

Session 10. METAL IONS: NUTRITION AND DEFICIENCIES

DETERMINATION OF EXCHANGEABLE MAGNESIUM POOL MASSES IN MAN AND ANIMAL: EFFECT OF MG DIETARY INTAKE

¹C. Feillet-Coudray, ¹C. Coudray, ¹E. Gueux, ¹A. Mazur, ²S.A. Abrams, ¹Y. Rayssiguier

¹Centre de Recherche en Nutrition Humaine d'Auvergne, Unité Maladies Métaboliques et Micronutriments, INRA Theix, 63122 St Genès Champanelle France; ²USDA/ ARS Children's Nutrition Research Center, Baylor College of Medicine, Houston, Texas 77030, USA.

Magnesium is a biologically essential mineral and Mg deficiency is known to lead to severe biochemical and symptomatic disorders. However, a sensitive and valid marker to assess Mg status in humans is still unavailable. We hypothesised that determination of exchangeable pools of Mg could be used to estimate tissue Mg status and turnover. In that aim, studies were conducted in animals and in human. In animal study, Mg pool sizes were determined in control rats, marginally Mg-deficient rats and severely Mg-deficient rats. Rats received an intravenous injection of ²⁵Mg, and the plasma ²⁵Mg disappearance curve was followed for several days. Tracer/tracee data were analysed with a SAAM II program, using a compartmental model based on the model of Avioli and Berman (1966). This model considered 3 exchangeable Mg pools with varied rates of turnover (pools 1 and 2. with a relatively fast turnover. and pool 3). We observed that the size of exchangeable pools of Mg decreased in proportion to Mg deficiency. We thus conclude that Mg pool size measurement can

constitute a good marker of Mg status in rats. To validate this concept in human, exploration of Mg pool size was performed in 10 healthy women before and after 8 weeks of Mg supplementation (366 mg Mg/d). All subjects had an intravenous catheter inserted into the right arm, and ²⁵Mg was perfused over 30 min. Each subject had also an intravenous catheter inserted into the left arm for blood sampling at T-30 to T-600 min. On the following days blood sampling was also performed after an overnight fast (D1 to D7). Total 24-h urinary Mg excretion was measured for 2 days, on the day before and the day of the isotopic loading test. We observed that Mg pool size were not affected by the Mg supplementation while urinary Mg excretion was significantly increased. Full Mg stores prior to Mg supplementation may explain such results. In conclusion, Mg pool size measurement may be a promising indicator of Mg status. Further studies are necessary to determine whether Mg pool size responds to Mg supplementation in Mg-deficient subjects.

SELENIUM AND DIABETIC ELDERLY

¹J.F. Escanero, ²A. Garcia de Jalyn, ²R.M. Pérez-Beriain, ²M.L. Calvo Ruata, ³A. Sanz-Parras, ⁴J. Abanto, ²A. Cabeza

¹Physiology Department of University, ²Biochemistry Department, ³Endocrinology and Nutrition Department, Miguel Servet University Hospital, ⁴Geriatric department of DGA, Zaragoza, Spain.

Background: Nutrition and aging are inseparably connected as eating patterns affect the progress of many degenerative diseases associated with aging. In turn, the nutritional status of elderly may be adversely affected by a number of factors associated either directly or indirectly with aging. Plasma glucose levels increase with advancing age as the result of progressive changes in insulin action and metabolism, and the incidence of non-insulin-dependent diabetes mellitus (NIDDM) increases with age and increased body fat. Some studies support the theory that free radical stress has a role in the causation of NIDDM. Many studies conclude that mean serum selenium concentrations in patients with diabetes are lower than in controls.

Aims: To study the relationship between diabetes and serum concentrations of selenium in elders.

Materials and Methods: Samples were analyzed

from 47 NIDDM elders, interned in a long-term care old people's home, comparing to a control group (n=49) of similar characteristics not diabetic.

Serum concentrations of selenium were analyzed by atomic absorption spectrophotometry with a graphite furnace and a Zeeman background corrector (*Perkin Elmer 4110 ZL*), using Pd(NO₃)₂ solution as matrix modifier.

Results: The results of the serum concentration of selenium in the diabetic group was of 61.19 mmg/l (C.I. 95% of 58.35-64.03). In the control group the mean of the selenium levels was of 68.99 mmg/l (C.I. 95% of 66.14-71.83). The means comparison using the Student T test shows a statistically significant difference with a p<0.001.

