

Dangerous Increase of Taurine in the Human Brain after Consumption of an 'Energy Drink'?

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Introduction

In the last few years a variety of modern 'fun' or 'energy' drinks, especially designed for the 'young and active' people, entered European shops. Most of these drinks contain caffeine and huge amounts of taurine, a free, relatively inactive amino acid occurring e.g. in the human brain, retina, muscle, and liver.

Taurine is taken up with the food (e.g. via meat or breast-milk), or it can be synthesized via cysteine. The ability of humans to synthesize taurine is limited [1]. It is an osmolyte which is e.g. important for the embryonic development. Especially in kittens a taurine deficiency frequently occurs. Thus animal food is nowadays enriched with taurine. Besides other functions, taurine is thought to modulate the excitability by interaction with brain membranes. In the human brain taurine synthesis is negligible, and its concentration, which decreases during brain maturation, is in the order of 1 mM. Even higher levels are found in the cerebellum [2].

In ^1H -MRS, the CH_2 -groups of taurine form a strongly coupled multiplet at 3.35 ppm, the same chemical shift position as of the singlet of *scyllo*-inositol. The purpose of the present study was to investigate by ^1H -MRS whether and how fast an oral dose of taurine leads to an increase of taurine concentration in the brain.

Subjects and Methods

Measurements were performed at 1.5 T using the standard circularly polarized headcoil on a Siemens Magnetom[®] SP whole body MR system. Up to date, 7 healthy volunteers (mean age 24 ± 4 years) were investigated. All subjects had no special dietary preparation. They were asked about their normal use of caffeine and taurine-containing drinks.

After image-guided localization a cubic voxel of 8 ml was selected in the cerebellum (6 male) or bioccipital gray matter (one female). Spectra were acquired using a STEAM sequence with TE/TM/TR = 15/30/3000 ms. 10 to 12 cycles of 100 acquisitions were performed, leading to a total measurement time of about 75 minutes. On the MR table, the subjects obtained 3 cans (0.25 ml each) of a commercially available 'energy drink' (Red Bull[®]). Each can contains 1000 mg of taurine, 600 mg of glucuronolactone, 80 mg of caffeine, different sugars and a few other compounds in minor concentrations (vitamins, acidificators, aroma, coloring matter). One of the male subjects obtained 5.5 g of taurine powder mixed in two cans of Red Bull[®], resulting in 7.5 g of taurine ingested.

All spectra were post-processed by a correction for eddy currents, Gaussian filtered ($\tau = 256$ ms) and phase corrected. The total investigation time was about 75 - 90 minutes.

Results

A resonance at 3.35 ppm was always visible in all volunteers, especially in the cerebellar spectra. In fig. 1 spectra from a subject who had drunk 3 cans of the drink (containing in total 3 g of taurine) are shown. The resonance at 3.35 ppm was highly elevated 25 minutes after consumption of the drink. Later the signal decreased within 70 minutes to normal levels.

This volunteer had the highest normal taurine consumption of all subjects who took part in the study, he usually drinks about 1 can of Red Bull[®] per day. In another two subjects the increase of taurine was delayed by about 20 min. and smaller. In the remaining volunteers, including the subject consuming 7.5 g of taurine, only minor spectral changes were observed. In gray matter no metabolic changes were detected.

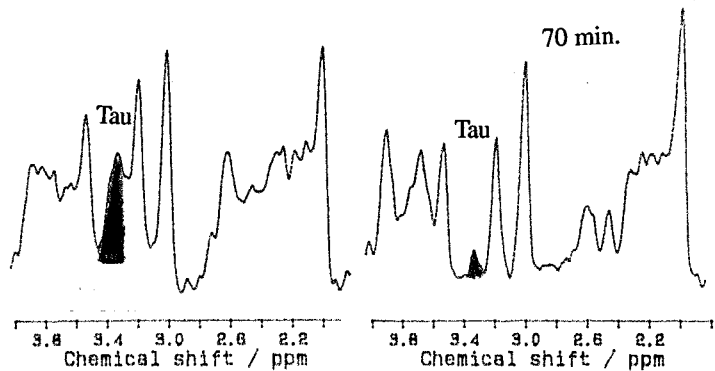


Fig. 1: MR spectra (TE = 15 ms) of the cerebellum of a healthy volunteer 25 and 70 minutes after oral dose of 3000 mg of taurine (Tau).

Discussion

We observed changes of the resonance at 3.35 ppm in *in vivo* ^1H MR spectra of the human cerebellum after an oral consumption of 3 g of taurine in 3 of 6 subjects investigated.

On the other hand, no metabolic changes were observed in the subject consuming 7.5 g of taurine. This is approximately 50 % of the amount usually available in the whole human body [3]. Interestingly enough, this subject never drank special taurine drinks before.

It is well-known that taurine can readily enter the central nervous system [2]. Although the question whether taurine enters the brain via the blood-brain barrier or via the blood-liquor barrier is a contentious issue [4], it has been previously shown on rats that even very large increases in plasma taurine are not reflected by changes in brain taurine concentration [5]. This could prevent the brain from dehydration due to the osmolytic behavior of taurine. It was found in humans that any excess of plasma taurine can be readily excreted via the kidney in the urine. However, the results of the present study on humans can only partly support these findings. The increase of taurine observed in the cerebellum of healthy volunteers after consumption of large doses of this 'energy drink' could indicate a serious potential for a possibly dangerous dehydration following taurine ingestion.

Conclusions

The results of the present study indicate that ^1H -MRS might serve as a fast and non-invasive diagnostic tool to observe taurine therapy, which is performed in cases of taurine deficiency. The effect of special taurine or 'energy' drinks on the taurine concentration in the human brain seems to be rather small and time-limited. However, since the potential relevance of increased taurine concentrations in humans remains unclear up to now, improved information for consumers of 'energy drinks' containing taurine seems to be of great importance.

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