유청단백질로 만들어진 식품포장재에 관한 연구

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Abstract

Edible films such as wax coatings, sugar and chocolate covers, and sausage casings, have been used in food applications for years [1]. However, interest in edible films and biodegradable polymers has been renewed due to concerns about the environment, a need to reduce the quantity of disposable packaging, and demand by the consumer for higher quality food products.

Edible films can function as secondary packaging materials to enhance food quality and reduce the amount of traditional packaging needed. For example, edible films can serve to enhance food quality by acting as moisture and gas barriers, thus, providing protection to a food product after the primary packaging is opened. Edible films are not meant to replace synthetic packaging materials; instead, they provide the potential as food packagings where traditional synthetic or biodegradable plastics cannot function. For instance, edible films can be used as convenient soluble pouches containing single-servings for products such as instant noodles and soup/seasoning combination. In the food industry, they can be used as ingredient delivery systems for delivering pre-measured ingredients during processing. Edible films also can provide the food processors with a variety of new opportunities for product development and processing.

Depends on materials of edible films, they also can be sources of nutritional supplements. Especially, whey proteins have excellent amino acid balance while some edible films resources lack adequate amount of certain amino acids, for example, soy protein is low in methionine and wheat flour is low in lysine [2]. Whey proteins have a surplus of the essential amino acid lysine, threonine, methionine and isoleucine. Thus, the idea of using whey protein-based films to individually pack cereal products, which often deficient in these amino acids, become very attractive [3]. Whey is a by-product of cheese manufacturing and much of annual production is not utilized [4]. Development of edible films from whey protein is one of the ways to recover whey from dairy industry waste. Whey proteins as raw materials of film production can be obtained at inexpensive cost.

I hypothesize that it is possible to make whey protein-based edible films with improved moisture barrier properties without significantly altering other properties by producing whey protein/lipid emulsion films and these films will be suitable for food applications. The following are the specific objectives of this research:

1. Develop whey protein/lipid emulsion edible films and determine their microstructures, barrier (moisture and oxygen) and mechanical (tensile strength and elongation) properties.
2. Study the nature of interactions involved in the formation and stability of the films.
3. Investigate thermal properties, heat sealability, and sealing properties of the films.
4. Demonstrate suitability of their application in foods as packaging materials.

Methodologies were developed to produce edible films from whey protein isolate (WPI) and concentrate (WPC),

and film-forming procedure was optimized. Lipids, butter fat (BF) and candelilla wax (CW), were added into film-forming solutions to produce whey protein/lipid emulsion edible films. Significant reduction in water vapor and oxygen permeabilities of the films could be achieved upon addition of BF and CW. Mechanical properties were also influenced by the lipid type. Microstructures of the films accounted for the differences in their barrier and mechanical properties. Studies with bond-dissociating agents indicated that disulfide and hydrogen bonds, cooperatively, were the primary forces involved in the formation and stability of whey protein/lipid emulsion films. Contribution of hydrophobic interactions was secondary.

Thermal properties of the films were studied using differential scanning calorimetry, and the results were used to optimize heat-sealing conditions for the films. Electron spectroscopy for chemical analysis (ESCA) was used to study the nature of the interfacial interaction of sealed films. All films were heat sealable and showed good seal strengths while the plasticizer type influenced optimum heat-sealing temperatures of the films, 130° C for sorbitol-plasticized WPI films and 110° C for glycerol-plasticized WPI films. ESCA spectra showed that the main interactions responsible for the heat-sealed joint of whey protein-based edible films were hydrogen bonds and covalent bonds involving C-O-H and N-C components.

Finally, solubility in water, moisture contents, moisture sorption isotherms and sensory attributes (using a trained sensory panel) of the films were determined. Solubility was influenced primarily by the plasticizer in the films, and the higher the plasticizer content, the greater was the solubility of the films in water. Moisture contents of the films showed a strong relationship with moisture sorption isotherm properties of the films. Lower moisture content of the films resulted in lower equilibrium moisture contents at all aw levels. Sensory evaluation of the films revealed that no distinctive odor existed in WPI films. All films tested showed slight sweetness and adhesiveness. Films with lipids were scored as being opaque while films without lipids were scored to be clear. Whey protein/lipid emulsion edible films may be suitable for packaging of powder mix and should be suitable for packaging of non-hygroscopic foods [5,6,7,8].

References

1. Guilbert, S. 1986. Technology and application of edible protective films. In *Food packaging and preservation: Theory and Practice*, Mathlouthi M, (Ed), p. 371-394. Elsevier Applied Science Publisher Ltd., Essex, England.
2. Huffman, L.M. 1996. Processing whey protein for use as a food ingredient. Food Technol. Feb: 49-52.
3. Gennadios, A., McHugh, T.H., Weller, C.L., and Krochta J.M. 1994. Edible coating and films based on proteins. Ch 9 In *Edible coating and films to improve food quality*, J.M. Krochta, E.A. Baldwin, M.O. Nisperos-Cariedo, (Eds.), p. 201-277. Technomic Publishing Co. Inc., Lancaster, PA.
4. Siso, M.I.G. 1996. The biotechnological utilization of cheese whey: A review. Bioresource Technology. 57: 1-11.
5. Kim, S-J. 2000. Properties of whey protein/lipid emulsion edible films. Ph.D. dissertation. Michigan State University, East Lansing, MI.
6. Kim, S-J and Ustunol, Z. 2001. Thermal properties, heat sealability and seal attributes of whey protein isolate/lipid emulsion edible films. J Food Sci. 66(7): 985-990.
7. Kim S-J and Ustunol, Z. 2001. Sensory attributes of whey protein isolate and candelilla wax emulsion edible films. J Food Sci. 66(6): 909-911.
8. Kim, S-J and Ustunol, Z. 2001. Solubility and moisture sorption isotherm of whey protein-based edible films as influenced by lipid and plasticizer incorporation. J Agric Food Chem. 49: 4388-4391.