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A Study on the Effect of Zamzam Water on the Germination and Growth of *Jasminum sambac*

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This paper seeks to investigate the role of Zamzam water in enhancing the germination and post-germination growth of *Jasminum sambac*. Zamzam water contains many mineral and chemical properties that have been previously tested as a model for supporting fertilization efforts in agricultural production. Seeds were planted for Zamzam water with a distilled water serving as a control to tabulate the rate of germination and the length of emergent seedlings. Zamzam's role in supporting the growth of *Jasminum sambac* was displayed with statistically significant differences being present, suggesting potential for further research into Zamzam's potential as an agent for plant growth.

Introduction

Jasmine sambac, commonly known as the Arabian jasmine, but also known as *sampaguita* or *melati putih*, is a small shrub or vine that is native to tropical Asia and is found in a number of desert-filled regions experiencing a shortage of water. Saudi Arabia is one of the many countries in the continent that cultivate *Jasmine sambac* for its enchanting and fragrant flowers. The country is known for experiencing large seasons of drought or periods with limited rainfall, which could affect the usage of the Zamzam Well in Mecca as a supplemental water source for irrigation practices. The well is located at a depth of 30 meters within Masjid Al-Haram, the holiest site for Muslims, and is believed to have been found by Hajar while caretaking for her son Ismail during the time of Abraham in the Islamic tradition. This experiment, centered around biological processes of plants, aimed to study the various effects of Zamzam water on the germination and growth of *Jasminum sambac* seeds.

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Past studies have shown positive results of Zamzam water when used in the production of food products, including broad beans and wheat (Mutwally et al., 2015; Mohammad & Al Hatem, 2022; Elmoula et al., 2020). Using Zamzam water as a stand-alone, or in congruence with distilled water, resulted in significantly observed increases in the percentage of seed germination, shoot length, and the fresh and dry weights of the shoots. On that note, in contrast to broad bean plants irrigated by other water sources, the ones using Zamzam water had a noticeably higher display of flowers. Research by Hamed et. al. (2009) into the yields of *Vicia faba L.* and *Triticum vulgare L.* found that harvests inundated with Zamzam water gave the most elevated estimations of yield, dissolvable starches, complete sugars, protein, and all-out nitrogen substance. Furthermore, Alsokari found a beneficial outcome on the development and protein substance of lentil seedlings when watered with that out of the Zamzam Well (Alsokari, 2011). The water system with Zamzam water expanded the protein, RNA, DNA, and the phenolic and antioxidant agent substances in lentil seedlings (Mardi et al., 2015). The primary inquiry motivating this study revolved around investigating whether Zamzam water elicits a notable disparity in the germination and subsequent growth of *Jasminum sambac* seeds when compared to distilled water.

Our prediction suggests that Zamzam water will significantly enhance the germination of *Jasminum sambac* compared to distilled water. This can be attributed to the abundance of chemicals such as calcium, magnesium, sodium, and chloride in Zamzam water, which are instrumental in enhancing predictions regarding its differentiations from distilled water (Donia & Mortada, 2021). These minerals serve as the paramount divalent cations that are essential to reacting with the multifaceted carbonates and bicarbonates in seeds and essential to the following processes under germination: enzyme activation, nutrient transport, and protein synthesis. Therefore, we can anticipate that germination. Hence, we can expect germination to be enhanced using Zamzam water, and specifically, this can be viewed by the root length should germination occur for a given sample.

Methods and Materials

Preliminary Experiment

To ensure this experiment was viable, and to observe firsthand the beginning processes of germination, *Jasminum sambac* seeds were purchased, while Zamzam water was transported from Mecca, Saudi Arabia. Twenty seeds were planted across two petri dishes, with a diameter of 5 cm each, of Miracle-Gro soil (ten seeds per dish). Each dish was given 15 ml of distilled water and left for one week at room temperature (range of 60°–75°F) before being watered again (for a total of two weeks). Following the conclusion of the two-week time frame, the number of germinating seeds was counted. Twelve of the seeds germinated for a total of 60% in germination results. This showed that the seeds do, in fact, germinate and would be viable for this experiment to use. The aforementioned protocol was organically developed to provide a standardized, replicable environment that would allow for accurate observation and measurement of the germination processes of *Jasminum sambac* seeds, thereby ensuring the consistency and validity of the results.

