

Report on Absorption of magnesium sulfate (Epsom salts) across the skin

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Protocol

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Recruitment

Subjects were recruited from the staff of the School of Biosciences, University of Birmingham. In all, 19 subjects (10M, 9F) were recruited for the various aspects of the study. All were in good health, and not on any current medication. No subject smoked more than 5 cigarettes/day or drank more than 2 units of alcohol/day. The ages ranged from 24-64 years.

Analyses

Magnesium levels in blood and urine were measured by a flame photometric method using magnesium nitrate as a reference standard. Sulfate was measured by anion-specific high pressure liquid chromatography (hplc), calibrated with a turbidimetric method and with sodium sulfate standards.

Results

After initial pilot studies, all volunteers took baths (temperatures 50-55°C) and stayed in the bath for 12 minutes. They added varying amounts of magnesium sulfate (Epsom salts) to the bath before entry and ensured that the salts were completely in solution.

Blood/Urine Samples

Blood samples were taken before the first bath, at 2h after the first bath and at 2h after the 7th consecutive bath. Baths were taken daily at the same time for 7 days for the experiment. Urine samples were collected before the first bath and then 2h after the first bath and at all subsequent baths. Urine samples were also taken 24h after the last bath. All urine samples were corrected for creatinine content.

Results

Magnesium

Magnesium levels in blood are very tightly controlled. Of 19 subjects, all except 3 showed a rise in magnesium concentrations in plasma, though this was small in some cases. The values before the first bath were, mean 104.68 ± 20.76 ppm/ml; after the first bath the mean was 114.08 ± 25.83

ppm/ml. Continuation of bathing for 7 days in all except 2 individuals gave a rise to a mean of 140.98 ± 17.00 ppm/ml. Prolonged soaking in Epsom salts therefore increases blood magnesium concentrations. Measurement of magnesium levels in urine showed a rise from the control level, mean 94.81 ± 44.26 ppm/ml to 198.93 ± 97.52 ppm/ml after the first bath. Those individuals where the blood magnesium levels were not increased had correspondingly large increases in urinary magnesium showing that the magnesium ions had crossed the skin barrier and had been excreted via the kidney, presumably because the blood levels were already optimal. Generally, urinary magnesium levels 24h after the first bath fell from the initial values found after day 1 (mean 118.43 ± 51.95) suggesting some retention of magnesium in tissues after bathing as blood levels were still high. Measurement of magnesium levels in urine 24h after the 7th bath gave values almost back to control levels.

Sulfate

Free inorganic sulfate levels in plasma rose in all subjects after bathing in Epsom salts (mean pre-bath, 3.28 nmol/mg protein ± 1.40 , 2h after 1st bath, mean 5.59 nmol/mg protein ± 3.08). In some individuals, the level post-bath reached > 9 nmol/mg protein. The plasma levels after 7 days showed a mean of 3.57 nmol/mg protein ± 1.70 , lower than the peak value, suggesting that sulfate stores in the body were being filled. Analysis of the urine samples again showed an increase in sulfate concentrations (pre-bath mean 623.74 ± 352.34 nmols/ml, 2h post bath 1093.30 ± 388.79 nmols/ml, 24h after 1st bath 899.83 ± 483.16 nmols/ml. Sulfate excretion in urine in some individuals was only slightly higher after 7 days bathing than the pre-bath levels.

Other Factors

Gender Differences

Males had slightly higher levels of blood magnesium than females (109.0 ± 14.4 ppm/ml v. 87.7 ± 6.3 ppm/ml. Females had higher free plasma sulfate than males (3.26 ± 0.86 nmol/mg. v. 2.54 ± 0.53 nmol/ug) although these differences were not significant. The mean levels of both magnesium and sulfate were almost identical for males and females after bathing.

Optimum Epsom Salt Levels

There was a wide individual variation in this parameter. However, all individuals had significant rises in plasma magnesium and sulfate at a level of 1% Epsom salts. This equates to 1g $MgSO_4$ /100ml water; 600g Epsom salts/60 litres, the standard size UK bath taken in this project (~15 US gallons). However, most volunteers had significantly raised Mg/SO_4 levels on baths with 400g $MgSO_4$ added. Above the 600g/bath level, volunteers complained that the water felt 'soapy'. Although this project did not specifically set out to answer the question of how frequently baths should be taken, the results are consistent with saturation of the skin (and possibly the gut) transporters. These proteins are not well understood or described but, at least for sulfate, they are believed to be high affinity but low capacity. The values obtained suggest that most people would find maximal benefit by bathing 2 or 3 times/ week, using 500-600g Epsom salts each time.

Other factors

No volunteer complained of any adverse effects, even at $MgSO_4$ levels of 2.5%. Possible effects on the kidneys were tested by measuring urinary protein content. This did not change significantly,

whichever Epsom salt levels were used, over the 8-day period. Kidney damage is therefore not an issue.

In other experiments using excised human skin, we found that sulfate does penetrate across the skin barrier. This is quite rapid so probably involves a sulfate transporter protein. We did not see any Mg penetration, but these experiments were conducted for a short time at only 37 degrees as opposed to the 50 degree bath temperature. To check this, 2 volunteers wore 'patches' where solid MgSO₄ was applied directly to the skin and sealed with a waterproof plaster. Plasma/urine analysis confirmed that both Mg and sulfate levels had increased so this is potentially a valuable way of ensuring Epsom salts dosage if bathing is not available. Interestingly, both volunteers, who were > 60 years old, commented without prompting that 'rheumatic' pains had disappeared.

Conclusion

Bathing in Epsom salts is a safe and easy way to increase sulfate and magnesium levels in the body.