

Study on preparation of polythene antibacterial and mildew proof packaging material and its technology for fruit and vegetable preservation

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Abstract: How to prolong the shelf life of fruit and vegetable products at room temperature and ensure the safety of food and the health of consumers is the pursuit of fruit and vegetable products industry. Through the screening of anti-mildew and anti-fogging agents, it is concluded that anti-mildew agent OBPA, and anti-fogging agents PGFE, GMS and PGM can improve the anti-mildew and anti-fogging performance of polyethylene plastic wrap respectively. Anti-fogging and antibacterial packaging film can obviously improve the appearance quality of packaged products, maintain the humidity in the packaging environment and inhibit the growth and reproduction of microorganisms on the food surface, thus ensuring the quality of fresh food and prolonging its shelf life. With the increase of the content of modified fluororesin powder, the transmittance of the film gradually decreases, the haze gradually increases, the tensile strength first increases and then decreases, and the oxygen permeability of the film increases first and then decreases. When the mass fraction of modified fluororesin powder is above 4%, it can inhibit mold. The antibacterial and mildewproof wrapping paper can control the growth of microorganisms in the packaging environment by slowly releasing the ingredients with antibacterial and mildewproof effects. Anti-mildew agent and anti-fog agent reduce the transparency of fresh-keeping film, and the addition amount is negatively related to the transparency. Anti-mildew agent and anti-fog agent reduce the oxygen permeability and moisture permeability of fresh-keeping film.

1. Introduction

Although the traditional fresh-keeping film can play the role of packaging and preservation, it can't meet the preservation needs of modern market. As a big fruit and vegetable producing country in China, the research foundation of postharvest physiology is very weak, the development is extremely slow, and the investment of state funds is relatively insufficient. Fruits and vegetables are prone to spoilage after harvest, and improper preservation and packaging methods will lead to a high loss rate, resulting in huge economic losses [1]. To some extent, food packaging can isolate food from the outside environment, prevent microorganisms from entering the food packaging system, and achieve the purpose of prolonging the storage period of fresh food by controlling the relative humidity of the packaging environment and adjusting the gas composition. Microorganisms that cause food mildew can grow and reproduce quickly under suitable temperature and conditions, which will make food lose its proper flavor and taste, thus losing its edible value and nutritional value, and even causing people's food poisoning and illness. Spontaneous controlled atmosphere storage technology combined with low temperature storage technology has become the main technology of fruit and vegetable storage in China, which is more suitable for the current situation of fruit and vegetable storage in China. About 80% of fruits and vegetables in China use this technology for storage [2]. Spontaneous modified atmosphere: Storage is also called simple modified atmosphere or limited atmosphere storage, and its abbreviation is storage. Anti-fogging and antibacterial packaging film combines anti-fogging function with antibacterial activity, which can not only effectively prevent fogging on the inner surface of packaging, but also inhibit the growth and reproduction of spoilage microorganisms. Polyethylene (PE) film is widely used in food

packaging and agricultural production because of its excellent performance, and the consumption of PE film accounts for more than 40% of the total consumption of plastic film. The modified active packaging film with antifogging and antibacterial effects can be obtained by adding antifogging agent and antibacterial agent into the packaging film. It has obvious inhibitory effect on Penicillium and Aspergillus in food. Moreover, the modified fluororesin is insoluble in water, and when it comes into contact with food, it migrates into food in a small amount, which will not cause harm to human body [3].

