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Harnessing nitrous oxide in postharvest management of fresh horticultural produce

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ABSTRACT

High postharvest losses in fresh horticultural produce and the increasing apprehensions among the consumers for harmful chemical residues have made it imperative for researchers to find safe, novel and natural techniques to achieve augmentation in shelf-life without having any detrimental influence on human health. Nitrous oxide, commonly known as "Laughing gas" is a naturally occurring colourless and non-flammable atmospheric gas. In the recent past, several researchers have documented that nitrous oxide gas inhibits ethylene production as well as action in freshly harvested fruits and vegetables. It also exhibits high potential in inhibiting fungal growth and decay, consequently reducing postharvest losses due to diseases. Owing to its non-toxic nature, nitrous oxide can be potentially used to delay ripening and senescence of fresh horticultural produce during postharvest storage and to assure food safety. In the present review, we have mainly focused on various effects of nitrous oxide on postharvest decay, ethylene biosynthesis and its action, respiration and other physico-chemical attributes of fruits and vegetables. Postharvest application of nitrous oxide may open up various opportunities for its commercial use to prolong storage and marketability of fresh horticultural produce.

Key words: Decay, Ethylene, Fruit ripening, Nitrous oxide, Postharvest

Fresh fruits and vegetables are highly perishable after harvest which causes a significant loss of the harvested produce. Synthetic pesticides and other chemicals are used indiscriminately to control the decay and postharvest loss of the fresh horticultural produce. However, with the increasing concerns among consumers about health and harmful effects of pesticide residues on human health and environment lead the researchers to search for safe postharvest technologies which can enhance the produce shelf life and retain the inherent nutritive value of the food up to consumer end (Asrey *et al*. 2008). Several reports have been published about the harmful effects of synthetic chemicals on human health and environment (*Ritter et al*. 1995, Siddiqui and Dhua 2010). Recently, there has been a great interest on exploiting the potential benefit of some atmospheric gases for postharvest management of fruit and vegetables (Spencer 1995). Nitrous oxide (N_2O) commonly known as 'laughing gas', is a naturally occurring atmospheric gas. In the atmosphere, the gas is principally produced by aerobic denitrifying bacteria present in soil (Firestone and Davidson 1989). However, its emission can be increased by addition of nitrite fertilizer in the soil (Shepherd *et al*. 1991). At room temperature, N_2O remains as inert and chemically neutral gas. Similar to carbon dioxide (CO_2), N_2O also has a linear structure (isostery) which confers similar physical properties like relative stability and high solubility to both the molecules (Leshem and Wills 1998; Benkeblia and Varoquaux 2003). Nitrous oxide is also classified as greenhouse gas with high global warming potential. Compared to carbon dioxide, N_2O has 298 times the ability to trap heat in the atmosphere on per molecule basis however; due to lower concentration in the atmosphere it contributes only 6% to total global warming (Williams *et al*. 1992). The effect of N_2O on postharvest management of fresh fruits and vegetables has been investigated by few researchers. The available evidences suggest that it plays an important role in reducing disease incidence and enhances shelf life by reducing respiration and ethylene production rates. Although, very limited work have been done till now on the effect of N_2O on postharvest management of horticultural produce, the present review attempts to sum up various effects of N_2O as reported by researchers (Table 1), its application and future prospects.

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Brief history of nitrous oxide

Nitrous oxide was first discovered in 1772 by Joseph