FINAL PROJECT SUMMARY

Title of the project: Investigation of interactions between the polyamine catabolism and hypusination processes in tomatoes during salt stress

OTKA project number: FK 129061

Principal Investigator: Dr. Szepesi Ágnes

General aims

The objective of this project was to study the connection between polyamine homeostasis and protein synthesis dependent of a novel post-translational modification (hypusination) in tomatoes during salt stress. We focused on deciphering the proper mechanism of hypusination and highlight some important regulation pathways connected to the tomato fruit development during salt stress.

Hypotheses

1. There is a connection between the polyamine catabolism and hypusination and this connection shows differences compared to the Arabidopsis model plant and tomato during salt stress.

Our experiments provided evidence that by inhibiting the polyamine catabolism, the increased free polyamines could be a fuel for the hypusination (reviewed by Köhler and Szepesi, 2023). We prepared a review about the hypusination in plants indicating some future perspectives of application of hypusination for the future (Pálfi et al., 2021; Fig.1.).

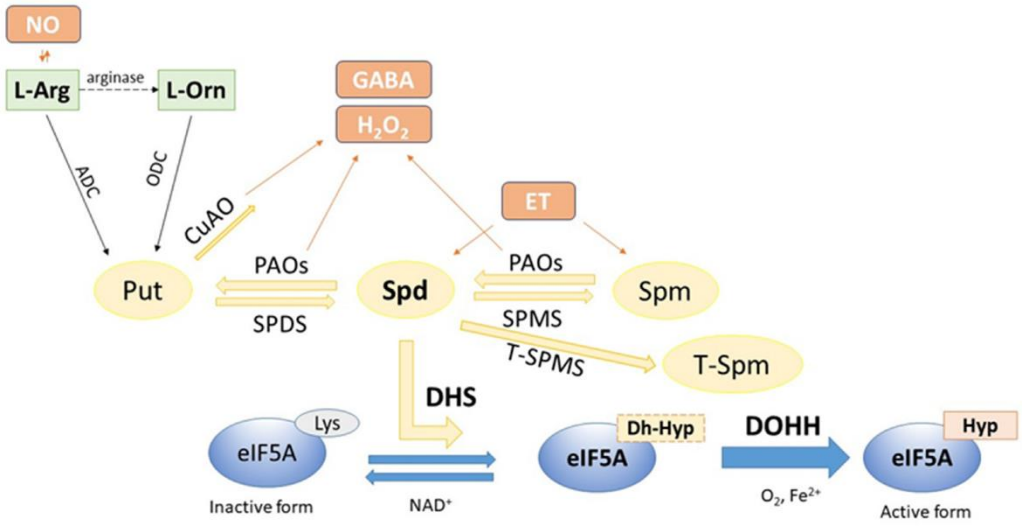

Figure 1. A schematic overview of the Spd-mediated hypusination process of eIF5A in plants and related pathways. Spd is essential for the DHS reaction to produce deoxyhypusine (Dh-Hyp) on inactive forms of eIF5A via cofactor NAD+. Spd is derived from both the PA biosynthesis catalysed by Spd-synthase (SPDS) and catabolism by polyamine oxidases (PAOs). It is worth mentioning that the metabolism of Spd is strongly connected to the biosynthesis of important signal molecules such as nitric oxide (NO), hydrogen peroxide (H2O2), gamma-aminobutyric acid (GABA), and ethylene (ET) providing routes for the complex influence of Spd levels in plants. The second step of hypusination is catalysed by DOHH, which needs oxygen and diiron for its function, in order to produce the hypusine of mature eIF5A. Abbreviations: Put—putrescine; Spm—spermine; L-Arg—L-arginine; L-Orn—L-ornithine; ADC—arginine decarboxylase; ODC—ornithine decarboxylase; CuAO—copper amine oxidase; SPMS—spermine synthase; T-SPMS—thermospermine synthase (Pálfi et al., 2021).

