International Journal of Research and Review
[Indexed, Peer-Reviewed Journal]
Volume 13; Issue: 7; July 2026
Website: www.ijrrjournal.com
Research Paper E-ISSN: 2349-9788; P-ISSN: 2454-2237

Potential of *Saccharomyces cerevisiae* in Reducing Cadmium (Cd) from Final Disposal Site Soil for Tomato (*Solanum lycopersicum* L.) Cultivation

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DOI: https://doi.org/10.52403/ijrr.20260729

ABSTRACT

Cadmium (Cd) contamination in soil is an environmental problem that can reduce soil quality, inhibit plant growth, and increase the risk of heavy metal accumulation in the food chain. This study aimed to evaluate the potential of *Saccharomyces cerevisiae* for reducing Cd concentration in contaminated soil and to determine its effect on the growth of tomato (*Solanum lycopersicum* L.). A completely randomized design with five treatments and three replications was employed, consisting of fertile soil as a positive control (P1), Cd-contaminated soil without bioremediation as a negative control (P2), and Cd-contaminated soil treated with *S. cerevisiae* at 5 mL (P3), 10 mL (P4), and 20 mL (P5). Soil Cd concentration, plant Cd concentration, plant height, number of leaves, and fresh weight were evaluated after four weeks. The results showed that the application of *S. cerevisiae* reduced Cd concentration in both soil and tomato plants while improving plant growth. The highest application rate (P5) produced the lowest Cd concentration in soil (0.05 mg/kg) and plant tissues (0.0002 mg/kg), compared with the untreated contaminated soil (0.14 mg/kg and 0.0012 mg/kg, respectively). The same treatment also resulted in the greatest plant height (26.30 cm), number of leaves (21 leaves), and fresh weight (11.53 g). These findings indicate that *S. cerevisiae* effectively reduced Cd availability in contaminated soil and enhanced tomato growth, suggesting its potential as an environmentally friendly bioremediation agent for Cd-contaminated agricultural soils.

Keywords: *Saccharomyces cerevisiae*; bioremediation; cadmium; contaminated soil; tomato growth

INTRODUCTION

Cadmium (Cd) is one of the most toxic heavy metals contaminating terrestrial ecosystems due to its persistence, high mobility, and non-biodegradable nature[1]. Anthropogenic activities, particularly municipal solid waste disposal, have significantly contributed to Cd accumulation in soil through landfill leachate[2]. Once accumulated, Cd can be readily absorbed by plants, disrupting nutrient uptake, photosynthesis, and other physiological processes, ultimately reducing crop productivity[3]. Furthermore, Cd accumulation in edible crops poses a serious threat to food safety and human health because of its bioaccumulative properties[4]. Previous studies have also reported the presence of heavy metal contamination in soils surrounding the Sumompo Landfill, Manado, Indonesia, highlighting the need for sustainable remediation strategies[5].

Bioremediation has emerged as an environmentally friendly and cost-effective alternative for restoring heavy metal-contaminated soils[6]. Among various microorganisms, *Saccharomyces cerevisiae* has received considerable attention because of its ability to adsorb heavy metals through biosorption mechanisms[7]. The yeast cell wall contains β-glucans, chitin, mannoproteins, and several functional groups, including carboxyl, hydroxyl, amino, phosphate, and sulfhydryl groups, which effectively bind metal ions and reduce their bioavailability in soil[8]. Previous studies have demonstrated that *S. cerevisiae* can decrease heavy metal concentrations while improving soil quality and promoting plant growth under contaminated conditions[9].

Tomato (*Solanum lycopersicum* L.) is one of the world's most important horticultural crops and is widely cultivated because of its high nutritional and economic value[10]. However, tomato is also capable of absorbing and accumulating Cd from contaminated soils, making it a potential pathway for heavy metal transfer into the human food chain[11]. Although the effectiveness of *S. cerevisiae* as a biosorbent has been widely reported, most studies have been conducted under laboratory conditions or using artificially contaminated media. Information regarding its application for remediating naturally Cd-contaminated landfill soils while simultaneously reducing Cd accumulation in tomato plants remains limited[9].

Therefore, this study evaluated the effectiveness of different application rates of *Saccharomyces cerevisiae* in reducing Cd concentrations in soil collected from the Sumompo Landfill, Indonesia, and assessed their effects on Cd accumulation and the growth of tomato (*Solanum lycopersicum* L.). By integrating soil remediation and plant growth evaluation under naturally contaminated conditions, this study provides scientific evidence supporting the potential application of *S. cerevisiae* as an environmentally friendly bioremediation agent for sustainable management of Cd-contaminated soils.

