

# Buttermilk and baking soda increase pancake fluffiness by liberating carbon dioxide

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## SUMMARY

The goal of this study was to determine whether adding buttermilk and baking soda to pancake mix would result in fluffier pancakes. To accomplish this, we made two batches of pancake mix in an identical manner. However, in one of the mixtures, we substituted milk for homemade buttermilk and added more baking soda. We measured the resulting height of 30 pancakes from each mix and found that pancakes made with buttermilk and baking soda were taller by an average of 2.4 mm. A *t*-test revealed this height difference (Buttermilk + baking soda Mean = 11.383 ± 1.3 mm; Control Mean = 8.960 ± 1.6 mm) to be significant ( $p = 0.0001$ ). These results support our hypothesis that the addition of buttermilk and baking soda into the mix result in fluffier pancakes.

## INTRODUCTION

An important chemical reaction behind making pancakes occurs when a leavening agent and an acidic ingredient are added to the batter (1). Sodium hydrogencarbonate (sodium bicarbonate or baking soda;  $\text{NaHCO}_3$ ), is a common leavening agent. On the other hand, carbohydrates found in buttermilk (fermented cow's milk) are metabolized by *Lactococcus lactis* or *Lactobacillus bulgaricus* into lactic acid which acts as the acidic ingredient (2). This acid is notorious for tenderizing gluten, giving baked goods a softer texture and more body (3). The combination of lactic acid from the buttermilk and baking soda, with heat, produces carbon dioxide ( $\text{CO}_2$ ) (4).



The gas is trapped as the batter solidifies, making the pancakes rise without making them too dense (5). Only half of the  $\text{CO}_2$  in the baking soda is released while the other half produces sodium carbonate ( $\text{Na}_2\text{CO}_3$ );  $\text{Na}_2\text{CO}_3$  is hygroscopic (capable of absorbing moisture which affects the batter's texture) while  $\text{NaHCO}_3$  is not. Additionally, when used on its own, baking soda can give food a bitter taste. This is why baking soda is regularly mixed with other ingredients to avoid an imbalance between the acidic and basic properties (5).

The purpose of this research was to determine if adding buttermilk and baking soda into pancake batter will result in fluffier pancakes. We hypothesized that if we add buttermilk and baking soda to the mix, then the pancakes would be fluffier. We saw that the addition of buttermilk and baking soda resulted in taller, fluffier pancakes ( $p = 0.0001$ ).

## RESULTS

To test the effect of adding buttermilk and baking soda on pancake fluffiness, we prepared two batches of pancakes. Our first mix contained only Pearl Milling Company (formerly Aunt Jemima) Classic Pancake mix. We prepared the other mix the same way, except of the addition of buttermilk and extra baking soda. We made and measured the height of 30 pancakes for each mix.

The mix with buttermilk and baking soda showed an increase in pancake height from the normal mix ( $11.3 \pm 1.3$  mm vs.  $8.9 \pm 1.6$  mm; **Figure 1**). The smallest value for the normal mix was 6.5 mm, while the altered mix was 9.4 mm. The pancakes from the normal mix were shorter in height from the altered pancakes by an average of 2.4 mm. An unpaired *t*-test showed that buttermilk and baking soda do increase pancake fluffiness ( $p = 0.0001$ ).

