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The effect of ascorbic acid on the germination of catnip (*Nepeta cataria*) plants at different salt concentrations

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Abstract

This study aimed to determine how administering ascorbic acid (AsA) at different salt concentrations (NaCl) affected the germination and other physiological characteristics of catnip (Nepeta cataria) seeds. For each application, the study employed four distinct AsA applications (0, 50, 100, and 150 mM) and four distinct NaCl concentrations (0, 50, 100, and 150 mM). Germination rate (%), germination time (day), root length (cm), and stem length (cm) were the criteria examined in this study.

This study showed that germination was adversely affected by increased salt concentrations. Treatments with 50 mM and 100 mM AsA also showed positive effects on germination and other measures. It has been shown that catnip plant germination in saline conditions may be positively impacted by the ideal administration of AsA.

Keywords: *Nepeta cataria*; Ascorbic acid (AsA); NaCl; Catnip; Chemistry

1. Introduction

With over 300 species, the genus Nepeta is one of the biggest in the Lamiaceae family. It is found in temperate climates and is naturalized in North America. It is mostly found in central and southern Europe, the Near East, central and southern Asia, and certain parts of Africa. Particularly in Southwestern Asia (Iran and Turkey), the majority of Nepeta species are native (Acimovic et al., 2021).

The most common and most researched species is *Nepeta cataria*, often referred to as catnip or catmint (Klimek and Modnicki, 2005; Acimovic et al., 2020). The intense affinity that most cats have to this species is the source of the term catmint (Manju et al., 2019). As the term catnip is derived from the word "nip" which means a little amount of liquor that intoxicates cats, it is widely known that this plant is a powerful behavior-altering stimulant that causes euphoria or stupor in both domestic cats and huge wild cats (Sherry and Koontz, 1979; Small 2012). In order to enhance the quality of life and reduce stress, it is frequently utilized in the pet toy sector as a safe cat attractant, particularly for indoor cats (Reichert et al., 2016; Bol et al., 2017).

Nepeta cataria plants are utilized in traditional medicine (Naghibi et al., 2005; Adiguzel et al., 2009). Their broth contains immunomodulatory qualities, normalizes the respiratory, neurological, and cardiovascular systems, and increases hunger. Malignancy, cough, liver illness, jaundice, intestinal atony, hysteria, headaches, gynecological problems, and anti-helminthes agents are among its uses (Gilani et al., 2009). Blood pressure quickly returns to normal with relatively modest concentrations of essential oils in the air as aerosols. *Nepeta cataria* essential oil has strong

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antimicrobial and fungicidal properties against mold fungi, including Mucor, Penicillium, and Aspergillus (Zomorodian et al., 2012; Foltinová, Tančinová and Císarová 2017; Tančinová et al., 2018; Stević et al., 2014). It is also a powerful source of nematicidal compounds that can be used in entomology and phytopathology (Pandey et al., 2000; Peterson and Ems-Wilson, 2003; Tworkoski, 2002; Juglal, Govinden and Odhav, 2002; Amer and Mehlhorn, 2006). Because it produces monodehydroascorbate, a radical that preferentially combines with radicals rather than non-radical substances, and because it provides a single reducing equivalent, ascorbic acid (vitamin C) is a unique antioxidant. This occurs because monodehydroascorbate would form an energetically unfavorable tricarbonyl structure if an electron were removed. Ascorbic acid does not produce this structure; instead, it oxidizes to monodehydroascorbate, which then combines with other radicals to oxidize through mechanisms that might prevent the creation of this undesirable structure (Njus et al., 2020).

By controlling plant metabolism and development, ascorbic acid makes more nutrients and water available to plants under salt stress (Torlak 2019). Using non-enzymatic antioxidant molecules like ascorbic acid is another way to decrease the negative effects of salt stress on plants (Khan et al. 2006).

This reserach aimed to determine how ascorbic acid application affected *Nepeta cataria* seed germination at different salt concentrations.

