Nano-TiO_2/Chitosan Coated Antibacterial Paper and Its Preservation Effect in Packaging Nanguo Pear

Zi-Bo JIANG [1,a], Jun-Yan HUANG[2,b], Lin-Lin YU[2], Xin SUN[2], Li-Hua CUI[1,c,*]

[1]Dalian Product Quality Inspection Institute, Dalian, 116021, China

[2]Dalian Polytechnic University, Dalian, 116034, China

[a]jiangzibo7@163.com, [b]hjunyan@126.com, [c]clh_hb@163.com

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Abstract. After nanguo pear respectively were dealt with water to wash, base paper packaging and nano-TiO_2/chitosan coated antibacterial paper packaging, and stored for some time, its sensory index and physiological index were measured and made comparative analysis. The determination results based on sensory index indicated that: nanguo pear packaged in coated antibacterial paper are small weight loss rate, moderate moisture, and can reduce the yellow index of fruit and prevent fruit rot. The determination results based on physiological indexes indicated that: the antibacterial effect of coated antibacterial paper is superior, can effectively maintain the nanguo pear taste. The experiment results show that the preservation effect of nano-TiO_2/chitosan coated antibacterial paper for fruits and vegetables is obvious, can be used for modified preservation packaging of nanguo pears and other fruits.

Introduction

The nano-TiO_2 has antibacterial and antivirus, UV absorption, self clean, good barrier properties and so on, and thus has been currently one of the most active research of inorganic nano materials. The photocatalysis of nano-TiO_2 can make oxidation of ethylene that produced in the storage of fruits and vegetables, and decompose ethylene into carbon dioxide and water, thereby slowing the rate of decay of fruits and vegetables[1,2]. Chitosan is a kind of amino polysaccharide extracted from the shell of shrimp or crab, and has good film forming, good air permeability, sterilization and other characteristics, and thus can be used for the packaging of fruits and vegetable. It can inhibit the evaporation of moisture, regulate respiratory, prevent infection of the microbial, and improve the surface gloss of fruits and vegetables, so as to prolong the preservation period effectively[3].The study make nano-TiO_2/chitosan antibacterial paint coat on base paper into antibacterial paper, then the paper was applied to preservation packaging of nanguo pear, and the sensory index and physiological index of the nanguo pear were measured, and the influence law of the preservation effect of antibacterial packaging nanguo pear was analysed. This study aimed at seeking for some reference for the research and application for nano-TiO_2/chitosan antibacterial paint.

Experiment

Materials and Instruments

The nanguo pear purchased from the fruit market was smooth and bright surface, consistent size, medium well, all green, no pests, no technical damages; Nano-TiO_2/chitosan coated antibacterial paper was been trial-produced in the laboratory; Phenolphthalein purchased from the market was analysis pure; Sodium hydroxide purchased from the market was analysis pure.

PL203 electronic balance was offered by Mettler-Toledo instruments (Shanghai) Co., Ltd.; JLQ-S1 bacterial colony counter was offered by Xishan jincheng instrument plant.

Method

Experimental Grouping and Treatment. 90 fresh nanguo pear selected were no spots, no

mechanical damage, no pest spots, uniform size, and divided into 3 groups, 30 each group, and pre cooked at room temperature, after 5 days the experiment was started. After nanguo pear respectively were dealt with water to wash, base paper packaging and nano-TiO_2/chitosan coated antibacterial paper packaging[4], and stored for some time at room temperature (25 ℃, RH 40%, indoor) in fruit storage box, its preservation index were measured every 3 days.

Measuring Project and Method. (1) Weight loss rate. It was performed by weighing method. The quality (m_0) of the tested nanguo pear samples and the quality (m_1) of nanguo pear after stored for some time respectively were weighed, then the weight loss rate was calculated according to the formula (1).

$$\text{Weight loss rate} = \frac{m_0 - m_1}{m_0} \times 100 \tag{1}$$

In the formula (1), the quality of the initial sample was denoted by m_0/g; the sample quality after stored for some time was denoted by m_1/g.