Conclusions: The findings of this study suggest that the diabetic elders showed lower selenium concentrations than the normal elders.

SILICON AND FLUORIDE IN WATER FOR HUMAN CONSUMPTION AND BONE MINERALISATION

¹L. Fabiani, ¹M. Scatigna, ¹G. Mosca, ¹G. Farello, ²V. Leoni

¹ Università degli Studi dell'Aquila, Dipartimento di Medicina Interna e Sanità Pubblica, via San Sisto 22/E, 67100 L'Aquila, Italia; ² Dipartimento di Scienze di Sanità Pubblica - Università di Roma "La Sapienza", Piazzale Aldo Moro 5, 00185 Roma, Italia.

Background: The bone mineralisation level in adolescents is due to several factors like dietary intake of calcium, phase of puberty, physical activity, genetic characteristics. The scientific literature about the biological effects of other minerals (silicon, fluoride) and the relationship between intake and health status examined in experimental animal and human beings were suggested the need of further studies, mostly epidemiological.

Aims: A cross-sectional epidemiological study was carried out to estimate the effects of calcium, fluoride and silicon content in the tap water for human consumption on adolescent bone mineralisation

Method: Into two Italian areas (area A and area B) was measured mineral content in the water for human consumption and anthropometric parameters, oral health and bone mineralisation (tested with ultrasonometric method, ADSoS – Amplitude Dependent Sound Speed) were measured in two groups of adolescents (10–14 years old).

Results: In the first area (A) the water is low in mineral content while in the second area (B) the water has considerable quantities of calcium, fluoride and silicon. Subjects resident in area with higher water mineral content (B) demonstrated higher bone mineralisation than residents in area A (with low mineral content) (see table).

TABLE 1: MINERAL CONTENT IN THE TAP WATER AND BONE MINERALISATION IN ADOLESCENT OF TWO ITALIAN AREAS.

	Area A	Area B (in two towns)	
Chemical characteristics of tap water			
SiO ₂ (mg/L)	3.8	76.6	61.5
Ca ²⁺ (mg/L)	24.5	32.8	14.0
F ⁻ (mg/L)	<0.05	1.7	1.2
Bone mineralisation			
ADSoS	1929.34±72.69	1969.94±71.91	
t-test	(p<0.0001)		

SPIRULINA PLATENSIS IS AN ADVANCED FOOD SOURCE OF THE ESSENTIAL TRACE ELEMENTS ORGANIC FORMS

¹V.K. Mazo, ¹I.V. Gmoshinski, ¹Ju.P. Aleshko-Ozhevski, ²N.A. Pronina, ³G.N. Mazo, ³S.N. Savvin

¹ State Institute of Nutrition, Russian Academy of Medical Sciences, 2/14 Ustjinski proezd, 109240 Moscow, Russia; ² Institute of Plant Physiology Russian Academy of Sciences, 35, Botanicheskaya ul. 127276, Moscow, Russia; ³ Moscow State University, Leninskie gory, 119899, Moscow, Russia.

Trace elements (Zn, Cr, Cu, Se) contents were characterized in *Spirulina platensis* biomass enriched with these minerals during the course of cultivation. Measurements were performed by means of Inductively Coupled Plasma Atomic Fluorescence spectrometry.

Biomass separation into fractions revealed the majority of trace elements being incorporated into protein matrix of micro algae. The materials presented confirm good advances of *Spirulina* with high levels of biologically incorporated minerals as stuff for new generation of bioactive food supplements.

THE INTAKE OF CA AND MG IN THE POLISH HABITUAL DIET AND THEIR RELATION TO SOCIO-ECONOMIC FACTORS

¹M. Schlegel-Zawadzka, ²J. Przyslawski, ³J. Bertrandt, ³A. Kios

¹ Department of Food Chemistry and Nutrition, Jagiellonian University 9 Medyczna, 30-688 Cracow, ² Chair and Department of Bromatology and Human Nutrition, Medical Academy, 42 Marcelinska, 60-345 Poznan, ³ Military Institute of Hygiene & Epidemiology, 4, Kozielska, 01-163 Warsaw; Poland.