Experimental Setup and Germination

Ten petri dishes, 150 g of Espoma organic potting soil, 100 seeds of *Jasminum sambac* that are 2.50 mm in diameter (±0.5mm), 100 ml of Zamzam water, 100 ml of distilled water to create the control, two sand baths, and two thermometers (±0.05°C) were required for an initial setup. Sand baths serve to create a level surface for planting and to provide consistent moisture to the seeds. The sandbags help to keep the soil in place and prevent erosion while also retaining water and promoting seed germination within a stable and controlled environment. The sand baths were set at 78°F and a thermometer placed in each one to authenticate the desired temperature setting. Five petri dishes were placed into one sand bath to be tested, with the remaining five dishes in another to be utilized as a control. Measurements of 15 × 10.0 g of the soil, while making use of the electronic weighing scale, and placement of 10.0 g into each one of ten petri dishes occurred. Five of the dishes were reserved to be tested with Zamzam water, while the remaining five dishes were treated with distilled water as the control. Then, ten *Jasminum sacrum* seeds were planted into each one of the petri dishes and planted into the prescribed soil at a consistent depth of 0.8 cm. Each of the respective sand baths was watered at a consistent time in the evening (6:00 p.m.) with 15 ml of either distilled or Zamzam water every 3 days for 15 days. After 15 days, the number of seeds that germinated was counted (noted from the emanation of the seedling) and measured to assess the height of the emergent seedling in the test and the control groups with the 10.0 cm ruler. The seedling height was taken from the soil surface to the highest visible part of the stem. The process outlined here was repeated to ensure that sufficient data was present for this experiment.

To ensure that the controlled variables served as a placeholder for tabulating precise germination data, the same amount of water, 15 ml of volume, was added to each petri dish simultaneously at the designated evening time every 3 days throughout the 15-day period. All 150 *Jasminum sambac* seeds used in this experiment were kept within a size range of 2.50 mm in diameter. The temperature of the seeds was kept constant at 78.0°F by the sand baths and was checked via thermometers every day to ensure consistency. All seeds were planted in Espoma organic potting soil. With the soil held constant, it is reasonable to infer that its contents contain similar concentrations of its various nutrients. The mass of the soil was also kept constant at 15.0 g. Near-same amounts of light were presumed to be received for each seed as the entirety of the experiment was conducted in the same location in front of a window. In addition to these precautions taken for ambient light, the seeds were consistently planted at a depth of 0.8 cm and near the edge of the petri dish, enabling an easy observation of its changes through the presence of the glass in lieu of digging the seeds up every time.

Some of the underlying assumptions going into the experiment included that the penetration/input of light through the petri dishes is the same intensity due to the physical proximity of the sand baths, the soil has the same concentration of its various nutrients and elements, any impurities and chemicals found in the air particles of the room will be the same for the two sand baths, and the *Jasmine sambac* seeds contain the same percentage of their respective elements.

The seeds that germinated from each of the petri dishes were counted from among the test and control groups by observing from the side of the glass if the seedling's outer coat had broken and if the plant's initial parts had emerged. Measurements of the height of the seedling (determined by the distance from the tip of the seedling to the soil surface) of the seeds that are germinated after a 15-day period were also taken. The $\chi 2$ test was used to assess differences in germination, and the t-test was used to assess differences in the growth of the seedlings.