(2) Peel yellow index. The peel color is divided into 5 levels: level 0: all green; level 1: slightly yellow (<25%) in the pedicel; level 2: the local yellow (25%~50%) in the peduncle and outside; level 3: the surface of fruit is about 50%~75% yellow; level 4: most of fruit epidermis turn yellow (>75%)[5,6]. Peel yellow index was calculated according to the formula (2).

$$\text{Peel yellowing index} = \frac{\text{peel color level} \times \text{ fruit number}}{\text{maximum extreme value} \times \text{total}} \times 100 \tag{2}$$

(3) Decay index. The decay index is divided into 5 levels: level 0: fruit in good condition, all green peduncle; level 1: the fruit surface lesion not more than 1 cm^2, peduncle wilt or mildew not up to sepals, sepals green or brown; level 2: the fruit surface lesion or rotten about 1/10, peduncle sepals slightly rotten; level 3: the fruit surface lesion or rotten about 1/3~1/2; level 4: the rotten area more than 1/2[7-9]. Decay index was calculated according to the formula (3).

$$\text{Decay index} = \frac{\text{number} \times \text{extreme value}}{\text{maximum extreme value} \times \text{total}} \times 100 \tag{3}$$

(4) Aerobic plate count. According to GB4789.2-2010 National food safety standard Food microbiological examination: Aerobic plate count, aerobic plate count were measured, and the results are expressed in terms of logarithmic aerobic plate count by log(cfu/g) [10].

(5) The content of titratable acid. According to GB/T 12456-2008 Determination of total acid in foods, a representative samples 200g were taken, mashed in stamping machine and mixed, from them taking sample 20g, accurate to 0.001g. Second, the sample were laid in a 250mL volumetric flask, and hot distilled water was added to them and diluted to about 150ml. Third, the sample were dealt with water bath boiling for 30min and cooling to room temperature, and the filtrate were filtered and collected for preparing test. Fourth, the 25mL test solutions were placed in 250mL erlenmeyer flask, and water and phenolphthalein indicator were added to them, and then the test solutions were titrated with NaOH standard titration solution to reddish, after 30s didn't fade. At last, the NaOH standard titration solution consumption (V_1) was recorded, and then repetitive operation was taken with water instead of test solution, and the NaOH standard titration solution consumption (V_2) [11] was recorded. The content of titratable acid was calculated according to the formula (4).

$$X = \frac{\mathrm{c} \times (V_1 - V_2) \times K \times F}{m} \times 100 \tag{4}$$

In the formula: X-the content of acid per kilogram of sample, g/kg; C-the concentration of NaOH standard titration solution, mol/L; V_1-titration solution consumption volume during NaOH standard titration, mL; V_2-NaOH standard titration solution consumption volume during the blank test, mL; F-the dilution multiple of test solution; m-sample weight, g; K-the conversion coefficient of acid, 0.067 in malic acid.

Results and Discussion

Impact on Sensory Indexes of Nanguo Pear in Different Packaging Processing Method

Determination of Nanguo Pear Weight Loss Rate. The change of fruit weight loss rate during storage is mainly caused by the water transpiration. In general, nanguo pear water loss is faster than apple, its losing water is equivalent to loss of fresh. In the condition of 18 ℃ nanguo pear weight loss rate were measured under different packaging process, the experimental results are shown in Fig.1.

It can be seen from Fig.1 that during the period from 0 to 30 days the control group sample fruit weight loss rate which didn't use any packing was significantly higher than that of base paper packaging and antibacterial paper packaging, so the packaging treatment has obvious relaxation effect on fruit water loss. When using coated antibacterial paper packaging the samples weight loss rate were smaller than that of base paper packaging. By day 18, the base paper packaging sample fruit were slightly withered, and the coated antibacterial paper packaging sample fruit were always moderate humidity. The possible reasons are that in coated antibacterial paper processing the antibacterial coating was able to fill the small gaps on the raw paper, increased the moisture resistance performance and prevented fruit water loss. Thus, using coated antibacterial paper packaging can keep the nanguo pear water better, and achieve good preservation effect.

