Evaluation of Natural Absorbent Materials for Menstrual Health Maintenance in Low-Resource Settings

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Abstract

Lack of menstrual health maintenance (MHM) supplies in low-resource countries has profound effects on the lives of girls. An experimental study was conducted to evaluate sawdust as an absorptive material for sanitary pads. Water absorption was fast. Water absorption depended on sawdust particle size, temperature, and total sawdust mass. The results of this study have implications for sanitary pad design with sawdust.

Introduction

Many girls in low-resource environments lack supplies to safely and privately manage menstruation. A lack of safe menstrual health maintenance (MHM) options affects the ability of girls to thrive in school (Sommers et al., 2016). MHM practices vary significantly. For example, in Ikwoto county, South Sudan, 43% of girls surveyed did nothing for protection during menstruation (Tamiru et al., 2015). MHM is implicit in several of the UN Sustainable Development Goals, including the target "to achieve access to adequate and equitable sanitation and hygiene for all … paying special attention to the needs of women and girls…" by 2030 (UN, undated).

The effectiveness of current menstrual health interventions is uncertain (Hennegan and Montgomery, 2016). Provisioning of sustainable and inexpensive sanitary products in schools is part of the solution. In this study, sawdust was evaluated as an absorptive medium for MHM. Sawdust was selected because it is an inexpensive and widely available byproduct capable of being sterilized. The effects of sawdust particle size, sawdust mass, and temperature on the rate and extent of fluid absorption were studied.

Methods

Sawdust was collected from the Engineering Shop at UB and sieved into two fractions. The larger fraction was between 297 and 841 µm and the smaller fraction was less than 297 µm (Figure 1). Tests were conducted in 0.9% NaCl (physiological saline) at room temperature (22-23°C) and body temperature (36-38°C). Sawdust (0.4-0.9 g) was enclosed in a piece of Whatman No. 5 filter paper (9 cm) and submerged in the salt solution. The sawdust packet was removed and weighed over time. Results reported here were corrected for the water mass absorbed by the filter paper and for the time required for weighing (approx. 20 seconds per weighing).

The measured bulk densities were 183 kg/m³ and 256 kg/m³ for the large and small particles, respectively.

Figure 1: Sawdust Size Fractions (left: small, right: large)

Results and Discussion

Temporal Profile

A typical result is shown in Figure 2. This figure plots the mass of water absorbed per mass of sawdust (g/g) over time. Most of the water absorption occurred during the first 5 minutes for both particle sizes. The larger particle sawdust absorbed more water per gram.

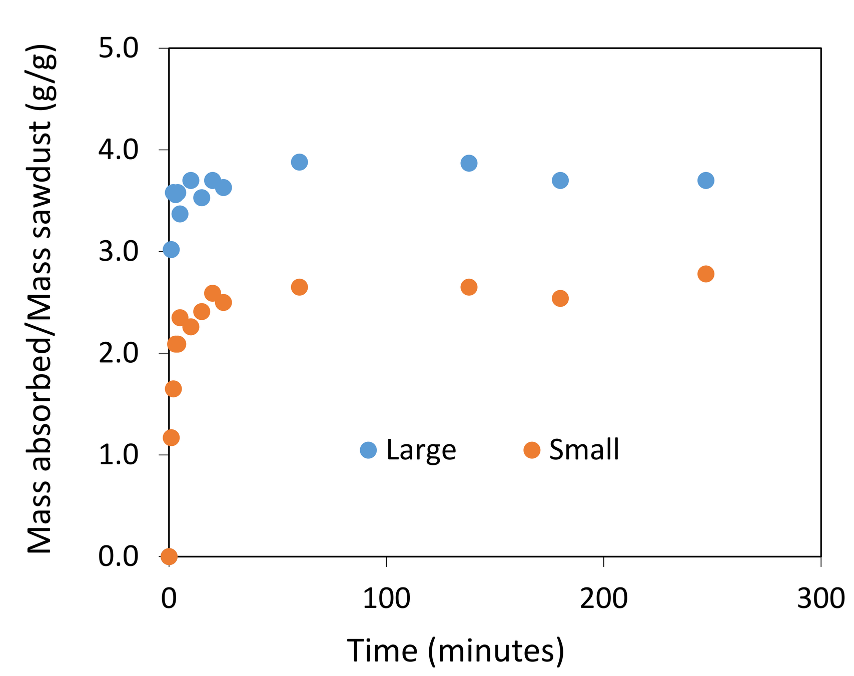

Figure 2: Change in Mass over Time. (22°C, 0.43-0.46g)

Effect of Particle Size and Temperature

The effects of particle size and temperature are shown in Figure 3. The data in Figure 3 show the water absorption of a ~0.40 g sample of large and small particles, and mixture of particle sizes at 22°C and 37°C. Measurements were taken after 25 minutes.

