Screening for metal-chelating antioxidant activity in peptides and protein hydrolysates

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Analytical technology in food and agriculture

Metal-catalyzed lipid oxidation significantly compromises the shelf-life and quality of food products. Transition metal ions, particularly Fe2+/Fe3+, can enter food production chains as contaminants or through raw materials, drastically accelerating lipid oxidation. Traditionally, synthetic antioxidants like ethylenediaminetetraacetic acid (EDTA) have been used to address this issue, even in acidic environments. However, rising consumer demand for natural and clean-label products has spurred interest in natural metal-chelating antioxidants. Bioactive peptides derived from sources such as fish, potato, or microalgae are emerging as promising alternatives due to their radical scavenging and metal-chelating properties. This presentation will discuss findings from our studies on replacing EDTA as a food antioxidant. The focus was on developing and optimizing rapid, specific screening techniques for evaluating metal-chelating antioxidant activity in peptides and protein hydrolysates. Both established and novel analytical techniques, including Surface Plasmon Resonance (SPR), Immobilized Metal Affinity Chromatography (IMAC), and switchSENSE®, were evaluated at both neutral and low pH conditions. Results obtained with these assays were then compared with results from storage experiments in simple emulsions and mayonnaise at neutral and low pH.

Key findings include:

- switchSENSE and SPR were successfully used to determine the Ni2+ affinity of peptides and hydrolysates at neutral pH. Ni2+ was used as a proxy for Fe2+
- For protein hydrolysates, a relationship was observed between Ni2+ affinity determined by SPR and Fe2+ chelation in simple emulsions at neutral pH
- SPR measurements could not be performed at pH 4
- IMAC effectively determined both Fe3+ and Ni2+ affinities at pH 4, revealing that peptides exhibited Fe3+ affinity but no Ni2+ affinity
- None of the tested peptides demonstrated antioxidant activity in mayonnaise

This presentation will highlight the advantages and limitations of these screening methods and discuss their implications for developing natural antioxidants as EDTA replacements. Future research directions include exploring the sensory impacts of these ingredients and refining IMAC techniques for low pH applications.