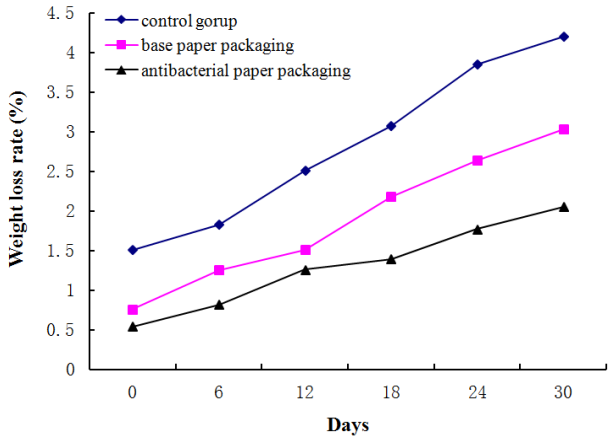

Fig.1 Determination of nanguo pear weight loss rate

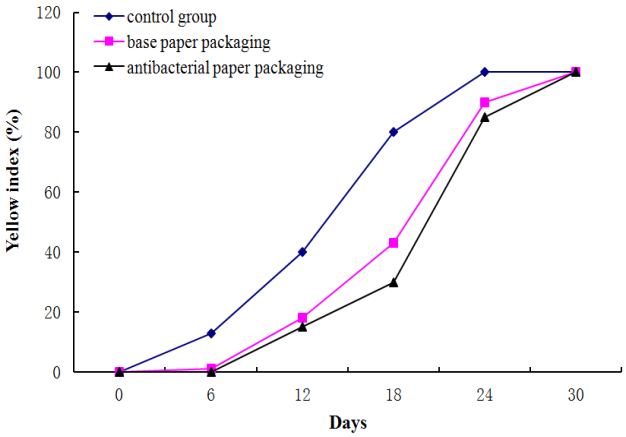

Fig. 2 Determination of nanguo pear peel yellow index

Determination of Nanguo Pear Peel Yellow Index. During the period from 0 to 30 days the determination results of nanguo pear peel yellow index are shown in Fig.2. From the chart, we can see that nanguo pear peel yellow index increased gradually with the increase of the storage time. After storage for 3 days the peel of nanguo pear began to turn yellow. At 24 days, the yellow index of control group sample fruit reached 100%, but at 30 days that of sample fruit packaged in base paper and antibacterial paper reached 100%. By contrast, using coated antibacterial paper packaging can reduce index of fruits turning yellow.

Determination of nanguo pear decay index. In the condition of 18 ℃ the determination results of nanguo pear decay index are shown in Fig. 3. The results show that the control group and sample fruit packaged in base paper didn't appear to decay in 12 days, and sample fruit packaged in coated antibacterial paper didn't appear to decay in 18 days. After storage for 30 days, the control group sample fruit decay index reached 7.5%, and base paper packaging sample fruit decay index was

5.3%, and the coated antibacterial paper packaging sample fruit decay index was 3.5%. Obviously, using coated antibacterial paper packaging can effectively prevent fruit rot.

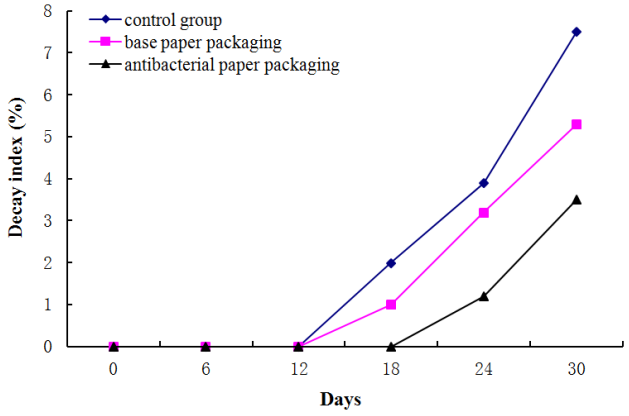

Fig.3 Determination of nanguo pear decay index

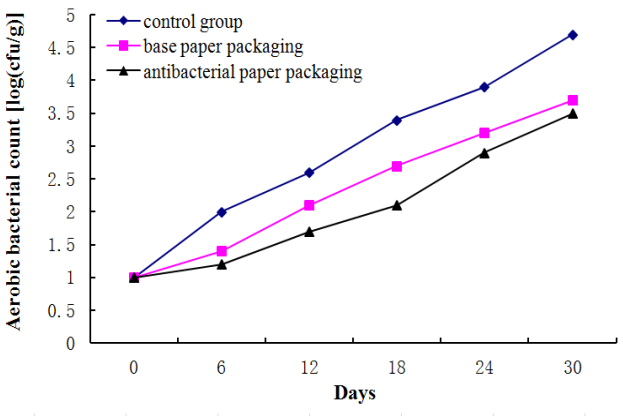

Fig.4 Determination of nanguo pear aerobic bacterial count

Different Packaging Processing Method Impact on Nanguo Pear Physiological Indexes

Determination of Nanguo Pear Peel Aerobic Bacterial Count. In the condition of 18 ℃ the determination results of nanguo pear peel aerobic bacterial count are shown in Fig.4. From the chart, we can see that unpackaged sample fruit was exposed in the air, its epidermal bacteria bred most quickly, the second was that of base paper packaging, and sample fruit packaged in coated antibacterial paper have best antimicrobial effect. At 30 days the peel aerobic bacterial count of the control group, sample fruit packaged in base paper and coated antibacterial paper were, in order, 4.7 log (cfu/g), 3.7 log (cfu/g), 3.5 log (cfu/g). Thus, using coated antibacterial paper packaging can provide the best protection for sample fruit.

