ISSN: 0975 -8542

Journal of Global Pharma Technology

Available Online at: www.jgpt.co.in

RESEARCH ARTICLE

Effective of Lemongrass (*Cymbopogon citratus* L.) Essential Oil Incorporated in Chitosan-Based Edible Coating to Extend Hen Egg Shelf-Life during Storage

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Abstract

Hen egg is one of the finest foods, offering human a complete balance of essential nutrients with proteins, vitamins, minerals and fatty acids with huge biological value. Eggshells have been regarded as natural protective barriers of eggs. However, eggs encounter different problems, such as weight loss, interior quality deterioration, and microbial contamination. Chitosan has attracted much attention owing to its extraordinary performance such as well-forming, low gas permeability, biocompatibility, strong antimicrobial attributes. Our present research focused on the application of lemongrass (*Cymbopogon citratus* L.) essential oil incorporated in chitosan-based edible coating to extend egg shelf-life during storage. This research was conducted from 2018 to 2019 in the scientific laboratory of Soc Trang Nanotech Ltd. Results revealed that 0.4% lemongrass oil incorporated with chitosan 1.5% was appropriated to extend hen egg shelf-life for 8 weeks. Chitosan incorporated with lemongrass essential oil coating is considered an efficient and practical way to preserve eggs at room temperature.

Keywords: *Hen egg, Lemongrass essential oil, Chitosan, coating, Shelf-life, storage.*

Introduction

Right after the egg is laid, its structure and internal components begin to affect. Carbon dioxide and moisture move through the shell accelerating quality fluctuation in yolk and albumen causing weight loss [1]. Eggshells are too fragile to retain their integrity during transport. Even a tiny crack in an eggshell would largely increase the risk of microbial contamination, particularly when eggs are stored at room temperature [2].

Microorganisms existing on the shell surface contaminate egg internal content [3, 6]. It is essential to preserve good egg quality during handling and commerce. Different coating materials such as polymers, polysaccharides, proteins, oils were investigated to store eggs [7, 10]. Coatings play important role as a barrier for moisture, gas, and aroma movement [11]. Chitosan coating is benifical in maintaining the internal egg quality without altering customer acceptance [8, 9, 10, 12]. Combination coatings of chitosan with natural antimicrobial agents [13], pullulan [14], oil [15], and montmorillonite [16] have also been applied to eggs and showed improved performance. Lemongrass (*Cymbopogon citratus)* is a perennial tropical grass with thin, long leaves and is one of the main medicinal and aromatic plants cultivated in Asia. Lemongrass essential oil is extracted by steam distillation from the dried or fresh leaves of the plant.

Lemon grass (*Cymbopogon citratus*) essential oil was demonstrated as a potent anti-inflammatory and antifungal agent [17]. It has been considerable commercial importance because it is used in the manufacture of fragrances, flavors, perfumery, cosmetics, detergents, and pharmaceuticals [18, 19]. Biological research has shown that the various chemical compounds in EO possess antibacterial, antifungal, analgesic, and mosquito repellent properties [20, 23].

In the present study, we focused on the application of lemongrass (*Cymbopogon citratus* L.) essential oil incorporated in chitosan-based edible coating to extend egg shelf-life during storage.

Materials and Method

Material

Hen eggs were collected from Bac Lieu province, Vietnam. Hen eggs were sanitized by peracetic acid (PAA) 20 ppm on the outer shell. Lab utensils were used including digital caliper, digital balance. Chemical agents were used in this study including lemongrass essential oil, chitosan, peracetic acid, acetic acid. All reagents were analytical grade. This research was conducted from 2018 to 2019 in the scientific laboratory of Soc Trang Nanotech Ltd.

Researching Procedure

Effect of Chitosan Concentration (%) Incorporated with 0.2% Lemongrass (Cymbopogon citratus L.) Essential Oil to Hen Egg quality during Storage

Hen eggs would be coated (by spraying) with different chitosan concentration (0.5%, 1.0%, 1.5%, 2.0%) incorporated with 0.2% lemongrass (*Cymbopogon citratus* L.) essential oil. The treated eggs would be weekly taken for 8 weeks by analyzing air space cell (mm) to validate the optimal chitosan concentration. The hen eggs treated with acetic acid 1.0% only and 0.2% lemongrass essential oil were used as control sample.

