Effect of Inulin on Adipose Tissue Deposition and on Appetite Regulation

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Introduction

Obesity is an increasingly prevalent disease and much research is being carried out to understand the many factors that contribute to its development. Research has looked at metabolic disturbances in particular concerning adipose tissue, as well as changes in neuronal appetite regulation. Effects of different diet constituents have been investigated in connection with obesity and related diseases. Inulin is an oligomer of fructose, found naturally in some plants, and indigestible by human intestinal enzymes. In addition, it acts as a prebiotic, promoting survival of beneficial gut bacteria over harmful pathogenic bacteria. Inulin and oligofructose (produced from enzymatic hydrolysis of inulin) have been shown to decrease hepatic lipogenesis and serum triglyceride levels in rats and in man (1,2,3). In this study, the effects of dietary intake of inulin on adipose tissue content and distribution as well as on appetite, was investigated.

Methods

Animals and Treatment

Male C57/Bl6 mice were maintained on a high (21%) fat diet supplemented with (7.5%) inulin (HF+In, n=15) or a high (21%) fat control diet containing corn starch (HF, n=13). A third group was given a normal (4%) fat diet containing starch (Control, n=8). Diets were given for a period of 8 weeks, during which body weights and food intake were recorded.

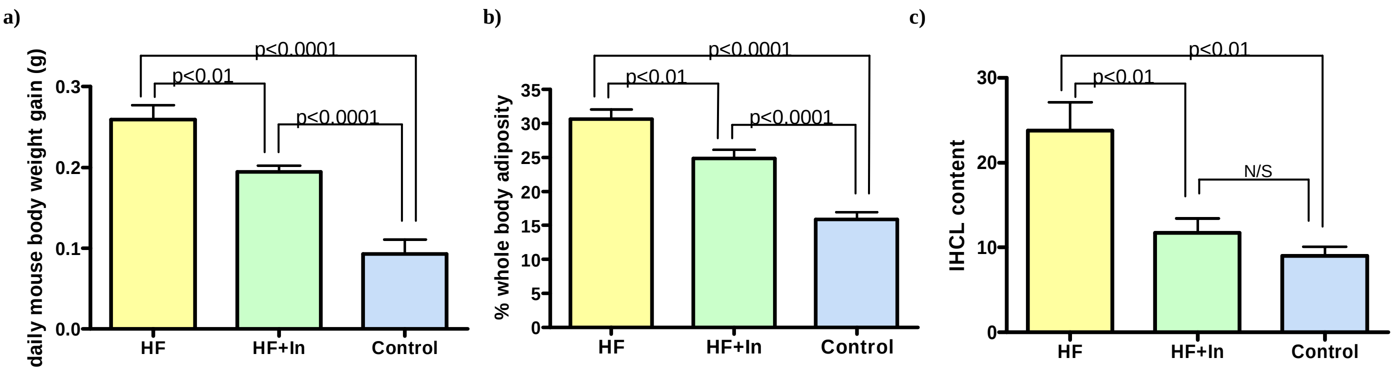
MR experiments

Mice (16 week old) were anaesthetised with an isoflurane-oxygen mix and scanned on a 4.7T Unity Inova MR scanner (Varian Inc, USA) using a birdcage whole body coil. Consecutive transverse MRI images of the whole mouse body were collected using a spin-echo sequence with parameters: TR 2.2s, TE 20ms, FOV 45mm x 45mm, matrix 256 x 192, 2 averages and 2mm thick slices. Segmentation analysis was performed with SliceOmatic™ (Tomovision®) to provide volumes (and mass) of internal and subcutaneous adipose tissue deposits.

Localised ^{1}H MRS of the liver was also performed using a PRESS sequence with TR 10s, TE 9ms and 64 averages following voxel (2x2x2mm) placement by MRI. The spectra were analysed using MestRe-C (Santiago de Compostela, SPAIN) where an exponential line broadening of 1.5Hz was applied, prior to baseline correction and peak integration of the water and lipid peak.

Manganese Enhanced MRI (MEMRI) was also performed on a 9.4T Unity Inova MR scanner (Varian Inc, USA), using a transmit-receive quadrature birdcage head coil. Following appropriate piloting, ten transverse slices were acquired repeatedly in an array, 66 times, using a 2D spin-echo multislice sequence with the following parameters: TR 0.6s, TE 10ms, FOV 25mm x 25mm, matrix 256 x 192, 1 average, and 1mm thick slices. After the third array, 100mM $MnCl_2$ was infused at a rate of 2ml/hour at a dose of 0.5µmol/g of body weight. Images were analysed using Image J (NIH, Bethesda, USA), by measurement of signal intensity changes as a result of manganese uptake, in specific appetite centres.

Results and Discussions



Figures: The effect of inulin supplementation in a high fat diet (HF+In), compared to a high (HF) and a normal fat diet control (Control), on a) daily increase in mouse body weight, b) % whole body adiposity and c) intrahepatocellular lipid (IHCL) content.

The increase in body weight per day was highest in the HF group (0.26±0.02g), followed by the HF+In group (0.19±0.01g, $p<0.01$) and was lowest in the Control group (0.09±0.02g, $p<0.0001$). There was no significant difference found in the weight of daily food intake between the two high fat diets, but as the HF+In diet is slightly lower in energy, the energy intake was significantly lower. Assessment by MRI showed that HF+In mice had decreased whole body adiposity (24.9±1.2%) compared with the HF mice (30.7±1.4%, $p<0.01$), while the Control group had the lowest body adiposity compared to the two high fat groups (15.9±1.1%, $p<0.0001$). Despite these differences, the ratio of subcutaneous and internal adipose tissue was comparable between the three groups. Mice fed the HF+In diet showed significantly lower IHCL content (11.7±1.7%) than those fed the HF diet (23.8±3.4%, $p<0.01$). The IHCL content of HF+In mice (11.7±1.7%) was in general higher but not significantly different from that of the Control group (9.0±1.1%). Assessment by MEMRI did not show significant differences in neuronal activation of appetite centres although there was a general trend towards a lower activation in the HF+In group.

Conclusion

We have shown that inulin can modulate total energy intake, possibly through changes in central appetite regulation, which induces changes in body composition. Inulin significantly decreases whole body adiposity but not adipose tissue distribution. Further, inulin significantly modulated intrahepatocellular lipid levels.

Inulin appears to favourably modulate appetite regulation, hepatic lipid metabolism and adipose tissue content.

References

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