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OXIDATIVE STRESS AND NON ENZYMATIC ANTIOXIDANTS DURING FRUIT RIPENING

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Abstract: Oxidative stress during the progression of ripening is the inherent property of fruits which accelerate the ripening processes. The causative agents of oxidative stress are reactive oxygen species (ROS) *viz.* superoxide (O_2^-**)**, singlet oxygen ($^1O_2^-$), hydroxyl (·OH), alkoxyl (RO•), peroxyl (ROO•), lipid peroxyl (LOO•), hydrogen peroxide (H_2O_2), etc. which causes damage and leakage of biomembrane and biomolecules. Simultaneously, antioxidants defense system activated for scavenging the excess ROS and suppresses the excess accumulation in the cell. The fruits are the rich source of non enzymatic antioxidants *viz.* Ascorbic acid, Glutathione, Carotenoids, Phenolics, flavonoids, Tocopherols, Tocotrienols, etc. which are scavenger of free radicals in human body as well as they protect the fruits from excess ROS. Thus, the balance between production and removal of ROS in the cell prolong the shelf life and retain the quality of the fruits during the storage period.
Keywords: Ascorbic acid, Carotenoids, Phenolics, ROS, Fruits, Ripening.

Introduction

Oxidative stress and antioxidants act antagonistically during ripening and senescence of the fruits. The accumulation of excess ROS during progression of ripening accelerates the senescence resulting in decrease of longevity of the fruits. The efficient antioxidant capacity of fruits keeps them fresh and consumable for longer period by suppressing the excess ROS. The fresh and ripened fruits are rich sources of antioxidants which are capable of suppressing the ROS as well as they are helpful in keeping us healthy and cure by improving immune system as well as lowering the risk of cardiovascular disease (Mundiyara et al., 2017). The sources of synthetic antioxidants have adverse side effects but fruits are the natural sources of antioxidants which are safer in the treatment of diseases caused by the free radicals. These antioxidants are phytochemicals and/or secondary metabolites viz. polyphenols, flavonoids, vitamins, alkaloids etc. having the capacity to reduce the ageing effects by suppressing the free radicals generated during metabolism (Forni et al., 2019).

Oxidative stress

Although ROS generally formed in mitochondria, peroxysome, chloroplast etc. but the fruit's chloroplast are going to degenerate during ripening hence mitochondrial and peroxisomal ROS affect the ripening behavior of the fruits (Hodges et al., 2004). They are the

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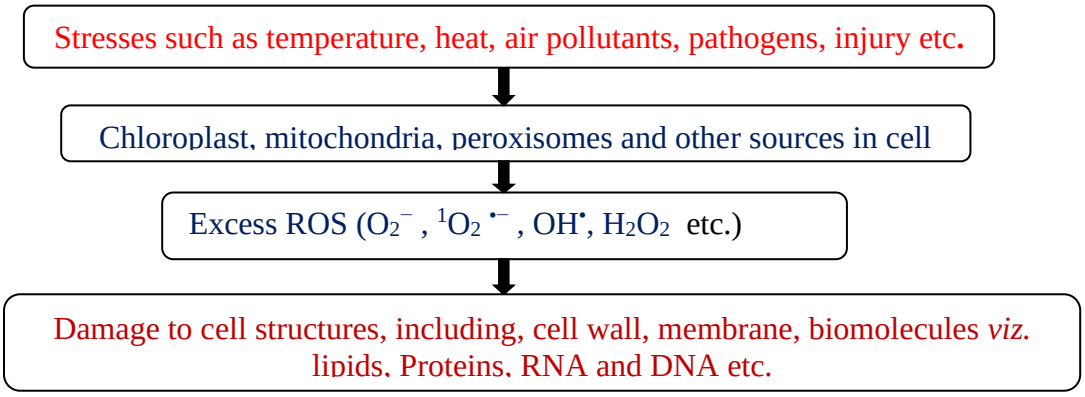
free radicals having the one or more unpaired electrons, produced due to lack of consumption and utilization of O_2 in the system especially during abiotic and biotic stress. These ROS molecules viz. O_2^-, $^1O_2^-$, OH^-, and H_2O_2. begin the series of chain reactions and regenerated repeatedly, and they form the free radicals include alkoxyl (RO•), peroxyl (ROO•), lipid peroxyl (LOO•) etc. in the system (Gill and Tuteja, 2010). During the progression of ripening the rate of respiration get first affected and the terminal acceptor of electron in aerobic respiration (O_2) do not get sufficient electron to produce water as in normal case. Thus, system get accumulation of O_2 having the unpaired electron resulting in production of excess ROS. Any system has the capacity to either tolerate or avoid the ROS, but the post harvested commodities have not such capacity and they need special care for storage. The formation of O_2^- during the progression of ripening fruits induce the formation of other ROS viz. $^1O_2^-$, $OH^•$, H_2O_2, etc. resulting in lipid peroxidation and a chain of reaction which led to leakage in the membrane (Jiménez et al., 2002).



Non Enzymatic Antioxidants

The water soluble non-enzymatic antioxidants are Ascorbic acid (AaA) and Glutathione (GSH) and lipid soluble are Carotenoids, Phenolics, Tocopherols and Tocotrienols, found in most of the fruits. These are the molecule act in different ways at different location/organelles in the cell and scavenge the excess ROS. Ascorbic acid, carotenoids and phenolics abundantly found in most of the fruits while Tocopherols and Tocotrienols are relatively in low amount as compared with nuts and grains. They are the molecules having the capacity to donate electron and reduced the oxidized state due to their electron-rich structure in the form of oxidizable double bonds and hydroxyl groups. The metal ions which are potent pro-oxidants viz. Cu, Fe etc. can be chelated by vicinal hydroxyl groups on certain phenolic antioxidants (Shahidi et al., 2009).

