

Effect of Flour Type on Sourdough Starters:

Irene Park & Kenith Taukolo

Science Department, IMSA

Methods in Scientific Inquiry

Dr. Jessica Amacher

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ABSTRACT:

After deciding on world hunger as our topic for our Methods in Scientific Inquiry (MSI) project, we decided to conduct an experiment about sourdough starters. In particular, we were asking how the type of flour (ie, whole wheat and all-purpose) may affect the rise of sourdough starters. The differences in height in the different types of sourdough starters using whole wheat and all-purpose flour were identified. We used paired t-tests for deciding if the heights of the starters grew overtime and a two-sample t-test to find if the mean change in height was statistically significant between the different types of flours. After analyzing data, it was discovered that each sourdough starter rose a statistically significant amount from the first day for both types of flour. When compared to each other, all-purpose flour starters rose a statistically significant amount more than whole wheat starters. The application of these results is to reduce world hunger and possibly provide more food to those who need it by using higher-rising flours to create sourdough breads.

INTRODUCTION:

The United Nations Sustainable Development Goals (UNSDG) strive to create a blueprint towards a better future for our planet. The UNSDG we picked for our project was world hunger because of the impact it has for all populations, and is exacerbated by the COVID-19 pandemics. This is an emergent problem and we wanted to propose a solution to lessen the impact of world hunger on food insecure populations. This goal specifically asks to use sustainable agriculture to feed the millions of people in this world who are malnourished. When researching topics, we found The Wild Sourdough Project explaining the use of sourdough starters and how to create one (McKenney, 2020). The first remnants of sourdough and leavening

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bread date back to ancient Egypt, where creating a starter with flour and water most likely came about by accident (The Sourdough School, 2015). Later, fermentation of bread and sourdough spread to other countries, such as Greece and France. This led us to wonder if sourdough starters were feasible in places where food insecurity is a challenging problem. In South Africa, a country in which twenty percent of households had inadequate access to food, wheat is a sustainable type of flour used there (Maize Suppliers, n.d). For our experiment, we decided to ask if there was a difference between the rises of wheat flour commonly found in South Africa, and all-purpose flour, a pantry staple in the United States of America. With the conclusion of this experiment, we can try to use this information to help eradicate hunger throughout the world.

We know that there is a difference between all-purpose flour and wheat flour through specific science journals. An experiment by Ghaddar et al (1997) found that there was a tangible difference in appearance, taste and texture between whole wheat flour and all-purpose flour when baked into banana bread. Another experiment found differences in the texture of bread when using wheat flour (Çetin-Babaoğlu et al., 2020). Also, the nutritional value is quite different between the two types of flour as all-purpose flour has only 10% protein content while whole wheat has 14% protein and whole wheat flour has four times the amount of fiber and less calories than all-purpose flour. Additionally, whole wheat flour utilizes the entire grain of a wheat berry while in all purpose flour, only the endosperm is used when grinding the flour (TheyDiffer, 2018). Using different flours also affects the sourdough starter because of factors like fermentation time and specific strains of bacteria present, so if we use two different flours, we should get differing results (Van Kerrebroeck et al., 2018). The differences between the two are vast, and so when doing the experiment, we expect to get different results.

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Considering that different types of flour are found in different nations, some of which are food insecure, we asked the question, “Is there a statistically significant difference between the rise in sourdough starters made from all-purpose flour and wheat flour?” This is a difference question because our goal was to find if there is a distinction between the rise of each flour when in sourdough starter form.

As explained, the flours are tangibly different, so we wanted to see the difference ourselves through the differences in sourdough starters, specifically the difference in the rise. To do this, we are using the exact same materials to make sure that the only difference can be the flours, and not an outside source. However, we kept in mind that temperatures are also not exact, and could cause minor change to the results. The materials include compostable plastic cups, coffee filters, and rubber bands. Sourdough starters work because they create lactic acid bacteria from their environment to make bread taste different and can be used as an ingredient for bread (Suo et al., 2020).

By studying this chosen topic, we can provide the scientific community with a significant contribution to address this UNSDG goal, World Hunger, by experimenting with sourdough starters. For example, when deciding what crop to cultivate in food insecure places, researchers can inform farmers about how exactly to grind the flour or what types of flour to produce in order to create more food using our experiment. Through our research and sourdough starters, we are making a change in the world through our experiment by discovering how we can make food more abundant and accessible.

