UTILIZATION OF A FLEXIBLE ELECTRODE DIELECTRIC BARRIER DISCHARGE FOR AGRICULTURE APPLICATIONS

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Atmospheric pressure plasmas are fit for agricultural applications being powerful chemical reactors that operate at room temperature. We have been using a surface dielectric barrier discharge produced with a flexible electrode, similar to one that has been proven useful for microorganism inactivation [1].

Our previous work focused on studying the effects of plasma in different conditions on the changes produced on different sprouting species (e.g. Japanese radish, broccoli, garden cress), in an attempt not only to reveal the optimum conditions for growth stimulation but to elucidate the insights of the plasma modification process. The trend is mostly to report positive effects, omitting the inhibitory possible outcome, which makes it difficult to get close to finding out how and what stimulates the germination and development and why [2].

The discharges are produced using a high voltage source of 10kHz and applying voltages in the range 9 – 14 kV pp values, treatments being performed either directly or when the seeds are placed inside a package; the latter case stops the reactive species to diffuse away from the processing area and intensifies the effects [3]. The net applied power is up to 100 W.

First noticeable modifications are the changes on the surface of the seeds detected using electron microscopy, with morphological changes that depend on the processed species, slight disintegration of the outer epidermis, irregular agglomerations, and strong etching in the case of in-package treatment. The physical changes are reflected on the water contact angle of the seeds measured using the water drop method. For in package treatment with low powers there is an increase of the water contact angle while for high power and long processing time there is a decrease of the water contact angle with about the same amount. The intensified action of the reactive species might trigger some biological response with increased germination potential, longer stems (with about 48%) as compared with the direct plasma treatment, especially for low applied power (~40 W).

Not only the physical properties of the species change after exposure in different conditions, but the biochemical profile of the resulting sprouts as well. The chlorophyll pigments concentrations increase after direct plasma treatment and decrease in the case of in-package exposure. We conclude that the reactive species concentrated action has an important role in the modification of the seeds and further affects the germination and plant growth, probably as physiological responses of the interactions that take place at cell level, which might be biological responses to abiotic stress. The changes are slightly different depending on the species, probably because of the difference in their morphology and biology.

References:

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