Gelatin/carboxymethyl cellulose edible films: modification of physical properties by different hydrocolloids and application in beef preservation in combination with shallot waste powder

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Abstract

In this work, a gelatin/carboxymethyl cellulose (CMC) base formulation was first modified by using different hydrocolloids like oxidized starch (1404), hydroxypropyl starch (1440), locust bean gum, xanthan gum, and guar gum. The properties of modified films were characterized using SEM, FT-IR, XRD and TGA-DSC before selecting of best-modified film for further development with shallot waste powder. SEM images showed that the rough or heterogeneous surface of the base was changed to more even and smooth depending on the hydrocolloids used while FTIR results demonstrated that a new NCO functional group nonexistent in the base formulation was found for most of the modified films, implying that the modification led to the formation of this functional group. Compared to other hydrocolloids, the addition of guar gum into the gelatin/CMC base has improved its properties such as better color appearance, higher stability, and less weight loss during thermal degradation, and had minimal effect on the structure of resulting films. Subsequently, the incorporation of spray-dried shallot peel powder into gelatin/CMC/guar gum was conducted to investigate the applicability of edible films in the preservation of raw beef. Antibacterial activity assays revealed that the films can inhibit and kill both Gram-positive and Gram-negative bacteria as well as fungi. It is noteworthy that the addition of 0.5% shallot powder not only effectively decelerated the microbial growth but also destroyed E. coli during 11 days of storage (2.8 log CFU g-1) and the bacterial count was even lower than that of uncoated raw beef on day 0 (3.3 log CFU g-1).

Introduction

Biodegradable materials

Extend the shelf life of meat products

Aligns with consumer preferences for clean-label products

ACTIVE PACKAGING

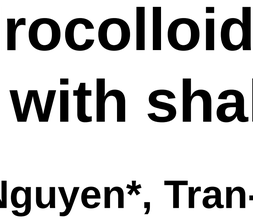


Fig 1. Shallot peel (*Allium ascalonicum* L.)

- ✓ **High anthocyanin content**
- ✓ **High antioxidant activity**
- ✓ **High antibacterial activity**

Fig 2. Beef

Materials and methods

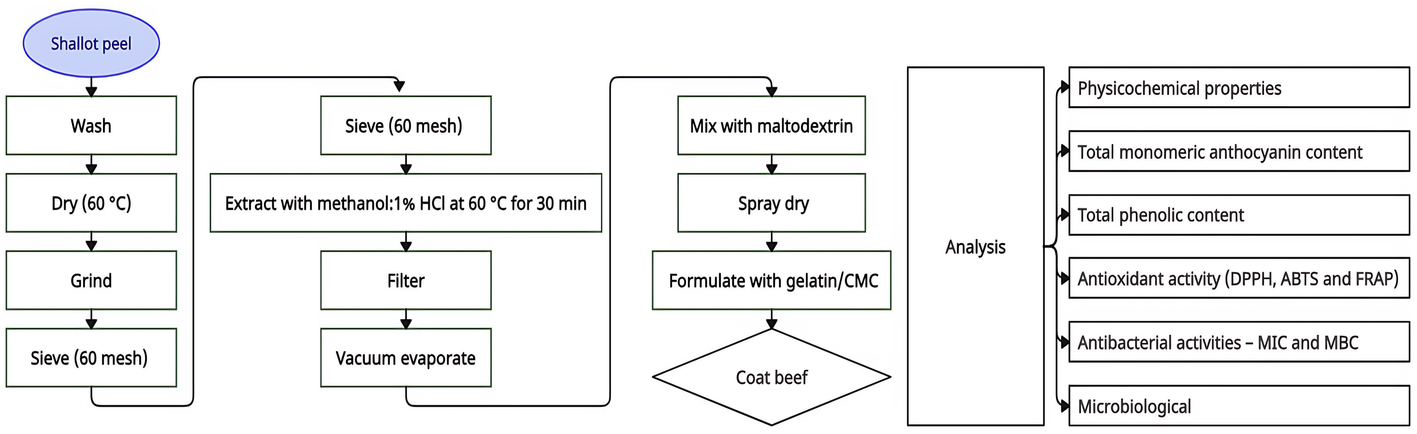
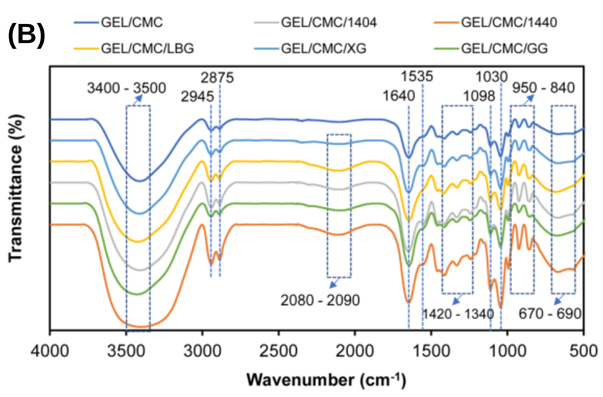
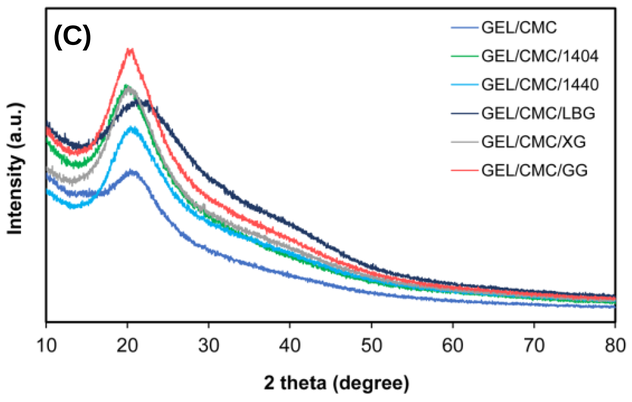


