Examination of the effects of chilling time on the spreading of cookies

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Abstract

The process of chilling is extensively utilized across a vast variety of baking recipes. Accordingly, in cookie recipes, the process of chilling cookie dough is practiced to allow for the incorporated fat to chill prior to baking. This results in the chilled fat melting at a slower speed which limits the spreading of the baked cookies since the size of the cookies are able to set prior to the fat melting. Despite the fact that this mechanism is widely understood by bakers, there are limited studies dedicated to analyzing whether varied chilling time results in cookies that exhibit significantly different diameters due to this process of spreading. Therefore, in this study, we offer a scientific investigation into the relationship between the chilling times of cookie dough and the spread of cookies. This study was conducted with the objective of determining whether longer a chilling time of cookie dough would result in the significant decrease of cookie spreading, measured by the cookie's diameter. Within this experiment, we utilized the same cookie recipe throughout the whole study and increased the chilling time of the cookie dough in 20 minute increments. In total, we baked thirteen batches of cookie dough that ranged from 0 minutes to 240 minutes chilling time. Accordingly, we predicted that the diameters of cookies from dough batches chilled for longer periods of time would exhibit significantly smaller diameters than those chilled for shorter periods of time in the refrigerator. In utilizing a total of 39 cookie diameters, the conducted one-way ANOVA analysis revealed a P-value of less than 0.0001. As this P-value is smaller than the significance level of 0.05, the statistical test enables us to reject the null hypothesis that states that the cookie diameters of cookies chilled for longer and shorter periods of time would not be significantly different. Conclusively, the results from the statistical analysis conducted on the collected cookie diameters suggests that there is a statistically significant difference between the diameters of cookies from dough batches chilled for longer and shorter periods of time. Hence, this study suggests that cookie dough chilled in the refrigerator for longer periods of time would result in less spreading of the cookies. Namely, cookie dough chilled for longer periods of time would result in cookies that exhibit smaller diameters.

Introduction

When baking cookies, recipes often instruct bakers to chill the cookie dough before placing them in the oven to bake. However, these chilling times vary between recipes. Cookie dough is chilled in order to affect the amount of spreading the cookies will exhibit when baked (Hammel, 2015). This is because when fat is chilled, it melts slower. Hence, limiting the spread of the cookies allows cookies to set before the fat melts (Sommer, 2020). This process results in the widely loved, ideal cookie texture: crispy edge and chewy center. Moreover, chilling the cookie dough also allows for the flour and sugar to hydrate which helps the cookies set more quickly in the oven. When the flour and sugar absorbs moisture from other components of the recipe, such as from the eggs and butter, this results in the sugar having less available moisture to absorb (Jampel, 2020). This process also contributes to limit the spreading, and therefore, diameters of cookies (Arias, 2020).

Although previous articles have investigated the spread of cookies in relation to different ingredients (Jacob & Leelavathi, 2007), such as using oil versus non-emulsified hydrogenated fat, there are limited studies that analyze whether varied chilling time results in cookies with significantly different diameters due to spreading despite bakers knowing that limiting cookie spread results in the ideal cookie texture. Therefore, in this study, we will investigate the relationship between the chilling times of cookie dough and the spreading of baked cookies. This study was conducted to determine whether a longer chilling time of cookie dough would result in a significant decrease of cookie spreading which would be measured by its diameter.

Given that the process of chilling cookie dough would result in the chilled fat melting at a slower rate and enabling the hydration of the incorporated flour and sugar, we predict that dough batches chilled for longer periods of time would result in cookie diameters that are significantly smaller than the cookie diameters baked from dough batches chilled for shorter periods of time. These known mechanisms that inform us that chilling cookie dough would limit the spreading of cookies enables us to establish this prediction that we strive to confirm with numerical evidence in our study.

Methods

To measure the spread of cookies in relation to the amount of time the cookie dough was chilled for, we used a refrigerator, an oven, a ruler, mixing bowls, and the following ingredients to make the cookie dough: 2 eggs, 12 tablespoons of white sugar, 18 tablespoons of brown sugar, ½ teaspoon of salt, 1 cup of melted butter, 2 eggs, 1 teaspoon of baking soda, and 2 ½ cups of all purpose flour.

Firstly, we added the two types of sugars together along with the salt and melted butter and combined the mixture until we achieved a pasty texture with no lumps. Following that, we whisked the eggs into the batter and sifted the flour and baking soda into the mixture. We then combined these ingredients until we achieved a homogenous batter. Subsequently, we divided the dough into thirteen sections, where each section corresponded to a single batch. We then shaped each batch into 3 cookies that weighed approximately 16 g. Therefore, we produced a total of 39 cookies throughout the whole study.