Germination Results

Observations

By the end of the experiment, the *Jasminum sambac* seeds were about 1–1.5 cm (100–150 mm) in length, with a width of about 0.5 cm in the middle. The seeds had an ovoid shape with a little notch in a circular shape on the top of them. The Zamzam water and distilled water were distinct in their effect on the seeds. The Zamzam water had a mild odor like the smell of the ocean from a distance. There was significantly more germination in the seeds that were planted with Zamzam water than those planted with distilled water. While there was less than expected uniformity in germination time between the *Jasminum sambac* seeds planted in Zamzam or distilled water, it was noted that those planted with Zamzam showed signs of seed cracking and emergence of root within four to six days, compared to around eight days for those with distilled water. Seeds watered with distilled water remained a licorice color for most of the time, only shifting to a maroon brown in some cases, while those left in Zamzam water showed slight lightening of the color to a light gray mixture in the black, as if the color of the seed was being drained out. Though only small roots emerged at any point from the seeds with a little white coating, germination developed further with Zamzam. There was a larger opening and larger roots sprouting in the seeds planted with Zamzam water. No leaves ever emanated in the two-week time frame from either the test or the control, indicating that they may have needed to grow longer.

Number of Successfully Germinated Seeds

To determine how many seeds could be classified as successfully germinating, a thorough analysis of both the cracking of the seed coat and the emergence of a root quantified germination for the purposes of this experiment. Those results have been recorded in Table 1.

Thirty-four of 50 seeds planted in Zamzam water germinated, a 68% success rate and an average of seven seeds germinating in each petri dish. Twenty-two of 50 seeds planted in distilled water germinated, a 44% success rate with an average of four seeds germinating in each petri dish. It is worth noting that this 44% rate fell below the 60% recorded in the pre-experimental trials involving distilled water. See Table 2.

Trial # (individual petri dishes)	Seeds Germinated with Zamzam Water (out of 10)	Seeds Germinated with Distilled Water (out of 10)
1	7	6
2	9	3
3	5	5
4	6	4
5	7	4

Table 1: Germination Statistics

	Zamzam Water	Distilled Water	Row Total
Germinated	34	22	56
Not Germinated	16	28	44
Column Total	50	50	100

Table 2: Processed Data

Chi-Square Test

A chi-square test was conducted to see if there was a significant difference between the germination growth of seeds planted with Zamzam versus distilled water. The null hypothesis stipulated that "Zamzam water does not affect the germination of *Jasmine sambac* seeds." The alternative hypothesis was "Zamzam water does affect the germination of *Jasmine sambac* seeds." See Table 3.

While values of the final column were rounded to three significant figures in the table, original values were used for the total on the bottom of 5.84 (also thereby rounded to three significant figures for the purpose of this report).

To calculate the number of degrees of freedom = (rows − 1) × (columns − 1), which in this case would translate to (2 − 1) × (2 − 1) = 1

$$x^2_{crit} = 3.84 \text{ at } p = 0.05$$

Due to x^2calc = 5.84 being larger than the $x^2_{crit} = 3.84$, the null hypothesis must be rejected in favor of the alternative hypothesis. The test value adopted was significant at some point between $0.01 < p < 0.05$. It would also further remain significant at $p < 0.01$. From these results, we were able to conclude that Zamzam water does affect the rate of germination in *Jasmine sambac* seeds.

Post-germination Growth of the *Jasmine sambac*

Having determined that Zamzam water does affect the rate of germination, a further test was conducted to measure post-germination growth. For this follow-up test, both distilled and Zamzam water were utilized to investigate the effectiveness of Zamzam water. The parameters of effectiveness were defined to be the length of the roots growing out of a seedling from successfully germinated seeds. Any additional growth from the seedling was construed as more effective for the purposes of this experiment. The initial raw data used to assess the processed results later can be found in the appendix. See Table 4 and Figure 1.

Observed Frequency	Expected Frequency	Difference	Absolute Difference		
O	E	O–E	|O–E|	$(O–E)^2$	$(O–E)^2/E$
34	28	−6	6	36	1.29
22	28	6	6	36	1.29
16	22	6	6	36	1.64
28	22	−6	6	36	1.64
X^2 calculation					5.84

Table 3: Chi-Square Test

Water Type	Average Height in mm (±0.5 mm)	Standard Deviation
Zamzam	9.65	3.58
Distilled	6.5	2.6

Table 4: Height of Seedlings for Germinated Seeds

328 is the combined height of all the seeds that germinated with Zamzam water, and 143 is the combined height of all the seeds that germinated with distilled water.

