ORIGINAL ARTICLE

Comparison of the Effectiveness of Pineapple Crown Leaf and Peel Extracts in Reducing Lead Levels in *Anadara granosa*

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ABSTRACT

Introduction: Industrial waste and domestic waste, especially heavy metals like lead (Pb), can pollute water and impact *Anadara granosa*. Pb that is absorbed over a long period of time can be dangerous if consumed in excess, so efforts are needed to minimize the Pb content in Anadara granosa. **Objective:** It was to determine more effective ratio between 1:1 and 1:2 composition of pineapple crown-leaves and peels extracts in reducing lead levels in *Anadara granosa*. **Methods:** Treatment was administered to *Anadara granosa* that had been exposed to Pb using 1:1 and 1:2 composition ratios of pineapple crown-leaves and peel extracts at 3% concentrations. Pb levels were determined in mg/kg using Atomic Absorption Spectrophotometry. **Results:** The average lead concentrations for control was 2,4509 mg/kg, The average lead concentrations for 1:1 and 1:2 composition ratios were 1,001 mg/kg (59%) and 0,908 mg/kg (62.95%), respectively. The 1:2 composition ratio is more effective in reducing lead levels. **Discussion:** Pineapple crown-leaf and peel waste can be used to reduce lead levels in Anadara granosa because the citric acid and cellulose in pineapple form Pb-citrate complex bonds, thereby reducing Pb concentration in the sample. **Conclusion:** The findings indicate that pineapple crown leaves and peels extracts (1:2 composition ratios) can effectively act as a biosorbent for heavy metal decontamination and serve as a valuable source of natural antioxidants to reduce lead levels, making them potential candidates for treating lead toxicity

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INTRODUCTION

Indonesia's Kenjeran Beach, near Surabaya, is surrounded by marine biodiversity, including fisheries and shellfish (1). However, human activities generate waste, affecting water quality. The water pollution index value at Kenjeran Beach is 4.6, indicating lightly polluted conditions (2). Human activities along Kenjeran Beach's coast, including household and industrial waste, can negatively impact the quality of the surrounding waters. The increasing industrialization also contributes to environmental pollution through waste disposal in the area(3). Marine pollutants include pesticides, petroleum, chemicals, organic substances, detergents, chemical fertilizers, heavy metals, solid waste, and radioactive materials. Heavy metal contaminants, such as lead, are hazardous due to their cumulative and carcinogenic properties (4).The WHO recommends against consuming seafood contaminated with heavy metals, stating that the safe level for human consumption is 1.0 mg/kg (5). The Indonesian National Standard (SNI) No. 7387: 2009 sets the maximum limit of heavy metal contamination in food for lead (Pb) in shellfish at 1.5 mg/kg, which can have adverse health impacts (neurodegeneration, anemia, liver and kidney damage, DNA damage), if exceeded (4,6,7).

Lead that settles in marine waters can deposit and accumulate in sediments, particularly affecting sedentary marine organisms. Heavy metals can significantly concentrate in these organisms through processes known as bioaccumulation and biomagnification, making them effective bioindicators of environmental health. One such organism is *Anadara granosa*, which remains stationary due to its slow movement and filters water for food. This characteristic makes it particularly vulnerable to water pollution from heavy metals like lead, which are accumulative in nature. Consequently, *Anadara granosa* can accumulate heavy metals in its body if the surrounding waters are contaminated (8,9).

