HEAVY METALS IN POTATO CHIPS AND MANGO JUICE AVAILABLE IN DHAKA CITY

REGISTRATION NO: 20-11139

DEPARTNIENT OF AGRICULTURAL CHEMISTRY
SHER-E- BANGLA AGRICULTURAL UNIVERSITY
DHAKA-1207

JUNE, 2022

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BY

REGISTRATION NO: 20-11139
E-mail: rabbani_bd20@yahoo.com
Contact No: +880176-7320303

A Thesis
Submitted to the Department of Agricultural Chemistry
Sher-e-Bangla Agricultural University, Dhaka
In partial Fulfillment of the requirements
for the degree of

MASTER OF SCIENCE (MS)

IN
AGRICULTURAL CHEMEISTRY

SEMESTER: JANUARY-JUNE 2022

Approved By:

Dr. Mohammed Ariful Islam
Professor
Department of Agricultural Chemistry
SAU, Dhaka.
Supervisor

Dr. Abdul Kaium
Associate Professor
Department of Agricultural Chemistry
SAU, Dhaka.
Co-Supervisor

Dr. Mohammed Ariful Islam
Professor
Chairman
Examination Committee
Department of Agricultural Chemistry
SAU, Dhaka.

DEPARTMENT OF AGRICULTURAL CHEMISTRY
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207

CERITFICATE

*This is to certify that the thesis entitled "**HEAVY METALS IN POTATO CHIPS AND MANGO JUICE AVAILABLE IN DHAKA CITY"** Submitted to the Department of Agricultural Chemistry,*

*Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in Partial fulfillment of the rudiments for the degree of **MASTER OF SCIENCE (M.S)** in AGRICULTURAL CHEMISTRY, embodies the result of a piece of bonafide research work carried out by **MD. GOLAM RABBANI,** Registration No: **20-11139** under my supervision and guidance. No part of thesis has been submitted for any other degree of diploma.*

I further certify that any help or Source of information received during the course of this investigation has been dully acknowledged

June 2022.
Dhaka, Bangladesh

Dr. Mohammed Ariful Islam
Professor
Department of Agricultural Chemistry
SAU, Dhaka.

DEDICATED

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BELOVED

PARENTS

ACKNOWLEDGEMENTS

All praises are due to "Almighty Allah" the beneficent and merciful whose blessings enabled to complete this work.

The author would like to express his gratitude, regards and indebtedness to his teacher and thesis supervisor ***Dr. Mohammed Ariful Islam,*** *professor, Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka-1207, for his guidance, constant inspiration and valuable advice*

The author wishes to express his earnest respect, sincere appreciation and enormous indebtedness to his Co- Supervisor, ***Dr. Abdul Kaium,*** *Associate Professor Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka- 1207*

The author feels to express his heartfelt thanks to the honorable chairman, ***Dr. Mohammed Ariful Islam,*** *Department of Agricultural Chemistry along with all other teachers and staff members of the Departments of Agricultural Chemistry, Sher-e-Bangla Agricultural University, and Dhaka for their co-operation during the period of the study.*

The author wishes to extend his special thanks to his lab mates, class mates for their keen help as well as their encouragement. The author express his gratitude to his beloved parents for their inspiration and moral support. May Allah bless and protect them all.

The Author

ABSTRACT

This study determined the heavy metal contents of ten mango juice samples and ten potato chips samples. The samples were collected from the Dhanmondi and Mirpur area of Dhaka, Bangladesh. Five mango Juice and five potato chips, total ten samples were collected from Dhanmondi and another five mango juice and five potato chips samples were collected from Mirpur. In order to determine the concentrations of heavy metals (Cd, Cr & Pb) in 20 samples sold under different brand names and readily available in Dhaka, Atomic Absorption spectrophotometer, AAS-Analytik Jena 400P was utilized. Lead was present beyond safety limit in samples number 3 and 4 but in number 10, almost reached the safety limit, Sample number 11, which was mango juice collected from Dhanmondi, contained lead just below the safety limit and the values were respectively 0.11 mg/L, 0.17 mg/L and 0.09 mg/L. This result showed that in the case of lead, potato chips contained more lead than mango juice. Alternatively in potato chips, chromium was found in sample 3 collected from Dhanmondi crossed the safety limit. Meanwhile mango juice sample number 16 almost reached the safety limit and in number 17 also crossed the safe limit, both were collected from Mirpur area and values were subsequently 1.05 mg/L, 0.94 mg/L and 1.41 mg/L. The result showed that mango juice had more chromium than potato chips. However, no cadmium was found in the samples, all were below the detection limit. Lead, chromium, and cadmium can be harmful, especially for children. Therefore, the presence above the permitted limit is alarming. Mango juice and potato chips are highly well-liked snacks among young people, especially kids. However, the health risks shown in the study, discovered that the makers need to be more careful in removing this dangerous ingredient. Additionally, the guardian needs to be extra watchful. Consumers and food safety authorities can utilize these findings improve the quality these food products. For covid-19 situation, the research work was done with limited resources as the number of collected samples was less in number and also the number of targeted heavy metals was limited.

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ABBREVIATIONS AND ACRONYMS

FDA	Food and Drug Administration
BCSIR	Bangladesh council of Scientific Research Institute
FAO	Food and Agricultural Organization
US EPA	United States Environmental Protection Agency
ATSDR	Agency for Toxic Substances & Disease Registry
SAU	Sher-e-Bangla Agricultural University
AAS	Atomic Absorption Spectrometer
Et al.,	and others
etc.	Etcetra
i.e.	id est (L), That is
mL	Millilitre
M.S.	Master of Science
No.	Number
Pb	Lead
Cd	Cadmium
Cr	Chromium
g	Gram
e.g	exempli gratia (L), for example
WHO	World Health Organization

CHAPTER I

INTRODUCTION

Potato chips and mango juices are considered the most popular snacks currently. Fruit juices are a significant scar of modern diets (Abdel. Rahman et al. 2013). These nutritious juices can play an important role because they offer quality taste and various nutrients naturally found in fruits. Juices are available in their natural concentrations or processed form so that consumers can buy and gulp them down when they need which form they want (Kellen J., 2007). In the present time of industrialization and development, one concern should be the future generation's health. Children are the most vulnerable age group to juice contamination. Major and minor elements are considered essential nutrients in food. The routine monitoring of the level of these elements in fruit juices is a standard quality control process (Phuong Truong et al. 2014.)

Fruit juice is the most widespread beverage in the diet, contributing significantly to trace element dietary intake. Fruit juice is a highly appreciated food and usually has exceptional qualities. However, it can be a potential source of toxic elements. Commercial fruit juices commonly contain nutrients, minerals, trace elements, vitamins, and phytochemicals, all of which have many health benefits when consumed in moderation as part of a balanced diet. As a result, fruit juices have a positive effect on promoting health and reducing disease risk. (International Federation of Fruit Juice Producers IFU, Paris, France, 2013.)

Trace element levels in fruit juices may be expected to be influenced by many factors, Including a. The nature of the fruit, b. the mineral composition of soil from which it originated and other characteristics that influence the availability of the element to be taken by the plant (Such as soil's cation exchange capacity, soil pH, and presence of fungi) c. the mineral composition of the irrigation water, d. the weather conditions, e. The agricultural practices, Such as the types and amount of fertilizer used f. the atmospheric deposition of metals from industrial activities and emissions from vehicles; g) other ingredients (such as added sugar) Used by manufacturers in juice processing steps, and h) packing and storage stages.(J.K. Tufuor et al. 2011) and V.L.C. Bragança et al. 2012).

On the other hand, the quality of Juice products is diminished with increasing concentrations of toxic metals such as lead, cadmium, chromium, Etc. The primary source of human exposure to lead and cadmium in food is believed to provide 80-90% of daily doses of those metals. (Chanson-Rolle A., Braesco V. et al. 2016)

Heavy metal toxicity that is, lead, cadmium, copper, etc., is well documented and recognized as a significant environmental and health risk worldwide. Lead affects humans of all ages, but the effect of lead is most profound at young age. In addition, the international agency for cancer research has identified cadmium as a known human carcinogen. The interaction of the metal with biological, clinical manifestations of lead toxicity include symptoms referable to the central nervous system, the peripheral nervous system, the hematopoietic system, the renal system, and the gastrointestinal system. (Krejpcio Z et al. 1997).

Although metals are essential, their increased concentrations make them potentially toxic elements. Besides, soil pollution from various sources, fertilizers, pesticides, and other chemicals directly impact mangoes' hazardous heavy metal uptake such as cadmium (Cd), chromium (Cr), lead (Pb) etc. from soil and fixation from the air (Fathabad, A.E. Shariatifar et al. 2018). The presence of heavy metals in mango fruits juices, especially in high quantities, can lead to chronic diseases. These diseases could therefore result in mutagenesis, carcinogenesis, and teratogenesis, especially in vulnerable populations such as children. (Mohamed, F. et al. 2020).

Health risk assessments of fruit juices targeted for human consumption are attracting increasing interest from researchers, governments, and international health organizations. In this context, several studies have aimed to assess the spatial distribution of heavy metals in consumed fruits and fruit juices. (E.M., Al-Huqail et al. 2022).The spatial assessment of heavy metals in mango fruits from South and Southeast Asia, and especially the Indian subcontinent, is limited. (E.M et al. 2022).

Potato chips are trendy worldwide, especially among young children, because of their mouthwatering taste and easy market availability (Satarug S. et al. 2004). A potato chip or crisp is a thin slice of potato that has been deep-fried or baked. The raw potato and corn chips are cooked and salted, and they are a portion often smaller than a regular meal between meals. (William S. et al. 2013) nevertheless, its chemical risk has been thoroughly explored yet. Studies have yet to be conducted to evaluate the heavy metal content of different potato chips (Jaradt QM, Tarawneh et al. 2014). Knowing what types of sources introduce heavy metals in potato chips is necessary. These types of sources can primarily divide into two main types. First, when they are raw, and second when they are in processing. In the first case, the contaminated soil where vegetables and fruits grow from which animals and human beings eat its product such products absorbs heavy metals from the soil. In the second case, which is processing and food production, the contamination during processing is attributable to the corrosion of equipment in the food industry or food storage. (Goplani, M; Shahare, M. et al. 2007).

It is indispensable that potato chips are fried in oil, and these potato chips absorb oil which may contain heavy metals. (Kikuchi, Y. et al. 2002). It is well established that heavy metals, i.e., arsenic, lead, chromium, cadmium, and copper, are toxic to humans. Children may be more exposed to these metals than adults because of their lower body, primarily if this product is marketed for daily use. (Mahindru, S.N et al. 2004). The toxicity of metals is closely related to age, route of exposure, daily intake, solubility, duration of exposure, and frequency of intake. Contamination of food by heavy metals i.e. cadmium, chromium and lead even in low concentrations, leads to metabolic disturbance and causes severe problems as it causes many health problems such as heart failure and cancer weakness and also affects kidney.(World Health Organization)

Many organizations and Agencies like World Health Organization (WHO), Food and Agricultural Organization (FAO), United States Environmental Protection Agencies (US EPA) work on maintaining the quality and definition of the amount of toxic substance in the food and focus on the legislation to protect consumers from this toxic substance in food. In Bangladesh, there are some organizations like BSTI (Bangladesh Standards and Testing Institute), BFSA (Bangladesh Food Safety Authority), BCSIR (Bangladesh Council of Scientific and Industrial Research) work on standar

The specific goals of the study are as follows:

1. To determine the heavy metal (Cadmium, Chromium & Lead) content of potato chips and mango juices gathered from various locations of Dhaka, Bangladesh.

2. To evaluate the potential health risk.

CHAPTER II

REVIEW OF LITERATURE

Ahmed Y. Hannon et al. (2016) used Atomic Absorption Spectroscopy (AAS) to measure heavy metal content in potato and corn chips in Iraqi markets. These metals are Cobalt (Co), cadmium (Cd), Copper (Cu), and Lead (Pb) determined by them. The study stated that potato chips contained fewer metals than corn chips. According to Iraqi markets, all tested types of potato chips were under the allowed levels. The mean accumulation trend for both types was Cu>Co>Pb>Cd.

Essa Hariri et al. (2015) did this study in Lebanon to assess Acrylamide and metals in potato and corn chips and to ascertain their carcinogenic and neurotoxic risk. They used Gas Chromatography-Mass Spectrometry (GC-MS) analysis, revealing that the standard Acrylamide amount in potato and corn chips was 3500-fold bigger than the safe value for Acrylamide in drinking water (0.5 µg/kg). Furthermore, in their study, spirit disseminative X-ray fluorescence and thermal atomic absorption analysis disclosed that the concentration of zinc, lead, and cadmium in corn chips was approximately 1.5-1.7 and 2.4-fold higher than the permissible limits set by Food and Agricultural Organization and WHO, respectively.