Aims: The objective of the study was to evaluate the intake of calcium and magnesium occurring in the habitual diet of healthy men and women in the region of Mid-West Poland.

Materials and Methods: The survey was conducted in the year 1999 and 2000. A sample from the general population consisted of 631 women and 522 men with the age range between 36 and 41. The nutritional assess-

ment was evaluated by a quantitative method consisted of 24-hour recalls of actual food intake. The qualitative and quantitative assessments of consumed food products were based on photo-models of various food and their portion size. The intake of calcium and magnesium respectively were expressed as median (Me) \pm quartile deviation (QD) and arithmetic average mean (Xaa).

Conclusions: The nutritional value of DFR's taken by healthy Polish adults was far from the recommended.

TABLE. THE INTAKE LEVEL OF CALCIUM AND MAGNESIUM IN THE DAILY RATIONS OF MALE AND FEMALE GROUPS STUDIED.

Mineral	Male group		Female group	
	Me \pm QD	Xaa	Me \pm QD	Xaa
Calcium (mg)	621 \pm 254	704	574 \pm 202	634
The realization percentage of recommended values	69%		63%	
Magnesium (mg)	319 \pm 62.3	333	249 \pm 52.9	262
The realization percentage of recommended values	86%		83%	

COPPER NUTRITION AND COPPER METABOLISM IN RAT NEWBORNS

¹T. Zhivulko, ¹B. Mishchenko, ²E. Zhiguleva, ²N. Bichevaya, ²N. Platonova, ²N. Tsymbalenko, ¹N. Gyulikhandanova, ¹A. Vasin, ²R. Povalikhin, ¹L. Puchkova

¹ St. Petersburg State Technical University, Russia; ² Institute of Experimental Medicine, St. Petersburg, Russia.

Background: The main source of Cu for newborns is milk ceruloplasmin (Cp) synthesized by mammary gland where the level of Cu in milk is controlled by Cp gene activity. Thus, the newborns fed with baby formula intake the excess of Cu not packed in the safe envelope. It can disturb the copper homeostasis in newborns.

Aim is to study the effect of Cu nutrition on the Cu metabolic system (CMS) which is responsible for safety of Cu turnover.

The methods of RNA/DNA blot-hybridization, velocity and equilibrium sedimentation, immunoblotting, enzymatic assays of Cp, acid phosphatase, ouabain-sensitive ATPase, atomic absorption spectrometry and rocket immunoelectrophoresis were used.

Results: A group of newborn rats were fed with baby formula during 8 days from the 1st day after birth (experimental group). The Cu and Cp levels in their serum were increased 3 times and the liver Cu concentration was decreased 2 times when compared with rats which were fed by rat Dams. The liver Cp-mRNA content is in-

creased and ATP7B gene expression appeared in liver of the experimental rats. The brain Cu concentration wasn't changed, but in cerebrospinal fluid the Cp and Cu levels were increased 7 times. In the first 12 days of life Cu is progressively accumulated in the liver of the normal rats and the major part of Cu was found in lysosomes and nuclei. A sharp drop of Cu level in liver cells of the experimental rats as early as to 5th day of experiment was observed. The liver starts to accumulate Cu during embryo development, but the yolk sac (YS) cells don't accumulate it. The YS cells produce two molecular forms of [¹⁴C]Cp, which are polarity secreted to embryonic and decidual covers. There are two forms of Cp-mRNA corresponding to them. Full length ATP7A and ATP7B were found by Western-blot hybridization in YS cells.

Conclusions: 1) the YS works as an adult mammalian liver; 2) CMS of the newborns is adapted to Cp as a source of Cu; 3) nutrition Cu not packed into Cp changes the activity of CMS genes in newborns.

METABOLISM OF FATTY ACIDS IN BROILER CHICKEN IS AFFECTED BY CHROMIUM

T. Kuryl, M. Lipko, B. Debski

Faculty of Veterinary Medicine, Div. Anim. Biochemistry, SGGW, Ul. Nowoursynowska 162, 02-787 Warsaw, Poland.

Background: Chromium was recognized as a factor engaged in insulin action on glucose metabolism. Broiler chicken fed with diet supplemented with chromium exhibits elevated protein concentration in liver and muscles as well as lower fat and cholesterol content in these tissues (Debski et al., 2001). Lipid metabolism is one of main energetic processes. Disorders in this metabolic pathway should effect among others in miopathies and atherosclerosis (Saudubray et al., 1999).

