

# **EVALUATION OF SOME HEAVY METALS CONCENTRATION IN CANDIES**

Submitted in partial fulfilment of the requirements  
for the award of Bachelor of Science  
degree in Chemistry

By

**S.ARCHANA [38030004]**

**M.SNEGA [38030015]**



**DEPARTMENT OF CHEMISTRY  
SCHOOL OF SCIENCE AND HUMANITIES**

## **SATHYABAMA**

**INSTITUTE OF SCIENCE AND TECHNOLOGY  
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A" by NAAC**

**JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119**

**March - 2021**



# SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY  
(DEEMED TO BE UNIVERSITY)

Accredited with "A" grade by NAAC  
Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600 119  
[www.sathyabama.ac.in](http://www.sathyabama.ac.in)

---



## DEPARTMENT OF CHEMISTRY

### BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **S.ARCHANA (38030004)** and **M.SNEGA (38030015)** who carried out the project entitled **"EVALUATION OF SOME HEAVY METALS CONCENTRATION IN CANDIES"** under my supervision from December 2020 to April 2021.

#### Internal Guide

Mr. C.ILANTHAMIZHAN M.Phil, Ph.d.,

#### Head of the Department

Dr. J. KARTHIKEYAN Ph.D.,

---

Submitted for Viva voce Examination held on \_\_\_\_\_

INTERNAL EXAMINER

EXTERNAL EXAMINER

## **DECLARATION**

We **S.ARCHANA (38030004)** and **M.SNEGA (38030015)**, hereby declare that the Project Report entitled “**EVALUATION OF SOME HEAVY METALS CONCENTRATION IN CANDIES**” done by us under the guidance of **MR.C.ILANTHAMIZHAN** Assistant professor, Department of Chemistry, Sathyabama Institute of Science and Technology is submitted in partial fulfilment of the requirements for the award of Bachelor of Science degree in Chemistry.

**DATE:**

**PLACE:**

**S.ARCHANA**

**M.SNEGA**

## ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of SATHYABAMA for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr.M.Sundareswari**, Dean, School of Science and Humanities and **Dr.J.Karthikeyan**, Head of the Department, Department of Chemistry for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide, **Mr.C.ILANTHAMIZHAN** for his valuable guidance, suggestions and constant encouragement which paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the Department of Chemistry who were helpful in many ways for the completion of the project.

I take this opportunity to thank my family members and friends for their constant encouragement without which this assignment would not be possible.

**S.ARCHAHA**

**M.SNEGA**

## **ABSTRACT**

Through the consumption of candies and chocolate, children are exposed to acute toxicity. Zn, Pb, Ni, and Cd concentrations were found to be  $2.5 \pm 2.49$ ,  $2.0 \pm 1.20$ ,  $0.84 \pm 1.35$ , and  $0.17 \pm 0.22$   $\mu\text{g/g}$  range respectively. The daily metal consumption of children who ate candies and chocolates was also measured, and the results showed that Pb and Zn had the highest intake, followed by Ni, Cd, and Cu.

Atomic absorption spectroscopy was used to assess the concentrations of toxic metals under analysis. So we took a specific candy off the shelf and checked it for AAS. AAS was used to test representative candies for selected heavy metals. The results show that the selected candy does not contain the heavy metals that we tested in AAS. So the chosen sample is safe to eat, but certain chocolates contain traces of heavy metals. As a result, excessive chocolate consumption will undoubtedly have harmed you.

## TABLES OF CONTENTS

| CHAPTER NO. | TITLE                                     | PAGE NO.    |
|-------------|-------------------------------------------|-------------|
|             | <b>ABSTRACT</b>                           | <b>v</b>    |
|             | <b>LIST OF TABLES</b>                     | <b>viii</b> |
|             | <b>LIST OF FIGURES</b>                    | <b>ix</b>   |
| <b>1</b>    | <b>INTRODUCTION</b>                       | <b>1</b>    |
|             | 1.1 BACKGROUND OF THE STUDY               | 1           |
|             | 1.2 HYPOTHESIS                            | 2           |
|             | 1.3 HEAVY METALS                          | 2           |
|             | 1.4 HEAVY METALS IN CHOCOLATE AND CANDIES | 3           |
| <b>2</b>    | <b>LITERATURE REVIEW</b>                  | <b>5</b>    |
|             | 2.1 ENVIRONMENTAL CONTAMINATION           | 5           |
|             | 2.2 HEAVY METALS IN FOOD SOURCE           | 6           |
|             | 2.3 HEAVY METALS IN SOIL AND VEGETABLES   | 7           |
|             | 2.4 TOXICITY OF HEAVY METALS              | 8           |
| <b>3</b>    | <b>AIM AND SCOPE</b>                      | <b>11</b>   |
|             | 3.1 AIM                                   | 11          |
|             | 3.2 SCOPE                                 | 11          |
| <b>4</b>    | <b>MATERIALS AND METHODS</b>              | <b>12</b>   |
|             | 4.1 MATERIALS                             | 12          |
|             | 4.2 METHODS                               | 12          |
|             | 4.2.1 Choice of analytical technique      | 12          |
|             | 4.2.2 Principle of AAS.                   | 12          |
|             | 4.2.3 Instrumentation of AAS              | 12          |
|             | 4.3 SAMPLE AND STANDARD PREPARATION       | 14          |
|             | 4.3.1 Sample preparation                  | 14          |
|             | 4.3.2 Cr, Cu and Cd standard preparation  | 14          |
| <b>5</b>    | <b>RESULTS AND DISCUSSION</b>             | <b>17</b>   |
|             | 5.1 CADMIUM                               | 17          |
|             | 5.2 CHROMIUM                              | 18          |
|             | 5.3 COPPER                                | 20          |

|          |                   |           |
|----------|-------------------|-----------|
| <b>6</b> | <b>CONCLUSION</b> | <b>22</b> |
|          | <b>REFERENCE</b>  | <b>23</b> |

