e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 5, Issue 7, July 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.54

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|

| Volume 5, Issue 7, July 2022 |

| DOI:10.15680/IJMRSET.2022.0507036 |

An Overview: Physiology of Polyamines in Plant

Kumari Nirmala[1]

Ph. D Student, Department of Botany, Nirwan University Jaipur, India[1]

ABSTRACT: This article present additional polyamines are present in smaller amounts in plant cells, the diamineputrescine, the triaminespermidine, and the tetraminespermine are present in all plant cells. Their chemistry and metabolic and biosynthetic routes have been extensively studied.In addition to being conjugated to different macromolecules and tiny molecules like phenolic acids, they can exist in the free form as cations. Their titer fluctuates between around micromolar and more than millimolar and is highly influenced by environmental factors, particularly stress. By practically every documented external stress, the activity of arginine decarboxylase, one of the main polyamine biosynthesis enzymes, is promptly and dramatically boosted in cereals, resulting in 50-fold or more increases in putrescinetiter within a few hours. Although most people believe that this growth has physiological relevance,

KEYWORDS: Physiology, Polyamines, plant

I. INTRODUCTION

All living things include low molecular weight polycations called polyamines (PAs) (Cohen, 1998). Prokaryotes and eukaryotes both require them for growth and development (Tabor and Tabor, 1984; Tiburcio et al., 1990). The primary PAs in plant cells are the diamineputrescine (Put), triaminespermidine (Spd), and tetraminespermine (Spm). They can be found unbound or conjugated to phenolic acids, other low-molecular-weight chemicals, or large macromolecules like proteins and nucleic acids. As a result, they promote DNA transcription, replication, and translation. They have been linked to a variety of biological processes that affect plant growth and development, including as senescence, environmental stress, and fungus and virus infection.

Their cationic state is what is responsible for their biological activity.The majority of reports on PAs2 in plants are less than 20 years old. Therefore, it is not surprising that their potential role in the physiology of the plant is still unknown. What is reasonably certain is that (a) putrescine, spermidine, and spermine, along with the enzymes regulating their metabolism, are present in every plant cell in titers ranging from about 10 gM to about millimolar; (b) they occur either free or bound to phenolic acids, other low molwt compounds, or macromolecules; and (c) their titer is highly responsive to external conditions, such as light, temperature, and different chemical[1].

II. A SUBTLE HISTORICIAN'S VIEW

As Seymour Cohen noted in his thought-provoking 1971 monograph [2], PA biochemistry has a more than 300-year history. In 1678, Antoni van Leeuwenhoek noticed the formation of stellate crystals in ageing sperm while peering through the lenses of his crude microscope at human semen. The primary constituent of these phosphate crystals was given the name spermine more than 200 years after it was discovered, but its precise chemical makeup and structure weren't discovered until the middle of the 20th century. Around this period, spermidine was also found and given a name.

For roughly the following 50 years, PAs continued to be mostly interesting to chemists.Research on the physiology and biochemistry of PAs in plants has primarily taken place in a small number of labs. Since the 1950s, the University of Bristol's Long Ashton research station has played an essential role, culminating in Terence Smith's seminal study on the biology of plant polyamines. [3]

Recent reviews of PAs in plants provide thorough coverage of the literature up to roughly 1988, while a different recent review provides an overview of the situation in animals and microbes as well (. International biannual meetings are collected in books and other media like Advances in Polyamine Research [4].

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|

| Volume 5, Issue 7, July 2022 |

| DOI:10.15680/IJMRSET.2022.0507036 |

III. THE IMPACT PAs HAVE ON BIOLOGY

It has been proven that PAs are necessary for both prokaryotic and eukaryotic bacteria. For instance, spermidine (Spd), spermine (Spm), or 1,3-diaminopropane, a byproduct of the oxidation of Spd and Spm, must be added for Haemophilusparainfluenzae to thrive on a synthetic medium [5].

