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Popular Article

MELATONIN: MITIGATE THE POSTHARVEST LOSSES OF PERISHABLES

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Melatonin (MLT) is known to be the hormone in the human body which regulates our sleep through its involvement in circadian rhythm or biological clock until its detection in the plant kingdom in the early 90s. Most of the fruits are highly perishable, which limits marketability and potential expansion. Melatonin has been reported in different fruits and its exact amount is influenced by many factors, including fruit type, variety and ripening stage and growth condition. It functions as a potent postharvest treatment for controlling biotic and abiotic stresses and play a significant role in postharvest management of fruits. Endogenous MLT was shown to be involved in fruit defence and growth, and its concentrations varied during fruit development, increased during the fruit set and decreased during fruit ripening stage. Melatonin synthesized from the plant is known as phytomelatonin & was first discovered in plants during 1995. It is widely found in a significant number of plant species and melatonin is a potent free radical scavenger and antioxidant, protects membrane lipids and proteins. Melatonin has contributed many physiological activities in plants such as fruit development, ripening, senescence and response to biotic & abiotic stresses. The structure of melatonin (N-acetyl-5-methoxytryptamine) is similar to tryptophan, auxin, serotonin etc. Apart from its structural similarity with other indoleamine compounds, melatonin has a biosynthetic pathway similar to auxins and share common precursor, tryptophan. Melatonin has been documented in fruits such as mango, apple, grapes, banana and cherries. The antioxidant capacity of melatonin has been reported in fruits. Melatonin is an alternate source to other chemicals which is used in the postharvest management of perishables particularly fruits. Thus, melatonin plays a important role in post-harvest preservation of fruits.

Mode of action:

Scavenge the hydrogen peroxide and induction of antioxidant enzymes by alleviating the ROS activity & recover the plants from biotic and abiotic stresses. Activates the nitric oxide (NO) and salicylic acid (SA) mediated defence signalling pathways by expressing the PR-protein. Ethylene production gets

minimized and retains the good sensory and nutritional quality of the fruits.

Melatonin rich fruits:

Fruits	Melatonin conc. (ng/g)
Mango	**0.70**
Papaya	0.24
Banana	**0.66**
Pomegranate	0.17
Grape	**0.97**
Orange	0.15
Apple	0.16
Cherry	0.22
Strawberry	0.14
Kiwifruit	0.24

Extraction of melatonin from fruits:

Melatonin in bananas was first extracted by applying liquid - liquid extraction using 10% sodium carbonate and diethyl ether in different steps. The same procedure was used for the extraction of melatonin from apples, pineapples, strawberries, and pomegranates. Melatonin in cherries was extracted using phosphate buffer and chloroform, and the recovery rate was 60% and 70.7% from sour and sweet cherries, respectively.

Melatonin may co-extract and partition with chlorophyll and phenolic compounds, as well as sublimating during vacuum drying and being susceptible to destruction by the impurities commonly found in organic solvents.

Micro-extraction by packed sorbent (MEPS) sample pretreatment procedure is faster and minimal cost than SPE procedures and it requires lower volume of sample and solvents for melatonin extraction. Melatonin is unstable in the extracts, the rapid generation of heat and pressure forces compounds from the matrix and produces the melatonin extracts with better recovery rates.

Sonication can induce cavitation which create micro-environment with high temperatures and high pressures, and in turn speed up the removal of analytes from the complex matrices. Hence, ultrasound-assisted method can be effectively used for melatonin extraction. Ultrasound-assisted extraction before SPE was employed for extracting melatonin in grape skins and strawberries. The optimal analytical conditions for melatonin were 200 W of ultrasonication for 7 min at 15º C in grape skin and the recovery rate was higher than 90%.

Role of melatonin in postharvest preservation of fruits:

- Chilling injury alleviation
- Delayed senescence
- Decay control
- Controlled ripening

Chilling injury alleviation:

Chilling injury (CI) is a predominant problem in tropical and sub-tropical fruits when stored at low temperature. The fruits which are pre-treated with melatonin shows positive response in controlling the symptoms. Postharvest application of melatonin alleviated the CI without impairing fruit quality in harvested peaches (100 µM) and sapota (90 µM). Fruits treated with melatonin at the concentration of 100 µM results in lower incidence of chilling injury.

Delayed senescence

The shelf life of most of the fruits is limited due to higher rates of ethylene production and respiration rate. Melatonin application (0.1 mM/l) to peaches effectively delayed senescence during cold storage. The melatonin treated pear fruits showed a delayed senescence, reduced ethylene production and maintained better firmness than control fruits throughout the storage.

Decay control

Most of the fruits contain very high moisture content and are highly vulnerable to the attack of microbes which ultimately causes decay in the harvested produce. Botrytis rot in apple is controlled by exogenous application of melatonin. The effectiveness of exogenous melatonin application against fungal pathogens was found to reduce green mold disease on the fruit of citrus through scavenging of defense-related ROS in the infected fruits.

Controlled ripening

Melatonin increased phenolic content and antioxidant activity in grapes, pomegranate and sweet cherry. Sweet cherries were treated with various concentrations of melatonin (50, 100, 150 µM/l) and reported that 100 µM/l melatonin treatment reduced weight loss and decay incidence effectively and maintained better TA, TSS and delayed the senescence process.

Application of melatonin during fruit development

Fruit	MLT level (mmol/l)	Effect
Banana	0.1	Enhanced defence
Grape	0.4	Higher fruit production
Apple	0.21, 0.32	Higher fruit production
Pear	0.1	Higher fruit production
Cherry	0.01	Ripening inhibition
Apricot	0.04	Higher fruit production

Method of melatonin application after harvest - Dipping

Dipping treatment consists of soaking the product of whole followed by the removal of the excess solution. It covers the maximum surface area of the product.

Effect of melatonin on the preservation and quality of post-harvest fruits

Fruit	Melatonin treatment concentration (µM)	Optimum concentration (µM)	Treatment time	Treatment method	Effect
Banana	50; 200; 500	200; 500	2 hr	Immersing	Reduce the Post-harvest banana ripening
Apple	100; 200; 300; 400	200	6; 12; 24; 48; 72; 96; 120 hr	Immersing	Gray mold disease minimized
Peach	100	100	10 min	Immersing	Decreases the Senescence & chilling injury
Pear	1; 100	100	12 hr	Immersing	Improves the shelf life
Strawberry	10; 100; 1,000	100	2 hr	Immersing	Decay is minimized

Conclusion:

Melatonin in plants is involved in regulation of plant development and protects plants against environmental stress from heavy metals, UV radiation, temperature fluctuations and drought. At the optimum concentration, melatonin can be considered as a promising method for maintaining the nutritive quality of fruits during storage. The multiple biological functions of melatonin in fruit were attributed to the interaction with reactive oxygen species and coordination with plant hormones and other signaling molecules, which enhanced antioxidant and defense systems & reduced oxidative damage.

Exogenous application of melatonin addresses the major postharvest-related issues such as chilling injury & pathogen attack. It also delays senescence in various horticultural crops and thereby helps in extending the shelf life without adversely affecting the nutritional quality. Hence, melatonin is a better postharvest alternative in maintaining quality and extending shelf life of fruits.