Effect of Lemongrass (Cymbopogon citratus L.) Essential Oil Concentration (%) Incorporated with Chitosan 1.5% to Hen Egg Quality during Storage

Hen eggs would be coated (by spraying) with different lemongrass (*Cymbopogon citratus* L.) essential oil concentration (0.2%, 0.3%, 0.4%, 0.5%) incorporated with 1.5% chitosan. The treated eggs would be weekly taken for 8 weeks by analyzing air space cell (mm) to validate the optimal lemongrass oil concentration. The hen eggs treated with chitosan 1.5% (without lemongrass essential oil) were used as control sample.

Physico-chemical and Biological Analysis

The depth of the air space cell (mm) was measured using a digital caliper after marking the air cell using an egg candler. The depth of the air space cell is the distance from its top to its bottom when the egg is held with the air space cell up**.**

Statistical Analysis

The experiments were run in triplicate with three different lots of samples. Data were subjected to analysis of variance (ANOVA) and mean comparison was carried out using Duncan's multiple range test (DMRT). Statistical analysis was performed by the Stat graphics Centurion XVI.

Result & Discussion

Effect of Chitosan Concentration (%) Incorporated with 0.2% Lemongrass (*Cymbopogon citratus* L.) Essential Oil to hen Egg Quality during Storage

As the egg ages, moisture and carbon dioxide continue to be lost through the pores. Air moves in and the air space increases in size at a rate which is determined by the temperature and the relative humidity of the surrounding air. The moisture loss from the egg will be quicker if the air is warm and dry.

In our experiment, hen eggs would be coated (by spraying) with different chitosan concentration (0.5%, 1.0%, 1.5%, 2.0%) incorporated with 0.2% lemongrass (*Cymbopogon citratus* L.) essential oil. The treated eggs would be weekly taken for 8 weeks by analyzing air space cell (mm) to validate the optimal chitosan concentration. Results were mentioned in table 1. It's obviously concluded that 0.2% lemongrass oil incorporated with chitosan 1.5% was appropriated to extend hen egg shelf-life for 8 weeks. This value was selected for further experiment.

Table 1: Effect of chitosan concentration (%) incorporated with 0.2% lemongrass (Cymbopogon citratus L.) essential oil to hen egg quality (air space cell, mm) during storage

Storage (week)	Control	Chitosan (0.5%)	Chitosan (1.0%)	Chitosan (1.5%)	Chitosan (2.0%)
1	1.27±0.00^{a}	1.21±0.00^{ab}	1.19±0.03^{b}	1.16±0.00^{bc}	1.14±0.02^{c}
2	1.80±0.03^{a}	1.64±0.00^{ab}	1.49±0.02^{b}	1.43±0.03^{bc}	1.37±0.01^{c}
3	1.96±0.01^{a}	1.83±0.03^{ab}	1.71±0.00^{b}	1.62±0.01^{bc}	1.49±0.03^{c}
4	2.13±0.04^{a}	2.01±0.01^{ab}	1.94±0.02^{b}	1.85±0.02^{bc}	1.74±0.01^{c}
5	2.41±0.01^{a}	2.28±0.04^{ab}	2.11±0.04^{b}	1.98±0.00^{bc}	1.86±0.02^{c}

6	2.49±0.02^{a}	2.36±0.02^{ab}	2.24±0.01^{b}	2.13±0.00^{bc}	1.97±0.06^{c}
7	2.82±0.00^{a}	2.63±0.00^{ab}	2.47±0.00^{b}	2.35±0.01^{bc}	2.16±0.03^{c}
8	2.93±0.03^{a}	2.75±0.03^{ab}	2.60±0.03^{b}	2.44±0.04^{bc}	2.31±0.02^{c}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Internal and sensory quality of eggs coated with chitosan was evaluated during a 5-wk storage at 25 °C. Three chitosans with high (HMw, 1100 KDa), medium (MMw, 746 KDa), and low (LMw, 470 KDa) molecular weight were used to prepare coating solutions. Coating with LMw chitosan was more effective in preventing weight loss than with MMw and HMw chitosans. The Haugh unit and yolk index values indicated that the albumen and yolk quality of coated eggs can be preserved up to 5 wk at 25 °C, which is at least 3 wk longer than observed for the control noncoated eggs [9].