MATERIALS & METHODS

Soil samples naturally contaminated with cadmium (Cd) were collected from the Sumompo Landfill, Manado, North Sulawesi, Indonesia. The laboratory experiment was conducted from January to March 2026 at the Advanced Biology Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Sam Ratulangi University, Indonesia. Fertile soil obtained from an uncontaminated agricultural area was used as the positive control. The biological materials consisted of *Saccharomyces cerevisiae* and tomato (*Solanum lycopersicum* L.) seedlings, while cadmium concentrations in soil and plant samples were determined using an Atomic Absorption Spectrophotometer (AAS).

A Completely Randomized Design (CRD) with five treatments and three replications was employed, resulting in fifteen experimental units. The treatments consisted of fertile soil as the positive control (P1), Cd-contaminated soil without *S. cerevisiae* application as the negative control (P2), and Cd-contaminated soil treated with *S. cerevisiae* at application volumes of 5 mL (P3), 10 mL (P4), and 20 mL (P5). Tomato seeds were germinated for three weeks before transplantation into polybags containing 2 kg of soil according to each treatment. The *S. cerevisiae* suspension was diluted with sterile distilled water to a final application volume of 200 mL per polybag and applied once every week throughout the experimental period[9].

Cadmium concentrations in soil and tomato plant samples were determined by flame AAS following the Indonesian National Standard (SNI 01-2896-1998). Prior to analysis, the samples were oven-dried, homogenized, and digested with concentrated nitric acid using a closed-vessel microwave digestion system. Plant growth was evaluated four weeks after transplantation by measuring plant height (cm), number of leaves, and fresh weight (g).

RESULT

Effect of *Saccharomyces cerevisiae* on Cadmium Concentration

Table 1 presents the cadmium (Cd) concentrations in soil and tomato plants after four weeks of treatment with different application rates of *Saccharomyces cerevisiae*. Analysis of variance indicated that *S. cerevisiae* application significantly affected Cd concentrations in both soil and tomato plants ($p < 0.05$). The untreated contaminated soil (P2) exhibited the highest Cd concentration, whereas the lowest concentration was recorded in treatment P5, which received 20 mL of *S. cerevisiae*. A similar trend was observed in tomato plants, where Cd accumulation progressively decreased with increasing application rates of *S. cerevisiae*. The reductions observed in plant tissues corresponded with the decreases in soil Cd concentrations, indicating that increasing *S. cerevisiae* application was associated with lower Cd availability and uptake.

Table 1. Cadmium concentrations in soil and tomato plants following different application rates of *Saccharomyces cerevisiae*

Treatment	Cadmium concentration (mg/kg)	
	Soil	Tomato Plant
P1	0.04	0.0004
P2	0.14	0.0012
P3	0.08	0.0010
P4	0.08	0.0013
P5	0.05	0.0002

Note: P1 = uncontaminated soil (positive control); P2 = Cd-contaminated soil without *Saccharomyces cerevisiae* (negative control); P3 = Cd-contaminated soil + 5 mL *S. cerevisiae*; P4 = Cd-contaminated soil + 10 mL *S. cerevisiae*; P5 = Cd-contaminated soil + 20 mL *S. cerevisiae*.

The reduction in Cd concentrations observed in the present study is consistent with previous reports describing the biosorption potential of *S. cerevisiae*. Volesky and May Phillips (1995) demonstrated that *S. cerevisiae* effectively adsorbs Cd through biosorption mechanisms. Similar findings were reported by Nurfadilah et al. (2022)[12], who showed that *S. cerevisiae* reduced Cd concentrations in contaminated soil media. These findings support the effectiveness of *S. cerevisiae* as a biological agent for reducing Cd contamination in naturally contaminated landfill soil.

Effect of *Saccharomyces cerevisiae* on Plant Height

Plant height was significantly affected by different application rates of *Saccharomyces cerevisiae* ($p < 0.05$), as presented in Table 2. Tomato plants grown in untreated contaminated soil (P2) exhibited the lowest mean plant height, whereas plants treated with 20 mL of *S. cerevisiae* (P5) attained the greatest height. Treatments P3 and P4 showed intermediate values, indicating a gradual increase in plant height with increasing *S. cerevisiae* application. Although plant height in P5 remained lower than that of the uncontaminated control (P1), the observed improvement suggested that microbial treatment alleviated the adverse effects of Cd contamination on plant growth. Comparable improvements in plant height following microbial application have been reported previously. Aulia *et al.* (2024)[9] reported that microbial bioremediation using *S. cerevisiae* significantly enhanced plant growth under Cd stress. The present findings further demonstrate that increasing application rates of *S. cerevisiae* were associated with better vegetative growth of tomato plants under Cd-contaminated conditions.