These processes are dependent from the organ, developmental stage and cultivar of the plant species (Szepesi et al., 2022). We examined the application of GC7, as a pharmacological inhibitor of deoxyhypusine synthase (DHS) in *Arabidopsis thaliana* indicating that a) inhibition of the eukaryotic translation factor 5A activation by the spermidine analogue GC7 has been shown to protect against salt stress; b) Its mechanism demonstrates some antioxidant features by alleviating ROS levels; c) Both steps of hypusination is affected by GC7 treatment independent from salt stress; d) GC7 is applicable as an inhibitor of hypusination in plants (submitted to *Plant Stress* in June of 2023).

2. Modification of polyamine catabolism and hypusination can cause significant alterations in C/N ratio influencing the growth and stress defense processes during salt stress.

Our submitted manuscript to the MDPI Antioxidants (Szepesi et al., 2023) demonstrates that polyamine catabolism mediated by amine oxidases are important in fine-tuning the optimal polyamine homeostasis and related mechanisms during salt stress. The significance of these amine ox-idases in short term responses to salt stress is however not well understood. In the present study, the effects of L-aminoguanidine (AG) on tomato roots treated with short-term

salt stress induced by NaCl were studied. AG is usually used as a copper amine oxidase (CuAO or DAO) inhibitor. In our study, other alterations of polyamine (PA) catabolism, such as reduced polyamine oxidase (PAO), were also observed in AG-treated plants. Salt stress led to an increase in the reactive oxygen and nitrogen species in tomato root apices, evidenced by in situ fluorescent staining and an increase in free PA levels. Such alterations were alleviated by AG treatment, showing the possible antioxidant effect of AG in tomato roots exposed to salt stress. PA catabolic enzyme activities decreased while the imbalance of hydrogen peroxide (H2O2), nitric oxide (NO), and hydrogen sulfide (H2S) concentrations displayed a dependence on the stress intensity. These changes suggest that AG-mediated inhibition could dramatically rearrange the PA catabolism and related reactive species backgrounds, especially the NO-related mechanisms. More studies are however needed to decipher the precise mode of action of AG in plants exposed to stress treatments. Also, this study suggest that TCA cycle is not significantly affected by inhibition of polyamine catabolism.

The effect of GC7 was studied in mature tomato plants, the treatment was applied for 1 week (manuscript preparation has started) and we found that GC7 could induce more root hairs and higher plant biomass, in control and salt stress conditions suggesting that modification of hypusination in DHS could significantly affect root hair development, however in order to reveal that it is a result of an increased polyamine level because of DHS inhibition or it is an unknown side effect of GC7, more experiments could be conducted.

3. Tomato fruit development strongly affected by the relationship of polyamine catabolism and hypusination during salt stress, implying alterations in the metabolite composition and fruit structure.

We have submitted our manuscript about the effect of GC7 on tomato reproductive system. Our main results are the following: a) inhibition of hypusination modulate tomato reproductive system during salt stress; b) GC7, a pharmacological inhibitor of deoxyhypusine synthase, promoted flower and fruit production; c) GC7 application was efficient to increase lycopene contents of tomato fruits; d) alleviated polyamine catabolism could enhance the polyamine level during salt stress causing better salt tolerance. A pot experiment was undertaken to study the inhibition of hypusination by GC7 to alleviate salt stress induced tomato (*Solanum lycopersicum*) flower and fruit parameters. The experiment was arranged in a completely randomized block design, with four treatments replicated three times. The results revealed that GC7 promoted more flowers and fruits in tomato plants subjected to salt stress. GC7 efficiently

increased lycopene contents during salt stress. It is concluded that based on our results, modulation of hypusination could be a promising breeding way to enhance salt stress tolerance of tomato plants (Szepesi et al., submitted to *Scientia Horticulturae* in June of 2023). We can conclude that modulation of hypusination could affect the tomato fruit development and these effects could change dependent from the salt stress. Enhanced lycopene content as a result of inhibition of hypusination could be a new route to modify our crop plants to be healthier for human consumption but it needs more investigations.

4. GABA, as a biological active reaction compound synthesized by polyamine catabolism have a strong impact on the relationship of polyamine catabolism and hypusination providing evidence its central role of regulation these processes during salt stress.

