Effect of Iron Diet on Aluminium Biokinetics in Rats

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Aluminium absorption, distribution and speciation in rats have been investigated by administering a single oral dose of ^{26}Al to three groups of each ten Sprague-Dawley rats which had normal, iron abundant and iron deficient diet before administration. The dose was 20 ng ^{26}Al together with 200 μg Al as $AlCl_3$. The group with iron abundance obtained for 3 weeks iron overloaded diet and i.m. administration of 30 mg iron on 5 days. The group with iron deficiency obtained iron deficient diet and deionized water. On 6 days, 2 ml of blood were taken. The rats were sacrificed 24 h after the administration of ^{26}Al. Samples of blood plasma, urine, femur, liver and spleen were taken. ^{26}Al was measured in the samples with accelerator mass spectrometry.

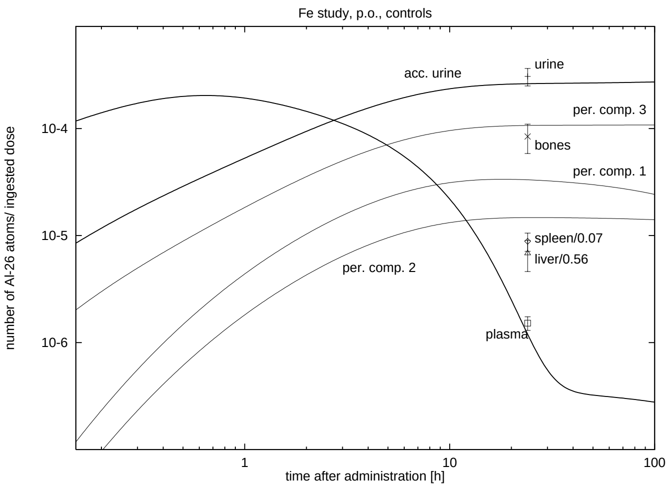

Fig. 1: ^{26}Al contents in blood plasma, urine, bones, liver and spleen relative to the orally administered dose for the control group of Sprague-Dawley rats, the group with iron deficient diet (Fe–) and the group with iron abundant diet (Fe+).

The data were described in an open compartimental model with the central compartment consisting of transferrin and citrate bound aluminium in blood plasma and interstitium, with 3 peripheral compartments for organs, muscles and bones and with the gastro-intestinal tract. The simulation calculations showed that the transferrin bound aluminium in the central compartment for the iron deficiency group was increased by a factor of 3.2 and was decreased by a factor of 2 for the iron abundance group compared to the control group. The simulations were able to describe different absorption factors, distributions in the rats and excretions for the three groups only by varying the concentration of transferrin bound aluminium in the central compartment. Differences in the aluminium uptake can be obtained by summing up the ^{26}Al contents in all parts of the body and in the urine. The average values for the total contents in plasma, urine, liver, spleen and bones relative to the administered dose are given in Table 1. It is seen that the contents in liver and spleen are higher by a factor of 10 for the Fe– group compared to the Fe+ group. The contents in bones and urine are higher by a factor of 2.5 for the Fe– group compared to the Fe+ group. The values for the control group are in between. Simulation calculations with the model were performed for the 3 groups of rats with the same set of time constants and compartment sizes except for the sizes of the transferrin compartments for the Fe+ and Fe– groups. For the Fe– group (fig. 1), the concentration of aluminium bound to transferrin has to be increased by a factor of 3.2 whereas it has to be decreased by a factor of 2 for the Fe– group compared to the control group. The transferrin bound aluminium concentrations in blood plasma are thus 180 μmol/l for the Fe– group, and 28 μmol/l for the Fe+ group compared to 56 μmol/l for the control group. Another result is the branching for the uptake of $AlCl_3$ from the duodenum into the transferrin and citrate phases of the blood plasma. The uptake of ^{26}Al is about 3.3 times higher for the Fe– group than for the Fe+ group whereas the size of the plasma transferrin compartment changes by a factor of 6.4. The studies of the present paper with rats under different conditions of iron diet have given clear results on absorption channels of aluminium chloride and on distribution and speciation of aluminium in rats.

References

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	Iron overload	Controls	Iron deficiency
urine	$(1,80 \pm 0,14) \cdot 10^{-4}$	$(3,07 \pm 0,29) \cdot 10^{-4}$	$(4,08 \pm 0,30) \cdot 10^{-4}$
plasma	$(6,58 \pm 0,89) \cdot 10^{-7}$	$(1,52 \pm 0,22) \cdot 10^{-6}$	$(2,83 \pm 0,67) \cdot 10^{-6}$
bones	$(9,20 \pm 1,05) \cdot 10^{-5}$	$(8,42 \pm 1,29) \cdot 10^{-5}$	$(1,56 \pm 0,13) \cdot 10^{-4}$
liver	$(6,11 \pm 0,95) \cdot 10^{-6}$	$(3,88 \pm 0,63) \cdot 10^{-6}$	$(6,60 \pm 0,53) \cdot 10^{-5}$
spleen	$(4,92 \pm 0,71) \cdot 10^{-7}$	$(6,18 \pm 0,66) \cdot 10^{-7}$	$(1,07 \pm 0,08) \cdot 10^{-5}$

Table 1: The average values for the total contents in plasma, urine, liver, spleen and bones relative to the administered dose.