Quantitative Analysis of Cadmium in Food Coloring Agents

By

S. M. Shahidul Aziz
15146099

A thesis submitted to the Department of Department of Pharmacy in partial fulfillment of the requirements for the degree of
Bachelor of Pharmacy (Hons)

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Brac University
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Declaration

It is hereby declared that

1. The project submitted is my own original work while completing degree at Brac University.
2. The project does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The project does not contain material, which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I have acknowledged all main sources of help.

Student's Full Name & Signature:

S. M. Shahidul Aziz
15146099

Approval

The project titled "Quantitative Analysis of Cadmium in Food Coloring Agents" submitted by S. M. Shahidul Aziz (15146099) of Spring, 2015 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Pharmacy on 10 October 2019.

Examining Committee:

Supervisor:
(Member)

____
Marzia Alam
Lecturer,
Department of Pharmacy
Brac University

Program Coordinator:
(Member)

____
Dr. Hasina Yasmin
Professor,
Department of Pharmacy
Brac University

Departmental Head:
(Chair)

____
Professor Dr. Eva Rahman Kabir
Chairperson,
Department of Pharmacy
Brac University

Ethics Statement

This study does not involve any kind of human or animal trial.

Abstract

Cadmium contamination occurs when cadmium enters into the body system. It is a very serious contaminant even if it is in a very little quantity. Especially children are more vulnerable to this contamination. This study aims to find out the amount of cadmium from food coloring agents. Environmental Protection Agency (EPA) declares the maximum permissible limit of cadmium in foods 0.001 mg/kg. We found the concentrations of some samples of this study are higher than the maximum permissible limit of cadmium declared by EPA. This is really very sensitive issue on which the world should look up. In this study, Direct Air-Acetylene Flame method was followed and the analysis was performed on 7 food color samples. 4 samples were out of limit. For this, we can say usage of this food colors in our daily life can be harmful for us and cause many toxicities even death.

Keywords: Cadmium, Contamination, Vulnerable, EPA

Dedication

This work is dedicated to my parents for their love and constant support.

Acknowledgement

All praise is for the Almighty who is the source of our life and strength of our knowledge and wisdom, has helped me to continue my study in full diligence, which I hope, will reflect in my project.

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Table of Contents

List of Tables

List of Figures

List of Acronyms

MPL	Maximum Permissible Limit
Cd	Cadmium
Pb	Lead/ Plumbum
Zn	Zinc
Ca	Calcium
Se	Selenium
WHO	World Health Organization
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
BSTI	Bangladesh Standard and Testing Institution
ACGIH	American Conference of Governmental Industrial Hygienists
OSHA	The Occupational Safety and Health Administration
NTP	National Toxicology Program
NIOSH	National Institute for Occupational Safety and Health
APHA	American Public Health Association
MRL	Maximum Risk Level

Chapter 1

Introduction

1.1 Background

Heavy metals, a group of natural chemical compounds are those, which are present everywhere and are not biodegradable. Although harmful effects from their contact have been usually recognized, their uses in the surroundings and levels are growing. There are various analyses on the poisonous effects of individual metals to environmental living systems. International organizations set norms for the utilization of individual metals to safeguard the health of human and animal from the dangerous effects of heavy metallic elements, significantly in aquatic contents. Contamination of heavy metal within this aquatic ecosystem became one in every of the burning issues towards the aquatic environmental bio-monitoring over the world (Idrus, Basri, Rahim, Rahim, & Chong, 2018; Lambert, Grant, & Sauvé, 2007; Wu et al., 2016).

1.2 Contamination by cadmium

Cadmium, an extremely toxic heavy metal is destructive at extremely low levels of exposure and has both immediate and prolonged effects on health as well as the environment. Cadmium is not biodegradable and remains in circulation until it is released to the environment. Cadmium and cadmium derivatives are highly soluble in water. These are therefore usually more bioavailable and prefer to bio accumulate (Pacyna J.M, 2003). Commercially, cadmium is employed in lasers, TV screens, batteries, paint pigments, stainless steel and cosmetics (Bernhoft, 2013). Prolonged exposure to cadmium leads to severe acute and chronic symptoms. Cadmium is deposited in almost all the internal organs but the amount of deposition in the kidneys is the maximum. That is why, the most critical health impact caused by cadmium exposure is kidney injury or renal tubular damage. Hypercalciuria, calcium metabolism disorders and development of stones in the kidney are other results of exposure to cadmium. Excessive exposure to cadmium will lead to high risk of lung cancer and prostate cancer (Pacyna J.M, 2003).

1.3 Cadmium in the food chain

Plants such as potatoes, grains, tobacco and beans and some vegetables tends to absorb cadmium from the soil compared to other heavy metals such as lead and mercury (Satarug et al., 2003). It is also found in sweetmeat, particularly in liver and kidney. Cadmium levels in shellfish and mushrooms are high in some areas (Järup et al., 2000). Cadmium is also obtained from water in the food chain. Zinc mining operations in Japan have polluted cadmium in the local water sources. For irrigation of their fields the local farmers used that rain. The topsoil come to be contaminated by cadmium, contributing to the absorption of cadmium (Järup et al., 2000).