In our manuscript which is prepared for the submission (Ali et al., 2023, IJMS), we get some interesting results about the exogenously added GABA induced hypusination in *Arabidopsis thaliana*. Gamma-aminobutyric acid (GABA) functions as a signalling molecule and a metabolite and has been implicated in playing a critical role in plant salinity stress tolerance. In this study, we determined the effect of exogenous GABA on Arabidopsis salt stress tolerance by examining morphological and physiological parameters and the interactions between GABA, polyamines, and the hypusination process in salt stress tolerance. Two weeks-old Arabidopsis seedlings were subjected to control, 1 mM GABA, 100 mM NaCl, and 1 mM GABA + 100 mM NaCl treatments (Figure 2.)

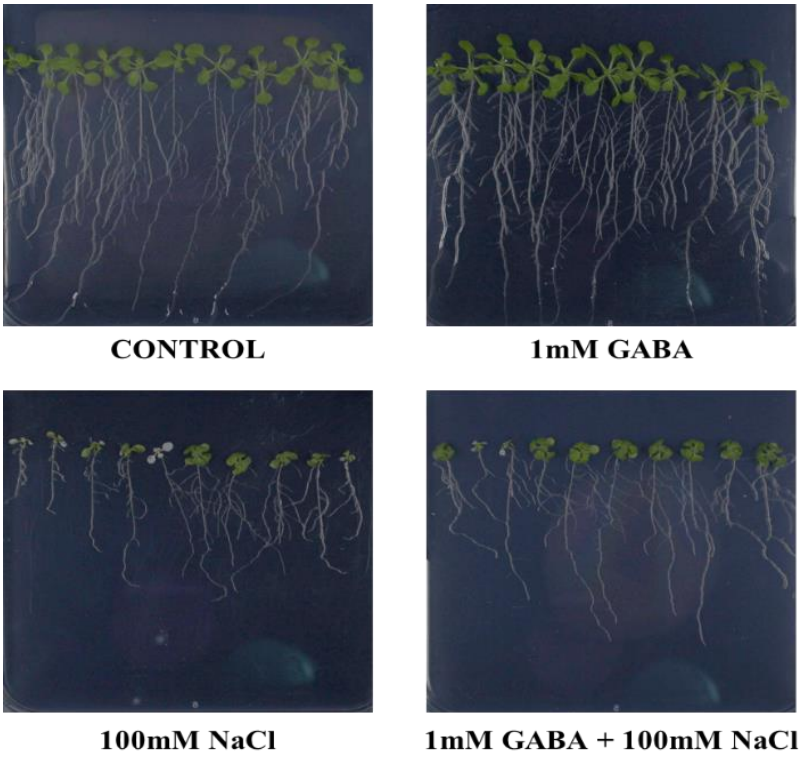

Figure 2. Arabidopsis seedlings grown on agar media supplemented with different treatments (Control, 1 mM GABA, 100 mM NaCl, and 1 mM GABA + 100 mM NaCl). Photographs were taken 7 days after the seedlings were transplanted onto the treated media (from Ali Mohamed Ali MSc thesis).

NaCl stress negatively affected the phenotypic appearance of the seedlings and significantly decreased the physiological parameters and *AtDHS*, *AtDOHH* and the three AteIF5A isoforms expression levels. Under control conditions, exogenous GABA significantly improved the physiological parameters and expression levels of genes involved in hypusination. However, exogenous GABA significantly increased primary root length, Put, *AtDOHH* and *AteIF5A-1* expression under salt stress conditions but significantly decreased Spm, total PAs, DAO and PAO activity and *AtDHS* expression. At the same time, there was no significant change in fresh weight, protein content, chlorophyll content, Spd, H_2O_2 and O_2- production, and *AteIF5A-2* and *AteIF5A-3* expression. Our results showed that exogenous GABA modulated endogenous polyamines, reduced PAs degradation and increased expression level of genes involved in the hypusination process. In conclusion, exogenous GABA is suggested to be involved in the Arabidopsis hypusination process and contribute to salt stress tolerance.

