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Improving Physical Properties of Methylcellulose-Whey Protein Based Edible Film

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Abstract

In this study, three whey proteins (WP) which have different chemical compositions and methylcellulose (MC) were used to obtain edible films and water vapor permeability (WVP) and mechanical properties were investigated. The films were prepared in two groups namely Group A and B and glycerol (Gly) was used as the plasticizer. In Group A, MC was added in the film forming solutions at different ratios (0.3-0.8 MC/WP), as Gly/Total polymer (TP= WP+MC,) ratio (0.5) was kept constant. MC/WP ratio was constant at 0.8 in Group B and Gly/TP ratio was increased from 0.25 to 1. Increasing MC/WP ratio caused a decrease on WVP in Group A. The film with Gly/TP ratio on 0.5 showed the lowest WVP value. Group B films had the highest tensile strength at 0.25 Gly/TP ratio and the films had the highest elongation at 0.5 Gly/TP ratios. MC and Gly amount in film forming solution affected the film properties significantly.

Keywords: edible film, whey protein, methylcellulose, water vapor permeability, mechanical properties

Introduction

Synthetic polymers are the most widely used packaging materials but due to their disposal problem, scientists investigate alternative packaging materials, which are cheap, light, and durable, good barrier to moisture, gas and solid migration. For this reason, interest in polysaccharide, lipid, protein and/or polyester biodegradable films have been accelerated. Edible films from natural polymeric resources are also biodegradable. Because of their low cost, simple technology requirement and functional properties edible films are the most popular packaging materials. Cellulose-based edible films are very good barriers to aroma, oxygen and oil transfer like other hydrophilic films (Turhan and Şahbaz, 2004). Whey protein gives transparent, bland, and flexible films with very good resistance to oxygen, aroma and lipid transfer at low humidities (Miller, 1997). Through the combined use of MC and WP, specific properties can be built into one film depending on application.

Materials and Methods

Three different WP were used: WPI-1 (Provon 190) and WPC (Avonlac 134 RW) were obtained from Glanbia Foods (Richfield, ID, USA) and WPI-2 (ProtArmor 907 LS) was from Euro Proteins (Wapakoneta, OH, USA). Methyl cellulose (MC) was purchased from Sigma-Aldrich (Cat No 274429, Poole, UK). MC-WP films were prepared according to Erdohan and Turhan (2005). In Group A, MC was used at different ratios (0.3-0.8 MC/WP), as Gly/TP ratio (0.5) was kept constant. MC/WP ratio was constant at 0.8 in Group B and Gly/TP ratio was increased from 0.25 to 1. ASTM E96-80 was used to determine WVP at 25±1°C and a texture analyzer (Model TA-XT2; SMS, Surrey, UK) was used to determine mechanical properties according to ASTM D638M. Data were evaluated using ANOVA with the LSD test used to determine different films ($p<0.05$) using a software program (Statistica® 6.0, StatSoft Inc., 1984-1985).

Results and Discussion

Increasing MC/WP ratio caused a decrease on WVP in Group A (Figure 1). The transport properties of the films were strongly affected by the addition of MC. MC decreased WVP of the films by increasing the solid content and producing a smaller pore size (Gutsche, 1994).

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Polymer structure significantly affects water vapor transport. Simple linear polymer chains, as in MC, can be packed tightly resulting in low permeability, but molecules with bulky side chains, as in proteins, are loosely packed and have high permeability (Chen, 1995). Gly is added to edible films to reduce brittleness and to increase flexibility, toughness and tear resistance (Erdohan and Turhan, 2005). It is also known that as the Gly content increases, the WVP of films is expected to increase. However the film with Gly/TP ratio on 0.5 showed the lowest WVP value (Figure 2). The film with Gly/TP ratio on 0.25 did not show the lowest WVP as expected. Air bubbles and pin holes may cause this (Kamper and Fennema, 1984). TS of both groups of films increased with increasing MC concentration ($p<0.05$). The increase in TS of Group A films with increasing MC concentration can be attributed to the given effect of MC. Group B films had the highest TS at 0.25 Gly/TP ratio and the films had the highest E at 0.5 Gly/TP ratios (Table 1).

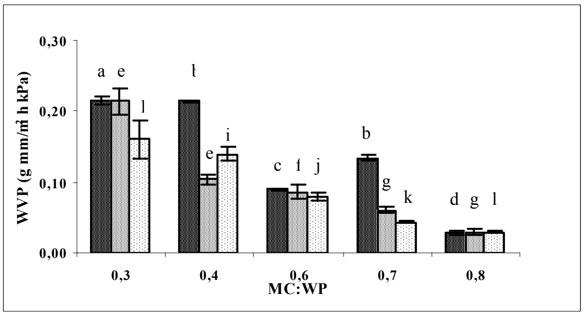

Figure 1. Effect of MC concentration on WVP of Group A films (Gly:TP, 0.5) ▓ WPI-1 ▒ WPI-2 ░ WPC

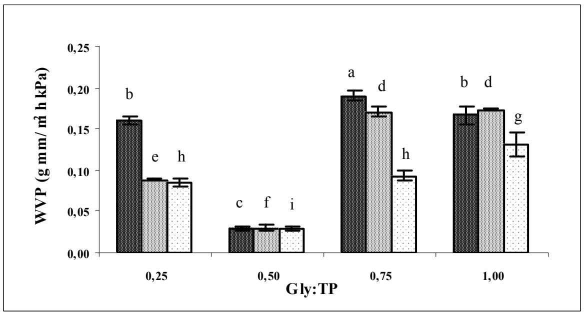

Figure 2.The effect of Gly amount on WVP of Group B films (MC:WP, 0.8) ▓ WPI-1 ▒ WPI-2 ░ WPC

The different letters at the top of columns indicate significant differences within the same pattern column (p<0..05)

Table 2. The effect of Gly amount on mechanical properties of Group B films.

	WPI-1		WPI-2		WPC	
Gly/TP (w/w)	**TS (N/mm^2)**	**E (%)**	**TS (N/mm^2)**	**E (%)**	**TS (N/mm^2)**	**E (%)**
0.25	11.6±0.9^a	10.8±0.8^c	10.9±0.9^a	8.3±1.9^c	13.9±1.7^a	19.7±2.7^d
0.50	6.8±0.6^b	48.4±1.3^a	4.2±0.8^c	40.0±1.7^a	4.9±0.5^c	45.2±3.2^a
0.75	4.9±0.4^c	39.0±4.0^b	5.0±0.6^b	35.6±3.6^b	5.8±0.8^b	33.8±3.6^c
1.00	5.8±0.8^b	42.0±4.6^b	5.3±0.6^b	39.6±4.9^{a,b}	4.9±0.4^c	39.0±4.0^b

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References

Chen H. 1995, *J. Dairy Sci.* 78: 2563.
Erdohan ZÖ. and Turhan KN. 2005, *Packag. Sci. Technol.* 18: 295.
Gutsche R. 1994, *Chem. Eng. Sci.* 49(2): 179.
Kamper SL. and Fennema O. 1984, *J. Food Sci.* 49: 1482.
Miller KS and Krochta JM. 1997, *Trends Food Sci. Technol.* 8(7): 228.
Turhan, KN and Şahbaz F. 2004, *J. Food Eng.* 61(3): 459.