

Cold Plasma as a Green Tool to Modify Chickpea Flour for Improved Food Applications

Mahsa Farrokhi¹, Antonia Nadilo², Kasper Bošnik³, Teresa R.S. Brandão¹, Elsa M. Gonçalves^{4,5}, Cristina L.M. Silva^{1*}

1. CBQF - Centro de Biotecnologia e Química Fina – Laboratório Associado, Escola Superior de Biotecnologia, Universidade Católica Portuguesa, Rua Diogo Botelho 1327, 4169-005, Porto, Portugal.
2. Faculty of Chemistry and Technology, University of Split, Ruđera Boškovića 35, 21000 Split, Croatia.
3. Faculty of Chemistry and Chemical Technology, University of Ljubljana, Večna pot 113, 1000 Ljubljana, Slovenia.
4. INIAV - Instituto Nacional de Investigação Agrária e Veterinária, Unidade de Tecnologia e Inovação, 2780-157 Oeiras, Portugal.
5. GeoBioTec - Geobiociências, Geoengenharias e Geotecnologias, FCT-UNL, 2829-516 Caparica, Portugal.

*clsilva@ucp.pt

Abstract (350 words):

Aim

Cold plasma, an emerging, eco-friendly food processing technology, generates reactive species that can modify biopolymers such as starch without the use of chemicals or excessive heat [1]. This study aimed to evaluate the effects of short-duration cold plasma treatment on the hydration-related functional properties and rheological behavior of chickpea flour, as a sustainable, eco-friendly, and non-thermal modification method, offering an alternative to conventional techniques for gluten-free and plant-based applications.

Methods

Chickpea flour was treated using the Blown Arc™ Cold Plasma System for 5 and 10 seconds at a fixed distance of 4 cm from the plasma source. The treatment caused a temperature increase from 22 °C to a maximum of 35 °C. Functional properties including water absorption capacity (WAC), water absorption index (WAI), water solubility index (WSI), and swelling power (SP) were evaluated [2]. Rheological properties were examined using oscillatory tests and modelled using the power-law equation [3]. All results were compared to untreated control samples.

Results

The 10-second cold plasma treatment significantly enhanced hydration-related functional properties of chickpea flour. WAC increased to 1.47 ± 0.14 g/g (vs. 1.25 ± 0.01 g/g in the control). WAI and SP also improved in the 10-second treated sample (6.33 ± 0.12 g/g and 6.98 ± 0.10 g/g, respectively). In contrast, WSI decreased significantly in the 10-second treated sample (9.29 ± 0.70 g/g) compared to the control (10.35 ± 0.30 g/g). The 5-second treatment produced intermediate results with no significant differences from the control in most parameters.

Rheological analysis confirmed that all samples exhibited solid-like ("true" gel) behavior, characterized by a higher storage modulus (G') than loss modulus (G''). The 10-second treated sample showed a significantly increased initial elastic modulus (G'_0), indicating improved gel strength and structural integrity. No significant changes were observed in G'' values across treatments, indicating that viscous behavior was less affected.

Conclusion

Cold plasma treatment, particularly at 10 seconds, effectively enhances the water interaction and viscoelastic properties of chickpea flour through physical and structural modifications. These findings support the application of cold plasma as an eco-friendly and clean-label technology for improving flour functionality in gluten-free and plant-based food systems.

References:

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