## LIST OF TABLES

| TABLE No. | TITLE                                                     | PAGE NO. |
|-----------|-----------------------------------------------------------|----------|
| 2.3.1     | Heavy metals and their effects on plants and human health | 10       |
| 5.1.1     | Cadmium standard concentration                            | 17       |
| 5.2.1     | Chromium standard concentration                           | 18       |
| 5.3.1     | Copper standard concentration                             | 20       |

## LIST OF FIGURES

| <b>FIGURE<br/>No.</b> | <b>TITLE</b>                              | <b>PAGE<br/>NO.</b> |
|-----------------------|-------------------------------------------|---------------------|
| 4.2.3                 | Atomic absorbtion spectroscopy instrument | 13                  |
| 4.3.1                 | Sample A and Sample B                     | 14                  |
| 5.1.2                 | Standard curve fit for Cd                 | 17                  |
| 5.2.2                 | Standard curve fit for Cr                 | 18                  |
| 5.3.2                 | Standard curve fit for Cu                 | 19                  |
| 5.1.3                 | Sample data tested for Cadmium            | 19                  |
| 5.2.3                 | Sample data tested for Chromium           | 19                  |
| 5.3.3                 | Sample data tested for Copper             | 21                  |

# **CHAPTER 1**

## **1. INTRODUCTION**

### **1.1 BACKGROUND STUDY**

Between 1850 and 1990, production of copper, lead and zinc increased 10-fold. The main anthropogenic sources of heavy metals are various industrial processes, mining, foundries, smelters, combustion of fossil fuel and gasoline, and waste incinerators.

Toxicological and environmental studies have interest in the determinations of toxic elements in food. "Food safety" implies absence or acceptable and safe levels of contaminants, adulterants, naturally occurring toxins or any other substance that may make food injurious to health on an acute or chronic basis. Food quality can be considered as a complex characteristic of food that determines its value or acceptability to consumers. Besides safety, quality attributes includes nutritional value, organoleptic properties such as appearance, color, texture, taste and functional properties (World Health Organization (WHO), 1998)

Taking into consideration that products passed through different industrial processes and are packaged to provide a means of protection, marketing or handling, and most of them have printed colour inks on the outer cover. Importantly, food products such as candies that are likely to be consumed frequently by small children are wrapped in colourful packages in order to induce them to purchase the products. Heavy metals, such as Pb, Cr, Ti, Zn and Cu can migrate from the printed surface to the food contact surface through four mechanisms: blocking, rubbing, peeling and diffusion. Contamination of imported food products with heavy metals may cause a serious risk to human health because of the consumption of even small amount of metals can lead to considerable concentrations in human body. Metals that cannot be metabolized like cadmium, lead and mercury persist in the body and exert their toxic effects by combination with one or more reactive groups essential for normal

physiological function and cellular disturbances or clinical manifestation may appear.

In spite of the hazard effects of heavy metals on public health, some of them are essential for normal physiological functions such as copper and zinc. Also, copper sulphate exhibits clear reduction of cadmium residues in animal tissues, the dietary deficiencies of copper, zinc, calcium, iron, protein and an excess dietary fat cause an increase in the absorption and toxicity of lead. Although there are standards set by the quality control bodies such as National Agency for Food and Drug Administration and Control (NAFDAC) and Standards Organization of Nigeria (SON) for permissible concentrations of these contaminants in imported products.

## **1.2 HYPOTHESIS**

The purpose of this study was to identify and determine the level of heavy metals in different chocolates and candies from different country, considering that these products are supplied to every market in the country. Therefore, the study is based on the following null hypotheses:

- i. Mean metal concentrations of candies and chocolates from different zones of the country do not differ, and their heavy metal levels are within acceptable or safe limits.
- ii. Candies and chocolate of different types do not have equal metal concentrations.

## **1.3 HEAVY METALS**

Although there is no specific definition of a heavy metal, literature has defined it as a naturally occurring element having a high atomic weight and high density which is five times greater than that of water. Among all the pollutants, heavy metals have received a paramount attention to environmental chemists due to their toxic nature. Heavy metals are usually present in trace amounts in natural waters but many of them are toxic even at very low concentrations. Metals such as arsenic, lead, cadmium, nickel, mercury, chromium, cobalt, zinc

and selenium are highly toxic even in minor quantity. Increasing quantity of heavy metals in our resources is currently an area of greater concern, especially since a large number of industries are discharging their metal containing effluents into fresh water without any adequate treatment.