Subsequently, the dough was chilled in the refrigerator according to the chill time assigned to each batch, where we baked the first batch of 3 cookies right away as this first batch had 0 minutes of chill time. We then baked the next batch, named batch 20, after a chilling period of 20 minutes in the refrigerator. We continued this process until we baked the last batch of cookie dough that chilled for 240 minutes. This process enabled us to achieve a total of thirteen batches labelled as batch 0, batch 20, batch 40, batch 60, batch 80, batch 100, batch 120, batch 140, batch 160, batch 180, batch 200, batch 220, and batch 240. We baked each batch for 12 minutes at 350 F in the oven and measured the spread of the baked cookie with a ruler. Hence, we recorded the diameter of each cookie and ensured that the data satisfied the ANOVA assumptions of exhibiting an normal distribution and equal variance. We checked for these by ensuring that our data passed the Shaprio-Wilks normality test to check to normal distribution and plotted a residual plot to check for equal variance. Therefore, we performed a one-way ANOVA test on GraphPad Prism 9 using the collected data to determine whether a statistically significant difference was present between the diameter, and therefore, the spread of the cookies chilled for longer and shorter amounts of time in the refrigerator.

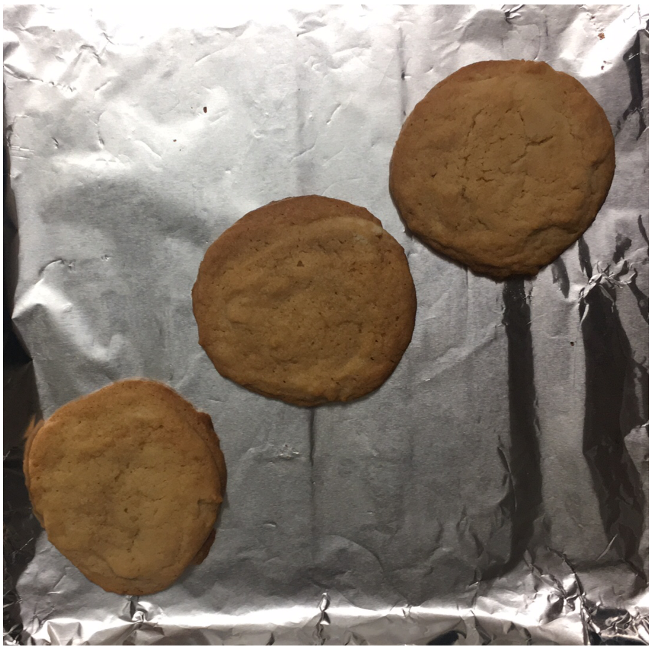

Figure 1. Baked cookies from batch 60.

Cookies from batch 60 were baked after a chilling time of 60 minutes. The baked cookies exhibited a light brown colour. The mean diameter of the three cookies was 6.8 cm. The aluminum foil was used so that the removal of the cookie from the pan was easier.

Results

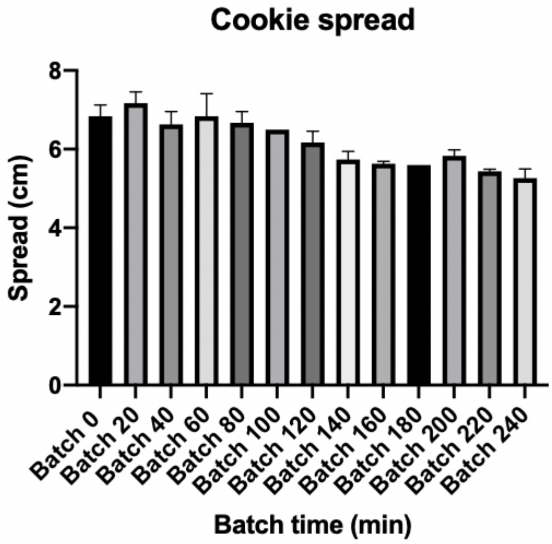

Figure 2: A bar graph was created on GraphPad Prism 9 showing the diameter (cm), and therefore, the spread of cookies put into the oven with no chilling time at batch 0, with chilling time increasing in increments of 20 minutes from batch 20 to batch 240. Each batch had 3 data points corresponding to the 3 cookies in each batch. Hence, a total of 39 data points were used. The mean diameter of cookies in batch 0 is 6.8 cm, batch 20 is 7.2 cm, batch 40 is 6.6 cm, batch 60 is 6.8 cm, batch 80 is 6.7 cm, batch 100 is 6.5 cm, batch 120 is 6.2 cm, batch 140 is 5.7 cm, batch 160 is 5.6 cm, batch 180 is 5.6 cm, batch 200 is 5.8 cm, batch 220 is 5.4 cm, and batch 240 is 5.3 cm. A one-way ANOVA test was performed (P-value 0.0001) to determine if there was a statistical significant difference in the spread of the cookies. The standard error bars are small, indicating low variation in our sample.