Meetu Gopalani et al. (2007) determined aggregation of some selected heavy metals from food items such as potato chips and biscuits from Nagpur, India. This study used Inductively Coupled Plasma Atomic Absorption Spectroscopy (ICP-AES) machine. They found the accumulation trend for potato chips was in the order Fe>Al>Zn>Ni>Cu>Mn>Co>Cr>Pb,While for biscuits, it was Al>Fe>Zn>Ni>Mn>Co>Cr>Pb>Cu>Cd.

In a study conducted by Islam et al. (2013), samples of potato chips and mango juice were collected from different regions of Bangladesh to determine the concentrations of lead, chromium, and cadmium. The results showed that all samples contained detectable levels of these heavy metals, with mean concentrations ranging from 0.056-0.515 mg/kg for lead, 0.015-0.144 mg/kg for chromium, and 0.042-0.262 mg/kg for cadmium. The authors concluded that consumption of contaminated potato chips and mango juice could pose a potential health risk to consumers in Bangladesh.

Al-Rajhi, M.A. et al. (2014) assessed different Potato chips using an Inductively Coupled plasma-optical emission spectrometer (ICP-OMS) in Riyadh, Kingdom of Saudi Arabia. They examined the concentrations of 12 chemical elements (i.e., Cd, Cr, Cu, Fe, Mn, Mg, Ni, Pb, Zn, As, Se, and Al). In addition, the average concentration of analyzed elements in all samples was examined and compared with the recommendations of the international organization. Their study showed no health risks to consumers due to the intake of those potato chips.

Quasem M. Jaradat et al. (2014) conducted a study to determine the heavy metal concentration in potato and corn chips sold in the Jordanian market. They used Atomic absorption spectrometry (AAS) to measure the levels of metals after the wet digestion process. The average concentration of heavy metals found in Potato chips is as follows 10.32, 2.25, 3.15, 6.57, 7.84, and 0.25 μg/kg for Fe, Cu, Mn, Pb, Zn, And Cd, respectively, where in corn chips, it was 6.42, 0.54, 1.33, 6.79, 5.67 and 0.21 μg/kg.

Kashif Ur Rehman Khalil et al. (2017) estimated the concentration of heavy metals (Lead, Cadmium, Chromium, and copper) in branded and non-branded (local) snacks in the markets of Peshawar, KPK, Pakistan. They got that Lead and Chromium exceeded in most branded and local snacks samples. They also found particular concern was chromium, which exceeded far beyond the allowed limits they took as a recommendation.

In a recent study by Ahmed et al. (2020), samples of potato chips and mango juice were collected from different regions of Bangladesh to determine the concentrations of heavy metals, including lead, chromium, and cadmium. The results showed that all samples contained detectable levels of these heavy metals, with mean concentrations ranging from 0.04-0.18 mg/kg for lead, 0.05-0.12 mg/kg for chromium, and 0.047-0.27 mg/kg for cadmium. The authors recommended that proper monitoring of heavy metal content in food products and public awareness campaigns, could help reduce the health risks associated with heavy metal contamination.

Florin Dumitru et al. (2020) determined trace and heavy metals in fruit juices in the Romanian Market using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Their study found that multifruit, mango, and kiwi juice have recorded the highest concentration of Cu. In contrast, apple and pear juice recorded the lowest concentration, and in the case of Zn, peach juice recorded the highest concentration. The concentration of Zn, Cu, Co, and As generally was higher in the juice samples packed in boxes, while Ni, Cr, b, and Cd recorded the highest values in the juice packed in plastic bottles.

Ayman S. M. Hassan Et al. (2014) estimated some trace metals in fruit juices (apple, guava, mango, orange, and peach juice and nectars) in the market of Egypt. Then, they analyzed those metals, i.e., Cd, Cu, Fe, Pb, and Zn, using Atomic Absorption Spectrometer. In their study, all juice and nectar samples had low Zn limits, and most samples were free from detectable levels of Cd and Pb except for a few samples. Therefore, they found their result below the guidelines for fruit juices given by commission regulation (EC) no 1881/2006.

Faez Mohamed et al. (2020) conducted a study to estimate the level of Cd, Cr, Cu, Pb, Zn, Sn and Fe in 6 types of fruit juices (Orange, Mango, guava, Pineapple, Peach and mixed fruits) of Yemen's market.They used Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-AES) to analyze the heavy metals. From their work, they found that the origin of metal contamination could be likely linked to war conditions even though it was difficult to be totally affirmative so far.

Fruit juices available on the Yemeni market are globally safe. Nonetheless further risk- based surveillance studies must be carried out to decrease child exposure to toxic metals from fruit juice sources.

Gomaa N. Abdel-Rahman et al. (2019) revealed a study about heavy metal content in some non-alcoholic beverages (carbonated drinks, flavoured yoghurt drinks, and juice drinks) of the Egyptian market by using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). From their study, it was found that non-alcoholic beverage samples in the Egyptian market are primarily free of Lead,Cadmium (Cd), and Chromium (Cr) contamination. On the other hand, their result for other current beverage samples indicates that iron (Fe), Manganese (Mg), and Nickel (Ni), except Mn in juices and carbonated drinks, were present in a concentration above the recommended permissible limits of both the World Health Organization (WHO) and Egyptian Ministry of Health.

Karima G. Abdel Hameed et al. (2015) determined heavy metals such as As, Al, Cd, and Pb by inductively Coupled Plasma Optical Emission spectrometers and their public health importance. They compared their results with Maximum permissible limits. The result of their study exceeds permissible limits, suggesting health hazards, and they hope strict regulations must be established during the manufacturing process.

Modhir N. A Hawraa et al. (2014) conducted a study to investigate the levels of heavy metals and minerals in some branded potato and corn chips collected from the local market of Hilla City, Iraq, in October 2013. Atomic Absorption Spectrometry was used to reveal the level of metals. They found more heavy metals in potato chips compared to corn chips. They said chips might have been contaminated during manufacturing, packing, or raw materials

Another study found that lead, chromium and cadmium were present in various fruit juices and soft drinks sold in Bangladesh, including mango juice. The levels of heavy metals were found to exceed the permissible limits set by the World Health Organization (WHO) in some samples. Hossain, M. A., Rahman, M. M., Rahman, M. A., & Ahmed, M. B. (2019).

A recent study analyzed the levels of heavy metals in potato chips sold in Bangladesh and found that lead, chromium and cadmium were present in varying concentrations. The researchers also assessed the potential health impacts of consuming these chips, which included damage to the liver, kidneys and nervous system. (Hossain M. A. Rahman, M. M. Rahman & Ahmed M. B. 2019, International Journal of Advanced Science and Technology)

This review article summarizes the sources of heavy metal contamination in potato chips and mango juice sold in Bangladesh and the potential health impacts of consuming them. The authors suggest that better regulation and monitoring of food products can help reduce heavy metal levels and protect public health.

"Assessment of Lead Contamination in Some Brands of Potato Chips in Bangladesh" (Rahman MI, Sultana S, Sabur MA, et al., 2021) - This study aimed to assess lead levels in different brands of potato chips in Bangladesh. Results showed that all samples had detectable lead levels, and some brands had levels exceeding the limits set by international regulatory bodies.

"Heavy Metal Contamination of Packaged Mango Juice in Bangladesh" (Haq MA, Rahman MO, Ali MY, et al., 2021) - This research investigated the presence of heavy metals, including lead, in packaged mango juice in Bangladesh. The study revealed that all samples had detectable lead levels, and some brands had levels exceeding the safe value set by the World Health Organization.

"Detection of Lead Contamination in Different Packaged Mango Juice Samples from Dhaka City" (Ratul SM, Sultana T, Afrin S, et al., 2018) - This research examined the levels of lead in different brands of packaged mango juice in Dhaka City. The study showed that all samples had detectable levels of lead, and some brands had levels exceeding the permissible limit set by the Bangladesh Standard and Testing Institution.

"Evaluation of Selected Heavy Metals in Packaged Mango Juice Brands from Dhaka and Comilla Districts of Bangladesh" (Bhuiyan MS, Khanam F, Hasan MM, et al., 2017) - This study aimed to evaluate the levels of selected heavy metals, including lead, in packaged mango juice brands in Dhaka and Comilla Districts of Bangladesh. Results showed that all samples had detectable levels of heavy metals, and some brands exceeded the permissible limit set by the Bangladesh Standard and Testing Institution.

Paul, J. (2017). Heavy metal contamination in food in Bangladesh: A review. Bangladesh Journal of Veterinary and Animal Sciences, 5(2), 11-24.
In this review, the author discusses the prevalence of heavy metal contamination in various food items in Bangladesh, including potato chips and mango juice. The review concludes that heavy metal contamination in food is a significant public health concern in the country due to unregulated industrial practices.

This study comprehensively reviews of the health implications of heavy metal contamination in food, including chromium. The study highlights the need for strict regulations and monitoring of food products to ensure public health and safety.

J. N Solidum et al. (2013) conducted a study to determine powdered fruit juices in Metro Manila, Philipines. They used a flameless Atomic Absorption Spectrometer to analyze the samples collected from the markets. They strongly recommended that the manufacturer review the actual production process and possible sources of contamination.

This study evaluates the level of heavy metal contamination in juices, including mango juice and bottled water, in the Bangladeshi market. The research originate that a remarkable amount of the samples contained high levels of chromium, presenting a possible health risk to consumers.

Soheli Sobhanardakani (2019) conducted research to determine the health risks associated with several typical foods such as chips, chocolate, and biscuits. She obtained lead, one of the targeted heavy metals, in all of the samples, exceeding the legal limits, which is a severe health concern because lead's effects on the body might have serious negative effects.

Foods cultivated in polluted soil acquire more heavy metals than foods grown in unpolluted water, according to a study by Naveed Munir et al. published in 2021. It also revealed that the carcinogenicity of those metals poses a serious threat to human health.

According to a recent study by M. Gopalani et al. (2007), heavy metals like lead, copper, and chromium were identified in a sample of potato chips and cookies in Nagpur City, India, and they have a negative impact on consumer health.

Biswas, A. K., & Islam, M. S. (2017). Heavy metal contamination in food, water, and vegetables in Bangladesh: A systematic review and meta-analysis. Journal of Health Research, 31(2), 103-115.

This review article summarizes the findings of several studies on heavy metal contamination in various food items, including potato chips and mango juice, in Bangladesh. The review concludes that heavy metal contamination in food is a significant public health concern in the country and calls for urgent regulatory measures to address the issue.

According to a report by UPI, the Food and Drug Administration claimed in a new report that during ongoing monitoring efforts, it discovered large quantities of harmful

Heavy metals in the U.S. food supply. In terms of lead and arsenic contamination, baby meals were among the worst. In its report, the FDA discovered lead, arsenic, and cadmium in 15%, 43%, and 61%, respectively, of dietary samples. Additionally, according to the agency's investigation, 51% of the 384 infant food samples it had gathered showed measurable levels of total arsenic. Infant cereals and foods like teething biscuits and puffed snacks have the highest arsenic concentrations.

Jesse Hirsch (2019) did research on Juice products to learn more about their quality, and they discovered some alarming findings. They examined 45 well- known fruit juices, including apple, grape, mango, pear, and fruit mixes, that are widely available in the nation and discovered higher amounts of these substances, also referred to as heavy metals, in over half of them, including juices intended for children. Because they provide some of the most serious dangers and previous research suggests they are frequently present in food and drink, our test concentrated on cadmium, lead, mercury, and inorganic arsenic (the form most detrimental to health).

Hina Abbasi et al. (2020) conducted a study.to evaluate the levels of heavy metals and associated health risks in processed fruit products sold in North Pakistani local markets, Hina Abbasi et al. (2020) conducted a study. According to the findings, Cd, Cr, and Pb had relatively high target hazard quotients (THQ) and hazard indices (HI). However, target cancer risk (TCR) analysis shows that, with the exception of Cd content, these metals were within the permissible range.

Many common baby foods and fruit juices contain trace amounts of heavy metals like lead, mercury, cadmium, and others. While these trace amounts of metals in food are probably a small portion of a child's overall exposure to metals, a child's overall exposure to metals from all sources can be harmful to their health, especially in developing their brain. (Pediatric Enviornmental Health Speciality unit, March 2022)

In a 2005 investigation into the safety of Poland's fresh fruits and juices, Z. Krejpcio et al. discovered that 9.6% of the samples had increased heavy metal contents(Pb

2.2%, Cd 4.4%, Cu 1.5%, and Zn 1.5%) and 2% had Pb and Cd levels that were higher than allowed (3% and 9%, respectively).

Overall, the above-reviewed studies suggest that heavy metal contamination is a serious issue in food products, including potato chips and mango juice. The high levels of lead, chromium, and cadmium found in these products pose potential health risks to consumers, and hence, stricter regulations and monitoring of food products are necessary to ensure food safety and prevent health hazards.

CHAPTER III
MATERIALS AND METODS

Description of Study Area and Sampling Sites:

The study was carried out in the Dhanmondi and Mirpur area of Dhaka, Bangladesh. These two area famous for different criteria but the similar thing was its population. From different shops of these two area, total 20 samples of Potato chips and Mango Juice of Different Company was collected on their availability.

