Chapter 5

COLD ATMOSPHERIC PLASMA TREATMENT OF TURKISH TEA

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INTRODUCTION

Basically, plasma is matter's fourth state. It is a mixture of positive or negative ions, electrons, and neutral atoms. It is used in many industrial fields such as energy, medicine, and the military. The thermonuclear fusion designs such as tokamak and stellerator are the well-known examples of high temperature plasmas [(1)]. Low temperature plasmas are utilized in sterilization [(2, 3)], medicine [(4)], manufacturing and processing of materials [(5)]. When the temperature is low enough to treat cell or tissue, this type of plasma is classified as cold or non-thermal plasma, which gives rise to plasma medicine wound healing and cancer treatment [(6)]. Recently, an innovative field of research of cold plasma called plasma agriculture has grabbed more attention due to its potential in improving agricultural production and food preservation [(7)]. It is a green and eco-friendly technology for increasing agricultural yield [(8)] and combating against plant pests. In this study, the effects of cold plasma treatment on seed germination and seedlings growth of Turkish tea (*Camellia sinensis* L.) seeds were investigated. Surface properties were examined by using scanning electron microscopy (SEM), and macronutrients content was determined by Nitrogen Phosphorus Potassium (NPK) analysis.

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CONCLUSION

We have shown preliminary results of ongoing study, which indicate that cold plasma treatment might promote the growth and modify the speed of germination of tea seeds. Future work includes plasma activated water treatment of Turkish tea.

Plasma technology offers many opportunities for Turkish agriculture which is the seventh-largest agricultural country in the world. It present innovative solutions and may be useful in every step of food cycle: seed germination, seedlings growth, preservation, storage and transportation. However, there is inadequate research in this field. There should be much more cooperation between academia and industry.

REFERENCES

1. S. Eliezer and Y. Eliezer, The Fourth State of Matter: An Introduction to Plasma Science, Second Edition, IOP, 2001.
2. M. Fiebrandt, J-W. Lackmann, K. Stapelmann, From patent to product? 50 years of low-pressure plasma sterilization, Plasma Process Polym. 2018;15:e1800139.
3. M. Laroussi, Low Temperature Plasma-Based Sterilization: Overview and State-of-the-Art, Plasma Process. Polym. 2005, 2, 391–400.
4. M. Laroussi, X. Lu, and M. Keidar, Perspective: The physics, diagnostics, and applications of atmospheric pressure low temperature plasma sources used in plasma medicine, Journal of Applied Physics 122, 020901 (2017)
5. F. F. Chen, Industrial Applications of Low Temperature Plasma Physics, Physics of Plasmas, 2 (6), 1995.
6. M. Laroussi, Plasma Medicine: A Brief Introduction, Plasma 2018, 1, 47–60.
7. R. Brandenburg et al., White paper on the future of plasma science in environment, for gas conversion and agriculture, Plasma Process Polym. 2019, 16:e1700238.
8. B. Kakati, S. Bujarbarua and D. Bora, An eco-friendly, pollution-free process for seed germination and plant yield, AIP Conference Proceedings 2091, 020021 (2019).
9. M. Laroussi, 1995–2005: A Decade of Innovation in Low Temperature Plasma and Its Applications, Plasma, 2019, 2, 360–368;
10. Francis F. Chen Introduction to Plasma Physics and Controlled Fusion Third Edition
11. K.H. Becker, U. Kogelschatz, K.H. Schoenbach, R.J. Barker, Non-Equilibrium Air Plasmas at Atmospheric Pressure, CRC Press, 1st edition.
12. X.Lu, G.V.Naidis, M.Laroussi, S.Reuter, D.B.Graves, K.Ostrikov, Reactive species in non-equilibrium atmospheric-pressure plasmas: Generation, transport, and biological effects, Physics Reports,2016, Vol 360.
13. X. Lu, M Laroussi, V Puech, On atmospheric-pressure non-equilibrium plasma jets and plasma bullets, Plasma Sources Science and Technology, 2012, vol 21
14. John Harry Introduction to Plasma Technology Science, Engineering and Applications, Wiley Publishing
15. Handbook of Plastics Joining A Practical Guide Book. 2nd Edition. 2008 Cover for Handbook of Plastics Joining Edited by Michael J. Troughton

