EFFECT OF pH VALUE ON TECHNO-FUNCTIONAL PROPERTIES OF BROAD BEAN PROTEIN IN OLEOGEL PRODUCTION

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INTRODUCTION

Oleogels are semi-solid systems formulated for the replacement of saturated and trans fats in food products, as texture improvers, or for active compound formulations. They enhance nutritional quality, but also improve techno-functional properties of food products. Examples of techno-functionality data are solubility (ability of ingredient to dissolve in water), water and oil binding activity, gelation (ability to trap water into solid structures), foamability (ability to form high foam volumes), and thickening (ability to increase viscosity).

This study investigates the impact of pH value on the techno-functional properties of broad bean (*Vicia faba* L.) protein isolates and their subsequent ability to form stable oleogels.

METHODS

MATERIALS

In this study, aerogels were produced using broad bean (*Vicia faba*) protein isolate from Nutris Tech, Croatia. The broad bean protein contains a minimum of 85% protein (ISO 1871), with a maximum moisture content of 7% (ISO 1666), a maximum ash content of 3.5% (ISO 3593), a pH value of 5.5, and a particle size distribution with no more than 2% of particles larger than 150 µm.

METHODS

Broad bean protein was hydrated in water at concentrations ranging from 5–30% (w/v). Each sample was divided into three aliquots and adjusted to pH values of 4.5, 7.0, and 9.5. The aqueous protein dispersions were subjected to thermal gelation, followed by freeze-drying (lyophilization). The freeze-drying process consisted of two steps: pre-freezing at −18 °C to solidify the wet gel, and sublimation under vacuum (0.375 mbar) to obtain porous aerogel structures.

