Comparison of the Effectiveness of Lactaid Regular versus Lactaid Extra Strength versus Life Regular in Breaking down Lactose

Leah Campbell, Jaiven Gill, Harry Park, Karmen Thong

Abstract

This study aimed to determine the effectiveness of different lactase supplements in breaking down lactose. The hypothesis was that fast-acting lactase supplements would have a higher reaction rate than regular lactase supplements, assuming the same concentration of lactase. Three different lactase supplements were tested, including two from Lactaid® and one from Life, with the same lactase concentration of 18,000 food chemical codex (FCC). Glucose concentrations were measured over 20 minutes using a glucose meter to determine the rate of lactose breakdown. No observable differences were found between the measured glucose concentrations across all three lactase supplement brands, suggesting that the labels on lactase supplements can be misleading. This study provides insights into the efficacy of different lactase supplements, which can improve the quality of life for those with lactose intolerance.

Introduction

Lactose is a disaccharide sugar molecule found in dairy products such as milk and cheese. Absorption of lactose into the bloodstream can only occur following its breakdown into D-glucose and D-galactose by the enzyme β-galactosidase, commonly known as lactase (Catanzaro et al., 2021). As people age, there is a decrease in their ability to produce sufficient amounts of lactose, leading to an indigestion of lactose (Deng et al., 2015). Lactose is fermented by bacteria in the large intestine and lack of breakdown causes symptoms such as abdominal pain, bloating, flatulence and diarrhea (Oak & Jha, 2018). This condition is lactose intolerance which affects a significant fraction of the world's population (Deng et al., 2015). A 2016 study by the Canadian Digestive Health Foundation suggests that approximately 44% of Canadians suffer from lactose intolerance (CDHF, 2023).

Lactase acts as a catalyst and speeds up the hydrolysis of lactose into glucose and galactose by cleaving the glycosidic bond between the two monosaccharides in lactose (Catanzaro et al., 2021). Lactose breakdown is a first-order reaction (Choi et al., 2021), that is the reaction rate is directly proportional to the concentration of the lactose present. However, lactase can affect the kinetics of the reaction, as the initial rate of the reaction will depend on several factors, such as the concentration of the lactase, or the ingredient of the capsule containing lactase which may vary across brands (Voget et al., 2022).

Much of the research centered on lactose intolerance explores the different factors such as temperature (Choi et al., 2021) that influence the ability to break down lactose, however, very little research is present regarding the effectiveness of the different lactase supplements on the market. Thus, the aim of this study is to determine the best brand of lactase supplement that can effectively break down lactose under the same labeled lactase concentration.

Lactase supplement brands were chosen based on familiarity and availability in stores. Thus, Life regular strength tablets and both Lactaid regular strength and fast acting tablets–which claim to act faster than a regular lactase tablet–will be used. The lactase supplements will be compared by utilizing a glucose meter to measure the glucose concentration produced following breakdown of lactose in solutions containing lactase. We hypothesize that if the lactase is labeled as a fast acting pill, its reaction rate of the breakdown of lactose will be greater than a regular strength lactase pill, assuming the same concentration of lactase is measured. Thus, we predict that Lactaid fasting acting will have a greater reaction rate than Life regular and Lactaid regular. Ultimately, this study will enhance the understanding of the role of lactase supplements in managing lactose intolerance and improve the quality of life for many individuals.

Methods

Three types of two lactase brands (Lactaid® regular strength, Life brand regular strength and Lactaid® ultra strength Fast Acting) of the same concentrations of lactase (18,000 FCC total), were compared by measuring their glucose concentrations per minute. Each lactase solution was produced by dissolving 18,000 food chemical codex (FCC: an international standard for determining purity of ingredients) (Pharmacopeia, n.d.) lactase pills in 20 mL of trisaminomethane (Tris) buffer solution. Homogeneous mixture was obtained using a stir bar. Lactose solution (6mL of 50 mM lactose) was pipetted into a falcon tube and placed in a water bath at ~37℃, which is the optimal temperature for the breakdown of lactose (Choi et al., 2021). Once the lactose solution reached 37℃, 2 mL of the lactase solution (lactase pill and Tris buffer), was pipetted into the falcon tubes and vortexed for further mixing. 7 uL of the lactose and lactase solution was immediately transferred to a piece of Parafilm to measure the initial concentration of glucose on the glucose meter shown in Figure 1. Using the same solution, the glucose concentration was measured every 2.5 minutes following vortexing for a total of 20 minutes to achieve the reaction rate for the breakdown of lactose. This procedure was repeated three times

