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Original Article

Lead Content in Weight Loss Food Supplements

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Abstract

Introduction: The control and prevention of lead exposure are widely discussed topics that seem to be current health concerns for the next decades. Ingestion of lead into the human body can cause toxicity which can be acute or chronic. Possible sources of lead exposure can be, among others, water, food, drugs, and food supplements. The lead content in drugs is a strictly controlled parameter worldwide. The different Pharmacopoeias (European, British, USA) provide information about the limits for lead in every drug substance and also about the tests that should be performed. Regulation of food supplements does not require obligatory analytical control. Often, these products are not monitored to ensure the quality. At the same time, during the last two decades, the global use of dietary supplements has increased manifold.

Aim: This study aimed to analyse the presence of lead in food supplements used for weight control.

Materials and methods: We have analysed 30 different samples of food supplements for lead content. These supplements are all sold as weight loss products. The method of analysis consists of determination the lead concentration in food supplements using inductively coupled plasma mass spectrometry.

Results: We found that 4 of the analysed samples provide a lead intake of between 2.339 and 2.88 μg per day. The lead content in the other 26 samples was not significant.

Conclusions: The regulation of food supplements is rather liberal and loose. Often the exact amount of the main ingredients is not properly labeled and the purity of these products is not controlled. Food supplements are used by consumers of different ages and with different medical conditions. Our recommendation is that the lead content should be obligatorily monitored and indicated on the label of every food supplement. This would be especially useful for the prevention and control of lead exposure worldwide.

Keywords

food supplements, lead, obesity, weight loss

INTRODUCTION

Lead was one of the earliest metals discovered by humanity. It is also one of the oldest known and most widely studied toxins.[1-3] Lead is naturally found in the Earth's crust and is persistently found in the air, water, soil and some manufactured products such as paint, ceramics, cosmetics, water pipes, etc.[4,5]

Human exposure to lead is very difficult to control because it could occur through various sources like water, numerous industrial products, plants, drugs, plant based food supplements etc.[3]

The ingestion of lead into the human body causes toxicity which can be acute or chronic. Lead toxicity is associated with disorders of the central nervous system, the respiratory, hematopoietic, cardiovascular, hepatic, and renal systems.[3-11] Lead also disrupts the calcium metabolism which leads to a decrease in the calcium levels.[8] While acute lead toxicity is quite uncommon, the chronic toxicity is much more common and occurs at blood lead levels of about 40–60 μg/dL. The limit of daily intake of lead is 1.0 μg/g, but prolonged intake of this dose is toxic.[12]

The prevention and control of lead exposure are widely discussed topics that seem to be current health concerns in the next decades.

In the past, there were no specific methods for detection of lead in low concentrations. Some of the classic methods used for detecting lead are the solubility-based determinations, titration methods, dry ashing, and hot plate acid digestion. These methods are not accurate enough. Nowadays, there are many analytical methods that could be used to detect very low concentrations of lead, such as, among others, the inductively coupled plasma mass spectrometry, the atomic absorption spectrometry, comparative tests using thioacetamide reagents, magnetic metal organic frameworks adsorbent modified with mercapto groups, laser-induced breakdown spectroscopy, and magnetic resonance imaging. The atomic absorption spectrometry is a sensitive, widely used method for detecting lead in samples, but it is prone to matrix interference.[13] Using these methods, the presence of lead in food, supplements, and drugs can be easily detected.

Possible sources of lead exposure are water, food, drugs, food supplements, and others. Food supplements are used daily by millions of people all over the world for different purposes like weight control, prevention of dysbacteriosis, enriching the diet, boosting immunity, to improve the memory and the function of the heart, kidneys and liver, and protection from oxidative stress. They are designed to normalize the diet. People take them to improve their health and to get enough essential nutrients. Usually the manufacturers of food supplements recommend long use of their products for better results. The consumers, however, not always consult with their doctors before using them. This almost surely causes adverse effects and toxicity.

In drugs, the amount of lead is strictly regulated and monitored – the lead levels for every drug are specific and controlled, but this does not apply to food supplements. The regulation of food supplements does not require analytical control. However, it should be controlled. In addition, often the product labels do not list all ingredients and their quantities.[14-20]

AIM

This study aimed to analyse the presence of lead in food supplements used for weight control.