Consuming *Anadara granosa* that contains lead (Pb) levels exceeding safety standards is highly hazardous. Therefore, it is essential to implement measures to reduce lead (Pb) concentrations, such as using chemical compounds that can bind to the metal (10). The adsorbent that can use, comes from ingredient natural (11–13), One of the natural products is the crown leaves and peel of the pineapple (*Ananas comosus L*). In 2023, Indonesia produced approximately 3.16 million tons of pineapples, showing a growth from 2.89 million tons in 2022, which was a 17.95% increase from 2021(14). Biomass from pineapple can be used to produce various innovative products, the crown leaves of the pineapple contain a chemical composition of fibers, including cellulose, lignin, pectin, fats, and other substances. The cellulose content in the fibers of the pineapple crown leaves ranges from 69.5% to 71.5% (15). Cellulose from pineapple crown leaves has the potential to be used as an alternative adsorbent material. Cellulose is an organic compound that contains hydroxyl groups in the pineapple crown leaves. This characteristic enhances its ability to bind with various substances, making it suitable for applications in adsorption processes. Research indicates that the cellulose content in pineapple crown leaves can be effectively extracted and utilized for various purposes, including environmental remediation and waste management (16–22). The peel of the pineapple contains citric acid, which makes up 78% of its total acid content. Citric acid can form complex compounds with metal ions and acts as a chelating agent. The citric acid in pineapple skin contains hydroxyl (OH) and carboxyl (COOH) functional groups, which generate citrate ions or chelators that can react with metal ions to form citrate salts. These citrate ions will bind with metals, allowing for the removal of accumulated metal ions in organisms as soluble complex compounds.(23,24). The results of in vitro studies indicate that the administration of pineapple crown leaf and skin extract (*Ananas comosus L*) in a 1:1 composition ratio has an effect on reducing lead (Pb) heavy metal levels in *Anadara granosa* by 59% (25). The research aims to determine the more effective ratio between 1:1 and 1:2 compositions of these extracts for further reduction of lead levels in the *Anadara granosa*.

MATERIALS AND METHODS

Materials

The tools and materials used in this research include: sieve, a blender, filter paper, analytical balance, distillation flask, Soxhlet chamber, condenser, 250 ml, 500 ml, and 1000 ml beaker glass, 100 ml measurings flask, Erlenmeyer 250 ml, tongs, spatula, acid chamber, hot plate, Atomic Absorption Spectrophotometry (AAS), *Anadara granosa*, aquadest 96% ethanol solution, Pb solution, crown-leaf and peel pineapple extract, HNO_3 + $HClO_4$ solution, H_2SO_4, HNO_3, HCl,

Methods

A. Making Simplicia crown Leaves and peels of Pineapple (Ananas comosus) is as follows by Separation and Cleaning cleaned by washing it with running water to remove dirt that sticks, then drain. Leaves and peels of pineapple (Ananas comosus) have been drained and then cut to speed up the drying process. Leaves and peels of pineapple (Ananas comosus) dried under the ray sun., Ratio Preparation For a 1:1 ratio, combine 500 grams of crown leaves with 500 grams of peels, For a 1:2 ratio, combine 500 grams of crown leaves with 1000 grams of peels.

B. Preparing Pineapple (Ananas comosus) Crown Leaf and Peel Extract : Weighing and Wrapping: Weigh 50 grams of pineapple crown leaves and skin with 1:1 compotition ratio , wrap them in filter paper, and place them in the Soxhlet chamber. Setting Up the Soxhlet Apparatus: Attach the distillation apparatus to the bottom of the Soxhlet chamber. Adding Solvent: Introduce 300 ml of 96% ethanol as the solvent, ensuring two cycles of circulation. Installing Condenser: Install a cooler return/condenser above the distillation flask. Heating Distillation Flask: Heat the distillation flask to initiate the Soxhletation process. Soxhletation Process: Continue the Soxhletation process until the solvent in the Soxhlet chamber is visibly clear. Evaporation: Collect and evaporate the extract to remove the 96% ethanol. Do the same with the simplicia using a 1:2.

C. Preparation of Treatment of *Anadara granosa* Samples. Is as follows Wash the *Anadara granosa* shells using running water and then drain them using filter paper. oak the cleaned *Anadara granosa* shells in a Pb reagent solution (dissolved with distilled water) with a concentration of 1.5 ppm for 1 hour. Drain the soaked shells using filter paper Weigh each sample to a total of 125 grams Add an extract of pineapple (Ananas comosus L) crown leaves and peels with 1:1 compotition ratio to each sample. Seal the samples and incubate them for 180 minutes. Label each sample accordingly. Do the same with the simplicia using a 1:2 composition ratio.