Ascorbic acid (AsA) is a naturally occurring organic compound in fruits. It is a Vitamin C and first discovered antioxidant, usually acts as a co-factor in many enzymatic reactions and detoxifies the excess ROS through ascorbate peroxidase (Forni et al., 2019). The content of AsA in ripening fruits depends on the strict regulation of metabolic recycling and degradation. The recycling of AsA under senescence and stress conditions occurs in association with glutahione/glutathione reductase and NADH/NADPH that prevents further damage from free radicals. Higher AsA levels improve both biotic and abiotic stress tolerance in plants and enhance postharvest fruit quality. Ascorbic acid can also interact with the plasma membrane by donating electrons to the α-tocopheroxyl radical and regenerating α-tocopherol. Recycling of α-tocopherol by ascorbate helps to protect membrane lipids from peroxidation (Malacrida et al., 2006).

Singlet oxygen as well as peroxyl radicals highly quenched by the Carotenoids due to the presence of number of conjugated double bonds. They get excited after quenching these free radicals and dissipate newly acquired energy through a series of rotational and vibrational interactions with the solvent. Thereby they regenerate as original unexcited carotenoid for reuse in further cycles (Gill and Tuteja, 2010). One of the important carotenoids is lycopene which is efficient singlet oxygen quenchers of the natural carotenoids, also provide red colour to the fruits. β-Carotene a yellow carotenoids scavenge peroxyl radicals via an unstable β-carotene radical adduct which are resonance stabilized and further undergo decay to generate non radical products and may terminate radical reactions by binding to the attacking free radicals (Fieder, J. and Burda, K. 2014). The tocopherol an another lipid soluble antioxidant predominantly found in biomembranes, quench $^1O_2$ and protect from oxidative stress. It is considered as potential scavengers of ROS and lipid radicals in biomembranes, where they have the role in both antioxidant and non-antioxidant functions (Hollander-Czytko et al., 2005). The antioxidant activity of the fruits also depends on the Phenolics compounds which are responsible for colour of the fruits. The fruits having the highly colored must have a high level of anthocyanin, such as blueberry, black currants, elderberry etc., and typically possess a high antioxidant capacity. Fruits and fruit products are a rich source of phenolics i.e. flavonols and it was suggested that 98% of the flavonols (quercetin) were occurring in the peel of tomato. The free radicals scavange with donation of electron or transferring hydrogen atom by flavonoids. The transition metal-catalyzed production of reactive species prevented by flavonoids through metal chelation and they also acts cooperatively with other antioxidants (Stewart et al., 2000).

Conclusion

The production and removal of ROS balanced in the fruits by its stage and antioxidants capacity. The maintenance of balance between ROS and antioxidants, either by intrinsic or extrinsic factors might be extending the shelf life and quality of the fruits.

References

[1] Fieder, J. and Burda, K. (2014). Potential role of Carotenoids as antioxidants in Human health and disease. *Nutrients*, 6, 466-488.

[2] Forni, C., Facchiano, F., Bartoli, M., Pieretti, S., Facchiano, A., Arcangelo, D., Norelli, S., Valle, G., Nisini, R., Simone, B., Tabolacci, C., and Jadeja, R.N. (2019). Beneficial role of Phytochemicals on Oxidative stress and age-related diseases. *Bio Med Research International*, 2019, 1-17.

[3] Gill, S.S. and Tuteja, N. (2010). Reactive oxygen species and antioxidant machinery in abiotic stress tolerance in crop plants. *Plant Physiology and Biochemistry,* 48, 909-930.

[4] Hollander-Czytko, H., Grabowski, J., Sandorf, I., Weckermann, K. and Weiler, E.W. (2005). Tocopherol content and activities of tyrosine aminotransferase and cystine lyase in Arabidopsis under stress conditions. *Journal of Plant Physiology,* 162,767-770.

[5] Hodges, D.M., Lester, G.E., Munro, D.K., Toivonen, P.M.A. (2004). Oxidative stress: Importance for postharvest quality. *Hort Science,* 39, 924-929.

[6] Jimenez, A., Creissen, G., Kular, B., Firmin, J., Robinson, S., Verhoeyen, M. and Mullineaux, P. (2002). Changes in oxidative processes and components of the antioxidant system during tomato fruit ripening. *Planta,* 214, 751-758.

[7] Malacrida, C.R., Kimura, M. and Jorge, N. (2012). Phytochemicals and antioxidant activity of citrus seed oils. *Food Science Technolgy Research*, 18, 399- 404.

[8] Mundiyara, R., Kumar, P., Jitarwal R.K., Bajya, M. and Bhat, L. (2017). Different antioxidants in fruits and vegetables for human health. *International Journal of Pure and Applied Bioscience,* 5, 340-346.

[9] Shahidi, F., Janitha, P.K. and Wanasundara P.D. (1992). Phenolic antioxidants. *Critical Review in Food Science and Nutrition,* 32, 67-103.

[10] Stewart, A.J., Bozonnet, S., Mullen, W., Jenkins, G.I., Lean, M.E.J. and Crozier, A. (2000). Occurrence of flavonols in tomatoes and tomato-based products. *Journal of Agricultural Food Chemistry,* 48, 2663-2669.