THE ROLE OF MAGNESIUM IN MUSCLE FUNCTION

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Muscle tissue deteriorates with aging leading to severe disabilities which are important medical and social concerns. The reduction of muscle mass and function is called sarcopenia, a definition that has been associated with the aging process. Sarcopenia is also observed in several different diseases such as Inflammatory Bowel Diseases (IBD), neurologic disorders, and cancer to name only few.

Muscle is a high energy requiring tissue to allow actin/myosin contraction and relaxation. These cytoscheletal structures sustain muscle function and are regulated by a subtle balance between protein synthesis and protein degradation. The prevalence of protein degradation over protein synthesis will lead to sarcopenia. A third cellular mechanism involved is autophagy which controls the correct degradation of damaged or aged protein that needs to be subsequently followed by re-synthesis, altogether determining the protein turnover.

We currently know the molecular mechanisms governing these functions, namely i) energy production by mitochondrial respiration; ii) protein synthesis induced by hormones, growth factors, or mechanical stress signals activating cytosolic regulatory pathways such as AKT/mTOR; iii) different autophagic pathways.

Needless to say, magnesium is a crucial component of all 3 mechanisms involved in physiologic muscle function thus it is interesting to investigate how magnesium availability can affect musculoskeletal health.

We will discuss the latest clinical, in vivo and in vitro evidences that support a role for magnesium on muscle health and whether we may foresee an intervention for reducing aging and other disease-related muscle dysfunctions.

MODERN ANALYTICAL METHODS FOR THE INVESTIGATION OF BIOELEMENTS IN BIOLOGICAL OBJECTS – ADVANTAGES AND LIMITATIONS

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The usefulness of the analytical techniques for the investigation of biological and clinical objects grew significantly over the last years. This is due mainly to the improved analytical performance and the ability to provide novel set of the information about the samples. Several instrumental techniques are considered to be very useful for the investigation of the elemental as well as isotopic composition of e.g. plants, animal tissues, bacterial strains, urine, blood or saliva.

In the last years, a lot of attention was focused on the investigation of the influence of various bio-molecules in plants and animal tissues. Various analytical scenarios were tested towards investigation of the elements transport as well as its bio-transformation via examination of the presence of specific compounds in various tissues.

Several examples will be given to illustrate growing analytical performance. Commonly used determination of the elemental composition of tissues will be exemplified by the evaluation of the transport efficiency of selected bioelements in tissues and cells. Chromatographic techniques coupled to IC PMS were used to identify chemical forms of selected elements. The analytical scenario for speciation studies which was developed toward the evaluation of the bio-mechanism will be exemplified by the investigation of the selenium, iron, platinum and zinc.

The laser ablation coupled to ICP MS facilitate to perform the elemental distribution over the solids surface and subsurface domain. This was used for the investigation either the cross section of various tissues (e.g. brain, ovary, uterus) or for the examination of the capillary gel after species separation in blood or serum. This approach will be exemplified by several projects related to the Wilson disease as well as investigation of the effect of platinum-based anticancer drugs.

COPING OF STRESS WITH MAGNESIUM

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According to H. Selye (1907–1982) stress is defined as "nonspecific response of the body to any demand", eliciting the General Adaptation Syndrome which is characterized by three stages: Alarm Reaction – Adaptation – Exhaustion. Hence a given stressor, e.g. forced muscular work, can be harmful on acute or prolonged exposure ("distress") or beneficial at increased level of resistance ("eustress"). [1, 2]

Magnesium (Mg) acts as physiological NMDA-receptor antagonist, stimulates GABAa-receptors, inhibits glutamate release from presynaptic neurons by antagonizing Ca^{2+} and leads to synaptic strengthening [3–5]. In cats with chronically implanted electrodes oral Mg caused electrophysiological alterations characteristic for tranquillizing effects. [6] Accordingly, plentiful Mg supply attenuates the release of stress hormones in man [7] and protects livestock (piglets, pigs, horses, chicken) against diverse stressors like transportation stress, restlessness or cannibalism. Positive effects on mood, sleep, depression and affective disorders have also been reported. [8, 9]

On the other hand, Mg deficiency sensitizes against various stressors, e.g., noise stress, [10–13] hearing loss, [14] cardiovascular diseases, [15] functional disorders in children and man ethanol withdrawal [16, 17]. Mg deficiency also plays a key pathogenic role in the development of diabetes [18] and osteoporosis [19].

