Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/15641
DOI URL: http://dx.doi.org/10.21474/IJAR01/15641

RESEARCH ARTICLE

QUANTIFICATION OF LEAD CONTAMINATION IN DIFFERENT SAUDI CHOCOLATE BRANDS USING ATOMIC ABSORPTION TECHNIQUE

Dr. Sherif A. Abdelgawad[1], Ph. Abdulmohsen M. Alanazi[2] and Ph. Abdulhadi S. Alharbi[3]

1. Associate Professor, Department of Pharmaceutical Chemistry, College of Pharmacy AL-Kharj, Prince SattamBin Abdulaziz University, Saudi Arabia.
2. Bachelor Degree in Pharmaceutical Science, College of Pharmacy AL-Kharj, Prince SattamBin Abdulaziz University, Saudi Arabia.
3. Bachelor Degree in Pharmaceutical Science, College of Pharmacy AL-Kharj, Prince SattamBin Abdulaziz University, Saudi Arabia.

Manuscript Info

Manuscript History
Received: 05 September 2022
Final Accepted: 09 October 2022
Published: November 2022

Key words:-
Lead Contamination of Chocolate, Toxic Heavy Metal, Lead in Saudi Chocolate Brands, Atomic Absorption Spectroscopy

Abstract

Introduction: Although chocolate and candies are widely preferred snacks for children and adults, they can carry a risk of lead (Pb) contamination. The lead is considered as a toxic heavy metal that can cause many diseases to adults, including renal, reproductive, nervous, immune, and cardiovascular systems diseases. In children, lead can cause behavioral, developmental diseases and learning deficits**.**

Aim and objectives: Our aim in this study is to measure the lead concentrations in different Saudi chocolate brands from different Saudi cities in order to compare it to the American FDA recommended levels of lead**.**Secondary objective: to assess if chocolate lead contamination contributes to the high blood lead levels that was found in our pediatric population**.**

Methods: Ten different chocolate brands products were brought from different Saudi cities' markets; these samples were digested using (MARS 6) Microwave Digestion system. The clear digested samples were diluted to 50 ml and subjected for the trace elements determination by Flame atomic absorption spectrometry using AAS-7000**.**

Results: All chocolate products that we investigated have shown lead levels between (0.00006 to 0.00654 ppm) which are below the recommended levels**.**

Conclusion: Depending on our findings, the different chocolate brands that we have studied are within the acceptable ranges of lead contamination, as recommended by the American FDA. Further studies should focus on other causes of lead exposure as we have a high blood lead levels in our pediatric population**.**

Introduction:-

Lead contamination in candies is a longstanding problem that has evolved with time [1]. Fred Accum. (1820) was the first person who systematically investigated the widespread contamination of confectionaries with metallic poisons

Corresponding Author:- Abdulmohsen M. Alanazi
Address**:-** Bachelor Degree in Pharmaceutical Science, College of Pharmacy AL-Kharj, Prince Sattam Bin Abdulaziz University, Saudi Arabia.

[2]. Cocoa powder and chocolate are sweet brown food and usually made from the dried seeds that are found in the cacao's fruit tree [1]. Carolus Linnaeus (a Swedish botanist) has replaced the name of a cocoa tree and gave it the Greek name Theobroma Cacao, which is the official botanical name now [3]. Chocolate contains the followings contents: Methylxanthines (caffeine and theobromine), Cannabinoid, Serotonin, Stearic acid, Sugars (mainly in the form of Glucose and Fructose), Proteins, Vitamins, and Minerals (Iron and Phosphorus) [4]. While there are three main types of chocolates which are dark chocolate, milk chocolate and white chocolate. Dark chocolate has the highest nutritional value [5]. While calcium (Ca) is considered as one of the major minerals in the human body, lead (Pb) is a toxic heavy metal that is naturally present in the environment and can also be released into the environment by industrial processes. Lead toxicity can occur after Lead inhalation or after gastrointestinal systems absorption. 30-40% of Lead can enter the bloodstream after Lead inhalation, while 99% can persist in blood up to 6 weeks if absorbed by gastrointestinal systems [6]. Lead is considered as an environmental pollutant. It accumulates in the soil and absorbed by the plants [6]. In humans, Lead is a known toxic metal that affects renal system, reproductive system, nervous system, immune system, and cardiovascular system. In children, blood lead levels of ≥10 µg/dL is considered as toxic levels and might cause behavioral diseases, developmental diseases and learning deficits [6]. In a study that was conducted 1999 by Al Saleh et al. on 538 girls in a public primary school; they concluded that 24.4% of those schoolgirls had blood lead levels of ≥10 µg/dL[7]. As recommended by the American food and drugs administration (FDA), the maximum allowed lead levels in candies and chocolates is 0.1 ppm[9]. Our aim in this study is to measure the calcium and Lead concentrations in different Saudi chocolate brands from different Saudi cities in order to compare it to the American FDA recommended levels, and to assess if chocolates in our markets contribute to the high blood levels in our Saudi pediatric population**.**

