Introductioni will die5, 6. when one buys cut

IntroductionI recently visited the Aalsmeer Flower Auction in the Netherlands, the largest flower auction in the world.

The Netherlands is centered within floriculture, being a huge international supplier of all types of flowers as well as remaining within the center of the European floral market1, 2. Annually, billions of flowers are transported all over the world1, 2. I noticed that a lot of the flowers that were being sold were cut flowers rather than potted plants, cut flowers are notorious for dying fast. Roses are among the most well recognizable flowers, so I decided to explore ways of extending their life as cut flowers using sucrose3.

In order to survive, flowering plants have roots and leaves. The roots absorb water and nutrients from the soil, while the leaves use sunlight to convert water and carbon dioxide in order to create chemical energy. The reaction produces sugars that feed the plant, and the oxygen that we breathe. This process is known as photosynthesis4. When a flower is cut away from it's flowering plant, it loses its connection to the roots, its support system.

Therefore, it can only absorb water from its stalk where the cut was made5. This is why florists cut flowers diagonally, in order to increase the surface area where the plant is in contact with the water-based solution it is placed in5. The loss of the flower's ability to get minerals is shocking to the plant, and its immediate reaction is to seal the cut to protect the resources it has in the stem from harmful bacteria potentially entering5. The plant draws from the solution it's placed in as water evaporates from its leaves, known as " transpiration-pull5.

” This happens due to the attraction between the water molecules which work together to “ pull” the water up the stem5. Despite “ transpiration-pull” helping the flower, it will not be able to maintain living as it will absorb water less effectively than if it was still connected to the flowering plant5. This is the same in regards to plant food, without the nutrients found in its natural environment the plant’s metabolism fails, eventually not pulling any water up at all.

This will start the process of deterioration, beginning with the farthest extremities: the blossom and leaves. Following this, the stem will also start to wilt as there is no water pulling it upright anymore and the plant will die5, 6. When one buys cut flowers such as a bouquet, we are provided with a packet of plant food consisting of nutrients such as potassium, magnesium, nitrogen, phosphorus, sulfur and calcium that somewhat mimic what the plant would gain from its soil7.

The household substitute of this is said to be table sugar (sucrose)6, with most people who pick flowers from their gardens using that to increase the longevity of their flowers6, 8, 9. This claim that sugar works in increasing the longevity of flowers is reflected in the scientific journal article “ Effect of Chemicals, Temperature, and Humidity on the Lasting Qualities of Cut Flowers” in the American Journal of Botany, 1929. The experiment was conducted and recorded by American Journal of Botany A. E. Hitchcock and P. W. Zimmerman.

They tried to increase the life of cut flowers with various substances such as ethyl alcohol, sodium nitrate and cane sugar. Cane sugar was listed as a favorable substance, that helped the flower last longer before wilting10. To verify whether table sugar actually helps cut flowers survive longer, I will be measuring the effect of different concentrations of sucrose solutions on the vertical length of the flower stalk over 5 days, measuring how much it has wilted daily.

I will be using Floribunda roses. Therefore, my research question is: how does the concentration of the sucrose solution cut flowers are placed in effect their longevity: what is the optimum molarity to ensure the least wilted flowers? HypothesesH0: The rigidity of the flowers over 5 days is not affected by concentration of the solution. HA: The rigidity of the flowers over 5 days is affected by concentration of the solution, the higher the concentration the more rigid the flower stays longer until a certain concentration. As the concentration of sucrose in the solution increases so will the longevity of the flowers, however after a certain concentration the flowers will die faster as the higher the concentration of sucrose the more susceptible the solution is to bacteria. I therefore believe that the second hypothesis will be supported by the data. VariablesIndependent Variable: The concentration of the solution: This is varied by changing the measurements of table sugar (sucrose) mixed with water, therefore altering the concentration of the solution the flower is kept in. The molarity of the solution can be measured using the weighing mass to calculate the ratio between the table sugar and the water. Dependent Variable: The amount the flower stalk wilted.

This is quantified by measuring the height at which the flower head was located in relation to the bottom of the stalk over 5 days using a ruler. This is possible as the first noticeable change of the deterioration of the flower occurs as the stalk close to flower head wilts, losing its rigidity. "Control Variables. The following variables must be controlled: VariableReason for Controlling ItHow it was ControlledVolume of SolutionThis will affect the longevity of the flower, as different amounts of solution might alter the amount the flower uses as well as increase the likelihood of bacteria growth with larger volumes.

The volumes of water was kept at 100mL for all trials. Length of StalkThe stalk of the flower is what we will be the base point of our measurements, as on day 1 the stalks will be fully rigid with the flower heads at the same height in relation to the base of the stalk in order to create a fair test. Using a ruler, all flower stalks were measured 20. 0cm away from the head of the flower and cut there. Number of Leaves and ThornsThe number of leaves and thorns on the stalk of the flowers could impact the final results as some of the water the flower uses to stay alive would be diverted to keeping the leaves alive as well.