for each individual lactase brand sample (Lactaid® regular strength, Life brand regular strength and Lactaid® extra strength).

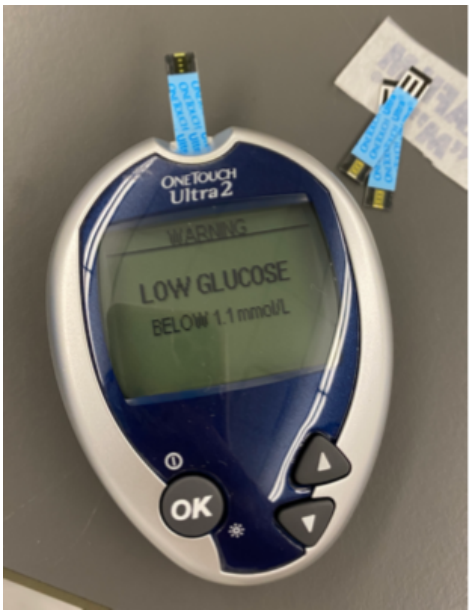

Figure 1: OneTouch Ultra 2® blood glucose meter with test strips.

This study was compared with two controls which were measured for glucose concentrations using the above method. The first control was 6 mL of distilled water mixed with 2 mL of lactase solution, in order to isolate the effect that lactase had when lactose was not present. The second control was 6 mL of lactose solution mixed with 2 mL of Tris buffer, to ensure that lactase was in fact responsible for the breakdown of lactose and there was not another factor controlling this.

Finally, to analyze the change in glucose concentration measurements for the different lactase brands, each glucose reading was standardized using the trendline equation obtained from the glucose standardization curve. Individual trials were plotted for each lactase brand and the slope values were recorded and later analyzed for statistical significance, using a one way ANOVA test in GraphPrism. Another one way ANOVA test was used to test the significance between the differences in the glucose concentration after the reaction had plateaued. A post hoc using the Tukey method was used for groups that differed significantly.

Results

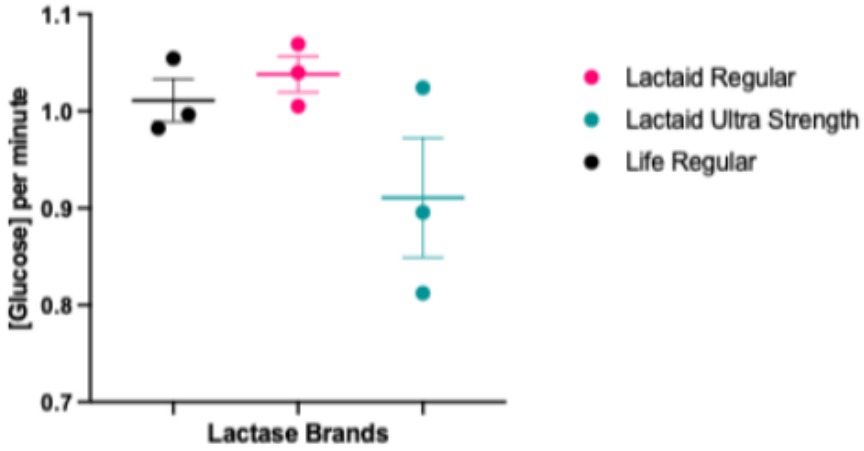

Figure 2: The plot shows the rate of change in concentration of glucose per minute. Each dot represents the rate of change in a singular trial. The different colours represent each brand of lactase supplement tested as labeled in the legend. Data represented as mean and 95% confidence intervals (n=3).