MATERIALS AND METHODS:

We collected data based on the difference between the rise of sourdough starters when using all-purpose flour and wheat flour. To find this data, we first measured the initial height of the sourdough starter each day to find the differences in height. We each conducted the same experiment, in detail below, over the course of 15 days, each using a different type of flour. To ensure that the conditions were the same for each person, we ordered the same materials and used the directions provided by The Wild Sourdough Project. In total, we have 20 data values to compare (10 each). To find this difference, we compiled all of the data into an Excel document, where we conducted a two-sample t-test with ten samples for each type of flour. The experimental method we are using to gather this data is found below.

In successfully completing this experiment, we needed 10 compostable plastic cups, a spoon, 10 coffee filters, 10 rubber bands, distilled water, measuring spoons (teaspoon and tablespoon), 10 rubber bands, ruler (cm), lab notebook, and either wheat or all-purpose flour. On the first day, we mixed in 2 tablespoons of the chosen flour and 2 tablespoons of distilled water in a compostable cup whilst carefully scraping down the sides of the cup. After labeling the cups and covering them with a coffee filter (secured with rubber bands), they were put into a room temperature environment away from the sun. We recorded the height of each starter in the lab notebooks using a ruler (in centimeters). From day 2 to the last day (15), we repeated the following methods every 24 hours. The height of each starter was measured and recorded before mixing with a spoon. We removed 1 tablespoon of the sourdough starter, while we added 4 teaspoons of the chosen flour and 1 tablespoon of water. Each cup was covered with a coffee filter and stored in a room temperature environment until day 15, repeating the above processes

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each day. After conducting the final measurement, we disposed of the sourdough starters safely (McKenney, 2020).

RESULTS:

t-Test: Paired Two-Sample for Means

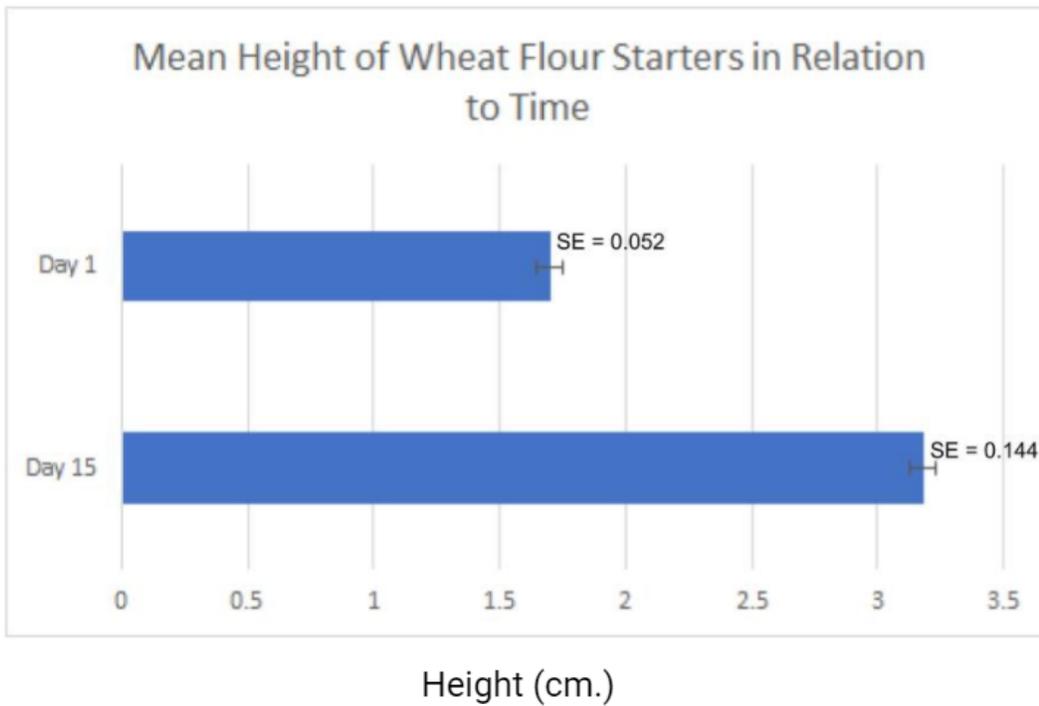


Fig. 1: This bar graph compares the mean height of the first and last days of whole wheat flour and includes standard error.