RESULTS & DISCUSSION

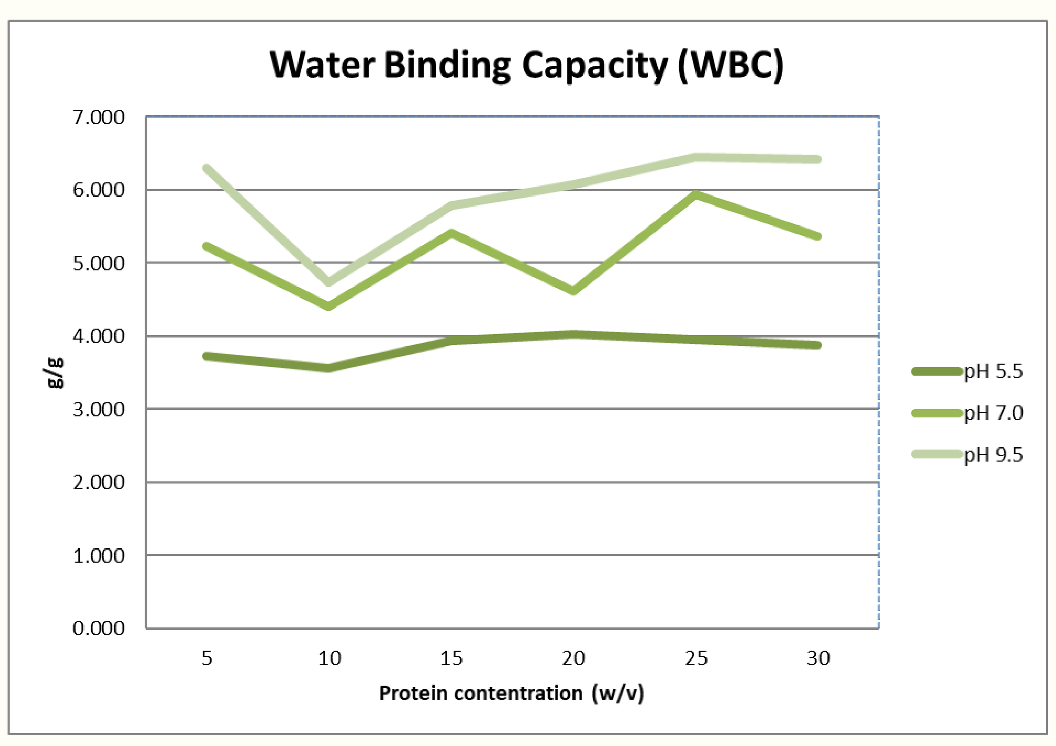

Figure 1: Water Binding Capacity of Faba bean protein

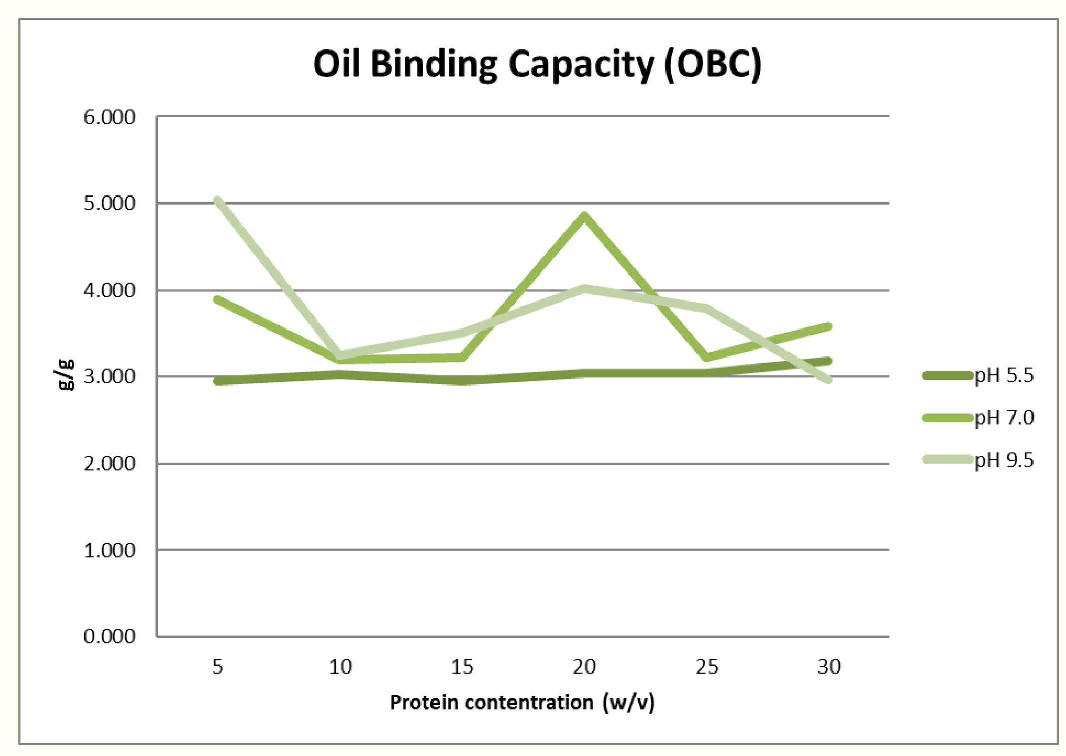

Figure 2: Oil Binding Capacity of Faba bean protein

WBC increases progressively with increasing pH, reaching its minimum at pH 5.5 (mean 3.85 g/g) and peaking at pH 9.5 (mean 5.96 g/g). At pH 5.5, which is close to the isoelectric point (pI) of faba bean globulins (typically around pH 4.5–5.0), net protein surface charge is minimized. This reduces electrostatic repulsion, promoting protein aggregation and yielding a tighter, more hydrophobic network with limited water-holding capability. Conversely, at alkaline pH (9.5), strong electrostatic repulsion causes partial unfolding of protein chains, exposing polar and hydrophilic groups that promote water-protein interactions and network swelling. The highest overall WBC was recorded at 25% w/v concentration and pH 9.5 (6.45 g/g).

Similar to WBC shows lower values under acidic conditions (mean 3.03 g/g at pH 5.5) compared to neutral and alkaline conditions (means of 3.66 g/g at pH 7.0 and 3.76 g/g at pH 9.5). Alkaline-induced protein unfolding exposes non-polar, hydrophobic amino acid residues previously buried inside the native protein core, enhancing lipophilic interactions. higher concentrations reduce oil entrapment efficiency in some formulations (e.g., 30% w/v at pH 9.5 drops to 2.97 g/g OBC), as overly dense crosslinked networks can restrict capillary penetration of lipophilic molecules.

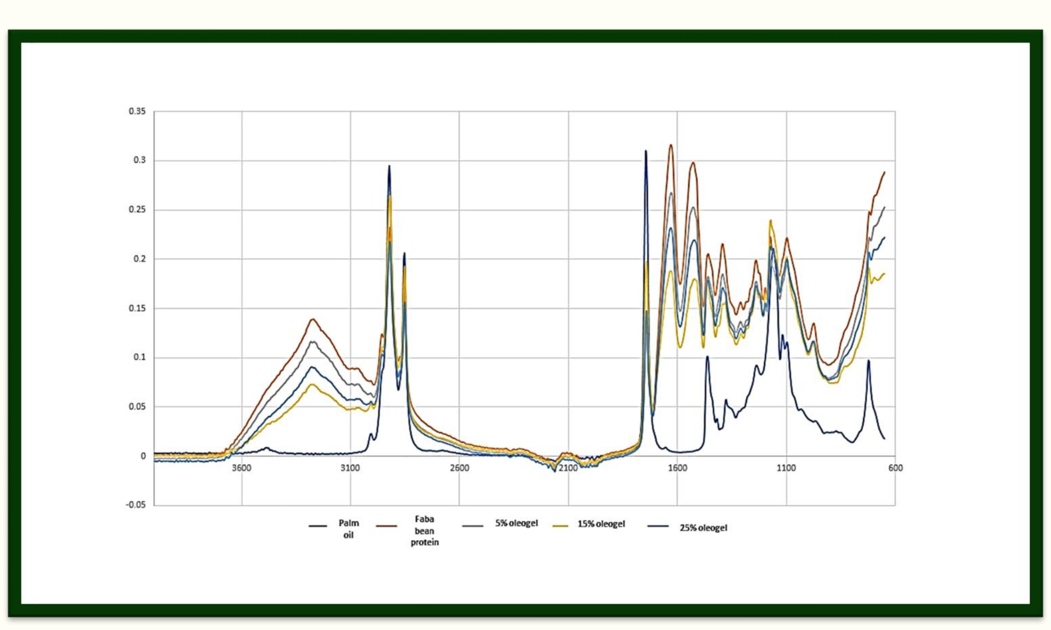

Figure 3: FTIR analysis of faba bean oleogels

Oleogels were subsequently formulated using palm oil. Spectra of oleogel samples show characteristic peaks from both oil and protein phases. In the 3100–3300 cm^{-1} region, peak broadening and increased intensity indicate potential hydrogen bonding between protein groups and the lipid matrix. Prominent peaks at 1745 cm^{-1} confirm triglyceride ester bonds. Intensity shifts in the 1650–1540 cm^{-1} region suggest protein–oleogel interactions, while minor overlaps below 1000 cm^{-1} correspond to C–O and C–C bond vibrations within the emulsion network.

ACKNOWLEDGEMENT

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CONCLUSION

The results indicated that pH significantly influenced the protein's structural network, with shifts away from the isoelectric point enhancing protein solubility and oil-binding capacity. Oleogels formed at 9.5 exhibited the highest oil-binding capacity and superior techno-functional properties. These findings demonstrate that adjusting pH value is an important parameter in producing plant-based food substitutes.