of the three-dimensional structure of Apple plastic box bag which can prevent hail, as is Shown in Fig.4.

Fig. 4 Diagram of the three-dimensional structure of Apple plastic box bag which can prevent hail.

The fruit bag is characterized as: on the face A, there are ten breathable tanks with a diameter of two millimeters. They are grooves 1, grooves 2, grooves 3, grooves 4, grooves 5, grooves 6, grooves 7, grooves 8, grooves 9, and grooves 10, fruit handle bayonet 1 and fruit handle bayonet 2 it is a semi-circular ring suction port. The semi-ring has a diameter of four millimeters and a height of two millimeters. It is a semi-circular bayonet of the Apple fruit handle. The convex platform one and the convex platform two are rectangular shapes. The length is eight millimeters, the width is three millimeters, and the height is three millimeters. The plastic uplift, the round hole of the fruit handle socket A is four millimeters in diameter. The table-top one and table-top four are six centimeters in diameter, the semi-circular ring table one and the semi-circular ring table four are one-centimeter-high
suction plastic curved surfaces, and the cross-section of the suction bulge one is a three-millimetre diameter. Semi-circle, fifteen plasticized bulges are evenly distributed on face A. Apple Bagging Tools and Material Map, as is shown in Fig.5.

![Fig. 5 Apple Bagging Tools and Material Map.](image)

The fruit bag is characterized as: on the face B, there are three mm height shading surfaces A, B, C and D, and the fruit handle and the fruit handle. The mouth four is the suction mouth of the semicircle ring, the diameter of the semi-ring is four millimeters, the shape of the concave one and the concave two rectangular body, the length is seven millimeters, the width is two millimeters, and the thickness is three millimeters. The diameter of the round hole B of the fruit handle is four millimeters. The countertop two and the countertop three are the suction plastic planes with a diameter of six centimeters, the semi-circular ring table two and the semi-circular ring table three are the suction plastic surfaces with a height of one centimeter, and the cross section of the suction bulge two is a three-mm diameter. Semi-circle, fifteen plastic bulges are venly distributed on the replacement surface B. Main view of an Apple plastic box bag for hail proof, as is shown in Fig.6.

![Fig.6 Main view of an Apple plastic box bag for hail proof.](image)

The fruit bag is characterized as follows: Scheme 1: After the fruit matures, take down the bag, the fruit handle is suspended through the incision in the fruit handle hook A, and the fruit bag faces the Southwest on the back. Hanging 3-5 days to prevent the sun from "burning" Apple fruit noodles; Option 2: After the fruit matures, take down the bag, and the fruit handle is suspended in the fruit handle hang B through the incision. The back of the fruit bag faces the Southwest direction and hangs for 3-5 days to prevent the sun from burning. Rear view of an Apple plastic box bag with hail resistance, As is Shown in Fig.7.
Fig. 7 Rear view of an Apple plastic box bag with hail resistance.

The fruit bag is made of one time suction plastic production, mechanized mass production, high efficiency of work, fast bag collection speed when the fruit farmer works, improves the labor efficiency per unit time, removes the fruit bag, and overlaps one stack. Reuse in the second year after disinfection. As is shown in Fig.8.

Fig. 8 Left view of the Apple plastic box bag for hail proof.

Refer to Figure 2, which is made of degradable, environmentally friendly materials that provide a closed growth environment for apples. When young fruit bags are placed in spring, fruit bags are placed. When the apples mature in autumn, they need to remove the bags. The thickness of the suction molding bag in the face A and in the face B is 0.3 mm, and it is made of a one-time suction molding. In the face A and on the inside of the face B, an animal oil with a thickness of 1 mm is sprayed. The replacement A and the outer side of the replacement B are gray and the inner side is red and black. As is shown in Fig.3.

Fig. 9 Right view of an Apple plastic box bag for hail proof.

Therefore, the invention has the following advantages: bagging, fast bagging speed, energy saving and environmental protection, easy to popularize and widely used. Save raw materials to meet the requirements of green packaging; Can package any alien products, packing does not need to add buffer material; Suitable for mechanization, automatic packaging, easy to modern management, saving manpower and improving efficiency. As is shown in Fig.3.
Fig. 10 Top view of an Apple plastic box bag for hail protection.

The fruit bag is characterized by: the face A rotates 180 degrees along the groove connection surface, the fruit handle can be set in the fruit handle bayonet and the fruit handle bayonet four, or it can be set in the fruit handle bayonet three and fruit handle bayonet four inside, The convex platform is pressed into the concave two inside fixed, the convex platform is pressed into the concave one fixed, and the incision one and the incision two twisted and interwoven together, double fixation prevents the natural force of the fruit bag from separating. Upturned view of an Apple plastic box bag for hail protection, As is Shown in Fig.11.

Fig. 11 Upturned view of an Apple plastic box bag for hail protection.

