

CHARACTERIZATION OF SUNFLOWER ACHENES, OIL, AND PRESS CAKE: PROTEIN ENRICHMENT FOR PASTA

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Introduction

Sunflower is an annual plant belonging to the Asteraceae family, known for its distinctive appearance and its agricultural importance in oil production. The extraction process converts approximately 25–50% of the initial seed weight into oil, depending on the method used. The residual press cake has a rich nutritional profile, particularly in protein content, ranging from 29 to 54%. This press cake is typically used exclusively as feed for beef or dairy cattle. However, the high protein content of this by-product highlights its potential for human consumption, providing value to a widely generated co-product.

Activities Carried Out

Chemical characterization was performed, including protein content, amino acid profile, lipid content, and fatty acid profile, on four different sunflower varieties and their corresponding press cakes obtained from oil extraction. Moreover, the most promising press cake in terms of protein content was used for enriching various homemade pasta formulations. The press cake was subjected to extraction with an ethanol:water mixture to reduce chlorogenic acid (CGA) content, which hinders protein digestibility and solubility. Additionally, physicochemical and technological analyses were conducted on the pasta formulations.

1. Characterization of Oil, Seeds, and Press Cake

1.1. Fatty Acid Profile: Fatty acid methyl esters (FAMES) were obtained and analyzed using gas chromatography with a flame ionization detector (GC-FID) equipped with a capillary column (Restek, Rt 2560, 100 m × 0.25 mm × 0.2 µm).

1.2. Protein Content and Amino Acid Profile: Protein content was determined using the Dumas method with a CHN elemental analyzer (Perkin Elmer Italia S.P.A, Milan, Italy, Series II 2400). The amino acid profile was obtained after acid hydrolysis with 6 M HCl and derivatized using the AccQ-Tag™ Ultra derivatization kit (Waters Corporation, Milford, USA). All samples were injected into a Waters UHPLC system (Waters Corporation, Milford, USA) equipped with a PDA detector and an AccQ-Tag Ultra 2.1 × 100 mm, 1.7 µm column.

1.3. Tocopherol Determination: Tocopherols were analyzed from the lipid fraction resuspended in 2-propanol and subsequently injected into a UPLC-PDA system (Waters Corporation, Acquity, MA, USA).

1.4. Total Phenolic Content: Determined according to the Folin-Ciocalteu method (Waterhouse, 2003), and absorbance was measured at 750 nm using a UV-Vis spectrophotometer (Wave, UV-31 SCAN, Beijing, China).

2. Pasta Formulation and Characterization: For the final 100 g of dough, three different enrichment levels were prepared: 20% (P20), 30% (P30), and 40% (P40), replacing commercial flour.

2.1. Fatty acid profile, protein content, amino acid profile, tocopherols, and total phenolic content were analyzed for the three pasta formulations using the methods described in section

2.2. Chlorogenic Acid Quantification: Using ultra-performance liquid chromatography coupled with mass spectrometry (UPLC-MS).

2.3. Color Measurement: Pasta color was evaluated before and after cooking using the CIELAB system, where lightness (L*), redness (a*), and yellowness (b*) were measured using a Minolta CR 200.

2.4. Cooking Properties: Optimal cooking time, water absorption, and cooking loss were measured.

2.5. Sensory Analysis: Consumer acceptability was assessed through a panel test. Attributes evaluated included color uniformity, aroma intensity, texture, flavor, and overall acceptability.

Results

The fatty acid profile shows a predominance of linoleic and oleic acids, with lower amounts of saturated fatty acids. α -Tocopherol content slightly increased with enrichment, reaching 0.06 mg/mL in P40. Protein content and essential amino acids also increased proportionally, with P40 reaching 14% total protein. CGA concentration was reduced from 0.54 mg/g in the sunflower cake to 0.10 mg/g in the CGA-reduced cake, and to even lower levels in the pasta formulations. Regarding cooking properties, higher enrichment resulted in shorter optimal cooking time, lower cooking loss, and reduced water absorption compared to the control. All three enrichment levels, both raw and cooked, showed a noticeable color difference compared to the control. Sensory analysis indicated that the 20% enrichment was the most appreciated, balanced, non-bitter, and perceived as homemade pasta, while higher enrichment levels provided more intense flavor and aroma. Importantly, over 80% of participants considered all three enriched pasta formulations to be “healthy.”

