PREPARATION AND CHARACTERIZATION OF NANOCOMPOSITE FILM LOADED WITH TIO_2 NANOPARTICLES AND MICROENCAPSULATED *LYCIUM BARBARUM* LEAF FLAVONOIDS AND ITS APPLICATION IN THE PRESERVATION OF TAN MUTTON

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I. INTRODUCTION

Tan mutton is rich in high-protein and unsaturated fatty acids. Hence, it is extremely prone to microbial corruption and oxidation reactions in the supply chain, seriously affecting its shelf life. As an edible and biodegradable material, edible film has stood out in meat packaging and preservation. Furthermore, the preparation and application of microencapsulated active ingredients represent a step towards strengthening the characteristics of sustainable and controllable food packaging, especially the successful incorporation of new substances and functions into traditional edible films/coatings [1]. *Lycium barbarum* leaf flavonoids (LBLF) have a potential for meat antioxidant due to their strong free radical scavenging ability [2]. Moreover, nano-TiO_2 can produce living oxygen in the photocatalytic reaction and effectively inhibit the growth of microorganisms [3]. Potato starch (Pst) has excellent slow-release, thickening, adhesion, and water-holding properties. After gelatinization, the film-forming properties are significantly better than those of ordinary starch especially in terms of flexibility and tensile strength [4]. Watermelon peel pectin (Wpp) is a carbohydrate rich in pectin, and exhibits excellent film-forming properties compared to those of the pectin-based other films in terms of tensile strength and Young's modulus [5]. As far as we know, the preparation of Pst/Wpp film loaded with TiO_2 nanoparticles and microencapsulated *Lycium barbarum* leaf flavonoids (MLF) and its application in the preservation of Tan mutton has not been reported.

II. MATERIALS AND METHODS

All materials are treated according to the methods provided in the literature [3,4,5,6]. Moreover, all experiments were conducted in triplicate. The results were expressed as mean ± standard deviation. Data were analysed by Duncan test with SPSS software and $p < 0.05$ was statistically significant.

III. RESULTS AND DISCUSSION

According to the results, the Pst/Wpp film showed a smooth, uniform and somewhat cavity-free surface by the Scanning electron microscopy (SEM) images. However, the film surface became more uneven and pores are created on the film surface by adding encapsulated MLF and TiO_2. Fourier-transform infrared (FTIR) results indicated electrostatic interactions between the components in the thin film system. With increasing the percentage of MLF, the film thickness and moisture content increased significantly ($p < 0.05$), while TiO_2 nanoparticles had little effect on the thickness, but has caused a relative decrease in moisture content. Also, the addition of TiO_2 nanoparticles reduced water vapor permeability ($p < 0.05$). The antioxidant properties of the film were enhanced by increasing MLF and its antibacterial property was increased by synergizing of TiO_2 and MLF. Meanwhile, the addition of MLF and TiO_2 nanoparticles has slightly reduced the crystal structure of St/Pec film, and improved the thermal stability of the film via characteristic of X-ray diffraction (XRD) and Differential scanning calorimetry (DSC), respectively. By adding encapsulated LBLF and TiO_2 to the film, the mechanical properties of the film were improved ($p < 0.05$). The release of flavonoids from the film into the environment occurs gradually and in a controlled manner. Release from the Pst/Wpp/MLF/TiO_2 film occurred more frequently than in the Pst/Wpp/MLF film. Comparing the effect

of Pst/Wpp/MLF and Pst/Wpp/TiO_2 films, it was clear that Pst/Wpp/TiO_2 film had a greater effect on the microbial stability of Tan mutton than Pst/Wpp/MLF film. Examination of the chemical properties of Tan mutton packaged with active films indicated the positive effect of encapsulated essential oil and TiO_2 nanoparticles in increasing the shelf life of Tan mutton for six days.

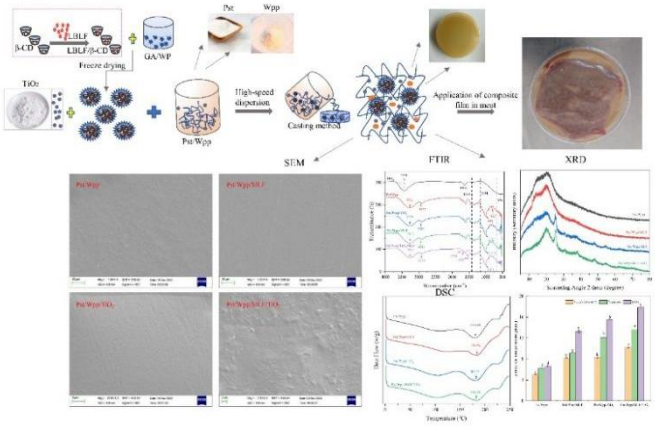

Figure 1. Preparation and characterization of nanocomposite film, and its application in meat

IV. CONCLUSION

In this study, a composite film of Pst / Wpp containing MLF/TiO_2 has porosity in the film structure by adding the MLF and TiO_2, at the same time they wonderfully improved the antioxidant and antibacterial properties and increased the melting point and glass temperature of the film. Due to the electrostatic interaction between the components, the mechanical properties of the composite film have been improved. Additionally, the study of releasing the flavonoids from the film revealed that the release of the flavonoids occurred gradually. Therefore, the encapsulation of the flavonoids has increased the effectiveness time of the flavonoids. Packaging of Tan mutton meat with such composite film prolonged the shelf life of the meat. Consequently, Pst/ Wpp containing MLF/TiO_2 film has the potential to be used as a packaging material for meat and meat products.

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