



Research Paper

Edible coating of sodium carboxymethylcellulose (CMC-Na) with different concentration to maintain the sensory quality of shiitake mushrooms (*Lentinula edodes*)

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ABSTRACT: The effect of edible coating of CMC-Na on sensory quality of shiitake mushrooms was studied. Different concentrations of CMC-Na (1%, 1.5%, 2%) were prepared for coating by immersion, and stored in 15°C storage chamber for 6 days. During storage, sensory evaluation, hardness, and cap color of shiitake were determined. The results showed that the 1 % edible coating with CMC-Na could better maintained the sensory quality; retard the softening and browning than others.

KEYWORDS: Edible coating, Shiitake mushrooms, Sensory quality, CMC-Na

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I. INTRODUCTION

Shiitake mushrooms (*Lentinula edodes*) have high water content, vigorous physiological metabolism, soft and tender tissues, intense respiration, thus they will quickly lose water, shrivel and shrink, causing serious browning and corruption. Shiitake mushrooms lose their commercial value when stored after 2 days under natural conditions [1]. Therefore, it is particularly important to study the preservation of shiitake mushrooms. Edible coating technology is a new way to keep fruit and vegetables fresh. Shiitake mushrooms will soon turn brown and deteriorate when exposed to the air at room temperature, because of the effects of microbial proliferation, enzyme activity changes and post-ripening [2-5]. Edible coating preservation has the advantages of low cost, less residue, less pollution, good preservation effect, simple and easy to operate. In this study, sodium carboxymethyl cellulose (CMC-Na) with different concentrations was used to make edible coating for fresh shiitake mushrooms. Weight loss rate, hardness, sensory attributes of overall quality, aroma, texture, cap color, gill color and gill integrity were measured. And the optimum concentration of CMC-Na coating solution and its effect on the sensory quality of shiitake mushrooms during storage were determined.

II. MATERIALS AND METHODS

2.1 Sample preparation

Shiitake mushrooms were harvested from local farm in Zibo, Shandong in China, and transported within 1 h to the lab [6-8]. After cooling to the room temperature, shiitake mushrooms were separated to four groups. Three groups of shiitake mushrooms were coated with different concentrations of CMC-Na (1%, 1.5%, 2%) were taken as the treatment groups, and the other one group without any treatment was taken as the control set (CK). Then all the samples were stored at 15 °C for 6 days. The quality attributes were determined every 3 days.

2.2 Hardness

The hardness was measured by hardness analyzer, and 3 points were measured for each mushroom. The probe was pressed down at a certain speed with a depth of about 6mm. The value of the force was recorded, in unit of kg cm⁻³ [9-11].

2.3 Sensory evaluation

Ten people were trained to conduct sensory evaluation on the overall apparent quality, flavor, texture, cap color, gill color, gill integrity and acceptance of shiitake mushrooms after storage. The evaluation criteria are as follows [12-14]:

Table 1 Sensory evaluation criteria

Score	Overall quality	Aroma	Texture	Cap color	Gill color	Gill integrity
9	Premium	Strong flavor	Firm and resilient	Light brown	White	Very integrated
7	Very good	General flavor	Firm	Brown	Light yellow	Integrated with
5	Good and available for sale	Flavor with slight fermentation	Less firm	Dark brown	Yellow	Not integrated
3	Only edible	Flavor with obvious fermentation	Soft	Dark brown and flecky	Dark yellow	Gill damaged
1	Bad, inedible	Stink smell	Very soft	Light black	Light brown	Totally damaged

III. RESULTS AND DISCUSSION

3.1 Changes in cap color

The L^* values decreased during the storage, which accompanied with browning. At the end of the storage, 1 % CMC-Na could maintain the higher L^* than other concentrations. The control set (CK) without any treatment induced the severe browning, with the lowest L^* of 17.23. Therefore, edible coating of CMC-Na could effectively maintain the cap color of shiitake mushrooms, and 1 % CMC-Na contributed the best effect on cap color maintenance.

The L^* value decreases with the increase of the concentration of the coating liquid, indicating that the higher the concentration of the coating liquid was not beneficial for shiitake mushrooms. This could be attributed to reduction in normal gas exchange by thicker coating on the surface of shiitake mushrooms, leading to the anaerobic respiration and browning finally.

