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Optimisation of hydrothermal treatment parameters to enhance the techno-functional quality of apple pomace powder

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INTRODUCTION & AIM

Apple pomace, a by-product of juice and cider production, is rich in dietary fiber, polyphenols, and other valuable nutrients, making it a promising ingredient for food applications. Its high fibre content contributes to improved water retention and viscosity, enhancing the structure and texture of food products by increasing thickness, moisture stability, and mouthfeel, especially in baked goods, meat analogues, and dairy alternatives.

The aim of the study was to investigate the impact of hydrothermal treatment parameters on the technological and functional properties of pulps obtained from dried apple pomace after rehydration in calcium lactate solution. This was evaluated in terms of texture properties, water-holding capacity, polyphenols content, and antioxidant activity.

METHOD

Design of experiment: The parameters of the hydrothermal treatment of dried apple pomace powder were examined based on the experiments arranged using a Box–Behnken design. The first factor (factor A), which was the time of the hydrothermal treatment, was set at the levels of 1, 5.5 and 10 min. The temperature of the processing was assigned as the second factor (factor B) and was evaluated at 60, 75 and 90°C.

Technological treatment: Formulation used in the research contained 10% of pomace powder, 0.03% of calcium lactate and 89.97% of tap water. Firstly, the solution was prepared and heated to the desired temperaturę, then the pomace was added and the treatment time started. After hydration, the pulp was homogenised and subjected to analytical part.

Water Holding Capacity (WHC): Approximately 10 g of prepared pulp was placed in 15 mL Falcon tubes (four replicates) and centrifuged (MPW-260R, MPW Med. Instruments, Warsaw, Poland) at 3046×g for 10 min. After removing the supernatant, the sediment was weighed and analyzed for dry matter content. WHC was expressed as grams of water retained per gram of dry matter.

Texture Analysis: Texture was evaluated using a back-extrusion test (TA.HD plus, Stable Micro Systems, UK). Pulp samples (46 mm diameter, 45 mm height) were compressed using a 36 mm probe at 1 mm s^{-1} to a depth of 30 mm. Results from four replicates were analysed with Texture Exponent software to determine firmness, adhesiveness, and viscosity index.

Total Polyphenol Content (TPC): TPC was measured by the Folin–Ciocâlteu method. Extracts were mixed in 96-well plates with 40 µL of fivefold-diluted Folin reagent and 250 µL of 7% Na_2CO_3. After 60 min incubation in the dark, absorbance was read at 750 nm (Multiskan Sky, Thermo Electron Co., USA). Results were expressed as mg chlorogenic acid equivalents (CGAE), in four replicates.

Antioxidant Activity: ABTS and DPPH assays were used as described previously. For ABTS, 10 µL of extract was added to 0.25 mL ABTS solution (A_{734} = 0.7 ± 0.05) and incubated for 6 min; absorbance was read at 734 nm (n = 4).

Statistical analysis: Response surface methodology (RSM) modelling was executed using Stat-Ease 360 software (version 25.0.2, Stat-Ease Inc., Minneapolis, MN, USA).

