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Supercritical carbon dioxide extraction of brewer's spent grain (BSG)

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Background



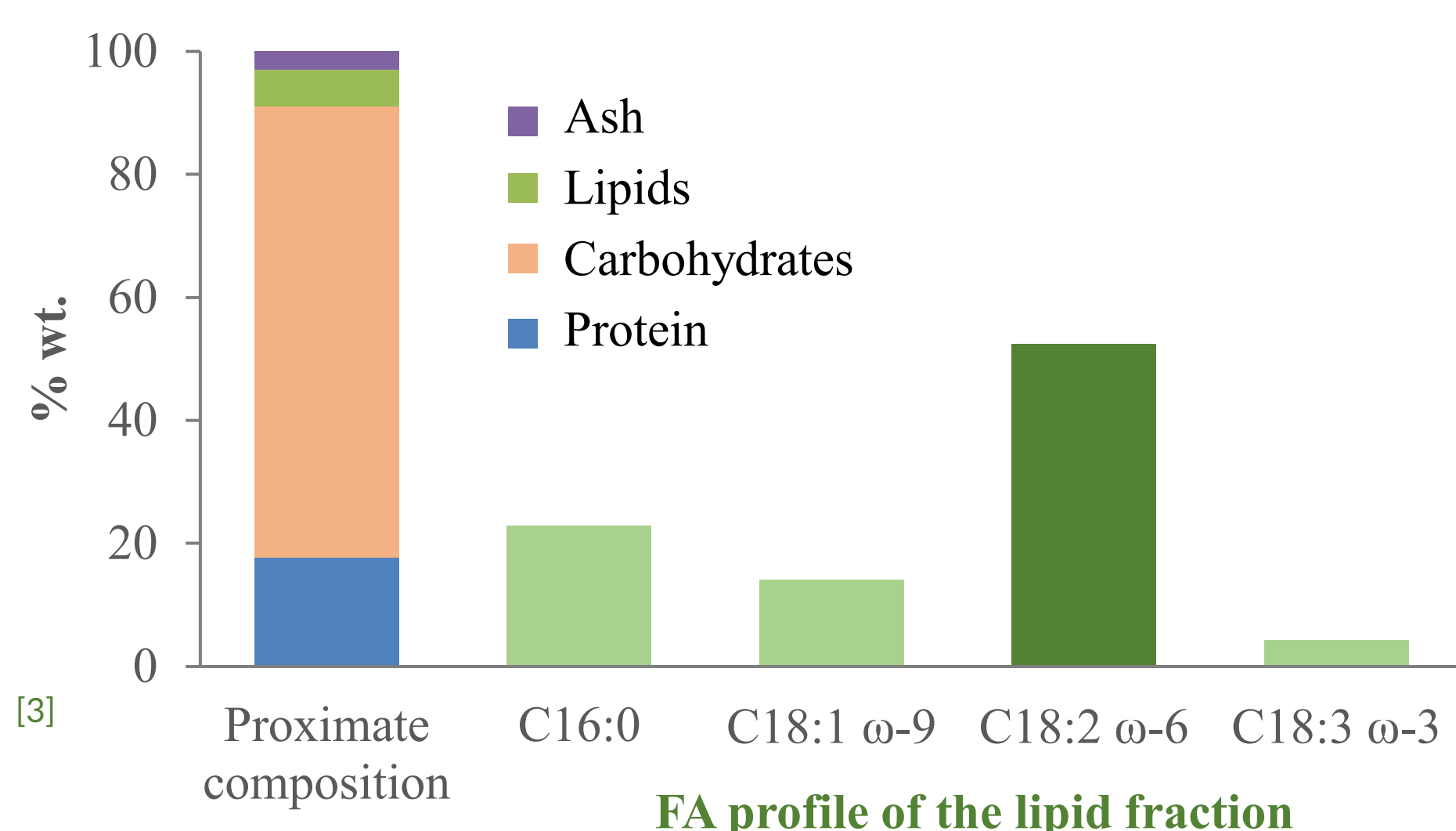
Discharge of BSG after mashing

Brewer's spent grain (BSG) is one of the most important by-products in the beer industry

- 100 L of beer generate ca. 20 kg of BSG
- BSG accounts for 85 % of the total residues of the brewing process [1]
- BSG is mainly used for animal feed (70 %), biogas production (10 %), or landfilled [2]

