Chapter

Introductory Chapter: Fundamental Discussion of Selenium Effect

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1. Introduction

Here, it contains a number of recent researches on the study of selenium as well as their effect in environment and human health. Generally, in environmental samples selenium can exist in inorganic forms and as organic species with direct carbon-selenium bonds. Thus, the development of reliable techniques to study the speciation and isolation of selenium in environmental samples is necessary. Beside that, selenium is existed into minerals of fundamental importance for human health as well as living plants. Selenium status in general population is very important due to its remarkable benefits to the human body as antioxidant, hormonal regulator, and anticarcinogenic. On the other way, selenium can be toxic leaving representing a multitude of disciplines from academic, industry, and governments for sharing their extraordinary innovative and unique knowledge on this Selenium results. Moreover, selenium is perhaps the naturally occurring trace rare-earth metallic element of extreme concern worldwide. The excess amounts of selenium can lead to toxicosis and teratogenesis in plants and animals, while the permanent effect of selenium insufficiency can be even more noteworthy. Both excess and deficit are known to cause a wide range of clinical manifestations. Even though a large body of evidence provides the information about selenium, the exact molecular mechanisms of its effect in physiologic and pathologic conditions remain unknown.

2. Literature survey

Generally, selenium status in general population is very important due to its remarkable benefits to the human body as antioxidant, hormonal regulator, and anticarcinogenic. However, the relationship between selenium and health has been the focus of medical community. Early observational studies have shown that the trace element selenium in the environment is closely related to the occurrence and development of tumors [1]. The incidence of cancer in patients with selenium deficiency is significantly increased, and the amount of selenium in the body is negatively correlated with cancer [2]. Furthermore, while some studies suggested selenium supplementation reduce the risk of cancer, some methodologically sound trials suggested selenium supplementation does not reduce the risk of cancer and may even increase it for some types, including advanced prostate cancer and skin cancer [3, 4]. Cattle in Brazil are fed basically from pasture, but there are strong evidences that soils contain low availability of Se; consequently plants and animals incorporate low Se levels. Pastures Se fertilized bring benefits to nutrition and health of animal and consequently humans already known in some countries. In contrast, Se fertilization on tropical weathered soils and tropical forages are little known. Selenium exists in many different inorganic materials. Inorganic selenium, present in water and soil, can be easily transformed into volatile compounds by plants and fungi. Organic species of selenium form covalent C-Se bonds. SeCys is included into selenoproteins and participate in redox reactions. The metabolic pathway of selenium in human body is complicated [5]. In young healthy non-pregnant women, the existence of a direct relationship of moderate strength between selenium content in blood plasma and urine is established. There is a highly significant direct strong correlation between selenium in serum and erythrocytes and medium-strength relationship between selenium in urine and selenium in erythrocytes. At the same time, during the physiological course of the gestational process in healthy mothers, serum selenium levels and urine selenium values have a direct relationship of average strength. For the growth and development of the fetus, normal pregnancy requires a constant consumption of sufficient amounts of nutrients; at least 40 of them are essential for pregnant and lactating women. Nutritional status of pregnant and lactating women is of great importance for the health of the child, as the development of the body is most actively carried out up to 18 months of life. Some earlier surveying studies found that low environmental selenium is associated with certain cancers in the digestive system and selenium supplementation may provide some cancer prevention effect [6].

Moreover, the agronomic biofortification of food through field fertilization with Se could be a solution to provide this micronutrient for animals and humans through plants. The plants are able to absorb and incorporate Se to organic compounds as seleno-amino acids. Thus, inorganic Se is converted to organic Se compounds through the plants which can be easily absorbed by the human body and be available where needed in the body [7]. In some countries, Se fertilization is well established, and it is annually made in New Zealand in which Se is applied along with phosphorus fertilization in pastures [8]. The interference of large amounts of chloride ions during selenium atomization was prevented by using iridium as a permanent chemical modifier. Clinical and diagnostic parallels were made to assess the role of trace element imbalance in the placenta in the formation of pathological conditions of newborns in the early neonatal period by calculating the relative risk with 95% confidence interval. The low natural levels of Se in soils and its absence in fertilization to crops explain the low contents in food from vegetables and consequently in Brazilian diet, except for North areas. However, in the study of hemodialysis patients from North and Southeast of Brazil, both patient groups presented low Se in plasma levels, when compared to recommend standard values; independent of the region, all patients are found the Se deficiency [9]. Concisely, the concentration of selenium in serum is reduced in children with intraventricular hemorrhage and diseases of the gastrointestinal tract. However, first of all, premature children are a risk group for selenium deficiency, aggravated by living in environmentally unfavorable conditions. Many of them, especially those receiving long-term inpatient treatment, are artificially fed, and baby foods contain predominantly sodium selenite—an inorganic compound of selenium with high toxicity and low bioavailability and not always in sufficient quantities. Selenium obtained from mother's milk is better absorbed than selenium nutrient mixtures. It is recommended to add selenium to the nutrition of mothers, as well as cows whose milk is used for the preparation of nutrient mixtures. Establishment of effective and safe rates in tropical environmental is still required and which is unknown regardless of the implication to the plant enrichment of Se. High Se availability in agriculture soils can cause toxicity to crops, but it is still more concerning if a crop shows accumulator character, i.e., if a crop has capacity of absorb high levels of selenium with no symptoms of toxicity, this could increase the possibilities to cause toxicity for animals or human.