Using a knife all leaves and thorns were carefully removed so that each flower simply had the rose attached to the stalk with no other appendages. Cutting of the StalkThe angle of the cut of the stalk impacts how much water the flower stem is absorbs, and florists cut them diagonally in order to increase the stalk to solution surface area. Using a ruler, all flowers have a diagonal cut from the 19. 0cm to the 20. 0cm. EquipmentRulerBalanceSticky TapeMarkerKnifeCutting BoardTray 40 Floribunda Roses400ml Deionized Water475g Table Sugar (sucrose)20 100ml Conical Flasks5 500ml Measuring Cylinder100ml Measuring Cylinder5ml PipetteSolutionsUse the measurements calculated below in order to make the solutions, using a balance and a 500ml measuring cylinder to measure the table sugar and deionized water. The first set of five concentrations have 4 trials each, during the first week. The second set of four concentrations have 5 trials each, during the second week.

Making all the solutions first saves time when conducting the experiment. The solutions can be made in advance all at once rather than going back and forth between making solutions with different moles and the other steps. Nuclear Formula of Table Sugar: C12H22O11Molar Mass of Table Sugar: 342g/molFormula Used: Molarity (M) = moles of soluteliters of solution Breakdown of the Different Solutions: S1: 1. 00 M = 136. 80g sugar, 400ml water S1: 0. 80 M = 109. 44 g sugar, 400ml water S1: 0.

60 M = 82. 08g sugar, 400ml water S1: 0. 40 M = 54. 72g sugar, 400ml water S1: 0. 20 M = 27. 36g sugar, 400ml water S2: 0. 15 M = 25. 65g sugar, 500ml water S2: 0.

10 M = 17. 10g sugar, 500ml water S2: 0. 05 M = 8. 55g sugar, 500ml water S2: 0. 00 M = 0.

00g sugar, 500ml water MethodOn Monday, using the marker and tape label four conical flasks 1, label four conical flasks 2, label four conical flasks 3, label four conical flasks 4, and label four conical flasks 5. Use the marker, label each of the similarly numbered conical flasks with A, B, C, D. Using the knife and the cutting board, measure the stalks of 20 flowers to 20. 0cm with a ruler and cut them in a straight line. Using the knife and the cutting board, measure the stalks of the same 20 flowers at 19. 0cm with a ruler and cut them in a diagonal line to the bottom of the stalkMeasure 100ml of the solution at 1. 00M using the 100ml measuring cylinder and 5ml pipette. Pour the 100ml of the solution into the first of the 100ml conical flasks, 1A carefully.

Repeat steps 5 and 6 accordingly till all of the similarly numbered (1B, 1C, 1D) conical flasks are full. Repeat Steps 5 to 7 with the other concentrations (0. 80M, 0. 60M, 0. 40M, 0. 20M) of the solution and the other numbered conical flasks (2A-D, 3A-D, 4A-D, 5A-D).

Place the freshly cut flowers into the conical flasks. Measure the height of the base of flowerhead from the bottom of the stalk using a ruler to the closest tenth recording the data in the tables (as seen in diagram to the right). Repeat the process with all the other 19 flowers. Place the conical flasks into the tray, and put them in the storage room away from the window. Mark the corners of the tray in the storage room with tape so that the tray can be placed back in the same spot every day. Come back at 15: 45 on Tuesday, Wednesday, Thursday and Friday and repeat steps 10 to 12. Measure the average loss of height per day per concentration, record it in the table. Once all the data has been collected, wash and clear the equipment.

Repeat steps 1 to 16, starting on the following Monday with new concentrations of the solutions (0. 00M, 0. 05M, 0.

10M, 0. 15M). Once all the data has been collected, wash and clear the equipment.

Use Microsoft Excel for all the solutions to calculate the: Mean: use the “= AVERAGE()” functionStandard Deviation: use the “= ST. DEV()” functionResultsTable 1. Showing the length the flower stalk had wilted by day 5 for various concentrations of sucrose solution, together with means and standard deviations (SD). Figure 1. Scatter graph showing the effect of different concentrations of sucrose solution on the length the flower stalk has wilted by day 5 together with the line of best fit, R2 value and error bars. Data AnalysisThe error bars for 0. 00M are relatively small, indicating a high degree of certainty in that particular value.

There are no error bars for 0. 05M to 0. 20M indicating no uncertainty for those values. However, the error bars for 0.

40M to 1. 00M are relatively larger, with the larger being the error bars on 0. 40M indicating a high level of uncertainty. The error bars for 0. 40M overlapped with all the values below it, as well as the error bars for 0. 60M suggesting that curve of the positive gradient could occur much later. The 0.

80M error bars also overlap with the 1. 00M error bars. However the error bars below 0. 60M don’t overlap with the error bars above 0. 80M, making me confident that while the curve might be more or less dramatic there is still a positive gradient that is not just by chance.

While all the data points below 0. 20M were scattered around the line of best fit, as well as the data points above 0. 60M being slightly off, the R2 value is 0.