BSG presents a valuable chemical composition, allowing its valorization

- High content of protein and carbohydrates
- Important quantities of phenolic compounds
- Non-negligible amount of lipids (ca. 6 %), with more than 50 % being linoleic acid (C18:2 ω-6) [3]



Materials & Methods

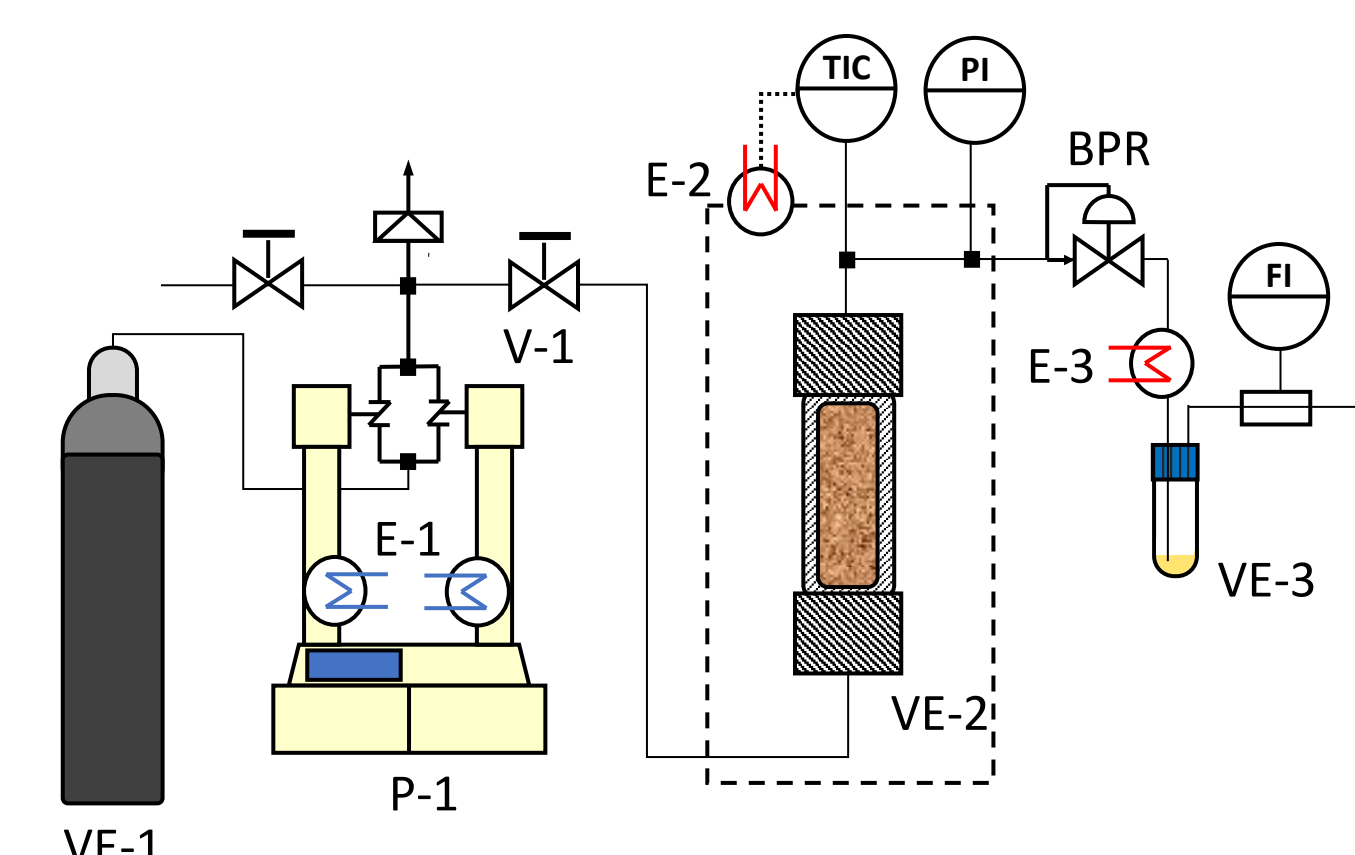
Supercritical CO₂ Extraction of the lipophilic fraction of BSG