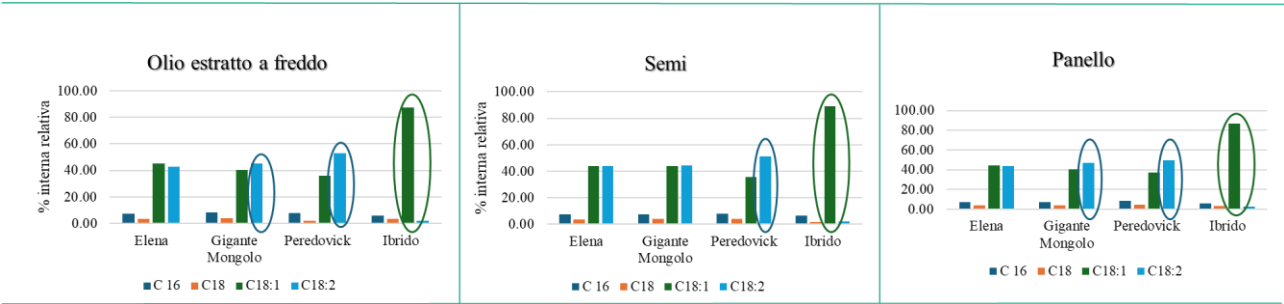


Figure 1. Fatty acid profile in oils, seeds, and press cake.

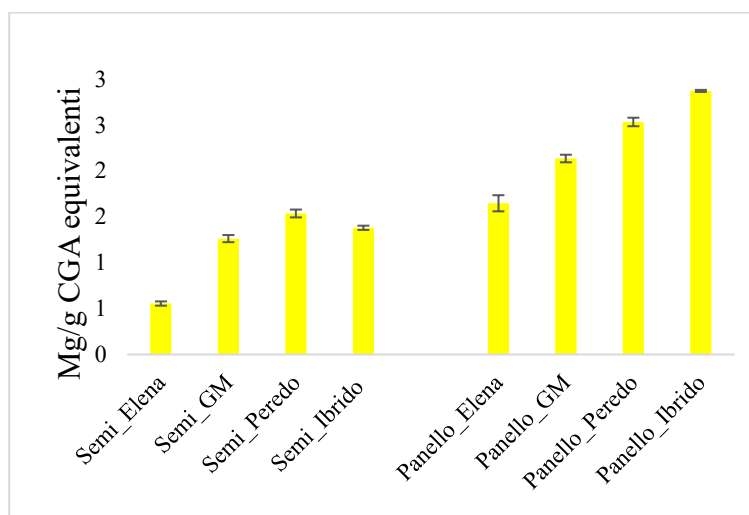


Figure 2. Total Phenolic Content in seeds and press cake.

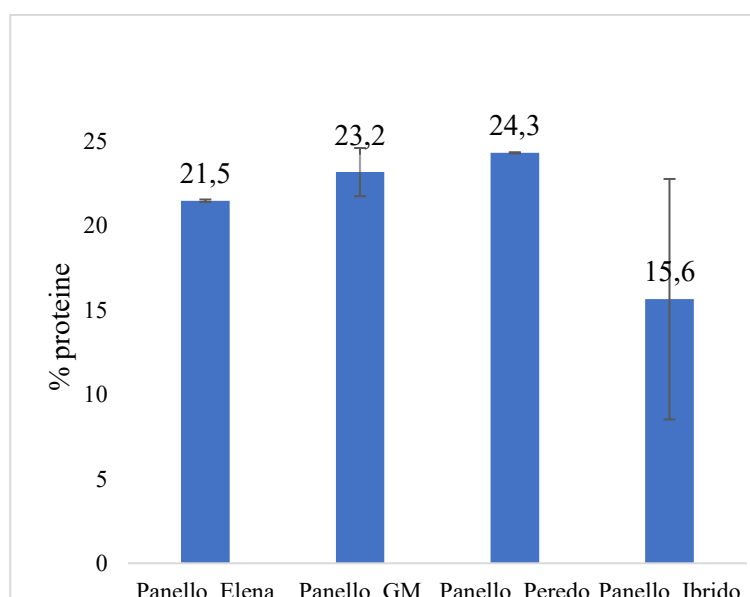


Figure 3. Protein content of the press cake.

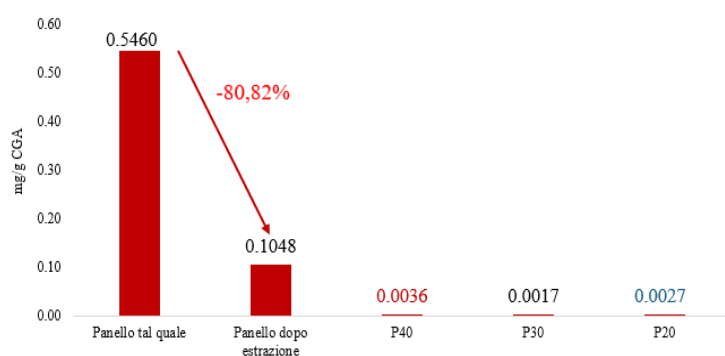


Figure 4. Quantification of chlorogenic acid in press cake and pasta.

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