The results show an overall decrease in the spread of cookies from batch 0 with a mean diameter of 6.8 cm to batch 240 with a mean diameter of 5.3 cm. This is represented in Figure 2 which shows the mean spread cookie in all batches from batch 0 to batch 240. The data passed all assumptions of a one-way ANOVA test, where the performed ANOVA test gave us a P-value of less than 0.0001. The spread of the data points within each batch was small as the diameter of the cookies were approximately the same and there were no outliers present in any batch. Therefore, there was low variation within each batch. This is indicated by the small standard error bars in Figure 2.

Discussion

For this experiment, our objective was to determine whether longer chilling times would lead to less spreading in our cookies after baking, and hence, result in the ideal texture of cookies: crispy edge and chewy center. Our data showed an overall decrease in cookie spreading, exhibited by the decrease in cookie diameters starting from batch 0 to batch 240. From the one-way ANOVA analysis, the P-value obtained was less than 0.0001, which is less than the significance level of 0.05. Therefore, the statistical test allowed us to reject the null hypothesis stating that the diameters of cookies chilled for longer and shorter periods of time would not be significantly different from each other. Therefore, the statistical analysis supports our alternative hypothesis stating that diameters of cookies chilled for longer and shorter periods of time would be significantly different from each other.

In this lab, we used a P-value of 0.05 or 5% as our alpha value as this value indicates that we have a 5% probability of rejecting the null hypothesis when it is true. The use of 5% is appropriate for this investigation as lower alpha levels are sometimes used when multiple tests are conducted at the same time. Nonetheless, since we are only doing one statistical test, the ANOVA test, the 5% risk of rejecting a null hypothesis when it is true is one that we can afford to risk in this experiment, hence a P-value of 0.05 was used.

Our prediction that longer chilling time will result in the cookies spreading less was supported by the one-way ANOVA analysis as the diameters of the cookies chilled for different periods of times was statistically significantly different from each other, as seen in Figure 2.

In answering our research question “does chilling cookie dough for a longer period of time result in cookies with less spreading?” the data points from our study used to produce the results from the one-way ANOVA analysis enables us to conclude that chilling cookie dough for longer periods of time results in cookies with statistically less spreading. This process is due to the incorporated fat melting at a slower rate when it has been chilled. Hence, limiting the spread of the cookies as the cookies are allowed to set to a smaller diameter before the fat melts (Vaughan, 2020). Furthermore, chilling the dough also enables the flour and sugar to hydrate by absorbing the moisture from other ingredients, such as the eggs, in the dough. This process also contributes to limiting the spreading of the cookies as this mechanism limits the amount of moisture available for the incorporated sugar to absorb (Jampel, 2020). These mechanisms, therefore, work simultaneously to limit the spreading of cookies. Hence, cookies chilled for longer periods of time exhibit significantly smaller diameters.

Additionally, it is important to highlight that batches 20, 60 and 200 are unusual as the diameters of the cookies in these batches were larger than expected. Since these cookies were chilled for a longer period of time than the previous batches 0, 40, and 180, they were expected to have a smaller diameter than them. However, cookies from these batches had mean diameters that exceeded the previous batches. The unexpected diameters can be attributed to the sources of variations present within our study. Due to the batch times being split between Liang baking batch 0 to 120 and Cho baking batch 140 to 240, there could have been sources of variation like different fridge temperatures affecting how much the cookies were chilled. Likewise, different baking techniques can also be another source of variation. The most plausible explanation for the unusual results for batches 20, 60, and 200 is the amount of mixing each individual performed on the dough when folding in the flour as over-mixing will activate the production of gluten and cause cookies to have a tougher texture. Likewise, overmixing can also make the dough more difficult to shape. Hence, the unusual diameter sizes for cookies in batches 20, 60, and 200 could be contributed to each individual shaping the cookie dough differently. Likewise, the shape of the cookie dough could differ within each batch due to varying amounts of pressure during the shaping process of the cookie dough. The combination of these factors together contributed to the variation in mean diameters.

Conclusion

This study provides scientific evidence that supports our prediction that cookie dough chilled for longer periods of time produces cookies with significantly smaller diameters. Through conducting a one-way ANOVA analysis, we rejected the null hypothesis stating the different chilling times would produce cookies with the same spread, and hence, diameters. Therefore, the results from our statistical analysis aligns with our hypothesis that chilling cookie dough for longer periods of time results in less spreading of cookies.

Acknowledgements

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Appendix

Table 1: Raw data of the diameters (spread) of the cookies baked by Liang and Cho with the batches corresponding to how long the batches were chilled in the fridge for in minutes.

Batch 0	Batch 20	Batch 40	Batch 60	Batch 80	Batch 100	Batch 120	Batch 140	Batch 160	Batch 180	Batch 200	Batch 220	Batch 240
6.5	7	6.35	7.5	6.5	6.5	6	5.5	5.7	5.6	6	5.5	5
7	7	6.5	6.5	7	6.5	6	5.9	5.6	5.6	5.8	5.4	5.4
7	7.5	7	6.5	6.5	6.5	6.5	5.8	5.6	5.6	5.7	5.4	5.4

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