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Downstreaming of valuable compounds from microalgae with spark discharges, instigated by 100-ns high voltage pulses

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Microalgae have become an important resource for blue-green biotechnologies. In addition to their potential for biofuel production, microalgae comprise also valuable metabolites for pharmaceutical and nutritional purposes, such as fatty acids, proteins, carbohydrates, and pigments. However, microalgae are distinguished by a sturdy cell wall, which affords a remarkable mechanical and chemical strength that often translates into inadequate extraction yields. Therefore, conventional extraction methods have shown to be often energy and/or time consuming and consequently are associated with unreasonable economic costs [1]. Accordingly, improvements and alternatives to current extraction methods are needed for successful commercialisation.

In our previous works [2], [3], we could show that spark discharges, instigated in microalgae suspensions with 100-ns high-voltage pulses, offer a gentle and yet effective extraction method, especially for heat sensitive compounds. When comparing with extraction by burst microwave heating, proteomic analysis revealed commonalities and differences in the protein distribution pattern. Although the yields and number of extracted proteins were similar, notably valuable heat-sensitive proteins, e.g. photosystem-related proteins could be extracted abundantly in comparison to the reference method. Schlieren diagnostics and atomic force microscopy were conducted to elucidate the responsible spark properties for successful cell wall disintegration. Results show that for the generation of sparks by short high-voltage pulses, in particular the energy that is dissipated by shockwaves could easily overcome the stiffness of the microalgae.

1. Lee, A.K., et al.; Biomass and bioenergy, 2012. 46: p. 89-101.
2. Zocher, K., et al., Plasma Medicine, 2016. 6(3-4): p. 273-302.
3. Zocher, K., et al., Algal Research 39, 2019. 101416.

Author: ZOCHER, Katja (Leibniz Institute for Plasma Science and Technology)

Co-authors: RATAJ, Raphael; Dr STEUER, Anna (Leibniz Institute for Plasma Science and Technology); KOLB, Juergen (Leibniz Institute for Plasma Science and Technology)

Presenter: ZOCHER, Katja (Leibniz Institute for Plasma Science and Technology)

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