Consequently, pathogenic factors causing Mg deficiency need further studies and, on the other hand, plentiful Mg supply is recommended for coping with distress either utilizing its pharmacological or its dietary effects.

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TRPM7 AT THE CROSSROAD OF CELLULAR MAGNESIUM AND CALCIUM SIGNALING

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The Melastatin-related Transient Receptor Potential member 7 (TRPM7) is a unique fusion protein between an ion channel and an α-kinase (Reviewed in [1]). TRPM7 is essential for cellular systemic magnesium (Mg^{2+}) homeostasis and early embryogenesis. It promotes calcium (Ca^{2+}) transport during global brain ischemia and emerges as a key player in cancer growth. Store-operated Ca^{2+} entry is an important signaling mechanism in most immune and other electrically non-excitable cells (SOCE, reviewed in [2]).

We find that TRPM7 synergistically interlaces with SOCE in the regulation of intracellular Ca^{2+} homeostasis. [3] Experiments in DT40 B lymphocytes carrying various STIM and ORAI combinations and TRPM7 mutations show that the TRPM7 kinase domain positively regulates SOCE. In addition, the TRPM7 channel domain participates in the maintenance of endoplasmic reticulum Ca^{2+} concentrations in resting cells. While the former mechanism contributes to receptor-mediated Ca^{2+} signaling, the latter is a homeostatic mechanism independent of receptor stimulation.

In primary mouse mast cells, we find that the TRPM7 kinase domain, but not the channel domain, is involved in the regulation of G protein-coupled receptor (GPCR) stimulation by setting the Ca^{2+} sensitivity of GPCR-triggered mast cell degranulation. [4]

Finally, we find that the TRPM7 kinase provides negative feedback inhibition on GPCR-mediated Ca^{2+} release. Heterologous overexpression of human TRPM7 leads to disruption of protease or purinergic receptor-induced Ca^{2+} release unless an adequate intracellular supply of adenosine triphosphate

(Mg·ATP) is guaranteed. The disruption occurs at the level of G_q, which requires intact TRPM7 kinase phosphorylation activity [5].

We propose that the TRPM7 kinase can modulate Ca^{2+} signaling by: 1) enhancing SOCE, 2) fine-tuning the Ca^{2+} sensitivity of GPCR signaling, and 3) limiting GPCR-mediated Ca^{2+} signaling during reduced cellular ATP levels.

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THE ROLE OF MAGNESIUM IN THE PATHOGENESIS OF ALZHEIMER DISEASE

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Alzheimer disease (AD) is the most frequent cause of dementias and one of the most common causes of deaths among the elderly population. It has been estimated that about 60% to 80% of patients diagnosed with dementia suffer from the disease. AD morbidity increases with age, and in adults more than 80 years old, exceeds 30%.

AD is an irreversible, neurodegenerative and progressive disease of the central nervous system. AD pathology includes senile plaques composed of pathological amyloid-beta, neurofibrillary tangles and reactive gliosis in the brain parenchyma of affected individuals. Most cases of the newly diagnosed AD (95%) are termed sporadic AD, while only about 5% are early onset AD associated with familial occurrence. Genetic determinants play a pivotal role in the pathogenesis of AD, but environmental factors are also important. Magnesium has been described as one of them.

Magnesium is a widely distributed element in nature. It acts as a cofactor of various enzymes involved in the synthesis of proteins and nucleic acids, energy processing, carbohydrate metabolism or mitochondrial membranes stabilization. Researchers pay an increasing attention to the key role of magnesium in the regulation of the central and peripheral nervous systems. Susceptibility to AD has been linked with a particular sensitivity of the brain to magnesium deficiency. Significantly decreased plasma magnesium concentrations in patients with AD, in comparison with healthy individuals of the same age, have been reported. In post-mortem neuropathological studies carried out in people who died from AD, significantly decreased magnesium levels

in pathologically changed tissues have been observed. Moreover, positive effects of magnesium on learning abilities and memory improvement have been described.

Taking into consideration all the aforementioned data, it seems advisable to include magnesium in the prevention and support of AD treatment.

ARE THERE ANAMNESTIC RISK FACTORS FOR MAGNESIUM DEFICIENCY IN PREGNANCY?