One BSc thesis from Szabó Dominik (2022) suggested that GABA applied in small concentration could alleviate the effect of salt stress in tomato. Based on primarily results, we selected the 1 mM GABA and 100 mM NaCl added by nutrient solution. After the combined stress, plants were wilted, however the chlorophyll contents were higher. GABA application induced the rapid increase of polyamine catabolic enzyme activities maybe because of the

increase of free polyamines level, especially the putrescine and spermidine in the roots. It can be concluded that GABA treatment alone was effective to induce polyamine catabolism in protective way during salt stress, but selection of the proper concentration is important to study in the future.

The results of project

In this project, publications are:

9 scientific articles, 3 MSc theses, and 8 BSc theses and 3 book chapters.

Number of submitted manuscripts: 3 in 2023.

1 PhD student started his studies in 2022 in our project, after his BSc and MSc studies (Pálfi Péter). He won OTDK III. Prize in 2022, and a second place in Magyar Növényanatómiai Szimpózium in 2021.

We started the Plant Polyamine Lab (No.226) in Department of Plant Biology, University of Szeged to investigate polyamine metabolism and hypusination in plants.

There was a Plenary Lecture in 2021, online because of covid-19, organized by Porto University.

Results in details

1st year 2018.12.01-2019.11.30.

Student Thesis Works:

BSc thesis

Kovács Henrietta: Az aminoguanidin poliamin lebontásra gyakorolt hatásának vizsgálata paradicsom növényeken

Conference Abstracts:

Ágnes, Szepesi ; László, Bakacsy ; Henrietta, Kovács ; Zoltán, Köhler ; Ervin, Molnár ; Péter, Poór ; Réka, Szőllősi
Beyond the inhibition of copper amine oxidase: L-aminoguanidine and polyamine catabolism in tomato plants after salt stress
In: Jörg, Durner; Christian, Lindermayr; Diana, Lochner (szerk.) 14th International Conference on Reactive Oxygen and Nitrogen Species in Plants : Conference Abstract Book

Munich, Germany (2019) p. 144.

Szepesi, Ágnes ; Bakacsy, László ; Kovács, Henrietta ; Molnár, Ervin ; Pálfi, Péter ; Zsigmond, Laura ; Szőllősi, Réka
Paradicsomfajták poliamin lebontásának és antioxidáns védekezési rendszerének biokémiai vizsgálata [Comparison of Polyamine Catabolism and Antioxidant Defence Mechanisms of Tomato Cultivars]
In: Poór, Péter; Blázovics, Anna (szerk.) Magyar Szabadgyök-Kutató Társaság X. Kongresszusa : Program és összefoglalók
Szeged, Magyarország : Szegedi Tudományegyetem (2019) pp. 52-52. , 1 p.

2nd year 2019.12.01-2020.11.30.

Scientific Articles:

Szepesi, Ágnes ✉

Halotropism: Phytohormonal Aspects and Potential Applications

FRONTIERS IN PLANT SCIENCE 11 Paper: 571025 , 9 p. (2020)

Student Thesis Works:

BSc thesis

Pálfi Péter: Manó és Romus paradicsomfajták növekedési paramétereinek összehasonlítása különböző fejlődési stádiumokban és sóstressz alatt

Book Chapters:

Szepesi, Ágnes
Role of metabolites in abiotic stress tolerance
In: Durgesh, Kumar Tripathi; Vijay, Pratap Singh; Devendra, Kumar Chauhan; Shivesh, Sharma; Sheo, Mohan Prasad; Nawal, Kishore Dubey; Naleeni, Ramawat (szerk.) Plant Life Under Changing Environment
Dordrecht, Netherlands : Elsevier (2020) 1,012 p. pp. 755-774. , 20 p.

Szepesi, Ágnes ; Bakacsy, László ; Kovács, Henrietta ; Pálfi, Péter ; Szőllősi, Réka
Paradicsomfajták sokszínűségének felhasználási lehetőségei a termés antioxidáns összetételének javításában
In: Poór, Péter; Mézes, Miklós; Blázovics, Anna (szerk.) Oxidatív stressz és antioxidáns védekezés a növényvilágtól a klinikumig
Budapest, Magyarország : Magyar Szabadgyök-Kutató Társaság (2020) 218 p. pp. 128-134. , 6 p.

