International Journal of Food Science and Agriculture, 2023, 7(4), 488-492
https://www. hillpublisher. com/journals/jsfa/
ISSN Online: 2578-3475
ISSN Print: 2578-3467

Application of Chitosan Ginger Garlic Composite Film in Chilled Pork Preservation

Xiaozhong Ma[1,2], Weiqiang Wang[3], Yaorui Lu[1], Xueying Xia[1], Shuangxi Li[1,*]

[1]Xingzhi College, Zhejiang Normal University, Jinhua, Zhejiang, China.
[2]Jinhua Jinzi Ham Co., Ltd., Jinhua, Zhejiang, China.
[3]Jinhua Jinnian Ham Co., Ltd., Jinhua, Zhejiang, China.

How to cite this paper: Xiaozhong Ma, Weiqiang Wang, Yaorui Lu, Xueying Xia, Shuangxi Li. (2023). Application of Chitosan Ginger Garlic Composite Film in Chilled Pork Preservation. *International Journal of Food Science and Agriculture*, 7(4), 488-492.
DOI: 10.26855/ijfsa.2023.12.011

Received: November 28, 2023
Accepted: December 25, 2023
Published: January 22, 2024

Corresponding author: Shuangxi Li, Xingzhi College, Zhejiang Normal University, Jinhua, Zhejiang, China.

Abstract

At present, research on edible film as a preservation material is increasingly attracting researchers' interest, but there is less research on adding active ingredients to edible film for cooking meat. Using chilled pork as the test material, the changes in bacterial count, pH, TBARS value, TVBN value, and sensory evaluation during 15 days of refrigeration at 4 ℃ were measured to explore the preservation and antioxidant effects of chitosan and different concentrations (60%, 80%, and 100%) of ginger extract composite films on chilled pork. The results showed that the addition of ginger extract had a certain concentration effect, with 80% and 100% ginger extract+chitosan composite coating treatments effectively inhibited the increase in total bacterial count and pH of chilled pork, inhibiting lipid peroxidation, maintaining a high level of sensory quality, and they could extend the shelf life of chilled pork to more than 15 days. It has great application value in real life.

Keywords

Chilled Pork, Chitosan, Garlic Ginger Extract, Composite Membrane

Chilled meat is a type of fresh meat that has undergone strict quarantine. Compared to frozen meat, chilled meat quickly drops to 0~4℃ in terms of safety, nutritional value, and sensory properties, and has higher advantages in subsequent processing, refrigeration, transportation, and sales quality. It is a type of fresh meat that has been consistently maintained within the 0~4℃ range in more and more consumer and sales processes and is favored by enthusiasts. However, under conditions of 0-4℃, the growth and reproduction of microorganisms in chilled meat cannot be completely inhibited, and due to the large amount of unsaturated fatty acids present in chilled meat, oxidation is highly likely to occur. After the chilled meat is oxidized, not only does its nutritional value decrease, but the browning of heme also darkens the color of the meat. How to reduce the initial bacterial load of chilled meat and inhibiting the growth and reproduction of residual microorganisms is the key to extending the shelf life of chilled meat. Chitosan has the characteristics of easy film-forming, antibacterial, and antioxidant properties, making it suitable for coating and preserving meat products 6-8. Ginger extract has good bactericidal effects and is widely used as a spice in the field of meat processing and storage research. This article uses chilled pork as the test material and adds ginger extract to an edible chitosan film to make a composite coating agent. It explores the effects of the composite film on the microbial, physicochemical, and sensory quality of chilled pork, in order to provide technical support for the storage and preservation of chilled pork and provide theoretical reference for the development of new packaging materials.

1. Materials and Methods

1.1 Main materials

Purple skin garlic, ginger, pork: (purchased from the slaughterhouse, stored in ice bags, transported to the laboratory for 0.5 hours); Anhydrous ethanol, chitosan, glacial acetic acid, nutrient agar, nutrient broth: China National Pharmaceutical Group Chemical Reagent Co., Ltd.

1.2 Main instruments and equipment

AR224CN electronic balance; GZX-9240MBE electric constant temperature blast drying oven; JY-1000A high-speed multifunctional crusher; SW-CJ-ID ultra-clean workbench; DNP-9082 electric constant temperature drying incubator; MLS-3751L-PC high-pressure sterilization pot; BCD-218A3BR refrigerator.

1.3 Test methods

1.3.1 Garlic and ginger pre-treatment

Peel and wash the garlic and ginger, shred them, and dry them in a constant temperature drying oven at 60℃ for more than 4.8 hours. Crush them separately with a grinder, and then pass through an 80-mesh sieve after crushing.