2. Material and methods

The study was conducted in 2024 at Balıkesir University Altınoluk Vocational School's Medicinal and Aromatic Plants Laboratory. Catnip seeds were used as plant material. Four different concentrations of NaCl (0, 50, 100, and 150 mM) for each priming application were examined in the study along with priming applications (AsA). Analytical grade sodium chloride was used to create salt stress. Ten minutes prior to germination, the seeds were surface sterilized in a 5% sodium hypochlorite solution (Uyanık et al., 2014). Nazarian (2016) reports that seedlings were primed by soaking them in AsA solutions at different concentrations for 12 hours after surface sterilization. To recover their initial moisture content, they were then dried on drying papers for a whole day at room temperature. The seeds were then seeded in petri dishes at 20±1 °C after these treatments. According to ISTA (1996) rules, seeds were first considered viable. Fourteen days were spent testing the germination of four-by-twenty-five seeds in petri dishes with two layers of blotting paper between them (ISTA, 1996). The following values were examined in this study: germination power (%), germination rate (%), germination index (%), average germination time (cm), root length (cm), and stem length (cm).

Germination time and germination rate were computed by dividing the total number of seeds sown by the number of seeds that germinated and were obtained on the seventh and fourteenth days (Akıncı and Çalışkan, 2010). The experiment's results were statistically examined using the TARIST statistical tool. The LSD test was used to compare the means.

3. Results

3.1. Effect of Ascorbic Acid on Germination Rate

According to the study's findings, there should be a comparison of the germination rate of catnip seeds in NaCl solution at the 5 % significance level for variations in NaCl dosages, Ascorbic acid dosages and the NaCl x AsA interaction (Table 1).

Table 1 Ascorbic acid's effect on the rate of seed germination (%)*

NaCL /AsA	0 mM	50 mM	100 mM	150 mM	Means
0 mM	88.00 e	95.00 b	96.00 a	91.00 d	92.50 a
50 mM	79.00 f	95.00 b	95.00 b	88.00 e	89.25 b
100 mM	71.00 i	92.00 c	92.00 c	78.00 g	83.25 c
150 mM	58.00 m	70.00 k	72.00 h	67.00 l	66.75 d
Means	74.00 c	88.00 a	88.75 a	81.00 b	

LSD $_{NaCl}$: 2.747; LSD $_{AsA}$:1.838; LSD $_{Int.}$: 0.541;*There is no statistical ($p < 0.05$) differences between values with the same letters in the same colums.

The average concentrations of NaCl were investigated and the highest germination rate was found at 0 mM NaCl with 92.50 % and the lowest at 150 mM NaCl with 66.75 %. The analysis of the average ascorbic acid dosages showed that the highest germination rates were 88.75 % at 100 mM AsA and 88.00 % at 50 mM AsA, while the lowest germination rate was 74.00 % at 0 mM AsA. Examining the NaCl x AsA interaction, the 0 mM x 100 mM interaction had the highest germination rate (96.00 %), whereas the 150 mM x 0 mM interaction had the lowest germination rate (58.00 %).

3.2. Effect of Ascorbic Acid on Germination Time

The study suggests that at the 5 % significant level, the germination durations of catnip seeds in NaCl solution with different concentrations should be compared to NaCl doses, Ascorbic acid dosages and the NaCl x AsA interaction (Table 2).

An investigation of average NaCl concentrations showed that the earliest germination time in 0 mM NaCl was 4.24 days, and the latest germination time in 150 mM NaCl was 5.68 days.

Table 2 Ascorbic acid's effect on the germination time of seeds (days)*

NaCL /AsA	0 mM	50 mM	100 mM	150 mM	Means
0 mM	4.12 h	3.96 i	3.71 k	5.04 de	4.24 d
50 mM	4.86 f	4.40 g	4.36 g	5.36 c	4.75 c
100 mM	5.28 cd	4.92 e	4.75 fg	5.88 b	5.21 b
150 mM	5.83 b	5.52	5.25 d	6.12 a	5.68 a
Means	5.03 b	4.70 c	4.55 d	5.60 a	

LSD_{NaCl}: 0.425; LSD_{AsA}:0.193; $LSD_{Int.}$: 0.219;*There is no statistical ($p < 0.05$) differences between values with the same letters in the same colums.