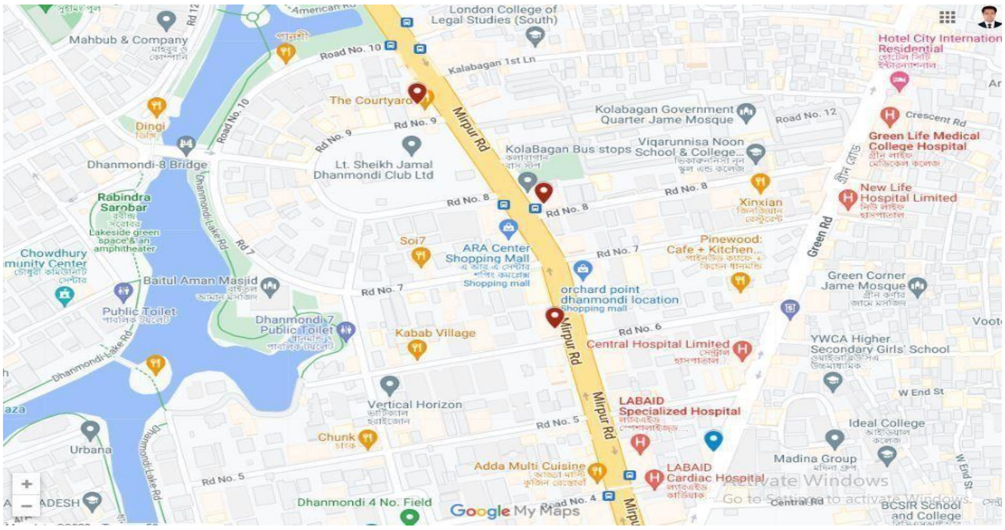


Figure 3.1: sampling site of Dhanmondi (red mark)

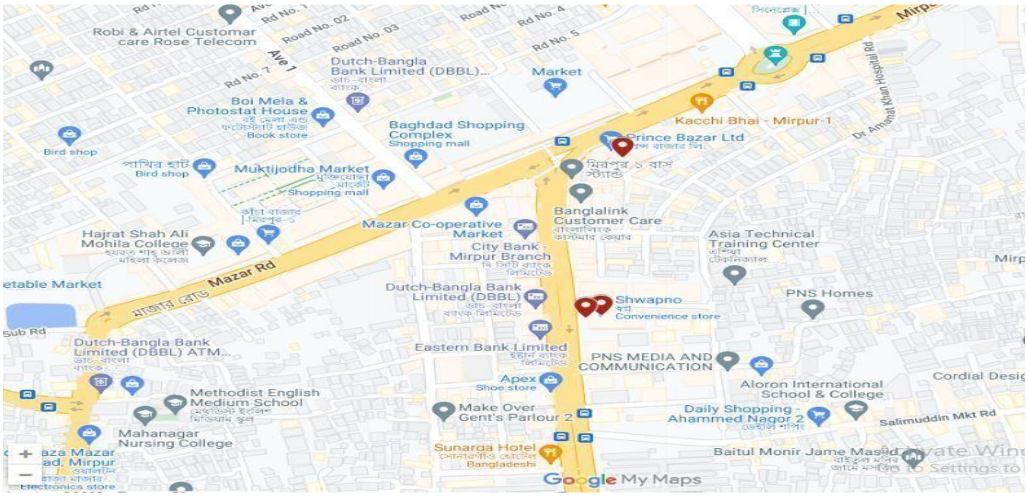


Figure 3.2: sampling site of Mirpur (red mark)

Sample Collection and Processing:

From the 20 samples, ten potato and mango Juice (5 potato chips samples and 5 mango Juice samples) were collected from the Dhanmondi area and the rest of the ten samples collected from the Mirpur. The collection process of sample was straightforward and concerned about the freshness of sample; the expiration date of the samples was checked and after collecting the samples, they were stored in a cool place.

Table 3.1: Collected Potato Chips name and their collection area

Sample Number	Sample Name	Company Name	Area of collection
1	Alooz Chips	Bombay Sweets & Co. Ltd.	Dhanmondi
2	Pran Potato Cracker	Pran Foods	Dhanmondi
3	Meridian Potato Cracker	Meridian Group BD	Dhanmondi
4	Lays Chips	PepsiCo	Dhanmondi
5	Sun chips	Quasem Foods Ltd	Dhanmondi
6	Alooz Chips	Bombay Sweets & Co. Ltd.	Mirpur
7	Pran Potato Cracker	Pran Foods Ltd.	Mirpur
8	Meridian Potato Cracker	Meridian Group BD	Mirpur
9	Lays Chips	PepsiCo	Mirpur
10	Sun Chips	Quasem Foods Ltd	Mirpur

Table 3.2: Collected Mango Juice Samples name and their collection area

Sample Number	Sample Name	Company Name	Area of collection
11	Acme Juice	The ACME Agrovet & Beverages Ltd.	Dhanmondi
12	Frutika	Akij Food & Beverage ltd.	Dhanmondi
13	Aafi Mango Juice	Akij Food Ltd.	Dhanmondi
14	Shezan Mango Juice	Sajeeb Group	Dhanmondi
15	Pran Frooto	Pran Foods Ltd.	Dhanmondi
16	Acme Juice	The ACME Agrovet & Beverages Ltd.	Mirpur
17	Frutika	Akij Food & Beverage Ltd.	Mirpur
18	Aafi Mango Juice	Akij Food Ltd.	Mirpur
19	Shezan Mango Juice	Sajeeb Group	Mirpur
20	Pran Frooto	Pran Foods Ltd.	Mirpur

Figure 3.3: Collected Chips Samples

Figure 3.4: Collected Juice Samples

Laboratory:

Agricultural Chemistry Laboratory, Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh.

Instruments, Glassware and Apparatus for Sample Digestion:

1. Balance Machine
2. Grinder Machine
3. Hot Plate by Sand
4. Conical Flask
5. Volumetric Flask
6. Beaker
7. Measuring Cylinder
8. Plastic Bottle
9. Whatman Filter paper

Figure 3.5: Balance Machine

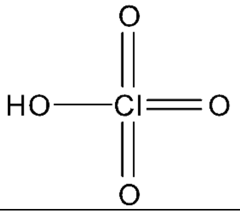
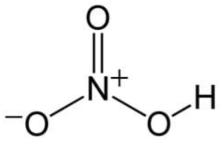
Figure 3.6: Grinder Machine

Figure 3.7: Sand Bath

Figure 3.8: Bottle of Acid

Chemical used in wet digestion:

Table: Name of acid and their chemical formula with structure used in sample preparation.
n.b: Nitric acid and Perchloric acid were used in sample digestion in a 2:1 ratio.

Name of the chemical	Chemical formula	Structure of the chemical
Perchloric acid	$HCLO_4$	
Nitric acid	HNO_3	

Methods of Sample Digestion:

1. With the help of a measuring cylinder, 10 mL juices of each sample were taken in a conical flask, adding 20 mL Di-acid (Nitric acid and Perchloric acid). After that, the samples were placed in a hot oven for 1-1.3 hours and waited until the colour turned white, reduced to 5-6 mL from the beginning, and then placed to cool. After cooling down, it was in a volumetric flask by filtering whatman filter paper. Finally added, distilled water in the volumetric flask and made the sample 100ml. Afterwards, it was stored in a cool place at room temperature for further use.

2. For Chips, with the help of a grinder, a fine powder was first made from chips and took 1gm from every sample. Then 20 mL Di-acid was added to the samples and placed in a hot oven for 1-1.30 hours and waited until the colour of the samples changed to white from brick red. After then, the samples were cooled at room temperature and stored in a volumetric flask by filtering Whitman filter paper. To prepare it for the next step, add distilled water and turn the sample amount to 100 mL.The whole digestion process was done to make the samples for its final laboratory test.

Working Methodology of an Atomic Absorption Spectrometer:

Atomic Absorption Spectrometer (AAS) is a type of analytical instrument widely used in various industries for the analysis of trace elements in a sample. The instrument is based on the principle of atomic absorption, which refers to the absorption of light by free, neutral atoms. The instrument works by introducing a sample into a flame or an atomizer, which vaporizes the sample and produces a cloud of free atoms. The atoms are then excited by a light source and the resulting light absorption is measured. The absorption is proportional to the concentration of the element being analyzed, and this information is used to determine the samples composition.

AAS has several advantages over other analytical techniques, including its high sensitivity, accuracy, and specificity. The instrument can detect elements in the parts-per-billion (ppb) to parts-per-million (ppm) range and can accurately measure elements in a wide range of sample types, including liquids, solids, and gases. In addition, AAS is a fast and versatile analytical technique that can be used to simultaneously determine multiple elements and makes it ideal for applications such as environmental analysis, food and beverage analysis, pharmaceutical analysis, and clinical analysis, among others.

Atomic Absorption Spectrometer is a powerful analytical tool widely used to analyze trace elements in a wide range of samples. With its high sensitivity, accuracy, and versatility, AAS has become an essential appliance in many commercial enterprises and continues to play a vital role in advancing of analytical science.

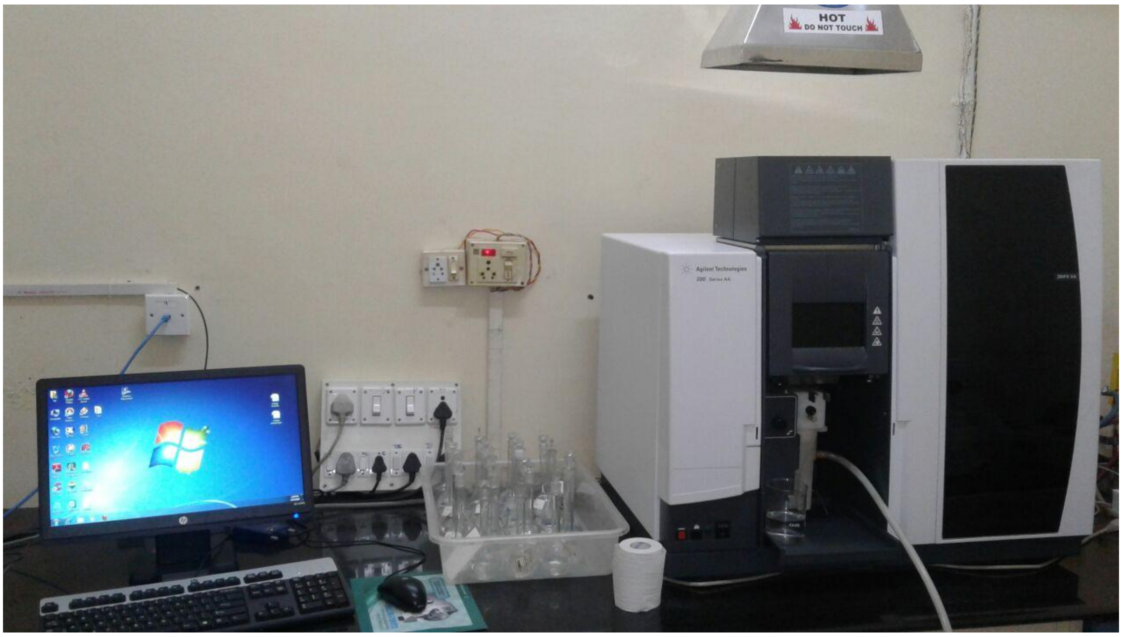


Figure 3.9: atomic absorption spectroscopy
(Photo collected from the website of Indian Institute of Horticultural Research)

Analysis of Lead:

In this analysis, the current was two mA, the lamp was HCl, the Pb wavelength was 217 nm, and the optical mode was a single beam. The measuring time was 3 seconds. The burner height and line parameters for the flame were 6 mm and 65 C2H2/Air, respectively. As the preparation was carried out manually, standard calibration was carried out. Before testing the sample, the calibration was performed a total of seven times.

The below figure shows about the calibration curve of the AAS machine for lead & its calibration information which were used in the laboratory during experiment.

R^2(adj.): 0.999338058 Slope: 0.06039 Abs./mg/L Char.conc.: 0.07219 mg/L/1%A
Method SD: 0.01523 mg/L y=a+bx a=-.0036281 b=0.0603922

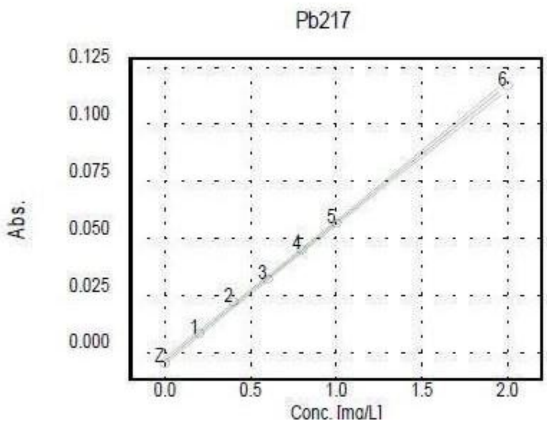


Figure 3.10: Calibration curve of lead for sample analysis

Analysis of chromium:

In the examination of chromium, the chromium wavelength was 357.9 nm, the lamp used was a Cathode lamp, the optical mode was single beam, the measuring time was 4 seconds, and the slit was 0.2 nm. The flame parameter used an 8 mm burner height. Seven Standard manual calibrations were performed in order to carry out the analysis as accurately as feasible.

