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Article Addendum

Melatonin in Plants

More Studies are Necessary

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Addendum to:

Melatonin Promotes Adventitious- and Lateral Root Regeneration in Etiolated Hypocotyls of Lupinus Albus L.

Arnao MB, Hernández-Ruiz J

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ABSTRACT

Melatonin (N-acetyl-5-methoxytryptamine) is a biogenic indoleamine structurally related with other important substances such as tryptophan, serotonin, indole-3-acetic acid (IAA). In mammals, birds, reptiles and fish melatonin is a biological modulator of several timing (circadian) processes such as mood, sleep, sexual behavior, immunological status, etc. Since its discovery in plants in 1995 several physiological roles, including a possible role in flowering, circadian rhythms and photoperiodicity and as growth-regulator have been postulated. Recently, a possible role in rhizogenesis in lupin has also been proposed. Here, these actions of melatonin in plant development are commented on and some other interesting recent data concerning melatonin in plants are also discussed. The need for more investigation into melatonin and plants is presented as an obvious conclusion.

Melatonin (N-acetyl-5-methoxytryptamine) is well known in human and animal physiology, but is an unknown player in the physiology of plants. Many studies have clearly demonstrated its presence in different parts of plants such as the root, stem, leaf, flower, fruit and seed.[1-3] In addition to its phytochemical interest (natural melatonin is absorbed by the human digestive tract), this compound has aroused attention as a possible signal molecule in plant physiology.[4,5] From it discovery in plants in 1995, some authors have postulated many physiological roles for melatonin, although, in general, research into melatonin in plants is clearly insufficient. Only the possible role of melatonin in flowering and as growth promotor have been studied with some detail. As regards the former, the studies of Kolar's group on the role of melatonin as plant rhythm regulator provided interesting data, pointing to melatonin's action in the later stages of the flowering process.[6,7] Melatonin seems to have a more obvious effect in the growth process of some species, as has been demonstrated by our group. Our data showed that melatonin has a growth-promoting effect on aerial organs (epi- and hypocotyls, coleoptiles) and a growth-inhibitory effect on roots, in a similar way to auxins.[8,9] Other authors, too, have provided evidence on the possible growth-promoting activity of melatonin in *Glycyrrhiza uralensis*, which doubled its melatonin content in roots in the 3–6 month development period.[10] A more recent paper, presented data concerning the effect that melatonin has on the rhizogenesis process. Melatonin produces and/or activates the generation of root primordia and their subsequent growth into lateral roots and adventitious roots in *Lupinus albus*.[11] Studies on melatonin in vegetative plant development pointed to a relationship between IAA and melatonin but more data are necessary to identify the particular interconnection. The most recent data in this respect, established the effect of melatonin on the enzymatic activity of ACC oxidase in hypocotyls and roots of *Lupinus albus*, pointing to the possible regulation of ethylene production in these vegetative organs.[12]

One aspect that has slowed down research into melatonin in plants is the difficulty involves in its detection, identification and measurement of melatonin in plants. Because the high degree of interference caused by melatonin-immunodetection kits using plant samples, the habitual use of the liquid chromatography-tandem mass spectrometry (LC-MS/MS) has been crucial.[13] The use of this sophisticated technique for melatonin identification combined with measuring levels by means of liquid chromatography with electrochemical or fluorescence detection seem to be an efficient methodological option. In this respect, studies such as that recently published by Cao et al. (2006),[14] where a robust method for determining melatonin, serotonin and auxin in plant samples using LC-MS/MS was presented, clearly contribute to improving accurate research into melatonin in plants.

Future studies on melatonin in plant physiology should take metabolic and molecular aspects into consideration. Thus, the participation of different enzymatic activities in melatonin biosynthesis and catabolism in plants appears to be an interesting challenge.[5] Also, the presence of melatonin receptor(s) in plant samples would strongly suggest a role for melatonin. Other interesting aspects to be investigated are: the possible tissular transport of melatonin, its action as plant cell protector due to its excellent antioxidative properties, and its involvement in particular physiological processes such as germination, cell growth, senescence, flowering, etc. Lastly, we must not forget the involvement of melatonin in stress processes in animal cells, which may be mirrored to some extent in plant cells. As can be seen, much remains to be done.

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