1.4 Routes of exposure for cadmium

Tobacco smoke is the main route for cadmium toxicity to smokers (Mannino et al., 2004; NTP, 2016). In general population, most commonly found routes of cadmium exposure are through inhalation, ingestion and the skin as well. Those routes are briefly described below.

1.4.1 Inhalation

Inhalation is referred as a major route of occupational exposure. Cadmium dust in the workplace is typically 1000 times higher than in the overall atmosphere. For example, cadmium fume or cadmium oxide allowed OSHA restricted at work is 0.1 mg/m^3; cadmium concentrations in ambient air are 1×10^{-6} mg/m^3 in non-industrialized areas and 4×10^{-5} mg/m^3

in urban areas. In non-industrialized areas, there are therefore no potential chances of adverse health effects for non-employment exposures from water (ATSDR, 2012).

Among the common people, cigarette smokers were exposed by inhalation of cadmium. A cigarette contains approximately 2 µg of cadmium, of which almost 2-10% are converted to smoke (Mannino et al., 2004). Smokers typically have more than twice the risk of cadmium exposure to blood and skin (Waalkes, 2003). The level of cadmium in the urine of a smoker is higher than that of a non-smoker (Mannino et al., 2004).

1.4.2 Ingestion

The main pathway of exposure for the common non-smoking people is oral intake. Nevertheless, the overall health of the North American population is not associated with the background level of cadmium in diet, liquid and ambient air. Typical intake of diets is roughly 30-50 µg per days (NTP, 2016; Satarug et al., 2003), whereas ordinary persons only ingest a small percentage of the dose orally absorbed (1-10 percent) (Horiguchi et al., 2004). There are regions with very significant cadmium levels in the land worldwide. Cadmium consumption in these areas can give the population living in the vicinity significant food exposure. For example, areas with soil polluted with cadmium exist in the Jinzu and Kakehashi river basins in Japan. Cadmium absorption from rice can result a major kidney and bone disorder called "Itai-Itai" disease, and particularly in females, during their lifetime of consumption of contaminated rice (Ezaki et al., 2003; Kobayashi et al., 2006).

1.4.3 Skin

Toxicity of cadmium through the skin is found negligible. This route is not considered that much significant for this chemical (ATSDR, 2012).

1.5 Standards and regulations for cadmium exposure

Many national and international organization efforts were made to control its use, due to increased evidence of cadmium toxicity. Leading to the awareness about toxic and health effects of cadmium, a large database is available to determine requirements for occupational, healthcare and the environment (Satoh, Koyama, Kaji, Kito, & Tohyama, 2002).

1.5.1 Workplace standards

To order to protect human health occupationally exposed to cadmium, OSHA has set standards in the workplace.

The Allowable Exposure Limit TWA (PEL) is 5 μg /m^3 (smoke) for OSHA regulations.

Immediately the dangerous standard of life and health (IHDL), which is 9 mg /m^3, was set by the National Occupational Health and Safety Institute (NIOSH, 2002; NTP, 2016).

1.5.2 Health Standards

Several health organizations have developed exposure guidelines to protect public opinion against over-exposure to cadmium from various sources.

FDA

- Maximum bottled water cadmium limit: 0.005 mg /L (ATSDR, 2012).
- Maximum risk level of cadmium (MRL) chronic durations based on its kidney toxicity, 0.1 μg/kg /day (ATSDR, 2012).
- This MRL norm specifies how much cadmium can be swallowed by mouth without the risk of negative well-being effects (ATSDR, 2012).

EPA

- Meal- Dose is 1×10^{-3} mg /kg /day (ATSDR, 2012).

- Water- Reference dose 5×10^{-4} mg / kg / day for human consumption (ATSDR, 2012).
- The reference dose (Rfd) is an average of the population's daily exposure, including the susceptible subgroups, which is likely to have no appreciable chance of lifelong deleterious effects (Tucker, 2011).

World Health Organization (WHO)

• Acceptable cadmium consumption of 7 μg/kg /day/week (ATSDR, 2012; Tucker, 2011).

1.5.3 Carcinogenicity

U.S. and international health agencies stance on the carcinogenicity of cadmium.

- Cadmium is listed as a likely human cancer by EPA (Group B1).
- Cadmium is listed as recognized as a human carcinogen by the International Agency for Cancer Research (IARC).
- ACGIH classifies cadmium as a potential human cancer.
- Cadmium classifies as a human carcinogen in the National Toxicology Program (NTP), (NTP, 2016).

1.5.4 Environmental standards

EPA

- Drinking water- The maximum level of cadmium contaminants is 0.005 mg / L in drinking water. (ATSDR, 2012)
- Air- Cadmium has 189 harmful air pollutants listed on the EPA National Pollution Emission Standards (NESHAP) database. Cadmium is listed as a significant threat to public health in urban areas as one of 33 hazardous air pollutants (ATSDR, 2012).
- Soil – EPA bio solids rule says the cadmium limit for land use is 85 mg /kg filling content (NTP, 2016).