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Magnesium deficiency is highly prevalent in our populations. This especially stands for pregnant women, where too low magnesium intakes in and already before pregnancy and also pregnancy-related metabolic changes may cause magnesium deficiency. Magnesium deficiency may lead to complications during pregnancy and birth. However, magnesium deficiency remains often unrecognized as associated symptoms are not specific, the results of laboratory methods are often misleading, and consensual threshold values do not exist.

Based on clinical observations that magnesium deficient patients often are complaining of diverse symptoms, our aim was to investigate if a short screening questionnaire operationalizing a set of symptoms and conditions could predict magnesium deficiency.

In a pretest study, we investigated a sample of n = 193 pregnant women. They had to fill in a questionnaire with sixty questions including also a diet history tool as well as a list of unspecific, but magnesium deficit-related symptoms. Blood samples were taken and magnesium deficiency was assessed using a cut off value of < 0.76 mmol/L. Participants with and without hypomagnesemia were compared for all relevant questionnaire items where 11 items showed significant differences. These items were used for a scoring model.

72% of the pregnant women turned out to have hypomagnesemia. The model led to an optimal cut off value with a sensitivity of 54% and a specificity of 89%. The positive Likelihood Ratio is 4.92. High scores in the screening questionnaire can reliably predict actual magnesium deficiency. In patients with low and moderate scores the test however is imprecise and not useful. Using the screening test will however detect a reasonable amount of patients. The test is already available in the Babycare-App. Further studies with higher samples could improve and confirm the results.

TECHNOLOGIES OF PRODUCING MAGNESIUM-CONTAINING DRINKING WATER

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Magnesium plays an important role in the development and existence of all living organisms including humans as a chemical element in nature. The methods currently proposed for replenishing and maintaining the necessary concentrations in the body vary greatly. Natural sources of magnesium (vegetables, fruits, mineral waters, etc.) as well as artificial (powders, tablets and others) are offered. It is proposed to consider the methods and technologies of the production of artificial drinking water which will contain magnesium ions and other minerals like a natural which are necessary for the human body for its development. The technologies are developed on the basis of existing world developments and inventions NTU "KhPI", Kharkov, Ukraine.

CHROMIUM REDOX SPECIATION IN FOOD SAMPLES

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Chromium is an element with important biological characteristics, depending on its different species. Cr(III) is considered as essential, but Cr(VI) form is classified as carcinogenic. For this reason speciation analysis in food samples is a very important question. The proposed in literature analytical procedures for speciation of chromium can be divided onto two groups. In the first of them, hyphenated techniques such as high-performance liquid chromatography or capillary electrophoresis have been utilized. In the second group, selective separation of one or two chromium species onto a solid phase extraction column or complexation reactions have been proposed. The extraction of chromium species from solid food samples is one of the most critical steps in the whole analytical procedure. The main difficulty is to preserve the initial distribution of both redox chromium species in a sample as well as to obtain the high extraction efficiency. The application of the proposed strategies for determination of Cr(III) and Cr(VI) content in some food samples will be presented and discussed.

MAGNESIUM – A CRITICAL COMPONENT IN AGRICULTURAL PRODUCTION IN POLAND

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Magnesium plays an important role in plants biochemical and physiological processes, significantly impacting both crop yield and the yield quality. Unfortunately, the unfavorable soil and climate conditions in most parts of Poland impede magnesium uptake by crop plants, thus creating a risk of the element deficiency in plants, and consequently, in animals and humans. The primary objective of this lecture is to present a range of factors that inhibit magnesium uptake and disturb its use by plants in terms of the yielding potential and the yield quality.

The main natural reasons for a poor magnesium supply to crops result from low contents of i) clay particles in soils (almost 60% of arable land in Poland consists of light and very light soils), ii) magnesium-bearing minerals, iii) capacity of the cation adsorption complex, iv) soil acidification and a presence of exchangeable aluminium (Al^{3+}). All these factors contribute to great magnesium leaching from the soil. [1, 2] Some of the anthropogenic causes may include an imbalanced fertilization, inappropriate technology, etc. There has been observed, based on agrochemical analysis, a considerable improvement of soil available magnesium content in soils across Poland in recent years. However, approximately 1/3 of agricultural areas display either very low or low content of ready for use forms of magnesium. [3]

