ISETC2025

UNIVERSITI TEKNOLOGI MARA

ISETC2025

2 ND INTERNATIONAL SCIENCE, ENGINEERING AND TECHNOLOGY COLLOQUIUM



THE POWER OF SCIENTIFIC INNOVATION

INTELLIGENT SOLUTIONS FOR A SUSTAINABLE WORLD

ORGANIZED BY:
FACULTY OF APPLIED SCIENCES
UNIVERSITI TEKNOLOGI MARA
PERAK BRANCH, TAPAH CAMPUS
MALAYSIA

CO-ORGANIZED BY:

三重大学
MIE UNIVERSITY

2nd International Science, Engineering and Technology Colloquium

(ISETC 2025)

Faculty of Applied Sciences,
Universiti Teknologi MARA,
Perak Branch, Tapah Campus,
35400 Tapah Road, Perak, Malaysia.

Colloquium date: 9th July 2025
Publication date: 9th September 2025

Proceedings of Extended Abstracts

EDITORS

Dr. Emi Norzehan Mohamad Mahbob
Dr. Saiyidah Nafisah Hashim
Ms. Lili Widarti Zainuddin
Ms. Nurul Nazwa Mohammad
Ms. Rozaina Saleh

e-ISBN: 978-629-97630-5-5

Copyright © 2025 ISETC
Published by Faculty of Applied Sciences, Universiti Teknologi MARA,
Perak Branch, Tapah Campus, 35400 Tapah Road, Perak, Malaysia.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, 35400 Tapah Road, Perak, Malaysia.

PREFACE

Welcome to the 2nd International Science, Engineering and Technology Colloquium 2025 (ISETC 2025)!

It is with great pleasure that we present this year's colloquium, a distinguished gathering of scholars, researchers, and professionals dedicated to the advancement of applied sciences. Held virtually on 9th July 2025, ISETC 2025 serves as a platform to highlight cutting-edge research, foster meaningful networking, encourage collaborations, and explore innovative solutions to global challenges.

This year's theme, "The Power of Scientific Innovation: Intelligent Solutions for a Sustainable World" highlights our shared goal to solve global challenges through applied science. It celebrates innovation as a key to building a more sustainable and resilient future. We're proud to feature keynote speakers and presenters who bring fresh insights, bold ideas, and breakthroughs shaping tomorrow's world.

We would like to extend our heartfelt appreciation to the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, for their outstanding support and assistance throughout the planning and execution of the event. Their dedication has been instrumental to the success of this colloquium. We would like to sincerely thank all participants and researchers for their valuable contributions. We also appreciate the reviewers for their careful evaluations and helpful feedback. Your hard work and support mean a lot to us.

As editors, we are proud to present this collection of proceedings. It is an honour to bring together the interesting and meaningful work of our speakers and authors. We hope the ideas shared will lead to new discoveries, encourage more research, and help solve global challenges through science and innovation.

Warm regards,

Dr. Emi Norzehan Mohamad Mahbob
Dr. Saiyidah Nafisah Hashim
Ms. Lili Widarti Zainuddin
Ms. Nurul Nazwa Mohammad
Ms. Rozaina Saleh

ISETC 2025 Proceedings Editors

REMOVAL OF HEAVY METALS USING FRUIT PEELS AS NATURAL ADSORBENTS

Siti Nur Azmu'i Abdullah*, Ain Fatehah Mohd Zabidi, Nur Imanina Hannani Tahirudin

Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, 35400 Tapah Road, Perak, Malaysia

**Corresponding author: siti6368@uitm.edu.my*

Abstract: Heavy metal pollutants in water, soil, and subsurface environments pose serious risks to human health and raise substantial environmental concerns. Natural substances, agricultural waste, and industrial by-products can all be used effectively as low-cost adsorbents to remove heavy metals. This study examines the potential of utilizing fruit waste specifically banana and orange peels as cost-effective and environmentally friendly adsorbents for the removal of heavy metals. The measured parameters are the adsorption percentage of natural adsorbent treated with different concentrations (1.0, 2.0 and 3.0 ppm) of iron (Fe) and different mass of adsorbent (1.0, 2.0, 3.0 g). Atomic Absorption Spectrometer (AAS) was employed to determine the residual metal concentrations after treatment. The results demonstrated that both types of fruit peels exhibited notable adsorption capacities for Fe. Orange peels showed the highest removal efficiency for 3.0 ppm Fe at an adsorbent mass of 3.0 g. These findings highlight the potential of fruit peel waste as a practical and sustainable solution for heavy metal removal, while also promoting the meaningful reuse of agricultural waste.