In this study, cation-exchange chromatography was used to analyze selenium-enriched yeast in a human adsorption study [10]. A mobile phase pyridinum formate buffer with 3% of methanol was used. This method was suitable for the separation of organic selenium species, however not suitable to separate the selenite. There were no differences in the content of selenium in the serum of young healthy nonpregnant women, donor volunteers, healthy pregnant women at the end of physiological pregnancy, and healthy puerperas. The provision in these groups was found to be average (82–85 μg/l), which is approximately 80% of the optimal level, since the interval of normal serum concentrations of selenium is on average 115 μg/l. At the end of physiological pregnancy and normal childbirth, the level of selenium in the blood serum was determined, which is lower than optimal for pregnant women. In premature births, serum levels of selenium were significantly lower, which is about half of the optimum. There are no significant differences in the content of selenium in the blood inversion in smoking and non-smoking women in the indicator group or in the group of healthy pregnant women. But there are significant differences found in the hair of smoking and non-smoking pregnant women. Hill et al. who investigated human liver cancer HepG2 cell line showed that in selenium-deprived HepG2 cells, selenoprotein P release decreased to 10% [11]. Further, various studies consistently reported apoptosis induction effect of selenite in human hepatoma cells HepG2 cells, potentially by inducing the release of lactate dehydrogenase (LDH) and decreasing glutathione (GSH) production [12–14]. Another study reported that selenite-induced apoptosis in HepG2 cells was mediated by reactive oxygen species (ROS) that activated JNK to regulate apoptosis [15]. A more recent study on selenium nanoparticles surface decorated with Galangin can induce apoptosis through p38 and AKT signaling pathway in HepG2 cells [16]. Similarly, selenium nanoparticles synthesized with extract of hawthorn fruit also induced apoptosis in HepG2 cells [17].

High Se contents in leaves from tropical grass and in legumes comprise another fact to be analyzed for Se fertilization rate establishment despite the few data. Usually, grass leaves and legumes are preference fractions for cattle according its intake selective behavior, mainly in tropical pastures due to high accumulation of stem portions and its low digestibility. Selenium is one of the few elements absorbed by plants in enough quantities able to intoxicate domestic animals [18]. Selenium and selenium supplementation for the treatment of liver disease should attract the attention of the medical community. However, controversies remain with whether a relationship exists between serum selenium level and HCC risk. In the study of selenium in breast milk of women living in the United States, it was determined that the average selenium content is 18 μg/l, and the maximum level reached 60 μg/l; a direct correlation was found between the level of selenium in milk and serum. In premature births, the milk of women living in New Zealand contains an average of 20 μg/l selenium. The question of the needs of newborns of selenium is not finally resolved, but most researchers recommend enriching the mixture for children with selenium in an amount corresponding to its content in breast milk. But the supply of children with selenium in an amount equal to its content in breast milk is not equivalent, because breast milk and mixtures contain different chemical forms of selenium with different levels of bioavailability and toxicity. However, epidemiological investigations and biological studies should be further conducted to demonstrate and verify whether selenium supplements are beneficial for the prevention and treatment of HCC and to elucidate its exact mechanism of action. Obtaining separation was satisfied for organic compounds but poor for selenite and selenite. For separation of organic and inorganic forms of selenium, tetrabutylammonium acetate was proposed [19]. Also mixed ion-pairing reagents (butanesulphonic and tetramethylammonium hydroxide) were also used to simultaneously separate inorganic and organic species with satisfactory separation efficiencies [20]. The most pronounced imbalance of trace elements in the groups of premature infants with a gestation period of 28–33 weeks and in newborns with intrauterine growth retardation syndrome is found, which is a manifestation of immaturity in the first and decompensation of the function of passive transport systems in the second case. Clinically, this will be manifested by a violation of acute neonatal adaptation with a low Apgar score, severe general condition, and the presence of markers of inflammatory response.

In the epidemiological study of the provision of selenium in children permanently living in Khabarovsk, a significant variability in the provision of selenium in different age groups of children with maximum security in adolescents 12–17 years is established, and the minimum level of selenium was detected in children aged 2 years of life, due to the peculiarities of nutrition and food preferences of children of different ages. In general, selenium deficiency was observed in 18% of the surveyed children, and only 28% of children found trace element content at the lower limit of the norm. The data obtained by us on the provision of selenium for children and residents of Khabarovsk are comparable with the data obtained by us from the adult population. In serum and placenta, selenium to some extent mimics the behavior of zinc and behaves opposite to copper. It is interesting to note that active smoking gave higher levels of selenium and zinc in the placenta. Both elements play an important role in protecting against oxidant stress: selenium in glutathione peroxidase and zinc in superoxide dismutase. Smoking causes severe chemical stress to the placenta, so a higher concentration of zinc and selenium in the placenta in smokers may reflect the activation of protective mechanisms.

3. Conclusion

Finally, selenium can be toxic leaving representing a multitude of disciplines from academic, industry, and governments for sharing their extraordinary innovative and unique knowledge on this Selenium results. Moreover, selenium is perhaps the naturally occurring trace rare-earth metallic element of extreme concern worldwide. The excess amounts of selenium can lead to toxicosis and teratogenesis in plants and animals, while the permanent effect of selenium insufficiency can be even more noteworthy. Both excess and deficit are known to cause a wide range of clinical manifestations. Even though a large body of evidence provides the information about selenium, the exact molecular mechanisms of its effect in physiologic and pathologic conditions remain unknown. This book explored the connection and interrelationships between selenium in environment, plants, agriculture, biology, human health, animals, molecular, and biochemistry process to complete this book. It is an important booklet for research organizations, governmental research centers, academic libraries, and R&D affianced in recent research and studied selenium effect in the environmental and human health.

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