Szepesi, Ágnes ; Királyfy, Rita ; Bencze, Gábor ; Futó, Zoltán
Antioxidánsok szerepe az alternatív szántóföldi növények abiotikus stressz elleni védekezésében
In: Poór, Péter; Mézes, Miklós; Blázovics, Anna (szerk.) Oxidatív stressz és antioxidáns védekezés a növényvilágtól a klinikumig
Budapest, Magyarország : Magyar Szabadgyök-Kutató Társaság (2020) 218 p. pp. 89-99. , 10 p.

Conference Abstracts:

Ágnes, Szepesi ; László, Bakacsy ; Péter, Pálfi ; Lilla, Sípos ; Réka, Szőllősi ; Laura, Zsigmond
SHORT-TERM SALT STRESS INDUCED ALTERATIONS IN POLYAMINE CATABOLISM OF TOMATO
In: SIBV/TOMRES SUMMER SCHOOL 2020 : Stress resilience in plants: from molecules to field
(2020) 44 p. pp. 11-11. , 1 p.

Szepesi, Ágnes ; Bakacsy, László ; Kovács, Henrietta ; Pálfi, Péter ; Kredics, László ; Marik, Tamás ; Szőllősi, Réka
Role of polyamine catabolism in tomato cultivars during salt stress
In: SOL International Online Meeting 2020 Abstract Book
(2020) 175 p. pp. 118-118. , 1 p.

Szepesi, Ágnes ; Bakacsy, László ; Kovács, Henrietta ; Kredics, László ; Marik, Tamás ; Pálfi, Péter ; Szőllősi, Réka ; Zsigmond, Laura
Catabolism of polyamines as bio-stimulant plant growth regulators for improving salt stress tolerance of tomatoes
In: Mohammad, I. Khalil; Bruce, A. Osborne (szerk.) 1st International Symposium on Climate-resilient Agri-environmental Systems 2020
Dublin, Ireland (2020) 79 p. pp. 49-49. , 1 p.

3rd year 2020.12.01.-2021.11.30.

Scientific Articles:

Szepesi, Ágnes ✉

Plant Metabolites and Regulation under Environmental Stress: Editorial

PLANTS-BASEL 10 : 10 Paper: 2013 (2021)

Pálfi, Péter ; Bakacsy, László ; Kovács, Henrietta ; **Szepesi, Ágnes** ✉

Hypusination, a Metabolic Posttranslational Modification of eIF5A in Plants during Development and Environmental Stress Responses

PLANTS-BASEL 10 : 7 Paper: 1261 , 13 p. (2021)

Kaszler, Nikolett ; Benkő, Péter ; Bernula, Dóra ; **Szepesi, Ágnes** ; Fehér, Attila ✉ ; Gémes, Katalin ✉

Polyamine Metabolism Is Involved in the Direct Regeneration of Shoots from Arabidopsis Lateral Root Primordia

PLANTS-BASEL 10 : 2 Paper: 305 , 15 p. (2021)

Student Thesis Works:

BSc thesis

Kovács Renáta: A sótűrő halofita növényfajok élettani és gazdasági jelentősége

BSc thesis

Zerebélyi Evelin: A poliaminok metabolizmusának jelentősége növényekben és állatokban, valamint a terápiás alkalmazás lehetőségei állati szervezetekben

MSc thesis

Kakas Edina: A deoxihipuzin-szintáz enzim gátlásának hatása sóstressznek kitett Arabidopsis csíranövények élettani folyamataira

Conference Abstracts:

Bakacsy, László ; Marik, Tamás ; **Szepesi, Ágnes**
Relatív klorofill tartalom térbeli jellegzetességeinek vizsgálata selyemkóró (Asclepias syriaca L.) állományokon
In: Takács, Attila; Sonkoly, Judit (szerk.) XIII. Aktuális Flóra- és Vegetációkutatás a Kárpát-medencében nemzetközi konferencia: Program és összefoglalók. 13th "Advances in Research on the Flora and Vegetation of the Carpato-Pannonian Region" International Conference: Programme and Abstracts
Debrecen, Magyarország : Debreceni Egyetem Természettudományi Kar (2021) p. 79

