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Hypobaric treatment: An innovative approach to control postharvest diseases of strawberries

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Abstract

Fungal decay is one of the major causes of postharvest losses in strawberries. Conventionally fungicides have been used to control fungal decay. However, fungicides have been questioned as a sustainable and safe method. Pre-storage application of short-term hypobaric treatment is one of the potential non-chemical methods for reducing fungal decay. In this study efficacy of postharvest hypobaric treatments to control natural rot development in strawberries was evaluated and analysed for the possible induction of resistance. Treatment of strawberries with hypobaric pressure (50 kPa_a for 4 h at 20 °C) consistently reduced rot development in subsequent storage at 20 or 5 °C. An *in vitro* study found that the rate of radial growth of colonies of *Botrytis cinerea* and *Rhizopus stolonifer* was unaffected by hypobaric treatment. Moreover, post-hypobaric treated strawberries inoculated immediately or 12 h after treatment with corresponding fungi led to significant ($P< 0.05$) rot reduction during storage at 20 °C. Bio-chemical analysis of strawberries suggested that hypobaric treatment upregulated the activities of defence-related enzymes with phenylalanine ammonia-lyase (PAL) and chitinase peaking 12 h after treatment, while peroxidase (POD) increased immediately after treatment. These results provide evidence that the mechanism of action of hypobaric treatment is induction of the defence system within the fruit rather than a direct effect on fungal viability. Furthermore, the 4 h delay in cooling required for hypobaric treatment did not cause greater rots compared to immediate cooling at-harvest. Therefore treatment is recommended to be applied at low temperature immediately after harvest. Despite these scientific results, a combination of hypobaric treatment and cold storage may not be sufficient for extending commercial storage life of strawberries. For more effective application, probably hypobaric treatment should be regarded as a hurdle technology to be used in conjunction with other physical treatments such as (UV-C, heat and ultrasound) and/or volatile chemical treatments.

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In the loving memory of my beloved mother

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1-MCP	1-methylcyclopropene
ANOVA	analysis of variance
CA	controlled atmosphere
° C	degree Celsius
d	day (s)
ETI	effector-triggered immunity
g	gram (s)
g	gravitational acceleration
h	hour (s)
JA	jasmonic acid
kPa_a	kilo Pascal absolute pressure
kg	kilogram (s)
L	litre (s)
MSCs	mechanosensitive ion channels
MeJA	methyl jasmonate
µL	microlitre (s)
mL	millilitre (s)
mm	millimetre (s)
mmol	millimole (s)
min	minutes
MA	modified atmosphere
MAP	modified atmosphere package
nmol	nanomole (s)
N	Newton
OD	optical density

PAMP	pathogen-associated molecular patterns
PR	pathogenesis-related
%	percent
POD	peroxidase
PAL	phenylalanine ammonia-lyase
PPO	polyphenol oxidase
PDA	potato dextrose agar
PCD	programmed cell death
PTI	PAMP-triggered immunity
RH	relative humidity
SA	salicylic acid
s	second (s)
SAR	systemic acquired resistance
UV	ultraviolet
WVP	water vapour pressure