1.6 Pharmacokinetics of cadmium

1.6.1 Absorption of cadmium

The key determining factor in the absorption of cadmium is the path of exposure. Once exposed, it depends on many factors to what degree cadmium is absorbed. Those factors are age, gender, smoking, dietary status etc. Cadmium level develops in the body over prolonged time. Blood cadmium levels in women are higher than in men. People with a lower blood iron level usually have a chance of increased cadmium absorption following oral exposure (Olsson et al., 2002).

1.6.1.1 Inhalation

Depending on the size of a molecule, solubility of a certain cadmium compound and the length of exposure, 10% to 50% of the inhaled dose is taken in the lungs (Järup, 2002). The absorption for large (over 10 μm) and water-insoluble particles, and for tiny particulates (under 0.1 μm) and water-soluble particles, is the least important. A high proportion of cadmium is absorbed into cigarette smoke as the cadmium particles in this smoke form are very small (ATSDR, 2012).

1.6.1.2 Ingestion

Some cadmium consumed by oral means passes unchanged through the gastrointestinal tract, as average people only consume about 6% of ingested cadmium, but up to 9% of those with iron deficiency can be absorbed (ATSDR, 2012). Through liquid, cadmium will also be consumed more readily than cadmium in foodstuff (5.5% through water vs. 2.5% in food) (Tucker, 2011). Cadmium absorption increases as a result of the heavy zinc and chromium in the diet (Tucker, 2011).

1.6.1.3 Dermal

Skin absorption does not constitute a significant route of cadmium adventure; the skin absorbs only about 0.5% of cadmium (ATSDR, 2012).

1.6.2 Excretion of cadmium

Cadmium ingested is mostly excreted in the urine from the body. The excretion rate is low, possibly because cadmium is still closely linked with metallothionine, MTN, which is reabsorbed almost entirely in the renal channel (ATSDR, 2012; Tucker, 2011). Due to slow excretion, the body can have substantial cadmium accumulation. Concentration of cadmium in the blood mirrors recent exposure; concentration of urinary cadmium reflects the overall body weight more closely. When renal impairment from exposure to cadmium occurs, however, the rate of excretion dramatically increases and levels of urinary cadmium no longer reflect the body (ATSDR, 2012; Tucker, 2011).

1.6.3 Accumulation of cadmium

The total body weight of cadmium at birth cannot be measured (Tucker, 2011). It is increased with the age from minimum 9.5 mg to maximum 50 mg (ATSDR, 2012). Almost 50% of cadmium in the body is deposited within the liver and kidneys (Tucker, 2011).

1.6.4 Cadmium half-life

It is estimated that the physiological half-life of cadmium in the kidney is between 6 and 38 years; cadmium is between 4 and 19 years long in the liver (ATSDR, 2012). The fact that humans have no active route to cadmium removal illustrates such long half-life. The biologic role of cadmium in humans is unclear. The by-product of growing industrialization seems to be bioaccumulation. Every excessive body contamination should be known to be harmful (ATSDR, 2012; Tucker, 2011).

1.7 Toxicity of cadmium

Cadmium has varying absorption rates and different health effects depending on the route of exposure. The accumulation and deposition are higher than the elimination. The liver and kidneys waste primarily. This builds up in the muscle and bone, though. The major organs affected acutely and chronically by cadmium toxicity, are the bones, kidneys and lungs. Active exposures to inhalation and more chronic circumstantial exposures can damage the lungs. Both high dose and chronic long-term exposure can be damaged in the kidneys. A cadmium effect on the kidney is thought to be related to a bone disease with over-average chronic exposures (Tucker, 2011).

1.7.1 Mechanisms of toxicity

Cadmium has been identified as a catalyst for sensitive oxygen species formation, increased lipid peroxidation, and degradation of glutathione and protein-like groupings of sulphide. Cadmium can also activate inflammatory cytokines and reduce the defense role of the formation of nitric oxides (Navas-Acien et al., 2005).