Table 2. Growth performance of tomato plants following different application rates of *Saccharomyces cerevisiae*.

Treatment	Plant height (cm)	Number of leaves	Fresh weight (g)
	Mean ± SD	Mean ± SD	Mean ± SD
P1	25,17 ± 0,15a	19,67 ± 2,08a	8,97 ± 2,76a
P2	20,37 ± 0,15a	12,33 ± 2,52c	2,67 ± 0,95c
P3	23,83 ± 2,49a	16,33 ± 2,08b	5,80 ± 1,40b
P4	25,43 ± 0,71b	17,33 ± 0,58ab	6,90 ± 2,76ab
P5	26,30 ± 1,07c	21 ± 2,65a	11,53 ± 2,97a

Note: Values are presented as mean ± standard deviation (SD). Means followed by the same lowercase letter within the same column are not significantly different according to the Least Significant Difference (LSD) test at **p** < 0.05.

Effect of *Saccharomyces cerevisiae* on Number of Leaves

The number of leaves differed significantly among treatments ($p < 0.05$) (Table 2). Plants grown in untreated contaminated soil produced the fewest leaves, whereas the highest number of leaves was recorded in plants treated with 20 mL of *S. cerevisiae*. The treatments receiving 5 mL and 10 mL of *S. cerevisiae* also showed improvements in leaf production compared with the untreated contaminated soil. These results indicate that increasing application rates of *S. cerevisiae* positively influenced vegetative development in tomato plants.

The increase in leaf number observed in the present study agrees with previous findings demonstrating that microbial remediation can improve plant performance under heavy metal stress. The innovative microbial-based approach could substantially improve plant growth under soil compaction stress (Yao *et al.,* 2025)[14]. Similar observations were also reported by Aulia *et al.* (2024)[9]**,** who found increased vegetative growth following *S. cerevisiae* application in Cd-contaminated soil.

Effect of *Saccharomyces cerevisiae* on Fresh Weight

Fresh weight was significantly influenced by *Saccharomyces cerevisiae* application ($p < 0.05$), as shown in Table 2. Tomato plants grown in untreated contaminated soil exhibited the lowest fresh weight, whereas plants receiving the highest application rate (20 mL) produced the greatest fresh biomass. Intermediate values were observed in treatments P3 and P4, demonstrating a gradual increase in biomass production with increasing *S. cerevisiae* application. Overall, fresh weight showed a positive trend corresponding to reductions in Cd concentration and improvements in vegetative growth.

Similar improvements in plant biomass following microbial remediation have been reported previously. Meirindany *et al.* (2026)[13] demonstrated that *S. cerevisiae* application increased plant biomass in Cd-contaminated soil. Likewise, Aulia *et al.* (2024)[9] observed significant improvements in plant growth parameters following microbial bioremediation treatments. These findings further support the potential of *S. cerevisiae* to improve tomato growth in naturally Cd-contaminated landfill soil.

CONCLUSION

The application of *Saccharomyces cerevisiae* effectively reduced cadmium (Cd) concentrations in naturally contaminated landfill soil and decreased Cd accumulation in tomato (*Solanum lycopersicum* L.) plants. Increasing application rates consistently enhanced the remediation performance, with the 20 mL treatment providing the greatest reduction in Cd concentration among all treatments. The decrease in Cd accumulation was accompanied by significant improvements in tomato growth, as reflected by greater plant height, increased leaf production, and higher fresh weight compared with untreated contaminated soil. These findings demonstrate that *S. cerevisiae* is an effective and environmentally friendly bioremediation agent for mitigating Cd contamination in landfill soil while improving tomato growth. The results also provide scientific evidence supporting the application of microbial bioremediation as a sustainable approach for the rehabilitation of Cd-contaminated soils and the production of safer agricultural crops.

Declaration by Authors

Acknowledgement: None
Source of Funding: None
Conflict of Interest: No conflicts of interest declared.

