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Upcycling Agricultural By Products: Developing Functional Plant Based Proteins from Oilseed Waste

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Abstract

The present review aims to critically evaluate the potential of oilseed processing residues, including press cakes and meals derived from sunflower, sesame, canola, flax, and rapeseed, as sustainable feedstocks for the development of functional plant based protein ingredients for human consumption. A systematic synthesis of peer reviewed literature from 2015 to 2025 was conducted, focusing on four key domains: chemical composition of defatted oilseed meals, protein extraction efficiencies across alkaline, enzymatic, and salt extraction methods, functional properties of isolated protein concentrates and hydrolysates, and nutritional quality assessed by amino acid scoring and in vitro digestibility. Comparative analysis revealed that defatted meals contain crude protein ranging from 30% to 55% by dry weight, with sesame and sunflower meals exhibiting the highest values at 42.7% and 38.4% respectively. Alkaline solubilisation followed by isoelectric precipitation yielded optimal extraction efficiencies between 54% and 68% across all feedstocks. Functional characterization demonstrated that oilseed protein isolates possess water holding capacities of 2.9 to 3.6 grams per gram of protein, oil holding capacities of 2.4 to 3.1 grams per gram, and foaming capacities exceeding 200% for sesame and flax isolates, values comparable or superior to commercial soy and pea protein benchmarks. Amino acid profiling identified sulphur containing amino acids as the primary limiting factor, while lysine, leucine, and arginine scores met or exceeded FAO reference patterns. In vitro protein digestibility corrected amino acid scores ranged from 0.70 to 0.79 across isolates. The evidence supports that oilseed waste streams can be effectively upcycled into high value functional protein ingredients for meat analogues, dairy alternatives, and baked goods. However, standardization of extraction protocols, mitigation of anti-nutritional factors including phytates and tannins, and sensory optimization remain critical barriers requiring further research prior to industrial scale adoption.

Keywords: *Agricultural by products; alkaline extraction; amino acid profiling; functional properties; oilseed waste; plant based protein; protein digestibility; upcycling*