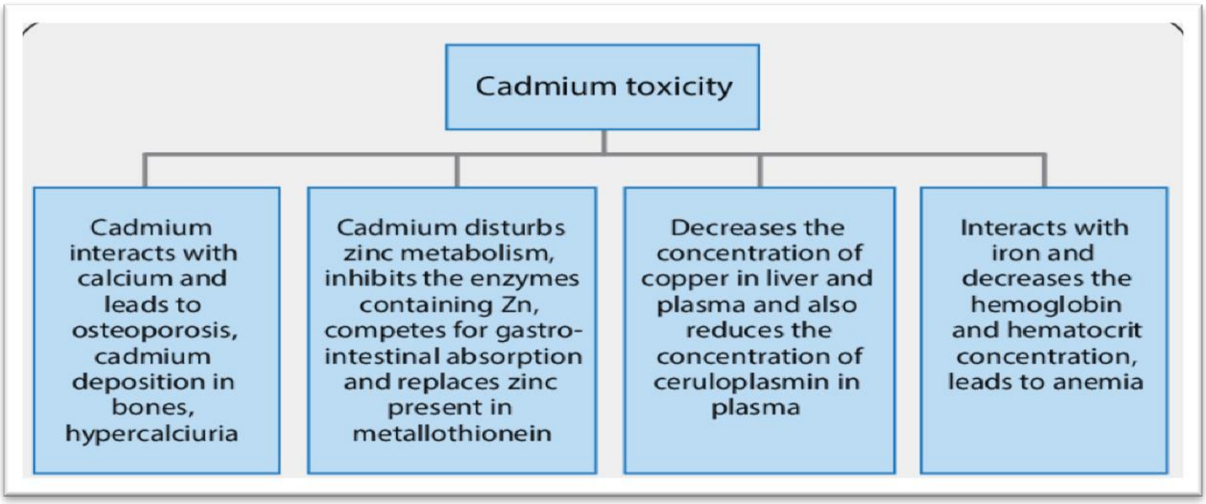

Figure 1: Possible cadmium induced toxicities

(Jaishankar, Tseten, Anbalagan, Mathew, & Beeregowda, 2014)

1.7.2 Genotoxicity

In vitro in cells and in vivo in animals, cadmium is a source of genotoxic activity; and limited epidemiologic evidence exists for human in vivo genotoxicity.

- An occupational study found that chromosomal aberrations in cadmium-exposed workers ' lymphocytes have increased (NTP, 2016).
- In subcutaneous administration animal tests cadmium has been found to cause chromosome damage (ATSDR, 2012).
- In developed mammalian cells, cadmium contributes to mutations, breakage of the DNA, chromosomal damage, cell transformation, and impaired DNA repair (NTP, 2016).
- The gene expression and signal transductor are known to modulate cadmium (Tucker, 2011).

1.7.3 Carcinogenicity

Cadmium metal and a variety of cadmium derivatives, such as cadmium chloride, oxide, sulfates and sulphides, are responsible enough for the carcinogenic effect on human and animals. Animals have been identified with increased rates of testicular, prostate and lung cancer (ATSDR, 2012; Sahmoun, Case, Jackson, Schwartz, & Schwartz, 2005). Work like cohort studies have shown a potential correlation with lung, prostate and genitourinary systems, such as kidneys, from chronic exposure to cadmium, in particular cadmium oxide (Sorahan & Esmen, 2004; Verougstraete, Lison, & Hotz, 2003). Such studies suggest that, up to now, the relative risk rises in lung cancer exposure in cadmium and cadmium staff have shown epidemiological evidence (NTP, 2016; Waalkes, 2003).

1.8 Different methods for heavy metal detection

1.8.1 Inductively coupled plasma-mass spectrometry

Inductively coupled plasma-mass spectrographic analysis is an efficient approach for hint multi-element and atom analysis, thanks to the real reality of its high sensitivity and attainable to come to a decision the atom composition of a pattern exploitation less cumbersome pretreatment approaches than choice mass spectrographic analysis strategies. Therefore, so as to attain correct and reliable results, matrix separation is required as soon as the matrix factors inside the prepared answer intervene with the determination (R. Barberá, 2019).

1.8.2 Direct air-acetylene flame method

This technique is relevant to the willpower of cadmium, antimony, calcium, bismuth, cobalt, copper, gold, cesium, chromium, iron, lead, iridium, manganese, palladium, lithium, magnesium, manganese, nickel, platinum, silver, palladium, sodium, thallium, tin, strontium, and zinc, rhodium, ruthenium, potassium, (APHA, 2005; Federation, 1999; Willis, 1962). Turning on instrument, followed the present day prescribed by the manufacturer to the hollow-cathode lamp and let the instrument warm up until the supply of strength stabilizes, typically around 10 to 20 minutes. Calibration curves for Ca and Mg shall be drawn earlier than dilution with lanthanum solution based on original attention from requirements. Nebulizer is rinsed with 1.5 mL of HNO3/L aspirating liquid. Each metal ion concentration must be calculated for trace elements in micrograms per liter, and for more common metals in milligrams per liter. Alternatively, if the instrument is equipped, the concentration is read directly from the read-out device.