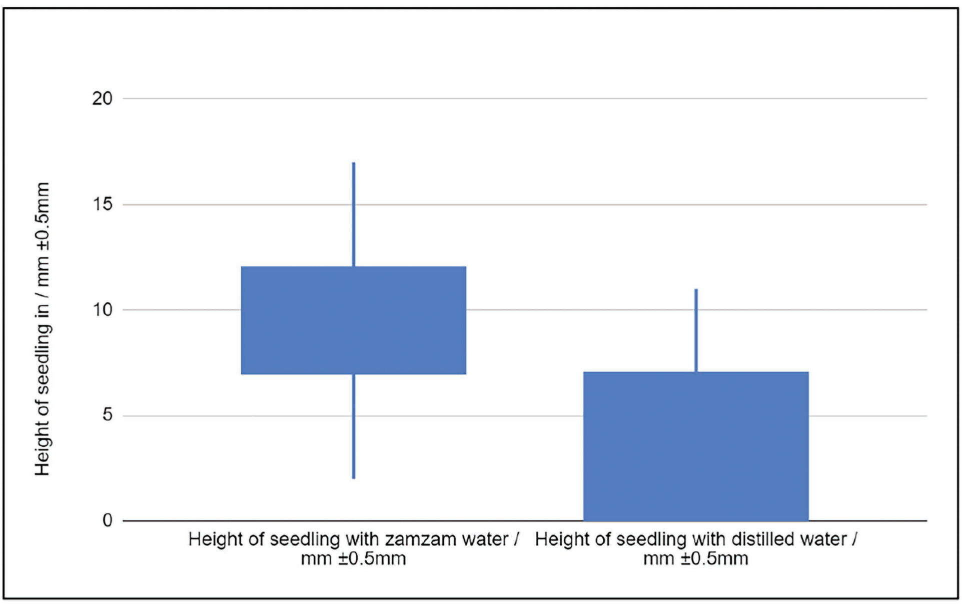

Figure 1: Average Seedling Length vs. Water Type

T-test: A two-tailed test was conducted to determine whether the seeds planted in Zamzam water germinated more (as in more root material came out) than the seeds planted in distilled water.

The null hypothesis proposed "Zamzam water has no effect on the post-germination growth of *Jasmine sambac* seeds." The alternative hypothesis postulated that "Zamzam water does have an effect on the post-germination growth of *Jasmine sambac* seeds."

Discussion

Over two weeks, this experiment yielded a 68% germination rate of Jasmine sambac *seeds planted in Zamzam water compared to the 44% rate of distilled water*. A further analysis of these results reveals that the average height (in mm) for seeds placed in Zamzam water after two weeks was greater than those put in distilled water. Furthermore, there is a higher standard deviation among those placed in Zamzam water, which could be attributed to a variety of reasons. This difference was also present in the raw data tables, suggesting that there may be some level of significant difference between the post-germination growth of seeds placed in Zamzam versus distilled water. Therefore, a t-test was conducted to ascertain the magnitude of any such difference.

The two-part hypothesis stating that Zamzam water would aid in enhancing germination and post-germination for the Jasminum sambac *in comparison to distilled water holds true from the results obtained, and there is a significant relationship between Zamzam and the effectiveness of germination*. The test value of 5.03 is greater than the $t_{crit} = 2.872$ at $p = 0.05$, indicating a likely relationship between Zamzam water and its ability to project and stimulate growth in *Jasmine sambac* seeds. The null hypothesis can be rejected.

Given the positive growth of the seeds under Zamzam water, this difference is highly favorable toward Zamzam water. A further analysis will need to be conducted to determine the true efficacy of Zamzam over distilled water. Regardless, our prediction and subsequent reasoning are supported by the results of the experiment.

