**Techno-functionality of pigeon pea proteins and their interfacial properties at the air-water interface**

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Pigeon pea (*Cajanus cajan*), an underutilised pulse native to tropical and subtropical regions, holds significant promise as alternative protein source. Despite this potential, its techno-functional properties remain largely unexplored. Therefore, This study investigates the extraction and characterisation of pigeon pea proteins using conventional alkaline processing followed by isoelectric point precipitation. Two protein fractions were obtained—globulin-rich and albumin-rich—and their physicochemical, structural, and techno-functional properties were analysed.

The globulin-rich fraction exhibited a higher protein purity (above 80%) compared to the albumin-rich fraction (20%). SDS-PAGE analysis revealed prominent 7S-vicilin subunit bands at 47 and 64 kDa in the globulin-rich fraction, with smaller 11S legumin subunit bands at 20, 25, and 35 kDa. The albumin-rich fraction displayed more low molecular weight bands (<20 kDa). Both fractions featured a complete amino acid profile, though the amount of methionine and tryptophan was limiting. Secondary structure analysis showed a dominance of β-sheets over α-helices, unlike typical animal-based proteins.

Surface hydrophobicity was at least three times higher in the globulin-rich fraction, indicating greater hydrophobic residue exposure. Solubility testing revealed that the globulin-rich fraction was highly soluble (>80%) at neutral and alkaline pH but showed minimal solubility near its isoelectric point (pH 4). In contrast, the albumin-rich fraction demonstrated excellent solubility across a wide pH range. Gelation experiments identified the least gelation concentration of the globulin-rich fraction at approximately 6% w/w, with yield stress and storage modulus values of 3.66 ± 0.52 Pa and 162.02 ± 2.69 Pa, respectively. Dilatational rheology assessed interfacial properties at the air-water interface. The albumin-rich fraction increased surface pressure more rapidly due to its smaller molecular size, lower surface charge, and reduced energy barrier for adsorption. It also exhibited lower dilatational moduli but a greater linear deformation range, indicating a more stretchable but less stiff interfacial film compared to the globulin-rich fraction. Frequency sweep results suggested that protein elasticity at the interface depended on in-plane interactions. Notably, the albumin-rich fraction demonstrated superior foaming capacity and stability relative to the globulin-rich fraction.

This study provides valuable insights into the interfacial and techno-functional properties of pigeon pea proteins, highlighting their potential applications in the food industry.