Heavy metals become toxic when they are not metabolised by the body and accumulate in the soft tissues. They may enter the human body through food, water, air or absorption through the skin when they come in contact with humans in agriculture, manufacturing, pharmaceutical, industrial or residential settings. Industrial exposure accounts for a common route of exposure for adults. Ingestion is the most common route of exposure in children. Natural and human activities are contaminating the environment and its resources, they are discharging more than what the environment can handle. The presence of heavy metals in the environment leads to a number of adverse impacts. Such impacts affect all spheres of the environment, that is, hydrosphere, lithosphere, biosphere and atmosphere. Until the impacts are dealt with, health and mortality problems break out, as well as the disturbance of food chains. Heavy metals contamination is becoming a serious issue of concern around the world as it has gained momentum due to the increase in the use and processing of heavy metals during various activities to meet the needs of the rapidly growing population. Soil, water and air are the major environmental compartments which are affected by heavy metals pollution. (Vhahangwele Masindi and Khathutshelo L. Muedi).

#### **1.4 HEAVY METALS IN CHOCOLATES AND CANDIES**

Actually, this was not really news, since it has long been known that cocoa (and many other foods) often contain trace amounts of heavy metals. Cadmium is naturally found in soil—a result, for example, of volcanic activity, forest fires, and weathering of rocks—and is taken up by many plants, including cocoa plants. Soil can also be contaminated by “man-made” sources of cadmium, such as from the manufacturing of certain batteries and the use of phosphate fertilizers. How much of the heavy metal ends up in cocoa beans depends on the geographic region, soil acidity, plant variety, and other factors.

Further contamination may occur, to varying degrees, during processing and manufacturing of cocoa products as well as during transport and storage. Cadmium accumulates in the body and can have detrimental effects on the kidneys, lungs, bones, and possibly fetal development; it's also classified as a probable human carcinogen. Unlike the Canadian government and the European Union, the FDA has not set cadmium limits in foods or supplements. The World Health Organization (WHO) suggests a maximum of 0.3 micrograms per gram in dried plants. And California requires a warning label on products that have more than 4.1 micrograms of cadmium per daily serving of a single product. Cadmium limits have been determined in many different ways, but it's unclear which approach is best. (Berkeley Wellness, 2015).

Children with higher cadmium levels are three times more likely to have learning disabilities and participate in special education, according to a study led by Harvard University researchers. Dr. Robert Wright, the study's senior author, emphasized that the links to learning disabilities and special education were found at commonplace levels previously thought to be benign. Some studies of adult workers have shown that high exposures can trigger neurological problems, and small, earlier studies of children found links to mental retardation and decreased IQs.(Environmental factor by NIH, 2012)

## **CHAPTER 2**

### **2.1 ENVIRONMENTAL CONTAMINATION OF HEAVY METALS**

Heavy metal are metallic elements with high atomic weight and density. These include the transition metals, some metalloids, lanthanides and actinides. Amounting to more than 20 metals generally exist in a positively charged form and can bind on to negatively-charged organic molecules. Being metals ions, heavy metal cannot be degraded or destroyed, therefore their stability make them as the persistent toxic substances in environment. Heavy metal as the environmental contaminants can be found in the air, soil and water, which pose health hazard to the general public. Presence of heavy metal in water as the contaminants is an indication of global industrialisation attributed to large scale of inappropriate disposal and untreated of wastewater containing heavy metal from anthropogenic sources. (United Nations Commission on Sustainable Development, 2010). Heavy metals arise from unorganised industrial growth and are considered as major pollutants of natural water bodies. Anthropogenic activities like industrial processes, unsafe disposal of industrial wastes, agricultural wastes, and the like release heavy metals into the environment. Once released they contaminate water, soil, plants and enter the food chain, posing health problems to human beings. These recalcitrant pollutants received considerable attention because of their inherent toxicity to living organisms. When they reach the aquatic environment and, being non-degradable remain suspended or partially dissolved in water and subsequently accumulate in aquatic lives (Sharma and Pande, 1998).

### **2.2 HEAVY METALS IN FOOD SOURCE**

Contamination of foods by heavy metals has a number of different sources. The most significant ones are: contamination of the soil from which foods are produced; residual muds; chemical fertilizers and pesticides used in agriculture; the use of other materials; etc. Since this contamination has so many different sources, there is a wide range of foods contaminated by heavy metals, including products of plant origin (cereals, rice, wheat, edible roots, mushrooms,

etc.) as well as foods of animal origin (fish, crustaceans, mollusks). In particular, fish is one of the products most affected by heavy metal contamination, because heavy metals are bioaccumulative in the food chain. When heavy metals accumulate in waters, fish ingest them through their diet and accumulate them over the course of their lives. The heavy metals then reach the consumer when that fish is consumed.

Many high-density metals are not especially toxic. Several of them are actually essential elements for human beings, though at certain concentrations they may be toxic in some of their forms. However, there is a series of elements that, regardless of their form, could represent a major environmental problem. These are commonly referred to with the generic term “heavy metals.”

