Andras S. Szabo[1]

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Mineral content of foodstuffs: osmium in foodstuffs

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1. SUMMARY

This paper – as a part of a series of articles about minerals after the former article about palladium [8] – deals with topics of toxic trace elements. In the paper information is given about a new microelement (osmium), belonging to the platinum group metals.

2. Introduction

The paper deals with questions of osmium, a trace element, belonging to the heavy platinum metals. Osmium is not an essential or beneficial element. The Os-concentration in the food chain is very low, therefore – although there are some strongly toxic Os-compounds, e.g. OsO_4 – the Os-toxicity is not a reality in the practical agricultural production and human nutrition.

2.1. The chemical importance and physiological role of osmium

Osmium, as a heavy metal trace element belongs to the platinum group metals, it is the first member of the third triade of the VIII. column of the periodical system. Osmium is a transit metal which can be taken also as a noble metal, classified together with iridium and platinum as a trace element of the heavy platium metals (Os, Ir, Pt). About iridium and platinum you will find information in the next parts of the series.

Osmium is a rather rare element in the nature, it was discovered in crude platinum and was named after its volatile, intensive smell having oxide (osmé = smell, odour). Osmium has the highest level of specific gravity (22.6 g/cm^3) of all chemical elements **[1]**. There are 7 osmium isotopes in the nature, among them 6 isotopes are stabile.

The osmium in chemical aspect – within the platinum group metals – is rather similar to ruthenium. In its chemical compounds the oxidation degree is between 0 and 8. The colour of its chemical compounds is various, it does not have simple ionic compounds, only occurs in form of complex ions. The water-solution of osmium oxides are neutral, even in case of high oxidation degree it is not an acid-forming element. Although osmium in strongly reactive matrix able to form different chemical compounds, but generally it is not an active chemical element, so it can be considered as a noble metal, as well.

Osmium and its alloys (because of their extra hardness) are used for solution of special industrial purposes and as catalyst, as well, but the amount, emitted in the environment as a polluting material is very small. The natural average concentration of osmium in the lithosphere is about 0.4 ng/g, but the typical Os-concentration in rocks and soils in general less **[2, 3]**. Osmium is a really a rare element, the abundance in fresh-waters and even in sea-water has a very low level.

Its physiological role is unknown, and osmium can be classified as a non-essential element and no reliable. Biopositive, stimulating effect of osmium isn't available in the literature. Therefore, the role of Os in biological terms can only be judged from point of view of its toxicity. There are some toxic compounds – eg. OsO4 is particularly toxic – but due to very low occurrence concentrations, this fact has no practical significance. It means tha the prevalence of osmium in the biosphere is significantly below the level of the typical microelements considered to be of physiological importance. In the food analyse practice an osmium polymer biosensor has been developed for the determination of sugar components in foods (eg. fruit juices, soft drinks, energy drinks) **[4, 5]**.

[1] Food Physics Public Utility Foundation

3. Osmium metabolism in the human body

The consumed amount of osmium per day in the human body is quite small, estimated at about 10^{-6} g. This low value comes mainly from food and, to a lesser extent, from drinking water. We do not know much about the absorption, but there is no doubt that the rate of absorption, and thus the amount of urine and faecal excreted osmium, strongly depends on the chemical form of the element, ie. the speciation.

3.1. Osmium content of foods

The concentration of osmium in food and feed plants – and thus obviously the plants of animal and human food chain – in the natural conditions is mainly determined by the bioavailability from the soils, if it is not necessary to calculate with a specific contamination or a special pollution source. Since the Os concentration of soil and groundwater is mostly very low - the geological origin of the soil plays a decisive role - the content of Os in food is in general quite low. Typically, it belongs to the concentration range ng/g **[6]**.

To be to emphasize that the platinum metals, although currently known to be non-essential to plant physiology, can be rather easily taken up from the soil by plants, so that the proportion of Os in plant ash can be much higher than in soils.

In foodstuffs of animal origin, even smaller Os concentrations can be measured or expected, than the plant origin ones. The typical concentration range in animal origin food materials is ng/g or even lower.

4. Conclusion

It can be concluded that osmium is not an essential element and that because of the very small concentrations in the agricultural production and in the human nutrition, the possible toxic effects of Os (or some of its compounds) have no practical significance **[7]**. During my work I have not found data in the literature about organism that would strongly enrich osmium or about food in which the concentration of osmium would be significant.

5. References

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