CHEMISTRY 101L DATA SUMMARY

EXPT. 3

Aqueous Reactions Part II

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Results

Table 1. Crushed and Whole Walgreens Ultra Strength (100mg) pH Data, raw and calculated

	Crushed Tablet	Crushed Tablet	Crushed Tablet	Whole Tablet
pH1	1.7	1.7	1.7	1.9
pH2	4.9	4.9	4.9	5
ΔpH	3.2	3.2	3.2	3.1
Time of antacid addition: T_0 (sec)	10	10	10	10
Time of pH1: T_1 (sec)	25	15	15	335
Time Elapsed before Antacid began working (sec): $T_1 - T_0$	15	5	5	325
Time of pH2: T_2 (sec)	200	250	245	670
ΔTime (sec): $T_2 - T_1$	175	235	230	335
ΔpH/ΔTime (pH/sec)	0.018	0.014	0.014	0.009
Mean ΔpH/ΔTime	0.015			0.009
Standard deviation σ, (pH/sec)	0.00231			0

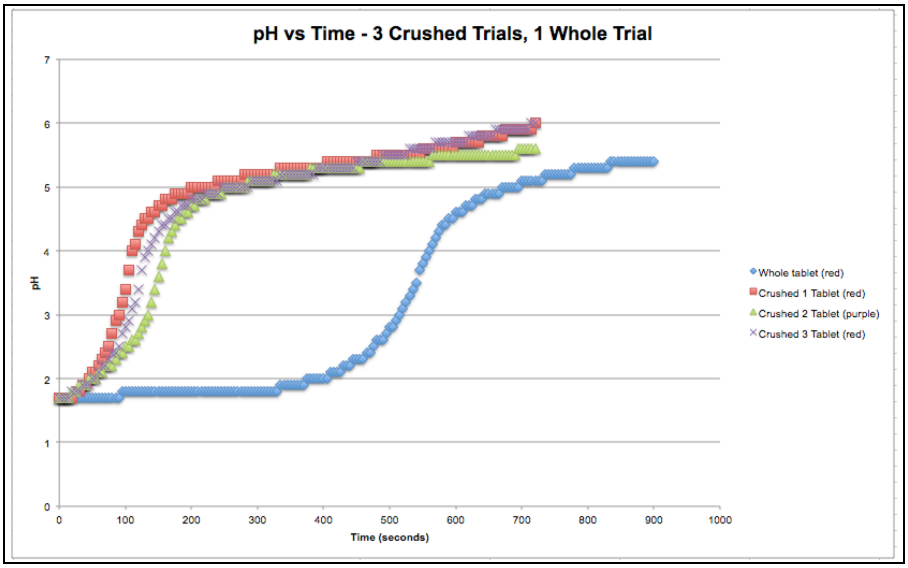

Figure 1. Change in pH over time for 3 Crushed Tablet Trials and 1 Whole Tablet Trial. In the case of all of the crushed tablet trials, the pH grows quickly (the majority of the growth occurs in the first 100 seconds), while the pH of the whole tablet trial is delayed relatively by nearly 500 seconds.

Table 2. Crushed and Whole static and calculated values across two different antacid brands

	Brand X = Extra Strength		Brand Y = Ultra Strength	
	Whole	Crushed	Whole	Crushed
Average ΔpH/ΔTime (pH/sec)	0.0126	0.03196	0.00919	0.01605
Average Time Elapsed (sec)	247.5	56.3	318.5	200.0
Active Ingredients	750mg Calcium Carbonate		1000mg Calcium Carbonate	
Mass $CaCO_3$ per Tablet (g)	.75		1	
Moles $CaCO_3$ per Tablet (mol)	0.00749		0.00999	
Mass $Mg(OH)_2$ per Tablet (g)	0		0	
Moles $mg(OH)_2$ per Tablet (mol)	0		0	
Total moles of base per tablet (mol)	.00749		0.00999	
Price	$4.49		$7.99	
Calculate Price per Tablet (dollars)	$0.046		$0.049	
Moles HCl in 150 mL of 0.1 M solution	0.015			

Discussion

The crushed tablet appeared to begin working first in our trials, as we can see that the pH began to rise (that is, the time of pH1) was 15-25 seconds for the crushed tablets while the time of pH1 was significantly later in the case of the whole tablet (325 seconds). Moreover, according to our data, the crushed tablet also acted faster than the whole tablet as we can see that the mean change in pH over change in time for the crushed tablets (0.015 pH/second) was significantly higher, almost by a factor of two, than that of the whole tablet (0.009 pH/second). The reason the crushed tablets began acting faster than the whole tablets is likely because only the inside of the tablets, that is, not the outermost shell, contains the active ingredients, as the deployment of these ingredients may need to be delayed until the pill has arrived in the stomach, or because of other manufacturing concerns. Thus, the active ingredient was only exposed to the acid after the corrosion of this outer shell. Moreover, strictly on the basis of surface area, the crushed tablet was exposing more of its active ingredients' surface area at an early time than was the whole tablet. This explains the faster reaction rate. This might encourage pharmaceutical companies to use chewable pills or pills that contain a powder in them, coated with a thin erodible layer, as it's likely that the active ingredients will be faster acting than if they were packed in a tablet.

The class' results echo our own. In fact, the class' Ultra Strength results were very near our own results, only on average the difference in how quickly the crushed tablet type worked was slightly larger (0.001

pH/second). For the entire class, the average length of the reaction ($T_2 - T_1$) for the Ultra Strength crushed tablet (200s), was very similar to the length of the reactions for our crushed tablets (~230s) as well as for the whole tablet (318.5s for the class compared to 325s for our trial).

The class' results for the time elapsed for the Extra Strength crushed tablet was significantly lower than the time elapsed for the Ultra Strength crushed, which could have to do with the fact that two tablets, and thus more base (active ingredient) was used. For both Extra Strength and Ultra Strength, the crushed tablet acted on average at a faster rate than the whole (0.0319 pH/second vs 0.0126 pH/second).

Based on the data, if the both of the antacid tablets were the same price per tablet, I would choose the Extra Strength tablet. This is because the Extra Strength tablet, when crushed, was able to provide the highest change in pH per unit time at 0.0319 pH/sec, which means it will show results the fastest because it also is not expected to delay acting when in crushed form. Considering the price per tablet information in Table 3, I would again purchase the Extra Strength tablets because not only are they cheaper on a per tablet basis, but they also provide a faster reaction time, based on our data, to acid compared to the Ultra Strength.

The acid used in this reaction was HCl, and the base used in this reaction was $CaCO_3$, based on the acidity of the solution at (the low pH level) T_0, we can conclude that the concentration of HCl was high. Based on the acidity at T_1, there were still high concentrations (although decreasing) of HCl. Finally, at T_2 the acidity was lower.

One possible source of error is the fact that many individuals did not appear to understand the calculations for the "Time elapsed during reaction", for instance, so outliers should have been rejected. For instance, on individual listed that their reaction occurred over the course of 3 seconds, which is a major outlier compared to the rest of the data. Another possible source of error is the fact that an uneven amount of active ingredient was used between the tablet types, as the Extra Strength contained 1250mg of active ingredient compared to the Ultra Strength's 1g. Moreover, because there were two Extra Strength tablets, in the uncrushed trial, there was more surface area exposed in the Extra strength compared to the Ultra Strength which means that the Extra Strength was likely to react faster. The low standard deviation (.0023) of our results indicate that our methodology was consistent. The Standard Deviation is a measure of precision.