97. Despite the line of best fit not being within all the error bars the margin of the R2 value makes me confident that the relationship is mostly positive. Given that despite a few inconsistencies and the outlier that is the data point of 0.

00M, most of the data analysis makes me moderately confident that the relationship between the concentration of sucrose solution and the length the flower stalk has wilted by day 5 is indeed mostly positive after a point between 0. 20M and 0. 59M. ConclusionThe data supports the hypothesis that the rigidity of the flowers over 5 days is affected by concentration of the solution, the higher the concentration the more rigid the flower stays longer until a certain concentration. It is true that the values for 0. 00M were higher than the values of 0. 05M to 0. 20M, meaning that the flowers were more rigid with a higher sucrose concentration.

However the last portion of the hypothesis is also true, at a certain concentration (between 0. 20M and 0. 59M) rather than helping maintain the rigidity of the flowers, the concentration caused them to wilt faster. There is a mostly positive correlation between the length of the flower stalk has wilted by day 5 and the sucrose concentration of the solution. Logically, this makes sense as too much of a sugar is not good for the flower because the sugar to water ratio is too high. Osmosis supports this statement, as when the concentration of sucrose in the water is too high the solution draws water from the flower stalk rather than the other way around.

This means that there is a negative correlation between the rigidity of the flowers over 5 days and the sucrose concentration of the solution. I can therefore conclude that there is a somewhat of a correlation between the rigidity of the flowers over 5 days and the sucrose concentration of the solution. EvaluationGiven the overall pattern seen through the data analysis, I can be moderately confident that there is a negative relationship between the rigidity of the flowers over 5 days and the sucrose concentration of the solution barring the first data point. However, my confidence in my conclusion is reduced as there are a number of limitations to the method.

Firstly, the experiment was done over 2 weeks, with one set of concentrations being tested in the first week and another set in the second. The biggest issue with this is that the flowers were most likely from a new batch the second week, meaning that there could have been differences in their quality in relation to the quality of the first batch. Furthermore, despite being placed in the same room, because they were there for substantial amounts of time it is possible that the temperature of the room changed week to week.

For example, the first week was cloudy but warm yet the second week was rainier and cold. This impacts the speed of the deterioration, as on warmer and sunnier days the water evaporates from the plant faster. This limitation could be overcome by conducting all the trials at once, rather than over multiple weeks. Placing the flowers in a room further inside a building with no windows would reduce the chance of sunlight or the weather causing a viable change in temperature. By doing this, the experiment would consist of more of a fair test and there might be a visible change among the connections of the two sets of concentrations.

Another weakness was the sourcing of the flowers. The origin of them, and even the collection should have been mentioned within the method. The flowers for this experiment were sourced from a local florist but because I didn't know where they were originally from it was hard to make it a completely fair test. The main issues were not knowing how old the flowers were, the stage of blooming they were in when they were picked as well as not being able to prevent damage to the blooms. While I bought the flowers, I assumed they were in similar stages as they were all in the same bouquet. However, this wasn't the case as I did more research. The longevity of a flower depends on when the flower is cut, and there is a specific time depending on each type of flower. Roses in the late bud stage, one where the outer petals are open but the inner petals aren't, are the best to pick11.

As they were in different stages, the range of the length the flower stalk has wilted by day 5 were wide. Younger flowers with thin stalks wilted faster than older flowers with thicker stalks. In order to solve this limitation it would be important to go and pick the flowers myself from my garden, taking note of the stage they were picked in and certain characteristics like stalk thickness. This research found through these trials has bearing on a real world scale, the flower market. To transport cut flowers, the supplier needs to ensure that the flowers will be able to last the trip to the buyer.

A possible solution would be to buy sugar and use it in accordance to the optimum molarity. The cost of refined sugar is about 32. 90 U. S. cents per pound that food manufacturers and grocery stores pay12. One tonne is about 2205 lbs, multiplied by 32. 90 is 72544. 5 cents.

This would be $725. 445 per tonne of sugar which converts to €625. 52. When billions of flowers are being sold, the flower suppliers will need to keep buying more sugar. By finding the optimum molarity of the sucrose concentration, suppliers can use the least amount of sugar required in order to keep the flowers alive while they're delivered globally. This would be the economic situation, as one tonne of sugar would be split up in the smallest working portions.

A possible extension to this investigation would be to continue trying to find the optimum molarity down to the closest 0. 01M of sugar. This would require more testing with more concentrations that range from 0.

20M and 0. 59M, as the error bar on 0. 40M crosses the x-axis.

Another possible extension would be redoing this investigation with different types of sugar such as brown sugar or even alternate substances such as the ones used by Hitchcock and Zimmerman in their 1929 experiment10. An alternate extension could include using various concentrations of bleach or citric acid, so instead of feeding the plant the experiment revolves around keeping the water bacteria free. BibliographyAalsmeer. Royal FloraHolland. https://www. royalflorahollland. com/en/about-floraholland/visit-the-flower-auction/aalsmeer.

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