Effects various distilled water brands have on *Chlorophytum comosum.*

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–Abstract–

When first attempting home gardening, one of the challenges many home-renters are starting to face is being able to supply enough clean water to one's plants. In order to overcome this challenge, many plant enthusiasts are utilizing prepackaged distilled water from price friendly brands available at most regional Walmart locations. With the number of choices available on the shelves of today's grocery stores, and vague ingredient lists on packaging it can be challenging to determine which brand is actually best suited for one's specific needs. In order to determine the best distilled water suited to grow *Chlorophytum comosum*, various gallons of distilled water manufactured by different companies will be used to treat the developing specimens. The effects of the distilled water on *Chlorophytum comosum* was observed over the selected growth period, and the relative dry weight of the roots was taken for analysis. After being weighed, the average dried root weight of Pure Life was 0.066 ± 0.019 grams, which is 0.002 more than the root weight of the control, while the average root weight of the Parent's Choice brand was 0.014 ± 0.004 grams.

–Introduction–

When embarking on the journey of home gardening, many individuals renting their residences encounter the formidable task of ensuring an ample supply of clean, desalinated, and uncontaminated water for their plants. The accessibility of such water is particularly challenging in light of financial constraints faced by a significant portion of the population. According to a 2011 national study, approximately twelve percent of households found their water bills surpassing federal affordability guidelines, placing strain on already tight budgets (U.N. Human Rights Council, 2011). This financial burden is further exacerbated for low-income households, which reportedly allocate over 9.7% of their disposable income towards sanitation and water services. Recent research underscores the persistent struggle faced by households earning less than $50,000 annually, with many expressing concerns about their ability to afford essential goods if water bills continue to rise (Medwid & Mack, 2021).

Consequently, the apprehension surrounding escalating water expenses has prompted individuals to adopt various water conservation strategies, encompassing measures such as reducing shower duration, minimising laundry frequency, and even curtailing gardening activities and toilet flushes (Sarango et al., 2023). This conscientious effort to conserve water reflects not only a response to economic pressures but also a recognition of the importance of sustainable resource management in the context of broader environmental concerns. Expanding on this narrative, future research could delve into the socio-economic factors driving water conservation behaviours and explore innovative solutions to alleviate the financial burden associated with maintaining gardens in rented spaces. Additionally, efforts to raise awareness about the importance of water conservation and the availability of alternative watering methods could empower individuals to sustain their gardening endeavours while minimising environmental impact and financial strain.

To tackle this challenge while maintaining thriving gardens, many gardening enthusiasts resort to using prepackaged distilled water, offered by budget-friendly brands like Pure Life, Parent's Choice, and Great Value. However, the abundance of options lining the shelves of grocery stores in recent years can be overwhelming. Coupled with vague ingredient lists on packaging, it becomes increasingly difficult to discern which product best suits one's specific gardening needs.

The process of distillation, dating back to ancient Rome as noted by Berthelot in 1893, serves as a cornerstone of water purification. Distilled water is obtained by boiling water and collecting the resulting steam, which is then condensed back into a fresh container. This method effectively removes most impurities, rendering it a highly efficient means of home water treatment. Alternatively, some manufacturers employ reverse osmosis as an alternative purification method, aiming to achieve distilled water while optimising profit margins. Reverse osmosis entails forcing water through a semipermeable membrane, allowing only pure water molecules to permeate while trapping impurities such as chlorine, lead, and fluoride on the other side.

The brands that were tested in this experiment were Nestle's Pure Life distilled water, and Parent's Choice distilled water. The average retail value for Nestle's Pure Life is approximately $2.38 for a one gallon jug, or 1.9 cents per fluid ounce. In addition to distilled water, this brand added trace amounts of chemicals–including: calcium chloride, sodium bicarbonate, and magnesium sulphate–which claimed to be added in order to improve the taste of the water. Pure Life claims to utilize a twelve step process in order to treat municipal tap water prior to distribution, which is first filtered using activated carbon. This is followed by a treatment of reverse osmosis, and then the minerals are added, to improve the flavour of the water. Finally, ultraviolet light is exposed to the water to disinfect any remaining microorganisms, and then ready to be bottled for distribution. The average retail price for Parent's Choice is $1.26 for a one gallon jug, or one cent per fluid ounce. This brand also does not solely contain distilled water, but this brand infuses its distilled water with potassium bicarbonate, magnesium sulphate, and potassium chloride. This company also claims that these minerals are added to improve the overall taste of the other-wise bland taste of distilled water. Additionally, this brand utilizes steam distillation in order to purify water for distribution, compared to the process of reverse osmosis which Pure Life implements.