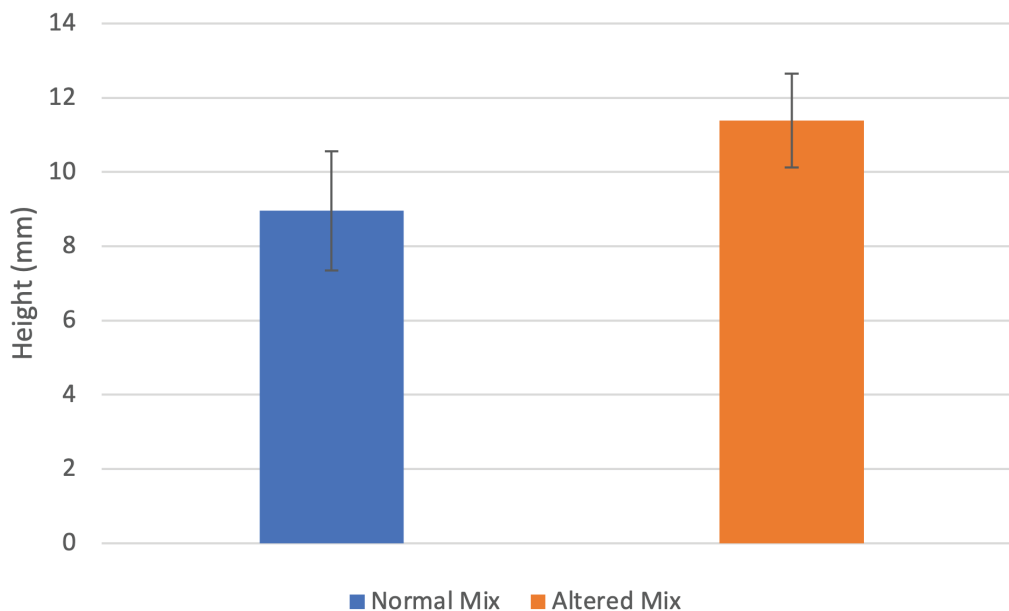
## DISCUSSION

Our hypothesis that adding buttermilk and baking soda to the pancake mix would make the pancakes fluffier was supported by our data. When comparing the height difference from both mixes, the pancakes with buttermilk and baking soda came out taller by an average of 2.4 mm. The smallest height value for both mixtures had a difference of 2.9 mm while the highest was 0.5 mm. The average height of the pancakes from the normal and altered mixes were  $8.9 \pm 1.6$  mm and  $11.3 \pm 1.3$  mm, respectively.

It must be noted that even if the pancakes are taller, they may not necessarily be fluffier because the density may have also been affected. The pancakes proved to be taller, but density was not measured in the experiment; however, we tried to use the same amount of mass by creating same sized pancakes to account for this. In addition to fluffiness, we noted that the pancake flavor was affected by the change of ingredients; the batter with buttermilk was a little bitter when tasted plain. However, when we added sweet toppings like maple syrup and berries to the pancakes after preparation, the bitterness was no longer noticeable.

Based on background research, we anticipated that the effect of the buttermilk and baking soda would be larger. The results of this experiment yielded similar results to those discussed by the Australian Academy of Science (2). It is conceivable that some changes to the variable ratios and cooking times may have affected the results.

Notably, the ratio of liquid in the altered mix is greater.



**Figure 1: Pancake means for normal mix and buttermilk + baking soda mix.** The buttermilk + baking soda mix (orange) showed a small increase in the average pancake height compared to the normal mix (blue) by 2.4 mm. Error bars represent standard deviation.

The normal mix contained 2 ¼ cups of liquids while the altered mix had an additional 2 tablespoons of lime juice due to the buttermilk. This could have liquified the batter a little which could have affected the results. Previous research mentions how the ratio between liquids, flour, egg, and fat can define pancake fluffiness (4). Furthermore, they mention that liquifying the batter could result in a crepe, which is a flat and very thin type of pancake (4). Finally, the Pearl Milling Company Classic Pancake mix already includes baking soda. It would be interesting to conduct this experiment with a mix that lacks baking soda in it. This could result in a reduced concentration of CO<sub>2</sub>, which would prevent the pancake from expanding.

Articles like the ones from Science Made Fun and The Australian Academy of Science also mention that the use of buttermilk and baking soda in the mix improves the outcome on pancake fluffiness; the use of store-bought or other buttermilk recipes could alter the results (1, 2). It would be beneficial to test if buttermilk and baking soda improve fluffiness on any other types of cakes. Lastly, another extension of this research would be to test other buttermilk substitutes like yogurt, water, and sour cream.

Based on our findings, buttermilk and baking soda do improve pancake fluffiness. These results can expand knowledge and understanding of this under investigated topic. People can improve pancake recipes and potentially apply this information in different types of cakes.

#### MATERIALS AND METHODS

The control group was comprised of one batch of pancakes prepared utilizing the brand Pearl Milling Company (formerly

Aunt Jemima) Classic Pancake mix (6). To make the normal recipe, 3 cups (378 g) of mix were poured into a bowl, followed by 2¼ cups of whole milk (532.1 mL) into the mix and 1 whole egg. Lastly, 3 tablespoons (42.9 g) of butter were poured into the mix. It should be noted that this mix already includes baking soda (the exact amount is not specified). Ingredients were mixed until no lumps were noticeable. Subsequently, 10 cm diameter batter circles were poured in a frying pan to obtain the same amount of mass for all pancakes. The frying pan was heated at medium heat and the pancakes were cooked for 90 seconds, and then they were flipped when the batter was filled with bubbles. The same process was followed for the other side and repeated for a total of 30 pancakes.

The experimental group was comprised of one batch of pancakes using the same brand and recipe as above, but we replaced the whole milk with homemade buttermilk and integrated an extra tablespoon of baking soda. The homemade buttermilk was made with 2¼ cups of whole milk (532.1 mL) and 2 tablespoons (29.4 mL) of lime juice. These two ingredients were mixed and left to rest for five minutes. Finally, the pancakes were cooked in the same manner as the control group until 30 pancakes were obtained.

The height of the 30 pancakes of each mix were quantified with a vernier caliper for precision. Then, the 60 results were entered into an unpaired *t*-test calculator and an  $\alpha$ -level of 0.05 was taken as significant.

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