Effects of Low Fat Dairy Products on Hepatic Lipid Accumulation

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Introduction

- Non-alcoholic fatty liver disease (NAFLD) is defined by the excess accumulation of lipids within the liver, causing disruption in the proper functioning of hepatocytes and eventually progressing into non-alcoholic steatohepatitis (NASH), fibrosis, and end-stage liver disease[1].
- NAFLD is increasing in prevalence in Canada with a projected 20% increase in NAFLD cases between 2019 and 2030 in Canadians[2].
- Lifestyle modifications, including healthy eating patterns, remains the primary and most effective strategy for preventing NAFLD. Low-fat dairy products as a component of a healthy diet may improve total body metabolism, but it's impact on accumulation of fat in hepatocytes is unknown.
- The aim of this project was to determine if low fat dairy products had an impact on the accumulation of lipids in a high fat diet (HFD) fed mice model.

Methods

Figure 1. Study flowchart

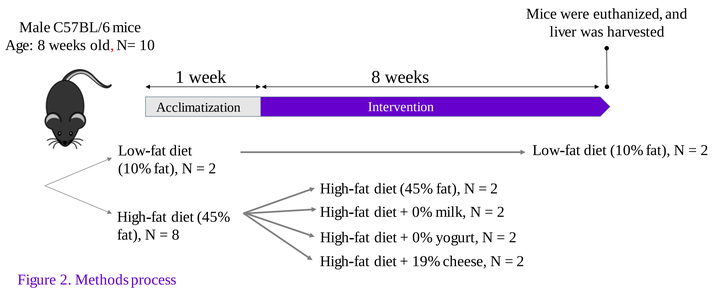
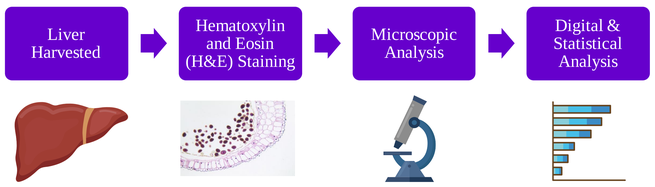


Figure 2. Methods process



Results

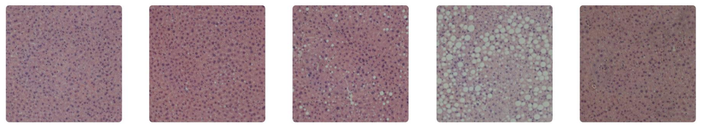


Figure 3A-E. Raw imaging of liver from microscopic images taken after H&E staining. Visually, there is variation between the HFD and LFD in lipid droplet count, frequency, and size. HFD + low fat cheese fed liver contains the highest increase in size and count amongst HFD + low fat dairy product livers.

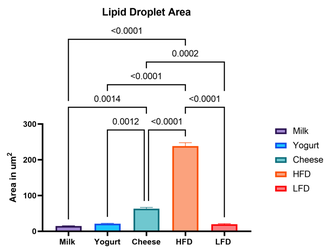


Figure 4. Area of lipid droplets measured in micrometres squared (um^2). This data shows an increase in lipid droplet count in HFD group in comparison to HFD + low fat dairy products and low fat diet (LFD).

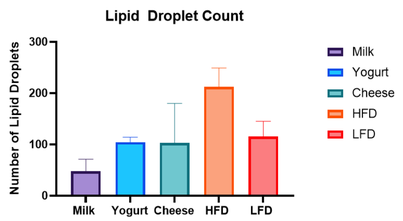


Figure 5. Total number of lipid droplets within the groups. The data shows an overall increase in lipid droplet count in the HFD group in comparison to HFD + low fat dairy groups.

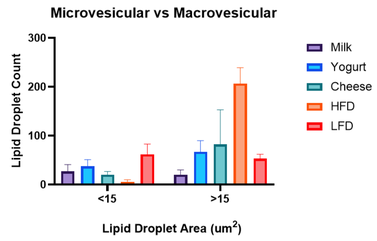


Figure 6. Number of macro- and micro-vesicular lipid droplets observed within the sample. All lipid droplets over $15um^2$ were classified as macrovesicular. HFD sample shows an increase in macrovesicular lipid droplets, and a decrease in microvesicular lipid droplets compared to HFD + low fat dairy products.

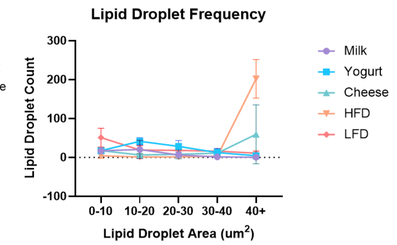


Figure 7. Number of lipid droplet in each category of size. The data above shows the increase in frequency for lipid droplets with area $\geq 40um^2$ in the HFD group in comparison to HFD + low fat dairy groups.

Conclusion

- High fat diet (HFD) had an overall increase in lipid droplet area, and macrovesicular lipid droplet count, thus signalling the significant role HFD plays in liver damage.
- HFD + low fat cheese diet had an increase in lipid droplet area and size in comparison to the HFD + low fat milk and HFD + low fat yogurt groups but still lower than HFD alone.
- HFD + low fat milk diet had a decrease in lipid droplet area and size in comparison to the HFD + low fat cheese and HFD + low fat yogurt groups.
- 0% fat milk provided to mice fed with HFD reduced liver fat. Yogurt had less pronounced effects than milk, whereas no benefit was seen with cheese feeding.
- These results are consistent with the lower number of lipid droplet in the liver of dairy-fed mice.
- The consumption of low fat dairy products with a high fat diet reduces the accumulation of larger lipid droplets within the liver, and therefore reduces the damage done to the liver.
- The dairy matrix may be important in determining physiological outcomes.

Literature Cited

[1]Smith, B. W. et al. (2011). Non-alcoholic fatty liver disease, Critical Reviews in Clinical Laboratory Sciences. *Critical Reviews in Clinical Laboratory Sciences*, *48*(3), 97–113. https://doi.org/10.3109/10408363.2011.596521

[2] Swain, M. G. et al. (2020). Burden of non-alcoholic fatty liver disease in Canada, 2019-2030: a modelling study. *CMAJ Open*, *8(2)*, *E429-E436.* https://doi.org/10.9778/cmajo.20190212

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