The earliest germination period in 100 mM AsA was 4.55 days, while the longest germination time in 150 mM AsA was 5.60 days, according to the study, which examined average ascorbic acid dosages. When the NaCl x AsA interaction was examined, the earliest germination durations were 3.71 days in the 0 mM x 100 mM interaction, and the latest germination time was 6.12 days in the 150 mM x 150 mM interaction.

3.3. Effect of Ascorbic Acid on Root Length

Catnip seed root length fluctuation in NaCl solution with different concentrations between salt doses, ascorbic acid doses and the NaCl x AsA interaction should be examined at the 5% significant level, the study suggests (Table 3).

When examining the typical NaCl values, the longest root measured 1.58 cm in 0 mM NaCl and the shortest 0.92 cm in 150 mM NaCl.

Table 3 Ascorbic acid's impact on root length (cm)*

NaCL /AsA	0 mM	50 mM	100 mM	150 mM	Means
0 mM	1.52 d	1.72 a	1.68 b	1.38 e	1.58 a
50 mM	1.38 e	1.54 d	1.60 c	1.22 g	1.43 b
100 mM	1.12 h	1.05	1.57 c	1.33 f	1.27 c
150 mM	0.55 l	0.90 k	1.08 i	1.14 h	0.92 d
Means	1.14 d	1.30 b	1.48 a	1.27 c	

LSD_{NaCl}: 0.117; LSD_{AsA}:0.121; $LSD_{Int.}$: 0.037; *There is no statistical ($p < 0.05$) differences between values with the same letters in the same colums.

The average ascorbic acid dosages were analyzed, and the longest root length was 1.48 cm at 100 mM AsA and the shortest was 1.14 cm at 0 mM AsA.

The NaCl x AsA interaction revealed the longest root length of 1.72 cm in the 0 mM x 50 mM interaction, while the 150 mM x 0 mM interaction revealed the shortest root length of 0.55 cm.

3.4. Effect of Ascorbic Acid on Stem Length

At the 5 % significant level, the study recommends comparing the stem length of catnip seeds in NaCl solution with different concentrations between NaCl doses, Ascorbic acid dosages, and the NaCl x AsA interaction (Table 4).

Table 4 Ascorbic acid's effect on stem length (cm)*

NaCL /AsA	0 mM	50 mM	100 mM	150 mM	Means
0 mM	1.08 cd	1.18 b	1.24 a	0.78 g	1.07 a
50 mM	1.05 de	1.16 b	1.11 c	0.70 h	1.00 b
100 mM	0.95 f	0.98 f	1.03 e	0.65 i	0.90 c
150 mM	0.75 gh	0.78 g	0.82 g	0.52 k	0.72 d
Means	0.96 b	1.03 a	1.05 a	0.66 c	

LSD_{NaCl}: 0.065; LSD_{AsA}:0.054; $LSD_{Int.}$: 0.033; *There is no statistical ($p < 0.05$) differences between values with the same letters in the same colums.

In comparison to the usual concentrations of NaCl, the highest stem length measured 1.07 cm in 0 mM NaCl and the smallest was 0.72 cm in 150 mM NaCl. According to an analysis of the average dosages of ascorbic acid, the minimum stem length was 0.66 cm at 150 mM AsA, and the maximum stem length was 1.05 and 1.03 cm at 100 mM and 50 mM AsA.

The investigation of the NaCl x AsA interaction revealed the lowest stem length in the 150 mM x 150 mM interaction and the longest stem length in the 0 mM x 100 mM interaction. They were, respectively, 1.24 cm and 0.52 cm.

4. Discussion

Although the methods for producing and utilizing ascorbic acid (ASA) can differ depending on the developmental and functional stages of the seed, the ASA system operates dynamically in seeds. According to Tullio and Arrigoni (2007), orthodox seeds have neither ASA nor ASA peroxidase at quiescence, but they do have a small amount of dehydroascorbic acid (DHA) and significant ASA recycling enzyme activity. This is because the ASA content and ASA peroxidase activity in orthodox seeds increase during the early stages of development and then decrease during the desiccation stage.