2. Anti-fogging principle and preparation of anti-fogging antibacterial packaging film

2.1 Anti-fog packaging film

The most basic function of food packaging is to wrap the food, isolate it from the outside world, prevent external microorganisms and factors affecting the shelf life of the food from entering the packaging, and keep the environment inside the food packaging in a relatively stable state, so that the food can maintain good quality within the shelf life [4]. Compared with uncoated kraft paper, the antibacterial paper has improved tensile strength, tear strength, water vapor permeability coefficient and oxygen permeability, denser and more uniform microstructure, and good antibacterial performance. The antibacterial effect increases with the increase of antibacterial agent concentration. This kind of fresh-keeping film can inhibit the growth and proliferation of mold to a certain extent, and play a fresh-keeping role [5]. This kind of fresh-keeping film is mainly based on PE and PE,PP PS. Under the condition that the film has the best anti-fog packaging performance, a better proportion of antibacterial agent is found, and finally a new modified packaging film with market application is hoped to be obtained. Modified mildew-proof polyethylene packaging film was prepared by blending, melting, extrusion, casting and other processes. The optical properties, tensile strength, air permeability and microstructure of the prepared mildew-proof film were studied, and the antibacterial and mildew-proof properties of the mildew-proof film were also investigated. The antifogging agent in the film starts to play its role because of its surface activity, which makes the surface of the film hydrophilic, and the contact angle between water droplets and the surface of the film becomes smaller to form a water film, thus making the film achieve better light transmission. Modified EF resin is a kind of self-made powder resin with antibacterial and mildewproof effects. It can be dispersed on the inner surface of the film and combined with metal ions such as sodium ions and magnesium ions inside the packaging bag. In the research field of food antibacterial packaging paper, foreign researchers have also done more research. A Japanese company has developed a new type of antibacterial paper, which can resist mildew for a long time. It is made by combining monoglyceride, a certain compound, water and ethanol on paper, and then drying it. It can maintain the flavor of food and play a long-term fresh-keeping role when applied to food packaging. The inner surface of the fresh-keeping film is treated with surfactant, which not only absorbs the excess water in the package, but also maintains the relative humidity in the package moderately, so as to achieve the purpose of fresh-keeping. Anti-fogging packaging film is a functional packaging material that can prevent water vapor from fogging on the surface of the packaging material, thus affecting its transparency [6]. The internal antifogging agent generally has amphiphilic molecular structure, which can be oriented on the film surface after being mixed with resin matrix and blown. Generally, the hydrophilic group is outward and the hydrophobic group is inward, which can reduce the contact angle between water and the film surface and further prevent the formation of fog. The change of protein content in dried fenugreek bean during storage is shown in Figure 1.

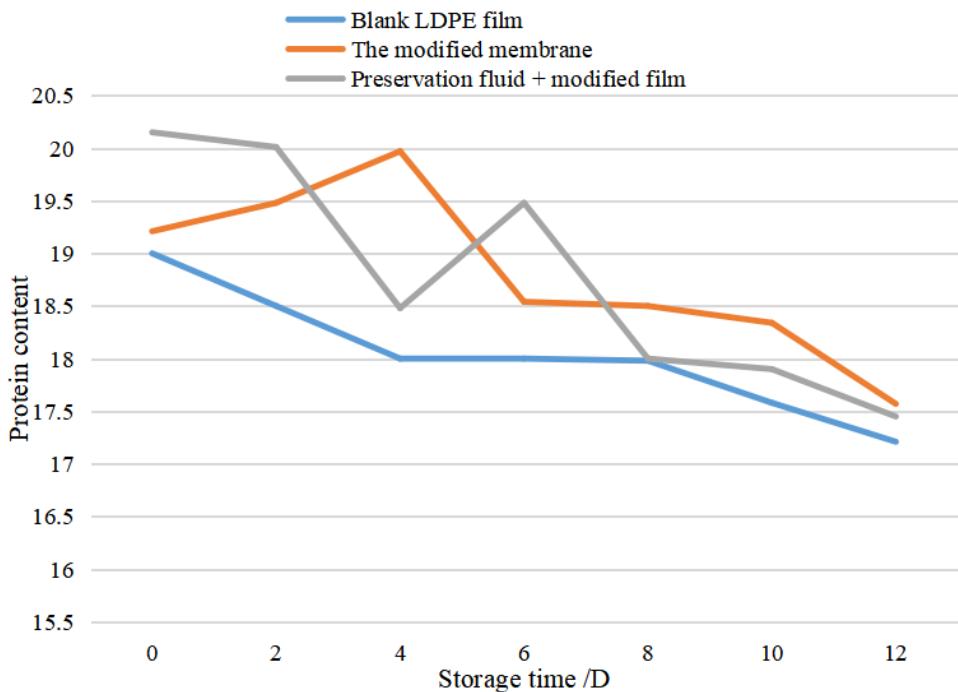


Figure 1 Changes of protein content in dried fenugreek bean during storage.

