The Impact of Cheese on Insulin Sensitivity

Amn Khaliqdina, Zohre Hashemi, Catherine Chan

Department of Agricultural, Food and Nutritional Science, University of Alberta

Supported by:

UNIVERSITY OF ALBERTA FACULTY OF AGRICULTURAL, LIFE & ENVIRONMENTAL SCIENCES

Canada

Introduction

- Type 2 diabetes (T2D) is characterized by insulin resistance in addition to pancreatic beta cell dysfunction, where the beta cells are unable to produce sufficient insulin to compensate for the insulin resistance.[1]
- It is estimated that by 2035, 592 million individuals will have diabetes worldwide.[2] In Canada, the prevalence of diabetes is estimated to rise to 5 million people by 2025.[3]
- Lifestyle changes, such as a healthier diet can reduce the risk of developing T2D by 40%-70%.[4]
- Previous research has suggested that the risk of developing T2D has an inverse relationship with dairy intake, and this may be due to the high content of calcium, magnesium, vitamin D, and whey proteins found in dairy products.[5]
- Cheese, as a highly consumed dairy product, contains fatty acids that have been shown to have beneficial effects on regulation of blood glucose, however, the mechanisms underlying these effects are not fully understood.
- In our lab, we previously found that feeding rats diets containing high-fat cheese (HFCh) and low-fat cheese (LFCh) resulted in improved insulin sensitivity (Figure 3), as measured by an insulin tolerance test (ITT).
- The purpose of this study was to investigate the effects of cheese feeding on epididymal fat cell area, since the size of adipocytes is known to negatively correlate with insulin sensitivity.
- **Hypothesis:** Feeding insulin resistant rats HFCh and LFCh will result in smaller adipocytes in epididymal adipose tissue, which would be associated with improved insulin sensitivity.

Methods

- 7-week old male Sprague Dawley rats (n=64) were used and housed at 2 rats/cage. They were randomized to two different diets (High fat diet(HFD), Low fat diet(LFD)) after 1 week of acclimatization. At week 6, HFD rats were randomized to three different diets: HFD, HFD+LFCh and HFD+HFCh. LFD rats were fed the same diet for the rest of the feeding trial (Figure 1).
- ITT was performed at week 13, followed by tissue collection at week 14.
- Epididymal adipose tissue was collected for immunostaining.
- All procedures involving animals were approved by the Animal Care and Use Committee at the University of Alberta.

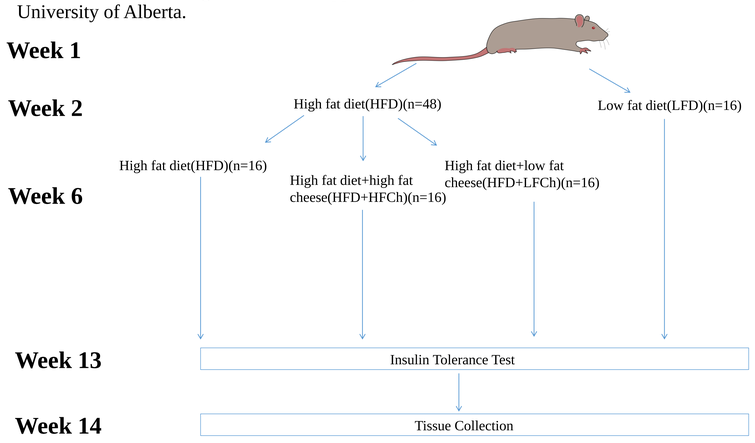

Figure 1. Procedures completed on male Sprague Dawley rats.

- 2 slides of epididymal fat from each group were prepared by hematoxylin and eosin staining.
- 20 pictures of each slide were taken with a Canon Powershot G10 camera using a Zeiss Axio Observer microscope at 20x magnification.
- 50 randomly selected cell areas from each sample were measured using ImageJ software.
- Data was analyzed using one-way ANOVA with post-hoc comparison tests in GraphPad Prism software with results being significant with a P value of less than 0.05.

Methods(cont'd)

Macronutrient Composition(g per kg)	LFD	HFD	HFD+LFCh	HFD+HFCh
Protein(total)	231.6	272.5	270.0	270.0
Protein from Cheese	0.0	0.0	94.8	79.7
Fat(total)	50.0	200.0	199.9	199.8
Fat from Cheese	0.0	0.0	74.9	99.8
Carbohydrates(total)	572.0	358.0	358.0	357.1
Carbohydrates from Cheese	0.0	0.0	5.0	4.1
Carbohydrates from Sucrose	255.0	300.0	295.0	295.0
Energy(kilocalories per kg)	3,681	4,332	4,312	4,308
Total choline(g per kg)	1.348	1.637	1.518	1.509

Table 1. Macronutrient composition of the experimental diet.