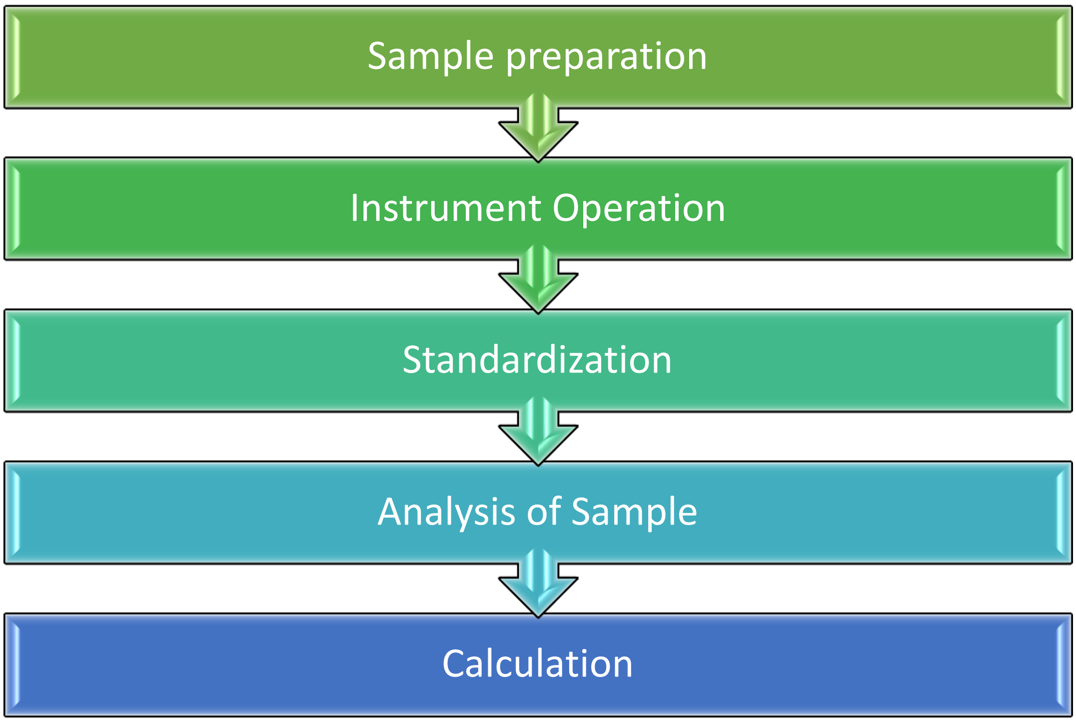

Figure 2: Direct Air-Acetylene Flame Method

1.9 Rationale of this study

This study aims achieving the following objectives:

- To make approach towards the studies of quantifying heavy metals in food coloring agents those are commonly used.
- To draw attention of the consumers for the sake of public health.

1.10 Literature review

The purpose of this section is to review the works of past analysis identified with the present study. Because literature review is a bridge between past and present study, helping to justify research work and draw a satisfactory conclusion. This part introduces the most relevant studies conducted in the recent past related to the current work.

In the research work of "Cadmium Exposure and Osteoporosis: A Population-Based Study and Benchmark Dose Estimation in Southern China" published in Journal of Bone and Mineral Research, the objective was to evaluate the relationship between osteoporosis and prolonged nutritional cadmium exposure in southern part of China. A total of 1116 topics from a region contaminated with cadmium and a non-cadmium-contaminated area were investigated. Urinary cadmium concentrations varied from 0.21 to 87.31 mu g / g of creatinine, with an average creatinine content of 3.97 mu g / g for all the subjects studied. Multivariate linear regression models proposed a noteworthy undesirable link with urinary cadmium concentrations of the bone mineral density (Lv et al., 2017).

In the research work of "Environmental Contamination by Heavy Metals" published in the journal of Heavy Metals, it shows how heavy metals harm the ability of the environment to support life and create its intrinsic values. Heavy metals are known to be compounds that happen naturally, but are introduced in large quantities in multiple environmental compartments by anthropogenic activities. This helps to reduce the environmental ability to encourage human, animal and plant health (Masindi & Muedi, 2018).

In the research work of "Relationship among prevalence of patients with Itai-itai disease, prevalence of abnormal urinary findings, and cadmium concentrations in rice of individual hamlets in the Jinzu River basin, Toyama prefecture of Japan" published in the journal of International Journal of Environmental Health Research, associations were studied among the incidence of patients suffering from Itai-itai illness and the incidence of uncommon urinary outcomes and concentrations of rice cadmium in individual hamlets in the Jinzu River Basin. They also verified that Itai-itai illness is occurred by natural contact to cadmium and that renal dysfunction is highly responsible in its development (Ogawa et al., 2004).

In the research work of "Metals in blood and urine, and thyroid function among adults in the United States 2007-2008" published in the journal of International Journal of Hygiene and Environmental Health, in occupationally exposed people, some metals showed that affect the thyroid function, but few trials in general population were performed. The study included people who had no history of thyroid disorder or use of the thyroid medications, and data on blood and urine metals, and serum thyroid hormones involved in the 2007-2008 National Health and Nutrition Survey. The relation between the levels of thyroid hormones and metals in both urine and blood was modelled by multivariate linear regression. Continuous and classification variables are considered in metal concentrations (Yorita Christensen, 2013).

In the research of "Cadmium toxicity and treatment" published in the journal of The Scientific World Journal, Toxic effects are discussed and the cadmium body burden appears to be commensurate. It is possible to detoxify cadmium with EDTA and other chelators and protocols established were found intensely helpful for humans and animals (Bernhoft, 2013).