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t-Test: Paired Two-Sample for Means

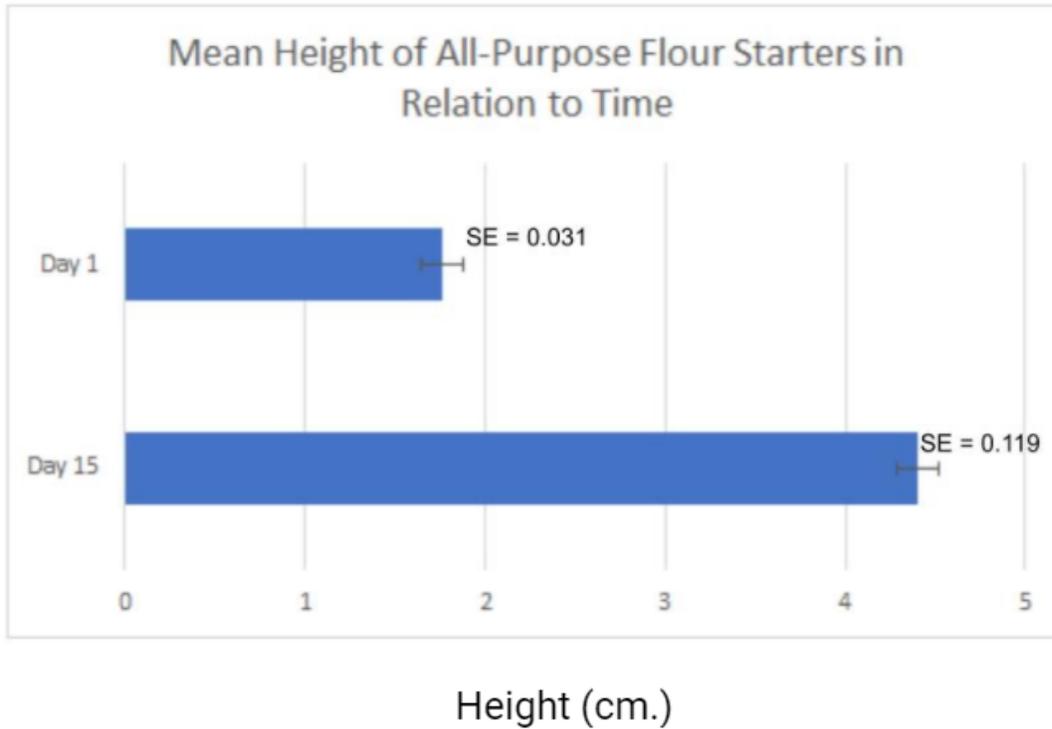


Fig. 2: This bar graph compares the mean height of the first and last days of all-purpose flour and includes standard error.