2.2 Anti-mildew additive

Pathogenic microorganisms, such as bacteria and mold, are harmful to human health and living environment. They are various, multiply rapidly and do great harm. In the process of food processing and preservation, food spoilage is often accelerated by microbial pollution, which leads to food safety problems. The solution grafting method uses strong acid solution to treat the film to carboxylate the surface of the film, thus improving the hydrophilic property of the film. However, this method has some defects such as strong acid waste liquid polluting the environment and irregular surface etching [7]. Release antibacterial packaging is to release antibacterial agents slowly to the food surface through release and diffusion, so as to achieve the effect of inhibiting the growth and reproduction of microorganisms. Solidified antibacterial packaging can inhibit microbial proliferation by directly contacting with food surface. The modified EF masterbatch was added into LDPE base material masterbatch according to the mass fraction of 10%, and they were stirred to mix evenly. The modified EF antibacterial and mildew-proof resin was prepared by blending, extruding and granulating with a twin-screw extruder. The temperature of each heating zone of the twin-screw extruder was 160, 175, 185, 185, 175, 175 and 175°C respectively, and the rotating speed was 40 r/min. Everything else needs a microscope to see clearly. The cell size of most bacteria is between 0.5 and 5 μ m. Yeast is a tiny unicellular microorganism, with a length of only 5~30 μ m and a smaller width (about 2~6 μ m). The mold is bigger and can be seen by naked eyes. The colony morphology of the fungus is large, but the basic unit of the fungus body is mycelium, with a width of only 2 ~ 10 μ m. However, there are many points in organic antimildew agents, such as poor toxicity and safety, easy drug resistance of microorganisms, poor thermal stability, volatility or oxidation and decomposition when exposed to heat and light, short life of antimildew, and so on. In the process of plastic processing, when subjected to high temperature, high pressure and high shear, the antimildew effect is reduced or even invalid, or products with toxic side effects are produced. The effective period of antifogging and antibacterial PE film at high temperature (60°C) is shown in Table 1.

Table 1 Duration of Anti-fogging Antibacterial PE Film at High Temperature (60°C)

| Group | 1 | 2 | 3 | 4 | 5 | 6 |
|---------------|------|------|------|------|------|------|
| Anti-fog time | 6min | 317h | 304h | 313h | 315h | 308h |

