Mung Bean Boost: A Pressure Experiment

I. Introduction

With growing concerns about food quality and rising grocery prices, more people are turning to home cultivation to ensure fresh, affordable, and healthy meals. Among the easiest and most practical foods to grow at home are mung bean sprouts. Requiring minimal space, time, and care, these sprouted mung beans can be harvested in just a few days, making them an ideal choice for those looking to incorporate a nutrient-rich ingredient into their diet. With their natural mild sweetness and high dietary fiber content, mung bean sprouts offer numerous health benefits such as improving digestion and supporting immune function.

However, a common challenge for home growers is that the final yield of mung bean sprouts often falls short of expectations. Specifically, when mung bean sprouts are grown at home using conventional methods, they tend to develop at only about half the size and weight of commercially grown sprouts. To address this inefficiency, some people place an evenly distributed pressure, such as a plate, on top of the mung bean seeds during cultivation. This serves as a mechanical stimulus, influencing root development and enhancing the sprouts' ability to absorb water and nutrients. Additionally, the applied pressure mimics the natural resistance seedlings encounter when pushing through soil, triggering adaptive growth mechanisms that result in taller, bigger, and more robust sprouts. Does applying this pressure-assisted technique truly increase the final weight of mung bean sprouts?

II. Statistical question

Is the mean weight of mung bean sprouts grown using the pressure-assisted technique greater than the mean weight of mung bean sprouts grown without the pressure-assisted technique?|

Hypothesis:

H_0: $\mu_1 - \mu_2 = 0$

H_a: $\mu_1 - \mu_2 > 0$

Where,

μ_1: the true mean weight of mung bean sprouts like the ones in this experiment grown using the pressure-assisted technique

μ_2: the true mean weight of mung bean sprouts like the ones in this experiment grown without the pressure-assisted technique

III. Data collection

For this experiment, we tested only one mung bean species to avoid confounding effects from varying growth weights across species. We also accounted for quality and germination variability among brands due to differences in cultivation, harvesting, packaging, storage, and transportation. To address this, we purchased only green mung beans (green gram) from all available brands at the Hong Kong Market in Duluth, Georgia, using cluster sampling with packages of beans as our clusters. At the Hong Kong Market, four brands sell green mung beans in 400g (14oz) packages: *(1) AH USA Group Inc* (26 packages available), *(2) Richin* (39 packages available), *(3) Yuan-Yi* (17 packages available), and *(4) Three Dear Brand* (42 packages available). Since each package contains a large quantity of beans, we decided to select one from each brand, making a total of four. To ensure randomness, we conducted separate selection processes for each brand, using a random number generator. For *(1) AH USA Group Inc*, we numbered its 26 packages 01–26 and selected the package corresponding to the generated number 14. For *(2) Richin*, we numbered its 39 packages 01–39 and chose the package corresponding to the generated number 22. For *(3)* Yuan-Yi, we numbered its 17 packages 01–17 and picked the package corresponding to the generated number 5. Finally, for *(4) Three Dear Brand*, we numbered its 42 packages 01–42 and

selected the package corresponding to the generated number 12. Next, we created a representative sample of the population, defined as all green mung beans sold at the Hong Kong Market in Duluth, Georgia, by combining the contents of all four packages into a single large container and thoroughly mixing the beans to ensure uniformity across brands. This step was crucial for eliminating brand-specific bias and producing a thoroughly randomized 1600g sample that accurately reflected the population, enabling us to generalize our experimental findings to all sprouts grown from green mung beans sold at the Hong Kong Market in Duluth, Georgia.

From this mixed sample, we divided the beans into 64 equal portions of 25g each to serve as experimental units, which were later randomly assigned to one of the two treatment groups. After thoroughly mixing the 1600g of mung beans in a large container, we confirmed the total weight using a digital scale. We then created 64 portions by weighing small scoops of beans from different areas of the container, adjusting as needed to achieve exactly 25g per portion. To avoid bias, we remixed the container after every five portions. Each 25g portion was placed in a labeled cup numbered from 1 to 64 for tracking. This approach guaranteed that each portion was a representative subset of the mixed sample, ensuring that the treatment groups were comparable and allowing us to accurately test the effect of the pressure-assisted technique on the mean weight of mung bean sprouts.