The danger of heavy metals is especially severe, because they are not chemically or biologically degradable. Once released into the environment, principally due to industrial or mining activities, they can remain for hundreds of years, polluting the soil and accumulating in plants and organic tissues. Moreover, their concentration in living beings increases as they move up the food chain(AGO lab, 2019). Among the most significant heavy metals from the point of view of health are mercury, lead, cadmium, nickel, and zinc. Some intermediate elements such as arsenic and aluminum, which are highly relevant from a toxicological point of view, are generally studied together with heavy metals. High levels of lead found in mini-blinds, hair dyes, and some calcium supplements and lead crystal. Gasoline is also a major source of lead. The vehicular exhaust, for example, releases lead into atmosphere (H2O Magazine, 2011)

## **2.2 HEAVY METALS IN SOIL AND VEGETABLES**

In situations where heavy metals like lead and arsenic may be high in the soil, selecting certain vegetables to grow can lower the risk of heavy metal exposure. Vegetable gardening can bring health benefits by growing and consuming fresh vegetables(Phil Tocco, 2016).

As the present study area is free from industrial pollution, the major sources of soil contamination with heavy metals might be due to the waste water irrigation, solid waste disposal, sludge applications, vehicular exhaust and agrochemicals. Excessive accumulation of heavy metals in agriculture soils through the use of agrochemicals and by other sources may not only result in soil contamination but also lead to elevated heavy metal up-take by vegetables and thus affect food quality and safety. Heavy metals are easily accumulate in edible parts of leafy vegetables, as compared to grain or fruit crops. Vegetables take up heavy metals and accumulate them in their edible and inedible parts in quantities high enough to cause clinical problems to both animals and humans when they consume these metal-rich plants. Intake of toxic metals in a chronic level through soil and vegetables has adverse impacts on human, plants and the associated harmful impacts become apparent only after several years of exposure. However, the consumption of heavy metal-contaminated food can seriously deplete some essential nutrients in the body that are further responsible for decreasing immunological defences, such as intrauterine growth retardation, impaired psycho-social facilities, disabilities associated with malnutrition and high prevalence of upper gastrointestinal cancer rates.(Tasrina et al., 2015)

## **2.3 TOXICITY OF HEAVY METALS**

Some debate exists as to exactly what constitutes a "heavy metal" and which elements should properly be classified as such. Some authors have based the definition on atomic weight; others, on a specific gravity of greater than 4.0, or greater than 5.0. The actinides (the chemical elements with atomic numbers from 89 to 103, actinium through lawrencium; eg, uranium) may or may not be included. Most recently, the term "heavy metal" has been used as a general term for those metals and semimetals with potential human or environmental toxicity. This definition includes a broad section of the periodic table under the rubric of interest. (Tchounwou PB, Yedjou CG, Patlolla AK, Sutton DJ, 2012).

The presence of toxic trace metals in the environment continues to generate a lot of concern (Awofolu, 2005). This is due to the health implications of their presence since they are non-essential metals that are not required for

any function either by plants or animals and are usually monitored for health purposes. This category of metals is not required by man even in small amount. However, metals such as Cu and Zn are classified as essential to life due to their involvement in certain physiological processes, although elevated levels of these metals were found to be toxic(Spear, 1981).

**Cadmium** accumulates in the body and can have detrimental effects on the kidneys, lungs, bones, and possibly fetal development; it's also classified as a probable human carcinogen. Unlike the Canadian government and the European Union, the FDA has not set cadmium limits in foods or supplements. The World Health Organization (WHO) suggests a maximum of 0.3 micrograms per gram in dried plants. And California requires a warning label on products that have more than 4.1 micrograms of cadmium per daily serving of a single product. Cadmium limits have been determined in many different ways, but it's unclear which approach is best.

**Copper** is one of the heavy metals that is essential to both plants and animals but could be toxic at elevated levels. It is toxic at low concentration and is known to cause brain damage in animals (Awofolu, 2005). However, symptoms of acute copper toxicity in man include hypertension, anaemia and cardiovascular collapse while chronic toxicity leads to sporadic fever, vomiting, diarrhoea and jaundice. It is also suspected that copper is carcinogenic due to high incidence of cancer among coppersmith (Luckey and Venugopal, 1977).

**Chromium** is present in human tissues in variable concentrations and its deficiency is characterised by disturbance in glucose, lipid and protein metabolism. It also plays an essential role in enhancing the activity of insulin in human body. However, its compounds are well known toxins particularly Cr6+ which, due to its oxidising potentials, easily permeates biological membranes and can also cause renal damage and various forms of cancer (Bae *et al.*, 2000).

**Nickel** is a naturally occurring element found in a number of mineral ores including nickel phosphates, oxides and silicates. It is present in the enzyme urease and as such is considered to be essential to plants and some domestic

animals (Awofolu, 2005). However, the essentiality of Ni to health has not been demonstrated, but Ni related health effects such as renal, cardiovascular, reproductive and immunological effects have been reported in animals. Also, its toxic effects in man are related to dermal, lung and nasal sinus cancer (Holynska *et al.*, 1996).

**Zinc** is an essential element to plants and animals. Although, Zn has been found to have low toxicity to man, prolonged consumption of large doses can result in some health complications such as fatigue, dizziness, and neutroeria reported that acute Zn toxicity in man causes diarrhoea, depression of central nervous system leading to tremous and paralysis, while chronic Zn toxicity causes growth retardation, faulty reproduction and anaemia in man. Audu and Lawal (2005) also noted that Zn is an essential element that is involved in metabolic functions, and is important for both animal and plant health growth. Zn content of normal plant tissues varies according to species, but it is usually within the range of 5 – 300mg/kg. Zinc is an element found in virtually every cell of the human body and plays vital roles in the development and healthy growth of human body and has a recognised action on more than 300 enzymes by participating in their structure or in their catalytic and regulatory action. Zn fortification is an important consideration especially because daily intakes appear to be more useful physiologically than in intermittent doses. Zinc deficiency can result in poor growth, difficulty in wound healing, and loss of appetite, undesirable skin changes, and adverse effects on the immune system. Also zinc deficiency is associated with sexual maturation, fertility, immunity, tastes and appetite. The current Reference Daily Intake for Zn is 15mg/day. Overload of Zn (> 100mg/day) can also be dangerous. It can depress the immune system, or cause anaemia (Nnorom *et al.*, 2007).

