

Study on Fresh Keeping Effect of Chitosan Antistaling Agent for Several Kinds of Fruits

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Abstract: This study aims to research the protective effect of chitosan on the fruit. With the preservation experiment on the Kiwifruit, apple, mango and honey peach, it can show that the fruit weight loss rate and decay index of chitosan protective agent are decreased at different degrees. Meanwhile, the fruit hardness decreased rate is dropped. The research illustrates that the nature of chitosan film property, antibacterial activity and respiration inhibition can be applied in the fruit reservation field.

Keywords: Antistaling agent, chitosan, decay index, fruits hardness

INTRODUCTION

Fresh fruits and vegetables are very perishable and susceptible to postharvest diseases which limit the storage period and marketing life of them. Moreover, postharvest decay results in substantial economic losses around the world (Hongyin *et al.*, 2011). Antistaling agent, in foods, any of numerous chemical additives used to prevent or retard spoilage caused by chemical changes, e.g., oxidation or the growth of mold. Along with emulsifying and stabilizing agents, preservatives also help to maintain freshness of appearance and consistency. As is known, synthetic fungicide treatment has long been the main method for controlling postharvest diseases. However, there is increasing international concern over the indiscriminate use of synthetic fungicides on crops because of the possible harmful effects on human health and the emergence of pathogen resistance to fungicides. Therefore, new alternatives for controlling postharvest diseases which have good efficacy, low residues and little or no toxicity to non-target organisms are in urgent demand.

Chitosan is a sugar that is obtained from the hard outer skeleton of shellfish, including crab, lobster and shrimp. The molecular formula of Chitosan is given in Fig. 1. Chitosan has a number of commercial and possible biomedical uses (Domingues *et al.*, 2012). It can be used in agriculture as a seed treatment and biopesticide, helping plants to fight off fungal infections. In winemaking it can be used as a fining agent, also helping to prevent spoilage. In industry, it can be used in a self-healing polyurethane paint coating. In medicine, it may be useful in bandages to reduce bleeding and as an antibacterial agent; it can also be used to help deliver drugs through the skin. According to researches, chitosan with density of

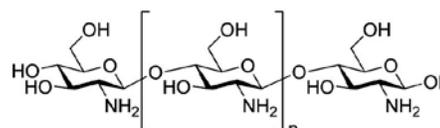


Fig. 1: The molecular formula of chitosan

0.02% is enough for the inhibition of bacillus; if the density is 0.005%, the inhibition rate could reach to 90% against escherichia coli and salmonella, while if the density rate comes up to 0.0075%, bacteria could be completely inhibited from growing (Sathive *et al.*, 2007).

In this study, we discussed about application of chitosan as antistaling agent on fruit.

MATERIALS AND METHODS

Experimental material:

Experimental fruit: Fresh Kiwifruit produced in Zhouzhi County, Shaanxi Province, China; fresh apple produced in Qixia County, Shandong, China; fresh mango produced in Anxi County, Fujian; honey peach produced in Mengyin County, Shandong. These fruits were purchased from the supermarket.

Preservative: Chitosan, the degree of deacetylation $\geq 95\%$, the viscosity is 100-200 mPa.s, produced in Shanghai Hansi Chemical Co., Ltd.

Method: Cut various fresh fruits from the midline to increase the contact area between the incision and the air and accelerate the decay speed of different fruits. Took 10 for each kind of fruit, placed above the flat tray after the incision and divided into the treatment group and control group for backup. After diluting the

chitosan preservative by 1: 35, evenly sprayed in the surface and incision of the fruit at the treatment group with watering can. The control group shall be sprayed with the distilled water. Each shall process 3 times. After slightly dried, loaded in the polyethylene plastic basket and totally sealed the plastic basket with the plastic wrap. All processed fruits shall be placed at the incubator with the temperature of 25°C and the humidity of 90% for observation (Peilong *et al.*, 2013).

Measured the respiration rate daily, measured the weight loss rate, decay index, respiration rate, fruit firmness, sugar content, VC content and titratable acidity every 2 days.

Weight loss rate: Adopted the weighing method to determine.

Decay index: The fruit was divided into 5 levels. 0: no signs of decay or shrinkage; 1: There is decay sign with the area of 5% or less; 2: The decay sign area was 5-10%; 3: The decay sign area was 10-20%; 4: The decay or shrinkage sign area was 20% or more. Then a decay index was determined to be used for the data analysis. The decay index can be obtained from the Eq. (1):

$$\text{Decay index} = \frac{\sum \text{Decay level} \times \text{Number of decay}}{\text{The total decay level} \times \text{The total number of fruit}} \quad (1)$$

Fruit firmness: The skin tissue at the relative two sides near the fruit equator shall be cut with a sharp blade and the cut area shall be 1 cm², it shall be determined with the fruit durometer at the probe diameter of 8 mm and measurement depth of 15 mm, the firmness unit was kg·cm and determined the average value.

RESULTS AND ANALYSIS

Influence of chitosan preservative on various fruit weight loss rate: Due to the respiratory metabolism and transpiration, the fruit moisture will dissipate over time, thus making the fruit lose the weight, drop the glossiness and influence the metabolism and taste. From the Fig. 2, after 2 days storage, among 4 kinds of fruits, the weight loss rate of the honey peach and mango with higher water content was larger. The weight loss rate for the fruits in the protected state was 40% lower than the control group. This was mainly because the chitosan was the derivative of the aminocellulose with the feature of polycation and it can gather the positive ion at the surface of negative ion, then the interaction between the positive ion and negative ion makes it have the biological adhesive property, then it can adhere the surrounding molecule to form the colloidal film. The formed film had the unique property (Ali *et al.*, 2011). It can change the amount of water vapor, oxygen and carbon dioxide to change the composition of the internal gas and reduce the respiration effect and reduce the evaporation.

