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MICROENCAPSULATION OF BLACK CHOKEBERRY EXTRACT USING PSYLLIUM HUSK AS A WALL MATERIAL AND ITS APPLICATION TO MYOFIBRILLAR PROTEINS

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I. INTRODUCTION

Psyllium husk possesses excellent moisture absorption and gelling properties, which may enhance the quality of meat products [1]. In addition, it has been investigated as an encapsulating wall material [2]. Black chokeberry (*Aronia melanocarpa*) is abundant in polyphenols, particularly anthocyanins, but its stability is sensitive to the environmental factors, which can compromise its functionality [3]. Microencapsulation has been proposed as an effective strategy to protect such sensitive compounds. Therefore, this study aimed to evaluate psyllium husk powder (PHP) as a wall material for the microencapsulating of black chokeberry extract (BCE) and to assess its application to myofibrillar proteins (MPs).

II. MATERIALS AND METHODS

PHP was used as a wall material to microencapsulate BCE. Microcapsules (MCs) were manufactured at different ratios of PHP-to-BCE (1:10, 1:20, 1:30, 1:40, and 1:80, w/w). To characterize them, their morphological properties, Fourier transform infrared spectroscopy (FTIR), and microencapsulation efficiency (ME) were conducted. Among the treatments, MCs with a PHP:BCE ratio of 1:20 were selected for meat products due to their excellent ME and improved redness. This selected MC was applied to MP to evaluate their functional effects. To determine the optimal addition level, MCs were incorporated at 0–1.5%, and their effect on rheological properties, protein digestibility, and antioxidant activity were evaluated.

III. RESULTS AND DISCUSSION

The surface morphology of MCs exhibited a smooth surface with a sharp glass-like shape (Fig. 1A). The FTIR spectrum results confirmed the formation of a new peak in the MC spectrum, indicating a chemical interaction between the BCP extract and PHP during encapsulation, as demonstrated by comparing the MC spectra with those of PHP and BCE (Fig. 1B). As shown in Fig. 1C, ME increased with decreasing PHP-to-BCE ratios, with the 1:10 and 1:20 ratios achieving the highest ME, both exceeding 90% for total phenolic content (TPC) and total anthocyanin content (TAC) ($p < 0.05$).

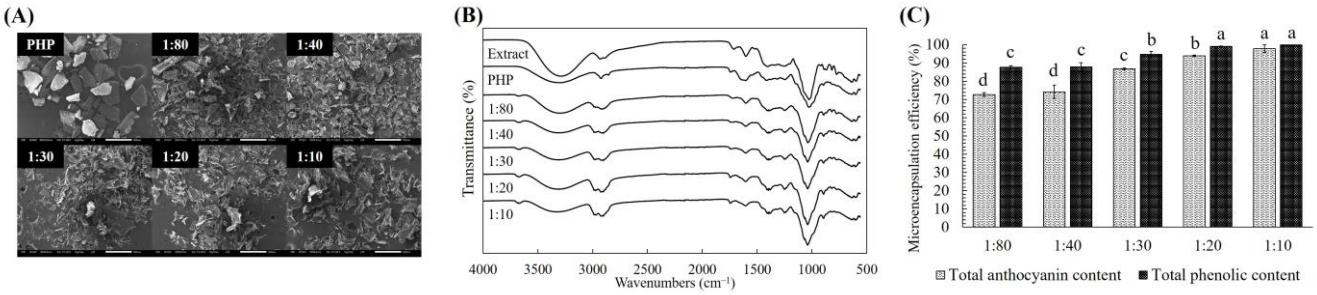


Figure 1. Physicochemical properties of microcapsules: surface morphology (A), FTIR (B), and microencapsulation efficiency (C). Error bars indicate the standard deviation. [a–d] Means with different superscripts in the same parameter are different ($p < 0.05$).

The rheological properties of MPs were investigated by applying MC prepared at a 1:20 ratio and added at various concentrations. Protein surface hydrophobicity decreased with the addition of MC (Fig. 2A) ($p < 0.05$). As microcapsules levels increased, the levels of SH group tended to decrease, while those of S–S group increased (Fig. 2B; $p < 0.05$). As shown in Fig. 2C, viscosity increased with higher MC levels. This may be attributed to the mucilage-forming properties of PHP used as the encapsulating wall material. Furthermore, the addition of microcapsules increased the cooking yield and gel strength of MPs in a concentration-dependent manner (Fig. 2D-E; $p < 0.05$). Therefore, these results confirmed that the rheological properties of MPs improved by the incorporation of MC formulated with PHP as a hydrocolloid.

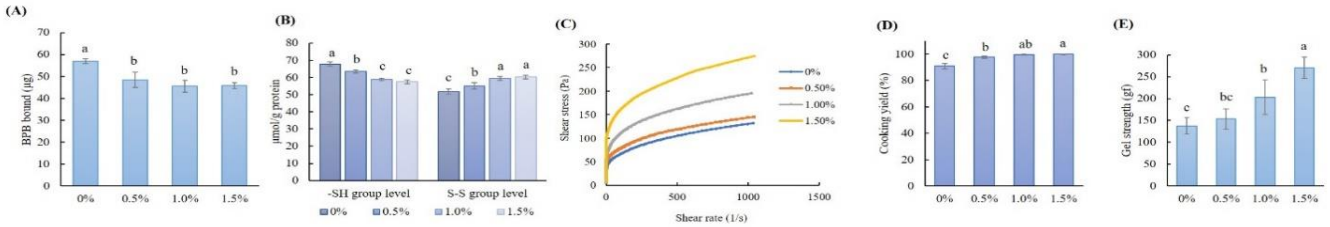


Figure 2. Rheological properties of myofibrillar proteins containing different levels of microcapsules: surface hydrophobicity (A), SH and S–S group level (B), viscosity (C), cooking yield (D), and gel strength (E). [a–d] Means with different superscripts in the same parameter are different ($p < 0.05$).