**Manganese** is an essential nutrient, functioning in the tissues as a co-factor for arginase and the phosphotransferases (Stanley *et al.*, 1975), and has its source from industrial effluents and at certain level, it is toxic to a number of crops. However, there is no available data for human toxicity (Cornish *et al.*, 1999). Cornish, *et al* (1999) noted a summary of the effects of heavy metals on plants and human health.

**TABLE 2.3.1: HEAVY METALS AND THEIR EFFECTS ON PLANTS AND HUMAN HEALTH**

| <b>Metal</b> | <b>Sources</b>                                          | <b>Agronomic effects</b>                                                                           | <b>Effect on human health</b>                                               |
|--------------|---------------------------------------------------------|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| Cr           | Leather tanneries (about) 40mg/L in surface discharges) | Not generally recognised as essential growth element. Lack of knowledge on its toxicity to plants. | Carcinogenic, dermatitis, painful chrome ulcers. Food main source of intake |
| Cu           | Plumbing, animal wastes, pesticides, earth crust        | Toxic to number of plants at 0.1 mg/L in nutrient solutions.                                       | Liver cirrhosis. Food main source of intake, uncertain toxicity to humans   |
| Mn           | Industrial effluents                                    | Toxic to a number of crops at a few tenths to a few mg/L                                           | No convincing data of human toxicity                                        |
| Ni           | Industrial effluents                                    | Toxic to a number of plants at 0.5mg/L to 1mg/L                                                    | Carcinogenic, lack of data on carcinogenic by the oral route                |
| Zn           | Plumbing, animal wastes, pesticides                     | Toxicity to many plants at widely varying concentrations                                           | Not a major hazard to health                                                |

## **CHAPTER 3**

### **AIM AND SCOPE**

#### **3.1 AIM**

The aim of this study was to identify the heavy metals (Cu, Cd, and Cr) that might be present in low concentrations or not at all in some candies (lollipops), as well as to provide data that could be used to develop preventive measures.

#### **3.1 SCOPE**

- Assessing the amount of heavy metal in sweets and chocolates.
- Relating heavy metal concentrations in sweets and chocolates to international requirements.
- Assessing the level of risk associated with the use of these items.
- The mean metal concentrations of market-purchased candies and chocolate are equal, and their heavy metal levels are within reasonable or safe limits.
- Metal amounts in various forms of candies and chocolate are not comparable.
- Examining the concentration of heavy metals, a suitable instrumental analytical technique is chosen.

## **CHAPTER 4**

### **MATERIALS AND METHOD**

#### **4.1 MATERIALS**

ALPENLIEBE is the chosen candy. Alpenliebe lollipops and candies provide a one-of-a-kind product experience. The rich and smooth milky flavour appeals to both children and adults' sweet tooth. Alpenliebe is irresistible to everyone because of its diverse flavour range, outstanding smooth texture, and high-quality packaging.

#### **4.2 METHOD**

##### ***4.2.1 Choice Of Analytical Method***

Because of its advantages, such as multi-elemental capability, high sensitivity, accuracy, and short analysis time, atomic absorption spectrometry (AAS) is suitable for this type of work. Other analytical methods for heavy metal determination, such as X-ray fluorescence (XRF) and neutron activation analysis (NAA), can also be used, but they all require thorough sample preparation.

##### ***4.2.2 Principle Of Atomic Absorbtion Spectroscopy***

The method is based on the theory of absorption spectroscopy. It is permissible to convert a liquid sample into free atoms (desolvated and atomized). These free atoms absorb light of a specific wavelength. The light that hasn't been absorbed is picked up and recorded. The rate of absorption is proportional to the sample concentration.

##### ***4.2.3 Instrumentation Of Aas***

The instrumentation for atomic absorption spectroscopy is basic. It does, however, have two additional requirements, unlike other spectroscopy methods. These include a specially designed lamp for producing light of a specific wavelength and a burner for preparing the sample for light absorption. In addition, the instrument sprays the solution-state sample over an atomizer (burner). This

causes the solvent to evaporate, leaving a fine dry residue. The ground state of this residue contains neutral atoms.

The following instruments are included in the setup:



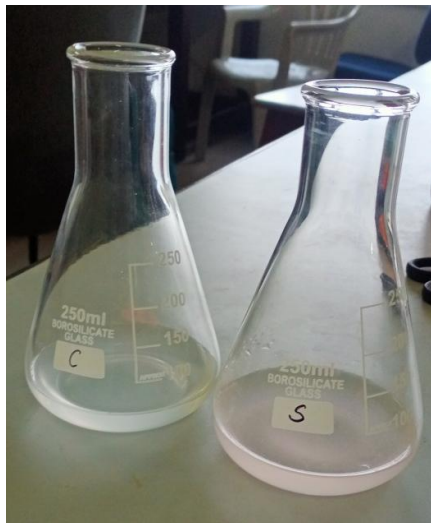
**Figure 4.2.3: Atomic Absorption Spectroscopy Instrument**

- The atomizer (burner), which is used to dry the sample and create atoms.
- Container for the sample.
- A fuel and an oxidant to heat-burn the sample.
- A hollow cathode lamp that produces the desired wavelength of light.
- Detector for measuring absorption intensity
- Data recorder and amplifier

The instrument comes in single and double beam configurations.