Pálfi, Péter ; Sípos, Lilla ; Szőllősi, Réka ; Szabó, Dominik ; **Szepesi, Ágnes**
A hipuzinációban szerepet játszó enzim, a dezoxihipuzin-hidroxiláz gátlásának hatása a paradicsom magok csírázására és korai fejlődésére
In: Papp, Nóra (szerk.) XVI. MAGYAR NÖVÉNYANATÓMIAI SZIMPÓZIUM
Pécs, Magyarország : PTE Gyógyszerésztudományi Kar, Farmakognóziai Intézet (2021) p. 19 , 1 p.
Péter Pálfi won second place of poster presentations.

Pálfi, Péter ; Sípos, Lilla ; Bakacsy, László ; Molnár, Árpád ; Szőllősi, Réka ; Zsigmond, Laura ; **Szepesi, Ágnes**
A hipuzinációban résztvevő enzim, a dezoxihipuzin-hidroxiláz jelentőségének vizsgálata paradicsom növényekben
In: Györgyey, János (szerk.) XIII. Magyar Növénybiológiai Kongresszus : Összefoglaló kötet
Szeged, Magyarország : Szegedi Biológiai Kutatóközpont (2021) p. 83

Sípos, Lilla ; Pálfi, Péter ; Bakacsy, László ; Molnár, Árpád ; Szőllősi, Réka ; Zsigmond, Laura ; **Szepesi, Ágnes**
A hipuzinációban résztvevő enzim, a dezoxihipuzin-hidroxiláz (DOHH) jelentőségének vizsgálata közönséges lúdfű (Arabidopsis thaliana) csíranövényekben
In: Györgyey, János (szerk.) XIII. Magyar Növénybiológiai Kongresszus : Összefoglaló kötet
Szeged, Magyarország : Szegedi Biológiai Kutatóközpont (2021) p. 90

Szepesi, Ágnes ; Erdei, László
Modernkori kihívások előtt a növényanatómia
In: Papp, Nóra (szerk.) XVI. MAGYAR NÖVÉNYANATÓMIAI SZIMPÓZIUM
Pécs, Magyarország : PTE Gyógyszerésztudományi Kar, Farmakognóziai Intézet (2021) p. 6 , 1 p.

Szepesi, Ágnes ; Pálfi, Péter ; Sípos, Lilla ; Bakacsy, László ; Kakas, Edina ; Molnár, Árpád ; Szőllősi, Réka ; Zsigmond, Laura
A hipuzinációban résztvevő enzimek szerepének vizsgálata növényekben
In: Györgyey, János (szerk.) XIII. Magyar Növénybiológiai Kongresszus : Összefoglaló kötet
Szeged, Magyarország : Szegedi Biológiai Kutatóközpont (2021) p. 8

Szepesi, Ágnes ; Bakacsy, László ; Kovács, Henrietta ; Pálfi, Péter ; Sípos, Lilla ; Szőllősi, Réka ; Zsigmond, Laura
AG-induced changes of polyamine catabolism and related reactive species in Arabidopsis thaliana and Solanum lycopersicum plants exposed to short-term salt stress
In: Kolbert, Zsuzsanna; Feigl, Gábor; Molnár, Árpád; Szepesi, Ágnes; Bodor, Attila; Fehér, Attila (Eds.) 8th Plant Nitric Oxide International Meeting : Program & Book of Abstracts
(2021) 84 p. p. 66 , 1 p.

Szepesi, Ágnes
Exploring the role of polyamine catabolism in plants during salt stress
In: Fernanda, Fidalgo Book of Abstracts: II Plant Abiotic Stress Forum: An Integrative Lens Over Plant Adaptation
Porto, Portugal (2021) 50 p. pp. 34-34. , 1 p.

4th year 2021.12.01.-2022.11.30. and the asked 5 months 2023.05.31.