1.3.2 Single-factor experiment on garlic ginger extract

Set the basic condition of garlic ginger ratio to 1:2, add 70% ethanol, and extract at 50℃ for 2.5 hours at a solid-liquid ratio of 1:10. Use this as the basic condition to completely evaporate the ethanol in a rotary evaporator, and change the garlic ginger ratio (1:3, 1:2, 1:1, 2:1, 3:1); Liquid to material ratio (1:5, 1:10, 1:15, 1:20, 1:25); Temperature (40℃, 50℃, 60℃, 70℃, 80℃) and extraction time (1h, 1.5h, 2.0h, 2.5h, 3.0h) were used to investigate the effect of the extracted solution on the diameter of the antibacterial zone of the chilled meat spoilage bacteria. Each experiment was repeated three times [1].

On the basis of single-factor experiments, response surface methodology was designed using the software Design expert12 to investigate the optimal extraction process of garlic ginger extract, using chilled pork spoilage bacteria as indicator bacteria and the diameter of the antibacterial zone as response value.

1.3.3 Chilled pork spoilage bacteria inhibition zone test

Take 25g of chilled pork stored in a 4℃ refrigerator for 6 days, cut it into small pieces, and bring it to a constant volume of 250mL with sterile water. Shake it thoroughly. Take 1mL of bacterial suspension and place it in beef extract peptone liquid culture medium. Concentrate and cultivate at 37℃ for 24 hours. Take 100 μ L of bacterial solution and coat it on sterilized nutrient agar. Soak 6mm filter paper discs in the extraction solution for 30 seconds. Take them out and place them on a nutrient agar culture medium. Use sterile physiological saline as the blank control and incubate at 36℃±1 for 48 hours±2 hours. Measure the diameter of the antibacterial zone and take its average value [2].

1.3.4 Combination of Chitosan and Garlic Ginger Extract

The composite experiment was divided into 8 groups. The first group is a blank control, where 50mL of sterile water is taken to conduct antibacterial tests on spoilage bacteria in chilled pork. The second to fourth groups were experimental groups. Three groups of 50mL garlic ginger extract were taken, and 0.25g, 0.5g, and 0.75g of chitosan were added to prepare a 0.5% chitosan garlic ginger extract, a 1.0% chitosan garlic ginger extract, and a 1.5% chitosan garlic ginger extract for antibacterial testing of chilled pork spoilage bacteria. The 5th to 7th groups were chitosan control groups, and chitosan control groups were prepared with chitosan solutions with mass fractions of 0.5%, 1.0%, and 1.5%, respectively, to conduct antibacterial tests on spoilage bacteria in chilled pork. The 8th group is the control group of garlic ginger extract, and 50mL of garlic ginger extract extracted by the optimal process in 1.3.2 is used for antibacterial tests on spoilage bacteria in chilled pork.

1.3.5 Chilled pork coated for preservation and antibacterial effect

The optimal combination solution is 20mL. Cut the chilled pork into blocks with a width of about 5cm and a thickness of 5mm and soak them in a preservation solution for 2-3 minutes. After draining for 3-5 minutes, place them in a sterile culture dish and store them at 4℃. Take samples at regular intervals to test the quality-related indicators of the cooled meat.

2. Results and Analysis

2.1 Single-factor experiment on the antibacterial effect of garlic ginger extract

2.1.1 Effect of garlic-ginger ratio on the diameter of the antibacterial zone of spoilage bacteria

The experimental data shows that when the mass ratio of garlic to ginger is 2:1, the antibacterial effect of garlic ginger extract is the best. When the garlic ginger ratio is between 1:1 and 2:1, the antibacterial effect increases with the increase of garlic ginger ratio, but the antibacterial effect rapidly decreases when the garlic ginger ratio exceeds 2:1 to the later garlic ginger ratio of 3:1. Perhaps it is because the ginger protease contained in ginger has an inhibitory effect on alliinase in the allicin synthesis pathway, reducing the content of garlic active substances. Excessive garlic proportion can easily

oxidize or degrade allicin. Therefore, the optimal ratio of garlic and ginger is 2:1.

2.1.2 The effect of temperature on the diameter of the antibacterial zone of spoilage bacteria

The experimental data shows that when the extraction temperature ranges from 40℃ to 50℃, the solubility of antibacterial substances extracted from garlic and ginger increases with the increase in temperature, and the diameter of the antibacterial ring also increases [3]. When the extraction temperature increases from 50℃ to 80℃, the antibacterial effect becomes worse with the increase of extraction temperature. It may be due to insufficient dissolution of the active ingredients at 40℃, but as the extraction temperature increases, the effective antibacterial substances are decomposed at high temperatures or the active ingredients are oxidized, resulting in poorer antibacterial effects. Therefore, the optimal extraction temperature is 50℃.