Keywords: *Heavy metals, adsorption, natural adsorbents, orange peels, banana peels*

INTRODUCTION

Water pollution, especially contamination of surface and groundwater by heavy metals, is a growing global problem. This issue is made worse by rapid population growth and industrial development, which increase the demand for clean water and lead to more pollution (Ávila et al., 2025). Heavy metals such as nickel (Ni) and iron (Fe) are commonly released into the environment through industrial activities like mining, metal plating, and manufacturing. These metals are toxic, do not break down easily, and can build up in living organisms, causing serious health and environmental risks (Gómez-Aguilar et al., 2022; Rahman et al., 2023). The World Health Organization (WHO) established that metal ion concentrations should range between 0.01 and 1 ppm in water, however, current concentrations of heavy metal ions can reach up to 450 ppm in effluents (Ávila et al., 2025). Traditional treatment methods such as chemical precipitation, ion exchange, membrane filtration, and coagulation are effective but often expensive and not environmentally friendly. Consequently, research has focused on low-cost and sustainable alternatives. One promising solution is the use of agricultural waste, like fruit peels, as natural adsorbents. Studies have shown that orange, banana, pomegranate, avocado and pineapple peels can remove heavy metals from water efficiently (Tolkou et al., 2024). This study aims to evaluate the effectiveness of selected fruit peels (orange and banana peels) as natural adsorbents for the removal of heavy metals. In addition, the effects of varying heavy metal concentrations and adsorbent masses on adsorption efficiency were also investigated. Residual metal concentrations in treated solutions were quantified using Atomic Absorption Spectrometer (AAS). The effectiveness of fruit peels as adsorbent for heavy metals were assessed based on the residual metal concentration of treatments. These results support the idea that fruit peel waste can be a low-cost and eco-friendly material for removing heavy metals from water. Orange and banana peels performed well under certain conditions, showing their potential for use in wastewater treatment. This also helps reduce agricultural waste by giving it a useful new purpose.

LITERATURE REVIEW

Heavy metal contamination in agricultural soils presents a significant threat to plant health, human well-being, and the global food supply. Elevated concentrations of heavy metals can impair soil quality and disrupt essential plant physiological processes, ultimately reducing crop productivity and yield (Angon et al., 2024). The toxicity, mobility,

and reactivity of heavy metals in the environment are largely determined by their chemical speciation, which in turn depends on factors such as pH, temperature, redox conditions, and soil moisture (Nagajyoti et al., 2010). Iron is one of the most abundant elements and is essential for both plants and animals. In contrast, these materials are also available abundantly in a typical industrial effluent (Rashid, 2009). Adsorption is a method used for the removal of heavy metals present in either drinking water or industrial and public wastewater discharges (Ávila et al., 2025). Natural adsorbents have gained attention as a sustainable and cost-effective approach for the removal of heavy metals from contaminated water sources (Kainth et al., 2023). Heavy metals are one of the contaminants that exhibit the greatest resistance to treatment in wastewater treatment plants (WWTPs) (Ávila et al., 2025). Typically derived from agricultural and biological waste such as fruit peels, nutshells, husks, and plant-based fibers. Their eco-friendly nature makes them a promising alternative to conventional chemical and synthetic adsorbents, which often present challenges related to cost, environmental impact, and post-treatment disposal (Kainth et al., 2023).

MATERIALS AND METHODS

Sample Collection and Preparation

Fruit peel samples (orange and banana) were obtained from local market and stall in Tapah Road. The fruit peels were cleaned and cut into small pieces prior to drying in oven at 70°C for 24 hours. The dried fruit peel samples were grounded into powdery samples to improve uniformity of particles size. Next, the samples were stored in closed plastic containers at room temperature until further analysis.

Preparation of Standard Solution

A series of standard solutions were prepared by diluting 1000 ppm of Fe standard solution (Merck, Germany) in 1% nitric acid. Concentration ranges of 1.0 – 3.0 ppm were prepared for Fe standard solution.