Systematic study

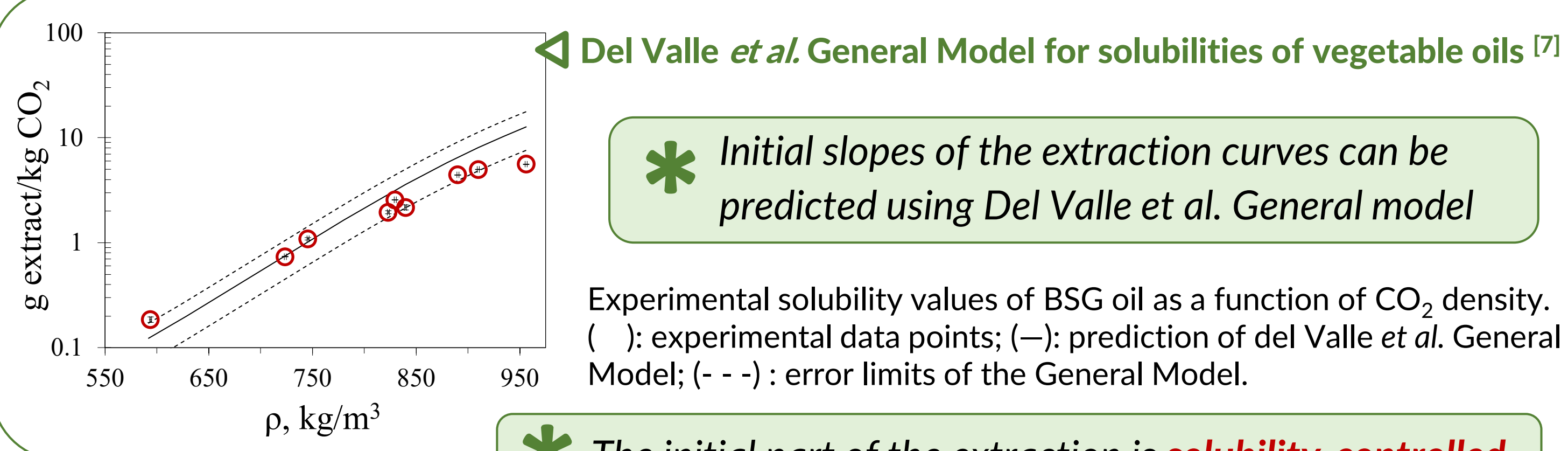
- Particle size
- p = 20 - 40 MPa
- T = 313 - 353 K

Effect on total yield, total phenolics (Folin method) [4], flavonoids (AlCl₃ method) [5] and antioxidant activity (ABTS method)

Extraction curves were fitted to the Sovová's Model [6]