While much of the experiment was done with adequate controls, there were certain areas wherein changes could be made to allow for the experiment to be done in a more concise and effective manner. Espoma organic potting soil was utilized in this experiment for both the seeds that were planted with Zamzam and distilled water. However, this soil is enhanced with myco-tone, which contains elements of endomycorrhizae and ectomycorrhizal acting as a fertilizer to promote root growth, specifically, which was analyzed for post-germination in this study. Zamzam water itself contains several chemicals including dissolved salt, sodium, calcium, and magnesium. Its pH level differs from that of distilled water, ranging from 6.5 to 8.5 versus 7 (Donia & Mortada, 2021). These properties may have an impact on the soil or the water, resulting in an imperfect attempt to ascertain what was truly caused by Zamzam water or not. Further study is warranted to examine differing conditions.

Future experiments can mitigate these variations by testing multiple soil samples with differing chemical compositions, including flat clean soil or mulch, tested in the same two-week time frame of the experiment to measure growth. Some uncertainty is expected with easily accessible outside soil having a variety of impurities unaccounted for present within them and would need to be measured in a lab for maximum accuracy.

This experiment could also be enhanced by utilizing different types of Zamzam water. Companies that sell mixtures of Zamzam and distilled water, to avoid excess use of pure Zamzam, could be scouted out for purchases. A third trial set of 50 seeds, containing a mixture of equal parts of Zamzam and distilled water, could produce results displaying a clearer picture of how much Zamzam affects the rate of germination. This trial could also have iterations of the parts of Zamzam or distilled water to measure the impact of Zamzam's properties on germination and post-germination to measure the maximum impact ratio. In addition, water with differing pH levels or with different chemical composition could be utilized in separate trials to determine which properties of Zamzam are enhancing growth.

While the seed size was mostly uniform length, another variation of testing could be seeds measured by weight, as there was some natural variation in the sample size. Seed weight was not factored into this experiment, and further studies could explore potential effects on germination and post-germination growth. Adoption of a universal control element, with precise weights and lengths, such as 1 cm, could be used to reduce possible fluctuations in results.

Difficulties in ensuring seeds were uniformly planted at a depth of 0.8 cm were present due to the surface layer of the soil not being perfectly evenly distributed and flat. Whether this impacted the trial significantly is uncertain, but further testing with a larger sample size could lead to more effective results. The 15-day time frame of this experiment and the limitation of testing only *Jasmine sambac* are restraining factors in a more cohesive understanding of the effects of Zamzam water. Additional investigations examining germination trends for Zamzam water across different specimens can be formulated to map out models for Zamzam's role as an agent of enhancing plant growth.

The nutrient-rich Zamzam water, as well as the interrelations of its various elements, stimulates plant growth. The naturally occurring salt content within Zamzam water could influence the growth observed in post-germination due to how it may have reacted with the soil. A study by Algandaby M. Mardi and Al-Zahrani S. Hassan (2015), working for the Department of Biological Sciences in the Kingdom of Saudi Arabia, found that varying concentrations of Zamzam water can universally help germination in many different plants, for irrigation or other purposes. They found that, using Zamzam water, *Sesamum indicum* as a field crop grew at a faster rate than with distilled water or other local water sources. In addition, they found higher protein content in plants given Zamzam water. Potassium chloride, known for germination and the seed-cracking process of plants, is one of the salts found in Zamzam.

The effects of Zamzam are of interest to researchers, who have conducted a spectrum of experiments ranging from anticancer properties and antimicrobial activity to mice offspring production. One study attempting to ascertain the role of potential pesticides found that when compared to globe artichoke extract alone, Zamzam water enhanced the characteristics of the extract and increased death of *P. solenopsis*, while Zamzam water alone induced mortality and was effective as a stand-alone pesticide (Abd-Allah, 2022).

Conclusion

There are clearly substantial effects of Zamzam water on plant germination and growth as well as agriculture. The water's high mineral concentration makes it a fantastic source of nutrients for plants, encouraging quicker germination, longer shoots and roots, and more biomass buildup. This might have an impact on food security and sustainability since it could offer a different supply of irrigation water for crops, particularly in areas with a scarcity of freshwater resources. In addition, Zamzam water's antimicrobial qualities may reduce the need for pesticides and other chemical treatments to control plant diseases, enhancing food safety and lowering agriculture's environmental impact.