Figure 2 showed the rate change of glucose concentration for each brand of lactase supplement tested. In the overall ANOVA model, it was found that there are no significant effects of lactase brand on the concentration of glucose produced per minute ($p > 0.05$).

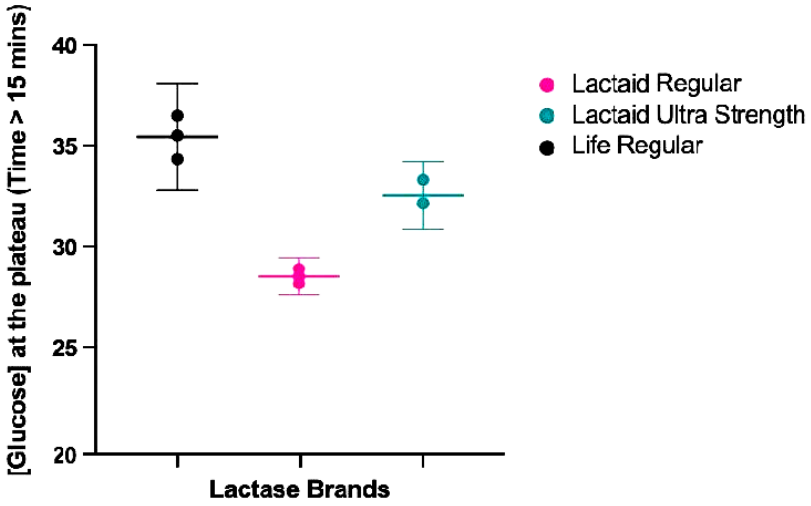

Figure 3: The average glucose concentrations during the plateau of each lactase brand. Each dot represents the average glucose concentration of each trial after 15 mins of testing. The different colours represent each brand of lactase supplement tested as labeled in the legend. Data represented as mean and 95% confidence intervals (n=3).

Figure 3 showed a comparison of the plateau values for each brand of lactase. In the overall ANOVA model, we observed significant differences in the plateau values across the three different lactase brands ($p < 0.01$). Life regular strength was found to have a significantly higher plateau value than Lactaid regular ($p<0.01$) and Lactaid extra strength ($p < 0.01$). We also observed a significantly higher plateau value for Lactaid ultra strength compared to Lactaid regular ($p < 0.01$). All control samples resulted in error messages due to absence of glucose in these trials.

Discussion

In this study, we demonstrated that there are no significant differences in lactase efficacy across the three lactase supplements used (Life Regular, Lactaid Regular and Lactaid Ultra Strength). The results of our experiment do not support the predicted outcome and thus we failed to reject the null hypothesis that there would be no observable difference in the glucose concentration across the different lactase supplements. It is likely that results were not significant due to the small sample size ($n = 3$). As such future studies should focus on using larger sample sizes to obtain more conclusive results. That being said, we did observe a significant difference in the plateau values of the different reactions for the three different lactase supplements. We can derive from this that there is a higher concentration of lactose that is broken down with the application of the Life brand supplements and a much lower concentration in the Lactaid brand regular strength pills. Taken together, the results from this study suggest that there is no difference in the glucose concentration produced following use of different lactase supplements at the same labeled concentration. This suggests that there is no difference that people with lactose intolerance will experience when using fasting acting versus regular strength lactase tablets; assuming they use the same concentration.

Little to no research has been done to test the efficacy of different lactase brands, thus there is relatively little literature to compare our results to. Typically fasting acting lactase pills contain a higher dosage of FCC compared to the regular acting lactase pills. Thus it's possible that once the same dosage of FCC is taken for both sets of pill types (fast acting versus regular) that no differences in glucose concentration would be observed similar to the results of this study. This is why it's imperative for further research to be conducted in this area using a larger

sample size to determine whether there is a difference in efficacy of different labeled lactase brands.