D. Examination using Atomic Absorption Spectrophotometry (AAS). The type of Atomic Absorption Spectrophotometry (AAS) used is the Shimadzu AA-7800 Series, which is equipped for both flame and furnace analysis. This model allows for the analysis of various heavy metals such as lead (Pb)

E. A statistical analysis: The statistical analysis, conducted using SPSS for Windows® version 26, revealed a normal distribution and homogeneity in the data ($p < 0.005$), enhancing the reliability of subsequent analyses like regression or ANOVA.

ETHICAL CLEARANCE

This study was approved by research Ethics Committee, Faculty of Health Sciences Muhammadiyah University Surabaya No No.002/KEPK/F/XI/FIK/2024

RESULTS

The study results revealed data on the average concentrations of heavy metals lead (Pb), in Anadara granosa after being immersed in 1;1 compotition ratio and 1;2 compotition ratio of pineapple crown leaves and peel, as presented in Table I. Based on the results of the study, the average lead content in the control treatment group (A) was 2.4509 mg/kg, while in the treatment group with a 1:1 ratio of pineapple leaf and skin extract (B) was 1.001 mg/kg, and in the treatment group with a 1:2 ratio of pineapple leaf and skin extract (C) was 0.908 mg/kg. Statistical analysis using SPSS for Windows® version 26 showed that the data were normally distributed and homogeneous with α (024) > 0.05) . After conducting an ANOVA and Tukey HSD tests test which showed significant results (α (0,0) < 0.05)

Table I: Results of laboratory tests for lead (Pb) levels in Anadara granosa in the concentration of leaves and peels pineapple extract (mg/kg) for 180 minutes.

Sample	Lead Level (mg/kg)			Percentage decrease		
	A (control)	B (1: 1)	C (1: 2)	A (control)	B (1: 1)	C (1: 2)
1	2.4508	1.002	0.907	0%	59.12%	62.99%
2	2.4511	1.001	0.909	0%	59.16%	62.92%
3	2.4509	1.0009	0.908	0%	59.16%	62.95%
mean	2.4509	1.0013	0.908	0.00%	59.15%	62.95%
SD	0.0002	0.0006	0.001	0	0.0003	0.0004

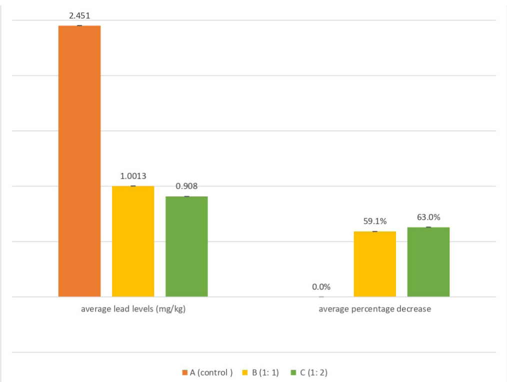

Figure 1: Averaage level lead (mg/kg) and average percentage decrease (%)

In addition, the average concentrations of lead, in *Anadara granosa* are illustrated in Figure 1.