For the majority of the steps in the biosynthetic chain for PAs, a number of single gene mutants are accessible in both Escherichia coli and Saccharomyces cerevisiae. A ribosomal protein lesion affects an E. coli mutant with an absolute requirement for PAs; the lesion is apparently fixed by the addition of a PA.Several mutations at the ODC locus in Saccharomyces, where Put can only originate from ODC activity, are unable to develop in the absence of additional PAs. Additionally, mutants unable to sporulate or enable the production of a double-stranded RNA "killing factor" are unable to convert Put to the higher PAs Spd and Spm.

These findings suggest that polyamines are not only necessary for the development of this organism but also that, under the right circumstances, particular polyamines may exercise particular morphogenetic regulatory roles. Several recent plant experiments are suggested by this intriguing hypothesis, which are described below. Aspergillusnidulans and Neurosporacrassa are two more microbes that have polyamine-requiring mutations that have been well-established (6).Some thermophilic bacteria respond to the stressful environment of high temperature by producing unique, long chain polyamines (Oshima, in [3]. These substances reportedly aid in preventing the inactivation of enzymes that are particularly susceptible to high temperatures.

Although neither mammals nor plants have any equivalent mutations that demonstrate an absolute need for PAs, conclusions about the necessity of PAs for particular processes have been drawn from the use of particular, enzyme-activated "suicide inhibitors" for both ODC and ADC. Difluoromethyl substitutes can be used to replace the hydrogen on the a-carbon of either arginine or ornithine. The resultant compounds, DFMA and DFMO, interact irreversibly with the active sites of ADC and ODC, respectively, and stop further enzyme activity.

One or more of the PAs in the cell may become depleted after treatment with either one or both of these inhibitors (or comparable, less focused inhibitors). It is plausible to assume that PAs are involved in the cellular process if such therapy inhibits some cellular function and this inhibition may be reversed by the application of PAs. For instance, it has recently been demonstrated that Put production from arginine by ADC action is significantly boosted in rice plants subjected to anaerobic circumstances.

Under these circumstances, the coleoptiles of rice elongateare remarkably resistant to auxin but closely connected to the Put titer. Put titer and coleoptile elongation are inhibited when DFMA prevents ADC activity; both inhibitions are undone when Put is introduced. These studies seem to indicate that Put is necessary for the anaerobic elongation of rice coleoptiles. It's interesting to note that Put has no impact on the aerobic extension of rice coleoptiles, where auxin is active.

IV. IN CEREALS, ARGININE DECARBOXYLASE ACTS AS A GENERAL "STRESS ENZYME

In hydroponic cultivation, barley plants responded to inadequate potassium levels in 1952 by accumulating high titers of Put, according to Richards and Coleman [6].

Since then, it has been demonstrated that Put accumulation, particularly in cereals, happens in response to a variety of stresses, including lack of water, high external osmolarity, high external concentrations of ammonium or hydrogen ion, lack of or excess of other monovalent cations, atmospheric pollutants like sulphur dioxide and cadmium ion, low temperature in subtropospheric environments, and low temperature in tropospheric environments.Anaerobiosis and species.

ADC activation has been connected to every instance where the extra Put creation pathway has been studied. As a result, it seems appropriate to describe ADC as a general stress enzyme in cereals and Put accumulation as a general indicator of stress-induced ADC activation in this group of plants [7].

Immediately following the application of stress, the accumulation of Put starts. For instance, within 1 to 2 hours of being exposed to a hypertonic sorbitol solution, oat leaves exhibit some Put buildup and ADC activation. If cyclohexamine is administered within the first hour following the application of stress, but not afterwards, it can stop this process. It took this inhibitor several minutes to take full effect in several studies. These findings suggest that protein synthesis is necessary for the manifestation of the increase in ADC activity and that it begins to occur quickly in response to stress.

