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Original article

Assessment of Elemental Composition in Multivitamin Preparations Marketed in Libya: Implications for Safety and Efficacy

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ABSTRACT

This study evaluates the actual and labeled amounts of macro and trace elements in five multivitamin preparations marketed in Libya, utilizing inductively coupled plasma optical emission spectrometry (ICP-OES). The analysis focuses on essential minerals such as calcium (Ca), copper (Cu), iron (Fe), magnesium (Mg), manganese (Mn), selenium (Se), and zinc (Zn), alongside common heavy metals including arsenic (As), cadmium (Cd), and lead (Pb). The findings reveal significant discrepancies between the actual and labeled amounts of certain elements, raising concerns regarding the safety and efficacy of these supplements for long-term consumption.

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INTRODUCTION

Dietary supplements, particularly multivitamins and minerals, play a crucial role in addressing nutritional deficiencies and promoting overall health. The increasing prevalence of lifestyle-related health issues, such as obesity, diabetes, and cardiovascular diseases, has led to a rise in the consumption of dietary supplements. Reports indicate that the global dietary supplement market has surpassed $140 billion in recent years, reflecting a growing consumer awareness of health and wellness [1]. In Libya, the use of multivitamins is prevalent among various demographics, particularly pregnant women, the elderly, and individuals with specific health conditions [2-4]

Multivitamins typically contain a combination of essential vitamins and minerals that are vital for numerous physiological functions, including immune response, bone health, and metabolic processes [1,5]. These micronutrients play critical roles in maintaining health, with deficiencies linked to various health issues, including anemia, osteoporosis, and impaired immune function [3]. However, the safety and efficacy of these products can be compromised by several factors, including manufacturing practices, ingredient sourcing, and potential contamination with heavy metals.

Heavy metals, such as arsenic, cadmium, and lead, are toxic elements that can accumulate in the body and lead to serious health complications, including neurotoxicity, cardiovascular diseases, and renal damage [2 ,3,6]. The presence of these contaminants in dietary supplements is a growing concern, as they can pose significant health risks, particularly with long-term use [7]. The U.S. Pharmacopeia (USP) has established permissible limits for heavy metals in dietary supplements to safeguard consumer health; however, many products on the market do not undergo rigorous testing, leading to discrepancies between labeled and actual ingredient amounts [8,9]. The aim of this study is to assess the elemental composition of multivitamin preparations available in the Libyan market, focusing on both the actual and labeled amounts of essential minerals and heavy metals. By utilizing inductively coupled plasma optical emission spectrometry (ICP-OES), this research seeks to determine whether these products meet safety standards and to evaluate their suitability for long-term consumption.

MATERIALS AND METHODS

Sample collection

Five multivitamin preparations from different manufacturers (designated as Company 1 to Company 5) were purchased from local pharmacies in Tripoli, Libya. Each product was selected based on its popularity and market availability.

Sample preparation

A slurry sampling technique was employed for elemental analysis. Approximately 0.1 g of each multivitamin sample was accurately weighed into a 100 mL volumetric flask. Six milliliters of concentrated nitric acid (HNO3) were added, followed by 30-50 mL of deionized water. The mixture was treated in an ultrasonic bath for 15 minutes to ensure complete digestion.

Elemental analysis

The samples were analyzed using inductively coupled plasma optical emission spectrometry (ICP-OES) (GBC, Dandenong, Australia). The instrument was calibrated with standard solutions of known concentrations for each element of interest.

Statistical analysis

Data were analyzed using statistical software, and results were expressed as mean ± standard deviation (SD) from three measurements for each sample.