The below figure shows about the calibration curve of the AAS machine for chromium & its calibration information which were used in the laboratory during experiment.

Cr357

R^2(adj.): 0.993073868 Slope: 0.09912 Abs./mg/L Char.conc.: 0.04399 mg/L/1%A

Method SD: 0.04938 mg/L   y=a+bx   a=0.0114520 b=0.0991246

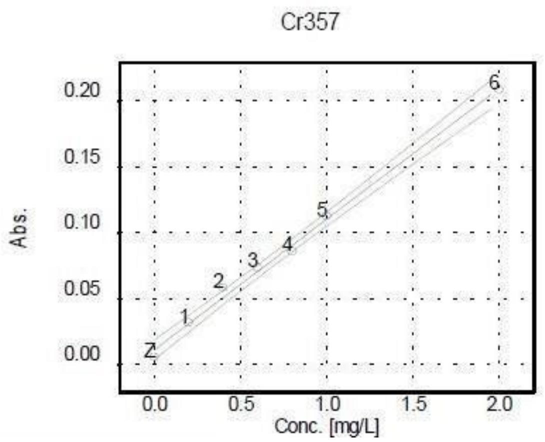


Figure 3.11: Calibration curve of chromium for sample analysis

Analysis of cadmium:

In the case of cadmium analysis, cadmium at a wavelength of 228.8 nm was employed, and the optical mode used an HCl lamp. The slit in this experiment had a width of 1.2 nm, and the measuring time was 3 seconds with a PMT 300V. The burner height was 6 mm, and the flame parameter was cd-228.8 l/h. seven cycles of standard calibration were performed to get the instrument ready for the final task.

R^2(adj.): 0.977740303 Slope: 0.31930 Abs./mg/L Char.conc.: 0.01365 mg/L/1%A
Method SD: 0.08899 y=a+bx a=0.0249049 b=0.3193012
mg/L

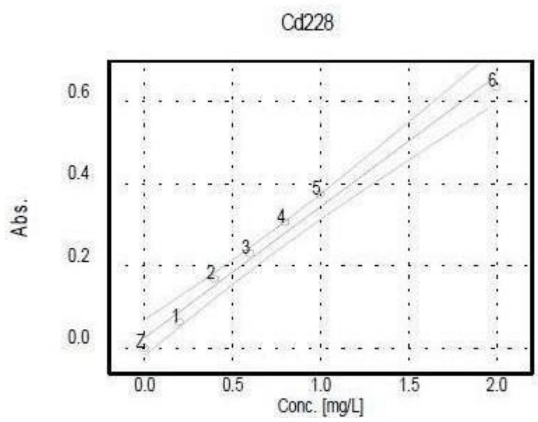


Figure 3.12: Calibration curve of cadmium for sample analysis

Risk assessment of heavy metal:

To assess the risk factor, single factor pollution index (SPI) is used. The pollution index (PI) is the ratio of metal concentration in a biotic or abiotic medium to that of the regulatory standard of international bodies such as World Health Organization (WHO), United States Enviornmental Protection Agency (USEPA) etc.

Mathematically, PI is expressed as:

$Pi = C_i/S_i$

Where Pi is the individual pollution index of study metal, C_i is the concentration of the metal in selected elements, S_i is the standard value of the regulatory limit of the heavy metal by standard organization such as WHO, FDA etc.

If the value of Pi less than 1 it means there is no threat but if greater than 1 then it can be harmful.

Sum of pollution index:

Sum of pollution index (SPI) previously described by qingjie et al. (2008) was used for the present application.

SPI= PiCd+PiCr+PiPb+PiNi

Where Pi= single factor pollution index of heavy metals

CHAPTER IV
Results and Discussions

In this chapter, the findings from the samples were examined for heavy metal content in order to determine their potential health risk factor. A total of 20 samples, including ten samples of potato chips and ten samples of mango juice were procured in the Bangladeshi capital of Dhaka's Dhanmondi and Mirpur neighborhoods. Three targeted heavy metals, lead (Pb), chromium (Cr), and cadmium (Cd), were analyzed to evaluate.

Table 4.1: The concentration of heavy metals in potato chips samples, BDL-Below Detection Limit

Sample No.	Sample Name	Collection Area	Lead(Pb) mg/L	Cadmium (Cd) mg/L	Chromium (Cr) mg/L
1	Alooz Chips	Dhanmondi	0.07	BDL	0.22
2	Pran Potato Cracker	Dhanmondi	BDL	BDL	0.50
3	Meridian Potato Cracker	Dhanmondi	0.11	BDL	1.05
4	Lays Chips	Dhanmondi	0.17	BDL	BDL
5	Sun chips	Dhanmondi	0.02	BDL	BDL
6	Alooz Chips	Mirpur	0.07	BDL	0.08
7	Pran Potato Cracker	Mirpur	0.01	BDL	0.05
8	Meridian potato Cracker	Mirpur	0.07	BDL	0.06
9	Lays Chips	Mirpur	0.07	BDL	BDL
10	Sun Chips	Mirpur	0.08	BDL	BDL

Table 4.2: The concentration of heavy metals in mango juice samples, BDL-Below Detection Limit

Sample No.	Sample Name	Collection Area	Lead (Pb) mg/L	Cadmium (Cd) mg/L	Chromium (Cr) mg/L
11	Acme Juice	Dhanmondi	0.09	BDL	BDL
12	Frutika	Dhanmondi	0.01	BDL	BDL
13	Aafi Mango juice	Dhanmondi	BDL	BDL	0.03
14	Shezan mango Juice	Dhanmondi	BDL	BDL	0.19
15	Pran Frooto	Dhanmondi	BDL	BDL	0.46
16	Acme Juice	Mirpur	0.01	BDL	0.94
17	Frutika	Mirpur	BDL	BDL	1.41
18	Aafi Mango Juice	Mirpur	BDL	BDL	BDL
19	Shezan Mango Juice	Mirpur	BDL	BDL	0.05
20	Pran Frooto	Mirpur	BDL	BDL	0.07

Table 4.3: Safe limit for food products

Elements	Maximum permissible limit (FDA & EC for heavy metals), mg/l
Pb	0.1
Cr	1
Cd	Not recognized

From the recommendation of FDA (Foods and Drugs Administration), USA the maximum permissible level of lead in food at 0.1 mg/kg (milligrams per kilogram) or 0.1 ppm (parts per million), which is equivalent to 0.1 mg/l. In case of potato chips sample, from the table 3, sample number 3-0.11 mg/l and sample number 4-0.17 mg/l were crossed the safe limit set by FDA and sample number 10 had the concentration of 0.08mg/l which very close to the safe limit. the other sample number 1-0.07mg/L, 5-0.02mg/L, 6-0.07mg/L, 7-0.01 mg/L, 8-0.07mg/L and 9-0.07 mg/L contained the presence of lead but those were not alarming because they had difference from the maximum permissible limit. The sample number 2 contained the negative value as the result showed it as below detection limit.

In case of Mango juice, from the table 4, sample number- 13, 14, 15, 17, 18, 19, 20 were under the detection limit as they showed negative value in time of experiment. But the sample number 11-0.09 mg/L almost touched the maximum permissible limit 0.01mg/l set by FDA which showed us it could be a threat for human health. It can be clearly said from the above discussion that potato chips contained more lead than potato chips.

From the data from table 3 and 4, regarding Cadmium, all the sample were below the detection limit so there were no chance of health threat associated with Cadmium in potato chips and mango juice samples.

From the regulation of European Commission for heavy metals in Food, the maximum permissible limit of Chromium is 1 mg/L.

From the table no. 3 of potato chips samples, the result of sample number 3-1.05 mg/L crossed the maximum permissible limit set by the authority which meant it could be a matter of thinking for health concern. Nevertheless the result of sample number 1-0.22 mg/L, 2-0.50 mg/L, 6-0.08 mg/L, 7-0.05 mg/L and 8-0.06 mg/L had also the presence of chromium but they were below the safety limit. On the other side, sample number 4, 5, 9, 10 were below the detection limit as they showed the negative result. From the table no. 4 of mango juice sample, the result of sample no.-17 which contained the value 1.05 mg/L clearly crossed the safe limit set by the standard authority not only this sample but also the sample no. 16 which having the value of 0.94 mg/L which was almost close to the safe limit as both can be considered as alarming for human health the sample no. 13 and 14 which having the value of concentrations 0.03 mg/L and 0.19 mg/L respectively was not a serious threat for health as they had far difference from safe limit the sample no. 11, 12 & 18 were below the detection limit as they were not taken in the considerations. In the matter of chromium for both the samples, mango juice having more chromium compare than potato chips.

The below chart showed more clear view about the heavy metal content in food samples:

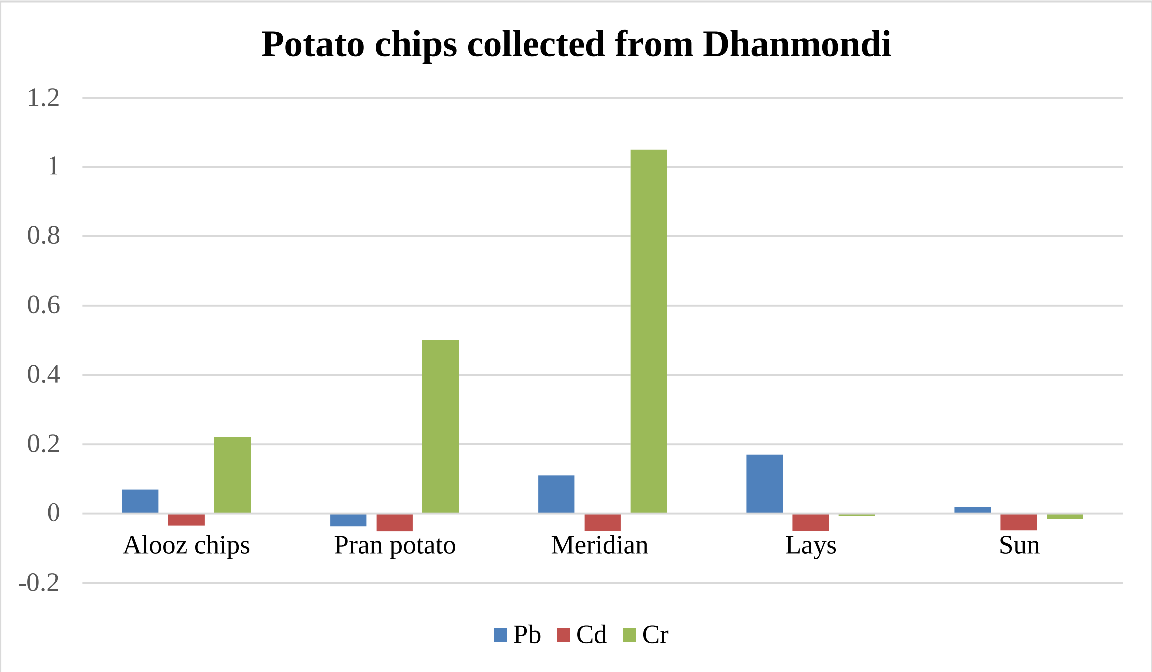


Figure 4.1: Level of lead, cadmium & chromium in potato chips collected from Dhanmondi

From the above chart, it’s clear that the level of chromium was high than other metals in the collected chips sample. On the other hand, the level of cadmium was below the considerable limit in all the samples.

Only three sample contained lead but the other two sample also below the considerable limit.