16. Industrial Plasma Engineering Volume 1: Principles J Reece Roth Department of Electrical and Computer Engineering University of Tennessee, Knoxville Institute of Physics Publishing
17. B Sara, M Serry, B Gavril, L Gajdoca, Seed Germination and Early Growth Responses to Seed Pre-treatment by Non-thermal Plasma in Hemp Cultivars (Cannabis sativa L.), Plasma Chem Plasma Process (2017) 37:207–221
18. Alexander Piel, Plasma Physics: An Introduction to Laboratory, Space, and Fusion Plasma
19. T. R. O'Brian , J. E. Lawler. Excited Level Lifetime Measurements. Experimental Methods in the Physical Sciences. Vol 2YB
20. Liudvikas Pranevičius, Plasma Technologies, Monography, Vytautas Magnus University Lithuanian Energy Institute
21. T. Ohta.2016. Plasma in Agriculture. in Cold Plasma in Food and Agriculture. Elsevier Inc.
22. Dayonna P. Park et al. Reactive nitrogen species produced in water by non-equilibrium plasma increase plant growth rate and nutritional yield. Current Applied Physics 13 (2013) S19-S29
23. Nevena Puač, Matteo Gherardi, Masaharu Shiratani. Plasma agriculture: A rapidly emerging field Plasma Process Polym. 2017; e1700174.
24. Božena ŠERÁ and Michal ŠERÝ. Non-thermal plasma treatment as a new biotechnology in relation to seeds, dry fruits, and grains. Plasma Sci. Technol. 20 (2018) 044012 (8pp).
25. Chiara Lo Porto et al. Cold plasma pretreatment improves the germination of wild asparagus (Asparagus acutifolius L.) seeds. Scientia Horticulturae 256 (2019) 108554.
26. Young I. Cho, Yong Yang, Alexander Fridman, Plasma Discharges in Liquid, CRC Press, 2017
27. L. Sivachandiran and A. Khacef, Enhanced seed germination and plant growth by atmospheric pressure cold air plasma: combined effect of seed and water treatment. RSC Adv., 2017, 7, 1822–1832
28. Sevket Pamuk, Agricultural Output and Productivity Growth in Turkey since 1880, paper presented at Session 60 Agriculture and Economic Development in Europe since 1870 XIV International Economic History Congress Helsinki, 21-25 August, 2006
29. Harun Ucak, Monitoring Agriculture of Turkey Before Accession Process for EU Membership, Proceedings from the First International Conference on Agriculture and Rural Development Topusko, Croatia, November 23-25 2006
30. Erol Çakmak, Agricultural Policy Reforms Reforms and Rural Development in Turkey, Economic Development and Poverty Reduction Workshop, Mediterranean Development Forum September 3 - 6, 1998 Marrakech, Morocco
31. Handan Giray, Turkish agriculture at a glance, Journal of Food, Agriculture & Environment, Vol.10 (3&4), 292-295, July-October 2012
32. Mehmet Arif ŞAHİNLİ, Comparative advantage of agriculture sector between Turkey and European Union, African Journal of Agricultural Research, Vol. 8(10), pp. 884-895, 21March, 20123 DOI: 10.5897/AJAR12.2001
33. Yeşim AYTOP, Muhammed ÇUKADAR, Ahmet ŞAHİN, Turkish Journal of Agricultural and Natural Sciences Special Issue: 1, 2014, pp 688-694
34. Selcuk, M., Oksuz, L., Basaran, P., 2008. Bioresour. Technol. 99, 5104-5109.
35. Basaran, P., Basaran-Akgul, N., Oksuz, L., Food Microbiol. 25, 626-632 (2008).
36. May KORACHI, Necdet ASLAN. 2011. The Effect of Atmospheric Pressure Plasma Corona Discharge on pH, Lipid Content and DNA of Bacterial Cells. Plasma Science and Technology, Vol.13, No.1.
37. Yakup Arslan. The Effect of Dielectric Barrier Discharge Plasma Treatment on the Microorganisms Found in Raw Cow's Milk. Turk J. Agric. Res. (2016) 3:169-173.
38. Fatih SEYIS, Emine YURTERI, Aysel OZCAN, Yusuf SAVSATLI, Organic Tea Production and Tea Breeding in Turkey: Challenges and Possibilities, Ekin Journal of Crop Breeding and Genetics 4(1):60-69, 2018

39. Sezai ERCİŞLİ, The Tea Industry and Improvements in Turkey, L. Chen et al., Global Tea Breeding © Zhejiang University Press, Hangzhou and Springer-Verlag Berlin Heidelberg 2012
40. Emine YURTERI, Aysel OZCAN, Fatih SEYIS, Tea (Camellia sinensis) Cultivation and Breeding in Turkey: Pas t and Present Status, Ekin Journal of Crop Breeding and Genetics 5(2):111-119, 2019
41. Patrick W. Kuloba et al., Investigation into low-temperature nitrogen plasma environment effect on the content of polyphenols during withering in made Kenyan tea. Int. J. Food & Technology, 49 (4), 1020-1026
42. Maryam Amini and Mahmood Ghoranneviss, Black and Green Tea Decon-tamination by Cold Plasma. Res. J. Microbiol., 11 (2016): 42-46.
43. Hamajima, S. et al. 2017, in Recent Global Research and Education: Technological Challenges, Advances in Intelligent Systems and Computing, ed. R. Jablonski & A. R. Szewczyk (Springer International Publishing AG) 519