Bagging, bagging speed, energy conservation and environmental protection, easy to promote and popular use. Save raw materials to meet the requirements of green packaging; Can package any alien products, packing does not need to add buffer material; Suitable for mechanization, automatic packaging, easy to modern management, saving manpower and improving efficiency.

4. Analysis and comparison
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. Experts carry out on-site apple bagging guidance map, As is Shown in Fig.12.
Fig. 12 Experts carry out on-site apple bagging guidance map.

Otsu algorithm for adaptive threshold segmentation is better than iterative threshold segmentation. Although some areas are not segmented, the desired results can be achieved by adjusting the threshold, which is very convenient and concise.

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.13.

Fig. 13 Analytical Charts of Coloring and Decoloring of Different Apple Bags.
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 10 month 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.14.

![Graph showing colouring and greening of bagged and unbagged apples](image)

**Fig. 14** Comparison of Colouring and Greening of Bagged and Unbagged Apple in the Simultaneous Period.

4.3. Bagging results of different apples

We have developed a new type of spherical fruit bag that is fast and time-saving, inexpensive and durable, and that avoids pesticide penetration, sunburn, bird pecks, hail and other damage to fruit products, so as to reduce the labor intensity of bags, improve the efficiency of bags, and reduce the production cost of fruit products. Improve the pollution-free or organic fruit quality and commodity rate, increase the time income of fruit farmers. It is of great and practical significance to promote the research and demonstration of new fruit bag products and new technologies, enhance the research and development of independent intellectual property rights of fruit bag, solve the commonalities and key technologies that restrict the development of fruit industry, improve the level of fruit industry development, and support the optimization and upgrading of industry.

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.

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. Experimental base for the production of Apple plastic box bags that can prevent hail. Experimental base for the production of Apple plastic box bags that can prevent hail, As is Shown in Fig.14.

![Fig. 15 Experimental base for the production of Apple plastic box bags that can prevent hail.](image1)

The hailproof Apple suction box bag is made of hard wax paper, synthetic plastics, degradation materials, composite pulp and other agricultural waste or by-product lightweight materials and other best materials and ratios. And according to the customer's needs can make a variety of new types of spherical fruit bags. You can use 1-2 years, and you can recycle new products as raw materials. Experimental raw materials for production of Apple plastic box bags with hail resistance. Experimental raw materials for production of Apple plastic box bags with hail resistance, As is Shown in Fig.15.

![Fig. 16 Experimental raw materials for production of Apple plastic box bags with hail resistance.](image2)

The two-half spherical plastic plastic plastic plastic bag can effectively prevent hail injury to apples, reduce the degree of natural harm, reduce energy waste, reduce waste pollution. The speed of bagging is accelerated and the production efficiency is improved. By calculation, the speed of an ordinary Apple bag is 12 seconds for an Apple, and the speed of a two-half spherical plastic Apple bag is 2
seconds for an Apple bag. The labor production efficiency is increased by 6 times, and the agricultural work efficiency is improved. Reduce agricultural costs, Increase Apple's profit.

5. 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. Associate professor Gou Xiaoping, Dr. Zhang Wanjun Professor-level Senior Engineer and Senior Economist (CNC Senior Craftsman, Mechanical Engineer) 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. Associate Professor Gou Xiaoping, Dr. Zhang Wanjun Professor-level Senior Engineer, Senior Economist (CNC Senior Craftsman, Mechanical Engineer) have done more in-depth research on apple bagging, applied for some patents and carried out some innovative experiments on apple bagging. Associate Professor Gou Xiaoping, Dr. Zhang Wanjun Professor-level Senior Engineer and Senior Economist (CNC Senior Craftsman and Mechanical Engineer) 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.

6. Summary
It is mainly related to the environmentally friendly, durable and cheap materials components and their best ratio. The product has formed a cooperative model with production, study and research. The main natural disaster in the Apple industry is hail. The circular Apple bag can effectively prevent small hail from injuring apples. It is a technical problem that can not be solved by ordinary paper bags. Secondly, the Apple bag with plastic molding is fast. The research and development of plastic Apple bagging and Internet sales, improving the development level of Gansu and the National fruit industry, solving the major common features and key technologies that restrict the development of the fruit industry, and supporting the optimization and upgrading of the industry, have great practical significance for promoting large-scale production and demonstration of the fruit industry in Gansu.

The fruit is bagged. First, the skin can be delicate and clean, significantly improving the appearance of quality. Secondly, the red variety fruit anthocyanin can be increased, bright and beautiful color.
Third, it can reduce the residue and pollution brought by pesticides, dust, etc. Fourth, can prevent and control diseases, insects, birds, rats, bees and other hazards, reduce fruit rust.

**Acknowledgements**

The authors thank the financial supports from National Natural Science Foundation of China(Grant no. 51165024), National key basic research development project (973 project) (2009CB724405) and New century talent support program of Ministry of Education (NCET-04-0935).

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