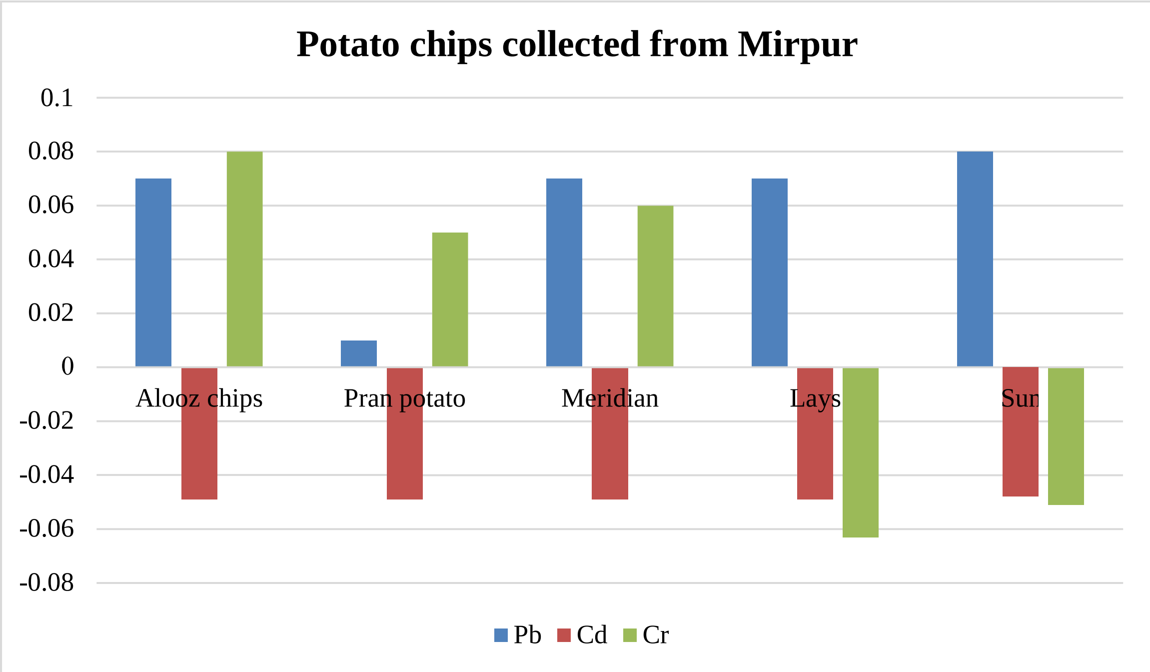


Figure 4.2: Level of lead, cadmium & chromium in potato chips collected from Mirpur

From the collected sample, the chart showed that the level of cadmium were below the level of consideration. But on the other side, the level of lead is higher than the chromium content because from the five samples, two sample were below the detection limit.

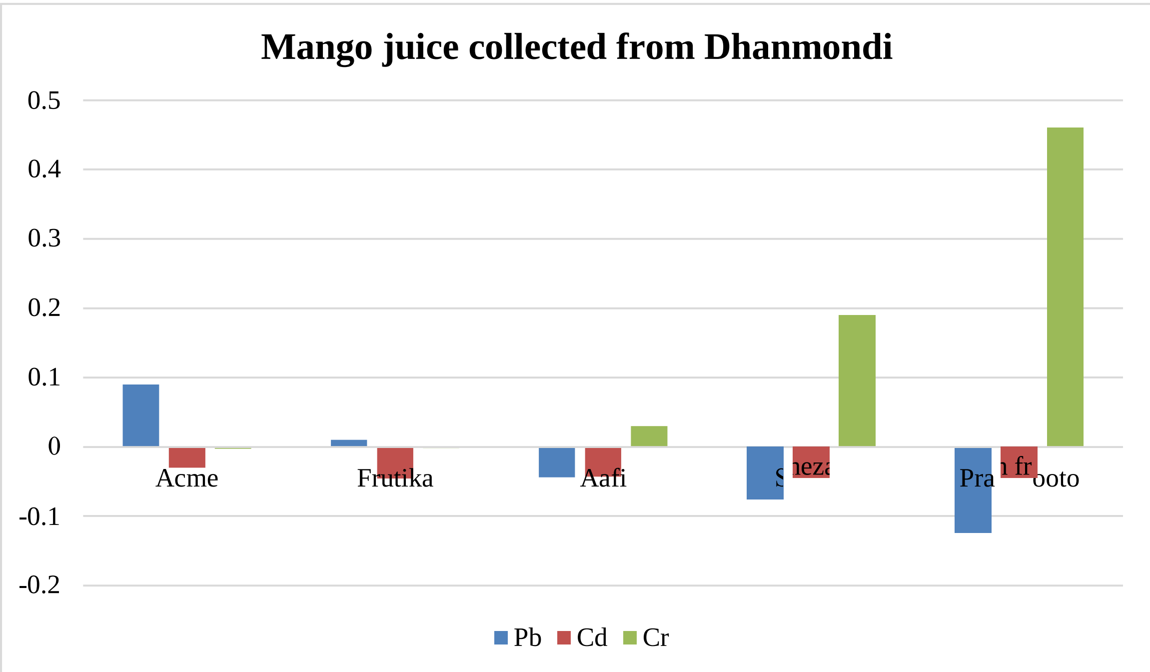


Figure 4.3: Level of lead, cadmium & chromium in mango juice collected from Dhanmondi.

From the above chart, the study got that from these samples the level of chromium was higher than lead. Because though there was presence of lead but those amount were not taken into consideration. In case of, cadmium the chart clearly showed that all the samples contained cadmium below the detection limit.

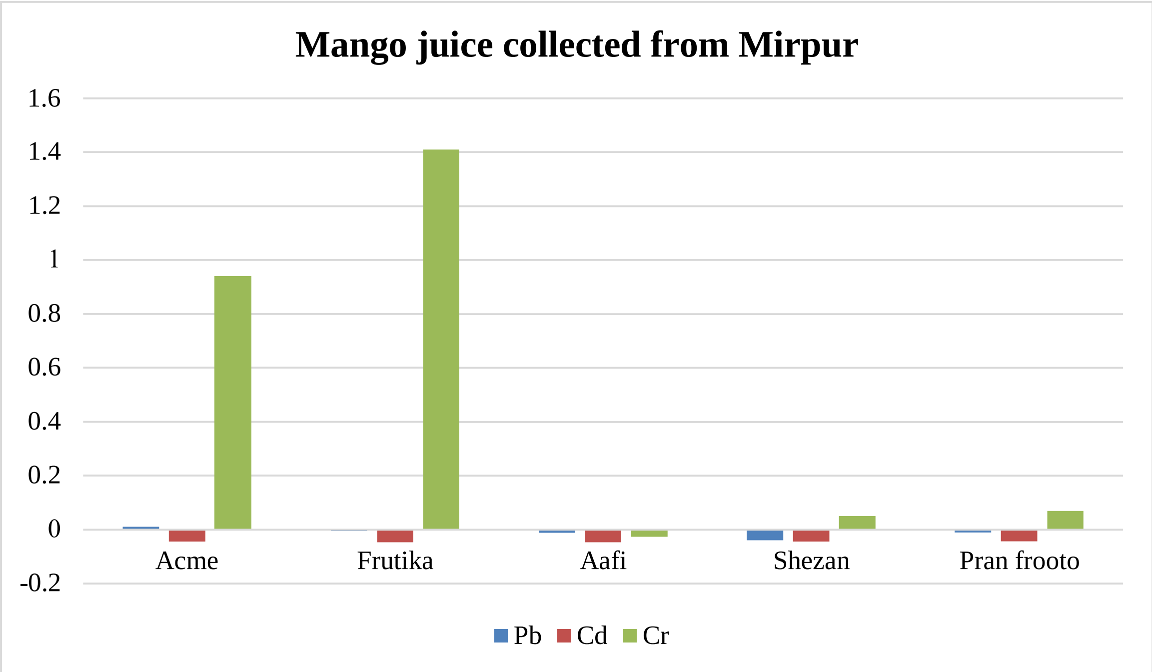


Figure 4.4: Level of lead, cadmium & chromium in mango juice collected from Mirpur.

In the matter of mango juice collected from mirpur, the level of chromium was higher than the other heavy metal i.e. lead and cadmium. But the significant news was that there were no cadmium which can be harmful because all were below the detection limit like lead.

There were so many study conducted around the world about determined the heavy metal presence in food and their health risk on People especially on children. Essa Hariri et al. (2015) did this study in Lebanon to quantify Acrylamide and metals in potato and corn chips and to determine their carcinogenic and neurotoxic risk. They used Gas Chromatography-Mass Spectrometry (GC-MS) analysis, and that revealed the average Acrylamide level in potato and corn chips (1756 µg/kg) was 3500-fold higher than the permissible limit for Acrylamide in drinking water (0.5 µg/kg).

Furthermore, in their study, energy dispersive X-ray fluorescence and thermal atomic absorption analysis revealed that the concentration of zinc, lead, and cadmium in corn chips was approximately 1.5-1.7 and 2.4-fold higher than the permissible limits set by Food and Agricultural Organization and WHO, respectively. Literature on the effects of heavy metal toxic exposure on the brain's health demonstrated that these effects can be severe. The tendency of heavy metals to bio accumulate includes mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), thallium (Tl), and lead (Pb). This means that over time, even low amounts of the chemical in an individual can have negative effects. When substances are ingested and kept in living organisms more quickly than they are decomposed (metabolized) or eliminated, compounds accumulate. Recent research demonstrated that the presence of heavy metals in the body may play a role in a variety of illnesses, including Alzheimer's and cognitive decline, behavioral issues, kidney failure, Parkinson's, epilepsy, and cardiovascular disease.

According to a report by UPI, the Food and Drug Administration claimed in a new report that during ongoing monitoring efforts, it discovered large quantities of harmful heavy metals in the U.S. food supply. In terms of lead and arsenic contamination, baby meals were among the worst. In its report, the FDA discovered lead, arsenic, and cadmium in 15%, 43%, and 61%, respectively, of dietary samples. Additionally, according to the agency's investigation, 51% of the 384 infant food samples it had gathered showed measurable levels of total arsenic. Infant cereals and foods like teething biscuits and puffed snacks have the highest arsenic concentrations.

From the report of New York State Children's Environmental Health Centers, many common baby foods and fruit juices contain trace amounts of heavy metals like lead, mercury, cadmium, and others. While these trace amounts of metals in food are probably a small portion of a child's overall exposure to metals, a child's overall exposure to metals from all sources can be harmful to their health, especially developing their brain.

The effects of lead, cadmium & chromium on health:

The health risk of consuming chromium in higher level can cause stomach problems, low blood sugar, and kidney or liver damage. On the other hand Lead exposure can have serious consequences for the health of children. At high levels of exposure lead attacks the brain and central nervous system, causing coma, convulsions and even death. Children who survive severe lead poisoning may be left with intellectual disability and behavioral disorders (WHO). In case of Cadmium, Only a small amount of cadmium remains in the body after eating food contaminated with cadmium, but if consumed over a long period of time, cadmium can lead to kidney disease and cause bones to become weaker. Large amounts of cadmium can damage the kidney, liver and heart and in severe cases may cause death.

Risk assessment of heavy metal:

Table 4.4: Single factor pollution index for lead in Potato chips for health concern

Sample No.	Sample Name	Collection Area	Lead(Pb), C_i (mg/l)	Safe Limit, S_i (mg/l), set by FDA	Single factor pollution index, P_i	Remarks
1	Alooz Chips	Dhanmondi	0.07	0.1	0.7	Safe
2	Pran Potato Cracker	Dhanmondi	BDL	0.1	BDL	Safe
3	Meridian Potato Cracker	Dhanmondi	0.11	0.1	1.1	Slightly not safe
4	Lays Chips	Dhanmondi	0.17	0.1	1.7	Slightly not safe
5	Sun chips	Dhanmondi	0.02	0.1	0.2	Safe
6	Alooz Chips	Mirpur	0.07	0.1	0.7	Safe
7	Pran Potato Cracker	Mirpur	0.01	0.1	0.1	Safe
8	Meridian Potato Cracker	Mirpur	0.07	0.1	0.7	Safe
9	Lays Chips	Mirpur	0.07	0.1	0.7	Safe
10	Sun Chips	Mirpur	0.08	0.1	0.8	Slightly not safe

Table 4.5: Single factor pollution index for Lead in mango juice for health concern

Sample No.	Sample Name	Collection Area	Lead(Pb), C_i (mg/l)	Safe Limit, S_i (mg/l), set by FDA	Single factor pollution index, P_i	Remarks
11	Acme Juice	Dhanmondi	0.09	0.1	0.9	Slightly not safe
12	Frutika	Dhanmondi	0.01	0.1	0.1	Safe
13	Aafi Mango juice	Dhanmondi	BDL	0.1	BDL	Safe
14	Shezan Mango Juice	Dhanmondi	BDL	0.1	BDL	Safe
15	Pran Frooto	Dhanmondi	BDL	0.1	BDL	Safe
16	Acme Juice	Mirpur	0.01	0.1	0.1	Safe
17	Frutika	Mirpur	BDL	0.1	BDL	Safe
18	Aafi Mango Juice	Mirpur	BDL	0.1	BDL	Safe
19	Shezan Juice	Mirpur	BDL	0.1	BDL	Safe
20	Pran frooto	Mirpur	BDL	0.1	BDL	Safe

From the above table of single factor pollution index, it showed us that from the total twenty samples, number 3 having the value 1.1 and number 4 contained the value 1.7 both were greater than 1 and it indicated that it had potential health risk threat. Also the sample 10 and 11 also reached almost the value of 1 and it could also be a threat for human health. For calculation this health risk factor, the formula for single factor pollution index was used.