DISCUSSION

The study found significant differences in lead levels in *Anadara granosa* samples , with the 1:1 and 1:2 composition ratios of pineapple crown leaf and peel extract showing different effectiveness in reducing lead content, as indicated by ANOVA and Tukey HSD tests (After conducting an ANOVA and Tukey HSD tests test which showed significant results (α (0,0) < 0.05)). Pineapple crown leaves extraction are rich in various fibers, particularly cellulose, which comprises 69.5% to 71.5% of their composition (26–29). This high cellulose content positions pineapple leaves as a potential alternative source for adsorbent materials. The presence of hydroxyl groups (OH) in cellulose enhances the adsorption process by facilitating interactions with metal ions, leading to increased adsorption until saturation occurs, followed by desorption.Pineapple skin is primarily composed of citric acid, which constitutes 78% of its total acidic content (30). Citric acid acts as a chelating agent due to its three carboxyl functional groups (COOH), capable of forming complex compounds with metal ions. Under specific conditions, these groups can release proton ions ($H+$), which can replace metal ions in a chelation process characterized by multiple bonds forming a ring structure around the metal, effectively binding it (31). The hydroxyl and carboxyl groups in citric acid allow for the formation of citrate ions that can react with metal ions to create soluble citrate salts, facilitating the removal of accumulated heavy metals from organisms. The high concentrations of cellulose in pineapple leaves and citric acid in the skin enable effective binding of heavy metals like lead (Pb). The formation of Pb-citrate coordination bonds reduces lead's ionic form and significantly lowers its toxicity (9,32,33). This study uses a combination of pineapple leaf and peel extracts to reduce lead levels and provide natural antioxidants. This approach is unique in addressing heavy metal contamination, unlike previous research that focused on one extract. This study contributes to environmental remediation and health, opening up opportunities for developing effective natural-based products to address heavy metal pollution and health benefits. The study suggests that the efficacy of pineapple crown leaf and peel extracts in reducing heavy metal toxicity could be further evaluated through in vivo testing on rats exposed to various heavy metals. This evaluation would assess parameters such as SGOT, SGPT, protein profile, and lipid profile, exploring the potential of these extracts as treatments for diseases caused by heavy metal exposure.

CONCLUSIONS

The 1:2 composition ratio is more effective in reducing lead levels by 63.2%, compared to the 1:1 composition ratio of pineapple crown-leaves and peels extracts, which resulted in a 59% reduction. The findings indicate that pineapple crown leaves and peels extracts (1:2 composition ratios) can effectively act as a biosorbent for heavy metal decontamination and serve as a valuable source of natural antioxidants to reduce lead levels, making them potential candidates for treating lead toxicity