#### **4.3 SAMPLE AND STANDARD PREPARATION**

##### **4.3.1 SAMPLE PREPARATION**



***Figure 4.3.1: Sample A and sample B***

- The two candies chosen are crushed.
- A total of 0.1g is Weighed from this.
- 50 mL of water is taken and labelled as sample A and sample B in two conical flasks.
- The weighed candy is added to sample A and sample B flasks, respectively.
- Shake the flasks until all of the candy had dissolved

##### **4.3.2 STANDARD PREPARATION**

The procedure for preparing Cr, Cu, and Cd requirements is as follows:

### **Cd Standard Preparation**

To prepare Cd standard solution, we selected Cadmium nitrate tetrahydrate salt ( $\text{CdH}_8\text{N}_2\text{O}_{10}$ ).

Molecular formula of  $\text{CdH}_8\text{N}_2\text{O}_{10}$  = 308.48g g/mol

Elemental mass of Cd = 112.411 g/mol

Therefore, average molecular weight is 2.744g (total molecular weight/elemental molecular weight =  $308.48/112.411$ ). We get 100 ppm of cadmium solution by dissolving 0.2744g of cadmium nitrate tetrahydrate in 1000ml of water, since  $1000\text{ppm} = 1000 \text{ mg/l}$ . By having cadmium ppm solution, the standard is made for different concentration 0.5, 1.0, 1.5, 2.0 and 2.5 respectively.

### **Cr Standard Preparation**

To prepare Cd standard solution, we selected Potassium dichromate

Molecular formula of  $\text{K}_2\text{Cr}_2\text{O}_7$  = 294.18 g/mol

Elemental mass of Cr = 51.9961 g/mol

Therefore, average molecular weight is 5.658 g (total molecular weight/elemental molecular weight =  $294.18/51.99$ ). We get 100 ppm of chromium solution by dissolving 0.5199g of potassium chromate in 1000ml of water, since  $1000\text{ppm} = 1000 \text{ mg/l}$ . By having chromium ppm solution, the standard is made for different concentration 5, 10, 15, 20 and 25 respectively in water.

### **Cu standard preparation**

To prepare Cu standard solution, we selected Copper Sulphate.

Molecular formula of  $\text{CuSO}_4$  = 159.61 g/mol

Elemental mass of Cu = 63.55 g/mol

Therefore, average molecular weight is 2.5115 g (total molecular weight/elemental molecular weight =  $159.61/63.55$ ). We get 100 ppm of copper

solution by dissolving 0.2511 g of copper sulphate in 1000ml of water, since  $1000\text{ppm} = 1000 \text{ mg/l}$ . The standard for various concentrations 1, 2, 3, 4, and 5 in water is made using chromium ppm solution.

## CHAPTER 5

### RESULTS AND DISCUSSION

The concentrations of heavy metals (Cd, Cr, and Cu) in samples A and B are compared. The normal concentrations of the selected heavy metals are listed in the table below for each metal. For each metal, we first measured the blank solution (deionized water), and then we tested for each metal separately. Each metal has its own wavelength. Here the wavelength for Cadmium, Chromium and Copper is 228.4nm, 359.5nm and 324.9nm respectively.

#### 5.1 CADMIUM:

TABLE 5.1.1 : Cd STANDARD CONCENTRATION

| NO | CONC | ABORSPTION |
|----|------|------------|
| 1  | 0    | 0.0142     |
| 2  | 0.5  | 0.1185     |
| 3  | 1    | 0.2257     |
| 4  | 1.5  | 0.3209     |
| 5  | 2    | 0.4041     |
| 6  | 2.5  | 0.4738     |