Assessment of Adsorption Capacity

The effectiveness of fruit peel samples as natural adsorbents was assessed based on two key parameters: the concentration of the metal solution and the mass of the adsorbent, both in relation to their effect on percentage adsorption. All samples were analyzed using an Atomic Absorption Spectrometer (AAnalyst 400).

i) Effect of Concentration of Heavy Metal Solution

1.0 g of each powdered fruit peel sample (banana and orange) was soaked for 2 hours in 30 mL of Fe solution at concentrations of 1.0 ppm, 2.0 ppm and 3.0 ppm. Then, the sample solution was filtered using filter paper. The filtrate obtained was further analyzed by using AAS. Each experimental condition was conducted in duplicate.

ii) Effect of Adsorbent Mass

Different mass of each powdered fruit peel sample (1.0, 2.0 and 3.0 g) was soaked in 30 mL of 3.0 ppm of Fe. Then, the sample solution was filtered using filter paper after 2 hours being soaked were then analyzed by using AAS. Each experimental condition was conducted in duplicate.

RESULTS

Figure 1 showed the calibration curve obtained for Fe. A series of standard solutions with known concentrations of Fe (1.0, 1.5, 2.0, 2.0, 2.5, 3.5 ppm) and their absorbance values were measured using AAS. These absorbance readings were plotted against the corresponding concentrations to generate a calibration curve.

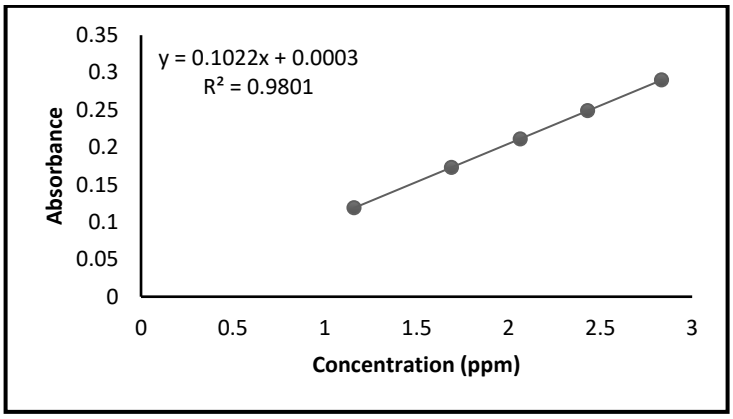


Figure 1. Calibration curve for Fe

Figure 2 illustrates the adsorption percentage (%) of 1.0 g adsorbent tested on different concentration of Fe standard solution (1.0, 2.0 and 3.0 ppm).

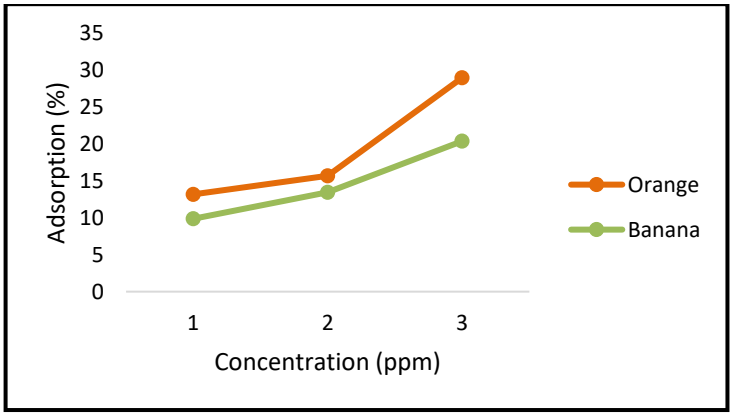


Figure 2. Adsorption percentage (%) at different concentration

Figure 3 showed the adsorption percentage (%) of 3.0 ppm Fe at different mass of adsorbents (1.0, 2.0 and 3.0 g).