In the research of "Pharmacokinetics of cadmium following intravenous and oral administration to non-lactating ewes" published in the journal of Veterinary Research, a preliminary study was performed in which daily oral cadmium chloride was administered to ewes and cadmium levels of blood and tissue were measured. In ewes given cadmium chloride IV and orally in the same ewes 21 months later, a pharmacokinetic evaluation of the disposition of cadmium was conducted. Pharmacokinetic parameters have been evaluated using an open 3-compartment model. After iv administration, cadmium was found in tissues roughly 2 years later (Houpert, Mehennaoui, Joseph-Enriquez, Federspiel, & Milhaud, 1995).

In the research of “Cadmium and zinc in soil solution extracts following the application of phosphate fertilizers” published in the journal of Science of the Total Environment, upon applying the phosphate fertilizers containing these two metals, they tested the solubility of cadmium and zinc in soils. Through checking their concentration in soil water samples, cadmium and zinc solubility have been measured. For cultivated fields three different concentrations were applied in the span of three years at three monoammonium phosphate fertilizers with separate quantities of iron. In a lab experiment, the same model used to examine the effect of long-term fertilizer applications on the solubility of cadmium and Zn was used with only a single fertilizer equal to 15 years of use (Lambert et al., 2007).

In the research of “Concentrations of Cadmium, Copper, and Zinc in Macrobrachiumrosenbergii (Giant Freshwater Prawn) from Natural Environment” published in the journal of Bulletin of Environmental Contamination and Toxicology, cadmium, copper, and zinc levels were assessed on November 25, 2015 in the muscle tissues, exoskeletons, and freshwater prawn gills harvested from natural habitat in Kerrang River, Malaysia. There was a significant increase in the quantity of metals in muscle tissue and gill with rises in length except Cu in gills. There was no link between metal level and length of the exoskeleton. All samples contained metals below the limit for human consumption (Idrus et al., 2018).

Chapter 2

Methodology

The aim of this research was to measure the presence of cadmium in food coloring agents. To do this job, there were various steps to be followed.

2.1 Collection of samples

A total of 7 food coloring samples were collected from two different places. 4 samples of them were in powder form. They were collected from 'M/S. Haji A. Kalam Store' situated at Chawk Bajar in Old Dhaka. The colors were Green, Yellow, Chocolate and Red. In addition, these powder colors were non-branded products purchased from a grocery shop. There were 3 more samples which were in Liquid form. They were collected from 'Mawola Traders' situated at D.N.C.C Market in Gulshan-1. Those colors were Green, Yellow and Red. Moreover, these liquid colors were branded products which were Foster Clark food colors.

2.2 Labeling of samples

After collecting the samples, they were labeled so that the results after being tested would be easier to understand. The colors were chosen randomly. Solid samples such as green, yellow, chocolate and red were labeled respectively as Food Color Sample (S-01), Food Color Sample (S-02), Food Color Sample (S-03) and Food Color Sample (S-04). Liquid samples such as green, yellow and red were labeled respectively as Food Color Sample (SS-01), Food Color Sample (SS-02) and Food Color Sample (SS-03).

Table 1: Labeling of Food Color Samples

Serial No	Colors	Labeled As	Sample Form
01	Green	Food Color Sample (S-01)	Solid
02	Yellow	Food Color Sample (S-02)	Solid
03	Chocolate	Food Color Sample (S-03)	Solid
04	Red	Food Color Sample (S-04)	Solid
05	Green	Food Color Sample (SS-01)	Liquid
06	Yellow	Food Color Sample (SS-02)	Liquid
07	Red	Food Color Sample (SS-03)	Liquid

2.3 Sample analysis

After labeling the samples, they were brought to BCSIR for further analysis, which was the actual step of this study on 27 August, 2019. The samples were received by the authorized officers. All the paper works and formalities were done properly. After all these, the samples were shifted to the Institute of Analytical Research & Services (INARS) laboratory.

The samples were analyzed by the scientists of Institute of Analytical Research & Services (INARS) laboratory, BCSIR. A standard atomic absorption spectroscopic method which is Direct Air-Acetylene Flame method was decided to be carried out for the identification and quantification of cadmium in the samples. This method is also known as APHA 3111.B method.

Chapter 3

Result

After carrying out the quantitative analysis by following Direct Air-Acetylene Flame method, the obtained concentrations of cadmium in the samples were listed in a table. That table is given below.

Table 2: Comparison between the concentrations of standard and samples

Particulars of Sample	Concentrations of cadmium	Permissible limit or equivalent (EPA)	Exceeding the Limit?
Food Color Sample (S-01)	Less than 0.01 mg/kg	0.001 mg/kg	Yes
Food Color Sample (S-02)	Less than 0.01 mg/kg	0.001 mg/kg	Yes
Food Color Sample (S-03)	Less than 0.01 mg/kg	0.001 mg/kg	Yes
Food Color Sample (S-04)	Less than 0.01 mg/kg	0.001 mg/kg	Yes
Food Color Sample (SS-01)	Less Than 0.001 mg/L	0.001 mg/L	No
Food Color Sample (SS-02)	Less Than 0.001 mg/L	0.001 mg/L	No
Food Color Sample (SS-03)	Less Than 0.001 mg/L	0.001 mg/L	No

The maximum permissible limit (MPL) of Cadmium is 0.001 mg/kg, which was declared by Environmental Protection Agency (EPA). Although this value is considered for liquid preparations, the equivalent value is taken for solid samples.

