Absorbency of Paper Towels Across Different Brands

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Abstract

The comparison of paper towel brands in their capacity to absorb water was investigated. A one-way ANOVA and Tukey's test was done with the collected data. It was found that Kirkland's paper towels on average absorb significantly more than both Viva and Sparkle ($p < 0.05$ for both comparisons). Bounty, which performed similarly to Kirkland, absorbed significantly more than Viva as well ($p < 0.05$). Viva and Sparkle performed similarly ($p > 0.05$). Bounty did not outperform Sparkle significantly ($p > 0.05$). Kirkland is perhaps the most optimal and safe choice for consumers which outperformed the most brands or at worst performed similarly, with Bounty following after.

Introduction

The purpose of this experiment is to determine which brand of paper towels is most absorbent for people buying these brands of paper towels.

Paper towels are made up of cellulose fibers, which also make up cotton, wood, and most other plants (Brown, 2017). These cellulose fibers are giant molecules that consist of many small molecules linked together. Capillary action in the fibers draws the water into the paper towels. Cellulose attracts water as well - the small molecules that combine to make up cellulose are sugar molecules which attract water. The spaces between the fibers also help hold the water. This is also why folded paper towels absorb more water (as well as paper towels that are manufactured with more 'layers'). Every little space in the surface of the paper towel has its own tiny "bubble" of surface tension (Cascio, 2019). Once the sheets are made they also have shapes pressed into them to make them look quilted. These shapes form air pockets to attract water.

Paper towels are made from the same types of plant fibers that other types of paper are made from. The difference between paper towels and other types of paper comes when the paper fibers are mixed with a special type of resin to make them strong when they are wet. That is the reason why paper towels don't tear as easily as opposed to tissue paper when wet.

Different brands of paper towels have different methods for manufacturing their paper towels, which may explain the differences in absorbency in paper towels.

The question that is investigated is which brand of paper towel will absorb the most amount of water (mL).

The hypothesis here is that the paper towel brand that can absorb the most water and leaves the least amount of water (mL) will be the most optimal brand of paper towels.

Methods

Make five 10cm by 20cm rectangles for each brand of paper towels (Bounty, Viva, Kirkland, Sparkle). Fill the beaker with 250 mL tap water and use that water to fill the large cake pan. Put the rectangles of paper towels into the cake pan and start the timer. The rectangles of paper towels will stay in the water-filled cake pan for 15 seconds. After 15 seconds, remove the paper towel. Then empty the water from the cake pan, with the help of a funnel, back into the 250ml beaker. We will then empty the water from the beaker into the 5 x 50mL graduated cylinders. Sum the water in the 50 mL graduated cylinders. We will then subtract the volume of water we get after the paper towel is done absorbing from the original amount we put into the cake pan. The entire process will repeat 5 times for each brand for a total of 20 times (with 4 brands and 5 repetitions each).

Our collected data in each repetition will consist of the amount in mL absorbed of the paper towel. Amount absorbed (mL) = Total initial volume (mL) - Left over volume (mL).

We will then conduct a normality test with a histogram on excel. If it is a normal distribution, and other important assumptions of an ANOVA test are acceptable (equal variance), then an one-way ANOVA test will be done to determine if there is a statistically significant difference between the volume of water absorbed between the different brands of paper towels. If the difference is statistically significant (and we reject the null hypothesis where we hypothesize that the paper towels would not absorb water in mL that are significantly different), we can run a Tukey Kramer multiple comparison test (Tukey's test) to see which group specifically is significantly different.

Materials/Supplies

- Bounty, Viva, Kirkland, Sparkle paper towels (10cm by 20cm rectangles)
    - They are all the same ply (e.g. not super absorbing or other features that have significant impact on absorbance in one brand but not the other)
- 1 x 250ml beaker
- Timer with phone
- Water (~10 degrees celsius)
- Thermometer
- Large cake pan (used in pervious lab - paper towel can lie completely flat)
- Funnel
- 5 x 50 mL Graduated Cylinder

Results

SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
Bounty	5	82	16.4	0.685
Viva	5	72	14.4	0.675
Kirkland	5	88	17.6	0.55
Sparkle	5	75.5	15.1	0.55

Figure 1. Table shows the number of repetitions done in each group (Count), the total sum of average volume absorbed in mL (Sum), the average amount of water absorbed in mL (Average), the variance across the 5 repetitions in each brand (Variance)

