Plasma and pulsed power applications to agriculture, fishery and food processing

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Plasma and pulsed power technologies are useful in several stages of agriculture, fishery and food processing. We developed repetitively operated compact pulsed power generators with a moderate peak power. Types of pulsed power that have biological effects are caused with gas discharges, water discharges, and intense high-electric fields. Some applications of agriculture, fishery and food processing were carried out collaborating with some institutions related to the agriculture.

The pulsed repetitive discharge were used for promoting growth of the vegetables and fruits. The growth rate of the vegetables and sugar content in the strawberry harvested after the cultivation increased by the plasma irradiation to the hydroponic solution [1]. **Fig.1** shows photographs of *Brassica rapa var. perviridis* at 28 days of cultivation for various plasma treatment times using a magnetic-compression pulsed power generator. The plasma was irradiated in the drainage water for 10 and 20 minutes each day. The leaf size of the plants increased with plasma treatment time. The yielding rate of Shiitake mushroom (*Lentinula edodes*) was also improved with the high-voltage stimulation in fruit-body formation phase [2].

The electrostatics effect is useful for keeping freshness of agricultural and fishery products [3,4]. **Fig. 2** shows the photographs of the strawberry after 10 days preservation without and with electric field. The mold is confirmed at without AC electric field after 10 days preservation. However, the mold is suppressed by applying AC electric field. The airborne particulates are collected by electrostatic effect. This collection by electric field contributes to reduce the infection risk with fungi spore.

The pulse electric field was utilized for an extraction of nutritive molecules from grape skin [5]. **Fig. 3** shows optical microscopy images of the grape skins with and without pulse electric field (PEF) treatment. Large number of red color pigments is confirmed in case without PEF treatment. The pigments are anthocyanoplasts which contain polyphenol. Many anthocyanoplasts in the grape skin cells are collapsed by PEF treatment with 1020 ns in pulse width, and the red color pigments are extracted from the anthocyanoplasts.

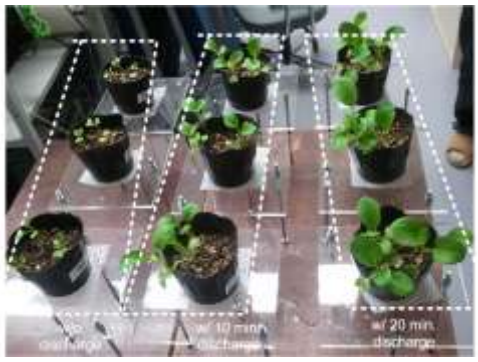
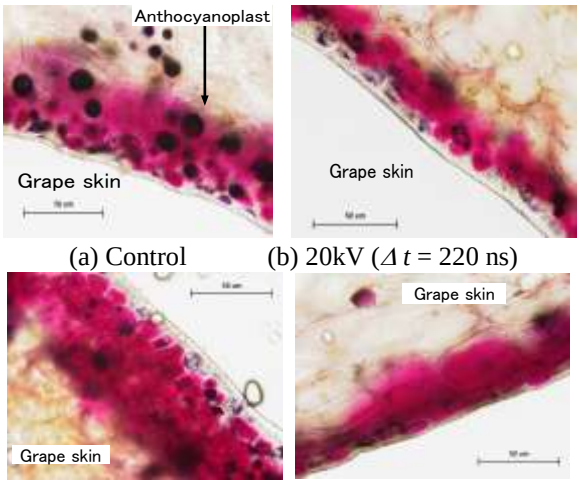


Fig. 1 Photographs of *Brassica rapa var. perviridis* cultivated for 28 days at (a) w/o plasma and with (b) 10 min. or (c) 20 min. treatment per day.

Fig. 2 Photographs of the strawberries after 10 days preservation without (left) and with (right) AC electric field.



(a) Control (b) 20kV (Δt = 220 ns)

(c) 20 kV (Δt = 610 ns) (d) 20 kV (Δt = 1020 ns)

Fig. 3 Optical microscopy images of reaction inside the grape skin cells at variable pulse widths.

References:

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