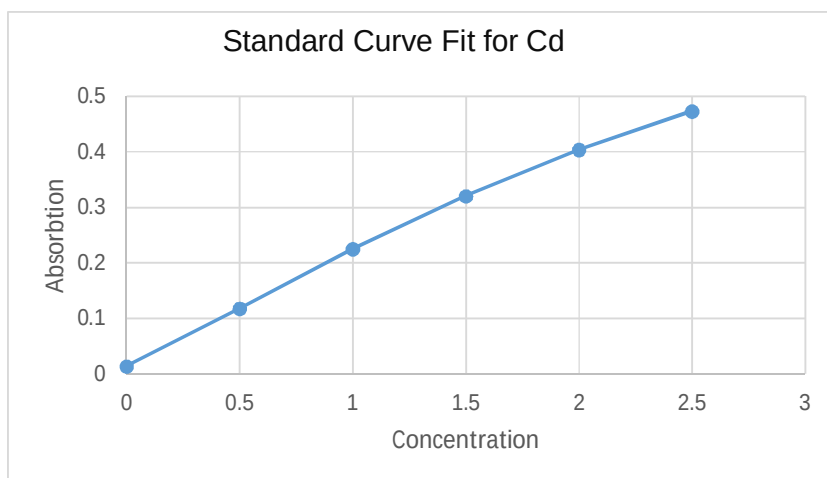


Figure 5.1.2 : Standard Curve Fit for Cd

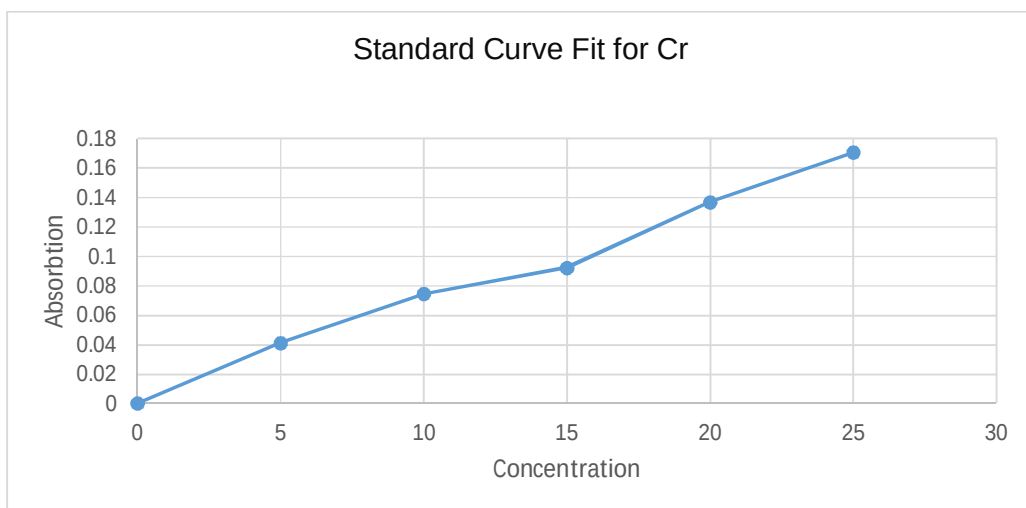
| SamplesData       |        |         |       |          |        |        |
|-------------------|--------|---------|-------|----------|--------|--------|
| File View         |        |         |       |          |        |        |
| No.of.Samples : 4 |        |         |       |          |        |        |
| Ilo               | Sample | Abs     | Conc  | %Wt      | %Conc  | D.Fact |
| 1                 |        | 0.0040  | -0.07 | -0.00001 | 0.0000 | 1      |
| 2                 |        | 0.0080  | -0.05 | -0.00001 | 0.0000 | 1      |
| 3                 |        | -0.0327 | -0.27 | -0.00003 | 0.0000 | 1      |
| 4                 |        |         |       |          |        |        |

**Figure 5.1.3 : Samples Data Tested for Cd**

## 5.2 CHROMIUM

**TABLE 5.2.1: Cr STANDARD CONCENTRATION**

| NO | CONC | ABORSPTION |
|----|------|------------|
| 1  | 0    | 0.0004     |
| 2  | 5    | 0.0414     |
| 3  | 10   | 0.0747     |
| 4  | 15   | 0.0924     |
| 5  | 20   | 0.1371     |
| 6  | 25   | 0.1707     |



**Figure 5.2.2: Standard Curve Fit for Cr**

**SamplesData**

File View

No.of.Samples :

| Ilo | Sample | Abs     | Conc  | %Wt      | %Conc   | D.Fact |
|-----|--------|---------|-------|----------|---------|--------|
| 1   |        | 0.0007  | -0.24 | -0.00002 | 0.0000  | 1      |
| 2   |        | -0.0349 | -5.58 | -0.00056 | -0.0006 | 1      |
| 3   |        | -0.0373 | -5.94 | -0.00059 | -0.0006 | 1      |
| 4   |        |         |       |          |         |        |

**Figure 5.2.3: Samples Data Tested for Cr**

### 5.3 COPPER

TABLE 5.3.1: CU STANDARD CONCENTRATION

| NO | CONC | ABORSPTION |
|----|------|------------|
| 1  | 0    | 0.0015     |
| 2  | 1    | 0.0619     |
| 3  | 2    | 0.0972     |
| 4  | 3    | 0.1839     |
| 5  | 4    | 0.2496     |
| 6  | 5    | 0.3449     |

