Journal of Food Composition and Analysis 139 (2025) 107146

Contents lists available at ScienceDirect

Journal of Food Composition and Analysis

journal homepage: www.elsevier.com/locate/jfca

Exploring the potential of amaranth proteins: Composition, functional characteristics, modifications, bioactive peptides, and possible applications in food and packaging industries

Dipak Das [a], Mohd Aaqib Sheikh [b], Nisar A. Mir [c,*]

[a] Department of Food Engineering & Technology, Sant Longowal Institute of Engineering & Technology, Longowal, Punjab 148106, India
[b] Department of Food Process Engineering, National Institute of Technology, Rourkela, Odisha 769008, India
[c] Department of Food Technology, School of Engineering and Technology, Islamic University of Science and Technology, Awantipora, Jammu & Kashmir 192122, India

ARTICLE INFO

Keywords:
Pseudocereal
Sustainability
Amaranth protein
Techno-functional properties
Bioactive peptides

ABSTRACT

This review examines the significance of amaranth protein, offering a comprehensive analysis of its nutritional composition, health-promoting features, functional characteristics, and versatile applications. The high digestibility and unique amino acid profile endow it with remarkable health-promoting properties and open doors to an array of applications in food, pharmaceuticals, and cosmetics. Amaranth protein extracted from the seeds of the amaranth plant is now recognized as an attractive alternative protein source owing to its distinctive nutritional profile and potential health benefits. The protein profile of amaranth protein, which includes albumins, globulins, prolamins, and glutelins, along with the well-balanced amino acid composition, makes it a suitable substitute to boost protein quality and meet dietary requirements. Amaranth protein isolate exhibits strong emulsifying, foaming, and gelation capabilities owing to the presence of protein-polysaccharide complexes and an abundance of disulfide bonds. Furthermore, modification approaches like physical, chemical, or biological treatments boost its functioning and broaden its prospects in the food and packaging sectors. The relevance of amaranth proteins in terms of their nutritional value, functional potential, health-promoting properties, and sustainability is outlined in this article, thereby highlighting its immense potential to revolutionize various industries and open up prospective applications in an array of food items.

1. Introduction

Protein is the primary component of all living cells, playing a crucial role in various aspects of cell structure and function. In plants, proteins are synthesized using inorganic sources like ammonia, nitrates, and nitrites. Among pseudo cereals, amaranth grain stands out as a highly nutritious option with superior protein quality compared to true cereals like wheat and maize. The functional properties of amaranth proteins are greatly influenced by their structural characteristics. Multiple researchers have conducted studies exploring the physicochemical, functional, and thermal properties of amaranth protein (López et al., 2018; Constantino and Garcia-Rojas, 2020). One crucial functional property is the ability of the protein to dissolve in water, as it significantly impacts other characteristics such as emulsification, gelation, and foaming (Figueroa-González et al., 2022). Gelation, which involves the formation of a gel-like structure, enhances the potential applications of protein in various product developments (Cortez-Trejo et al., 2021; Hadidi et al., 2023). The bonds within the protein, including covalent, non-covalent, and disulfide bonds, contribute to the improvement of gel hardness, while the network structure primarily relies on hydrogen and hydrophobic interactions (Peyrano et al., 2019). Proteins possess surfactant properties, making them widely used in dispersed food systems. Studies on amaranth protein's emulsifying properties indicate its ability to function as a superior oil-to-water interface and form stable emulsions. Under acidic conditions, proteins exhibit enhanced adsorption capacity and foaming properties, including foam-forming capacity and stability. Other functional properties, including surface hydrophobicity, fat and oil absorption capacity, and microstructure, have been examined based on specific requirements for product formulation. These properties can be altered through physical, chemical, and enzymatic treatments. Enzymatic treatments are particularly favored due to their minimal processing requirements, ease of reaction control, and limited

* Corresponding author.
E-mail address: nisarmir89@gmail.com (N.A. Mir).

https://doi.org/10.1016/j.jfca.2024.107146
Received 30 August 2024; Received in revised form 30 November 2024; Accepted 18 December 2024
Available online 19 December 2024