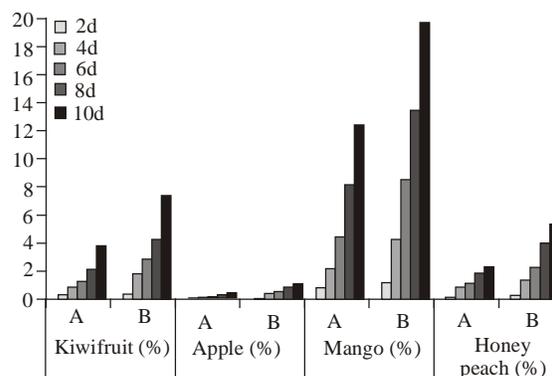


Fig. 2: Weight loss rate for various fruits (A group was the protection group and B group was the non-protection group)

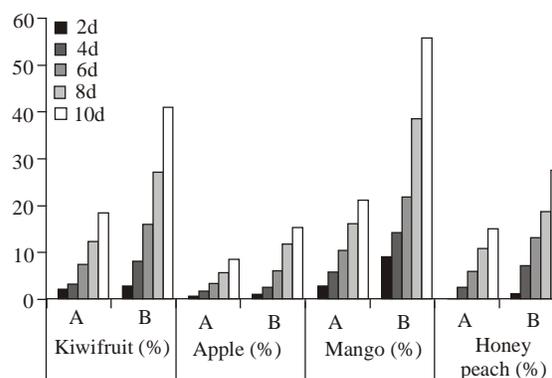


Fig. 3: Decay index of various fruits (A group is protection group and B group is non-protection group)

Influence of chitosan preservative on the decay index of various fruits: Decay index is the most important indicator to judge whether the preservative is effective. From the Fig. 3, the fruit adding the chitosan protection was much better than that not adding in the decay degree, especially the protection on the apple. At the 10 day, most fruits were in good condition and it can protect other fruits to a certain degree. This was mainly because the chitosan has a good killing role on various microorganisms and it can inhibit the common fungus in the food, such as *Staphylococcus aureus*, *Escherichia coli*, *Yersinia intestinal inflammation knot*, *Salmonella typhimurium* and *Listeria single-nuclear proliferation*. The principle is that the chitosan can combine with the molecule with negative charge contained in the cell wall of fungi, which may cause the deformation of the membrane, expose the membrane and result in the leakage of the cytoplasm and the cell death. It has been reported that the chitosan can penetrate in the nucleus of bacteria and combine with DNA to inhibit the synthesis of mRNA, thus preventing the synthesis of mRNA and protein and achieve the antibacterial effect (Pitak and Rakshit, 2011).

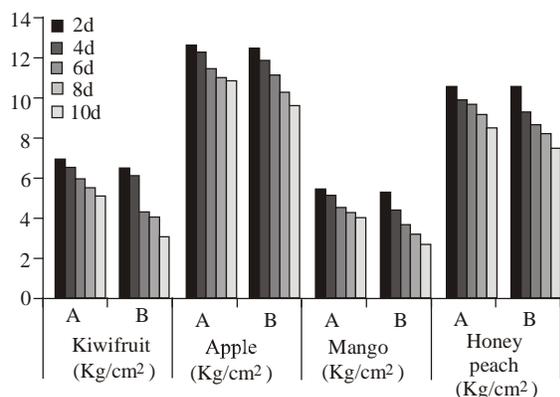


Fig. 4: Influence of protective agent on various fruit hardness (A group was the protection group and B group was non-protection group)

Influence of chitosan preservative on various fruits hardness:

Fruit hardness is an important sign to reflect the fruit quality. In the storage process, the gradual mature fruit and moisture loss can reduce the fruit hardness and this is an important role influencing the fruit quality. The research can show that after spraying the chitosan protective agent, the decrease speed of fruit hardness declined (Fig. 4). The decrease degree of mango and kiwifruit was the most obvious. This was mainly because the chitosan had a good film property (Sachin and Arya, 2013). After spraying the protective solution at the surface of the fruit, it may form a layer of colorless and transparent semi-permeable membrane at the surface of the fruit to suppress the fruit respiration and delay the fruit ripening. For the fruit with larger moisture like the mango and kiwifruit, the effect was particularly evident (García *et al.*, 2010).

CONCLUSION

With the improvement of people's living standard at each region, the fruit consumption has increased year by year. The fruit preservation problem becomes an important research direction. For the chitosan has no toxic and side effect, the raw material source is rich and the cost is low, the coating process for the fruit preservation is simple and easy to be developed and used. At present, the chitosan coating has achieved satisfactory results in the preservation experiment of strawberry, grape, mango and various fresh fruits and vegetables. Although there are many preliminary researches on the antibacterial mechanism of the chitosan, it still lacks the systematic experimental data and it has not been completely elucidated theoretically.

This research selected the chitosan as the protective agent to conduct the fruit preservation experiment on various fresh fruits. The experimental result proved that after spraying the chitosan protective agent, the fruit's weight loss rate and decay index declined and the decrease speed of the hardness slowed down. Chitosan's film property, antibacterial property and respiration inhibition can be applied in the fruit preservation field and it has a great application prospect on the fruit storage at the post-harvest.

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