Fig 3. Sample processing and research diagram

Results and discussion





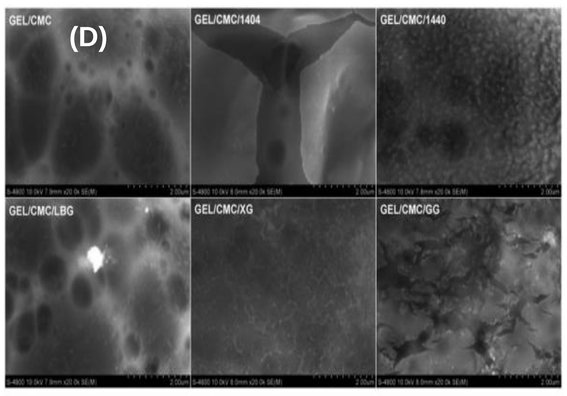
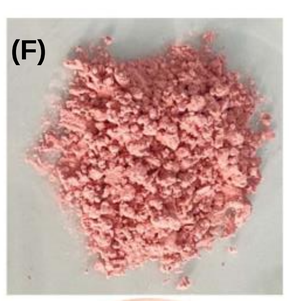
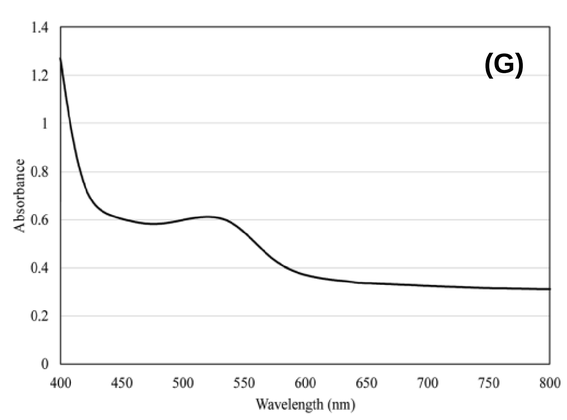
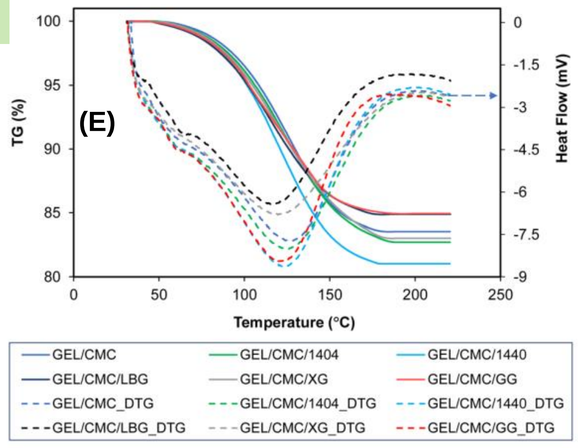


Fig 4. (A) Visual appearance, (B) FTIR, (C) TGA-DSC, (D) SEM, (E) XRD of gelatin/CMC-based films and their modification by the addition of different hydrocolloids (GEL/CMC/x).







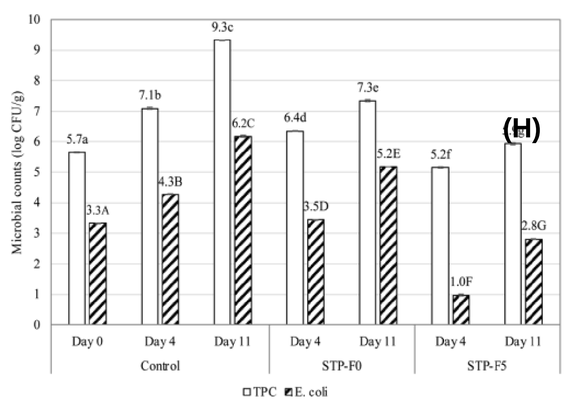


Fig 5. (F) Visual appearance, (G) absorption spectra, (H) TPC and *E. coli* of shallot tunic powder (left) and gelatin/ CMC/guar gum films after the addition of shallot tunic powder at 0.5% (right).

Conclusions

Gelatin/CMC was used as a base for further modification with different hydrocolloids such as 1404, 1440, LBG, XG and GG. Most of the modified films showed a good visual appearance even observed by the naked eye. After the modification, the original rough and uneven structure of GEL/CMC was improved depending on the hydrocolloids used. Interestingly, FT-IR showed a newly formed functional group of NCO found on all modified GEL/CMC films. Particularly, modification with GG enhanced the thermal stability and therefore was chosen to incorporate with shallot spray-dried powder to develop active edible films for beef preservation based on its high antibacterial activity against 11 pathogenic microorganisms. The results revealed that the addition of shallot powder to the GEL/CMC/ GG was efficient in prolonging the shelf-life of coated beef according to the destruction of E. coli.

References

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