Chapter 68
Influences of Cleaning and Coating Conditions on the Quality of Eggs

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Abstract China maintains a leading position in egg production in the world, but the rate of the mass and the industrialized cleaning for eggs remain low. In this study, different preservation conditions and cleaning processes were applied on fresh eggs, a day after it has been laid. Some conditions were compared, including the coating process (single-layer coating and double–layer coating)—2 % polyvinyl alcohol (PVA) solution and 2‰ dehydrogenation sodium acetate solution, temperature of the solution, hot air drying, and white mineral oil coating. An analysis was conducted on the results, including the weight loss rate, Haugh value, pH value, height of albumen, and the color of yolk. The results are as follows: the color of yolk had no significant difference; set 7 had the highest Haugh value; sets 5, 6, 8 had the lowest weight loss rate; set 1 owned the highest pH value while set 8 the lowest. Heat treatment is useful for reducing the weight loss rate. Coating is good for reducing weight loss rate and delaying the decline of Haugh value.

Keywords Egg cleaning · Coating · Conditions · Freshness

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68.1 Introduction

In recent years, the worldwide occurrence of epidemic like bird flu had triggered high attention for cleaning and sterilization of eggs, impacting China's conventional consumption habits on dirty eggs. The egg coating preservation technology is a top guarantee for the safety and the quality of clean eggs. Moreover, with the improvements in livelihood, people have put forward higher demands to the quality and the safety of poultry eggs [1]. The egg shells without any treatment could be adhered with a big number of microorganisms, resulting in hidden risks to food safety [2]. Existing methods of egg cleaning often involve washing with warm water, sterilization with hot water, ultraviolet sterilization, coating film, and so on [3]. When eggs are washed with water to remove the attached dirt, the wax protective film on the surface of the shell is also destroyed, resulting in easier invasion of pathogenic microorganism [4].

In this study, an egg cleaner was used to perform egg cleaning adopting different treatment combinations. A comparison was made on the influences on eggs, involving factors such as polyvinyl alcohol (PVA) coating film, sodium dehydroacetate solution and its temperature, drying temperature of hot air, white mineral oil membrane. At last, we figured out cost-effective process conditions to inspire the proper egg cleaning methods and processes.

68.2 Experiment and Method

68.2.1 Material and Instrument

Materials and reagents: eggs, Beijing Haoyi Livestock Farming Limited Company; polyvinyl alcohol 088-05 (alcoholysis degree (mole fraction) 86.0–90.0 %, the purity ≥ 91.5 %), Shanxi Sanwei Group Co., Ltd; 10 # white mineral oil, Dongguan Luofu Lubricating Oil Co., Ltd.

Instruments: ZYX–JS1 egg cleaner, Shenzhen Zhenye Intelligent Egg Machinery Co., Ltd.; egg analyzer, ORKA Food Technology Ltd.; electronic balance, Germany Sartorius Co., Ltd; XPT-D high-speed disperser, The HI-2225 pH meter, egg candler, compasses, homogenizer, pH acidity meter.

68.2.2 Method

Fresh eggs, 24 h after being laid, went through water cleaning, water bathing (2 % PVA solution, 2 ‰ dehydrogenation sodium acetate, and water temperature control), the controlled air drying, and white mineral oil film. The storage conditions

Table 68.1 Condition numbers and treatment methods

No.	2 % PVA solution	2 ‰ dehydrogenation sodium acetate	85 °C water temperature	100 °C air drying	White mineral oil membrane
0 (blank)	Void	Void	Void	Void	Void
1	Void	Being	Being	Being	Void
2	Being	Being	Being	Being	Void
3	Being	Being	Being	Being	Being
4	Being	Void	Being	Being	Being
5	Void	Void	Being	Being	Being
6	Void	Void	Void	Being	Being
7	Being	Being	Void	Being	Void
8	Being	Being	Void	Being	Being
9	Void	Void	Being	Being	Void
10	Being	Being	Being	Being	Being

are as follows: a temperature of 32 ± 5 °C, normal temperature of Beijing between July and September, and humidity of 60 ± 5 %. The experiment was repeated five times on each combination. According to the actual production conditions, 11 sets of conditions were compared (Table 68.1).