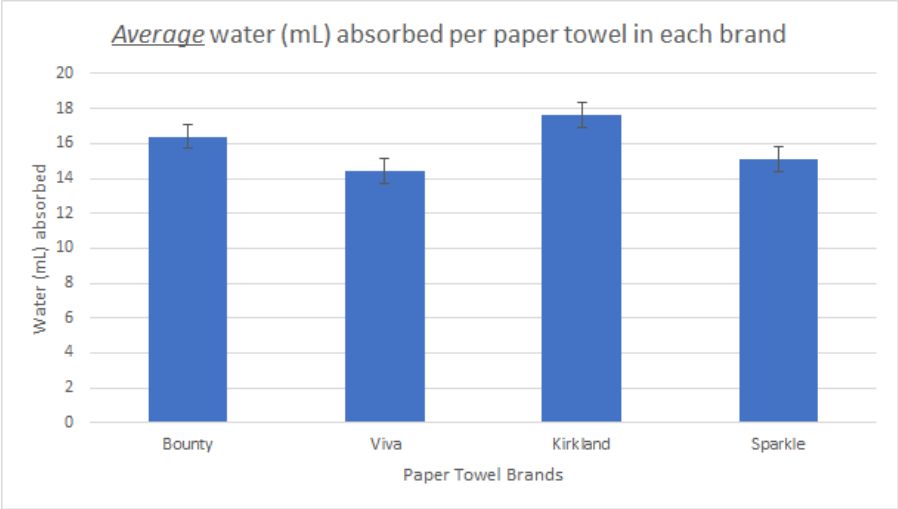

Figure 2. A bar graph of the average mL absorbed per paper towel in each brand.

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	30.1375	3	10.04583	12.55729	0.000178	3.238872
Within Groups	12.8	16	0.8			
Total	42.9375	19				

Figure 3. Anova test of the absorbed amounts in each repetition for each brand. The amount absorbed was recorded in each repetition for a total of 5 repetitions in each of the 4 brands chosen in this experiment.

treatments pair	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inferfence
A vs B	5.0000	0.0131734	* p<0.05
A vs C	3.0000	0.1884517	insignificant
A vs D	3.2500	0.1399989	insignificant
B vs C	8.0000	0.0010053	** p<0.01
B vs D	1.7500	0.6036177	insignificant
C vs D	6.2500	0.0021855	** p<0.01

Figure 4. Tukey's HSD (or Tukey's test) - a multiple comparison test to find means that are significantly different. (tool used from https://astatsa.com/)

[**Brands: A = Bounty, B = Viva, C = Kirkland, D = Sparkle**]

With the data being quite normal and with variance very similar to one another, we move forward with an one-way ANOVA. (Sample size is still perhaps low)

The ANOVA test produced a P-value of 0.000178 which shows significant difference between the groups (although with an ANOVA we don't know which groups), with our alpha value of 0.05.
The F-value is 12.557 with a F-critical value of 3.239. This further points towards the difference between the groups being significant with a F-value greater than the F-critical value.

The Tukey's test showed that Bounty vs Viva, Kirkland vs Viva, and Kirkland vs Sparkle are all significantly different from each other ($p < 0.05$) in their mean absorbed amounts of water in mL. The rest of the comparisons between two brands are not significantly different ($p > 0.05$).

With Bounty vs Viva, we have a P-value of 0.01317 ($p < 0.05$)
With Kirkland vs Viva, we have a P-value of 0.001005 ($p < 0.05$)
With Kirkland vs Sparkle, we have a P-value of 0.002186 ($p < 0.05$)

Discussion

The data presented above shows evidence supporting that Kirkland paper towel absorbs significantly more than both Viva and Sparkle. Also, Bounty absorbed significantly more than Viva. The data points towards Kirkland and Bounty outperforming Viva and Sparkle when it comes to water absorbency per paper towel (while keeping in mind that Bounty did not significantly outperform Sparkle ($p > 0.05$)). Kirkland is perhaps the most optimal and safe choice which outperformed the most brands or at worst performed similarly with Bounty following after.

The data gathered from this experiment supports consumers choosing Kirkland or Bounty over Viva and Sparkle when it comes to water absorbency. Perhaps more experiments can be done with other liquids or substances. However, looking at the mean values across the brands, there is not a big difference in

absorbance when it comes to daily use of paper towels, but across the entire industry where millions of rolls of paper towels are produced, a slight percentage difference in absorbance thus influencing consumer behavior (using less paper towel sheets) can impact areas such as business costs, environmental wastes and sustainability issues. On a more basic level, consumers who choose Kirkland or Bounty may find that they are getting more bang for their buck.

Considerations made during the experiment were important to make sure the paper towels used are "similar" in that we are comparing paper towels that all have the same ply. Our control further included water temperature, the time in which the paper towels were dunked, and the techniques used to extract the paper towel from the water, etc. Overall the procedure was quite standardized. However, factors that may not pertain to the paper itself may also influence the absorbance, such as the outside packaging, the amount of time since manufacturing, the environments in which the paper towel has been (humidity, temperature). These factors may cause unintended differences between the paper towels themselves, but may also serve as a marker of difference between the brands (e.g. one brand has 'better' storage strategies to maintain the quality of its towels)

Some possible explanations include the shape / indentations differences on the paper towels itself in each brand of paper towel, the space between each ply, and the material composition of the paper towels. To uncover or find clues for what is causing the differences between the brands is a challenge for future experiments.

Conclusion

The aim in this experiment is to find out which paper towel brand absorbs the most amount of water and is thus the optimal brand for consumers to buy. From the gathered data, Bounty performed similarly to Kirkland which outperformed Viva and Sparkle. Viva and Sparkle performed similarly. Bounty did not outperform Sparkle significantly. Kirkland is perhaps the most optimal and safe choice for consumers which outperformed the most brands or at worst performed similarly, with Bounty following after.

Works Cited

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