Scientific Articles:

Szepesi, Ágnes ✉ ; Poór, Péter ; Bakacsy, László

Short-Term Salicylic Acid Treatment Affects Polyamine Metabolism Causing ROS–NO Imbalance in Tomato Roots

PLANTS-BASEL 11 : 13 Paper: 1670 , 8 p. (2022)

Riyazuddin, Riyazuddin ; Bela, Krisztina ; Poór, Péter ; **Szepesi, Ágnes** ; Horváth, Edit ; Rigó, Gábor ; Szabados, László ; Fehér, Attila ; Csiszár, Jolán ✉

Crosstalk between the Arabidopsis Glutathione Peroxidase-Like 5 Isoenzyme (AtGPXL5) and Ethylene

INTERNATIONAL JOURNAL OF MOLECULAR SCIENCES 23 : 10 Paper: 5749 , 24 p. (2022)

Bakacsy, László ; Sípos, Lilla ; Barta, Anita ; Stefkó, Dóra ; Vasas, Andrea ; **Szepesi, Ágnes** ✉

Concentration-dependent effects of effusol and juncusol from Juncus compressus on seedling development of Arabidopsis thaliana

SCIENTIFIC REPORTS 12 : 1 Paper: 13870 , 12 p. (2022)

Ágnes, Szepesi ; László, Bakacsy ; Henrietta, Kovács ; Árpád, Szilágyi ; Zoltán, Márton Köhler

Inhibiting Copper Amine Oxidase Using L-Aminoguanidine Induces Cultivar and Age-Dependent Alterations of Polyamine Catabolism in Tomato Seedlings

AGRICULTURE-BASEL 12 : 2 Paper: 274 , 14 p. (2022)

Köhler, Zoltán Márton ; **Szepesi, Ágnes**

More Than a Diamine Oxidase Inhibitor: L-Aminoguanidine Modulates Polyamine-Related Abiotic Stress Responses of Plants

LIFE-BASEL 13 : 3 p. 747 (2023)

Submitted Articles in 2023

Submitted and status: Major Revisions:

MDPI Antioxidants
Manuscript ID: antioxidants-2415963
Type of manuscript: **Article**
Title: L-aminoguanidine induces imbalance of ROS/RNS homeostasis and polyamine catabolism of tomato roots after short-term salt exposure
Authors: **Ágnes Szepesi *,** László Bakacsy, Attila Fehér, Henrietta Kovács, Péter Pálfi, Péter Poór, Réka Szőllősi, Orsolya Kinga Gondor, Tibor Janda, Gabriella Szalai, Christian Lindermayr, László Szabados, Laura Zsigmond

Submitted and status: under Review:

Plant Stress
Manuscript Number: STRESS-D-23-00258
Type of manuscript: **Article**
Title: Application of GC7 to reduce hypusination via inhibiting deoxyhypusine synthase in Arabidopsis thaliana seedlings exposed salt stress
Authors: **Ágnes Szepesi*,** Edina Kakas, Réka Szőllősi, Árpád Molnár, Péter Pálfi

Submitted and status: under Review

Scientia Horticulturae

Manuscript number: HORTI42316
Type of manuscript: **Short Communication**
Title: Inhibition of deoxyhypusine synthase by GC7 induces modification of fruit set and polyamine catabolism in tomato plants exposed to salt stress
Ágnes Szepesi*, László Bakacsy, Lilla Sípos, Réka Szőllősi, Péter Pálfi

Student Thesis Works:

BSc thesis

Sípos Lilla: Az effuzol és a junkuzol élettani hatásainak vizsgálata Arabidopsis thaliana csíranövényeken

BSc thesis

Szabó Dominik: Exogén gamma-aminovajsav (GABA) kezelés hatása sóstressznek kitett paradicsom növények poliamin lebontására

MSc thesis in English

ALI MOHAMED ALI: Effect of GABA on hypusination process of Arabidopsis thaliana seedlings

Msc thesis

Pálfi Péter: A hipuzináció vizsgálata gátlószerek alkalmazásával paradicsom növények két fejlődési stádiumában