In agricultural production, one of the most important factors controlling yield forming potential of crop plants is the content of mineral nitrogen in soil. An effective use of N directly from soil, or from N fertilizers, requires not only an appropriately adopted technology but also a presence of other nutrients, capable for controlling its uptake and use by crop plants. Magnesium is among them one of the most distinctive nutrients. Its presence in the chlorophyll particle and an ability to activate the enzyme responsible for CO_2 bond (ribulose-1,5-bisphosphate carboxylase) are considered as particularly important, yet highly specific functions. [4] Magnesium is, therefore, the basic nutrient controlling processes responsible for photosynthesis, assimilates production, and their partitioning among plant organs. [5] The optimal yield forming effect of magnesium can generally occur under conditions of relatively low nitrogen supply (soil + fertilizer nitrogen), but high supply of magnesium. This phenomenon can best be described as magnesium-induced nitrogen uptake. [6]

What also deserves attention is the key role of magnesium in the biosynthesis of protein compounds, carbohydrates or fats. That is precisely why magnesium fertilization is recommended as a highly effective treatment for improving the quality of various crops. [7] Its high concentration in plant products ensures the appropriate supply of this nutrient to animals as well as humans. This phenomenon has acquired a real significance in recent years, as, due to an increased yield forming potential of modern varieties, the magnesium concentration in grain and other edible parts of a plant has declined. [8] Appropriate magnesium fertilization allows for a better environmental protection, as it limits any non-productive losses of water and nitrogen from the soil. [9]

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CHANGES OF MAGNESIUM CONTENT AND ACTIVITY OF NITROGENASE IN CULTIVATION OF ALFALFA FERTILIZED NPKFEMO

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The aim of the study was to determine the changes in magnesium content in alfalfa biomass (*Medicago sativa* L.) and nitrogenase activity under the influence of NPK fertilization and differential doses of Fe and Mo.

In a three-year field experiment conducted in a completely random system, eight levels of fertilizer were considered in the experimental plots of the Siedlce University of Natural Sciences and Humanities: 0, NPK, $NPKFe_1$, $NPKMo_1$, $NPKFe_1Mo_1$, $NPKFe_2$, $NPKMo_2$, $NPKFe_2Mo_2$ (N – 20, P – 22, K – 124.5, Fe_1 – 0.5, Mo_1 – 0.5, Fe_2 – 1.0, Mo_2 – 1.0 kg ha^{-1}). In the following years, four swaths of alfalfa were collected in the budding phase. [1] Magnesium content was determined by ICP-AES method after prior mineralization of plant samples. Nitrogenase activity was determined by acetylene reduction to ethylene using a CSI gas chromatograph with an FID detector (flame ionization).

The applied fertilization significantly differentiated the magnesium content in the first and second year of research. During the first growing season, in the following cuttings of alfalfa biomass, increased amounts of magnesium were determined. [2, 3] In the second and third year of the experiment, the next dates of the test plants collection affected the reduction of the magnesium content in alfalfa. In subsequent years of research, significantly lower amounts of magnesium in the biomass of test plants were determined (2.03 – 1.83 – 1.76 g kg^{-1} d.m.). Fertilization of $NPKFe_1$ and $NPKFe_1Mo_1$ in the second year of research significantly differentiated magnesium content in soil. Only in the first year of research, the level of magnesium in the soil was reduced, in subsequent dates of harvesting of alfalfa. Magnesium content significantly decreased in soil in subsequent years of research (1.04 – 0.87 – 0.77 g kg^{-1}). Soil fertilized with $NPKMo_2$ was characterized by the highest nitrogenase activity (34.81 nM C_2H_4). [4]

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MAGNESIUM IN HYPERTENSION

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An increasing role for intracellular magnesium concentration in vascular tone has been postulated in essential hypertension. In essential hypertensives decreased intracellular free magnesium concentrations in red blood cells as estimated by nuclear magnetic resonance spectroscopy were found years ago. Analogous findings were reported in the spontaneously hypertensive rat. Thus an intracellular magnesium deficiency and possibly a defect in cellular magnesium transport could play a pathogenetic role. On the basis of experimental data, the mechanisms underlying the magnesium induced vasodilation may be: a modification of response to vasopressor hormones, and an interaction with cellular calcium handling. These possible mechanisms are supported by 3 lines of evidence. First, the extracellular magnesium concentration can influence calcium metabolism of vascular smooth muscle by changing the calcium influx through the plasma membrane. In single myocytes from frog ventricle, the site of interaction between magnesium and calcium was identified as the calcium inward current that is dependent on phosphorylation by cyclic adenosine monophosphatase. Second, changes in the calcium content of vascular smooth muscle and in exchangeable calcium. Third, a decrease in the intracellular free magnesium concentration results in diminished membrane sodium, potassium adenosine triphosphatase and calcium ATPase activities, and, as a corollary, increased sodium–calcium exchange and increased intracellular sodium and calcium concentrations.