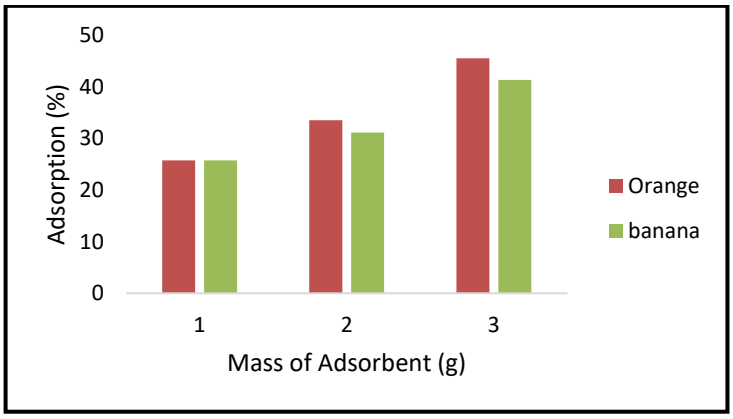


Figure 3. Adsorption percentage (%) at different mass of adsorbent

DISCUSSION/ANALYSIS

The calibration curve shown in Figure 1 indicates good linearity as the r^2 value is 0.9802. The calibration curve plays a critical role in the quantitative analysis of trace metals using AAS, particularly in environmental studies that require accurate detection of contaminants at low concentrations. By comparing the absorbance of treated samples to the established curve, the actual concentration of residual Fe can be quantified. This, in turn, allows for the calculation of adsorption efficiency and removal percentage, which are essential indicators of the adsorbent's performance. The use of calibration curves is a standard approach in instrumental analysis due to its accuracy, repeatability, and sensitivity (Prashanth & Basavaiah, 2020). Meanwhile, Figure 2 reveals that both adsorbents were effective in adsorbing Fe at highest concentration tested, with adsorption percentages of 29.0% and 20.4% for orange and banana, respectively. The overall pattern observed supports the general principle that increasing metal ion concentration enhances adsorption capacity. As highlighted by Arifiyana and Devianti (2021), this is primarily because higher concentrations of metal ions increase the chances of interaction with the active sites on the adsorbent surface. At lower concentrations, the abundance of free binding sites allows for quick and efficient adsorption. However, at higher concentrations, the metal ions must diffuse further into the porous structure of the adsorbent. Some metal ions, particularly those that hydrolyze easily, may diffuse more slowly or form complexes, reducing overall adsorption efficiency. As shown in Figure 3, different adsorbents were tested on a 3.0 ppm Fe metal concentration. Both orange and banana peel adsorbents exhibited their highest adsorption efficiencies at a dosage of 3.0 g, achieving 45.51% and 41.32% removal, respectively. Adsorption happens on the surface, so materials with larger surface areas tend to adsorb metals more quickly and effectively. This relationship is also closely tied to the amount of adsorbent. Increasing the amount of adsorbent enhances the availability of active sites which can bind to heavy metal ions (Arifiyana & Devianti, 2021). Based on both parameters studied, orange peel shows the highest adsorption percentages at 3.0 g and 3.0 ppm Fe. Nijmou et al. (2025) stated that this may be due to its porous structure and natural components like cellulose, lignin, hemicellulose, and pectin in orange peels that help bind the metal ions.

CONCLUSIONS

The results demonstrated that both orange and banana fruit peels were effective as adsorbents when tested in Fe solution., confirming their potential as low-cost and environmentally friendly alternatives to conventional adsorbents. Study also found that orange peels provided the highest percentage (45.51%) at 3.0 g and 3.0 ppm of Fe as compared to banana peels. For future research, it is recommended to investigate the effect of other variables such as pH and adsorbent particle size, as these can significantly influence adsorption performance. Additionally, exploring the morphological characteristics of the adsorbents through techniques such as scanning electron microscopy (SEM) or Fourier-transform infrared spectroscopy (FTIR) could provide deeper insight into their surface structure and functional groups, further enhancing their optimization and application.

REFERENCES

Angon, P. B., Islam Md. S., Shreejana K. C, Das, A., Anjum, N., Poudel, A., & Suchi, S. A. (2024). Sources, effects and present perspectives of heavy metals contamination: Soil, plants and human food chain. *Heliyon*, *10*(7), 1-15. https://doi.org/10.1016/j.heliyon.2024.e28357

Arifiyana, D., & Devianti, V. A. (2021). Biosorption of Fe (II) Ions from Aqueous Solution using Kepok Banana Peel (*Musa acuminate*). *JKPK (Jurnal Kimia Dan Pendidikan Kimia), 6*(2), 206. https://doi.org/10.20961/jkpk.v6i2.45181

