

SHORT COMMUNICATION

# Non-invasive photoacoustic spectroscopic determination of relative endogenous nitric oxide and ethylene content stoichiometry during the ripening of strawberries *Fragaria anannasa* (Duch.) and avocados *Persea americana* (Mill.)<sup>1</sup>

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## Abstract

**Employing non-invasive photoacoustic spectrometry, emissions of nitric oxide (NO) and ethylene in post-harvest strawberries and avocados were monitored. A clear-cut stoichiometric relationship was found between the two gases: unripe fruit manifesting high NO and low ethylene levels—the converse in ripe fruit. Findings are discussed in the light of putative control of ethylene-promoted fruit senescence by endogenous NO.**

Key words: Strawberries, avocados, photoacoustic spectroscopy, nitric oxide, ethylene.

## Introduction

In the 1880s the first reports of the photoacoustic effect—the production of sound waves as a consequence of light absorption—were published practically concurrently by Bell in the USA, Tyndall in Britain and Röntgen in Germany (Bell, 1880; Tyndall, 1881; Röntgen, 1881). A reverse effect based on the same physical principle, where 'the people saw the voices', is described even earlier in Exodus XX:15 upon the issuing of the Ten Commandments to Moses on Mt. Sinai.

Criticism has been expressed of the hypothesis that in fruit maturation an endogenous stoichiometric NO/C<sub>2</sub>H<sub>4</sub>

relationship exists and that, concomitantly, NO may be employed as a post-harvest senescence retarding agent (Leshem and Wills, 1998; Leshem *et al.*, 1998). This criticism particularly pertains to endogenous plant NO emissions which, in the above reports, were partially based on data obtained from an invasive technique whereby an NO-sensitive microprobe was inserted into the fruit tissue and therefore that the wounding caused, albeit minor, NO emissions which ordinarily would not occur. The present research addresses this contention by using the recently renewed non-invasive and rapid PAS technique as described in the Materials and methods.

## Materials and methods

### Plant material

Hydroponically grown green and consumer ripe red strawberries (*Fragaria anannasa* cv. Malach) used for the initial experiment were obtained from the B'sor Regional Agricultural Experimental Farm in the northern Negev region of Israel. The fruits were air-shipped to the Netherlands, the time duration from dispatch to arrival in Nijmegen being *c.* 5 h. Subsequent experiments were performed on strawberries on fruits purchased at the Nijmegen wholesale fruit market. Firm and ripening avocados (*Persea americana* cv. Carmel) were also obtained from the market. Each experiment outlined in the next section was repeated five times.

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Abbreviations: C<sub>2</sub>H<sub>4</sub>, ethylene; NO, nitric oxide; PAS, photoacoustic spectrometry.