68.2.3 Measurement Indicators

Weight loss: egg weight loss rate after the storage period.

$$w = (m_1 - m_2) \times 100\,\%/m_1 \tag{68.2.1}$$

w: weight loss rate; m_1: pre-storage weight; m_2: post-storage weight.

Haugh units: an indicator of egg quality, it is calculated with an egg analyzer by measuring the swan's egg weight and thick albumen height [5].

$$\mathrm{Hu} = 100 \times \lg\left(H - 1.7m^{0.37} + 7.57\right) \tag{68.2.2}$$

Hu: Haugh Unit; H: thick albumen height (mm); m: weight of swan egg(s).

Yolk color: measured by egg analyzer.

pH value(whole egg): eggs were homogenized by homogenizer and then measured with pH acidity meter.

68.2.4 Data Processing

Five parallel data were analyzed through Duncan's multiple comparison. MS Excel 2007 was used to perform SPSS 19.0 and 90 % confidence level (CL) evaluation on the data [6]. The drawings were completed with, Origin 8.0.

68.3 Results and Discussion

68.3.1 Weight Loss Rate

As shown in Fig. 68.1, the weight loss rate rose gradually in the whole storage. Sets 0, 1, 2, 7, and 9, which had no white oil films, had a higher weight loss than the sets of non-white mineral oil membranes, indicating that the membranes had a remarkable effect. Moreover, slight denaturation of eggshell membrane protein resulted from temporary temperature increase, along with PVA membranes, also had certain influence. Set 10, which got through high temperature, PVA, and white mineral oil membranes treatment, had a low weight loss rate from door to door, but there was no significant statistical difference between set 10 and sets 3, 4, 5, 6, and 8 in these white mineral oil sets. PVA could prompt the solution to have a relatively high viscosity, influencing the rotation of the conveyors and the sediment of PVA at the bottom, which was not easy to remove, resulting in increase of labor and material cost. In the perspective of the weight loss rate, temporary temperature increase and white mineral oil film worked well.

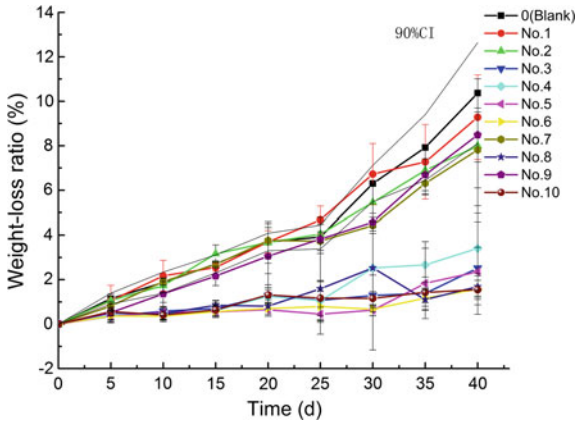

Fig. 68.1 Weight loss rate in each set

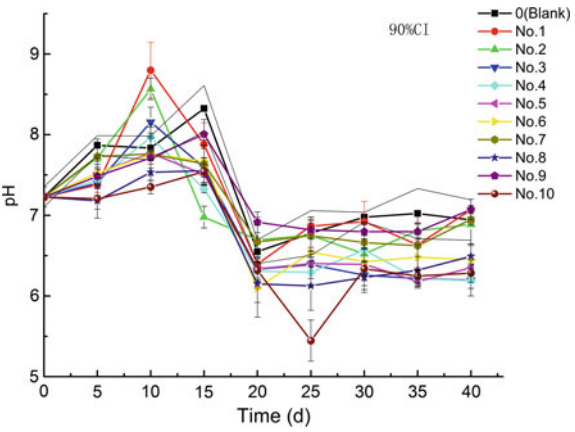

Fig. 68.2 pH value in each set

68.3.2 pH Value (Whole Egg)

The results of pH value are shown in Fig. 68.2. On the whole, the pH value rose first, then fell and was flat at last. The uptrend was caused by less CO_2 out flow from eggs; and a drop of pH value was due to the fact that remaining CO_2 was higher than CO_2 emitted from biochemical reaction in the shell chamber or egg protein; at last, the balanced trend was resulted from a dynamic balance between the emitted and outflowed CO_2. Temporary heating could make the above process go forward. The CO_2 permeability of eggshell protein membrane was likely to be lower due to slight denaturation. For this point, temporary heating is beneficial to the relatively bigger change of pH value and increased stress resistance performance of the processed eggs.