Aims: The aim of these studies was if chromium affects the degradation of fatty acids in broilers.

Methods: Broilers were fed 4 weeks with standard

diet and diet supplemented with 0.5 ppm of chromium yeast. β -oxidation of fatty acids was studied in lymphocytes by the method of Manning et al. (1990) in own modification (Kuryl et al., 2001) used for human system.

Results: Lymphocytes from broiler chicken degraded palmitic acid and should be used in studies on fatty acid metabolism. In control system the activity of β -oxidation of ¹⁴C-palmitic acid was 7,261 \pm 3,59 units (pmol/min/mg of protein). Addition of 0,5 ppm of chromium yeast to the feed elevated the activity to 15.592 \pm 3.50 units. Two weeks after termination of chromium supplementation the activity of β -oxidation

of fatty acids lowered to 12.327 ± 1.313 units and 7.366 ± 1.577 after 8 weeks without chromium supplementation. Preliminary experiments on optimization of the reaction conditions (amount of protein, substrate concentration) indicated, that the activity of palmitic acid degradation should be 2–4 times higher than in our

preliminary experiments. It let us to conclude:

1. Broiler chicken lymphocytes degrade palmitic acid and may be used in studies on fatty acid degradation.
2. Chicken given 0.5 ppm organic chromium supplementation metabolized fatty acids almost 2-times faster than control birds.

ZINC, COPPER AND SELENIUM CONTENT IN THE DIETS OF CHILDREN WITH FOOD INTOLERANCE

¹R. Markiewicz, ¹M.H. Borawska, ²J.D. Piotrowska–Jastrzłbska,
²M.J. Piotrowska–Depta, ¹K. Hukaiowicz

¹Department of Bromatology, Medical Academy, 1 Kilinski St., 15-230 Bialystok, Poland; ²Department of Axiology, Medical Academy, 17 Waszyngton St., 15-274 Bialystok, Poland.

Adverse reactions to food and synthetic food constituents can be elicited by a variety of pathomechanisms. The spectrum of clinical symptoms ranges from gastroenteritis, urticaria, bronchial asthma, rhinitis, exacerbations of atopic eczema or allergic contact dermatitis. The basis of food allergy treatment is introduction of elimination diets. The purpose of this study was to determine the content of zinc, copper and selenium in the 40 daily food rations received from Children's Clinical Hospital and orphanage located in the city of Bialystok. Averaged samples of the food rations were decomposed with concentrated nitric acid in microwave mineralizer, BM-1z instrument UniClever (Plazmatronika, Poland). Zinc and copper were determined by flame atomic absorption spectrometry and selenium by

electrothermal atomic absorption spectrometry with a Zeeman background correction on a Z-5000 instrument (Hitachi, Japan). Certified reference material – Simulated diet A – was used to test the accuracy of this method. Average daily zinc intake values with children's food rations were 5.31 mg (from hospital) and 5.81 mg (from orphanage). The corresponding daily values for copper were 0.63 and 0.67 respectively. The average level of the selenium in food rations from hospital (17.32 µg) was lower than from orphanage (43.84 µg). Daily food rations from orphanage were more variegated, rich in selenium and minor deficit of Zn and Cu was observed. Elimination diets from Children's Clinical Hospital did not supply recommended daily intake for Zn, Cu and Se.

THE INTAKE OF SELECTED MINERALS IN DAILY FOOD RATIONS TAKEN BY POLISH ADOLESCENTS

¹J. Przyslawski, ²M. Schlegel-Zawadzka, ³L. Wnodojowska, ⁴E. Babicz-Zielinska

¹Chair and Department of Bromatology and Human Nutrition, Medical Academy, 42 Marcelinska, 60-345 Poznan; ²Department of Food Chemistry and Nutrition, Jagiellonian University, 9 Medyczna, 30-688 Cracow, ³Institute of Human Nutrition University of Warmia and Mazury, 44a Sloneczna, 10-718 Olsztyn; ⁴Department of Nutrition Sciences, Gdynia Maritime Academy, 81-87 Morska, 81-225 Gdynia; Poland.

Aims: The objective of the study was to evaluate the intake of calcium, phosphorus and magnesium respectively in daily food rations taken by Polish girls and boys aged between 13 and 15 years.