RESULTS

Analysis of beneficial minerals

The actual amounts of several beneficial minerals in the multivitamin preparations were measured and compared to the labeled amounts. The following table summarizes the findings:

Table 1. Actual vs. Labeled Amounts of Beneficial Minerals in Multivitamin Preparations

Element	Company 1 (mg)	Company 2 (mg)	Company 3 (mg)	Company 4 (mg)	Company 5 (mg)
Ca	50.02	47.1 µg	163.55	29.44	14.5
Cu	1000.4µg	0.72	0.25	876.81 µg	470.34 µg
Fe	14.03	18.8	2.49	18.26	8.91
Mg	19.52	66.6	97.53	153.44	147.09
Mn	1.9	0.4	1.02	0.12	0.1
Se	60.17 µg	47.1 µg	30.1	29.44 µg	17.27 µg
Zn	10.37	0.03	2.59	16.07	14.54

Analysis of heavy metals

The levels of heavy metals (As, Cd, Pb) in the multivitamin preparations were also assessed. The results are summarized in the following table:

Table 2. Actual Amounts of Heavy Metals in Multivitamin Preparations

Toxic Metal	Company 1 (µg)	Company 2 (µg)	Company 3 (µg)	Company 4 (µg)	Company 5 (µg)
Pb	0.0183	0.023	0.045	0.022	0.026
As	0.0122	7.91	30.16	7.53	8.723
Cd	0.0012	0.0015	0.003	0.0015	0.0017

DISCUSSION

The analysis revealed significant discrepancies between the actual and labeled amounts of essential minerals in the multivitamin preparations. Company 1's product showed the closest alignment with labeled values, indicating a reliable formulation. In contrast, Company 3 exhibited the largest deviations, particularly in the amounts of iron and selenium, which were significantly lower than labeled. This raises concerns about the efficacy of the product in addressing nutritional deficiencies. Moreover, the presence of heavy metals was concerning. Company 2 and Company 3 had arsenic levels exceeding the USP permissible limits, suggesting potential health risks associated with long-term

consumption. The findings highlight the need for stringent quality control measures in the production of dietary supplements to ensure consumer safety.

The results indicate that while some products meet safety standards, others contain unacceptable levels of heavy metals and significant discrepancies in labeled versus actual mineral content. The high levels of arsenic found in several products, particularly in Company 2 and Company 3, pose a serious risk to consumers, as chronic exposure to arsenic can lead to various health issues, including cancer and cardiovascular diseases [6,9,10].

CONCLUSION

This study underscores the importance of evaluating the elemental composition of multivitamin preparations available in the Libyan market. The findings indicate that while some products meet safety standards, others contain unacceptable levels of heavy metals and significant discrepancies in labeled versus actual mineral content. It is recommended that regulatory bodies enforce stricter testing and labeling requirements for dietary supplements to protect consumer health. Furthermore, manufacturers should adopt good manufacturing practices (GMP) to ensure the quality and safety of their products. Regular monitoring and testing of dietary supplements for heavy metals and other contaminants should be mandatory to safeguard public health.

Conflict of interest. Nil

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تقييم التركيب العنصري في المستحضرات متعددة الفيتامينات المتوفرة في السوق الليبي: الآثار المترتبة على السلامة والفعالية

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المستخلص

تُقيّم هذه الدراسة الكميات الفعلية والمُعلنة للعناصر الكلية والنادرة في خمسة مستحضرات متعددة الفيتامينات تُسوّق في ليبيا، باستخدام تقنية التحليل الطيفي للانبعاثات الضوئية بالبلازما المقترنة حثيًا .(ICP-OES) تُركز التحليلات على المعادن الأساسية مثل الكالسيوم(Ca) ، النحاس(Cu) ، الحديد(Fe) ، المغنيسيوم(Mg) ، المنغنيز(Mn) ، السيلينيوم(Se) ، والزنك (Zn)، بالإضافة إلى المعادن الثقيلة الشائعة مثل الزرنيخ(As) ، الكادميوم(Cd) ، والرصاص .(Pb) وقد كشفت النتائج عن وجود تباينات كبيرة بين الكميات الفعلية والمُعلنة لبعض العناصر، مما يثير مخاوف بشأن سلامة وكفاءة هذه المكملات عند استخدامها على المدى الطويل.

الكلمات الدالة. الفيتامينات المتعددة، المعادن الثقيلة، ICP-OES، السلامة الغذائية، ليبيا.