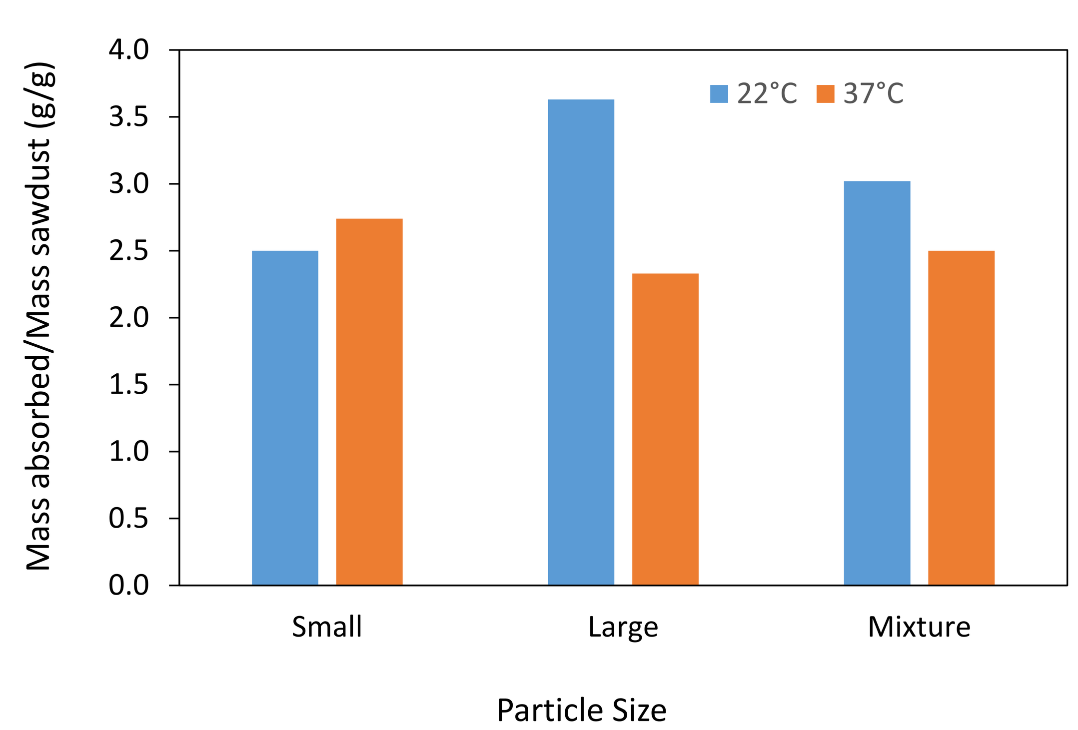

Figure 3: Effect of Particle Size and Temperature

As shown in Figure 3, large particle sawdust absorbed more water per gram at room temperature. However, at body temperature (37°C), small particle sawdust absorbed more water per gram. The mixture (0.2 g of each particle size), as expected, absorbed water to an intermediate extent. The mass of water absorbed per gram of sawdust for the mixture was almost exactly equal to the average water per gram of small and large particle sawdust.

Effect of Mass

The effect of sawdust mass on water absorption is shown in Figure 4. Measurements were taken at room temperature after 25 minutes. The total mass of sawdust ranged from about 0.4 to 0.9 g.