Because DFMO is not an effective inhibitor, but DFMA is, it is possible that stress activates ADC production. This suppositionhas received additional support from certain studies that labelled pure oat leaf proteins with methionine in unstressed and stressed leaves.can have a long-lasting impact on important metabolic processes, a quality typically

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|

| Volume 5, Issue 7, July 2022 |

| DOI:10.15680/IJMRSET.2022.0507036 |

associated with oligodynamic regulating molecules. Calcium, which is also a regulator of senescence in some systems, interfered with the action of the applied PA throughout the 30 to 60 min of contact between leaf and PA. Given that calcium had no effect when administered either before or after the PA, it is assumed that calcium obstructs the entry of the PA into the cell, maybe by competing for the same entry point.

V. A PA AND SENESCENCE

When an organ is young and not senescent, polyamines, notably Spd, are typically abundant; nevertheless, as an organ ages and senesces, their concentrations decrease [8]. The pattern of onset of senescence symptoms and the drop in ADC activity seem to be approximated by the decline in PA titer. It is reasonable to hypothesise that the development of senescence may be mediated by a fall in ADC activity and, consequently, of PA titer since the addition of exogenous PAs prevents the formation of the signs of senescence. This theory has been covered in a number of articles; the most of them are positive, but others are contradicting.Freshly produced mesophyll protoplasts of oat and other cereals were the first tissues in which the anti-senescence action of exogenously applied PAs was observed. By using PAs in the 10-100 uM range, their capacity to integrate uridine and leucine into RNA was able to slow down.
Additionally, the exogenous PAs prevented the protoplasts' Chl from breaking down while improving their capacity to make DNA and divide repeatedly. Later, comparable effects were observed in leaves, where exogenous PAs totally or partially stopped the abnormally rapid spike in RNAase activity that followed the removal of a leaf. Exogenous PAs also delayed and reduced an increase in acid protease activity after around 6 to 8 hours, and after 24 to 36 hours, they reduced the rate at which Chl vanished.Since applied PAs have been shown to reduce ethylene production in vivo and the effectiveness of applied ethylene, all these findings may be explained by an antiethylene activity [9].

VI. PAS AND PLANT MORPHOGENESIS

Because of the effects that PAs have been shown to have in other animals, it seems sense to think of them as potential regulators of morphogenesis in plants. The study by C. W. Tabor (22) using the yeast Saccharomyces cerevisiae is probably the most suggestive. In the biosynthetic route for PAs, Tabor was able to obtain single gene mutants that were inhibited at various locations. A mutant with the ODC locus blocked was unable to produce Put or any other PA and was incapable of growing at all without the addition of Put or other PA to the medium. This demonstrates that PAs are necessary and that ODC is the only avenue for their synthesis in this organism. The organism can grow but will not sporulate if the mutation is at the Spd synthase gene[10].
This demonstrates that Put can maintain proliferation on its own, but that the differentiation of specific sporangial cells requires a higher PA (Spd or Spm). A double-stranded RNA "death factor" also failed to replicate in the absence of these increased PAs, suggesting once more a potential link between PAs and nucleic acid production[11].

There are several atypical PAs in nature, which may play specific roles, in addition to Put, Spd, and Spm, with which we have been concerned. For instance, bacteria found in hot springs produce peculiar PAs such thermospermine, which has five or more amino groups and appears to shield enzymes from heat denaturation. These PAs also interact with nucleic acids and significantly change their structure[12]. In this context, it is interesting that the attachment of PAs to the DNA, particularly at G and C residues, facilitates the in vitro shift from the transcriptionally active B-DNA configuration to the inert Z-configuration[13]. Rhizobium root nodule bacteria that are rapidly expanding produce huge amounts of aminobutylhomospermidine, a tetraamine not often found in nature.in breeds that develop slowly . The physiological effects of this substance on roots and other plant components have not been investigated, despite the fact that it has also been identified from volcanic ash soils in Japan[14]-[15].