3. Study on the Mechanism of Anti-fogging Antibacterial Film on Fresh-keeping Packaging of Fruits and Vegetables

3.1 Action mechanism of antifogging and antibacterial film

The selected antifogging agent and antibacterial agent are added into the resin base material, in which antifogging agent is amphiphilic and can be oriented on the surface of the film, with hydrophilic groups outward and hydrophobic groups inward, thus reducing the surface tension of the film and preventing the formation of fog. The elongation at break is 223.93%; When the addition amount is 5% and 6%, the tensile strength and elongation at break obviously increase, and the maximum is that the tensile strength of the film with 6% addition amount is 18. 13 MPa and the elongation at break is 569.41%. The ratio (expressed as a percentage) of the luminous flux passing through the sample to the luminous flux impinging on the sample is called transmittance. The optical properties of the film were measured by transmittance/haze tester, and multi-point sampling was adopted. Each sample was tested for 5 times and the average value was taken [8]. By studying its antibacterial properties, mechanical properties, barrier properties and microstructure, the best antibacterial and mildew-proof functional packaging paper was found by optimizing the experiment, aiming to provide some reference for the research and industrial production of food antibacterial and fresh-keeping materials. As for the mechanism of action of chitosan, it is generally believed that chitosan with high molecular weight will become a cationic bioflocculant after being dissolved in acid solution. In the flocculation process, bacterial cells will gather and settle, and high molecular chains will be concentrated on the surface of bacterial cells, forming a polymer film, which will affect the absorption of nutrients by bacteria, molds and other microorganisms. Using hydrophilic substances as the substrate of packaging film or coating can improve the hydrophilicity of the surface of packaging film, thus achieving the anti-fog function [9]. Its mechanism of action is mainly based on the principle of ion wall-breaking. Ions can effectively penetrate into microbial cells, further inhibit the respiration of microorganisms, and eventually lead to the death of microorganisms, thus achieving the functions of anti-corrosion, anti-mildew and preservation.

3.2 Effect of antifogging agent on mechanical properties of mildew-proof and antifogging polyethylene film

At present, anti-fog film has been widely developed and applied to agricultural shed film. Although anti-fog packaging of fruit and vegetable products has begun to appear in the market, it is still relatively rare, and there are not many researches on the application of anti-fog packaging materials in food at home and abroad. On the disposable plastic cup with 200m L of tap water, put the cup in a water bath at 60°C for 30min, cover the slide with a film of 3cm×2cm, observe and shoot with Nikon biomicroscope at 40 times magnification, and test and analyze the surface morphology of water droplets on the film. A blank film was used as a control [10]. The treated culture dish was placed upside down in a constant temperature incubator at 37°C for culture. After 24 hours, the growth of bacteria on the surface of the film was observed, and the diameter of the bacteriostatic circle was determined. Make 5 parallel samples of each kind and take the average value. The bigger the bacteriostatic circle, the better the bacteriostatic effect. On the contrary, the smaller the bacteriostatic circle, the worse the bacteriostatic effect. Escherichia coli used in the experiment is the representative of Gram-negative bacteria, and Staphylococcus aureus is the representative of Gram-positive bacteria. Fresh fruits and vegetables are easily infected by spoilage microorganisms in the process of harvesting, transportation and storage, and the number and types of spoilage microorganisms carried by fruits and vegetables in different varieties and growing environments are quite different. When the content of PGFE reaches 2%, the transmittance of the film decreases obviously, but the haze increases sharply. When the content of PGFE reaches 3%, the transmittance of the film reaches the minimum of 67.14% and the haze reaches the maximum of 22.22%.

4. Conclusions

The physical and chemical properties of anti-mildew and anti-fogging polyethylene film were studied. The results showed that the anti-mildew agent could reduce the elongation at break and tensile strength of the film, while the anti-fogging agent could strengthen the elongation at break and tensile strength of the film. Combining the existing preparation methods of antifogging film, antibacterial film and antifogging antibacterial film, the preparation methods of high-efficiency antifogging and antibacterial film were studied based on a certain kind of substrate. In order to solve the problem that the mechanical properties of the material decreased due to the addition of PGFE, different proportions of antifogging masterbatch YS and PGFE were added into PE resin for compound use, and their effects on the properties of PE film were studied, including antifogging property, optical property, mechanical property, barrier property, thermal weight loss, compatibility, etc., and the results were obtained. Among them, the film with 4% ~ 6% content with obvious bacteriostatic effect can inhibit the mold when the content is above 4%. There is still a lot of room for improving the performance of low-density polyethylene film, which is the base film. Aiming at the defects of low-density polyethylene film itself, it can be mixed with other resins to improve its defects first, and then the properties of the modified film can be studied on this basis. The growth of the total number of colonies was effectively inhibited, and the deterioration of sensory quality was delayed. Compared with common PE film, the antibacterial and mildew-proof paper can obviously slow down the quality deterioration of semi-hay fillets.

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