An Investigation into the Paper Chromatography of Dyes and Dyes used in M&Ms

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Jared Compaleo Section 17M

Academic Honesty Statement

I have read and agree to the terms of the Academic Honesty Statement.

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Introduction

This report investigates how intermolecular forces impact the interactions between the sample, mobile phase and stationary phase through the use of paper chromatography. This report investigates chromatography which is a method to separate a mixture into its components based on how they interact with the mobile and stationary phases (Coskun, 2016). This report specifically investigates paper chromatography which is chromatography where a piece of paper is the stationary phase and capillary action draws the mobile phase up along with the mixture to separate it (Sanders, 2019). Where the stationary phase is where the separated mixture will move more slowly and will eventually be deposited when the sample becomes more attracted to the stationary phase than the strength of the mobile phase, which carries the sample over it, can pull it upwards (Sanders, 2019). To test the dyes used in M&Ms, the equation Rf = Ddye/Dsol is used to calculate a constant for various dyes that may be used in the coloring of M&Ms (Sanders, 2019). To determine the dyes used in M&Ms we calculated the Rf values of various dyes and if they are used in the coloring of M&Ms, then when we applied paper chromatography to the dissolved colored dyes of an M&M the segments with Rf values and colors similar to the dyes are likely used in the coloration of M&Ms.

Methods

20mL of mobile phase were added to each of the two 600mL beakers and covered (Sanders, 2019). Two 10 by 20 cm pieces of chromatography paper were placed with their longer side horizontal and marked with a straight line 1.5 cm above from the bottom and tick marks at 2cm intervals on said line (Sanders, 2019). The known FD&C dyes were applied to different tick marks on one of the papers 3-4 times after the dyes dried (Sanders, 2019). The chromatography paper with the dyes was stapled (marked side outwards) in the shape of a cylinder with a gap between either edge of the cylinder (Sanders, 2019). The cylinder was then lowered into one of the 600mL beakers with mobile phase in it and covered again (Sanders, 2019). Once the solution line was approximately 1cm from the top, the cylinder was removed and the solution line was marked (Sanders, 2019). The wet chromatography paper was quickly given to the graduate teaching assistant to dry in an oven (Sanders, 2019). The positions of the dyes were marked, and all the necessary data was recorded in table 8.1 (Sanders, 2019). 3mL of a 50/50 water/ethanol solution was added to a beaker containing 6 M&Ms of the same color (Sanders, 2019). The dyes from the five different colors of M&Ms were acquired (Sanders, 2019). The second chromatography paper was prepared in a similar fashion to earlier except that every M&M dye was applied 7-10 times except for the yellow M&M dye which was applied 13-15 times (Sanders, 2019). The experiment is conducted in a similar fashion as earlier except the results are now recorded in table 8.2 (Sanders, 2019).

Results

Table 8.1 Characterization of Standard Dyes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Dye (FD&C)** | **Dye Color** | **Distance Dye Traveled (Ddye)(mm)** | **Distance Solution Traveled ± 5mm (Dsol)(mm)** | **Rf ± ??** |
| red 3 | pink | 7 ± 3 | 76 | 0.1 ± 0.04 |
| red 40 | red | 16 ± 6 | 75 | 0.2 ± 0.08 |
| blue 1 | dark blue | 72 ± 3 | 77 | 0.9 ± 0.08 |
| blue 2 | clear | 18 ± 6 | 78 | 0.2 ± 0.07 |
| yellow 6 | orange | 26 ± 4 | 74 | 0.4 ± 0.07 |
| yellow 5 | pale yellow | 35 ± 3 | 74 | 0.5 ± 0.05 |
| green 3 | blue-green | 73 ± 5 | 77 | 0.9 ± 0.08 |

Table 8.2 Characterization of Dyes Used to coat M&M Candies

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **M&M Color** | **Dye Color** | **Distance Dye Traveled (Ddye)(mm)** | **Distance Solution Traveled ± 5mm (Dsol)(mm)** | **Rf ± ??** | **Matching FD&C Food Dye** | **Rf of Matching Food Dye** |
| red | red | 9 ± 4 | 69 | 0.1 ± 0.05 | red 3 | 0.1 ± 0.04 |
| yellow | yellow | 32 ± 4 | 71 | 0.5 ± 0.07 | yellow 5 | 0.5 ± 0.05 |
| green | yellow | 35 ± 2 | 73 | 0.5 ± 0.04 | yellow 5 | 0.5 ± 0.05 |
| blue-green | 54 ± 2 | 73 | 0.7 ± 0.05 | blue 1 | 0.9 ± 0.08 |
| blue | blue (up) | 57 ± 5 | 74 | 0.8 ± 0.09 | blue 11 | 0.9 ± 0.08 |
| blue (down) | 1 ± 1 | 74 | 0.01 ± 0.01 | blue 2 | 0.2 ± 0.07 |
| orange | orange | 22 ± 4 | 73 | 0.3 ± 0.06 | yellow 6 | 0.4 ± 0.07 |
| brown | red | 14 ± 5 | 72 | 0.2 ± 0.07 | red 40 | 0.2 ± 0.08 |
| orange | 21 ± 3 | 72 | 0.3 ± 0.05 | yellow 6 | 0.4 ± 0.07 |
| yellow | 34 ± 2 | 72 | 0.5 ± 0.05 | yellow 5 | 0.5 ± 0.05 |

Discussion

As our claim stated, through the use of Rf values and the colors of the food dyes, we were able to identify all the food dyes used in the coloring of M&Ms. This was possible because Rf values are a ratio based on how much a dye is able to be moved up a stationary phase compared to how much the mobile phase can move up a stationary phase, and even if there were multiple dyes with similar Rf values, we could still differentiate between them through the use of the color of the dyes. Our results also makes sense because from our research, we tested all the dyes used in M&Ms ("M&M'S Milk Chocolate"). Out of the six M&Ms that were tested, there were three that were made of more than one dye, those M&Ms being green, blue, and brown.

References

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