In total, we tested two treatments. Treatment C followed the conventional sprouting method, serving as a control, where the beans were first soaked for 24 hours to initiate germination, then spread evenly over a layer of cheesecloth placed on a tray with drainage holes, and covered with a second layer of damp cheesecloth to retain moisture. Treatment P followed the same procedure as Treatment C, with the addition of the pressure-assisted technique: after placing the second layer of damp cheesecloth over the beans, a 3 lb.

hardboard was placed on top to apply uniform pressure, mimicking the natural resistance of soil to stimulate adaptive growth mechanisms. By establishing Treatment C as the control, we aimed to create a reliable standard that allowed us to assess whether the pressure-assisted technique in Treatment P produced any significant impact in increasing the weight of the mung bean sprouts relative to the conventional approach.

To assign the 64 portions to the treatment groups, we used a random number generator to select 32 portions for the control group and 32 portions for the pressure-assisted group. Specifically, we employed a random number generator to produce thirty-two unique 2-digit numbers from 01 to 64, ensuring no duplicates by setting the generator to sample without replacement. The 32 portions corresponding to these numbers generated by the random number generator were assigned to Treatment P, the pressure-assisted group. The remaining 32 portions were assigned to Treatment C, the control group. This randomization process ensured that any differences in the mean weight of the mung bean sprouts between the two groups could be attributed to the effect of the pressure-assisted technique, allowing for a fair comparison in our statistical analysis.

To conduct the experiment, we used a single large tray with drainage holes, divided into 64 equal 15cm x 15cm areas using waterproof dividers to ensure that each 25g portion of mung beans was isolated and did not influence neighboring portions through water crossover or competition for space. Each portion was rinsed with clean water and drained thoroughly twice daily (morning and evening) to promote healthy germination and prevent mold. For Treatment C (control group), the 32 assigned portions were soaked in water for 24 hours to initiate germination, then spread evenly in their respective tray sections and covered with a damp cheesecloth to retain moisture. For Treatment P (pressure-assisted group), the 32 assigned portions followed the same soaking and spreading process, but a 3 lb. hardboard was

placed on top of the beans in each section to apply uniform pressure, simulating natural resistance to stimulate growth. The big tray with 64 separated sections was placed in a room with controlled environmental conditions to eliminate confounding variables. A large blackout plastic sheet was draped over the trays to maintain darkness, as research indicates that mung bean sprouts grow best in dark conditions. The room's thermostat was set to a constant 22°C (72°F) for the duration of the experiment to ensure consistent temperature across all portions. Both treatment groups were grown simultaneously to control for time-related effects. The experiment ran for five days, as research suggests, this is the minimum time required for mung bean sprouts to reach full maturity. We used a two-sample t-test for a difference in means because the random assignment of the 64 portions to two treatment groups establishes two independent populations, and the response variable, the weight of the sprouts in grams, is quantitative.