Ávila, F. G., Cabrera-Sumba, J., Valdez-Pilataxi, S., Villalta-Chungata, J., Valdiviezo-Gonzales, L., & Alegria-Arnedo, C. (2025). Removal of heavy metals in industrial wastewater using adsorption technology: efficiency and influencing factors. *Cleaner Engineering and Technology, 24*, 100879. https://doi.org/10.1016/j.clet.2025.100879

Gómez Aguilar, D. L., Rodríguez Miranda, J. P., & Salcedo Parra, O. J. (2022). Fruit peels as a sustainable waste for the biosorption of heavy metals in wastewater: A review. *Molecules, 27*(7), 2124. https://doi.org/10.3390/molecules27072124

Kainth, S., Sharma, P., & Pandey, O. (2023). Green sorbents from agricultural wastes: A review of sustainable adsorption materials. *Applied Surface Science Advances, 19*, 100562. https://doi.org/10.1016/j.apsadv.2023.100562

Nagajyoti, P. C., Lee, K. D., & Sreekanth, T. V. M. (2010). Heavy metals, occurrence and toxicity for plants: A review. *Environmental Chemistry Letters, 8*(3), 199–216. https://doi.org/10.1007/s10311-010-0297-8

Nijmou, Y., El Messaoudi, N., Belmouden, M., & Rghioui, L. (2025). Sustainable use of orange peel waste as an eco-friendly adsorbent for heavy metal removal: A review. *Journal of Environmental Chemical Engineering, 13*(4), 109857. https://doi.org/10.1016/j.jece.2025.109857

Prashanth, K. N., & Basavaiah, K. (2020). Calibration curve method for reliable quantification in instrumental analysis: A review. *Critical Reviews in Analytical Chemistry, 50*(5), 440–456. https://doi.org/10.1080/10408347.2019.1605306

Rahman, A., Yoshida, K., Islam, M. M., & Kobayashi, G. (2023). Investigation of efficient adsorption of toxic heavy metals (chromium, lead, cadmium) from aquatic environment using orange peel cellulose as adsorbent. *Sustainability, 15*(5), 4470. https://doi.org/10.3390/su15054470

Rashid, A. Z. (2009). Removal of heavy metals in aqueous solution using banana and orange peels. Universiti Teknologi PETRONAS. http://utpedia.utp.edu.my/id/eprint/9391

Tolkou, A. K., Maroulas, K. N., Theologis, D., Katsoyiannis, I. A., & Kyzas, G. Z. (2024). Comparison of modified peels: Natural peels or peels based activated carbons for the removal of several pollutants found in wastewaters. *C, 10*(1), 22. https://doi.org/10.3390/c10010022

Pejabat Perpustakaan
Library Office

Universiti Teknologi MARA
Cawangan Perak
Kampus Seri Iskandar
32610 Bandar Baru Seri Iskandar,
Perak Darul Ridzuan, MALAYSIA
Tel: (+605) 374 2093/2453 Faks: (+605) 374 2299

UNIVERSITI TEKNOLOGI MARA

Surat kami : 700-KPK (PRP.UP.1/20/1)
Tarikh : 20 Januari 2023



Prof. Madya Dr. Nur Hisham Ibrahim
Rektor
Universiti Teknologi MARA
Cawangan Perak

Tuan,

PERMOHONAN KELULUSAN MEMUAT NAIK PENERBITAN UiTM CAWANGAN PERAK MELALUI REPOSITORI INSTITUSI UiTM (IR)

Perkara di atas adalah dirujuk.

2. Adalah dimaklumkan bahawa pihak kami ingin memohon kelulusan tuan untuk mengimbas (*digitize*) dan memuat naik semua jenis penerbitan di bawah UiTM Cawangan Perak melalui Repositori Institusi UiTM, PTAR.

3. Tujuan permohonan ini adalah bagi membolehkan akses yang lebih meluas oleh pengguna perpustakaan terhadap semua maklumat yang terkandung di dalam penerbitan melalui laman Web PTAR UiTM Cawangan Perak.

Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Setuju.

27.1.2023

PROF. MADYA DR. NUR HISHAM IBRAHIM
REKTOR
UNIVERSITI TEKNOLOGI MARA
CAWANGAN PERAK
KAMPUS SERI ISKANDAR

Saya yang menjalankan amanah,

SITI BASRIYAH SHAIK BAHARUDIN
Timbalan Ketua Pustakawan

nar

Powered by CamScanner