However, Zamzam water's creation through synthetic means and potential for commercialization should be handled delicately. The well has important cultural and religious connotations and is a holy place for Muslims. The well is also a significant historical monument for the Hejaz region and is said to be around 4,000 years old. Any commercial use of the water would have to consider how crucial it is to protect the well and its surroundings for future generations. Overall, even though Zamzam water has a lot of potential for agricultural use, any commercialization efforts should carefully consider its special qualities and cultural significance.

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Appendix

Seed Number	Did the Seed Germinate	Height of Seedling in/mm ±0.5 mm
1	Yes	13.0
2	No	0.0
3	Yes	11.0
4	Yes	10.0
5	Yes	10.0
6	No	0.0
7	No	0.0
8	Yes	12.0
9	Yes	6.0
10	Yes	9.0
11	Yes	8.0
12	No	0.0
13	Yes	13.0
14	Yes	14.0
15	Yes	7.0
16	Yes	3.0
17	Yes	5.0
18	Yes	7.0
19	Yes	2.0
20	Yes	4.0
21	Yes	11.0
22	Yes	11.0
23	No	0.0

Table 1: Results of Seeds Watered with Zamzam Water

Seed Number	Did the Seed Germinate	Height of Seedling in/mm ±0.5 mm
24	No	0.0
25	Yes	8.0
26	Yes	8.0
27	No	0.0
28	Yes	7.0
29	No	0.0
30	No	0.0
31	No	0.0
32	Yes	15.0
33	Yes	17.0
34	Yes	14.0
35	Yes	9.0
36	Yes	13.0
37	No	0.0
38	No	0.0
39	Yes	6.0
40	No	0.0
41	No	0.0
42	Yes	11.0
43	Yes	10.0
44	Yes	9.0
45	Yes	15.0
46	Yes	12.0
47	No	0.0
48	Yes	7.0
49	No	0.0
50	Yes	11.0

Table 1: (Continued)

Seed Number	Did the Seed Germinate	Height of Seedling in/mm ±0.5 mm
1	Yes	9.0
2	No	0.0
3	Yes	7.0
4	Yes	8.0
5	No	0.0
6	No	0.0
7	No	0.0
8	No	0.0
9	Yes	5.0
10	No	0.0
11	Yes	6.0
12	No	0.0
13	Yes	10.0
14	No	0.0
15	No	0.0
16	No	0.0
17	No	0.0
18	Yes	9.0
19	No	0.0
20	Yes	5.0
21	No	0.0
22	Yes	4.0
23	No	0
24	No	0.0
25	Yes	3.0
26	Yes	6.0
27	No	0.0
28	Yes	7.0
29	No	0.0
30	No	0.0
31	No	0.0
32	Yes	11.0

Table 2: Results of Seeds Watered with Distilled Water

Seed Number	Did the Seed Germinate	Height of Seedling in/mm ±0.5 mm
33	No	0.0
34	Yes	6.0
35	Yes	10.0
36	Yes	7.0
37	No	0.0
38	No	0.0
39	Yes	3.0
40	No	0.0
41	No	0.0
42	Yes	6.0
43	No	0.0
44	Yes	7.0
45	Yes	4.0
46	No	0.0
47	No	0.0
48	Yes	1.0
49	No	0.0
50	Yes	9.0

Table 2: (Continued)

Calculations for % Germination of Seeds

56% of all seeds germinated:

56 / 100 = 0.56, multiplied by 100 for a 56% overall germination rate. 100% − 56% = 44%; 44% of seeds did not germinate.

The number of seeds planted in Zamzam water that were expected to germinate was calculated as: 56% of 50 = 28.

The number of seeds planted in distilled water that were expected to germinate was calculated as: 56% of 50 = 28.

The number of seeds planted in Zamzam water that were expected to not germinate was calculated as: 44% of 50 = 22.

The number of seeds planted in distilled water that were expected to not germinate would be calculated by: 44% of 50 = 22.