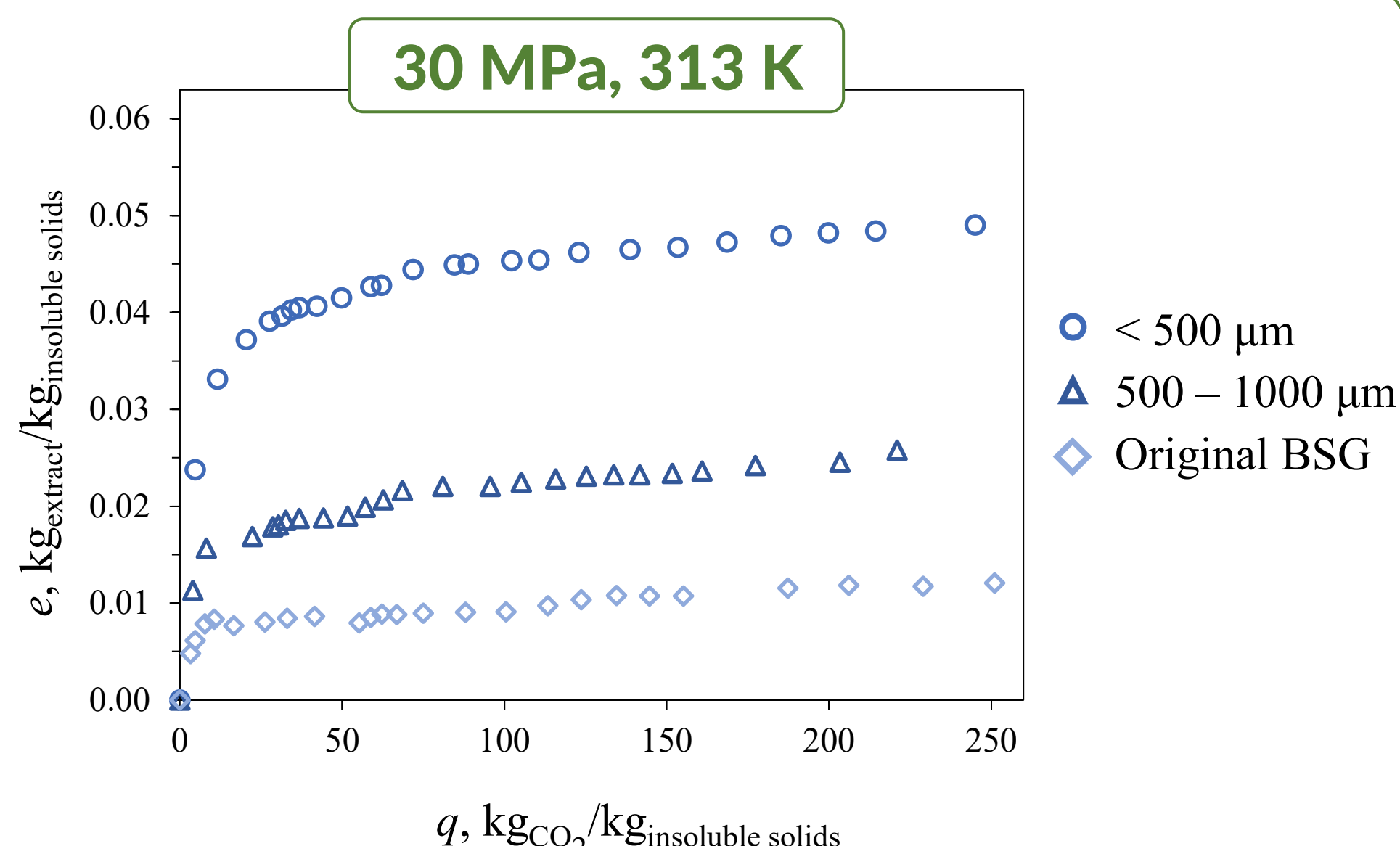


Schematic representation of the SFE apparatus
VE-1: CO₂ reservoir; VE-2: extractor; VE-3: separator; P-1: CO₂ pump; E-1: cryostat, E-2: oven, E-3: heating resistance; BPR: Back-pressure regulator; Temperature and Pressure Indicators and Controllers.



Results

∇ Influence of the particle size



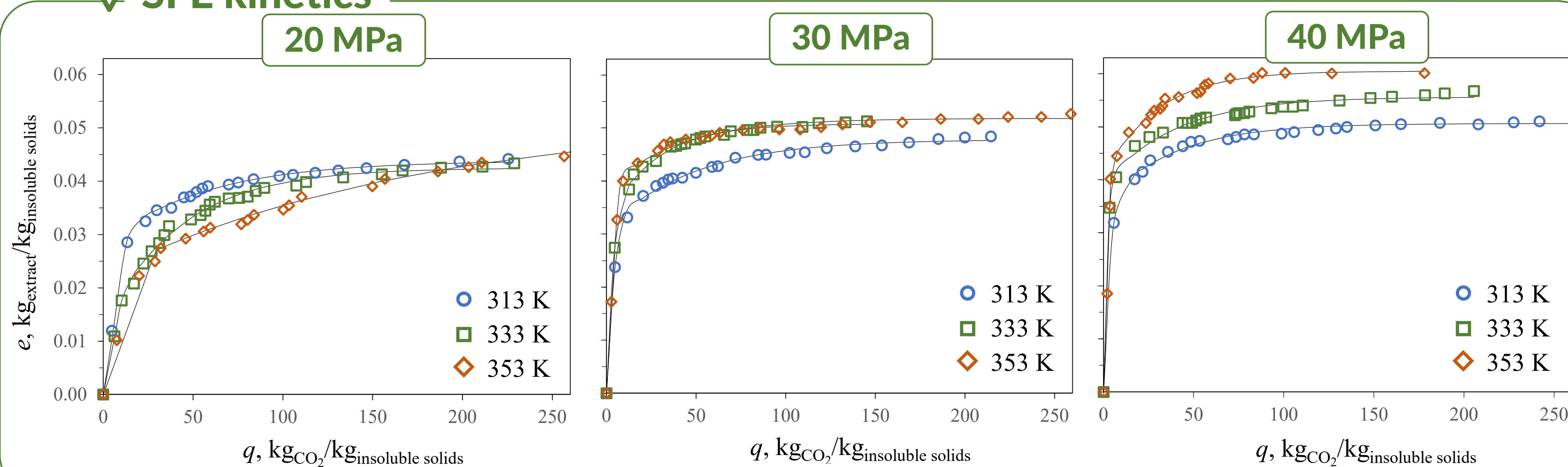
∇ Original particle size distribution of BSG