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REFERENCES

1. Setiyowati D, Ayub AF, Zulkifli M. 48274-ID-statistik-sumber-daya-laut-dan-pesisir-2016. 1st ed. Setiyowati D, Ayub AF, Zulkifli M, editors. Jakarta: BPS-Statistics Indonesia; 2016. xxii–259. Available from : https://media.neliti.com/media/publications/48274-ID-statistik-sumber-daya-laut-dan-pesisir-2016.pdf
2. Guntur G, Yanuar AT, Sari SHJ, Kurniawan A. Analisis kualitas perairan berdasarkan metode indeks pencemaran di Pesisir Timur Kota Surabaya. Depik. 2017;6(1):81–9. DOI: https://doi.org/10.13170/depik.6.1.5709
3. Bahri R, Rachmaniyah R, Darjati D. Evaluation of Waste Management Facilities Through Land-Based Marine Litter Data: Case Study of Kenjeran Beach, Surabaya. Journal of Environmental Science and Sustainable Development. 2020;3(1):156–76. DOI : https://doi.org/10.7454/jessd.v3i1.1040
4. Flora G, Gupta D, Tiwari A. Toxicity of lead: A review with recent updates. Vol. 5, Interdisciplinary Toxicology. 2012. p. 47–58. DOI : https://doi.org/10.2478/v10102-012-0009-2
5. Nurgitarini Mahluddin K, Gafur A, Kesehatan Lingkungan P, Kesehatan Masyarakat F, Muslim Indonesia U, Kesehatan dan Keselamatan Kerja P. BIOAKUMULASI LOGAM BERAT TIMBAL (Pb) DAN KADMIUM (Cd) PADA KERANG HIJAU, AIR, DAN SEDIMEN [Internet]. Available from: http://jurnal.fkm.umi.ac.id/index.pHp/wopH/article/view/woph3112
6. Barregard L, Sallsten G, Lundh T, Mulne J. Low-level exposure to lead, cadmium and mercury, and histopathological findings in kidney biopsies. Environ Res. 2022 Aug 1;211. DOI : https://doi.org/10.1016/j.envres.2022.113119
7. Singh N, Kumar A, Gupta VK, Sharma B. Biochemical and Molecular Bases of Lead-Induced Toxicity in Mammalian Systems and Possible Mitigations. Vol. 31, Chemical Research in Toxicology. American Chemical Society; 2018. p. 1009–21. DOI : https://doi.org/10.1021/acs.chemrestox.8b00193
8. Yulianto B, Radjasa OK, Soegianto A. Heavy metals (Cd, Pb, Cu, Zn) in green mussel (perna viridis) and health risk analysis on residentsof semarang coastal waters, Central Java, Indonesia. Asian Journal of Water, Environment and Pollution. 2020;17(3):71–6. DOI : https://doi.org/10.3233/AJW200039
9. Jailani AQ, Kristiani M. Heavy Metals Pb In Water , Sediment And Shrimp Ghost Shrimp In The Coastal Subdistrict Labang , Bangkalan Madura. 2018;1(1):25–30. DOI : https://doi.org/10.31002/jade.v1i1.1017
10. Kim JJ, Kim YS, Kumar V. Heavy metal toxicity: An update of chelating therapeutic strategies. Journal of Trace Elements in Medicine and Biology. 2019;54(November 2018):226–31. DOI : https://doi.org/10.1016/j.jtemb.2019.05.003
11. Ratna Shelke, Jagdish Bharad, Balaji Madje MUbale. Adsorption of Nickel (II), Copper (II) and Iron (III) on Kammoni Leaf Powder: A Case Study. Asian J Research Chem. 2011;4(1):100-103. Available from : https://sciensage.info/index.php/JASR/article/view/4
12. B. K. Uphade, A. G. Gadhave RBGaikar. Removal of copper (II) from aqueous solution by modified agricultural waste materials. Asian J Research Chem. 2016;9(9):409–12. DOI : https://www.doi.org/10.5958/0974-4150.2016.00061.4
13. Ankita Chatterjee JA. Biosorption of Copper using Oryza sativa and Aspergillus oryzae. Research J Pharm and Tech. 2016;9(6):664–70. DOI : https://doi.org/10.5958/0974-360X.2016.00125.6
14. Outlook_Nenas_2023. Available from : https://satudata.pertanian.go.id/assets/docs/publikasi/Outlook_Nenas_2023.pdf
15. Difonzo G, Vollmer K, Caponio F, Pasqualone A, Carle R, Steingass CB. Characterisation and classification of pineapple (Ananas comosus [L.] Merr.) juice from pulp and peel. Food Control. 2019;96:260–70. DOI : http://dx.doi.org/10.1016/j.foodcont.2018.09.015
16. Shih YF, Chou MY, Chang WC, Lian HY, Chen CM. Completely biodegradable composites reinforced by the cellulose nanofibers of pineapple leaves modified by eco-friendly methods. Journal of Polymer Research. 2017;24(11). DOI : http://dx.doi.org/10.1007/s10965-017-1367-4
17. Mayangsari NE, Apriani M, Veptiyan ED. Pemanfaatan Daun Nanas sebagai adsorben Logam Berat. Journal of Research and Technology. 2019;5(2):129–38. DOI : https://doi.org/10.55732/jrt.v5i2.322
18. Sri Febriani Hatam, Edi Suryanto JA. Aktivitas Antioksidan Dari Ekstrak Kulit Nanas (Ananas comosus (L) Merr). PHARMACON Jurnal Ilmiah Farmasi. 2013;2(01):7–12. DOI : https://doi.