The interior quality of eggs, shell impact strength, and consumer perception of eggs coated with chitosan containing an organic acid (acetic, lactic and propionic) were evaluated. His study shows a great potential of using chitosan and lactic acid mixture as a coating material for egg coating to extend the shelf life [24]. Effects of chitosan coating structure and changes during storage on their egg preservation performance were evaluated. Eggs with the thickest coating showed the best qualities during storage, while destructions on coating layers led to the quality drop of eggs [2]. One research focused on the effect of different chitosan concentrations (0%, 0.5%, 1.0%, 1.5%, 2.0%, 2.5%, 3.0%), effect of storage temperature condition (4oC, 28oC) to quail egg quality. Results showed that coating 2.5% of chitosan and preserving at 4oC could extend quail egg quality for 60 days [25].

Effect of Lemongrass (*Cymbopogon citratus* L.) Essential Oil Concentration (%) Incorporated with Chitosan 1.5% to hen Egg Quality during Storage

Hen eggs would be coated (by spraying) with different lemongrass (*Cymbopogon citratus* L.) essential oil concentration (0.2%, 0.3%, 0.4%, 0.5%) incorporated with 1.5% chitosan. The treated eggs would be weekly taken for 8 weeks by analyzing air space cell (mm) to validate the optimal lemongrass oil concentration. Results were noted in Table 2. It's obviously concluded that 0.4% lemongrass oil incorporated with chitosan 1.5% was appropriated to extend hen egg shelf-life for 8 weeks.

Table 2: Effect of lemongrass (*Cymbopogon citratus* L.) essential oil concentration (%) incorporated with chitosan 1.5% to hen egg quality (air space cell, mm) during storage

Storage (week)	Control	Lemongrass essential oil (0.2%)	Lemongrass essential oil (0.3%)	Lemongrass essential oil (0.4%)	Lemongrass essential oil (0.5%)
1	1.23±0.03^{a}	1.16±0.00^{ab}	1.08±0.03^{b}	1.01±0.02^{bc}	0.95±0.02^{c}
2	1.51±0.01^{a}	1.43±0.03^{ab}	1.29±0.01^{b}	1.21±0.01^{bc}	1.12±0.01^{c}
3	1.73±0.02^{a}	1.62±0.01^{ab}	1.43±0.00^{b}	1.37±0.04^{bc}	1.24±0.00^{c}
4	1.99±0.01^{a}	1.85±0.02^{ab}	1.68±0.00^{b}	1.57±0.01^{bc}	1.49±0.01^{c}
5	2.09±0.03^{a}	1.98±0.00^{ab}	1.84±0.04^{b}	1.71±0.03^{bc}	1.63±0.03^{c}
6	2.26±0.02^{a}	2.13±0.00^{ab}	2.03±0.02^{b}	1.94±0.01^{bc}	1.82±0.02^{c}
7	2.48±0.00^{a}	2.35±0.01^{ab}	2.17±0.03^{b}	2.02±0.00^{bc}	1.90±0.00^{c}
8	2.51±0.00^{a}	2.44±0.04^{ab}	2.35±0.01^{b}	2.26±0.02^{bc}	2.13±0.01^{c}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

The current investigation was conducted to study the effectiveness of chitosan coating in preserving the internal quality of table eggs stored under tropical room conditions of 32 ± 1 °C and 60-70 % r. h. Internal, physical and microbiological quality of eggs coated with chitosan was evaluated during 5-week storage at different temperature (22 ± 1 and 32 ± 1 °C). Coating of eggs with shrimp α-chitosan increased the shelf life of eggs by almost 4-week at 22 ± 1 °C and 3-week at 32 ± 1 °C compared with controls [26]. The composite bilayer film based on polyvinyl alcohol, sodium alginate, and chitosan were developed in to examine the effects of the related coating on internal-quality changes of salted duck eggs (SDEs) during storage. Bilayer coating could prolong the shelf life of SDEs to more than 60 days at 25°C and 50% relative humidity [27].

Conclusion

Quantities of tiny pores on the eggshells for gas exchange lead to the moisture and CO_2

loss of eggs, as well as the penetration of microbial, which would then cause the quality deterioration of eggs.

Lemongrass essential oil incorporated in Chitosan as edible coating can protect eggshell from both physicochemical changes and microbial contamination, leading to promising effects on quality preservation of eggs.

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