Results

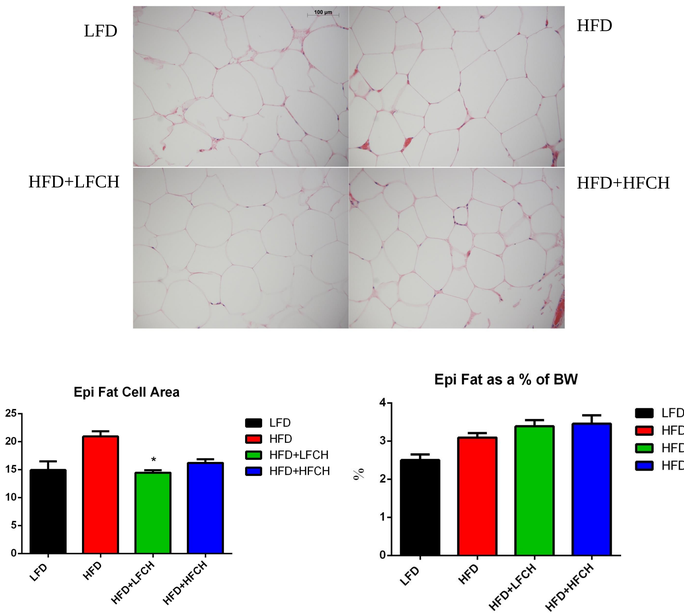

Figure 2. 20x magnification, hematoxylin and eosin stained epididymal fat cells with the mean area of the cells, and epididymal fat as a % of body weight, *P<0.05 (n=2-16).

Results(cont'd)

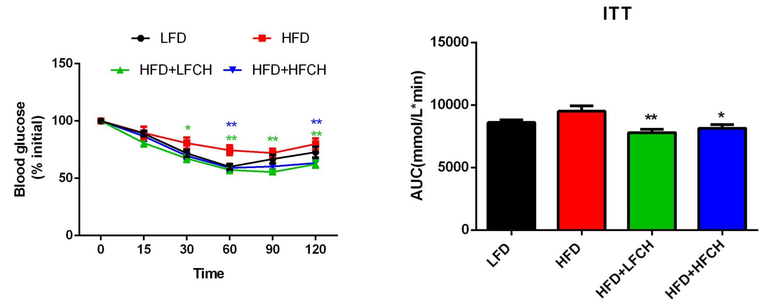

Figure 3. Blood glucose levels during an insulin tolerance test, shown as percentage of fasting blood glucose, and their corresponding AUC, *P<0.05 (n=8).

Conclusions

- We previously showed that both HFD+HFCh and HFD+LFCh diets improved insulin sensitivity when compared to the high fat diet.
- The HFD+LFCh group was most sensitive to insulin when an insulin tolerance test was performed.
- The HFD+LFCh group also had the smallest epididymal fat cell area compared to HFD.
- This data suggests low fat cheese consumption may beneficially affect epididymal adipose tissue morphology, which was associated with improved insulin sensitivity.
- The relationship between the insulin tolerance test and epididymal fat cell area could not be explained by the epididymal fat weight as a % of bodyweight.
- The small sample size may limit the validity of this research, and a larger sample size in the future may help to achieve more definite conclusions.

Acknowledgments

- Thank you to my Principal Investigator, Dr. Catherine Chan, my supervisor, Dr. Zohre Hashemi, and all the members of the Chan lab for giving me the opportunity to be apart of their research.
- Thank you to the Faculty of Agriculture, Life & Environmental Sciences and Canada Summer Jobs for sponsoring me to be a part of this program.
- Thank you to WISEST for giving me the opportunity to get exposure to research at the University of Alberta.

Literature Cited

1. Cree-Green, M., Triolo, T. M., & Nadeau, K. J. (2013). Etiology of Insulin Resistance in Youth with Type 2 Diabetes. *Current Diabetes Reports*, *13*(1), 81–88. http://doi.org/10.1007/s11892-012-0341-0
2. Yabe, D., Seino, Y., Fukushima, M., & Seino, S. (2015). β Cell Dysfunction Versus Insulin Resistance in the Pathogenesis of Type 2 Diabetes in East Asians. *Current Diabetes Reports*, *15*(6), 36. http://doi.org/10.1007/s11892-015-0602-9
3. Diabetes Canada Clinical Practice Guidelines Expert Committee. *Diabetes Canada 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada*. Can J Diabetes. 2018;42(Suppl 1):S1-S325.
4. Den Biggelaar, L. J. C. J., Eussen, S. J. P. M., Sep, S. J. S., Mari, A., Ferrannini, E., van Dongen, M. C. J. M., … Dagnelie, P. C. (2017). Associations of Dietary Glucose, Fructose, and Sucrose with β-Cell Function, Insulin Sensitivity, and Type 2 Diabetes in the Maastricht Study. *Nutrients*, *9*(4), 380. http://doi.org/10.3390/nu9040380
5. Dagfinn Aune, Teresa Norat, Pål Romundstad, Lars J Vatten; Dairy products and the risk of type 2 diabetes: a systematic review and dose-response meta-analysis of cohort studies, *The American Journal of Clinical Nutrition*, Volume 98, Issue 4, 1 October 2013, Pages 1066–1083, https://doi.org/10.3945/ajcn.113.059030