Materials and Methods:-

We have brought ten different chocolate brands products from different Saudi cities' markets as the followings: Hobby chocolate (produced by Ulker company) was brought from Arar city, Safari chocolate (by Gandour company) was brought from Buraidah city, Kitkat (by Nestle company) was brought from Hafar Al-Batin city, Galaxy Caramel chocolate (by Galaxy company) was brought from Hail city, Bubbly chocolate (by Mondelez company) was brought from Dammam city, Mars chocolate (by Mars company) was brought from Al Madina Al Monawara city, Oreo chocolate (by Napisco company) was brought from Jeddah city, Patchi chocolate (by Patchi company) was brought from Riyadh city, lindt chocolate (Lindit&Sprungli company) was brought from Riyadh city and joy chocolate (by joy company) was brought from Riyadh city**.**

Instrument:

We used Flame Atomic Absorption Spectroscopy-7000 (Shimadzu) (FAAS), which is the most popular quantitative analytical technique. FASS is very sensitive where it can measure the chocolate elements down to parts per billion (ppb) of a gram in a given sample [8].

Procedures:-

0.25g was taken from each chocolate sample and transferred to the express plus closed vessels, which are made up of Teflon. Analytical grade reagents were added to the sample. These analytical grade reagents were 5 ml of a 65% nitric acid and 1 ml of a 30% hydrogen peroxide. The samples were digested using MARS 6 Microwave Digestion system. The parameters set for the digestion were as: 1200 watts, 20 minutes for ramping to 200 °C, 15 minutes was maintained at 200°C and then 20 minutes for cooling. The clear digested samples were diluted to 50 ml and subjected for the trace elements determination by FAAS using AAS-7000**.**

Results and Discussion:-

The amount of lead (Pb) and Calcium (Ca) which are presented in chocolate samples after digested using MARS 6 Microwave Digestion System and detected by atomic absorption spectroscopy, flame technique is shown in table 1 below. The results unit are shown as part per million (ppm)**.**

(Table-1):- The results of lead and calcium levels in different chocolate brands after digestion using the MARS 6 Microwave Digestion System).

Name of Chocolate brand	Pb conc. [ppm]	Ca conc. [ppm]
Huppy	0.00271	0.589
Safari	0.0013	1.0029
Kitkat	0.00006	0.014

Galaxy Caramel	0.0022	1.059
Patchi	0.00183	1.200
Bubbly	0.00161	1.311
Mars	0.00194	0.487
Oreo	0.00654	0.801
Lindt	0.00252	0.135
JOY	0.00166	0.0885

Among the previous mentioned products, Kitkat chocolate product showed the lowest lead levels (0.00006 ppm), while Oreo chocolate product showed the highest (0.00654 ppm). The other products showed lead levels in between (0 to 0.00654 ppm). This means that the lead levels in all chocolate samples that we analyzed in this research were less than 0.1 ppm, which is the acceptable lead limits that is recommended by the American FDA[9]. Although we have a high blood lead levels in Saudi children [7], these high levels seem not to be caused by chocolate lead contamination.

Conclusion and Recommendations:-

Depending on our findings, the different chocolate brands that we have studied are within the acceptable ranges of lead contamination as recommended by the American FDA [9]. Further studies should focus on other causes of lead exposure as we have a high blood lead levels in our pediatric population.

Funding:
This research received no external funding.

Institutional Review Board Statement:
The study was approved by The Standing Committee of Bioethics Research (SCBR) at Prince Sattam bin Abdulaziz University with Approval No SCBR-067-2022**.**

Conflicts of Interest:
The authors declare no conflict of interest in this research.

References:-

[1] Dico GML, Galvano F, Dugo G, D'ascenzi C, Macaluso A, Vella A, et al. Toxic metal levels in cocoa powder and chocolate by ICP-MS method after microwave-assisted digestion. Food chemistry. 2018;245:1163-8.
[2] Rankin CW, Nriagu JO, Aggarwal JK, Arowolo TA, Adebayo K, Flegal AR. Lead contamination in cocoa and cocoa products: isotopic evidence of global contamination. Environmental health perspectives. 2005;113(10):1344.
[3] Sharif N, Ghafoor S, Qamar F. Chocolate Consumption in Children and Adults.
[4] afilaNaveed* AH, Neelam Sharif, SadafGhafoor, Fatima Qamar. Chocolate Consumption inChildren and Adults. Archives of medicine. 2015;7(1):4.
[5] Katz DL, Doughty K, Ali A. Cocoa and chocolate in human health and disease. Antioxidants & redox signaling. 2011;15(10):2779-811.
[6] Gillis BS, Arbieva Z, Gavin IM. Analysis of lead toxicity in human cells. BMC genomics. 2012;13(1):344.
[7] Al-Saleh I, Nester M, Devol E, Shinwari N, Al-Shahria S. Determinants of blood lead levels in Saudi Arabian schoolgirls. International journal of occupational and environmental health. 1999;5(2):107-14.
[8] Azeem SA, Attaf SM, El-Shahat M. Acetylacetonephenylhydrazone functionalized polyurethane foam: Determination of copper, zinc and manganese in environmental samples and pharmaceutics using flame atomic absorption spectrometry. Reactive and Functional Polymers. 2013;73(1):182-91.
[9] US Food and Drug Administration. (2006). Supporting document for recommended maximum level for lead in candy likely to be consumed frequently by small children. US Food and Drug Administration: Silver Spring, MD, USA.