Table 4.6: Single factor pollution index for Chromium in potato chips for health concern

Sample No.	Sample Name	Collection Area	Chromium (Cr), C_i (mg/l)	Safe Limit, S_i (mg/l), set by European commission for safe Food.	Single factor pollution index, P_i	Remarks
1	Alooz Chips	Dhanmondi	0.22	1	0.22	Safe
2	Pran Potato Cracker	Dhanmondi	0.50	1	0.50	Safe
3	Meridian Potato Cracker	Dhanmondi	1.05	1	1.05	Slightly not safe
4	Lays Chips	Dhanmondi	BDL	1	BDL	Safe
5	Sun chips	Dhanmondi	BDL	1	BDL	safe
6	Alooz Chips	Mirpur	0.08	1	0.08	safe
7	Pran Potato Cracker	Mirpur	0.05	1	0.05	safe
8	Meridian Potato Cracker	Mirpur	0.06	1	0.06	safe
9	Lays Chips	Mirpur	BDL	1	BDL	safe
10	Sun Chips	Mirpur	BDL	1	BDL	safe

Table 4.7: Single factor pollution index for Chromium in mango juice for health concern

Sample No.	Sample Name	Collection Area	Chromium (Cr), C_i (mg/l)	Safe Limit, S_i (mg/l), set by European commission for safe Food.	Single factor pollution index, P_i	Remarks
11	Acme Juice	Dhanmondi	BDL	1	BDL	safe
12	Frutika	Dhanmondi	BDL	1	BDL	safe
13	Aafi Mango juice	Dhanmondi	0.03	1	0.03	safe
14	Shezan Mango Juice	Dhanmondi	0.19	1	0.19	safe
15	Pran Frooto	Dhanmondi	0.46	1	0.46	Safe
16	Acme Juice	Mirpur	0.94	1	0.94	Slightly not safe
17	Frutika	Mirpur	1.41	1	1.41	Slightly not safe
18	Aafi Mango Juice	Mirpur	BDL	1	BDL	Safe
19	Shezan Juice	Mirpur	BDL	1	0.05	Safe
20	Pran frooto	Mirpur	0.03	1	0.07	Safe

In case of chromium, the single factor pollution index result clearly showed that from the total 20 samples, the sample 3 had the value of 1.05 and sample 17 had the value of 1.41, both were greater than 1 which means these samples had health risk for the consumers. There was another sample which was number 16 having the value 0.94 which was almost reached the value 1 and it also could be a threat. In this study, the other seventeen samples were not showed any threat for health. In this analysis, the maximum permissible limit of heavy metal taken from the European regulation commission

for cadmium, as all the concentration of the samples were below the detection limit so there were no potential health risk factor for consumers and as a result in this study no indexing was done for cadmium.

SUMMARY AND CONCLUSION

Conclusion:

The aforementioned information and analysis lead to the conclusion that only four samples out of the total number of samples exceeded the maximum safety limit, but that lead and chromium, which were present in significant amounts and at various concentrations, posed a significant risk to human health.

The findings of this research study, in conclusion, offer important information about the safety and nutritional value of potato chips and mango drinks sold in Bangladesh. The results can contribute to ensuring that customers have access to wholesome food selections.

Recommendations:

- ❖ The guardians should conscious about the expired date of this food products.
- ❖ They should aware about their children for the excess consumption of this food item.
- ❖ Consciousness must be need while buying this food whether it's carry any Harmful substances or not.
- ❖ The manufacturer should be aware of the production process more so that they can understand why these harmful substances present there.
- ❖ From the collection from the raw material to the final product they must ensure That their product free from harmful heavy metals as their potential customers are Children the most vulnerable age group.
- ❖ The food safety authority and others responsible organizations should conduct Strong monitoring over this issue and if found any guilty handover them to the Court.
- ❖ The media should contribute more in a making consciousness among consumers.

Limitations of the study:

Due to the COVID-19 situation, this study faced several limitations. Some of these limitations are:

Limitation in data collection: Due to strict social distancing rules and travel restrictions, it was difficult to collect sample from the field. This might limit the sample size and diversity of the study.

Impact on research design: The hazardous pandemic affected the research design, making it difficult to conduct trials or experiments that require face-to-face interactions.

Difficulty in accessing laboratories: Many laboratories and research facilities have been closed or have limited access due to the COVID-19 situation. This might limit the ability to access relevant laboratories for doing the research work.

Inability to conduct follow-up visits: It was difficult to conduct follow-up visits due to the restrictions on travel and face-to-face meetings. This might limit the ability to collect data over time and assess the long-term impact of the intervention.

Changes in the amount of targeted heavy Metal: The drastic pandemic had created a unique social and economic situation, which may impact the study results. This might limit the number of targeted heavy metals only three. On the other hand, for this situation the study opposed to lower the amount of the sample size.

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APPENDICES

Appendix I: Lead Concentration of the Collected Samples

Line	*Mean*	*SD*	*RSD[%]*	*CI*	*Unit*	*Rem.*
Rabbani-Pb-1	default(2)				*Date:*	2/5/2023 14:45
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217						
Conc.1	0.0733	0.0739	100.9	0.0295	mg/L	
Conc.2	0.0733	0.0739	100.9	0.0295	mg/L	
Abs	0.00080	0.00446	560.9			
Single values (Abs.): #1: 0.00570 #2: -0.00028 #3: -0.00303 (SEV: 479V)						

Figure: Concentration of Lead from the potato chips sample (Alooz) collected from Dhanmondi

Rabbani-Pb-2	default(2)				*Date:*	2/5/2023 14:45
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217						
Conc.1	-0.0376	0.0034	9.1	0.0311	mg/L	<KAL
Conc.2	-0.0376	0.0034	9.1	0.0311	mg/L	<KAL
Abs	-0.00590	0.00021	3.5			<KAL
Single values (Abs.): #1: -0.00603 #2: -0.00566 #3: -0.00601 (SEV: 479V)						

Figure: Concentration of Lead from the potato chips sample (pran potato) collected from Dhanmondi

Rabbani-Pb-3	default(2)				*Date:*	2/5/2023 14:46
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217						
Conc.1	0.1086	0.0089	8.2	0.0290	mg/L	
Conc.2	0.1086	0.0089	8.2	0.0290	mg/L	
Abs	0.00293	0.00054	18.3			
Single values (Abs.): #1: 0.00253 #2: 0.00271 #3: 0.00354 (SEV: 479V)						

Figure: Concentration of Lead from the potato chips sample (Meridian) collected from Dhanmondi

Rabbani-Pb-4	default(2)					Date:	2/5/2023 14:46
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0		*Blank corr.:*	off
Pb217							
Conc.1	0.0971	0.0333	34.3	0.0292	mg/L		
Conc.2	0.0971	0.0333	34.3	0.0292	mg/L		
Abs	0.00224	0.00201	89.9				
Single values (Abs.): #1: -0.00007 #2: 0.00317 #3: 0.00362 (SEV: 479V)							

Figure: Concentration of Lead from the potato chips sample (Lays) collected from Dhanmondi

Rabbani-Pb-5	default(2)					Date:	2/5/2023 14:47
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0		*Blank corr.:*	off
Pb217							
Conc.1	0.0216	0.0319	147.6	0.0302	mg/L		
Conc.2	0.0216	0.0319	147.6	0.0302	mg/L		
Abs	-0.00232	0.00193	82.9				
Single values (Abs.): #1: -0.00093 #2: -0.00452 #3: -0.00153 (SEV: 479V)							

Figure: Concentration of Lead from the potato chips sample (Sun chips) collected from Dhanmondi

Rabbani-Pb-6	default(2)					Date:	2/5/2023 14:48
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0		*Blank corr.:*	off
Pb217							
Conc.1	0.0746	0.0304	40.7	0.0295	mg/L		
Conc.2	0.0746	0.0304	40.7	0.0295	mg/L		
Abs	0.00088	0.00183	208.6				
Single values (Abs.): #1: 0.00058 #2: -0.00079 #3: 0.00285 (SEV: 479V)							

Figure: Concentration of Lead from the potato chips sample (Alooz) collected from Mirpur

Rabbani-Pb-7	default(2)			Date:	2/5/2023 14:48
Pre-DF: 1	*Wt.[g]:*	*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217					
Conc.1	0.0982	0.0063	6.4	0.0292	mg/L
Conc.2	0.0982	0.0063	6.4	0.0292	mg/L
Abs	0.00230	0.00038	16.5		

Single values (Abs.): #1: 0.00199 #2: 0.00219 #3: 0.00272 (SEV: 479V)

Figure: Concentration of Lead from the potato chips sample (Pran potato) collected from Mirpur

Rabbani-Pb-8	default(2)			Date:	2/5/2023 14:49
Pre-DF: 1	*Wt.[g]:*	*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217					
Conc.1	0.0665	0.0202	30.4	0.0296	mg/L
Conc.2	0.0665	0.0202	30.4	0.0296	mg/L
Abs	0.00039	0.00122	314.0		

Single values (Abs.): #1: -0.00098 #2: 0.00138 #3: 0.00077 (SEV: 479V)

Figure: Concentration of Lead from the potato chips sample (Meridian) collected from Mirpur

Rabbani-Pb-9	default(2)			Date:	2/5/2023 14:49
Pre-DF: 1	*Wt.[g]:*	*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217					
Conc.1	0.0709	0.0192	27.1	0.0295	mg/L
Conc.2	0.0709	0.0192	27.1	0.0295	mg/L
Abs	0.00065	0.00116	178.0		

Single values (Abs.): #1: 0.00191 #2: -0.00038 #3: 0.00043 (SEV: 479V)

Figure: Concentration of Lead from the potato chips sample (Lays) collected from Mirpur

Rabbani-Pb-10	default(2)			Date:	2/5/2023 14:50
Pre-DF: 1	*Wt.[g]:*	*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217					
Conc.1	0.0836	0.0145	17.4	0.0293	mg/L
Conc.2	0.0836	0.0145	17.4	0.0293	mg/L
Abs	0.00142	0.00088	61.8		

Single values (Abs.): #1: 0.00085 #2: 0.00243 #3: 0.00097 (SEV: 479V)

Figure: Concentration of Lead from the potato chips sample (Sun chips) collected from Mirpur

Rabbani-Pb-11	default(2)			Date:	2/5/2023 14:51
Pre-DF: 1	*Wt.[g]:*	*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217					
Conc.1	0.0922	0.0530	57.5	0.0292	mg/L
Conc.2	0.0922	0.0530	57.5	0.0292	mg/L
Abs	0.00194	0.00320	164.8		

Single values (Abs.): #1: 0.00555 #2: -0.00055 #3: 0.00083 (SEV: 479V)

Figure: Concentration of Lead from the mango juice sample (Acme) collected from Dhanmondi

Rabbani-Pb-12	default(2)			Date:	2/5/2023 14:52
Pre-DF: 1	*Wt.[g]:*	*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217					
Conc.1	0.0145	0.0080	55.4	0.0303	mg/L
Conc.2	0.0145	0.0080	55.4	0.0303	mg/L
Abs	-0.00275	0.00048	17.6		

Single values (Abs.): #1: -0.00282 #2: -0.00320 #3: -0.00224 (SEV: 479V)

Figure: Concentration of Lead from the mango juice sample (Frutika) collected from Dhanmondi

Rabbani-Pb-13	default(2)			Date:		2/5/2023 14:52
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217						
Conc.1	-0.0445	0.0130	29.1	0.0312	mg/L	<KAL
Conc.2	-0.0445	0.0130	29.1	0.0312	mg/L	<KAL
Abs	-0.00631	0.00078	12.4			<KAL

Single values (Abs.): #1: -0.00640 #2: -0.00549 #3: -0.00705 (SEV: 479V)

Figure: Concentration of Lead from the mango juice sample (Aafi) collected from Dhanmondi

Rabbani-Pb-14	default(2)			Date:		2/5/2023 14:53
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217						
Conc.1	-0.0767	0.0119	15.5	0.0316	mg/L	<KAL
Conc.2	-0.0767	0.0119	15.5	0.0316	mg/L	<KAL
Abs	-0.00826	0.00072	8.7			<KAL

Single values (Abs.): #1: -0.00902 #2: -0.00759 #3: -0.00818 (SEV: 479V)

Figure: Concentration of Lead from the mango juice sample (Shezan) collected from Dhanmondi

Rabbani-Pb-15	default(2)			Date:		2/5/2023 14:53
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217						
Conc.1	-0.1243	0.0209	16.8	0.0324	mg/L	<KAL
Conc.2	-0.1243	0.0209	16.8	0.0324	mg/L	<KAL
Abs	-0.01113	0.00126	11.4			<KAL

Single values (Abs.): #1: -0.01258 #2: -0.01026 #3: -0.01056 (SEV: 479V)

Figure: Concentration of Lead from the mango juice sample (Pran frooto) collected from Dhanmondi

Rabbani-Pb-16	default(2)				*Date:*	2/5/2023 14:54
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217						
Conc.1	0.0046	0.0085	184.8	0.0304	mg/L	
Conc.2	0.0046	0.0085	184.8	0.0304	mg/L	
Abs	-0.00335	0.00051	15.4			

Single values (Abs.): #1: -0.00308 #2: -0.00394 #3: -0.00303 (SEV: 479V)

Figure: Concentration of Lead from the mango juice sample (Acme) collected from Mirpur

Rabbani-Pb-17	default(2)				*Date:*	2/5/2023 14:54
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217						
Conc.1	-0.0054	0.0273	504.7	0.0306	mg/L	<KAL
Conc.2	-0.0054	0.0273	504.7	0.0306	mg/L	<KAL
Abs	-0.00396	0.00165	41.7			<KAL