The incorporation of microcapsules improved protein digestibility during both the oral-gastric and oral-gastrointestinal digestion phase with dose-dependent manner, with oral-gastrointestinal digestion exhibiting better digestion than oral-gastric phase (Fig. 3A; $p < 0.05$). This may be attributed to the water absorption and swelling, which alter the structural properties of meat proteins, making them more accessible to digestive enzymes, and thereby improving digestibility [4]. It was confirmed that the addition of microcapsules increased the ABTS radical scavenging activity and reducing power during *in vitro* digestion (Fig 3B-C; $p < 0.05$). During *in vitro* digestion, ABTS activity increased at 0.5% and 1.5% levels, whereas reducing power decreased at 1.5% ($p < 0.05$). The discrepancy between ABTS activity and ferric reducing antioxidant power during *in vitro* digestion may result from methodological differences—metal reduction vs. radical scavenging—and from the degradation or biotransformation of anthocyanins and other phenolics [5], as supported by MCs data (Fig. 1F–G).

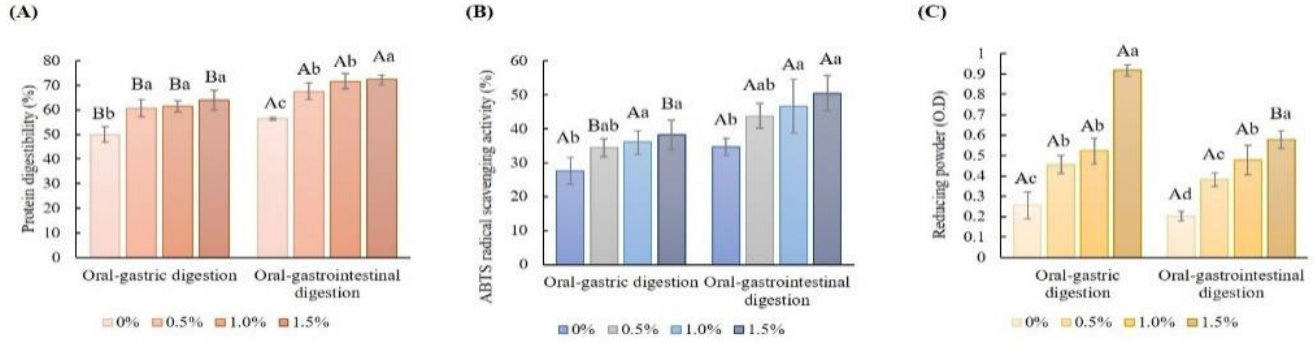


Figure 3. Protein digestibility (A), ABTS radical scavenging activity (B), and reducing power (C) of MPs containing different levels of microcapsules during *in vitro* digestion. [a–d] Means with different superscripts in the same digestion phase are different ($p < 0.05$). [A,B] Means with different superscripts in the same treatment during *in vitro* digestion are different ($p < 0.05$).

IV. CONCLUSION

ME increased as the PHP-to-BCE ratio decreased, with the 1:10 and 1:20 ratios demonstrating the highest ME. The rheological properties of MPs were improved by the incorporation of MCs using PHP as a wall material. The addition of MCs significantly improved protein digestibility and antioxidant activity during *in vitro* digestion.

ACKNOWLEDGEMENTS

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REFERENCES

1. Verma, A., & Mogra, R. (2013). Psyllium (*Plantago ovata*) husk: a wonder food for good health. International Journal of Science and Research, 4(9): 1581-1585.
2. Neto, A. Á. M., Tomazini, L. F., Mizuta, A. G., Corrêa, R. C. G., Madrona, G. S., de Moraes, F. F., & Peralta, R. M. (2021). Direct microencapsulation of an annatto extract by precipitation of psyllium husk mucilage polysaccharides. Food Hydrocolloids, 112: 106333.
3. Gerasimov, M. A., Perova, I. B., Eller, K. I., Akimov, M. Y., Sukhanova, A. M., Rodionova, G. M., & Ramenskaya, G. V. (2023). Investigation of polyphenolic compounds in different varieties of black chokeberry *Aronia melanocarpa*. Molecules, 28(10): 4101.
4. Yuan, D., Liang, X., Kong, B., Sun, F., Li, X., Cao, C., & Liu, Q. (2023). In-depth insight into the mechanism of incorporation of *Abelmoschus manihot* gum on the enhancement of gel properties and in vitro digestibility of frankfurters. Foods: 12, 1507.
5. Ferreira-Santos, P., Nogueira, A., Rocha, C. M., Wilson, C. P., Teixeira, J. A., & Botelho, C. (2022). *Sambucus nigra* flower and berry extracts for food and therapeutic applications: Effect of gastrointestinal digestion on in vitro and in vivo bioactivity and toxicity. Food & Function, 13(12): 6762-6776.