The effect of Cold Atmospheric Plasma treatment on the nutritional quality of leafy greens

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Objective
Cold atmospheric plasma (CAP) is a surface modification technology that has shown extensive promise as a pathogen inactivation technology due to its production of multiple highly reactive products including reactive oxygen and nitrogen species (RONS). RONS inactivate pathogens via oxidative damage to the cell membrane as well as DNA damage. However, this oxidative damage is not restricted to the pathogenic organisms and can result in quality loss in the products treated with CAP. While investigating the interactions of plasma product on leafy greens, we have found that plasma treatment triggers a stress response in plant tissue.
Methods
Leafy greens purchased from a local supermarket were treated by a bench top dielectric barrier discharge (DBD) plasma device (Advanced Plasma Solutions, Malvern Pennsylvania). After treatment, the ROS levels were evaluated using the fluorescein assay (em/ex: 485-525). Flavonoid content was also measured using the diphenylborinic 2-aminoethyl ester (DPBA) assay (em/ex:400/465nm) with epigallocatechin gallate (EGCG) used as the reference compound.
Results
Spinach, red leaf lettuce, and kale all significantly ($p<0.05$) increased their ROS content following CAP treatment, however significant differences were observed in flavonoid content in the three different species. After CAP treatment, flavonoid content in spinach leaves treated with 120 W CAP increased significantly ($p<0.05$) to 3.92 ± 1.83 g EGCG Eq /g. The opposite effect was observed in kale where all treatments resulted in a significant reduction in flavonoid content. No significant difference in flavonoid content was observed in red leaf lettuce compared to control.
Conclusions
CAP treatment of leafy greens appears to trigger the plant stress response system which is still active in plant tissues post-harvest. The products of the stress response appear to differ between species and appear to significantly increase the nutritional value of spinach. Results suggest that different treatment conditions and electrode designs may be needed to preserve leafy green quality while enhancing product safety. Additionally, treatment modifications and innovations in electrode design could enable further nutritional enhancements in these popular and already highly nutritious foods.