Electrorheological behaviour of flour/olive oil dough

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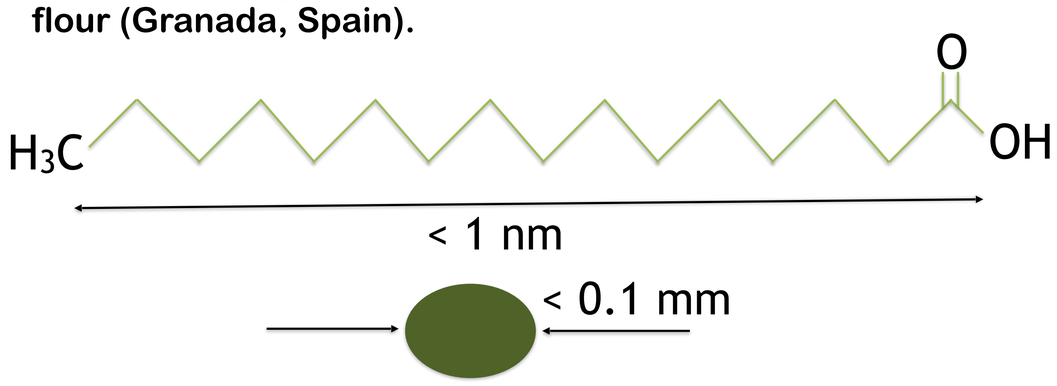
Background

- Changes in flow properties upon the application of an electrical field can be evaluated using of electrorheological techniques.
- The fact that it had shown successful to reduce the fat content [1] has aimed us to explore potential benefits resulting from the wide use of this technique in food science.
- It was claimed long time ago that the integration of this technique in food processing should translate into the development of new products [2].
- A study on the influence of the solid content and temperature on the steady viscous flow electrorheological behavior of wheat flour/olive oil dough has been made.
- The overall conclusion is that this system is electrorheological positive, i.e. the yield stress increases with the electric field.

Experimental

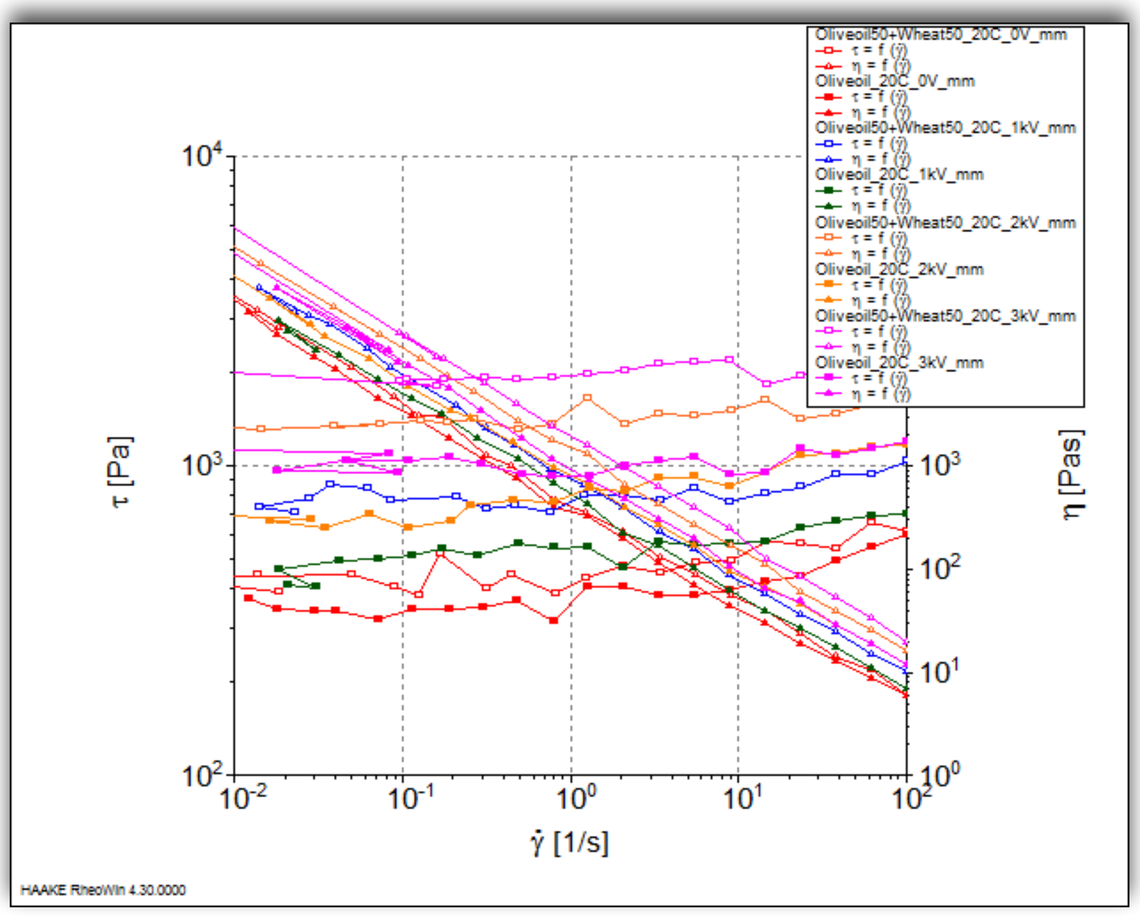
- Materials: "Virgen extra" olive oil (Córdoba, Spain) and Wheat flour (Granada, Spain).



- Stress controlled rheometer: RS600 (Thermo Scientific, Germany). Plate-plate (35mm). Electrorheological module.

- Methods: Oil added to flour and handle agitated during 5 min just prior to measurement. Pre-shear of 100s^{-1} during 60s and decreasing shear rate sweep. Temperature control with a bath circulator.

Results



- Herschel-Bulkley model was fitted to experimental data:

$$T = T_y + KD^n$$

Olive oil

Electric field (kV/mm)	K·10^{-5} (Pa·s^n)	n	T_y (Pa)	r^2
0	5.2±0.5	0.40±0.02	350±10	0.9987
1	5.8±0.6	0.42±0.04	500±12	0.9799
2	6.2±0.4	0.43±0.03	690±15	0.9892
3	6.7±0.3	0.41±0.04	995±15	0.9977

50% w/w flour/olive oil dough

Electric field (kV/mm)	K ·10^{-5} (Pa·s^n)	n	T_y (Pa)	r^2
0	5.4±0.6	0.41±0.02	460±14	0.9897
1	6.1±0.4	0.42±0.03	810±10	0.9979
2	6.6±0.4	0.41±0.05	1200±20	0.9982
3	7.0±0.5	0.41±0.03	2000±30	0.9797

- The yield stress increases with the electric field.
- The flow index does not depend on the electric field, therefore, we can affirm that the consistency increases with the electric field.
- Consistency and yield stress increase with wheat flour content.

References

[1] Daubert, C.R., and Steffe, J.F. (1996). J. Texture Studies. 27, 93-108.
[2] Tao, R., Tang, H., Tawhid-Al-Islam, K., Du, E., and Kim, J. (2016). PNAS. 113, 7399-7402.

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