MATERIALS AND METHODS

The method consists of determination of lead in food or food supplements using the inductively coupled plasma mass spectrometry (ICP-MS).

- Introduction of the measured solution in radio-frequency plasma, where dissolution, atomization and ionization of the elements occur;
- Extraction of ions from the plasma by means of a differential vacuum interface with integrated ion optics and separation based on the mass-to-charge ratio using mass spectrometer (in this case, a quadrupole);
- Ion transfer through a mass separation system (quadrupole), measurement with a dynode electronic photomultiplier SEM (dual mode secondary multiplier) and information processing through a data management system;
- Quantification after calibration with appropriate calibration solutions.

The analysed sample was well homogenised. Then, depending on the matrix, it was subjected to acid digestion under pressure by microwave heating in closed vessels (standard BDS EN ISO 13805: 2003 is observed). In case the sample was easily soluble and did not require microwave treatment, acidification and direct dilution were applied with an appropriate factor. If necessary, the sample was filtered with a 0.45-μm PTFE filter.

Sample preparation involved the following steps: 0.2–1.0 grams of the sample was weighed directly into a microwave digestion vessel (at least two replicas were prepared), 5–10 mL of HNO_3 was poured on and 1–2 mL of H_2O_2 was added. After completing the appropriate microwave digestion and cooling program, the sample solutions were quantitatively transferred to 25-mL volumetric flasks (50 or 100 mL) and, if necessary, further diluted to avoid matrix effects and to introduce analytes in the working range of the method. The content of the test analytes is calculated on the basis of the concentration obtained from the calibration dependence, taking into account the dilution ratios from the performed sample preparation.

RESULTS

We have analysed 30 samples of food supplements which are sold as products for weight loss. The lead concentration in ppm is presented in **Table 1**. We have established the content of lead in every food supplement and calculated the daily intake of lead for the products with high levels. We found only 4 products that were potentially dangerous. The lead concentration in these 4 products varied from 1.72 to 2.44 ppm, but according to the recommendations on the labels, these products should be taken several times daily for a period of 1 or 2 months, which exposes the consumers to a potential risk. The daily intake of lead in the other 26 samples was not significant.

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Table 1. Lead content in 30 weight loss food supplements

Sample	Content	Total weight of 1 capsule/ tablet	Formula-tion	Recommended dose (on the label of the product)	Lead conc.	Lead conc. per dose	Lead intake per day
No		mg			ppm	µg	µg
1	Garcinia cambogia extract	570	capsules	1-2 capsules 2 times per day	0.151	NS	NS
2	Green tea extract	340	capsules	2 capsules 2 times per day	1.72	0.5848	2.339
3	Green tea extract	190	capsules	2 capsules 3 times per day	0.86	NS	NS
4	Combination – plant extracts	450	capsules	1 capsule 2 times daily	0.004	NS	NS
5	Combination – plant extracts	500	capsules	2 capsules 2 times per day	0.06	NS	NS
6	Combination – plant extracts	450	capsules	1 capsule 2 times daily	0.004	NS	NS
7	Green tea extract	500	capsules	1 capsule 2 times daily	0.795	NS	NS
8	Green coffee extract	730	capsules	1 capsule 2 times daily	0.044	NS	NS
9	Green tea extract	650	capsules	1 capsule 2 times daily	0.004	NS	NS
10	Garcinia cambogia extract	1500	tablets	1-2 capsules 2 times per day	0.164	NS	NS
11	Green tea extract	500	capsules	1 capsule 2 times daily	0.131	NS	NS
12	Combination – plant extracts	500	capsules	1 capsule 2 times daily	2.42	1.21	2.41
13	Combination – plant extracts	1400	powder	1 dose once or twice per day	0.112	NS	NS
14	Guarana extract	900	tablets	2 doses 4 times per day (2×4)	0.72	NS	NS
15	Combination – plant extracts	400	capsules	1 capsule 2 times daily	0.146	NS	NS
16	Green tea extract	200	tablets	2 tablets once a day	0.193	NS	NS
17	Combination – plant extracts	500	tablets	1 tablet 2 or 3 times daily	0.12	NS	NS
18	Combination – plant extracts	600	capsules	1 capsule 2 times daily	0.319	NS	NS
19	Combination – plant extracts	450	capsules	1 capsule 2 times daily	0.004	NS	NS
20	Combination – plant extracts	450	capsules	1 capsule 2 times daily	0.036	NS	NS
21	Combination – plant extracts	350	capsules	1 capsule 3 times daily	0.289	NS	NS
22	Combination – plant extracts	450	capsules	1 capsule 2 times daily	0.004	NS	NS
23	Biotin	220	tablets	1 tablet 2 times daily	0.042	NS	NS
24	White Kidney Bean Extract	125	capsules	1 capsule 3 times daily	0.116	NS	NS
25	Yohimbine	900	capsules	1 capsule 2 times daily	1.6	1.44	2.88
27	Combination – plant extracts	500	capsules	1 capsule 2 times daily	0.055	NS	NS
26	Combination – plant extracts	450	capsules	1 capsule 2 times daily	0.095	NS	NS
28	Combination – plant extracts	550	capsules	2 capsules once	2.17	1.2	2.4
29	Combination – plant extracts	800	capsules	1 capsule 2 times daily	0.035	NS	NS
30	L-carnitine	1700	tablets	2 tablets 2 or 3 times daily	0.009	NS	NS