BSc thesis

Gutheil Adél: A poliamin metabolizmus vizsgálata ozmotikus stressznek kitett paradicsom csíranövények korai egyedfejlődésében

BSc thesis

Lackó Márk: A poliamin metabolizmus vizsgálata ionos stressznek kitett paradicsom csíranövények korai egyedfejlődésében

Book Chapters:

Péter, Pálfi ; Riyazuddin, Riyazuddin ; László, Bakacsy ; **Ágnes, Szepesi**
Functions of Polyamines in Abiotic Stress Tolerance in Plants

In: M., Iqbal R. Khan; Palakolanu, Reddy; Ravi, Gupta Advancements in Developing Abiotic Stress-Resilient Plants
London, United Kingdom / England: Taylor and Francis Group (2022) 394 p. Paper: 9781003159636

Ágnes, Szepesi ; Péter, Poór
Interaction between the key defense-related phytohormones and polyamines in crops
In: M., Iqbal R. Khan; Amarjeet, Singh; Péter, Poór (szerk.) Plant Hormones in Crop Improvement
Amszterdam, The Netherlands: Elsevier Academic Press (2023) p. 249

TDK and OTDK prizes:

Pálfi Péter, MSc (2022) TDK local Spring Competition, **II. Prize**

TDK thesis Title: *A hipuzináció gátlására használt ciklopirox hatása a különböző életkorú paradicsom növények fejlődésére*

In National TDK Competition in 2023, Péter Pálfi won **OTDK III. Prize.**

Conference Abstracts:

Ágnes, Szepesi ; Henrietta, Kovács ; Péter, Pálfi ; Lilla, Sípos ; Dominik, Szabó ; László, Bakacsy
Hypusination and salt stress in tomato: a metabolic post-translational modification by polyamines and hypusine
In: ISCRAES 2022 28-31 AUGUST 2022, DUBLIN, IRELAND Programme
(2022) p. 2

Ali, Mohamed Ali ; Lilla, Sípos ; László, Bakacsy ; Laura, Zsigmond ; **Ágnes, Szepesi**
Connection between GABA and hypusination process of Arabidopsis thaliana seedlings influencing polyamine catabolism
In: 6 th International Conference on Polyamines in Rome-Tivoli, Italy: biochemical , physiological and clinical perspectives-Scientific Programme and Abstracts
(2022) p. 34

Szepesi, Ágnes ✉ ; Sípos, Lilla ; Barta, Anita ; Stefkó, Dóra ; Vasas, Andrea ; Bakacsy, László
Bioactivity of rush-specific (Juncus sp.) compounds on antioxidant defence mechanisms of Arabidopsis thaliana
In: Abstract Book Redox Biology Congress Ghent 2022
(2022) pp. 113-113. , 1 p.

Szepesi, Ágnes ; Bakacsy, László ; Sípos, Lilla ; Szőllősi, Réka ; Zsigmond, Laura ; Molnár, Árpád ; Pálfi, Péter
Inhibition of deoxyhypusine synthase by GC7 induces modification of polyamine catabolism in tomatoes during salt stress

In: XXth EUCARPIA Meeting of the Tomato Working Group Programme and Abstracts (2022) pp. 80-80. , 1 p.

Future perspectives of this topic

- Péter Pálfi investigated the application of ciclopirox (CPX) in plants to inhibit the other enzyme, DOHH in hypusination. We have to test some unexpected side effects, for example chlorosis in leaves and areas with dead cells, so other experiments are needed.
- Lilla Sípos won UNKP grant in 2022 to discover the significance of polyamine oxidase 5 in hypusination processes in plants.
- We would like to conduct some experiments with GABA mutant plants after successful growing.
- We would like to make DOHH mutant *Arabidopsis thaliana* plants with cooperation of Portuguese colleagues from University of Porto.
- There is ongoing manuscript preparation from Ali Mohamed Ali MSc thesis about the protective effect of GABA in *Arabidopsis thaliana*.
- Our lab in the future is open to cooperate for investigating the polyamine metabolism and hypusination in plants.

Overall, I would like to thank for the opportunity to make this project and results and publications could help develop our scientific experiences in the future.