Materials and Methods: The survey was conducted in the year 2000. A random sample from the general population consisted of 443 girls and 321 boys. Food intake in daily food rations (DFR's) was assessed by the 24-h recall method. The qualitative and quantitative assessments of consumed food products were based on photo-models of various food and their portion size. All nutritional factors were expressed as mean (X) ± standard deviation (SD). The statistical differences between selected groups were calculated with the use of Mann-Whitney test with a significance level of $p < 0.05$.

TABLE: THE INTAKE LEVEL OF ENERGY, CALCIUM, MAGNESIUM AND PHOSPHORUS IN THE DAILY RATIONS OF BOYS AND GIRLS GROUPS STUDIED. [NUTRIENT DENSITY PER 4.184 MJ (1000 KCAL)].

	Boys X±SD	Nutrient density	Girls X±SD	Nutrient density
Energy [kcal]	2521±607	–	2104±673	–
Ca [mg]	850±515	336±185*	741±392	363±175*
P [mg]	1252±425	498±128	1057±397	509±126
Mg [mg]	285±99.4	113±29.7*	256±99.2	124±35.2*

* $p < 0.05$ – difference statistically significant

Conclusions: The nutritional value of DFR's taken by healthy Polish adolescents was far from the recommended. It was clear in the case of calcium and phospho-

rus. From the epidemiological point of view this may lead to disturbances in the development of bone struc-

ture of adolescent girls and boys and with time aggravate the risk of osteoporosis.

DIETARY SELENIUM (SE) INTAKE OF BREAST-FED AND FORMULA-FED YOUNG INFANTS IN HUNGARY

¹I. Sziklai-L6szly, ²M.B. Cser, ³J. Cholnoky

¹KFKI Atomic Energy Research Institute, H-1525 Budapest, P.O. Box 49; ²Bethesda Children's Hospital, H-1146 Budapest, Bethesda Street 3; ³Nestl6 Hung6ria Ltd., H-1525 Budapest, Hungary.

Background: Selenium is a cofactor of several antioxidant seleno - enzymes such as glutathione peroxidase and therefore is essential for the proper function of cellular defense mechanisms. Sufficient supply of Se for infants is necessary for normal growth and development.

Aim: of the study was to measure Se concentrations in human milk and milk-based formulas and to calculate Se intake for infants fed on human milk or milk-based formulas.

Method: Se concentrations were measured by Instrumental Neutron Activation Analysis (INAA). The age of the babies in both groups ranged from 4 – 8 weeks.

Results: human milk (mature milk, n=30) gave a mean of 13.7 ± 2.3 mcg Se/L with a range from 10.4 to 16.6 mcg/L. The Se content of infant formulas ranged from 4.4 to 9.9 mcg/L and found to be significantly lower in comparison with human milk. The daily Se intakes were calculated from the milk volumes (mean: 721 ± 83 mL/d) consumed, determined by the weight gain of the babies after feedings. This resulted in 10.7 ± 2.7 mcg daily Se intake in babies fed exclusively on human milk. The Se content of starter formulas ranged from 4.4

to 8.4 mcg/L, follow up formulas varied from 7.2 to 9.9 mcg/L. The lowest Se intake was obtained in the group of infants fed locally produced formula: 3.2 ± 0.4 mcg/d (n=9), whereas 6.9 ± 0.8 mcg/d were observed in babies (n=9) fed on imported formulas. The Se content of formulas positively correlated with its protein content ($r=0.76$, $p<0.01$) and this association was even stronger in the human milk ($r=0.99$, $p<0.001$).

Conclusion: the formulas provide significantly less Se than the 10 mcg/day corresponding to the Recommended Daily Allowances (USA, 1989) for infants aged 0 to 6 months. All infant formulas provided significantly less Se intake ($p<0.001$) compared to human milk. Locally produced milk-based formulas had the lowest Se concentrations. The Se intake of breast-fed infants was within the range of the recommended values. Infant formulas have lower Se concentrations than human milk. Therefore babies fed on formulas may be at increased risk for inadequate Se intake induced diseases.

Acknowledgments: This work was supported by the grants from KFKI Condensed Matter Research Centre (KFKI-CMRC, No. ICA1-CT-2000-70029).