Table 2 Changes in L^* of shiitake mushrooms during the storage

	0d	3d	6d
1%CMC-Na	48.02±3.67	44.04±3.21	38.93±3.75
1.5%CMC-Na	48.02±3.67	44.36±3.85	37.19±2.48
2%CMC-Na	48.02±3.67	40.14±3.59	34.13±2.99
CK	48.02±3.67	42.81±2.93	17.23±1.98

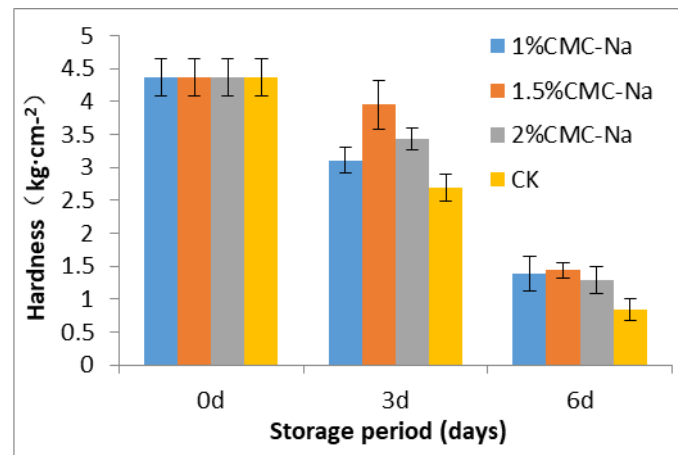
3.2 Changes in hardness

After harvest, the hardness of shiitake mushrooms will gradually decrease with time, and the hardness is an important index to measure the quality of agro-products. The hardness was determined every 3 days during storage. The experimental data were recorded and processed, and the following figure was obtained.

The hardness of shiitake mushrooms decreased greatly with the increase of storage time. On the sixth day, the hardness was lower in CK than CMC-Na coating, which indicated that edible coating of CMC-Na has an effect on maintaining the hardness of shiitake mushrooms.

Postharvest shiitake mushrooms still have high respiration during transpiration and storage, which will lead to the loss of water and nutrients, thus the morphology and structure of the cells will change. Hardness is related to lignin in cells of mushrooms. Edible coating formed a thin film on the surface of shiitake mushrooms, which could reduce respiration and prevent water loss. To a certain extent, it can delay the decline of hardness and prevent shiitake mushrooms from softening. The hardness value of shiitake mushroom coated with 1% and 1.5% CMC-Na were higher. The hardness of shiitake mushrooms in all the CMC-Na groups were higher than

those in the control group, indicating that edible coating preservation can effectively maintain the hardness of shiitake mushrooms and prevent them from softening.



3.3 Changes in sensory characteristics

Sensory evaluation of shiitake mushrooms can reflect people's acceptance of shiitake mushrooms, which is the simplest and most direct way to judge the freshness of shiitake mushrooms. We evaluated the overall quality, aroma, texture, cap color, gill color and gill integrity every 3 days, and the results were shown in Table 3. Sensory score of shiitake mushrooms decreased with storage days. From the comprehensive score, on the sixth day, the sensory score of shiitake mushrooms coated with CMC-Na coating solution showed a downward trend as the concentration of coating solution increased. At the end of storage, the highest score was shiitake mushrooms coated with 1% CMC-Na coating solution, with a score of 5.62, which was higher than that of the control group.

Postharvest shiitake mushrooms still carries out respiration and other life activities during storage, consuming the accumulated nutrients [15]. Metabolism accumulates toxic substances that damage cells [16]. All these factors will change the overall appearance of shiitake mushrooms and show a downward trend. After coating shiitake mushrooms with film solution, the coating film formed can reduce water loss, reduce oxygen corrosion of shiitake mushrooms, slow down browning reaction, and have a certain protective effect on the appearance of shiitake mushrooms. On the whole, the higher the concentration of the coating liquid is, the lower the sensory score is. It may be attributed to the reason that the increased concentration of the coating liquid leads to the failure of normal gas exchange between shiitake mushrooms and the outside world, resulting in anaerobic respiration, alcohol production, corrosion of shiitake mushrooms, and the decrease of sensory score.

Table 3 Sensory quality score of shiitake mushrooms with different concentrations of CMC-Na coating during storage

	Overall quality	Aroma	Texture	Cap color	Gill color	Gill integrity	Average score
0d	8.60	8.36	8.36	8.68	8.36	8.60	8.49
3d							
1%CMC-Na	6.76	6.12	7.40	7.16	7.08	6.60	6.85
1.5%CMC-Na	5.56	6.44	6.12	5.64	7.64	6.76	6.36
2%CMC-Na	5.48	6.52	5.16	6.44	7.24	6.28	6.19
CK	5.32	5.96	4.44	6.04	5.72	5.24	5.45
6d							
1%CMC-Na	4.77	5.32	5.12	5.87	6.21	6.45	5.62

1.5%CMC-Na	4.44	5.12	4.64	5.36	6.46	6.21	5.37
2%CMC-Na	3.64	4.12	4.88	5.21	5.68	5.87	4.90
CK	4.20	4.64	4.36	4.44	4.06	4.72	4.40

IV. CONCLUSION

Edible coating of 0.1 % CMC-Na could maintain the hardness and sensory quality of shiitake mushrooms, slowed down browning, which has a good effect on the storage and preservation effect of shiitake mushrooms.

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