In order to determine the most adept distilled water brand suited to grow *Chlorophytum comosum*, two gallons of distilled water–manufactured by Pure Life and Parent's Choice–will be used in the development of the specimen. *Chlorophytum comosum,* more commonly referred to as Spider Ivy or Spider Plant, is a type of perennial flowering plant belonging to the Asparagaceae family (Poulsen & Nordal, 2005). This is a species that is beloved by many first time house plant growers due to its resilience and hypothesized air purifying effects (McCune & Hardin, 1994). This species is capable of producing plantlets, or spiderettes, which are baby spider plants that are able to be propagated by further means of cultivation. Typically, when placed in water these plantlets are able to form roots within one week. One additional curiosity is that this species is extremely sensitive to fluoride and boron. With those elements' presence in the water supply, the plant will display atypical morphology on their leaves by changing colour to a red-like brown indicative of fluoride, and a grey-brown indicative of boron.

It is expected that the morphology of these specimens are to remain consistent between the samples during experimentation. However, the samples that contain the highest relative dry root weight, after treatment, are expected to be reflective of the most beneficial brand of distilled water for at-home growing of this species. The brand that is expected to be the most beneficial for species development is Pure Life, based on the claimed meticulous nature of this brand's distillation process (Singleton). The control is expected to express typical morphology throughout its development, and demonstrate similar but less overall root growth. The null hypothesis for this experiment was that there will be no change seen between samples in overall dry root weight after the treatment period. The alternative hypothesis was that the Pure Life brand will demonstrate the largest overall root growth compared to the other samples.

–Methodology–

In order to achieve the best experimental results, each plantlet utilized in experimentation were derived from three mother plants[1], at comparable developmental stages, and then placed in small, separate containers. In addition to this the plantlets that were selected did appear to be free of any insect infestations, abiotic or biotic diseases. Each experimental specimen was given a total 150 millilitres of the corresponding distilled water each week, and kept at identical conditions to ensure the experimental validity. The control sample was given 150 millilitres of

[1] These mother plants were purchased from Lanoha Nurseries in Elkhorn, NE, in 2021, and currently reside within my home.

tap water instead of the distilled water samples, since each brand influenced trace amounts of various minerals that are present in most tap water samples. All plant specimens were kept at a constant temperature–ranging between 18 degrees Celsius to 23 degrees Celsius–and sat approximately 22 centimetres away from a glass pane, East-facing window that is free of any obstructions. Since this species is known to produce dry, brown-tinged tips when exposed to either fluoride or boron tainted in the water supply, any changes in morphology were recorded.

For each treatment group, there were four individual plantlets tested for each brand and the control, in order to ensure reproducibility. Each plantlet was weighed prior to propagation, and this weight is outlined in Table 1.2, in the Additional information section. After one month of ample light and consistent growth, the specimens were removed from their respective containers. At this time, any leaf and stem tissue that was present on the specimens was removed, and the remaining tuberous root tissue was dried. These samples were dried using a drying rack[2], and were weighed[3] after 36 hours at 120 degrees Celsius. The average root weight of each brand was calculated along with the standard error. The specimens that were able to demonstrate the most root growth are presumed to have the most beneficial water supply. Additionally a statistical t-Test will be conducted since the null hypothesis was stated as demonstrating no difference among specimen populations.

–Results–

After being weighed the average dried root weight of Pure Life was 0.066 ± 0.019 grams which is 0.002 more than the root weight of the control. The average dried root rate of the

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[2] This drying rack was provided for use by the University of Nebraska at Omaha Department of Biology.
[3] The scale used to weigh the specimens went to the third decimal place, and was a Sartorius scale. This was provided by the University as well.

control was determined to be 0.064 ± 0.035 grams, and the average root weight of the Parent's Choice brand was 0.014 ± 0.004 grams. Table 1.1 outlines the specific dry root weight of each specimen.

Figure 1. The average dried root weight of the specimens.