Ascorbic acid (AsA) is essential for the germination phase in addition to regulating the physiology of stress in plants (Arrigoni et al. 1997; Noctor and Foyer, 1998; Conklin, 2001). Bassuony et al. (2008); Mohsen et al. (2013); The findings of this study are consistent with the research conducted by Erkoyuncu and Yorgancılar (2020).

Yaver and Paşa (2009), Paşa (2022), Farahbakhsh (2012), Jam et al. (2012), Soliman et al. (2016), Ramanujam et al. (1998), Mendoza et al. (2002), Tari et al. (2002), El-Tayeb (2005), and Erkoyuncu and Yorgancılar (2020) have all shown that the findings of this study are in line with previous research.

5. Conclusion

According to this study, germination was negatively impacted by increased salt concentrations. Additionally, high values for the germination rate, germination time, stem length, and root length criteria were attained in 50 mM and 100 mM AsA treatments. It has been discovered that catnip plant germination in saline conditions can be positively impacted by the ideal administration of AsA.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Aćimović, M.; Stanković Jeremić, J.; Cvetković, M. Phyto-pharmacological aspects of Nepeta nuda L.: A systematic review. Natural Medicinal Materials. 2020, 40, 75-83.

[2] Aćimović M, Zeremski T, Kiprovski M, Brdar-Jokanović M, Popović V, Koren A and Sikora V. Nepeta cataria – Cultivation, Chemical Composition and Biological Activity. J Agron Technol Eng Manag 2021, 4(4)

[3] Adiguzel, A., Ozer, H., Sokmen, M., Gulluce, M., Sokmen, A., Kilic, H., Sahin, F., Baris, O. 2009. Antimicrobial and antioxidant activity of the essential oil and methanol extract of Nepeta cataria. Polish Journal of Microbiology, vol. 58, no. 1, p. 69-76.

[4] Akıncı IE, Calıskan U, 2010. Effect of lead on seed germination and tolerance levels in some summer vegetables. Ekoloji Dergisi, 19: 164-172.

[5] Amer, A., Mehlhorn, H. 2006. Repellencyeffect of forty-one essential oils against Aedes, Anophelesand Culexmosquitoes. Parasitology Res., vol. 99, no.4, p. 478-490. https://doi.org/10.1007/s00436-006-0184-1

[6] Arrigoni O, Calabrese G, De Gara L, Bitonti MB, Liso R, 1997. Correlation between Changes in Cell Ascorbate and Growth of *Lupinus albus* Seedlings. Journal of Plant Physiology, 150 (3):302-308.

[7] Bassuony F, Hassanein R, Baraka D, Khalil R, 2008. Physiological Effects of Nicotinamide and Ascorbic Acid on *Zea mays* Plant Grown Under Salinity Stress. II-Changes in Nitrogen Constituents, Protein Profiles, Protease Enzyme and Certain Inorganic Cations. Australian Journal of Basic and Applied Sciences, 2 (3): 350-359.

[8] Bol, S.; Caspers, J.; Buckingham, L.; Anderson-Shelton, G.D.; Ridgway, C.; Buffington, T.; Schulz, S.; Bunnik, E. Responsiveness of cats (Felidae) to silver vine (Actinidia polygama), Tatarian honeysuckle (Lonicera tatarica), valerian (Valeriana officinalis) and catnip (Nepeta cataria). BMC Vet Res. 2017, 13, 70.

[9] Conklin PL, 2001. Recent Advances in the Role and Biosynthesis of Ascorbic Acid in Plants. Plant, Cell & Environment, 24 (4): 383-394.

[10] El-Tayeb MA, 2005. Response of barley grains to the interactive effect of salinity and salicylic acid. Plant Growth Regulation, 45: 215–224.

[11] Erkoyuncu MT, Yorgancılar M, 2020. The Effect of Priming Applications (Salicylic Acid and Ascorbic Acid) on Germination in Canola (Brassica napus L.) Exposed to Salt Stress, Iğdır University Journal of the Institute of Science and Technology, 10(4): 3109-3121, 2020.

[12] Farahbakhsh H, 2012. Germination and Seedling Growth in Unprimed and Primed Seeds of Fennel as Affected by Reduced Water Potential Induced by NaCl. International Research Journal of Applied and Basic Sciences, 3 (4): 737-744.

