Modification of Powder Rehydration Sediment Tests Tailored for Image Analysis Purposes

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Abstract

The purpose of this study was to modify current sediment quantification tests for infant formula powders. Existing tests do not capture finer sediment fractions or consider the sediment remaining in the beaker [1]. In this study, the sediment height visible on the bottle sidewall was compared with the sediment weights obtained from a reference test [2] and a modified test using seven pilot infant formula powders. In the reference test, powder was stirred in water and vacuum filtered through a sediment disk. In the modified test, rehydration was performed in a baby bottle using a collaborative robot. The modified test showed a higher correlation (0.92) with sediment height than the reference test (-0.62). Further research will focus on robotic agitation and measuring a wider range of powders.

Introduction

For infant formula powders to deliver nutrients and meet end-user quality expectations, they must rehydrate without forming sediment. The use of image analysis for sediment estimation is expected to improve the objectivity of the measurements. However, more accurate ground truth data is required to assess the performance of the algorithms. Hence, there is a need to modify the existing tests so that they can fulfill this purpose. For example, the tests use large pore-size sieves that are not capable of catching finer sediment fraction. They do not consider the sediment remaining in the beaker or distinguish between sediment and undissolved material on the surface and in the bulk (middle) of the prepared sample.

Methodology

1. A collaborative robot (YuMi, ABB, Switzerland) was used to reconstitute seven pilot stage-1 infant formula powders in an off-the-shelf baby bottle using a 'shake' robotic agitation.

2. The mixture was prepared in a baby bottle to more closely resemble the consumer evaluation carried out at home.

3. A ruler was used by one of the authors to measure the sediment height from outside the bottle before filtering.

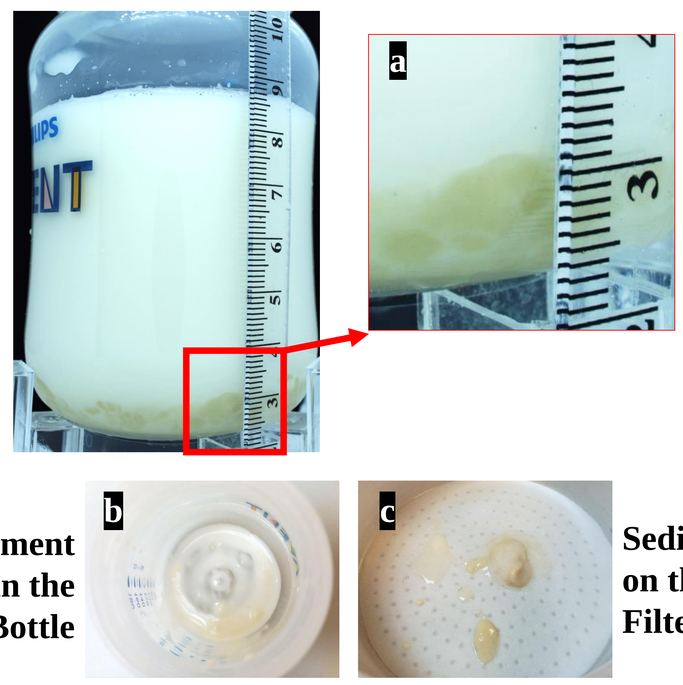

Figure 1 – Sediment: (a) visible on the bottle sidewall, (b) in the bottle, and (c) on the filter.

4. The sediment was weighed using both a reference test and a modified test:

- Reference test [2]:
  - Powder and water were stirred in a beaker and vacuum filtered through a sediment disk described in [3] to catch the fine sediment.
- Modified test:
  - A collaborative robot agitated the samples in a baby bottle for 15 seconds.
  - Surface lumps were removed.
  - Two-thirds of the mixture was vacuumed/discarded from the top and the remainder was filtered through a Whatman filter grade 4.
  - The filter and bottle sediment weights (excluding filter/bottle) were summed.

Results

The reference (Sludge Test) and modified tests demonstrated -0.62 and 0.92 correlations with sediment height, respectively (Figure 2).

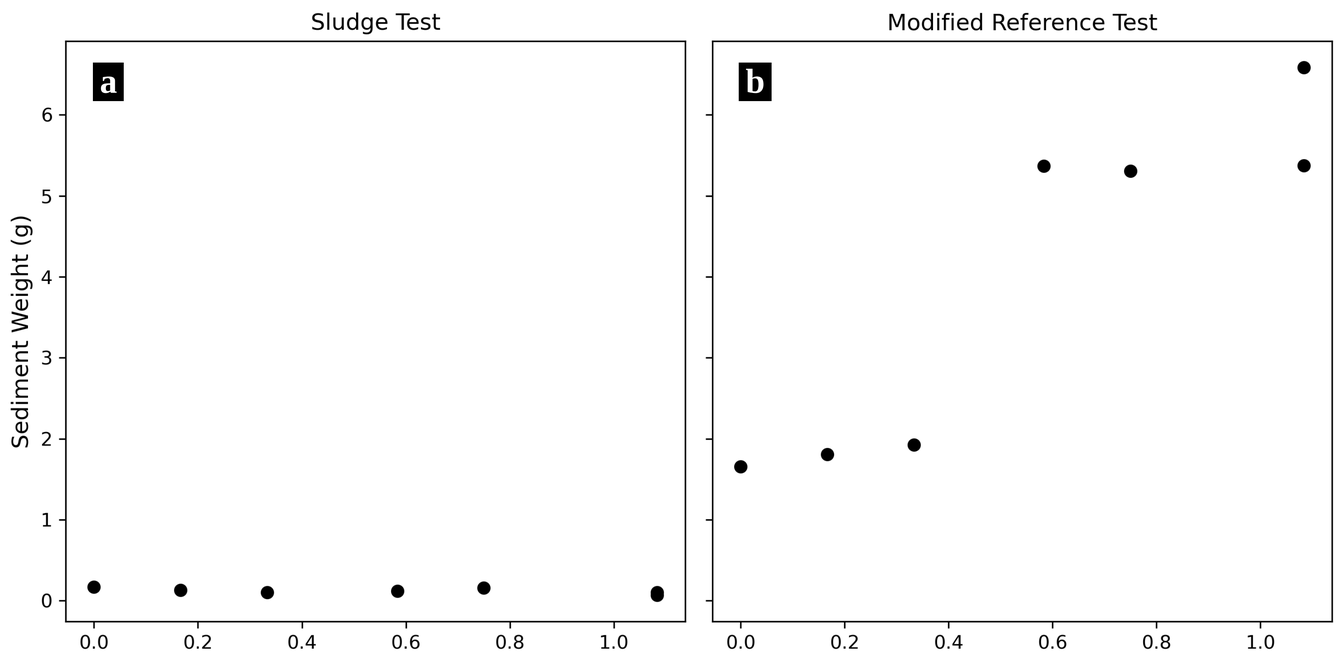

Figure 2 – Sediment height versus sediment weight using the reference (a) and modified (b) methods.

The increase in correlation may have occurred from discarding non-sediment material (e.g., lumps), as well as taking into consideration the small bottle-sediment which is expected to represent the sediment that is visible on the sidewall of the bottle (Figure 1 a and b).

Conclusion

Preliminary results indicate that the modified method for sediment quantification can capture finer fractions of sediment after powder reconstitution. In future studies, the effects of robotic agitation on sedimentation using a wider range of powders, including commercial powders will be investigated. This method may also be used to measure sedimentation in dairy or food powders.

Acknowledgement

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