NS: not significant

We calculated that consumption of sample 25 produces a lead intake of 2.88 μg per day, which makes 86.4 μg per 1 month. Sample 25 contained yohimbine extract.

Consumption of sample 12 produces a lead intake of 2.41 μg per day (or 72.3 μg per 1 month).

Consumption of sample 28 would result in a lead intake equal to 2.4 μg per day, which is 72 μg per 1 month. Sample 28 contained different plant extracts.

Consumption of sample 2 would result in 2.339 μg of lead intake per day, which is 70.17 μg per 1 month. Sample 2 contained green tea extract.

DISCUSSION

Globally, consumption of dietary supplements has increased manifold over the last two decades. One of the categories of food supplements of wide use is the weight control category which is used by different age users. Most often, the weight control products contain plant extracts. The majority of consumers consider this type of products to be safe. In fact, unlike medicinal products, the food supplements are not subject to mandatory quality control. There are many cases of poor manufacturing practices that lead to the presence of admixtures of toxic and dangerous substances in low or high concentrations, undeclared substances, and incorrect concentrations of active ingredients. Food supplements are usually labelled as side effect free and completely safe.

A number of studies in the last ten years have found that the category of food supplements in the "weight reduction" segment is one of the most affected by the presence of a number of undeclared substances[14-20] that can lead to serious consequences for consumers such as allergic reactions, tremor, hypertension, arrhythmia, etc.

In order to ensure the safety of consumers, the food supplements should be subjected to mandatory laboratory testing similar to those for pharmaceutical products. This is necessary due to fact that supplements are usually recommended to be taken for a long period of time, weeks, often months.

In addition to qualitative and quantitative control of the active substances, or the basic "extracts" of which these products are composed, an analysis of the percentage of sulphated ash as well as lead levels analyses should be carried out. Lead levels should also be mentioned on the label of the respective product because food supplements are usually taken over a long period of time. Increasing the level of lead in the blood can cause serious diseases. Controlling the quality and content of food supplements can reduce the global problem of toxicity.

Lead is a heavy metal with weak metallic character which is illustrated by its amphoteric nature; lead oxides react with acids and bases, and lead can form a bond with itself. This metal can cause serious acute and chronic toxicity. Lead may interact with some of the ingredients in the food supplements and form complexes, which can increase or reduce the effect of the supplements. Lead and its compounds can accumulate. In the human body, lead can interfere with the normal physiological processes. It is not physiologically important for the human body, it is toxic.

We have tested 30 different samples of food supplements in order to determine if they contain lead, the limits within which the amount of lead should be, and whether the supplements are safe to use. The results show that all of the studied supplements contain lead but in different amounts. Most of them do not exceed the levels of the allowable daily intake and are safe when taken rationally.