[13] Foltinová, D., Tančinová, D., Císarová, M.2017. Influence of essential oils on the growth of Aspergillus flavus. Potravinarstvo Slovak Journal of Food Sciences, vol. 11, no. 1, p. 322-331. https://doi.org/10.5219/725

[14] Gilani, A. H., Shah, A. J., Zubair, A., Khalid, S., Kiani,J., Ahmed, A., Rasheed, M., Ahmad, V. U. 2009. Chemical composition and mechanisms underlying the spasmolytic and bronchodilatory properties of the essential oil of Nepeta catariaL. J. Ethnopharmacol., vol. 121, no. 3, p. 405-411.https://doi.org/10.1016/j.jep.2008.11.004

[15] ISTA 1996, International rules for seed testing, Edition 1996/6, International Seed Testing Association, Zurich. Switzerland, pp: 196.

[16] Jam B, Shekari F, Azimi M, Zangani E, 2012. Effect of Priming by Salicylic Acid on Germination and Seedling Growth of Safflower Seeds under $CaCl_2$ Stress. Internatıonal Journal of Agrıcultural Research And Revıews, 2: 1097-1105.

[17] Juglal, S., Govinden, R., Odhav, B. 2002. Spice oils for the control of co-occurring mycotoxin-producing fungi. Journal of Food Protection, vol. 65, no. 4, p. 683-687.https://doi.org/10.4315/0362-028X-65.4.683.

[18] Khan A, Ahmad MSA, Athar RE, Ashraf M, 2006. Interactive effect of foliarly applied ascorbic acid and salt stress on wheat (*Triticum aestivum* L.) at the seedling state. Pakistan Journal of Botany, 38, 1407-1414.

[19] Klimek, B.; Modnicki, D. Terpenoids and sterols from Nepeta cataria L. var. citriodora (Lamiaceae). Acta Pol Pharm. 2005, 62, 231-235.

[20] Manju, M.; Satish, S.; Sabaraya, A.R. A review on pharmacological activities of essential oil in Nepeta cataria. Int J Pharma Chem Res. 2019, 5, 14-17.

[21] Mendoza AB, Rodriguez HR, Torres VR, Davila J H, Mezquitic JGR, Tellez EB, Rangel AS, Garcia MAB, 2002. Seed Treatment with Salicylates Modifies Stomatal Distrubution, Stomatal Density, Seedlings. Proceedings of the 16th International Pepper Conference Tampico, Tamaulipas, Mexico, November 10-12.

[22] Mohsen A, Ebrahim M, Ghoraba W, 2013. Effect of Salinity Stress on *Vicia faba*. Productivity with Respect to Ascorbic Acid Treatment. Iranıan Journal Of Plant Physıology, 3 (3): 725-736.

[23] Naghibi,F., Mossaddegh M. G., Mohamed S. M., Ghorbani A. 2005. Labiatae family in folk medicine in Iran: from ethnobotany to pharmacology. Iranian Journal of pharmaceutical Research, vol. 2, p. 63-79.

[24] Nazarian G, 2016. The Effect of Priming Application of Salicylic Acid on the Morphological and Physiological Characteristics of Canola Plant under Salinity Stress, Ege University Institute of Science and Technology, Master's Thesis (Printed).

[25] Njus, D; Kelly, P; Tu Yi-Jung; Schlegel, H.B. 2020. Ascorbic acid: The chemistry underlying its antioxidant properties. Free Radical Biology and Medicine, Volume 159, 1 November 2020, Pages 37-43.

[26] Noctor G, Foyer CH, 1998. Ascorbate and Glutathione: Keeping Active Oxygen under Control, Annual Review of Plant Biology, 49 (1): 249-279.

[27] Pandey, R., Kalra, A., Tandon, S., Mehrotra, N., Singh, H. N., Kumar, S. 2000. Essential oil compounds as potent source of nematicidal compounds. Journal of Phytopathology, vol. 148, no. 7-8, p. 501-502. https://doi.org/10.1046/j.1439-0434.2000.00493.