As described earlier a disturbed sodium and magnesium exchange is involved in the pathogenesis of primary hypertension.

In recent literature the role of TRPM6 and TRPM7 channels is described.

In borderline hypertensives decreased intracellular magnesium concentrations have also recently been described, as well as a positive magnesium effect on hypertensive heart disease. [1–3]

In addition, a magnesium therapy is effective in lowering blood pressure values in borderline hypertensives and essential hypertensives also preventing the development of arteriosclerosis. A positive effect of magnesium on hypertensive heart disease has also been described.

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MAGNESIUM STATUS EVALUATION: THE PRESENT AND THE PERSPECTIVES

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This review focuses on current knowledge and future trends in the magnesium status evaluation.

Sub-optimal magnesium intake in large part of population in Western countries supports an increased risk of latent magnesium deficiency. This chronic mild deficiency can cause a wide spectrum of health disorders that can be considered nonspecific and may be at the origin of progressive severe health deterioration, in particular, cardio-metabolic diseases. In turn, several pathophysiological conditions e.g. metabolic syndrome, obesity, type 2 diabetes, stress and aging-related dysfunctions can contribute to and deepen chronic magnesium deficiency.

Compared with severe magnesium deficiency, the diagnosis of latent deficiency is difficult because of nonspecific clinical symptoms and magnesemia often within reference intervals. Current clinical laboratory tests are almost limited to total serum magnesium. Less frequently ionized serum magnesium, red blood cell magnesium and urinary excretion of magnesium are measured. Recent meta-analyses have shown that both circulating and urine magnesium concentrations respond to oral magnesium supplementation and dietary depletion, confirming their value as markers of magnesium status. However, the assessment of magnesium status to diagnose latent deficiency is still problematic because only subtle changes occur in these parameters and there is a large inter-individual variability. Accurate assessment of magnesium status remains a major challenge for the clinical laboratory. Magnesium is mainly an intracellular cation and in the body is mostly found in the bone and soft tissues. Therefore, to develop rapid and robust test representative for intracellular magnesium or for the whole body magnesium in humans is difficult to achieve.

The presentation aims at discussing on significant progress in various areas (chemistry, molecular biology, mass spectrometry) and the great opportunities in developing new approaches to the assessment of magnesium status, e.g. use of stable isotopes of magnesium, new dyes for intracellular magnesium or magnesium-metabolism related gene expression measurements.

THE EFFECT OF ACUTE LOWER LIMBS ISCHEMIA ON THE OXIDATIVE STRESS BIOMARKERS AND BLOOD PLASMA MAGNESIUM AND CALCIUM CONCENTRATION

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Acute lower limb ischemia (ALI) is a potential threat to viability of the limb, and according to the guidelines of TransAtlantic Inter-Society Consensus (TASC II) [1, 2] it is the clinical manifestation of a sudden decrease in blood flow to a limb causing complex changes to the limb, also to the patient's life. The hypoperfusion period induces systemic disturbances and results in the release of highly toxic free radicals and reactive oxygen species exacerbating mechanisms of the oxidative stress arose during ischemia, and inducing systemic disturbances of acid-base balance, and water and electrolyte balance. [3–5]

The aim of the study was to investigate the effect of the ALI on blood plasma calcium and magnesium concentration, total antioxidant status (TAS), serum CRP levels, and the activity of superoxide dismutase (SOD) and glutathione peroxidase (GPx) before and after revascularization of the lower limb due to ALI.

The study group was 52 patients with symptoms of ALI, divided into two groups according to classification SVS/ISCVS of acute ischemia degree. All patients underwent urgent revascularization therapy. Venous blood was collected in following sequences: after admission and before surgery, 30–40 minutes, 12, 24, and 48 hours after revascularization.

In the study, the mean Ca concentration in plasma was found within the reference range, similar in patients of different degree of ischemia (2.31–2.49 mmol/L), and remained unchanged during the whole treatment period.

