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Extended Abstract

Increasing the Microbial and Oxidative Stability of Buffalo Meat using a Bioactive Edible Coating Based on *Cordia myxa* Fruit Mucilage and *Citrus sinensis* Eessential Oil

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Abstract

In this study, *Citrus sinensis* essential oil was extracted by hydrodistillation method and the results of gas chromatography-mass spectrometry showed that the oil is rich in limonene (87.86%). Total phenol and flavonoid contents of the CSEO were 125.41 mg GAE/g and 32.50 mg QE/g, respectively. Its antioxidant activity was found to be 39.75 and 52.43%, based on DPPH and ABTS radical scavenging activity, respectively. The presence of limonene in the CSEO was confirmed by furrier transform infrared spectroscopy. The CSEO was then combined with *Cordia myxa* fruit mucilage to produce an edible coating in order to improve the microbial and oxidative stability of buffalo meat during storage (10 days, 4 °C). Results showed that the growth of total viable count, psychrotrophic bacteria, *E. coli*, *Staphylococcus aureus*, and fungi were significantly inhibited in the buffalo meat samples coated with CMFM+CSEO. The CMFM+CSEO edible coating was also more effective in inhibiting the oxidation progression and moisture and texture losses, in comparison with control sample. According to the sensory evaluation results, the CMFM+CSEO edible coating increased the shelf-life of buffalo meat samples; the samples were acceptable even at the end of storage period (10 days), but the control sample was unacceptable after 7 days of storage. Therefore, the edible coating based on *Cordia myxa* fruit mucilage and *Citrus sinensis* essential oil could be used as a natural preservative to increase the shelf-life of buffalo meat and other meat products.

Keywords: Buffalo meat, Edible coating, Microbial stability, Oxidative stability, Shelf-life

Introduction

Synthetic antimicrobial and antioxidant compounds are widely used to inhibit lipid oxidation/microbial growth and to increase the shelf-life of meat and meat products; however,

their high price and possible carcinogenic properties make them to be currently less accepted by consumers (Hassanzadeh *et al*., 2012). Essential oils are known as safe substances and contain active compounds with antimicrobial and antioxidant activity (Vital *et al*., 2018). Orange (*Citrus sinensis*) peel essential oil (CSEO) is one of the most important and common essential oils in the world, due to its pleasant aroma. Its bioactive compounds such as mirecene, linalool, limonene make it a suitable alternative to synthetic preservatives (Dehghan, Esmaeilzadeh Kenari, & Raftani Amiri, 2019). However, the intense aroma and flavor of essential oils, their instability, and their hydrophobic properties prevent their direct use in food products. In this context, essential oils could be added to other matrices such as edible films and coatings (Noshad, Alizadeh behbahani, & Dehghani, 2020). *Cordia myxa* L. fruit contains bioactive molecules with positive biological effects, and its mucilage (CMFM) shows antimicrobial and antioxidant activity (Ebrahimi Hemmati Kaykha, Jooyandeh, Alizadeh Behbahani, & Noshad, 2020). The present study was then aimed to produce a novel edible coating, CSEO-loaded CMFM coating, with antioxidant and antimicrobial effects to improve the oxidative and microbial stability of beef during cold storage.

Materials and methods

CSEO was extracted by the hydrodistillation method, and its chemical compounds, total phenolic and flavonoid contents, and DPPH/ABTS antioxidant activity were determined. It was then incorporated into CMFM solution at different concentrations (0, 0.5, 1, 1.5 and 2%) to produce an active edible coating, CMFM+CSEO. The edible coating was then used to improve the shelf-life of beef slices during cold storage (10 days, 4 °C). The microbial load (total viable count (TVC), psychrotrophic bacteria count (PTC), *E. coil*, *S. aureus*, and fungi count), physicochemical (pH, moisture, hardness, and peroxide value), color (L*, a* and b*), and sensory (odor, color, appearance, texture, overall acceptance) of beef samples were measured during cold storage. Data were analyzed by SPSS software (Version 26) thorough one-way ANOVA and the differences between means were determined by Duncan test (P<0.05).

Results and discussion

The CSEO mainly contained limonene (87.86%), and its total phenolic content, flavonoid content, DPPH-radical scavenging activity, and ABTS-radical scavenging effect were found to be 125.41 mg GAE/g, 32.50 mg QE/g, 39.75%, and 52.43%, respectively.

The TVC, PTC, *E. coli*, *S. aureus*, and fungi counts of beef slices were significantly increased as the storage time increased from 1 to 10 days; however, the CMFM+CSEO coated samples had significantly lower microbial loads by the end of storage time. Indeed, the higher CSEO concentrations in the edible coating, the lower was the microbial growth. This could be mainly due to the antimicrobial activity of the CSEO and oxygen- and physical-barrier properties of the edible coating (Noshad *et al*., 2021). The CSEO-loaded CMFM coatings, particularly CMFM+1.5%CSEO and CMFM+2%CSEO ones, were more effective in inhibiting pH increment, moisture loss, hardness loss, and lipid oxidation progression (P<0.05), compared with the control sample. This positive effect could be attributed to the antimicrobial ability, alkaline compounds-production suppression effect, anti-proteolytic activity, and antioxidant potential of the CSEO, in conjugation with physical-barrier properties and low-oxygen permeability of the edible coating (Choulitoudi *et al*., 2017; Heydari, Jooyandeh, Alizadeh Behbahani, & Noshad, 2020).

The color and sensory properties of beef samples were also preserved better in the presence of CSEO-loaded edible coating; the beef samples coated with CMFM+CSEO had an improved shelf-life (> 10 days) compared to the control sample (≤ 7 days). The sensory

evaluation results were generally in good agreement with the physiochemical, color, and microbial load properties.

Conclusions

In the present study, the effect of CSEO-loaded CMFM edible coating was evaluated on beef quality. Beef samples coated with CSEO+CMFM showed lower TVC, PTC, *E. coli*, *S. aureus* and fungi than the control sample during storage. The CSEO+CMFM treatments (especially high level CSEO-loaded ones) have the ability to improve the shelf life of beef (> 10 days), without having negative effects on the texture, odor, color, and overall acceptance of beef slices. The CMFM enriched with CSEO could be introduced as a new type of active coatings to increase the shelf life of food products.

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