2.1.3 Effect of liquid-to-material ratio on the diameter of the antibacterial zone of spoilage bacteria

The experimental data shows that as the liquid-to-material ratio increases in the range of 5:1 to 10:1, the effective substances in the garlic ginger extract will increase, and the antibacterial effect will be better. When the liquid-to-material ratio increases in the range of 10:1 to 25:1, the antibacterial effect of the garlic ginger extract on pork spoilage bacteria will become worse. This may be due to a large liquid-to-material ratio that is not conducive to the heat and mass transfer of the extraction system, resulting in a decrease in the content of effective substances in the garlic ginger extract.

2.2 Quality evaluation of chitosan garlic ginger composite film on the preservation of chilled pork

2.2.1 Effect of chitosan garlic ginger composite film on sensory indicators of chilled pork during different storage periods

According to the national standard sensory score, it should not be less than 3 points, otherwise it is not edible. The experimental data shows that the sensory comprehensive score of chilled pork decreases with time throughout the entire storage process. The chilled pork coated with 1.5% chitosan garlic ginger extract showed a significant decrease in sensory score from the 7th day, but the score was still above 5 points. However, the sensory score of the blank group on the 10th day was 2.5, indicating that it had already deteriorated and was not edible [4]. The sensory evaluation of the 1.5% chitosan garlic ginger extract group was only lower than 3 on the 15th day. Therefore, the 1.5% chitosan garlic ginger composite preservation film can effectively extend the shelf life of chilled pork.

2.2.2 Effect of chitosan garlic ginger composite film on the loss rate of chilled pork juice during different storage periods

The degree of loss of chilled pork juice can indirectly reflect the freshness and nutrient loss of chilled pork, and the juice loss rate is one of the important indicators for evaluating the quality of chilled pork. The experimental data shows that the juice loss rate also increases with the extension of storage time. On the 10th day, the juice loss rate of cooled pork coated with 1.5% chitosan garlic ginger composite preservation film was 6.89%, and the juice loss rate of the blank control group was 10.9%, with a significant difference ($P<0.05$). On the 15th day, the loss rate of 1.5% chitosan garlic ginger extract was only 10.57%, which was lower than the blank group on the 10th day. Therefore, the 1.5% chitosan garlic ginger composite preservation film can effectively control the loss of chilled pork juice.

2.2.3 Effect of chitosan garlic ginger composite film on pH of chilled pork at different storage periods

PH is one of the important indicators for evaluating changes in pork freshness. According to the national standard, a pH greater than 6.7 is considered spoiled meat and is not edible. The experimental data showed that on the 7th day, the pH of the group coated with 1.5% chitosan garlic ginger extract was 5.8, belonging to the first-grade fresh meat, while the pH of the blank control group was 6.5. The 1.5% chitosan garlic ginger extract group had a pH of 6.6 on the 15th day and belonged to the second-grade fresh meat category [5]. The blank control group had a pH exceeding 6.7 on the 10th day and lost its edible value. The experimental results show that the 1.5% chitosan garlic ginger composite preservation film can prolong the time for cooling pork to thaw and become acidic and self-dissolve after acid removal and hardening, achieving the purpose of preservation.

2.2.4 Effect of Chitosan Garlic Ginger Composite Film on TVB-N of Chilled Pork at Different Storage Periods

In the national standard, the TVB-N content is an extremely important indicator for evaluating the freshness of meat. According to the national standard, the TVB-N content should be less than or equal to 20mg/100g, otherwise, it is not edible. The experimental data shows that TVB-N increases with the extension of refrigeration time, and there is a significant increase in both groups from the 4th day. However, the increase rate in the 1.5% chitosan garlic ginger extract group is slower than that in the blank group. On the 7th day, the TVB-N content in the group coated with 1.5% chitosan garlic ginger extract was 9mg/100g, which belongs to first-grade fresh meat. The TVB-N content in the blank control group was 15mg/100g. On the 15th day, the TVB-N content in the group coated with 1.5% chitosan garlic ginger extract was

19mg/100g, belonging to the second-grade fresh meat [6]. However, on the 10th day, the TVB-N content in the blank control group reached 20mg/100g, losing its edible value. Experiments have shown that the 1.5% chitosan garlic ginger extract slows down the generation of TVB-N in chilled pork and prolongs its shelf life.

