Pulsed electric field for agricultural applications

- Accelerating drying of tobacco
- Increasing yield of potatoes
- Killing of weeds
PEF for acceleration tobacco leaves drying process

The main problem during tobacco leaves drying is connected with dehydration of the leaves’ main vein.

A treatment should accelerate the drying but preserve the quality of the leaves.
Electrical circuit of PEF equipment – simultaneous treatment of two or more tobacco leaves

Treatment voltage
Capacitance of discharge couture
Number of pulses
System electrodes for the energy dosage supplying to the main vein, depending on main vein length.
PEF equipment for the energy dosage supplied to the main vein, depending on the main vein length.
PEF equipment - energy dosage supplied to the main vein, depends on main vein length
PEF equipment - energy dosage supplied to the main vein, depends of main vein thickness
PEF equipment - energy dosage supplied to the main vein, depends on main vein thickness
PEF treatment of potato tubes

The yield increases by 30%:
- Treatment voltage – 5 kV;
- Capacitance of discharge capacitor 5 nF;
- Pulse number 2;
PEF treatment of weeds - destroy them

Treatment voltage depend of the kind of weed from 2 to 40 kV.
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PEF of frozen cranberry

Freezing breaks the cell membrane similarly to the PEF treatment.

Conclusion: Never treat a frozen food to enhance juice extraction.
PEF generator TG1-6 kV 250 W
Spark gap switch
PEF Treatment chamber for enhancement alfalfa juice extraction
Pressing the treated alfalfa
Treatment parameters

Electric field: 1.5, 2.0 and 2.5 kV/cm;
Capacitance: 1μF;
Pulse numbers ranging from 10 to 200.

Pressure: 0.5, 2.0 and 4.0 MPa using an Instron Universal Testing Machine.
Results

PEF treatment increased extraction of juice from alfalfa mash by 38% compared to non-PEF treated samples.

• PEF treatment increased the quantity of protein extractable from alfalfa by 57%.

• PEF apparently enhanced mineral extraction from alfalfa by 73%.
PEF for enhancement of lycopene extraction in tomatoes
Tomato pulp  PEF treatment

Treatment parameters:

Electrical field 4, 8, 16, 20 and 24 kV/cm;
Capacity of discharged capacitor 0.02, 0.06, 1, 2 and 3 μF;
Pulse number 10, 20, 30, 40 and 50.

A rapid spectrophotometric determination at 503 nm was used to determine of lycopene content.
Results

A maximum percentage of 68.8% lycopene content was obtained using pulsed electrical field with parameters:

Electrical field: 16 kV/cm;
Capacitance: 2 μF;
Pulse number: 50.
PEF equipment for tomato treatment
PEF equipment for tomato treatment
PEF generator TG2 30 kV 25 kW
PEF generator

30 kV and 20, 40 and 60 nF;
15 kV and 1, 2 and 3 μF
PEF treatment of carrots before drying and rehydration

Treatment parameters
1) \(E = 1 \text{kV/cm}, \ C = 0.5 \mu \text{F}, \ n = 20\)
2) \(E = 1.5 \text{kV/cm}, \ C = 1 \mu \text{F}, \ n = 20\)
Following pretreatment, samples were oven dried at 70\(^\circ\) C.
Results

PEF pretreatment increased the drying rate of carrots. The rehydration rate of PEF-pretreated carrots was lower than that of blanched carrots.

There were no color differences between PEF-pretreated and blanched carrots before drying and after rehydration.

In terms of texture, PEF-pretreated carrots were firmer than blanched carrots.

PEF pretreatment reduced the activity of peroxidase by 30 – 50%, while blanching completely inactivated the enzyme.
Pretreatments on drying characteristics of okra

Results

Drying rates were significantly ($P < 0.05$) influenced by the different pretreatments.

The control samples had the lowest coefficient of diffusivity while samples pretreated with PEF at maximum energy input (4 kV/cm, 500 nF) had the highest coefficient.

Rehydration capacities of the control and pretreated samples were significantly different.
Pulsed electric field-induced structural modification of whey protein

PEF treatments of WPI resulted in an increase in intrinsic tryptophan fluorescence intensity with a 2-4 nm red shift at electric field intensity of 20 kV/cm and 30 pulses.

Treatment parameters:
Electric field - 12, 16 and 20 kV/cm
Capacitance - 0.33 μF
Pulse number -10-30
Static parallel plates treatment chamber
Continues parallel plates treatment chamber
Continues parallel plates treatment chamber
Co-field treatment chamber
Three co-field chamber connected parallel for treatment and series for flow
Spark gap switch
PEF system for treatment of liquids
UV light treatment chamber
Results

Ultraviolet light is a potent catalyzer for lipid oxidation, which caused the off-flavors, therefore UV light should be use for liquids that not contain fats (milk, egg and other).

Ultraviolet light and PEF treatments have additive effect on inactivation of *E. coli* in apple Juice
PEF and ultrasound for bacteria inactivation
PEF treatment of potatoes to improve the cutting process (for French fries)

Treatment parameters
Electrical field: 1-2 kV/cm;
Capacitance: 1 μF;
Pulse number: 5.
Enhanced anthocyanin extraction from red cabbage using PEF

Mashed cabbage was PEF treated with: E=2.5 kV/cm, C=1 μF, and n=50.

Extracted anthocyanin concentrations were determined using HPLC.

Results

PEF treatments enhanced total anthocyanin extraction in water from red cabbage by 2.15.

The heat and light stabilities of the PEF-treated samples and control samples were not significantly different (P > 0.05).
Enhanced anthocyanin extraction from red cabbage using PEF
Enhanced $\beta$-carotene extraction from orange pills using PEF
Power semiconductor switch

HV Single
Discrete IGBT
60 Amperes/4500 Volts
Power semiconductor module
Conclusion

PEF application can been seen in many articles, but to see them in the real life, scientists from electrical engineering and food should cooperate and work together.
Thank you