org/10.35799/pha.2.2013.880
19. Firmansyah D. Identifikasi Gugus Hidroksil dan Karbonil dalam Senyawa Organik Pada Tanaman Daun Nanas. SainsTech Innovation Journal. 2020;3(1):49–53. DOI : https://doi.org/10.37824/sij.v3i1.2020.226
20. Setiawan AA, Shofiyani A, Syahbanu I, Hadari Nawawi JH. Pemanfaatan Limbah Daun Nanas (Ananas comosus) Sebagai Bahan Dasar Arang Aktif Untuk Adsorpsi Fe(II). Jurnal JKK. 2017;6(3):66–74. Available from : https://jurnal.untan.ac.id/index.php/jkkmipa/article/download/22339/17789
21. Setiawan A, Shofiyani A, Khatulistiwa ISJK, 2017 undefined. Pemanfaatan limbah daun nanas (Ananas comosus) sebagai bahan dasar arang aktif untuk adsorpsi Fe (II). JurnalUntanAcId [Internet]. 2017;6(3):66–74. Available from: https://jurnal.untan.ac.id/index.php/jkkmipa/article/view/22339
22. Yosefina Keon D, Yulianti IM, Jati WN. Kemampuan Selulosa Daun Mahkota Nanas (Ananas comosus) Sebagai Bioadsorben Logam Tembaga (Cu) Ability of Cellulose by Pineapple Crown Leaf (Ananas comosus) Cellulose as Bio-adsorbent of Heavy Metal Copper (Cu). Vol. 3. 2018. DOI : https://doi.org/10.24002/biota.v3i2.1895
23. Jailani AQ, Kristiani M. Heavy Metals Pb In Water , Sediment And Shrimp Ghost Shrimp In The Coastal Subdistrict Labang , Bangkalan Madura. 2018;1(1):25–30. DOI : https://doi.org/10.31002/jade.v1i1.1017
24. Nangare S, Vispute Y, Tade R, Dugam S, Patil P. Pharmaceutical applications of citric acid. Futur J Pharm Sci. 2021;7(1). DOI : https://doi.org/10.1186/s43094-021-00203-9
25. Kunsah B, Kartikorini N, Ariana D, Mardiyah S. Potential Bioabsorbent Extract of Skin and Leaves Ananas Comosus on reduction of Copper, Mercury, and Lead in Anadara granosa. Research J Pharm and Tech [Internet]. 2024;17(3). DOI : https://doi.org/10.52711/0974-360X.2024.00185
26. Shih YF, Chou MY, Chang WC, Lian HY, Chen CM. Completely biodegradable composites reinforced by the cellulose nanofibers of pineapple leaves modified by eco-friendly methods. Journal of Polymer Research. 2017;24(11). DOI : http://dx.doi.org/10.1007/s10965-017-1367-4
27. B. K. Uphade, A. G. Gadhave RBGaikar. Removal of copper (II) from aqueous solution by modified agricultural waste materials. Asian J Research Chem. 2016;9(9):409–12. DOI : https://www.doi.org/10.5958/0974-4150.2016.00061.4
28. Sepъlveda L, Romaнн A, Aguilar CN, Teixeira J. Valorization of pineapple waste for the extraction of bioactive compounds and glycosides using autohydrolysis. Innovative Food Science and Emerging Technologies. 2018 Jun 1;47:38–45. DOI : https://doi.org/10.1016/j.ifset.2018.01.012
29. Betenй ADO, Betenй FE, Ngali FE, Noah PMA, Ndiwй B, Soppie AG, et al. Influence of sampling area and extraction method on the thermal, physical and mechanical properties of Cameroonian Ananas comosus leaf fibers. Heliyon. 2022 Aug 1;8(8). DOI : https://doi.org/10.1016/j.heliyon.2022.e10127
30. Olszowy M. What is responsible for antioxidant properties of polyphenolic compounds from plants? Plant Physiology and Biochemistry [Internet]. 2019;144:135–43. Available from: https://doi.org/10.1016/j.plaphy.2019.09.039
31. Ilyasa AT, Susatyo EB, Prasetya AT. Penurunan kadar ion Pb2+ dan Cd2+ pada kerang dengan menggunakan filtrat kulit nanas. Indonesian Journal of Chemical Science. 2016;5(3):6. Available from : https://web.archive.org/web/20180412221928/https://journal.unnes.ac.id/sju/index.php/ijcs/article/download/9276/7608
32. Nangare S, Vispute Y, Tade R, Dugam S, Patil P. Pharmaceutical applications of citric acid. Futur J Pharm Sci. 2021;7(1). DOI : http://dx.doi.org/10.1186/s43094-021-00203-9
33. S. Gnanasekaran, Ahamad Nordin NIA, M.M.M. Hamidi, J.H. Shariffuddin. Effect of Alkaline treatment on the characteristics of pineapple leaves fibre and PALF/PP biocomposite. Journal of Mechanical Engineering and Sciences. 2021;15(4):8518–28. DOI : http://dx.doi.org/10.15282/jmes.15.4.2021.05.0671