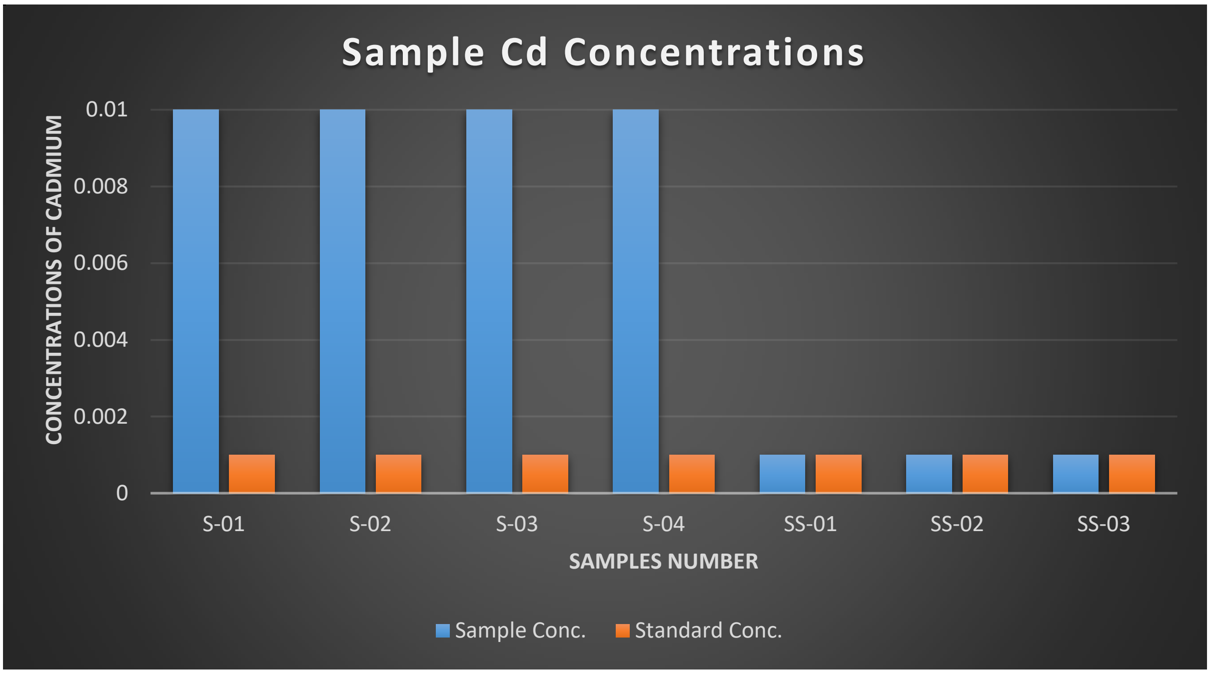

Figure 3: Sample Concentrations Vs. Permissible Limit

Chapter 4

Discussion

When the analysis was done, different concentrations of Cadmium (Cd) were found.

- For Food Color Sample (S-01), the concentration of Cadmium was found less than 0.01 mg/kg.
- For Food Color Sample (S-02), the concentration of Cadmium was found less than 0.01 mg/kg.
- For Food Color Sample (S-03), the concentration of Cadmium was found less than 0.01 mg/kg.
- For Food Color Sample (S-04), the concentration of Cadmium was found less than 0.01 mg/kg.
- For Food Color Sample (SS-01), the concentration of Cadmium was found Less Than 0.001 mg/L.
- For Food Color Sample (SS-02), the concentration of Cadmium was found Less Than 0.001 mg/L.
- For Food Color Sample (SS-03), the concentration of Cadmium was found Less Than 0.001 mg/L.

Here, the concentrations of Cadmium in the non-branded solid samples, Food Color Sample (S-01), Food Color Sample (S-02), Food Color Sample (S-03) and Food Color Sample (S-04) are respectively less than 0.01 mg/kg, less than 0.01 mg/kg, less than 0.01 mg/kg and less than 0.01 mg/kg. All these concentrations of Cadmium are higher than the permissible concentration given by EPA. Again, the concentrations of Cadmium in the branded liquid samples, Food Color Sample (SS-01), Food Color Sample (SS-02) and Food Color Sample (SS-03) are respectively less than 0.001 mg/L, less than 0.001 mg/L and less than 0.001

mg/L. All these concentrations of Cadmium are lower than the permissible concentration given by EPA.