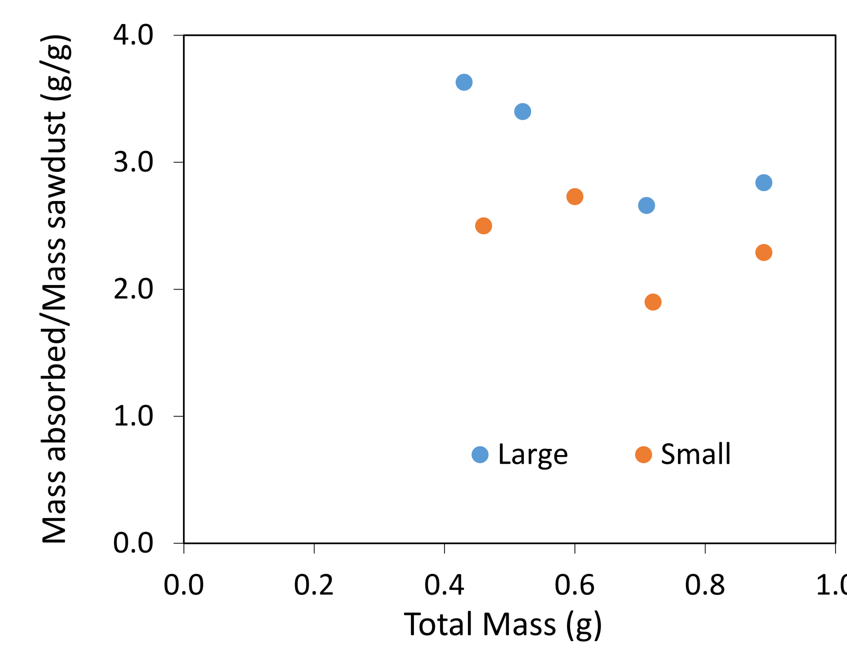

Figure 4: Effect of Total Mass

Both small and large particle sawdust follow a similar pattern, with the mass absorbed per gram generally decreasing from 0.4 to 0.9 g of sawdust. The reason for this behavior is unknown and will be explored in future work.

Bulk Density

To explore the differences between particle sizes shown in Figures 2 through 4, an experiment was conducted using the same *volume* of each particle size (approx. 3 cm³) at room temperature. Results are shown in Figure 5 and are normalized to the initial sawdust volume.

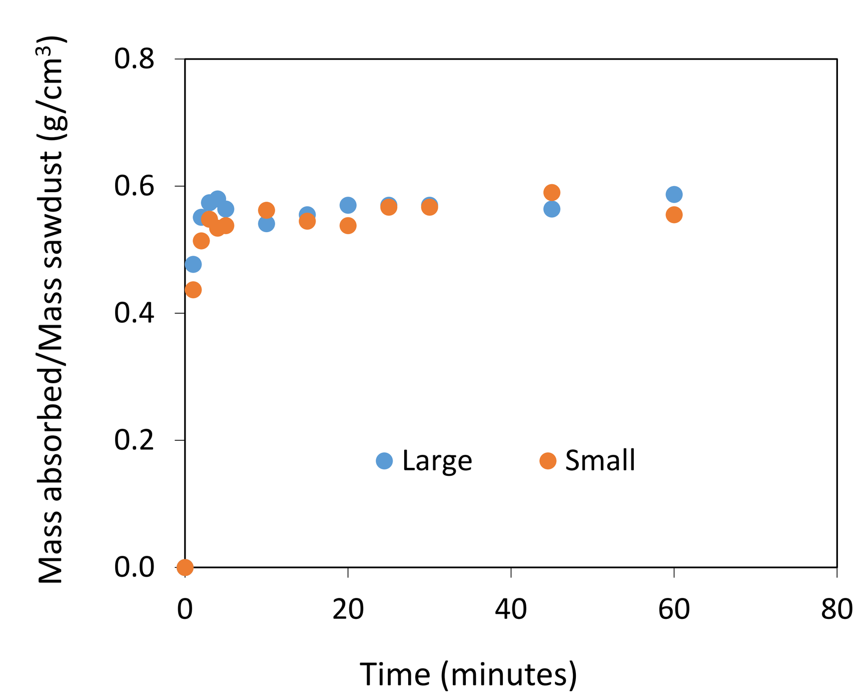

Figure 5: Change in Mass over Time with Constant Sawdust Volume

As shown in Figure 5, the two particle sizes showed about the same mass of water absorbed per volume of sawdust. This suggests that the absorptive properties of the two particle sizes are due to the difference in bulk density at room temperature. The effects of bulk density have not been studied at 37°C.

Conclusions

1. The absorptive properties of sawdust vary by temperature, particle size, and total mass.
2. Large particles are more absorptive at room temperature, and small particles are more absorptive at body temperature.
3. The mass of water absorbed per gram of sawdust appears to decrease with an increase in total mass.
4. At room temperature, equal volumes of the two particle sizes absorbed about the same mass of water.

Implications and Future Work

1. When the effects of temperature on water absorption were examined, it was concluded that smaller particles absorb more water per gram. For a sanitary pad, the appropriate temperature to test effective water absorption would need to be further examined.
2. The data in Figure 4 suggest the absorptive properties of sawdust varies with total mass. Sanitary pads would contain a much larger mass of sawdust than tested. For application purposes, more realistic masses would need to be examined.
3. The data suggest that at similar volumes, both large and small particles exhibit similar behavior. For application purposes, it is more appropriate to measure sawdust by volume rather than mass given the volume constraints of a typical sanitary pad.
4. To develop a prototype of a sanitary pad, sawdust behavior must be investigated under applicable conditions.

Acknowledgments

We acknowledge the UB Center for Global Health Equity for the idea of examinating sustainable materials for menstrual health maintenance in the developing world.

References

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