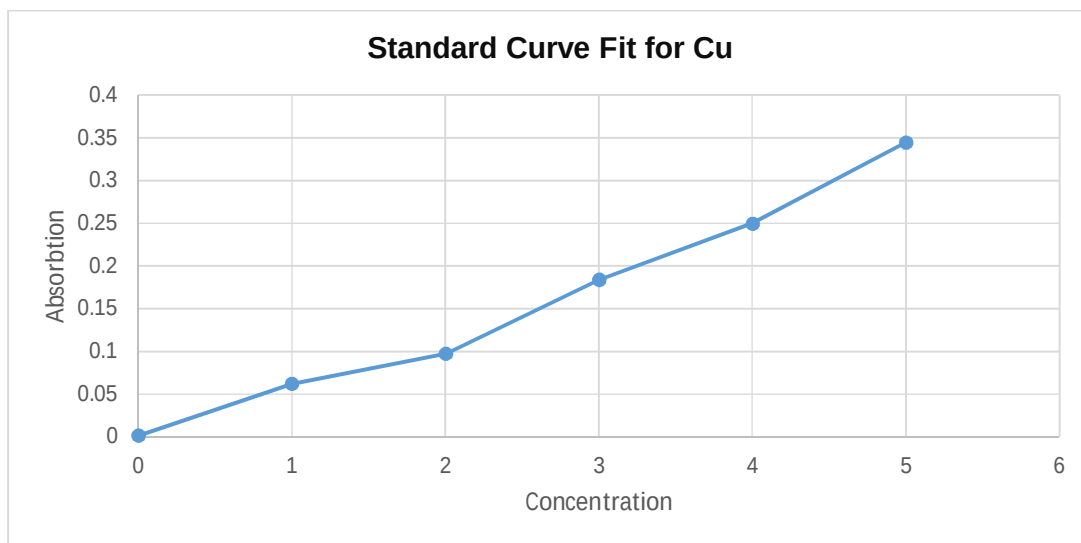


Figure 5.3.3: Standard Curve Fit for Cu

| SamplesData       |        |         |       |         |        |        |
|-------------------|--------|---------|-------|---------|--------|--------|
| File View         |        |         |       |         |        |        |
| No.of.Samples : 4 |        |         |       |         |        |        |
| Ilo               | Sample | Abs     | Conc  | %Wt     | %Conc  | D.Fact |
| 1                 |        | 0.0019  | 0.15  | 0.00002 | 0.0000 | 1      |
| 2                 |        | 0.0444  | 0.79  | 0.00008 | 0.0001 | 1      |
| 3                 |        | -0.0100 | -0.03 | 0.00000 | 0.0000 | 1      |
| 4                 |        |         |       |         |        |        |

*Figure 5.3.3 : Samples Data Tested for Cu*

## **CHAPTER 6**

### **CONCLUSION**

The result indicates that the candy we chose to examine by Atomic Absorption Spectroscopy does not contain the heavy metals we wanted to look for. We observed negative concentrations in the three heavy metals we tested, suggesting the absence of Cd, Cr, and Cu. As a consequence, the chosen candy is free of Cadmium, Chromium, and Copper. Other chocolates and candies, on the other hand, contain heavy metals.

## REFERENCE

1. Audu, A. A. and Lawal, A. O., Variation in metal contents of plants in vegetable garden sites in Kano Metropolis. *Journal of Applied Sciences and Environmental Management*(2005), 10(2): 105 – 109.
2. AGO Lab, Heavy metals in foods, 23<sup>rd</sup> January 2019.
3. Awofolu, O. R., A survey of trace metals in vegetation, soil and lower animal along some selected major roads in Metropolitan city of Lagos. *Environmental Monitoring and Assessment*(2005)., 105: 431 – 447
4. Bae, D., Toxicological interaction among Arsenic, Cadmium and Lead in Human Keratinocytes (2000).
5. Berkley wellness, Is there Cadmium in your cocoa?, 2015, 1-2
6. Cornish, G. A., Mensah, E. and Ghesquire, P., Water quality and peri-urban irrigation. An assessment of surface water quality for irrigation and its implication on human health in the peri-urban zone of Kumasi, Ghana. Report OD/TN9519. R. Wallingford 1999.
7. Carol Kelley, Environmental factor by NIH – Childrens exposed to Cadmium may be at higher risk for learning disabilities, 2012, pp38.
8. Holyncka, B. Ostachowicz, B. and Wearzynek, D., Simple method of determination of copper, mercury and lead in potable water with preliminary pre-concentration by total reflection X-ray fluorescence spectrometry. *Spectrochemical Acta Part B. Spectroscopy*(1996), 51(7): 769 – 773.
9. H2O Magazin., Origins of heavy metals in our food and ill effect on human body.(2011)

10. Luckey, T. D. and Venugopal, B. Metal toxicity in mammals, In: Physiologic and Chemical Basis of Metal Toxicity. Plenum Press, New York. (1977) PP. 93 – 153.
11. Nnorom, I. C., Osibanjo, O. and Ogugua, K. Trace heavy metal levels of bouillon cubes and food condiments readily consumed in Nigeria. Pakistan Journal of Nutrition (2007), **B**: 122 – 127
12. Phil Tocco, Michigan State University Extension, Vegetable selection makes difference in heavy metals accumulation, February 10, 2016.
13. Spear, P. A. Zinc in the aquatic environment, chemistry, distribution and toxicity. National Research Council of Canada, Association Committee on Scientific criteria for environmental quality report NRCC No. 17589, Ottawa (1981).
14. Stanley, D., Passmore, R., Brock, J. F. and Truswell, A. S. Human nutrition and dietetics Churchill Livingstone Edinburgh, London. 6th Edition (1975). PP. 164 – 169.
15. Tasrina et al, Journal of environmental analytical chemistry, volume 2 , 2015.
16. Tchounwou PB, Yedjou CG, Patlolla AK, Sutton DJ., Heavy metal toxicity and the environment, 2012: 101-103.
17. United nations commission on sustainable development, 2010: 8-9.
18. Vhahangwele Masindi and Khathutshelo L. Muedi, Environmental contamination by heavy metals, 27<sup>th</sup> June, 2018: 4
19. WHO (1998). The world health report 1998. Life in the 21st century: A vision for all. Retrieved 21st January, 2011.