Part. size (μm)	>1000	1000-500	500-250	250-125	< 125
% wt.	3.85	6.53	17.37	58.05	14.21

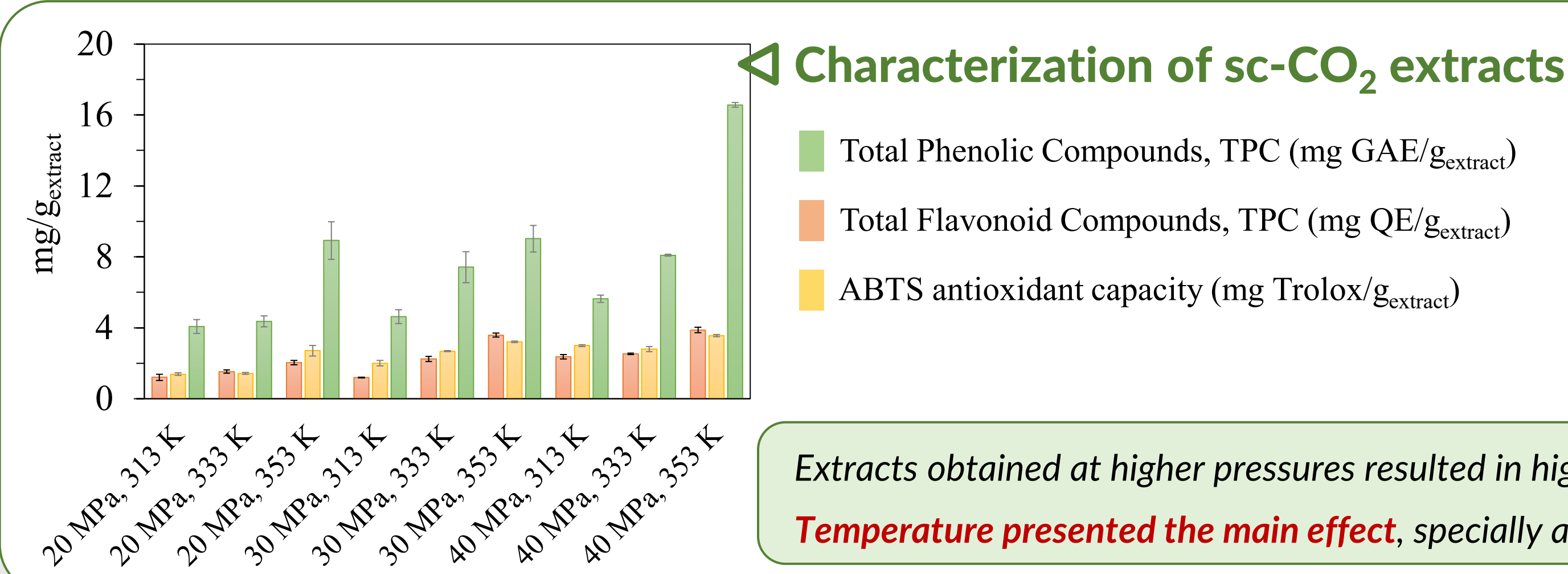
Grinding and sieving to < 500 μm improved accessibility and diffusivity, increasing extraction rate and final yield

* Further experiments were performed with ground and sieved BSG (< 500 μm)

∇ SFE kinetics



* As in many vegetable oils, a cross-over behavior was observed at 40 MPa



Extracts obtained at higher pressures resulted in higher content of TPC, TFC and ABTS
Temperature presented the main effect, specially at the highest pressure studied in this work

* Continuous lines are from the fitting of the Sovová's Model

$$e = q \cdot y_s, \text{ for } 0 \leq q \leq q_c$$

$$e = x_u [1 - C_1 \exp(-C_2 \cdot q)] \text{ for } q \geq q_c$$

where C_1 and C_2 are adjusting constants, y_s is the experimental solubility datum, q_c the crossing point, and x_u is the solute concentration in the untreated solid

References

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Acknowledgements

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