Minimal amounts of lead can be found in the blood of every person because lead can be found in all parts of our environment. Normal blood lead levels in adults are below 25 μg/dL. However, these values can be reached or exceeded with constant exposure to lead from drinking sources, food, food supplements, etc.

If the lead in the blood exceeds the safe levels, intoxication can occur – chronic or acute. Acute and chronic poisoning will manifest faster in patients with predisposing diseases. Symptoms of chronic poisoning can develop from several weeks to months. Symptoms can vary, including most often headache, weakness, memory loss, and abdominal pain.

As these symptoms are characteristic also of other diseases, patients may not notice them or misinterpret them.

The results presented in **Table 1** show that only a small part of the studied products contain high levels of lead which could increase the patients' blood levels of lead, in combination with additional intake of lead from food, water, or other dietary supplements. Such products are not recommended for breastfeeding women who want to lose weight, because lead is excreted in breast milk. It is also not recommended to be taken by overweight adolescents, because children are particularly sensitive to lead exposure.

In children, the maximum permissible levels of lead in the blood are lower than those in in adults, which is less than 9 μg/dL. Lead disrupts the calcium metabolism of children and can cause disorders associated with the lack of calcium. In children, the symptoms of lead poisoning manifest quicker and affect the nervous system more dangerously than in adults.

Supplements with low lead concentration would not cause poisoning symptoms unless patients have pre-exposure factors for poisoning; however, we believe that patients should be informed about the levels of lead in the respective products, and should be able to make the right choice when deciding which product to include in their weight reduction program.

CONCLUSIONS

In the last two decades, the consumption of food supplements has grown worldwide. At the same time the regulation of these products is quite liberal and loose. Often, the exact content of the main ingredients is not properly labeled and the purity of these products is not controlled.

Food supplements are used by consumers of different ages and different medical conditions. Most of these people do not know that the food supplement they take could contain lead and thereby may cause health concerns. Our recommendation is that the lead content should be indicated on the label allowing the consumers to make an informed decision whether they should take the product. This would be also especially useful for the prevention and control of lead exposure worldwide.

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Содержание свинца в пищевых добавках для похудения

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Резюме

Введение: Контроль и предотвращение воздействия свинца являются широко обсуждаемыми темами, которые, по-видимому, будут актуальными для здоровья в ближайшие десятилетия. Попадание свинца в организм человека может вызвать отравление, которое может быть острым или хроническим. Возможными источниками воздействия свинца могут быть, среди прочего, вода, продукты питания, лекарства и пищевые добавки. Содержание свинца в лекарственных препаратах является строго контролируемым параметром во всём мире. Различные фармакопеи (Европейская, Британская, США) предоставляют информацию о пределах содержания свинца в каждом лекарственном веществе, а также о тестах, которые необходимо провести. Регулирование пищевых добавок не требует обязательного аналитического контроля. Часто эти продукты не контролируются для обеспечения качества. В то же время за последние два десятилетия глобальное использование пищевых добавок увеличилось в разы.

Цель: Это исследование было направлено на анализ присутствия свинца в пищевых добавках, используемых для контроля веса.

Материалы и методы: Мы проанализировали 30 различных образцов пищевых добавок на содержание свинца. Все эти добавки продаются как продукты для похудения. Метод анализа заключается в определении концентрации свинца в пищевых добавках с помощью масс-спектрометрии с индуктивно-связанной плазмой.

Результаты: Мы обнаружили, что 4 из проанализированных образцов обеспечивают потребление свинца от 2.339 до 2.88 μg в день. Содержание свинца в остальных 26 образцах было незначительным.

Заключение: Регулирование пищевых добавок достаточно либерально и расплывчато. Часто точное количество основных ингредиентов не маркируется должным образом, а чистота этих продуктов не контролируется. Пищевые добавки используются потребителями разного возраста и с разными заболеваниями. Мы рекомендуем обязательно контролировать содержание свинца и указывать его на этикетке каждой пищевой добавки. Это было бы особенно полезно для предотвращения и контроля воздействия свинца во всём мире.

Ключевые слова

пищевые добавки, свинец, ожирение, потеря веса