Fenugreek Protein-Based Edible Film

Subjects: Food Science & Technology

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Fenugreek seeds are a recent choice and a well-suited source of protein under food enrichment concerns. The proportion of seed protein in fenugreek accounts for about 25 to 38%, which is composed of globulin (27.2%), prolamine (7.4%), glutelins (17.2%), and albumin protein (43.8%). Fenugreek seeds reside under leguminous crops and are edible, rich in protein and dietary fibers but low in fat proportion. The standard of protein composed among fenugreek seed is as good as soybean protein, moreover, lysine availability in them is almost competitive as like soybean protein.

Keywords: fenugreek protein concentrate ; edible film ; tensile strength ; water vapor permeability ; Fourier-transform infrared spectroscopy ; X-ray diffraction

1. Overview

Films were produced at different pH—9, 10, 11, and 12—and the effect of the pH on the films was studied. As the pH increased, tensile strength increased while water vapor absorption decreased, which is interrelated to the surface morphological properties; as the pH increased, the surface became smoother and compact without any cavities. The films produced were darker in color. Fenugreek protein films exhibited good thermal stability. Fourier transform infrared spectroscopy (FTIR) revealed the presence of strong bonding for the films made at alkaline pH. X-ray diffraction analysis (XRD) indicated the major structure of the film was amorphous. The study demonstrated that the fenugreek protein concentrate film has influential characteristics and can be used as an edible packaging film.

2. Edible Films

The diverse consumption of plastic as a packaging material has led to multiple generations of waste streams. The large volume of plastic waste has created serious havoc on the environmental problem. In an endeavor to preserve the environs, most countries have started to bring down the consumption of one-use plastics in food packaging, thereby decreasing the price of controlling pollution [1]. One of the most accepted phenomena using traditional plastic is the transfer of potentially toxic and harmful components from the packaging plastic matrix towards the wrapped food and this is ascribed to the photo-oxidation reaction [2]. The trending global spotlight on bio-economy and health awareness has focused on the evolution of justifiable plastics that should be biodegradable, eatable, safe, thermally resilient, and mechanically strong [3][4]. Biological protection of the food product directly governs the product life-span, and hence it is very important [5]. Packaging executes a salient role in the prevention of food waste and in the achievement of establishing safety goals by creating a barrier between the environment and the food [6]. These edible plastics could be utilized in food product's smart and active packaging materials [4][7]. Food-packaging innovations have helped to meet-up the emerging demands of the functional food market. The advancing concept of intelligent and active packaging technology provides a diverse innovatory way to extend lifespan, quality improvement, and safe consumption of food products. Waste minimization and the trending demand for green or sustainable packaging made using plant extract, which is either edible or biodegradable, are important for a clean environment and health longevity [4]. Natural polymer-based edible films are biodegradable and non-toxic that possess easy storage and safe transportation [8]. Amongst the biomaterial protein, edible films from various sources impressively expand environmental-friendly films due to their relative abundance and better film-forming capability [9]. Protein-based films are ideal for hydrophilic surfaces and provide oxygen and carbon dioxide barriers [10][11]. Structural specifications of protein-embedded edible films impart lots of functionalities such as intermolecular bonding [12]. Protein-based films are anticipated to have a good oxygen barrier. Recently investigated protein to have an edible film of biodegradable terms are peanut protein, casein, whey protein, gelatin, soy protein, gluten protein, corn zein, and mung-bean protein [13][14][15].

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in protein and dietary fibers but low in fat proportion. The standard of protein composed among fenugreek seed is as good as soybean protein, moreover, lysine availability in them is almost competitive as like soybean protein [17].

Additionally, the fenugreek seeds are rich in bioactive compounds such as polyphenols and saponins [17]. Polyphenolic compounds from fenugreek seeds exhibit anti-diabetic properties. They hold powerful antioxidant properties which control high blood cholesterol, improves reduction in cell death, aging, and strengthens the immune system [18][19]. Compounds extracted from fenugreek have promising biological activities, including protection against cancer, allergies, bacteria, malaria, and viruses [20]. This necessitates the expansion in the utilization and preparation of value-added materials.

Thus, the use of fenugreek protein to prepare edible film introduces a sustainable way out for intensifying protein utilization, creating novel environmental-friendly and bio-based packaging. The potential applications of fenugreek protein-based edible film on food packaging were investigated owing to the non-existence of published literature on fenugreek protein concentrate used for the development of edible film as packaging means.

3. Conclusions

Fenugreek protein films were properly developed, and the attributes essential for the potential use of the film were determined successfully. The effect of pH was studied in 4 different ranges viz; pH from 9 to 12. The tensile strength, water vapor permeability, and solubility aspect of the fenugreek protein amended films were affected through pH fluctuations. The properties of the fenugreek protein concentrate edible films were similar to other edible films developed from protein. The best fenugreek protein concentrate film was obtained at pH 12. Edible films from fenugreek protein concentrate displayed better mechanical properties. Thus it can be further used as packaging materials. Film's color was dark due to the darker color of fenugreek protein at higher alkaline conditions. Present communication explores a new horizon for upcoming researchers wherein pH significantly addresses fenugreek protein concentrate film properties with better keeping characteristics. When compared to synthetic films, the mechanical properties and the optical properties needs to be improved.