When the exposure to cadmium is higher than the permissible limit, mostly affected areas of a human body are the respiratory system, kidneys, bones as well as the reproductive system. Pneumonitis as well as destruction of mucous membrane in the respiratory tract can occur due to high cadmium exposure (Godt et al., 2006). Moreover, formation of stones in the kidneys, glomerular and tabular damages can also be occurred. In the reproductive system, testicular necrosis is caused due to higher exposure to cadmium (Godt et al., 2006). Synthesis of steroid hormone can also be affected. In the skeletal system, loss of bone density, bone mineralization and Itai-itai disease are the most commonly found consequences of high exposure to cadmium.

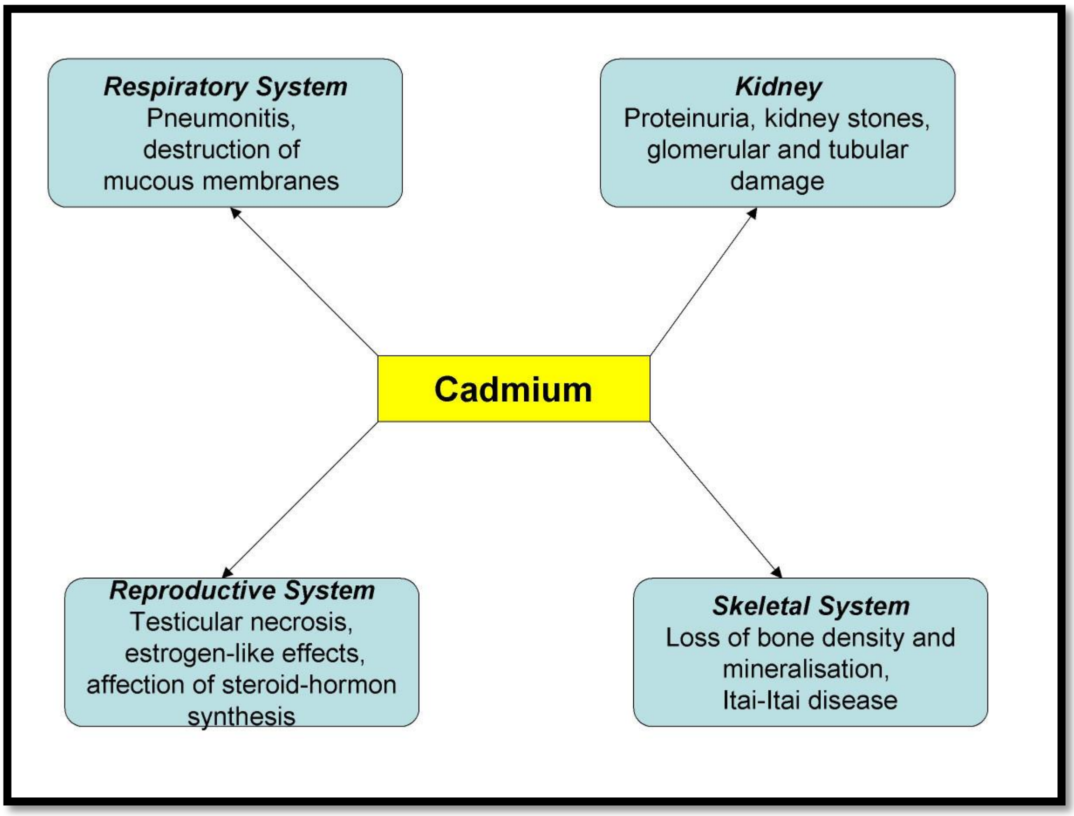

Figure 4: Most affected areas by cadmium contamination

(Godt et al., 2006)

Chapter 5

Conclusion

In this study, cadmium levels in non-branded food colors were found to be higher than the permissible range while the levels in branded products were lower. Therefore, the use of these non-branded food color samples is not suggested as they may cause contamination. Although, the levels of cadmium in branded food colors are safer, a little quantity of cadmium is available there. For this reason, this fact must be taken into account while consuming these. The food colors purchased from random chemical shops are cheaper in price and very easy to access. Majority of the consumers are attracted to these for this reason. Moreover, cadmium contamination is detected in food like candies, bakeries, ice creams, chocolates etc. Children are attracted by these foods a lot. They are more vulnerable compared to the adults. In addition, the food industry is also being regulated very poorly which must be considered as an important issue. The policies set by BSTI must be followed appropriately. Although this test was done for heavy metal testing, there are some limitations. Because of not being budget friendly to all research workers, these kinds of analysis cannot be performed in regular and frequent basis. In addition, huge technical skills are required to carry out the process. In these types of food coloring agents and many other food additives used in daily lives, there could be many other heavy metal contaminants. That is why, quantitative analysis on other metallic and non-metallic contaminants can be performed in future studies to see the permissible threshold of these metals whether or not they are in excess. Again, in vivo analysis should also be carried out to observe the toxicity of cadmium and other metals, non-metals and metalloids after the consumption of these food-coloring agents. Thus, we can maintain control over health problems by generating consciousness.

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