[28] Paşa, C. (2022). The response of some calendula cultivars (Calendula officinalis L.) to salt during the germination period, GSC Biological and Pharmaceutical Sciences. 21 (2), 263–268.

[29] Peterson, C. J., Ems-Wilson, J. 2003. Catnip essential oil as a barrier to subterranean termites (Isoptera: Rhinotermitidae) in the laboratory. J. Econ. Entomol., vol. 96, no. 4, p. 1275-1282. https://doi.org/10.1603/0022-0493-96.4.1275.

[30] Ramanujam M P, Jaleel V A, Kumaravelu G, 1998. Effect of salicylic acid on nodulation, nitrogenous compounds and related enzymes of Vigna mungo. Biologia Plantarum 41: 307-311.

[31] Reichert, W.; Park, C.H.; Juliani, R.H.; Simon, J.E. 'CR9': A new highly aromaric catnip Nepeta cataria L. cultivar rich in Z,E-nepetalactone. Hort Science. 2016, 51, 588-591.

[32] Sherry, C.J.; Koontz, J.A. Pharmacologistic studies of "Catnip tea": the hot water extract of Nepeta cataria. Quart J Crude Drug Res. 1979, 17, 68-72.

[33] Small, E. Blossoming treasures of biodiversity: 39. Catnip – safer pesticide potential. Biodiversity. 2012, 13, 118-126.

[34] Soliman M, Al-Juhani R, Hashash M, Al-Juhani F, 2016. Effect of Seed Priming With Salicylic Acid on Seed Germination and Seedling Growth of Broad Bean (*Vicia faba* L.). International Journal of Agricultural Technology, 12 (6):1125-1138.

[35] Stević, T., Berić, T., Šavikin, K., Soković, M., Gođevac, D., Dimkić, I., Stanković, S. 2014. Antifungal activity of selected essential oils against fungi isolated from medicinal plant. Industrial Crops and Products, vol. 55, p. 116-122. https://doi.org/10.1016/j.indcrop.2014.02.011

[36] Tančinová, D., Mašková, Z., Foltinová, D., Štefániková, J., Árvay, J. 2018. Effect of essential oils of Lamiaceaeplants on the Rhizopusssp. Potravinarstvo Slovak Journal of Food Sciences, vol. 12, no. 1, p. 491-498. https://doi.org/10.5219/921

[37] Tari I, Csiszár J, Szalai G, Horváth F, Pécsvárad A, Kiss G, Szepesi A, Szabó M, Erdei L, 2002. Acclimation of tomato plants to salinity stress after a salicylic acid pretreatment. Acta Biologica 46(3-4):55-56, Szegediensis.

[38] Torlak 2019. Investigation of the Physiological and Biochemical Effects of Ascorbic Acid Applications on Corn (Zea mays L.) Plants Under Salt Stress. Sakarya University Institute of Science and Technology, Master's Thesis (Printed).

[39] Tullio, M.C. and Arrigoni, O. (2007). The ascorbic acid system in seeds: to protect and to serve. Seed Science Research, Vol. 13, Issue 4, pp: 249-260. https://doi.org/10.1079/SSR2003143

[40] Tworkoski, T. 2002. Herbicide effects of essential oils. Weed Science, vol. 50, p. 425-431.

[41] Uyanık M, Kara ŞM, Korkmaz K, 2014. Determination of Responses of Some Winter Rapeseed (Brassica napus L.) Varieties to Salt Stress during the Germination Period. Journal of Agricultural Sciences, 20 (2014): 368-375.

[42] Yaver, S, Paşa, C. (2009). Application of different NaCl concentrations on seed germination of flax (Linum usitatissimum L.) cultivar. Agricultural Science and Technology, 2009, Vol. 1, No. 3, 103-105 ref. 12.

[43] Zomorodian,K., Sahakhiz,M. J., Shariati,S., Pakshir,K., Rahimi,M. J., Khashei,R. 2012. Chemical composition and antimicrobial activities of essential oils from Nepeta cataria L. against common causes of food-borne infections. ISRN Pharm., vol. 2012, p. 1-6. https://doi.org/10.5402/2012/591953