УДК: 581.6

Development of Nanofilms Via the Usage of Soy Protein Isolate and *Salvia officinalis* Extract

Sharabati A. (ITMO)

Scientific Supervisor – PhD Eremeeva N.B. (ITMO)

Introduction: Although chemical additives and plastic packaging systems have vastly been applied for food preservation purposes, their potential detrimental effects to both human health and the environment have pushed recent research works to move toward healthier and safer sources. Along the journey of experiments and observations, many molecules and compounds of an organic source have shown potential preservative characteristics, in addition to their other health benefits, such as antioxidant, antibacterial, and anticancer activities, while also, unlike plastics, are eco-friendly, that is, renewable, biodegradable, and non-toxic. Among the organic sources, proteins and other polymers are a promising source of food preservation, nevertheless, with certain limitations, such as weak water barrier properties and low mechanical strength (Samadani et al., 2019), restricting their applicability while used alone. Likewise, despite plant extracts possessing several characteristics that render them a promising replacement of chemical and plastic preservation methods, they exhibit several limitations, including lipophilicity, high volatility, sensitivity to oxygen and light, low solubility, low bioavailability, and chemical instability (Zhang & Piao, 2023). Therefore, current methodologies have become more focused on finding ways to overcome the limitations and improve the barrier properties of such molecules, mainly via the complexation of two or more molecules into one nanofilm, known as encapsulation. One of such encapsulates was proposed by (Cui et al., 2023), where *Litsea cubeba* essential oil (LCEO) was complexed with soy protein isolate (SPI), selected thanks to its high ratio (> 60%) of hydrophobic bioactive substances, rendering it an ideal delivery material. In attempts to optimize the proposed system, the nanoparticles prepared by LCEO and SPI (LSNPs) were compounded in a lentinan edible film. Encapsulates were prepared through dissolving SPI in deionized water and LCEO in absolute ethanol, then mixing the two solutions, then freeze-drying them, after which nanofilms were made by heating and mixing with glycerin. After testing the nanofilm on beef, observing using scanning electron microscopy (SEM), and assessing its antioxidant activity, antibacterial activity against *Staphylococcus aureus* (*S. aureus*) and *Escherichia coli* (*E. coli*), and other physical properties, results showed successful complexation and modification, which generally enhanced barrier properties, antioxidant and antibacterial activities, with exception of SPI addition, which is thought to have been a source of nourishment for bacteria, and other physical properties, such as thickness and opacity.

Main Body: In our experiment, we are working on the encapsulation of SPI and *Salvia officinalis* (sage) and subsequent nanofilm formation. The SPI is dissolved in diluted water, while sage is dissolved in 70% ethanol, shaken overnight at 30 °C, then SPI solution is agitated by an ultrasonic power of 120 W for 5 minutes, while sage solution is filtered, before mixing together and stirring at room temperature for 4 hours, after which the mixture is processed in a rotary evaporator at a low pressure of ~50 mbars to selectively evaporate the solvents while retaining the solutes, which are deep-frozen overnight at -80 °C then freeze-dried. The resultant powder, as well as the sage extract, are assessed for their antioxidant activity, flavonoids, and phenolic compounds by 2,2-Diphenyl-1-picrylhydrazyl (DPPH) test, aluminum chloride method, and Folin–Ciocalteu method, respectively. Further analyses to observe characteristics and test effectiveness are also conducted before the formation of nanofilms, including observation under a scanning electron microscopy (SEM), thermostability, where the samples are exposed to a high temperature of 80 °C for 6-8 hours, then assessed again for their antioxidant activity, flavonoids, and

phenolic compounds, and *in vitro* gastrointestinal digestion stability, where the samples are exposed to an *in vitro* environment that mimics that of *in vivo* digestion, then assessed again for their antioxidant activity, flavonoids, and phenolic compounds, where results of both tests, thermostability and *in vitro* gastrointestinal digestion stability, are compared to those of the solution in a normal state. Eventually, nanofilms are formed from the samples and are applied on different foods and edibles as a coat, where the food is kept at a certain temperature and other conditions and observed for its spoilage.

Conclusion: Sage extract has already demonstrated positive results for its antioxidant activity, where DPPH spectroscopical inspection at 517 nm showed a concentration of 22.5 mg/ml, flavonoids, where spectroscopy at 510 nm showed a catechin concentration of 72 mg/g, and phenolic compounds, where spectroscopy at 795 nm showed a gallic acid concentration of 265 mg/g. We anticipate a slower deterioration of different foods upon applying the proposed nanofilm on them, theoretically owing to the antibacterial and antioxidant activity of both sage and SPI. In addition, success of encapsulation and improvement of barrier properties of both sage and SPI is expected to be seen in the nanofilm.

References:

Cui, H., Xu, R., Hu, W., Li, C., Abdel-Samie, M. A., & Lin, L. (2023). Effect of soy protein isolate nanoparticles loaded with litsea cubeba essential oil on performance of lentinan edible films. *International Journal of Biological Macromolecules*, *242*, 124686. https://doi.org/10.1016/J.IJBIOMAC.2023.124686

Samadani, F., Behzad, T., & Enayati, M. S. (2019). Facile strategy for improvement properties of whey protein isolate/walnut oil bio-packaging films: Using modified cellulose nanofibers. *International Journal of Biological Macromolecules*, *139*, 858–866. https://doi.org/10.1016/J.IJBIOMAC.2019.08.042

Zhang, L., & Piao, X. (2023). Use of aromatic plant-derived essential oils in meat and derived products: Phytochemical compositions, functional properties, and encapsulation. *Food Bioscience*, *53*, 102520. https://doi.org/10.1016/J.FBIO.2023.102520