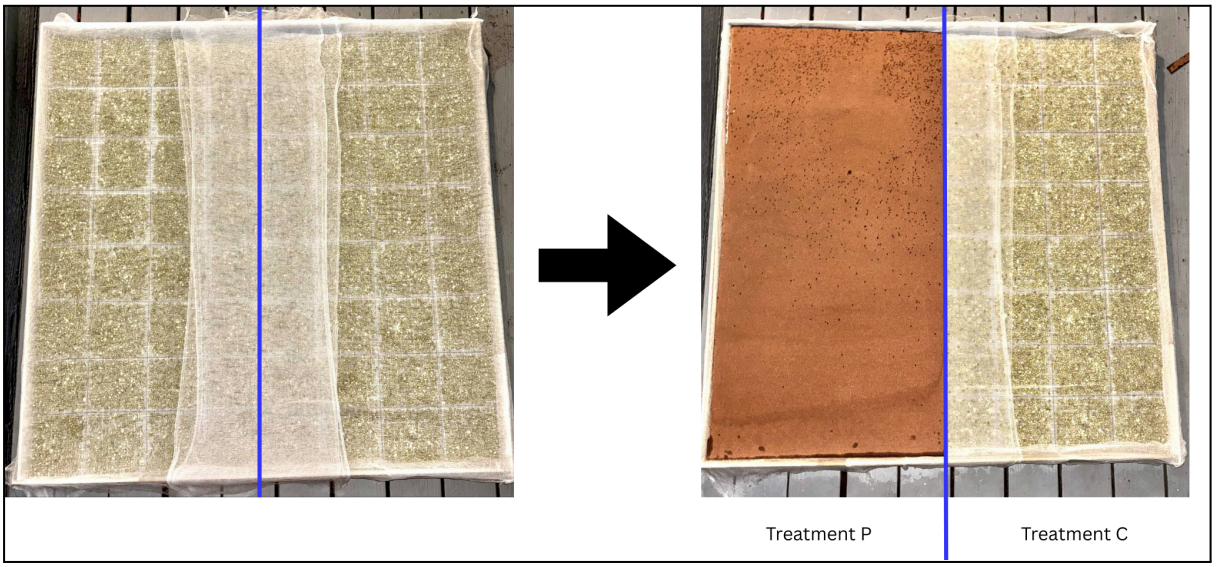


Figure 3. All 64 portions of beans, each spread on their respective 15cm x 15cm section, are covered with a layer of damp cheesecloth. Note: The left image shows the entire tray before treatment assignment, with the hardboard lifted to display the layout. The right image depicts the tray after assigning Treatment P to 32 portions (left side) and Treatment C to the remaining 32 portions (right side); during the experiment, the hardboard fully covers 32 sections on the left.

After 120 hours, we harvested the sprouts portion by portion, drying each on a paper towel for 30 minutes to remove residual water, ensuring weight measurements reflect only sprout biomass. Each portion was then weighed individually using a digital scale with 0.01g precision, and the weights were recorded for analysis.

IV. Data Display

Treatment C: Control group

Portion number	Weight (g)
3	68.14
4	67.38
5	70.15
9	71.25
13	68.79
14	71.8
15	69.03
16	72.37
20	67.77
21	72.66
22	72.38
23	70.77
25	67.5
27	69.87
28	70.23
29	68.46
30	71.76
32	69.99
33	67.52
38	70.94
39	70.87
40	72.76
41	68.34
42	68.41
43	72.59
47	67.81
49	71.78
53	69.93
54	70.06
57	68.53
60	70.76
61	69.24

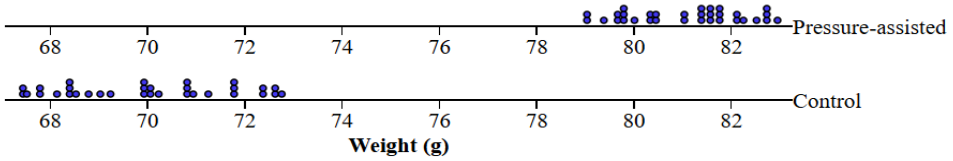
Figure 4. A table shows the final weights of the 32 portions in the control group

Treatment P: Pressure-assisted group

Portion number	Weight (g)
1	79.03
2	81.33
6	80.01
7	81.89
8	82.78
10	79.71
11	81.04
12	79.79
17	81.57
18	82.95
19	80.58
24	82.52
26	81.34
31	81.44
34	81.03
35	81.63
36	79.82
37	79.62
44	81.59
45	81.76
46	80.45
48	81.89
50	79.38
51	80.39
52	82.72
55	82.11
56	82.12
58	79.83
59	82.68
62	80.28
63	82.25
64	79.04

Figure 5. A table shows the final weights of the 32 portions in the pressure-assisted group

V. Data Analysis



Summary Statistics

Group Name	n	mean	SD	min	Q_1	med	Q_3	max
1: Pressure-assisted	32	81.0803	1.1784	79.03	79.92	81.335	82	82.95
2: Control	32	69.995	1.7223	67.38	68.435	70.025	71.505	72.76

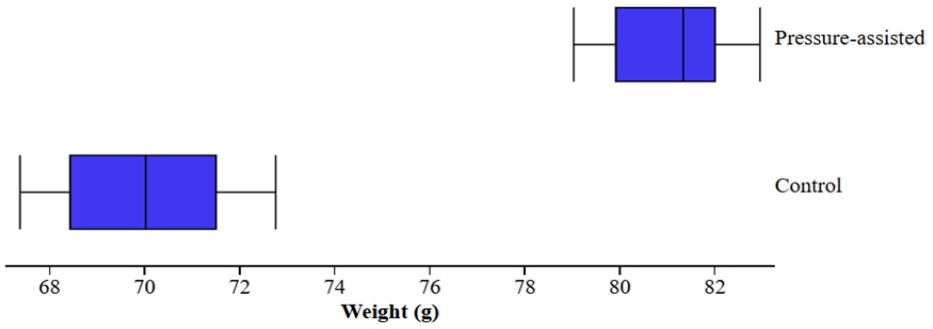


Figure 6. A box plot and dot plot showing the data distribution, along with summary statistics.

Conditions for a two-sample t test for a difference in means:

1. Random: Our portions of mung beans were randomly assigned to each of our two treatment groups using a random number generator, ensuring independence between the groups. This condition is met.

