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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
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ISETC 2025 Proceedings Editors

DETERMINATION OF HEAVY METAL CONTAMINATION IN MALAYSIA LOCAL PINEAPPLE CANNED FOOD BRANDS USING ATOMIC ABSORPTION SPECTROMETER (AAS)

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Abstract: Canned pineapple is widely consumed in Malaysia due to affordability and long shelf life. However, potential heavy metal contamination during manufacturing and storage raises safety concerns. This study aimed to determine the concentrations of selected heavy metals - Chromium (Cr), Cadmium (Cd), Iron (Fe), Nickel (Ni), Zinc (Zn), Copper (Cu), and Manganese (Mn) in canned pineapple products from six local brands using Atomic Absorption Spectroscopy (AAS). Samples were wet-digested and analyzed. Iron (Fe) was most abundant (0.4927–0.6183 mg/L), while Cadmium (Cd) remained within safety limits. Certain brands showed elevated Cr, Mn, and Ni levels, highlighting the need for stricter quality control.

***Keywords*:** *Heavy metal, pineapple, Atomic Absorption Spectrophotometry (AAS), wet digestion*

INTRODUCTION

Canned fruits are popular for their convenience, extended shelf life, and availability (Youvan, 2024). Canned pineapple is commonly used in Malaysia in desserts and dishes. However, canned food can pose health risks due to heavy metal contamination introduced during agriculture, processing, or leaching from metal packaging (Anual et al., 2023; Fuadi & Wardana, 2024; Lebelo et al., 2021). Heavy metals like Cr, Cd, Fe, Ni, Zn, Cu, and Mn are naturally occurring and may accumulate in food (Munir et al., 2022). Some (Fe, Zn, Cu, Mn) are essential but toxic at high levels, while others (Cd, Cr, Ni) are toxic even in small amounts (Dordevic et al., 2023). Long-term exposure is linked to serious health issues. Food safety agencies like EFSA and Malaysia's Food Regulations 1985 set permissible intake levels. To assess heavy metal contamination accurately, sensitive analytical techniques are required. Atomic Absorption Spectroscopy (AAS) is widely used for trace metal analysis due to its sensitivity and reliability (Rawat et al., 2024). This study aims to determine the concentrations of seven metals in six local canned pineapple brands, compare them to safety standards, and assess potential health risks.

LITERATURE REVIEW

Heavy metal contamination in food products is a growing concern due to its potential health risks and environmental origins. Canned fruits, including pineapple, can accumulate heavy metals such as Cadmium (Cd), Chromium (Cr), Iron (Fe), Nickel (Ni), Zinc (Zn), Copper (Cu), and Manganese (Mn) during agricultural production, processing, packaging, or storage (Lebelo et al., 2021). Metal leaching may also occur from packaging materials, especially tin-coated or aluminium cans, which react under acidic conditions found in fruits like pineapple (Ofoegbu, 2021). Some metals, like Fe, Zn, Cu, and Mn, serve as essential micronutrients in small amounts. However, excessive intake can result in toxicity and organ damage (Awuchi et al., 2020). In contrast, non-essential metals such as Cd, Cr (VI), and Ni are toxic even at low concentrations and have been associated with carcinogenicity, kidney damage, and neurological disorders (Dordevic et al., 2023). Several studies have been conducted worldwide on heavy metal presence in canned foods. For example, there are experiment that highlighted challenges in copper detection in food and water sample (Elkhatat et al., 2021). These findings emphasize the importance of reliable analytical methods such as Atomic Absorption Spectroscopy (AAS), which has been widely adopted due to its sensitivity and accuracy in detecting metal concentrations (Rawat et al., 2024; Senila, 2024). Regulatory frameworks such as the European Food Safety Authority (EFSA), Scientific Committee on Food (SCF), and Malaysia’s Food Regulations 1985 provide

guidelines for permissible limits of heavy metals in food (DRI: dietary reference intakes, 2001; Food Regulation 1985, 2023). Continuous monitoring and assessment are essential to ensure consumer safety, especially in widely consumed products like canned pineapple.

MATERIALS AND METHODS

Fresh pineapple and five canned brands (A–E) were bought from Perak supermarkets. Chemicals used included 65% HNO_3, 37% HCl, and standard metal solutions. Samples were blended and dried at 70°C. Calibration standards were made from 1000 ppm metal solutions. 3.00 g of dried sample was digested with HNO_3 and HCl, heated until fuming, cooled, filtered, and diluted. Samples were microfiltered before AAS analysis. Instrument settings were metal-specific (de Souza et al., 2021; Senila, 2024).