2.2.5 Effect of Chitosan Garlic Ginger Composite Film on TBARS of Chilled Pork at Different Storage Periods

Fat oxidation can produce rancidity and harmful substances such as hydroperoxides. The TBARS value in the national standard reflects the degree of fat oxidation in meat and is an important indicator for evaluating chilled pork. According to the national standard, TBARS values greater than 1 μ g/g belong to spoiled meat. The experimental data shows that the TBARS value increases with the extension of refrigeration time, and the growth rate of chilled pork treated with 1.5% chitosan garlic ginger extract is significantly slower than that of the blank control. On the 7th day, the group coated with 1.5% chitosan garlic ginger extract had a TBARS content of 0.7 μ g/g, belonging to first-grade fresh meat. The blank control group had a TBARS content of 1.3 μ g/g, which had deteriorated and was not edible [7]. On the 15th day, the 1.5% chitosan garlic ginger extract group had a TBARS content of 0.9 μ g/g, belonging to second-grade fresh meat. Therefore, the 1.5% chitosan garlic ginger composite preservation film can slow down the oxidation rate of various fatty acids in chilled pork and effectively extend its shelf life.

2.2.6 Effect of Chitosan Garlic Ginger Composite Film on the Total Colony Count of Chilled Pork during Different Storage Periods

The national standard stipulates that the bacterial count of chilled pork should not exceed 6lgCFU/g. The experimental data shows that during the 0-15-day storage period, the bacterial count of the 1.5% chitosan garlic ginger extract group increased slowly compared to the blank control. The blank group had a bacterial count of 6.5lgCFU/g on the 10th day, losing its edible value, while the 1.5% chitosan garlic ginger extract group had a bacterial count of 5.3lgCFU/g on the 10th day, belonging to second-grade fresh meat. The chilled pork coated with 1.5% chitosan garlic ginger extract had a colony count of more than 6lgCFU/g after 15 days, losing its edible value. Therefore, 1.5% chitosan garlic ginger extract can delay the spoilage of chilled pork, and the total bacterial count reaches the inedible standard only after the 15th day [8].

3. Conclusion

Garlic and Ginger are essential seasonings for Chinese cooking. They not only come from a wide range of sources but also serve as seasonings for meat to enhance food flavor. Chitosan ginger composite preservation film made from garlic, ginger, and chitosan was used to treat chilled pork. The preservation effect was evaluated based on juice loss rate, pH, thiobarbituric acid reactant content (TBARS), volatile base nitrogen content (TVB-N), and bacterial colony count. The results showed that the garlic ginger ratio was 2.2:1 (g/g), the extraction temperature was 51.6℃, the liquid-to-material ratio was 10.5:1 (mL/g), the extraction time was 2.5 hours, and the chitosan mass fraction was 1.5%. Coating and cooling the pork can extend the shelf life to 15 days. Therefore, chitosan garlic ginger composite preservation film has high application prospects and low cost, which can be produced on a large scale. This provides a theoretical and technical basis for the preservation application of garlic and ginger in fresh food.

Funding

This research was supported by the General Project of Jinhua Science and Technology (No. 2020-4-090) in 2020, hosted by Li Shuangxi, from Xingzhi College, Zhejiang Normal University.

References

[1] Zhao Lijun, Zhao Ke, Ai Mingyan, et al. The effect of light source on the preservation effect of chilled meat during storage [J]. Modern Food Technology, 2022, 38 (8): 148-152, 88.

[2] Xing Xiaoqing, Zhao Yang, & Si Fengling. The preservation effect of loquat leaf extract on chilled meat [J]. Food and Fermentation Industry, 2022, 48 (7): 219-225.

[3] Xu Mingshu, Zhang Liang, Chen Yu, et al. Analysis of cooling characteristics and energy consumption of pig carcasses [J]. Energy Research and Information, 2022, 38 (3): 181-185.

[4] Guo Lifang, Su Peng, & Zhou Shuquan. Application of Hainan Qiaotou sweet potato selenium polysaccharide in the preservation of chilled meat [J]. Tropical Agricultural Engineering, 2022, 46 (3): 1-3.

[5] Yan Biyun, Li Xi, Huang Aini, et al. The application of chitosan garlic ginger composite film in the preservation of chilled pork [J]. China Food Additives, 2021, 32 (12): 72-81.

[6] Wu Danfeng, Zhang Ming, Xie Jing, et al. Optimization of the formula for extending the shelf life of chilled pork with composite

natural antioxidants [J]. Food Technology, 2021, 46 (10): 108-114.

[7] Cao Yingying, Si Xupeng, &Yang Mingjun. The preservation effect of ginger, onion, and clove extracts on pork [J]. Meat Research, 2021, 35 (2): 41-47.

[8] Pan Yanmei, Wu Hailing, Liu Xiao, et al. The effect of sodium alginate/rosemary coating on the quality of chilled pork [J]. Anhui Agricultural Science, 2021, 49 (14): 166-168, 171.