Determination of Nanguo Pear Titratable Acid Content. The content of titratable acid is an important index of evaluating the taste of fruit[12]. In the condition of 18 ℃ the determination of the content of titratable acid of sample fruit in three different processing methods were made, the results are shown in Fig.5. We can see from Fig.5, along with the increase of days, the content of titratable acid of sample fruit in three different processing methods were all increased first and then decreased. This is mainly because the period from 1 to12 days is pre maturity stage of nanguo pear, and with fruit matures the content of titratable acid increased; As getting into the ripening stage, the speed of synthesis acid decreased and the decomposition rate was constant, these caused acid content decline. The whole content of titratable acid of sample fruit packaged in coated antibacterial paper were higher than that of base paper packaging and controls group. Can see from this, coated antibacterial paper packaging have relaxation effect on decreasing nanguo pear titratable acid content, and can effectively keep the nanguo pear taste.

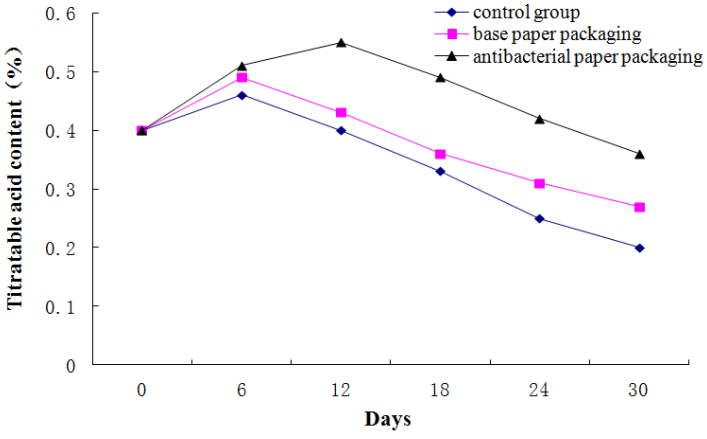

Fig.5 Determination of nanguo pear titratable acid content

Conclusion

In order to verify the antibacterial effect of the nano-TiO_2/chitosan coated antibacterial paper developed by ourselves, the nanguo pear handled by three different processing methods such as water to wash, base paper packaging and nano-TiO_2/chitosan coated antibacterial paper packaging. After a storage time, its sensory index and physiological index were measured. By this way, the antibacterial properties and preservation properties of coated antimicrobial paper can be tested, the results are as follows:

Sensory index of nanguo pear: (1) The weight loss rate of nanguo pear packaged in coated antibacterial paper was less than that packaged in base paper. At 18 days, nanguo pear packaged in base paper slightly became some withered, but nanguo pears packaged in coated antibacterial paper always were in the condition of moderate humidity. (2) After 30 days, the yellow index of the nanguo pears packaged in coated antibacterial paper and base paper reached 100%, but in contrast, coated antibacterial paper packaging can reduce the yellow index of fruit. (3) By day 30, the decay index of nanguo pear packaged in coated antibacterial paper reached 3.5%, relative minimum. Obviously, using coated antibacterial paper packaging can prevent fruit rot.

Physiological indexes of nanguo pear: (1) At 30 days the peel aerobic bacterial count of nanguo pear packaged in coated antibacterial paper were up to 3.5 log (cfu/g), compared with the base paper packaging, the antimicrobial effect of coated paper packaging is more superior. (2) The whole content of titratable acid of nanguo pear packaged in coated antibacterial paper were higher than that of base paper packaging and controls group. This can be seen coated antibacterial paper packaging have relaxation effect on decreasing nanguo pear titratable acid content, it can effectively keep the nanguo pear taste.

The study shows that the antibacterial and preservation effect of nano-TiO_2/chitosan coated antibacterial paper is obvious, can be used for preservation packaging of nanguo pears and other fruits and vegetable.

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