During the experiment, we encountered three main sources of error that could have impacted the results. The first source of error arose when dissolving the lactase fine powder into the Tris buffer; a problem that was previously found for other studies (Choi et al., 2021). A fine powder of undissolved lactase coated the edges of the beaker containing the solution. To mitigate this: the same solution was drawn up using a pipette to wash down the powder coating the beaker's walls. Additionally, the lactase solution was consistently mixed to ensure a homogenized solution was used for each trial; and qualitative transferring techniques were applied when pipetting all solutions of any amount. The inconsistencies with dissolving of lactase powder in Tris solution was observed during the measurement of glucose concentrations as lactase powder remained clumped at the bottom of the falcon tube despite vortexing immediately prior to taking measurements. Secondly, there were also noticeable air bubbles in some pipetted samples so the volume tested on each glucose meter strip may differ; however readings for all trials containing air bubbles were successful. There was one trial where we received an error reading on the glucose meter - another sample was pipetted immediately after and a viable reading was taken. These errors likely resulted in minimal impact on the collected data, though replication of the whole experiment with more controlled precision of these factors may help strengthen the statistical significance. Lastly, the third source of error was the standardized glucose curve. It was made using an approximation of values from the standardized glucose curve of the Choi et al. (2021) paper.

One important note about this study is that it was performed in-vitro and thus might not accurately reflect the human digestive system in terms of optimal pH. That being said, we did conduct the experiment at 37℃ because it was found to be the optimal temperature for lactose breakdown (Choi et al., 2021). Future studies should focus on testing an array of different lactase supplements to compare their effectiveness. The consequences of studies such as this are far reaching as individuals suffering from a deficiency in lactase production will benefit from the knowledge of which supplements work more effectively.

Conclusion

The basis of this study was to test if the efficacy of lactase supplements at the same concentrations differed by brand. We found that there were no significant differences between the reaction rates of the fast acting supplements and the regular strength supplements. This study provides important information for the population of people who are lactose intolerant and rely on lactase supplements for the digestion of dairy products. It remains uncertain, however, whether the efficacy of the lactase supplement is accurate to what is labeled.

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Appendix

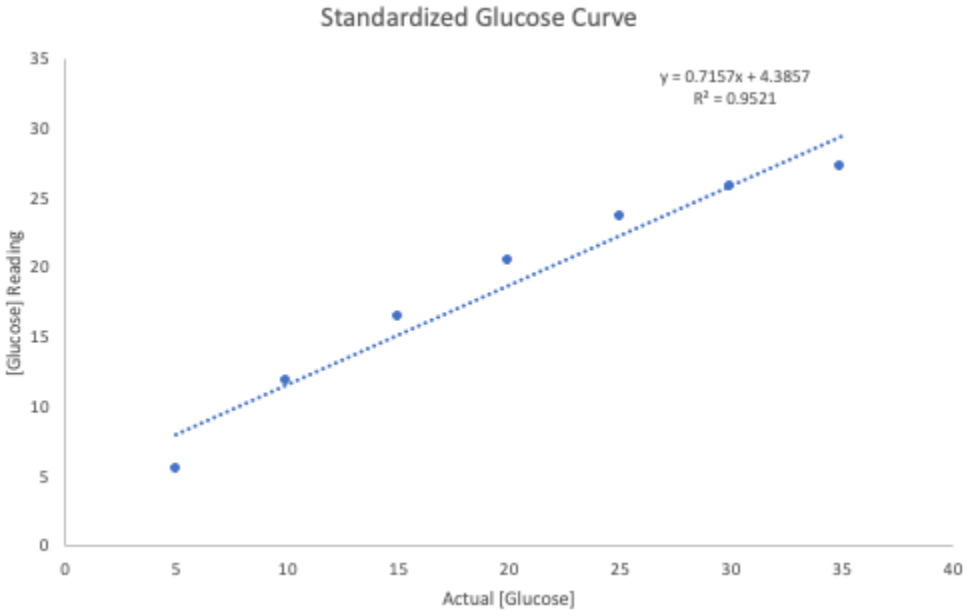

Figure 1: Standardized glucose curve approximated from the standardized glucose curve taken from the Choi et al. (2021) paper.