Mg concentration was found low in both groups as compared to the reference range (0.69–0.73 mmol/L) and remained low during the postoperative treatment. In patients with a serious degree of acute ischemia, Mg level decreased significantly after 48 hours of the treatment. The decrease in plasma TAS was observed in the postoperative period (1.51 mmol/L before surgery and 1.27 mmol/L after 48 h) correlated with the degree and time of acute ischemia. CRP level, and the activity of SOD and GPx increased significantly after revascularization in comparison to the values found before surgery and correlated with the degree and time of ALI.

The results showed the lowering effect of ALI on Mg, but not on Ca concentration. Surgery, the degree and time of ischemia in patients with ALI caused the decrease in the total antioxidant status followed by the increase of the antioxidative mechanisms: the activity of SOD and GPx. The study confirmed that the ischemia-reperfusion syndrome induces a systemic inflammatory response, shown as the significant increase in CRP level.

It may be assumed that there is a correlation between hypomagnesemia and the increased risk of ALI. Moreover, magnesium supplementation may have protective effects on patients with ALI and could improve overall prognosis.

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Mg^{2+} COMPLEXES WITH BIOLIGANDS. ANALYTICAL AND BIOMIMETIC APPROACH

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Magnesium complexes with ligands that are present in biological liquids and biomembranes are in focus. The ligands studied are: lactate, oxalate, citrate, hydrogen carbonate and phosphate, asparagine, glutamine, adenosine phosphates (ATP, ADP) and heparin. Conducting polymers, purposely doped with these ligands, are used as the biomimetic membranes.

The electroanalytical methods employed for characterization of the Mg^{2+} complexation processes and membrane potential formation are shown, and the outcomes discussed. Finally, by integrating the thermodynamic and kinetic properties of Mg^{2+} complexes and the membrane potential mechanism, a method is demonstrated which gives deeper insight into the physiological role of magnesium ion in the biological cell membranes than is thus far known. This integration is mathematically possible owing to the Nernst–Planck–Poisson model, which is also briefly characterized.

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IONIZED AND TOTAL MAGNESIUM CONCENTRATION MEASUREMENTS IN BIOLOGICAL SAMPLES

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The most frequently used techniques of total magnesium determination in the routine analysis are atomic absorption spectrometry (AAS), either with atomization in graphite furnace (GF AAS) or in flame (F-AAS), and spectrophotometric methods using magnesium complexing agents, such as Xylidyl Blue, calmagite, and 8-hydroxychinoline. X-ray fluorescence can also be used for total magnesium determination, being the only method that does not destroy the investigated sample. The other methods, such as potentiometry with ion-selective electrode sensitive to magnesium ions, ^{31}P nuclear magnetic resonance (NMR) investigating chemical shift dependent on complex Mg-adenosine triphosphate (Mg-ATP) formation, UV/Vis fluorescence using fluorescent dye, and mainly Mag-Fura 2, all allow to determine ionized, hydrated magnesium. Potentiometry and NMR do not destroy the investigated sample. Moreover, ^{31}P NMR can be used in vivo. X-ray fluorescence, ^{31}P NMR and UV/Vis fluorescence are used for mapping magnesium, total or ionized, inside the cell or tissue. Potentiometry with ion-selective microelectrodes, with a tip diameter of one micrometer, are used to investigate the local concentration of ionized magnesium inside the cell. [1–4] Not only total and ionized magnesium concentration but also their spatial distribution is of great importance because the different localization of a specific element within a cell or a tissue often refers to a different biological function. Recently, several novel fluorescent dyes that allow imaging the distribution of total magnesium inside a cell were synthesized and investigated. [5]

The importance of both ionized and total magnesium concentration determination inside the biological fluids and cells will be discussed.

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IDENTIFICATION AND QUANTIFICATION OF SELENIUM COMPOUNDS IN BIOLOGICAL SAMPLES BY MASS SPECTROMETRY

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Selenium is one of essential trace elements. A lot of effort has been taken to find out and understand the role of this element in physiological and pathological processes taking place in a variety of living organisms including humans. Selenium-containing compounds have been recognized as antioxidant or chemo-preventive agents which at present are applied in the supportive therapy for cancer treatment.

Nowadays mass spectrometry is the most powerful technique to identify and quantify both low- and high-molecular weight chemical compounds in complex biological samples such as plant and animal tissues.

Here we present the analytical procedures using mass spectrometry techniques allowing qualitative and quantitative analysis of low-molecular weight selenium compounds (selenium metabolites) as well as high-molecular weight compounds such as selenoproteins and selenium-containing proteins in the plant (garlic, radish and onion) and animal tissues' samples (sheep and humans).