Single values (Abs.): #1: -0.00579 #2: -0.00260 #3: -0.00347 (SEV: 479V)

Figure: Concentration of Lead from the mango juice sample (Frutika) collected from Mirpur

Rabbani-Pb-18	default(2)				*Date:*	2/5/2023 14:55
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217						
Conc.1	-0.0131	0.0153	116.7	0.0307	mg/L	<KAL
Conc.2	-0.0131	0.0153	116.7	0.0307	mg/L	<KAL
Abs	-0.00442	0.00092	20.9			<KAL

Single values (Abs.): #1: -0.00351 #2: -0.00439 #3: -0.00535 (SEV: 479V)

Figure: Concentration of Lead from the mango juice sample (Aafi) collected from Mirpur

Rabbani-Pb-19	default(2)			Date:		2/5/2023 14:55
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217						
Conc.1	-0.0402	0.0215	53.4	0.0311	mg/L	<KAL
Conc.2	-0.0402	0.0215	53.4	0.0311	mg/L	<KAL
Abs	-0.00605	0.00130	21.4			<KAL
Single values (Abs.): #1: -0.00687 #2: -0.00673 #3: -0.00456 (SEV: 479V)						

Figure: Concentration of Lead from the mango juice sample (Shezan) collected from Mirpur

Rabbani-Pb-20	default(2)			Date:		2/5/2023 14:56
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Pb217						
Conc.1	-0.0118	0.0069	58.5	0.0307	mg/L	<KAL
Conc.2	-0.0118	0.0069	58.5	0.0307	mg/L	<KAL
Abs	-0.00434	0.00042	9.6			<KAL
Single values (Abs.): #1: -0.00415 #2: -0.00482 #3: -0.00405 (SEV: 479V)						

Figure: Concentration of Lead from the mango juice sample (Pran frooto) collected from Mirpur

Appendix II: Cadmium concentration of the collected samples

Line	Mean	SD	RSD[%]	CI	Unit	Rem.
Rabbani-Cd-1	default(1)				Date:	2/14/2023 16:18
Pre-DF: 1	Wt.[g]:		Vol.[mL]: 100	AS-DF: 1.0	Blank corr.:	off
Cd228						
Conc.1	-0.0357	0.0099	27.7	0.1812	mg/L	<KAL
Conc.2	-0.0357	0.0099	27.7	0.1812	mg/L	<KAL
Abs	0.01350	0.00316	23.4			<KAL
Single values (Abs.): #1: 0.01695 #2: 0.01281 #3: 0.01074 (SEV: 393V)						

Figure: Concentration of Cadmium from the potato chips sample (Alooz) collected from Dhanmondi

Rabbani-Cd-2	default(1)				Date:	2/14/2023 16:18
Pre-DF: 1	Wt.[g]:		Vol.[mL]: 100	AS-DF: 1.0	Blank corr.:	off
Cd228						
Conc.1	-0.0519	0.0005	1.0	0.1826	mg/L	<KAL
Conc.2	-0.0519	0.0005	1.0	0.1826	mg/L	<KAL
Abs	0.00834	0.00017	2.1			<KAL
Single values (Abs.): #1: 0.00816 #2: 0.00835 #3: 0.00850 (SEV: 393V)						

Figure: Concentration of Cadmium from the potato chips sample (pran potato) collected from Dhanmondi

Rabbani-Cd-3	default(1)				Date:	2/14/2023 16:19
Pre-DF: 1	Wt.[g]:		Vol.[mL]: 100	AS-DF: 1.0	Blank corr.:	off
Cd228						
Conc.1	-0.0502	0.0027	5.5	0.1825	mg/L	<KAL
Conc.2	-0.0502	0.0027	5.5	0.1825	mg/L	<KAL
Abs	0.00887	0.00088	9.9			<KAL
Single values (Abs.): #1: 0.00791 #2: 0.00908 #3: 0.00963 (SEV: 393V)						

Figure: Concentration of Cadmium from the potato chips sample (Meridian) collected from Dhanmondi

Rabbani-Cd-4	default(1)					Date:	2/14/2023 16:19
Pre-DF: 1	Wt.[g]:		Vol.[mL]: 100	AS-DF: 1.0		Blank corr.:	off
Cd228							
Conc.1	-0.0501	0.0017	3.5	0.1825	mg/L	<KAL	
Conc.2	-0.0501	0.0017	3.5	0.1825	mg/L	<KAL	
Abs	0.00889	0.00056	6.2			<KAL	

Single values (Abs.): #1: 0.00829 #2: 0.00939 #3: 0.00900 (SEV: 393V)

Figure: Concentration of Cadmium from the potato chips sample (Lays) collected from Dhanmondi

Rabbani-Cd-5	default(1)					Date:	2/14/2023 16:20
Pre-DF: 1	Wt.[g]:		Vol.[mL]: 100	AS-DF: 1.0		Blank corr.:	off
Cd228							
Conc.1	-0.0497	0.0010	1.9	0.1824	mg/L	<KAL	
Conc.2	-0.0497	0.0010	1.9	0.1824	mg/L	<KAL	
Abs	0.00903	0.00030	3.4			<KAL	

Single values (Abs.): #1: 0.00868 #2: 0.00921 #3: 0.00919 (SEV: 393V)

Figure: Concentration of Cadmium from the potato chips sample (Sun chips) collected from Dhanmondi

Rabbani-Cd-6	default(1)					Date:	2/14/2023 16:21
Pre-DF: 1	Wt.[g]:		Vol.[mL]: 100	AS-DF: 1.0		Blank corr.:	off
Cd228							
Conc.1	-0.0499	0.0020	3.9	0.1825	mg/L	<KAL	
Conc.2	-0.0499	0.0020	3.9	0.1825	mg/L	<KAL	
Abs	0.00896	0.00063	7.0			<KAL	

Single values (Abs.): #1: 0.00968 #2: 0.00850 #3: 0.00871 (SEV: 393V)

Figure: Concentration of Cadmium from the potato chips sample (Alooz) collected from Mirpur

Rabbani-Cd-7	default(1)				Date:		2/14/2023 16:21
Pre-DF: 1	Wt.[g]:		Vol.[mL]: 100	AS-DF: 1.0	Blank corr.:		off
Cd228							
Conc.1	-0.0499	0.0009	1.8	0.1825	mg/L	<KAL	
Conc.2	-0.0499	0.0009	1.8	0.1825	mg/L	<KAL	
Abs	0.00898	0.00029	3.2			<KAL	

Single values (Abs.): #1: 0.00866 #2: 0.00906 #3: 0.00923 (SEV: 393V)

Figure: Concentration of Cadmium from the potato chips sample (Pran potato) collected from Mirpur

Rabbani-Cd-8	default(1)				Date:		2/14/2023 16:22
Pre-DF: 1	Wt.[g]:		Vol.[mL]: 100	AS-DF: 1.0	Blank corr.:		off
Cd228							
Conc.1	-0.0498	0.0008	1.7	0.1824	mg/L	<KAL	
Conc.2	-0.0498	0.0008	1.7	0.1824	mg/L	<KAL	
Abs	0.00901	0.00026	2.9			<KAL	

Single values (Abs.): #1: 0.00888 #2: 0.00931 #3: 0.00883 (SEV: 393V)

Figure: Concentration of Cadmium from the potato chips sample (Meridian) collected from Mirpur

Rabbani-Cd-9	default(1)				Date:		2/14/2023 16:22
Pre-DF: 1	Wt.[g]:		Vol.[mL]: 100	AS-DF: 1.0	Blank corr.:		off
Cd228							
Conc.1	-0.0499	0.0007	1.3	0.1825	mg/L	<KAL	
Conc.2	-0.0499	0.0007	1.3	0.1825	mg/L	<KAL	
Abs	0.00898	0.00021	2.3			<KAL	

Single values (Abs.): #1: 0.00920 #2: 0.00894 #3: 0.00879 (SEV: 393V)

Figure: Concentration of Cadmium from the potato chips sample (Lays) collected from Mirpur

Rabbani-Cd-10	default(1)			Date:		2/14/2023 16:23
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cd228						
Conc.1	-0.0482	0.0005	1.1	0.1823	mg/L	<KAL
Conc.2	-0.0482	0.0005	1.1	0.1823	mg/L	<KAL
Abs	0.00951	0.00016	1.7			<KAL

Single values (Abs.): #1: 0.00962 #2: 0.00933 #3: 0.00959 (SEV: 393V)

Figure: Concentration of Cadmium from the potato chips sample (Sun chips) collected from Mirpur

Rabbani-Cd-11	default(1)			Date:		2/14/2023 16:24
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cd228						
Conc.1	-0.0302	0.0106	35.0	0.1807	mg/L	<KAL
Conc.2	-0.0302	0.0106	35.0	0.1807	mg/L	<KAL
Abs	0.01526	0.00338	22.1			<KAL

Single values (Abs.): #1: 0.01909 #2: 0.01398 #3: 0.01272 (SEV: 393V)

Figure: Concentration of Cadmium from the mango juice sample (Acme) collected from Dhanmondi

Rabbani-Cd-12	default(1)			Date:		2/14/2023 16:25
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cd228						
Conc.1	-0.0466	0.0015	3.2	0.1822	mg/L	<KAL
Conc.2	-0.0466	0.0015	3.2	0.1822	mg/L	<KAL
Abs	0.01001	0.00048	4.8			<KAL

Single values (Abs.): #1: 0.01037 #2: 0.01020 #3: 0.00946 (SEV: 393V)

Figure: Concentration of Cadmium from the mango juice sample (Frutika) collected from Dhanmondi

Rabbani-Cd-13	default(1)					Date:	2/14/2023 16:25
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0		*Blank corr.:*	off
Cd228							
Conc.1	-0.0436	0.0012	2.7	0.1819	mg/L	<KAL	
Conc.2	-0.0436	0.0012	2.7	0.1819	mg/L	<KAL	
Abs	0.01097	0.00037	3.4			<KAL	

Single values (Abs.): #1: 0.01059 #2: 0.01133 #3: 0.01098 (SEV: 393V)

Figure: Concentration of Cadmium from the mango juice sample (Aafi) collected from Dhanmondi

Rabbani-Cd-14	default(1)					Date:	2/14/2023 16:26
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0		*Blank corr.:*	off
Cd228							
Conc.1	-0.0457	0.0024	5.2	0.1821	mg/L	<KAL	
Conc.2	-0.0457	0.0024	5.2	0.1821	mg/L	<KAL	
Abs	0.01031	0.00076	7.4			<KAL	

Single values (Abs.): #1: 0.00943 #2: 0.01066 #3: 0.01083 (SEV: 393V)

Figure: Concentration of Cadmium from the mango juice sample (Shezan) collected from Dhanmondi

Rabbani-Cd-15	default(1)					Date:	2/14/2023 16:26
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0		*Blank corr.:*	off
Cd228							
Conc.1	-0.0451	0.0009	2.0	0.1820	mg/L	<KAL	
Conc.2	-0.0451	0.0009	2.0	0.1820	mg/L	<KAL	
Abs	0.01051	0.00029	2.8			<KAL	

Single values (Abs.): #1: 0.01018 #2: 0.01069 #3: 0.01066 (SEV: 393V)

Figure: Concentration of Cadmium from the mango juice sample (Pran frooto) collected from Dhanmondi

Rabbani-Cd-16	default(1)				Date:	2/14/2023 16:27
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cd228						
Conc.1	-0.0440	0.0014	3.2	0.1819	mg/L	<KAL
Conc.2	-0.0440	0.0014	3.2	0.1819	mg/L	<KAL
Abs	0.01087	0.00045	4.1			<KAL

Single values (Abs.): #1: 0.01107 #2: 0.01118 #3: 0.01035 (SEV: 393V)

Figure: Concentration of Cadmium from the mango juice sample (Acme) collected from Mirpur

Rabbani-Cd-17	default(1)				Date:	2/14/2023 16:27
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cd228						
Conc.1	-0.0470	0.0010	2.0	0.1822	mg/L	<KAL
Conc.2	-0.0470	0.0010	2.0	0.1822	mg/L	<KAL
Abs	0.00989	0.00031	3.1			<KAL

Single values (Abs.): #1: 0.00956 #2: 0.00994 #3: 0.01017 (SEV: 393V)

Figure: Concentration of Cadmium from the mango juice sample (Frutika) collected from Mirpur

Rabbani-Cd-18	default(1)				Date:	2/14/2023 16:28
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cd228						
Conc.1	-0.0477	0.0002	0.4	0.1823	mg/L	<KAL
Conc.2	-0.0477	0.0002	0.4	0.1823	mg/L	<KAL
Abs	0.00967	0.00006	0.6			<KAL

Single values (Abs.): #1: 0.00960 #2: 0.00969 #3: 0.00972 (SEV: 393V)

Figure: Concentration of Cadmium from the mango juice sample (Frutika) collected from Mirpur