VII. CONCLUSION

There are several atypical PAs in nature, which may play specific roles, in addition to Put, Spd, and Spm, with which we have been concerned. For instance, bacteria found in hot springs produce peculiar PAs such thermospermine, which has five or more amino groups and appears to shield enzymes from heat denaturation. These PAs also interact with nucleic acids and significantly change their structure. In this context, it is interesting that the attachment of PAs to the DNA, particularly at G and C residues, facilitates the in vitro shift from the transcriptionally active B-DNA

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|

| Volume 5, Issue 7, July 2022 |

| DOI:10.15680/IJMRSET.2022.0507036 |

configuration to the inert Z-configurati.Rhizobium root nodule bacteria that are rapidly expanding produce huge amounts of aminobutylhomospermidine, a tetraamine not often found in nature.in breeds that develop slowly. The physiological effects of this substance on roots and other plant components have not been investigated, despite the fact that it has also been identified from volcanic ash soils in Japan.

REFERENCES

[1] Advances in Polyamine Research, vols 1-4 (1978-1983) Raven Press, New York
[2] Apelbaum A, Canellakis ZN, Applewhite PB, Kaur-Sawhney R, Galston AW (1988) Binding of spermidine to a unique protein in thin-layer tobacco tissue culture. Plant Physiol 88: 996-998
[3] Macrae M, Plasterk RHA and Coffino P. The ornithine decarboxylase gene of Caenorhabditiselegans-cloning, mapping and mutagenesis. Genetics. 140:517-525, 1995
[4] Malmberg RL, Watson MB, Galloway GL and Yu W. Molecular genetic analyses of plant polyamines. Critical Rev Plant Sci. 17: 199-224, 1998.
[5] Martin-Tanguy J. The occurrence and possible function of hydroxy-cinnamoyl acid amides in plants. Plant Growth Regul. 3: 383-399, 1985.
[6] Martin-Tanguy J. Metabolism and function of polyamines in plants: Recent development (new approaches). Plant Growth Regul. 34: 135-148, 2001.
[7] Hibasami H, Tanaka M, Nagai J and Ikeda T. Dicyclohexylamine, a potent inhibitor of spermidine synthase in mammalian cells. FEBS Letters. 116: 99- 101, 1980.
[8] Galston AW and Tiburcio AF (Ed). Lecture Course on Polyamines as Modulators of Plant Development 257: FundacionJaun Madrid, March, 1991.
[9] Galston AW and Kaur-Sawhney R. Polyamines as endogenous growth regulators. In: Plant Hormones, Physiology, Biochemistry and Molecular Biology (2 ndedn). Davies PJ (Ed). Kluwer Academic Publishers, Dordrecht, The Netherlands. 158-178, 1995.
[10] Kumar A and Minocha SC. Transgenic manipulation of polyamine metabolism. In: Transgenic Plant Research. Lindsey K (Ed). Academic Publishers. Harwood. 187-199, 1998.
[11] Malmberg RL and Rose DJ. Biochemical genetics of resistance to MGBG in tobacco: Mutants that alter SAM decarboxylases or polyamine ratios and floral morphology. Mol Gen Genet. 207: 9-14, 1987.
[12] Panicot M, Minguet E, Ferrando A, Alcázar R, Blázquez MA, Carbonell J, Altabella T, Koncz C and Tiburcio AF. A polyamine metabolon involving aminopropyltransferases complexes in Arabidopsis. Plant Cell. 2002b. In press
[13] Williams-Ashman HG and Schenone A. Methyl-glyoxyl-bis (guanylhydrazone) as a potent inhibitor of mammalian and yeast S-adenosylmethionine. BiochemBiophys Res Commun. 46: 288-295, 1972.
[14] Wang Y, Devereux W, Stewart TM and Casero RA. Polyamine-modulated factor-1 binds to the human homologue of the 7a subunit of the Arabidopsis COP9 signalosome: implications in gene expression. Biochem J. 366: 79-86, 2002
[15] Walden R, Cordeiro A and Tiburcio AF. Polyamines: Small molecules triggering pathways in plant growth and development. Plant Physiol. 113: 1009-1013, 1997.

Impact Factor
7.54

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com