

【Grant-in-Aid for Scientific Research (S)】

Broad Section C



Title of Project : Novel function control of plant and marine products by pulsed power and its scientifically deepening

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Research Project Number : 19H05611 Researcher Number : 00216615

Keyword : pulsed power, plasma, plant, food

【Purpose and Background of the Research】

Pulse-electric field and electrostatic effects have been used in agriculture and food processing as electro-spray, electroporation. Recently, pulse voltage and plasma are newly used in agriculture and food processing as seed germination promotion, seedling growth enhancement and inactivation of bacteria. Objective of the study is development of novel function control of plant and marine products based on pulsed power technologies and its scientifically deepening for contribution in agriculture and food science. Multi-reaction field of plasma and intense electric field are produced and controlled spatially and temporally with micro-meter and nano-second range using highly optimized pulsed power generators. The novel control of plant activity and marine product functional content are produced using the multi-reaction field.

【Research Methods】

Key issue of the project is production of multi-reaction field of plasma and intense electric field with spatially and temporally control to adapt whole bio-scale as shown in Fig. 1. Especially, pulse width of the intense electric field is designed to match relaxation time (nano-second or lower scale) of water molecule and protein. The pulsed power generator is also designed to match temporally changed impedance of bio-specimen by choosing optimum system (pulse forming line, inductive and capacitive energy storage circuit, H-bridge circuit) and semiconductor switching devise such as SiC-FET. In the plant activity control, seed germination, effect of the multi-reaction on seedling growth enhancement, resistance for pathogenic bacteria and photosynthesis are evaluated through redox, metabolism, phytohormone and gene expression analysis.

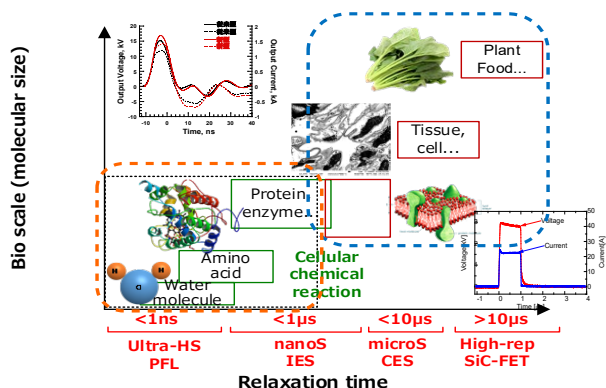


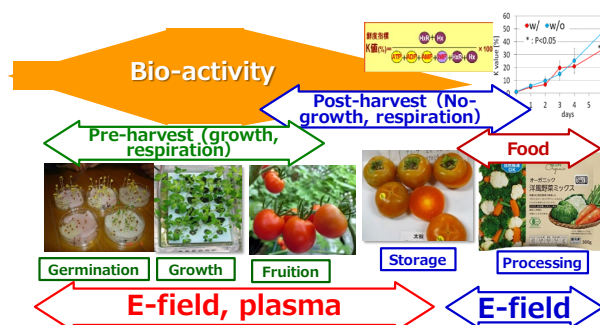
Fig. 1 Relation between bio-scale and relaxation time.

In the food safety issue, the effect on qualities (freshness) of agricultural and marine products are evaluated by

k-value, bacteria number density, color index for ripening, enzyme activity and protein conformational change. In the functional food issue, the effect on functional group content in processed food from agricultural and marine products is evaluated by enzyme activity analysis, nutritional analysis, fermentability of yeast, SDS-PAGE, LC and GC analysis and conformational change of protein which is analyzed by UV absorption spectra.

【Expected Research Achievements and Scientific Significance】

This project focus on pulsed power based multi-reaction field effect on plant activity and food function in science based on not only relaxation time of each bio-scale but also bio-activity of each growth phase as shown in Fig. 2. This approach is highly motivated challenge and has possibility to contribute the cutting-edge science.



【Publications Relevant to the Project】

- Fig. 2 Multi-reaction fields for each growth phase.
- K. Takaki et al, "Topical Review, High-voltage technologies for agriculture and food processing", J. Phys. D: Appl. Phys. (accepted) (42pp).
- K. Takaki et al, "High-Voltage Methods for Mushroom Fruit-Body Developments", in "Plant and Mushroom Development" (IntechOpen Limited, London, 2018.9)

【Term of Project】 FY2019-2023

【Budget Allocation】 153,100 Thousand Yen

【Homepage Address and Other Contact Information】

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