Rabbani-Cd-19	default(1)					Date:	2/14/2023 16:28
Pre-DF: 1	Wt.[g]:		Vol.[mL]: 100	AS-DF: 1.0		Blank corr.:	off
Cd228							
Conc.1	-0.0443	0.0004	1.0	0.1820	mg/L	<KAL	
Conc.2	-0.0443	0.0004	1.0	0.1820	mg/L	<KAL	
Abs	0.01075	0.00014	1.3			<KAL	
Single values (Abs.): #1: 0.01063 #2: 0.01090 #3: 0.01073 (SEV: 393V)							

Figure: Concentration of Cadmium from the mango juice sample (Shezan) collected from Mirpur

Rabbani-Cd-20	default(1)					Date:	2/14/2023 16:29
Pre-DF: 1	Wt.[g]:		Vol.[mL]: 100	AS-DF: 1.0		Blank corr.:	off
Cd228							
Conc.1	-0.0436	0.0007	1.6	0.1819	mg/L	<KAL	
Conc.2	-0.0436	0.0007	1.6	0.1819	mg/L	<KAL	
Abs	0.01097	0.00023	2.1			<KAL	
Single values (Abs.): #1: 0.01121 #2: 0.01095 #3: 0.01075 (SEV: 393V)							

Figure: Concentration of Cadmium from the mango juice sample (Pran frooto) collected from Mirpur

Appendix III: Chromium concentration of the collected samples

Rabbani-Cr-1	default(1)			Date:	2/5/2023 17:31
Pre-DF: 1	Wt.[g]:	Vol.[mL]: 100	AS-DF: 1.0	Blank corr.:	off
Cr357					
Conc.1	0.2197	0.0313	14.2	0.0898	mg/L
Conc.2	0.2197	0.0313	14.2	0.0898	mg/L
Abs	0.03323	0.00310	9.3		

Single values (Abs.): #1: 0.03113 #2: 0.03176 #3: 0.03679 (SEV: 422V)

Figure: Concentration of Chromium from the potato chips sample (Alooz) collected from Dhanmondi

Line	Mean	SD	RSD[%]	CI	Unit	Rem.
Rabbani-Cr-2	default(1)			Date:	2/5/2023 17:32	
Pre-DF: 1	Wt.[g]:	Vol.[mL]: 100	AS-DF: 1.0	Blank corr.:	off	
Cr357						
Conc.1	0.5023	0.0706	14.1	0.0823	mg/L	
Conc.2	0.5023	0.0706	14.1	0.0823	mg/L	
Abs	0.06124	0.00700	11.4			

Single values (Abs.): #1: 0.05495 #2: 0.06001 #3: 0.06877 (SEV: 422V)

Figure: Concentration of Chromium from the potato chips sample (Pran potato) collected from Dhanmondi

Rabbani-Cr-3	default(1)			Date:	2/5/2023 17:32
Pre-DF: 1	Wt.[g]:	Vol.[mL]: 100	AS-DF: 1.0	Blank corr.:	off
Cr357					
Conc.1	1.045	0.1218	11.7	0.0847	mg/L
Conc.2	1.045	0.1218	11.7	0.0847	mg/L
Abs	0.11501	0.01207	10.5		

Single values (Abs.): #1: 0.10389 #2: 0.11328 #3: 0.12785 (SEV: 422V)

Figure: Concentration of Chromium from the potato chips sample (Meridian) collected from Dhanmondi

Rabbani-Cr-4	default(1)			Date:		2/5/2023 17:33
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cr357						
Conc.1	-0.0076	0.0681	895.9	0.0992	mg/L	<KAL
Conc.2	-0.0076	0.0681	895.9	0.0992	mg/L	<KAL
Abs	0.01070	0.00675	63.1			<KAL

Single values (Abs.): #1: 0.01849 #2: 0.00664 #3: 0.00697 (SEV: 422V)

Figure: Concentration of Chromium from the potato chips sample (Lays) collected from Dhanmondi

Line	***Mean***	***SD***	***RSD[%]***	***CI***	***Unit***	***Rem.***
Rabbani-Cr-5	default(1)			Date:		2/5/2023 17:33
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cr357						
Conc.1	-0.0150	0.0206	137.3	0.0996	mg/L	<KAL
Conc.2	-0.0150	0.0206	137.3	0.0996	mg/L	<KAL
Abs	0.00996	0.00204	20.5			<KAL

Single values (Abs.): #1: 0.00796 #2: 0.00989 #3: 0.01204 (SEV: 422V)

Figure: Concentration of Chromium from the potato chips sample (Sun chips) collected from Dhanmondi

Rabbani-Cr-6	default(1)			Date:		2/5/2023 17:34
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cr357						
Conc.1	0.0832	0.0325	39.0	0.0951	mg/L	
Conc.2	0.0832	0.0325	39.0	0.0951	mg/L	
Abs	0.01970	0.00322	16.3			

Single values (Abs.): #1: 0.01740 #2: 0.02338 #3: 0.01832 (SEV: 422V)

Figure: Concentration of Chromium from the potato chips sample (Alooz) collected from Mirpur

Rabbani-Cr-7	default(1)			Date:	2/5/2023 17:34
Pre-DF: 1	Wt.[g]:	Vol.[mL]: 100	AS-DF: 1.0	Blank corr.:	off
Cr357					
Conc.1	0.0545	0.0141	25.8	0.0964	mg/L
Conc.2	0.0545	0.0141	25.8	0.0964	mg/L
Abs	0.01686	0.00139	8.3		

Single values (Abs.): #1: 0.01834 #2: 0.01557 #3: 0.01666 (SEV: 422V)

Figure: Concentration of Chromium from the potato chips sample (pran potato) collected from Mirpur

Rabbani-Cr-8	default(1)			Date:	2/5/2023 17:35
Pre-DF: 1	Wt.[g]:	Vol.[mL]: 100	AS-DF: 1.0	Blank corr.:	off
Cr357					
Conc.1	0.0606	0.0139	22.9	0.0961	mg/L
Conc.2	0.0606	0.0139	22.9	0.0961	mg/L
Abs	0.01746	0.00138	7.9		

Single values (Abs.): #1: 0.01721 #2: 0.01894 #3: 0.01622 (SEV: 422V)

Figure: Concentration of Chromium from the potato chips sample (Meridian) collected from Mirpur

Rabbani-Cr-9	default(1)			Date:	2/5/2023 17:36	
Pre-DF: 1	Wt.[g]:	Vol.[mL]: 100	AS-DF: 1.0	Blank corr.:	off	
Cr357						
Conc.1	-0.0639	0.0369	57.8	0.1019	mg/L	<KAL
Conc.2	-0.0639	0.0369	57.8	0.1019	mg/L	<KAL
Abs	0.00512	0.00366	71.5			<KAL

Single values (Abs.): #1: 0.00934 #2: 0.00304 #3: 0.00297 (SEV: 422V)

Figure: Concentration of Chromium from the potato chips sample (Lays) collected from Mirpur

Rabbani-Cr-10	default(1)			*Date:*		2/5/2023 17:36
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cr357						
Conc.1	-0.0512	0.0340	66.4	0.1013	mg/L	<KAL
Conc.2	-0.0512	0.0340	66.4	0.1013	mg/L	<KAL
Abs	0.00637	0.00337	52.9			<KAL
Single values (Abs.): #1: 0.00541 #2: 0.00359 #3: 0.01012 (SEV: 422V)						

Figure: Concentration of Chromium from the potato chips sample (Sun chips) collected from Mirpur

Rabbani-Cr-11	default(1)			*Date:*		2/5/2023 17:37
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cr357						
Conc.1	-0.0037	0.0298	800.2	0.0990	mg/L	<KAL
Conc.2	-0.0037	0.0298	800.2	0.0990	mg/L	<KAL
Abs	0.01108	0.00296	26.7			<KAL
Single values (Abs.): #1: 0.00795 #2: 0.01382 #3: 0.01148 (SEV: 422V)						

Figure: Concentration of Chromium from the mango juice sample (Acme) collected from Dhanmondi

Rabbani-Cr-12	default(1)			*Date:*		2/5/2023 17:37
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cr357						
Conc.1	-0.0029	0.0181	628.7	0.0990	mg/L	<KAL
Conc.2	-0.0029	0.0181	628.7	0.0990	mg/L	<KAL
Abs	0.01117	0.00179	16.0			<KAL
Single values (Abs.): #1: 0.00995 #2: 0.01322 #3: 0.01033 (SEV: 422V)						

Figure: Concentration of Chromium from the mango juice sample (Frutika) collected from Dhanmondi

Rabbani-Cr-13	default(1)				Date:	2/5/2023 17:38
Pre-DF: 1	Wt.[g]:		Vol.[mL]: 100	AS-DF: 1.0	Blank corr.:	off
Cr357						
Conc.1	0.0306	0.0012	4.0	0.0975	mg/L	
Conc.2	0.0306	0.0012	4.0	0.0975	mg/L	
Abs	0.01449	0.00012	0.8			

Single values (Abs.): #1: 0.01463 #2: 0.01444 #3: 0.01440 (SEV: 422V)

Figure: Concentration of Chromium from the mango juice sample (Aafi) collected from Dhanmondi

Rabbani-Cr-14	default(1)				Date:	2/5/2023 17:38
Pre-DF: 1	Wt.[g]:		Vol.[mL]: 100	AS-DF: 1.0	Blank corr.:	off
Cr357						
Conc.1	0.1941	0.0321	16.5	0.0907	mg/L	
Conc.2	0.1941	0.0321	16.5	0.0907	mg/L	
Abs	0.03069	0.00318	10.4			

Single values (Abs.): #1: 0.02704 #2: 0.03216 #3: 0.03287 (SEV: 422V)

Figure: Concentration of Chromium from the mango juice sample (Shezan) collected from Dhanmondi

Rabbani-Cr-15	default(1)				Date:	2/5/2023 17:39
Pre-DF: 1	Wt.[g]:		Vol.[mL]: 100	AS-DF: 1.0	Blank corr.:	off
Cr357						
Conc.1	0.4591	0.0692	15.1	0.0830	mg/L	
Conc.2	0.4591	0.0692	15.1	0.0830	mg/L	
Abs	0.05696	0.00686	12.0			

Single values (Abs.): #1: 0.05007 #2: 0.05702 #3: 0.06380 (SEV: 422V)

Figure: Concentration of Chromium from the mango juice sample (pran frooto) collected from Dhanmondi

Rabbani-Cr-16	default(1)				Date:	2/5/2023 17:39
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cr357						
Conc.1	0.9447	0.1117	11.8	0.0826	mg/L	
Conc.2	0.9447	0.1117	11.8	0.0826	mg/L	
Abs	0.10510	0.01108	10.5			

Single values (Abs.): #1: 0.09687 #2: 0.10073 #3: 0.11769 (SEV: 422V)

Figure: Concentration of Chromium from the mango juice sample (Acme) collected from Mirpur

Rabbani-Cr-17	default(1)				Date:	2/5/2023 17:40
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cr357						
Conc.1	1.413	0.1548	11.0	0.0981	mg/L	
Conc.2	1.413	0.1548	11.0	0.0981	mg/L	
Abs	0.15149	0.01535	10.1			

Single values (Abs.): #1: 0.14971 #2: 0.16765 #3: 0.13711 (SEV: 422V)

Figure: Concentration of Chromium from the mango juice sample (Frutika) collected from Mirpur

Rabbani-Cr-18	default(1)				Date:	2/5/2023 17:41
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cr357						
Conc.1	-0.0271	0.0220	81.2	0.1002	mg/L	<KAL
Conc.2	-0.0271	0.0220	81.2	0.1002	mg/L	<KAL
Abs	0.00876	0.00218	24.9			<KAL

Single values (Abs.): #1: 0.01034 #2: 0.00968 #3: 0.00627 (SEV: 422V)

Figure: Concentration of Chromium from the mango juice sample (Aafi) collected from Mirpur

Rabbani-Cr-19	default(1)				Date:	2/5/2023 17:41
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cr357						
Conc.1	0.0461	0.0293	63.6	0.0968	mg/L	
Conc.2	0.0461	0.0293	63.6	0.0968	mg/L	
Abs	0.01602	0.00291	18.1			
Single values (Abs.): #1: 0.01728 #2: 0.01809 #3: 0.01270 (SEV: 422V)						

Figure: Concentration of Chromium from the mango juice sample (Shezan) collected from Mirpur

Rabbani-Cr-20	default(1)				Date:	2/5/2023 17:42
Pre-DF: 1	*Wt.[g]:*		*Vol.[mL]:* 100	*AS-DF:* 1.0	*Blank corr.:*	off
Cr357						
Conc.1	0.0765	0.0034	4.5	0.0954	mg/L	
Conc.2	0.0765	0.0034	4.5	0.0954	mg/L	
Abs	0.01904	0.00034	1.8			
Single values (Abs.): #1: 0.01869 #2: 0.01906 #3: 0.01937 (SEV: 422V)						

Figure: Concentration of Chromium from the mango juice sample (Pran frooto) collected from Mirpur