RESULTS

Table 1. Permissible Limits and Health Effects of Selected Heavy Metals in Food

No.	Metal	Limit	Effect	Reference
1	Cu	5 mg/d	Can cause liver damage, nausea, and vomiting	(Committee on Food, 2003)
2	Zn	25 mg/d	Lower Cu absorption weakens the immune system	
3	Fe	40 mg/d	Can be toxic to the gastrointestinal system and liver, and poisoning (in large amounts)	(Bērziņš, 2025)
4	Mn	8 mg/d	Can cause neurological symptoms	
5	Ni	1.0 mg/d	High exposure is linked to allergies and carcinogenicity. In industrial settings	(DRI: dietary reference intakes, 2001)
6	Cr	0.02 mg/d	Toxic and carcinogenic	(Food Regulation 1985, 2023)
7	Cd	1.0 mg/kg	Toxic even at low levels, damages the kidney, brain, and bone	

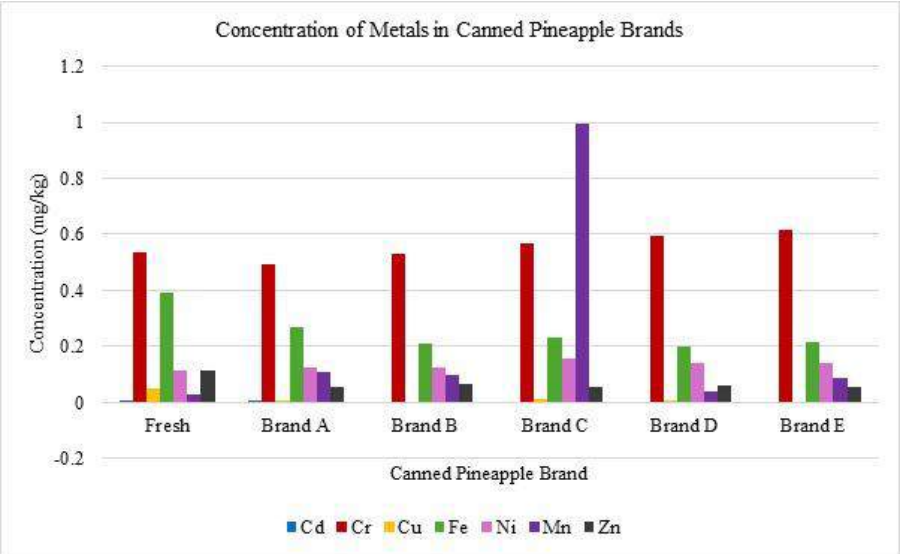

Figure 1. Concentration of Metal in Canned Pineapple Brands

DISCUSSION/ANALYSIS

Table 1 summarizes the permissible limits and health effects of selected heavy metals in food, showing that some (Cu, Zn, Fe, Mn) are essential at low levels but toxic when consumed in excess, while others (Ni, Cr, Cd) are primarily harmful even at trace amounts. For example, excess copper can damage the liver, zinc in high intake weakens the immune system by reducing copper absorption, and too much iron may cause gastrointestinal and liver problems. Manganese is needed for metabolism but can lead to neurological symptoms if overconsumed. On the other hand, nickel exposure is linked to allergies and carcinogenic risks, chromium is highly toxic and carcinogenic, and cadmium is particularly dangerous as it can damage the kidneys, brain, and bones even at very low levels. These findings highlight the importance of monitoring and regulating heavy metals in food to ensure public health safety.

Figure 1 shows all metals that were detected in both fresh and canned pineapples. Fresh pineapple (control) had 0.005 mg/kg Cd; canned samples showed negative values, possibly due to instrument errors. Cd levels were under safe limits (Genchi et al., 2020; Wang et al., 2023). Cr levels were highest in Brand E (0.6183 mg/kg), exceeding the 0.02 mg/kg limit, indicating a potential health risk (Hamzah et al., 2021). Cu was below 5 mg/day in all samples. Brand C had the highest canned Cu at 0.013 mg/kg. Fe levels were highest in Brand A (0.2686 mg/kg), all under the 40 mg/day limit. Ni was higher in canned samples, especially Brand C (0.1587 mg/kg), within the 1.0 mg/day threshold. Mn was high in Brand C (0.995 mg/kg), below the 8 mg/day limit. Zn was highest in Brand B (0.064 mg/kg), under the 25 mg/day limit. Negative values for Cd and Cu may result from detection limits or instrument correction errors (Krzebietke et al., 2023). Contamination could stem from machinery or packaging (Gupta et al., 2024). Lastly, environmental factors like soil and irrigation also play a role (Aboelghait et al., 2024; Kelbore et al., 2024).

CONCLUSIONS

This study confirmed the presence of Cr, Cd, Fe, Ni, Zn, Cu, and Mn in canned and fresh pineapple samples using AAS. Most values were within safety limits, except for Cr in certain brands. While products appear safe, elevated Cr levels warrant caution. AAS proved to be an effective method for heavy metal analysis. Regular monitoring and strict GMP are essential to prevent contamination. Future studies should analyze more brands, batches, and fruit types to improve food safety risk assessments.

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Sekian, terima kasih.

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SITI BASRIYAH SHAIK BAHARUDIN
Timbalan Ketua Pustakawan

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