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**Effectiveness of UV-C irradiation on controlling growth of
L. monocytogenes on fresh cut broccoli**

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ABSTRACT

Increasing numbers of foodborne disease outbreaks related to fresh produce are reported every year from around the world. This increase is partly attributed to increased consumption of fresh produce such as whole and fresh cut fruits and vegetables. Fresh produce can be contaminated at any time from field to table, providing channels for transmitting foodborne pathogens to humans. Studies have reported that human pathogens such as *Listeria monocytogenes*, which can grow and survive under refrigerated conditions, cannot be adequately removed by washing with commonly used chemical disinfectants. Consumers prefer products that have not been treated chemically, especially fresh products that are consumed without further processing before consumption. Physical treatments such as UV-C irradiation have shown promising effects in improving storage life, nutritional quality, and microbial safety of fresh produce. UV-C irradiation is beneficial due to its direct germicidal effect, and could possibly induce defence responses in fresh produce which may further improve quality and safety. However, direct germicidal effects would be limited by the uneven surfaces of fresh produce, with risk of survival of pathogens in areas shaded from direct UV exposure. It is also not clear whether induced defence related changes would be sufficient to offer any significant protection against human pathogens. Therefore, this study focused on evaluating the efficacy of postharvest UV-C irradiation to control growth of *L. monocytogenes* inoculated onto fresh cut broccoli at different times after UV-C treatment, and possible mechanisms of induced resistance.

UV-C irradiation supplied at a total dose of 5.2 kJ m^{-2} significantly reduced growth of *L. monocytogenes* inoculated onto fresh cut broccoli 6 h and 24 h after treatment, whereas a 2.6 kJ m^{-2} treatment was suppressive only 24 h after treatment. Neither dose of UV-C adversely affected the quality of fresh cut broccoli compared to untreated broccoli. The *in vitro* study of extracts of UV-C treated broccoli extracted 24 h after UV-C treatment showed that certain extracts were indeed suppressive against *L. monocytogenes*. Aqueous extract of UV-C treated broccoli extracted 24 h after treatment suppressed growth of *L. monocytogenes* compared to extracts of untreated broccoli. Phytochemical analysis of broccoli extracts by LC-HRMS revealed that UV-C irradiation significantly increased production of particular

phytochemical compounds. Compound identifications included raphanusamic acid, salicylic acid- β -glucoside, *p*-coumaryl quinic acid, all of which have been previously reported as being involved in plant defence. Therefore, UV-C irradiation appears to induce defence responses which may be effective systemically, and therefore not critically dependent on achieving an effective sanitising dose of UV-C across the entire broccoli surface. This may alleviate concerns about relying on uniform illumination for anticipated benefits.

Overall, these results suggest that treatment of broccoli with UV-C irradiation should lead to immediate microbial mortality, and a longer-lasting induction of defence systems in the tissues, which would suppress growth of pathogens such as *L. monocytogenes* if the tissue became contaminated during processing. Therefore this treatment can be recommended as a hurdle technology to improve microbial safety of packaged fresh produce.

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LIST OF ABBREVIATIONS

CFU	Colony forming units
CSLM	Confocal scanning laser microscopy
DMSO	Dimethyl sulfoxide
GC-MS	Gas chromatography - mass spectrometry
GLSs	Glucosinolates
H	Hours
ITC	Isothiocyanate
JA	Jasmonic acid
kJ	Kilo joules
LC-HRMS	Liquid chromatography - high resolution mass spectrometry
OD	Optical density
PAL	Phenylalanine ammonia-lyase
PCA	Principal component analysis
RT	Retention time
RTE	Ready - to - eat
SA	Salicylic acid
SEM	Scanning electron microscopy
SOD	Superoxide dismutase
TSB	Tryptic soy broth
UV	Ultraviolet