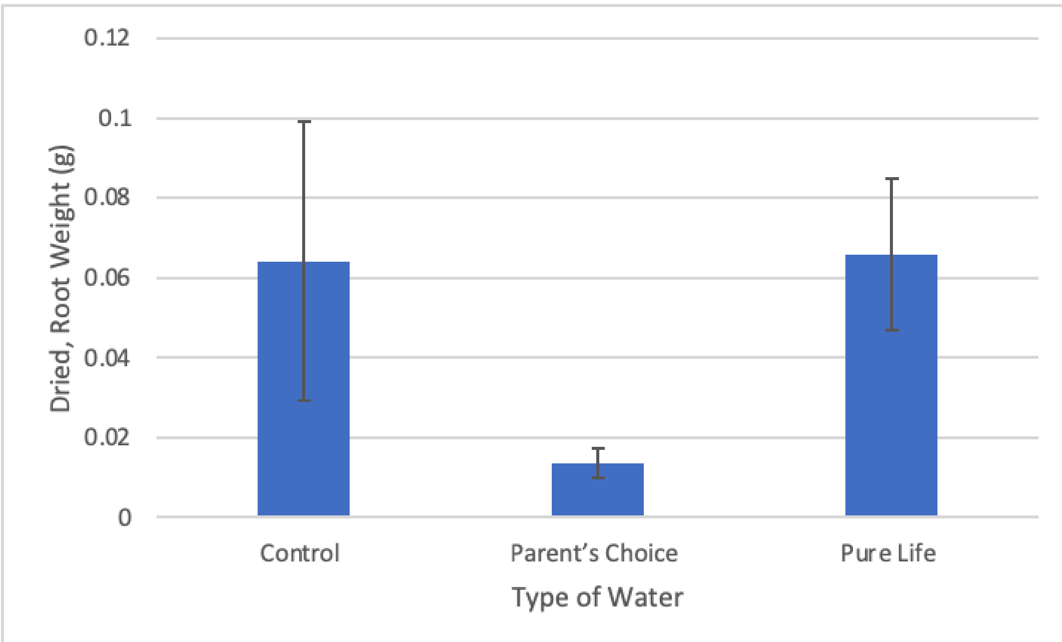

Table 1: Dried Root Weight of Specimens

Control (g)	Parent's Choice (g)	Pure Life (g)
0.0258	0.0062	0.0866
0.0286	0.0231	0.0088
0.0191	0.0145	0.0822
0.1447	0.0101	0.0863

Additionally, an F-Test was applied and since $43.499 > 19$ and $p < 0.05$, the null hypothesis is rejected because the variances of the two populations are unequal. The results of the F-Test are outlined in the additional information section, Table 3. Following the conclusions of that F-test, a t-Test was then used, specifically the t-Test assuming unequal variances. In a two-tail test (inequality), if t Stat $<$ $-t$ Critical two-tail or t Stat $>$ t Critical two-tail, thus null hypothesis is rejected. The result of this test was recorded in Table 4., and was found to result in $-3.182 < 2.702 < 3.182$ and $p \nless 0.05$.

–Discussion–

In Figure 1. the average dried root weight of the specimens is outlined as well as the standard error of each value. There was no significant difference demonstrated in the average dried root weight between Pure Life and Parent's Choice (t-test; $t_{12}= 2.70$. $p=0.07$). Based on the results, the alternative hypothesis which stated that Pure Life would result in the most root growth is rejected, and the null hypothesis is accepted. There was no distilled water brand found to be more suitable to grow the species, commonly referred to as Spider Ivy. The results of these tests are recorded in Table 4., and resulted in $-3.182 < 2.702 < 3.182$ and $p \nless 0.05$. Therefore we are unable to reject the null hypothesis, since the observed difference between the two specimen means (0.066 - 0.014) was not convincing enough to say that the average dry root weight between distilled water brands differed significantly.

For future experiments, it is advisable to extend the duration of the study to allow for a more comprehensive assessment of potential differences in root growth. A prolonged observation period would afford researchers the opportunity to detect subtle changes in root development that may only manifest over time. Furthermore, subsequent investigations could delve deeper into the physiological responses of the specimens, particularly by examining whether they exhibit characteristic chemical markers associated with stress responses in the species. Techniques such as transcriptome analysis could be employed to elucidate the underlying genetic mechanisms at play.

Exploring these facets could yield valuable insights into the complex interplay between distilled water brands and plant growth dynamics. Moreover, conducting water analysis either prior to or after experimentation would enhance our understanding of key differences in water quality. By scrutinising the composition of the water used in the study, researchers can identify any potential contaminants or variations that may influence plant responses. This comprehensive approach would contribute to a more robust evaluation of the factors shaping plant health and productivity in relation to different distilled water brands.

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–Additional Information–

Table 2: Initial Weight of Samples

Control (g)	Parent's Choice (g)	Pure Life (g)
1.69	0.93	1.10
1.33	1.21	1.36
1.45	1.32	1.27
1.38	1.05	1.22

Table 3: F-Test Two-Sample for Variances

	0.0866	*0.0062*
Mean	0.0591	0.0159
Variance	0.00190177	0.00004372
Observations	3	3
df	2	2
F	43.4988564	
P(F<=f) one-tail	0.02247249	
F Critical one-tail	19	

Table 4. t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	*Variable 2*
Mean	0.065975	0.013475
Variance	0.00145691	5.2669E-05
Observations	4	4
Hypothesised Mean Difference	0	
df	3	
t Stat	2.70247367	
P(T<=t) one-tail	0.03681584	
t Critical one-tail	2.35336343	
P(T<=t) two-tail	0.07363168	
t Critical two-tail	3.18244631	