68.3.3 Haugh Values

Haugh value is an important indicator of the freshness of eggs. The higher Haugh value is, the fresher the egg is. As shown in Fig. 68.3, the Haugh values gradually decreased in the storage periods. There were significant variations on the fifth, tenth, and fifteenth day; on the twentieth day, set 9, which had non-white oil membrane or non-PVA film and sets 5 and 8, which had white oil membranes, had significant variations; on the twenty-fifth day, the variation is higher between these sets, and sets 8 and 5 had the highest value; at last, the variation tended to be low. From the point of Haugh values, white oil sets had obvious advantages, especially from the twentieth to twenty-fifth days. PVA film, dehydrogenation sodium acetate, and temporary heating process were only better than blank. Possibly, white oil film polyvinyl alcohol membrane and slight denaturation caused by heating could partly seal the eggshell microporous to some extent, and then restrain inner physiological

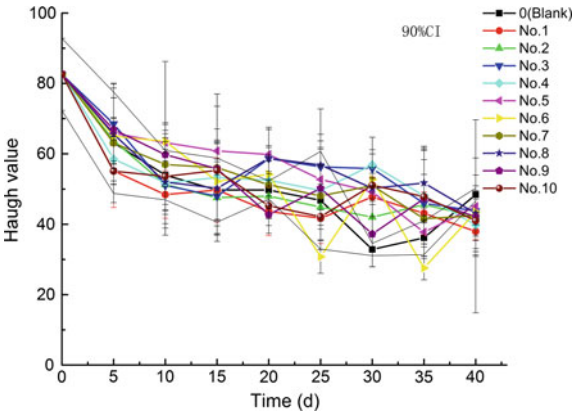

Fig. 68.3 Haugh value in each set

and biochemical reaction [7]. White oil membranes worked best in all of the three. Temporary heating treatment and white mineral oil membranes are more cost-effective.

68.3.4 Yolk Color

As shown in Fig. 68.4, yolk color was slightly higher in storage and had no significant variation in sets. A few outliers may be caused by the error. The yolk color somewhat changed while selecting processing conditions. Yolk color was not an important indicator in these sets.

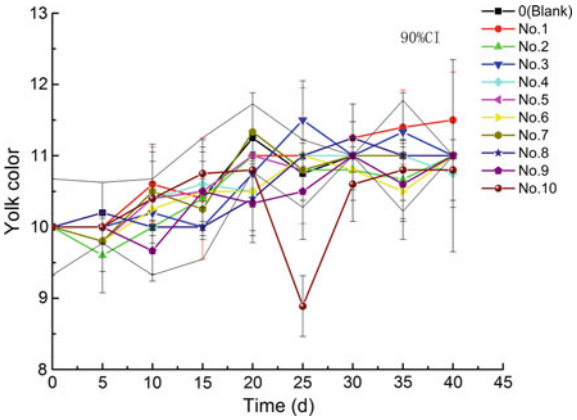

Fig. 68.4 Yolk color in each set

68.4 Conclusion

The protective eggshell, inner film, and lysozyme in albumen can help eggs to prevent invasion of microbes. Cleaning with water alone can damage the egg's self-protection mechanism. As indicated from the results of weight loss rate and Haugh value, temporary heating and white mineral oil membranes are more cost-effective, easy to operate. The yolk color did not have a significant variation in each condition. All in all, the conditions of set 5, including washing with water of 36 °C, heating with water of 85 °C, drying with 100 °C hot air to dry, and spraying of white mineral oil, are of low-cost and convenience. With a lower cost of maintenance, they can effectively extend the shelf life of eggs and ensure the quality.

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