2. Independence: Since this is an experiment with random assignment, independence between Treatment C and Treatment P is ensured by isolating each portion in separate tray sections. Additionally, the 1600g sample of beans represents less than 10% of the total mung bean population at the market, so the 10% condition is met.

3. Normal/Large Sample: Each treatment group (Treatment C and Treatment P) has a

sample size of 32 portions of mung beans. According to the Central Limit Theorem, a sample size of 30 or more per group allows us to assume an approximately normal sampling distribution of the mean. With our sample sizes meeting the threshold, this condition is met.

All conditions were met, so we performed the 2-SampTTest using the TI-84 Plus Calculator and acquired the following results:

t = 30.0491

p-value = 4.9576 E-36

df = 54.8069

VI. Conclusion

The p-value (4.9576 E-36) is less than the significance level (0.05), or $p < \alpha$. We can reject the null hypothesis. We do have convincing evidence that the mean weight of mung bean sprouts grown using the pressure-assisted technique is greater than the mean weight of mung bean sprouts grown without the pressure-assisted technique. The large t-statistic and extremely small p-value indicate a highly significant difference, supporting the effectiveness of the pressure-assisted technique in increasing sprout weight under our controlled experimental conditions.

VII. Reflection

Our experiment aimed to determine whether the pressure-assisted technique increases the mean weight of mung bean sprouts compared to the conventional method, helping home growers tackle the challenge of low yields. We controlled several conditions during the experiment to mitigate confounding variables: we maintained a consistent temperature of 22°C using a room thermostat, ensured darkness with a blackout sheet, rinsed each portion twice daily with clean water to promote germination, and used a single tray divided into 64

isolated 15cm x 15cm sections to prevent cross-contamination. We also randomly divided our 64 portions into two treatment groups of 32 using a random number generator to ensure randomness and independence. After performing a two-sample t test, we were able to conclude that the mean weight of mung bean sprouts grown with the pressure-assisted technique is significantly greater than those grown without it. However, certain aspects of our experiment revealed a few limitations and offered opportunities for improvement.

One limitation we noted is that, despite our careful research to optimize sprout growth conditions, the control group's average weight of 69.995g per 25g portion was lower than expected, likely due to insufficient moisture retention.We observed that, even with twice-daily rinsing, many sprouts appeared thin and dry at harvest, indicating that the damp cheesecloth may not have retained enough water throughout the day; thus, we might need to improve humidity management, such as by experimenting with thicker or more absorbent cloths like cotton or burlap, which could better maintain moisture levels, potentially increasing the control group's yield and providing a more accurate baseline for comparison. Additionally, the uniform application of a 3 lb. hardboard in the pressure-assisted group might not be the optimal pressure level, as some portions showed inconsistent growth rates, possibly due to excessive force limiting root expansion. For future studies, we could test varying pressure levels, such as 0.5 lb. to 2 lb., to find the ideal amount that maximizes sprout weight without impeding their development.

Based on our conclusion, we acknowledge the potential for making a Type I error, which occurs when we incorrectly reject a true null hypothesis, with a probability equivalent to our chosen significance level of 0.05. To reduce this, we could lower the significance level to a more stringent threshold, such as 0.01, requiring stronger evidence to reject the null

hypothesis. Additionally, increasing our sample size beyond 32 portions per group could reduce variability and strengthen our evidence, minimizing Type I error risk.

Since we randomly chose one package from each of the four brands at the Hong Kong Market using a random number generator, we can generalize our findings to all green mung beans sold there, but this limits our results to that specific store and bean type. To expand our experiment's scope in future studies, we want to apply our findings to mung beans from other stores across the region and even to different bean types, like black or red mung beans, to see if the pressure-assisted technique works the same way for them. To do this, we would need to sample beans from various markets, such as Asian grocery stores in neighboring cities, which would let us generalize our results to a larger population of mung beans. This would require more trays, hardboards, and a bigger space to grow hundreds of portions at once, so we would need to plan for extra funds and a larger growing area, like a community garden space.

Through these efforts, we could help more home growers everywhere improve their sprout yields, and our findings might even apply to other sprouts, like alfalfa or lentil, making home gardening easier and more productive for everyone.

VIII. Citation

"Mung Beans: Nutritional Values and Potential Benefits." *Nutrition Advance*, 13 Mar. 2024, https://www.nutritionadvance.com/mung-beans-nutrition/

How to Sprout Mung Beans - Done Right and Perfect Every Time. Youtube, uploaded by Fine Art of Cooking, 11 Jan. 2021, www.youtube.com/watch?v=mrkBqRK64TY&t=265s.