References

1. Liu, C.; Huang, J.; Zheng, X.; Liu, S.; Lu, K.; Tang, K.; Liu, J. Heat sealable soluble soybean polysaccha-ride/gelatin blend edible films for food packaging applications. Food Pack. Shelf Life 2020, 24, 100485.
2. Hahladakis, J.N.; Velis, C.A.; Weber, R.; Iacovidou, E.; Purnell, P. An overview of chemical additives pre-sent in plastics: Migration, release, fate and environmental impact during their use, disposal, and recycling. J. Hazard. Mater. 2018, 344, 179–199.
3. Lambert, S.; Wagner, M. Environmental performance of bio-based and biodegradable plastics: The road ahead. Chem. Soc. Rev. 2017, 46, 6855–6871.
4. Han, J.-W.; Ruiz-Garcia, L.; Qian, J.-P.; Yang, X.-T. Food Packaging: A Comprehensive Review and Future Trends. Compr. Rev. Food Sci. Food Saf. 2018, 17, 860–877.
5. Montes, E.D.; Muñoz, R.C. Edible films and coatings as food-quality preservers: An overview. Foods 2021, 10, 249.
6. Mohamed, S.A.; El-Sakhawy, M. Polysaccharides, Protein and Lipid -Based Natural Edible Films in Food Packaging: A Review. Carbohydr. Polym. 2020, 238, 116178.
7. Mlalila, N.; Hilonga, A.; Swai, H.; Devlieghere, F.; Ragaert, P. Antimicrobial packaging based on starch, poly(3-hydroxybutyrate) and poly(lactic-co-glycolide) materials and application challenges. Trends Food Sci. Technol. 2018, 74, 1–11.
8. Park, J.; Nam, J.; Yun, H.; Jin, H.J.; Kwak, H.W. Aquatic polymer-based edible films of fish gelatin cross-linked with alginate dialdehyde having enhanced physicochemical properties. Carbo. Polym. 2021, 254, 117317.
9. Arfat, Y.A.; Benjakul, S.; Prodpran, T.; Osako, K. Development and characterisation of blend films based on fish protein isolate and fish skin gelatin. Food Hydrocoll. 2014, 39, 58–67.
10. Dinika, I.; Verma, D.K.; Balia, R.; Utama, G.L.; Patel, A.R. Potential of cheese whey bioactive proteins and peptides in the development of antimicrobial edible film composite: A review of recent trends. Trends Food Sci. Technol. 2020, 103, 57–67.
11. Corrado, I.; Abdalrazeq, M.; Pezzella, C.; Di Girolamo, R.; Porta, R.; Sannia, G.; Giosafatto, C.V.L. Design and characterization of poly (3-hydroxybutyrate-co-hydroxyhexanoate) nanoparticles and their grafting in whey protein-based nanocomposites. Food Hydrocoll. 2021, 110, 106167.

12. Prodpran, T.; Benjakul, S.; Artharn, A. Properties and microstructure of protein-based film from round scad (Decapterus maruadsi) muscle as affected by palm oil and chitosan incorporation. Inter. J. Biol. Macromol. 2007, 41, 605–614.
13. Gennadios, A.; Weller, C.; Testin, R. Temperature Effect on Oxygen Permeability of Edible Protein-based Films. J. Food Sci. 1993, 58, 212–214.
14. Bourtoom, T. Factors affecting the properties of edible film prepared from mung bean proteins. Int. Food Res. J. 2008, 15, 167–180.
15. Saglam, D.; Venema, P.; de Vries, R.; Shi, J.; van der Linden, E. Concentrated whey protein particle dispersions: Heat stability and rheological properties. Food Hydrocoll. 2013, 30, 100–109.
16. Feyzi, S.; Varidi, M.; Zare, F.; Varidi, M.J. Fenugreek (Trigonella foenum graecum) seed protein isolate: Extraction opti mization, amino acid composition, thermo and functional properties. J. Sci. Food Agric. 2015, 95, 3165–3176.
17. Sauvaire, Y.; Girardon, P.; Baccou, J.; Ristérucci, A. Changes in growth, proteins and free amino acids of developing se ed and pod of fenugreek. Phytochemistry 1984, 23, 479–486.
18. Kaviarasan, S.; Vijayalakshmi, K.; Anuradha, C. Polyphenol-Rich Extract of Fenugreek Seeds Protect Erythrocytes fro m Oxidative Damage. Plant Foods Hum. Nutr. 2004, 59, 143–147.
19. Srinivasan, K. Fenugreek (Trigonella foenum-graecum): A review of health beneficial physiological effects. Food Rev. In t. 2006, 22, 203–224.
20. Naidu, M.M.; Shyamala, B.N.; Naik, J.P.; Sulochanamma, G.; Srinivas, P. Chemical composition and anti-oxidant activit y of the husk and endosperm of fenugreek seeds. LWT Food Sci. Technol. 2011, 44, 451–456.