t-Test: Two-Sample Assuming Equal Variances

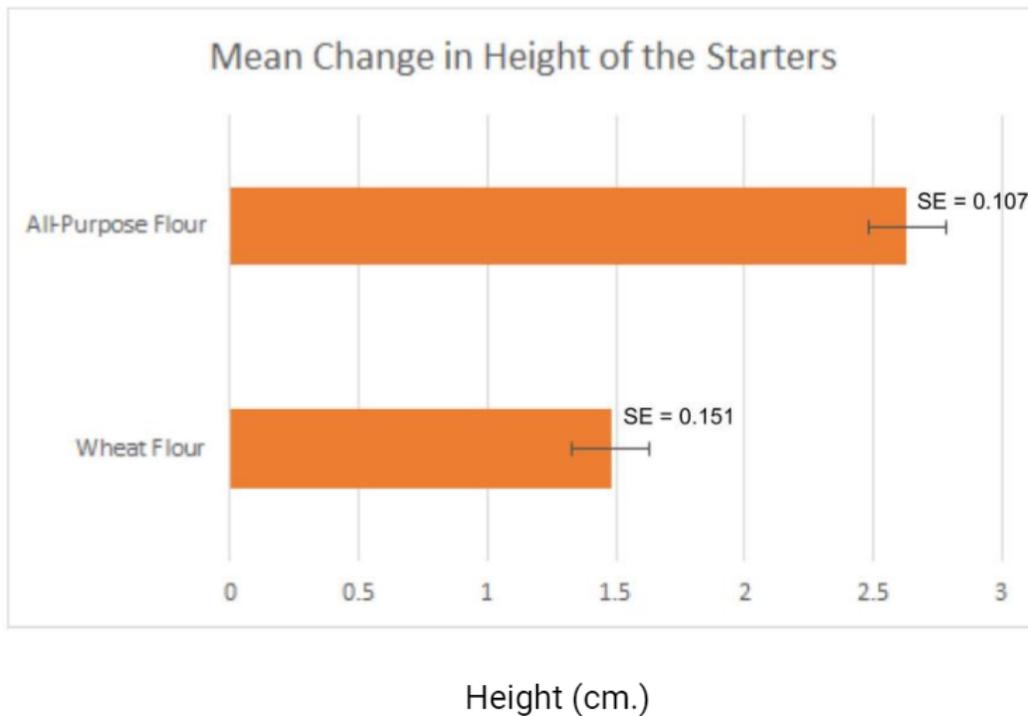


Fig. 3: This bar graph compares the mean change in height between the two types of flours and includes standard error.

Results showed a statistically significant difference between the first and last day's sourdough starter heights in whole wheat flour ($t=-9.792$, $df=9$, $p<0.01$). Figure 1 displays a standard error of 0.052 for the first day and 0.144 for the last day of whole wheat starters. Statistical significance was also found in the all-purpose flour ($t=-24.055$, $df=9$, $p<0.01$). Figure 2 shows a standard error value of 0.031 and 0.119 respectively, for the first and last days of conducting all-purpose flour starters. The next task was then to compare the height differences of each type of flour. Next, we conducted the t-test for two-samples assuming equal variance, where we found that the two data sets were significantly different ($t=-6.219$, $df=18$, $p<0.01$). Figure 3 shows the standard error of all-purpose flour, which was 0.107, and 0.151 for whole wheat flour.

DISCUSSION:

Our hypothesis was that there would be a statistically significant difference between the rises in all-purpose flour and whole wheat flour when placed in sourdough starter form. A possible margin for error includes the fact that each experiment was conducted in different environments, and differing temperatures may have changed the outcomes to a minor extent. However, after conducting numerous tests, we concluded that there is in fact a difference between the rise in all-purpose and whole wheat flour regarding its rise as a sourdough starter. Over the course of 15 days, the use of The Wild Sourdough Project, and other resources, we were able to come to this conclusion (McKenney, 2020). This positive rise between the first and fifteenth day was expected because of the creation of lactic acid by bacteria (Suo et al., 2020).

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This fuels a rise of the flour and water mixture. This is mirrored in a different study that looked specifically at whole wheat flour which increased acid and CO₂ in the creation of a starter (Clément et al., 2018). The combination of all of these articles demonstrates the height differences in sourdough starters we were hoping to observe. Looking at our results for the paired t-tests, the p-value was extremely low ($p < 0.01$), meaning we can confidently state that between the first and last days of testing, there was a statistically significant difference in heights within both types of sourdough starters. This is an important step in establishing the difference in rise height between the whole wheat starters and all-purpose starters.

When looking at different flours though, there is a difference between their rises. However, we had expected this difference because of an experiment that conducted a similar project but using banana bread (Ghaddar et al., 1997). Because of our results, we are able to corroborate his and his team's findings. Another study also supported the theory that all-purpose flour and whole wheat flour were different because of differing textures of bread (Çetin-Babaoğlu et al., 2020). Our p-value that we observed after conducting the t-test assuming equal variances was extremely low, meaning that there is a statistically significant difference between the heights of the sourdough starters made with all purpose and whole wheat flour. After fifteen days of testing and lots of hard work, we were able to accept and confirm our hypothesis. Further, we can use our data to take a step in reducing world hunger with the knowledge of which types of flours yield higher-rising starters.

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