RESULTS

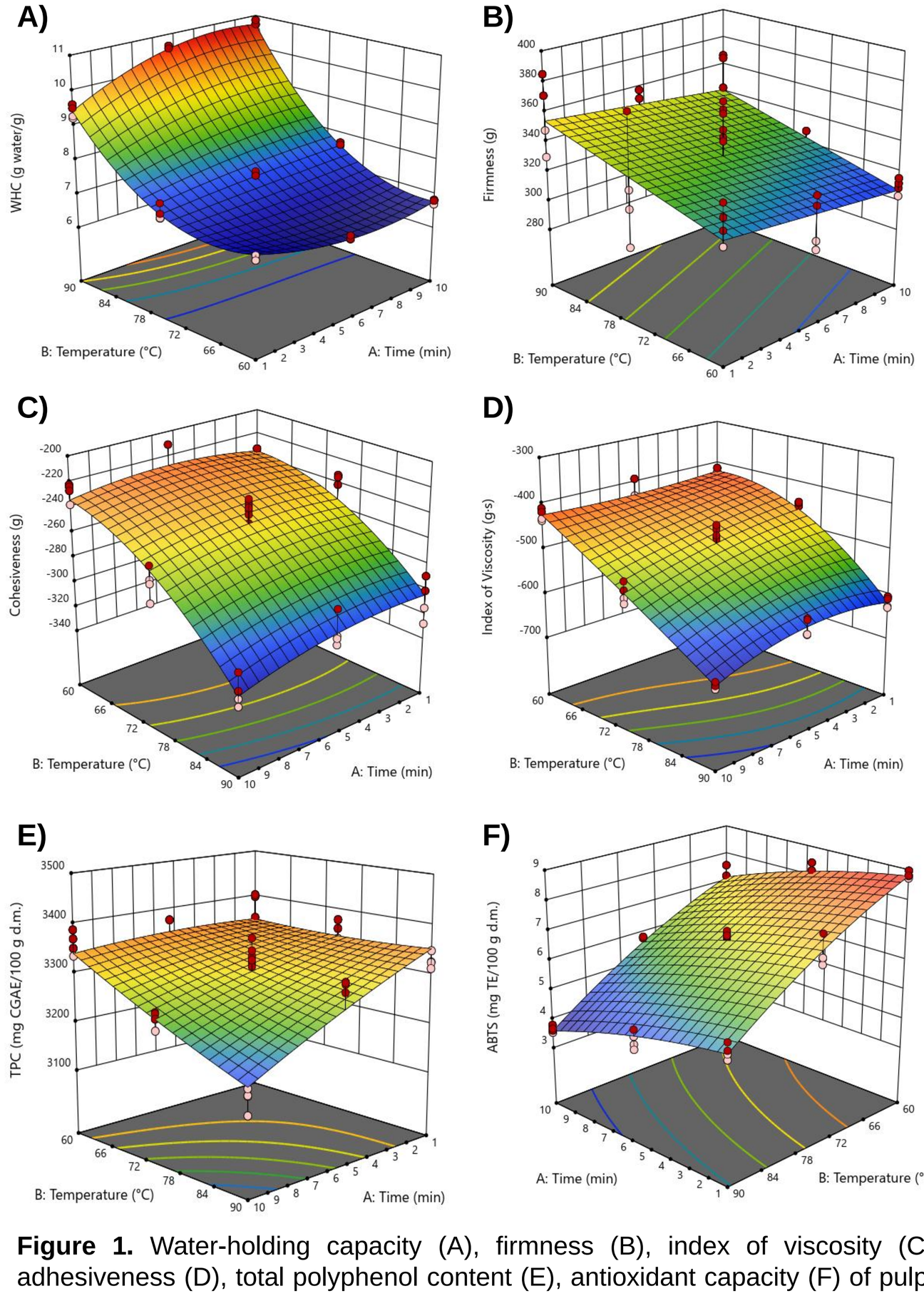

Figure 1. Water-holding capacity (A), firmness (B), index of viscosity (C), adhesiveness (D), total polyphenol content (E), antioxidant capacity (F) of pulps made out of hydrothermally treated apple pomace powder.

CONCLUSION

Hydrothermal treatment enhanced the functional properties of apple pomace powder, including water-holding capacity and texture, making it more suitable for food applications. Although high temperatures decreased bioactive compounds and antioxidant activity. To provide optimal effect in terms of texture properties and bioactive activity retention, a compromise between high temperature and shorter processing time needs to be considered.

FUTURE WORK / REFERENCES

More detailed descriptions of the results are available in Karwacka, M., Szulc, K., Galus, S., Ciurzyńska, A., & Janowicz, M. (2025). Modelling and optimisation of apple pomace powder hydrothermal treatment parameters using response surface methodology. *Journal of the Science of Food and Agriculture*.