REFERENCES

1. Han, F. X., Sridhar, B. B. M., Monts, D. L., & Su, Y. (2013). Managing heavy metal toxicity stress in plants. BioMed Research International, 2013, Article 346785. https://doi.org/10.1155/2013/346785
2. Tang, J., Su, M., Peng, H., Shi, Q., Chen, D., Wang, N., Xiao, E., Huang, L., Zhang, H., & Xiao, T. (2021). Assessment of heavy metals mobility and correlative recovery and decontamination from MSWI fly ash: Mechanism and hydrometallurgical process evaluation. Science of the Total Environment, 768, 145050. https://doi.org/10.1016/j.scitotenv.2021.145050
3. Liao, W., Chen, X., Xiao, Q., Mashhadi Akbar Boojar, M., Wang, Y., Chen, J., & Li, Q. (2024). Cadmium uptake and detoxification in tomato plants: Revealing promising targets for genetic improvement. Physiology and Molecular Biology of Plants. https://doi.org/10.1007/s12298-024-01489-4
4. Saeni, S., Istiqomah, L., & Wahyuni, S. (2019). Dampak logam berat kadmium pada kesehatan petani dan solusinya. Jurnal Kesehatan Masyarakat Indonesia, 14(2), 123–130.
5. Manullang, I., Simanjuntak, R., & Hendrik, H. (2023). Analisis kandungan logam berat di sekitar TPA Sumompo dan dampaknya terhadap lingkungan dan kesehatan masyarakat. Jurnal Lingkungan Hidup, 15(2), 110–121. https://ejournal.unsrat.ac.id/index.php/samrat-agrotek/article/view/44124
6. Saha, L., Tiwari, J., Basak, B. B., & Gajbhiye, N. A. (2021). Recent developments in microbe–plant-based bioremediation of heavy metal-polluted soils. Frontiers in Microbiology, 12, 754527. https://doi.org/10.3389/fmicb.2021.754527
7. Volesky, B., & May-Phillips, H. A. (1995). Cadmium biosorption by Saccharomyces cerevisiae. Biotechnology and Bioengineering, 41(8), 819–825. https://biosorption.mcgill.ca/publication/PDFs/91-BB%2793-41,819-25-CdSacchMay.pdf
8. Rahmawati, D., Putra, A. G., & Santoso, B. (2022). Struktur dinding sel dan peran gugus kimia aktif Saccharomyces cerevisiae dalam proses biosorpsi logam berat. Jurnal Bioteknologi Indonesia, 18(1), 50–60.
9. Aulia, A. J., Ridwan, I., & Tambung, A. (2024). Bioremediasi tanah tercemar logam berat kadmium (Cd) dari Tempat Pemrosesan Akhir Sampah Tamangapa di Kota Makassar menggunakan Saccharomyces cerevisiae untuk budidaya tanaman kedelai (Glycine max L.). Jurnal Lanskap dan Lingkungan (JULIA), 1(2), 108–119. https://journal.unhas.ac.id/index.php/julia/article/view/34909
10. Liu, Y., Chen, X., & Zhang, J. (2023). Nutritional components of tomatoes and their cardiovascular health implications. Frontiers in Nutrition, 10, 941251. https://doi.org/10.3389/fnut.2023.941251
11. Akinci, I. E., Akinci, S., & Yilmaz, K. (2010). Response of tomato (Solanum lycopersicum L.) to lead toxicity: Growth, element uptake, chlorophyll and water content. African Journal of Agricultural Research, 5(6), 416–423. https://academicjournals.org/article/article1380547743_Akinci%20et%20al.pdf
12. Nurfadilah, S., Hidayat, R., & Lestari, D. (2022). Pemanfaatan Saccharomyces cerevisiae sebagai biosorben logam berat kadmium (Cd) pada media tanah. Jurnal Bioteknologi, 9(1), 45–53. https://ejournal.unair.ac.id/JBT/article/view/60530
13. Meirindany, T., Nurmaini, N., Indirawati, S.M., & Ashar, T. (2026). Effectiveness of *Saccharomyces cerevisiae*-fermented rice bran in cadmium immobilization in cadmium-contaminated soil and rice plants. Journal of Degraded and Mining Lands and Management, 13(2), 10223-10229. doi:10.15243/jdmlm.2026.132.10223
14. Yao, X., Guo, H., Li, D., Zong, J., Zhang, R., Chen, J., Hao, D., Zhao, X., Liu, J., Wang,

H., & Li, C. (2025). Novel approaches for alleviating shallow soil compaction using microbial fertilizer and their beneficial impacts on plant growth and soil physicochemical properties. Soil and Tillage Research, 247, 106380, https://doi.org/10.1016/j.still.2024.106380

How to cite this article: Rivaldo Nababan, Marina Singkoh, Agustina Monalisa Tangapo. Potential of *Saccharomyces cerevisiae* in reducing cadmium (Cd) from final disposal site soil for tomato (*Solanum lycopersicum* L.) cultivation. *International Journal of Research and Review*. 2026; 13(7): 260-265. DOI: *https://doi.org/10.52403/ijrr.20260729*

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