Green Chemistry Initiative for Formulating, Pressing and Evaluating Tablets in Low-Resource Settings

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PURPOSE

There is a growing need for advanced education, training, and experience to be transferred to scientists in low-resource settings. Specifically, educating students to understand the process of making pharmaceutical products with regards to both manufacturing and regulatory aspects is critical in these regions. An additional challenge is the lack of waste disposal systems in these countries, limiting the materials that can be responsibility used. To address this issue, our team utilized locally sourced ingredients to prepare wet granulated formulations that easily demonstrated the variability in granule size and behavior with different formulations. This green approach will be used in future laboratory courses and will alter the way that hands-on labs are taught in countries with low-resources.

OBJECTIVES

- Prepare wet-granulation tablets using common household items purchased in a grocery store.
- Evaluate the hand-pressed tablets by measuring disintegration and friability and compare the results.

METHODS

Lack of readily available pharmaceutical excipients led to the development of unique formulations for a high-shear wet granulation demonstration. Easy to source, household items were purchased in an African grocery store and used to represent pharmaceutical materials. Table salt was used as the active ingredient for the tablet, powdered sugar was used as the binder, infant formula was used as the disintegrant, baby powder was used as the glidant, and corn flour was used as the diluent. A small amount of water was used to granulate the components. Four different formulations that varied in composition of the selected ingredients were prepared. After appropriate mixing, the formulations were pressed into tablets using hand-held presses. After making the granules, pressing tablets, and evaluating disintegration time as well as friability, the groups reconvened to compare their results, discuss the differences observed, and hypothesize on potential causes and implications of the different formulations.

RESULTS

Four different formulations containing ingredients commonly found in local grocery stores were successfully prepared and pressed into functioning tablets using a hand-held press. Each formulation contained the active ingredient, binder, disintegrant, glidant, diluent and a small amount of water. The active ingredient, disintegrant, and lubricant amounts were the same for each formulation. The formulations were created at a 50-gram scale, using a small food blender for mixing (see Figure 1). The amounts for the diluent, binder, and water were varied among the formulations, resulting in visibly different granule sizes (see Table 1).

The first formulation was designed as a "standard" formulation and contained 60% diluent and 20% binder, using 3 mL of water during the granulation process. The second formulation contained equal parts binder and diluent at 40% and the same water content for granulation. The third formulation had the same excipient content as the first formulation with 5 mL of water used during the granulation process. The students observed from their granulations that the first formulation had the smallest granules. The second formulation had slightly larger granules that when dried were much harder. The third formulation produced the largest granules (Figure 2). A fourth formulation (not shown) was the same as Formulation 3 but used 6 mL of water. This formulation resulted in over-wetting and was only demonstrated once.

In addition to observing the differences between the granulations, the students tested tablets they created and compared the strength and disintegration time of their tablets. The students noted that the disintegration time was nearly identical for each of the tablets at about one minute. The groups created strong enough tablets to endure a friability test, and the second formulation with increased binder content was determined to have created the hardest tablets (Figures 3 and 4).

Table 1. Formulation Components

Formulation 1			Formulation 2			Formulation 3		
Component	Amount (g)	Amount (%)	Component	Amount (g)	Amount (%)	Component	Amount (g)	Amount (%)
Diluent	30	60	Diluent	20	40	Diluent	30	60
Binder	10	20	Binder	20	40	Binder	10	20
Active	5	10	Active	5	10	Active	5	10
Disintegrant	4	8	Disintegrant	4	8	Disintegrant	4	8
Lubricant	1	2	Lubricant	1	2	Lubricant	1	2
Total	50	100	Total	50	100	Total	50	100
Water [mL]	3		Water [mL]	3		Water [mL]	5	
Observations: Smallest granules			**Observations:** Medium granules, harder when dried			**Observations:** Large granules		

Figure 1. Students preparing different formulations listed in Table 1 using a small blender.

Figure 2. Representative granules obtained from preparing different formulations listed in Table 1.

Figure 3. Students preparing tablets of different formulations listed in Table 1 using a small hand-held press.

Figure 4. Final tablets after removal from a hand-held press.

CONCLUSIONS

Advanced education of scientists in low-resources settings on all aspects of pharmaceutical development is critical as we continue to move towards sustainable drug development in-country. Using ingredients found in local grocery stores, wet granulated formulations were successfully prepared that could be easily pressed into tablets and characterized using both disintegration times and friability. By varying the amounts of specific ingredients in the formulations, visibly different sized granules resulted. The tablets exhibited similar disintegration times at one minute while the formulation containing the most binder produced the hardest tablets. The students learned how different components of a formulation can impact the appearance and performance of the final product. This learning was enhanced by being able to be hands-on in the laboratory. The use of safe ingredients found in-country facilitated the laboratory and allowed for the safe disposal of the spent materials. This laboratory can easily be implemented in other courses taught in emerging countries, enabling the development and manufacturing of quality medicines.

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