Cushioning Effect of Loofah

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Abstract
A sustainable alternative to bubble wrap to protect items during shipping is needed. The suitability of using loofah was explored. The cushioning effect of loofah during collisions was measured using a metal cart and varying layers of loofah. The maximum deceleration of the cart during the collision was determined. Increasing the number of layers of loofah showed a strong inverse relationship with maximum deceleration upon collision compared to layers of bubble wrap.

Keywords: Loofah, cushioning, impact, sustainable packaging

I. INTRODUCTION

Due to the development of online markets such as Amazon, it has become essential for companies to deliver products without damage, and that means using large quantities of bubble wrap. This has led to bubble wrap becoming a significant contributor to plastic waste in the modern world. Bubble wrap is made from low-density polyethylene film and takes a long time to naturally decompose.[1] Although modern-day bubble wrap is recyclable, only about 10 percent of plastic waste is recycled.[2] Zucchini loofahs may be an eco-friendly replacement. We present a preliminary study of the suitability of loofah as a replacement for bubble wrap in packaging.

Natural zucchini loofahs are made from dried zucchini from the genus *Luffa aegyptiaca* and are usually used as a body scrub.[3] Most zucchinis are picked when they are green, but in order to harvest zucchini loofahs, the zucchinis are left until they turn brown, to maximize the growth of fibrous tissues inside that act as natural sponges.[3] Due to its fibrous tissues, loofah may provide a cushioning effect like bubble wrap.

Figure 1. One layer of the loofa used.

The cushioning effect of flattened layers of loofah fibers, shown in Figure 1, was investigated. A metal dynamics cart was released from the top of a ramp, as shown in figure 2, and the maximum deceleration upon collision of the metal cart with various layers of loofah at the bottom of the ramp was measured.

The cushioning effect of loofah was implied from the maximum deceleration during the collision. A large maximum deceleration during the collision indicates a low cushioning effect, and vice versa. Maximum force was recorded with a force meter; the maximum deceleration was recorded with an accelerometer.

The maximum force values were converted into deceleration values by factoring out the combined mass of the metal cart and accelerometer, then the two sets of deceleration values were averaged. Different layers of loofah and bubble wrap were tested to derive a relationship between the number of layers and its corresponding impact deceleration.

II. METHODS

The 5 x 8 x 0.3 cm loofah sheets used in the investigation were produced by Luffa Thai, while the dynamics cart and track, the integrated force meter, and the 3-axis accelerometer were from Vernier. The rail for the cart was set to an angle of elevation of 1.22 ± 0.04 degrees from the table. The accelerometer was calibrated and attached to the metal cart with tape, while the force meter was calibrated and fixed to the end of the track.

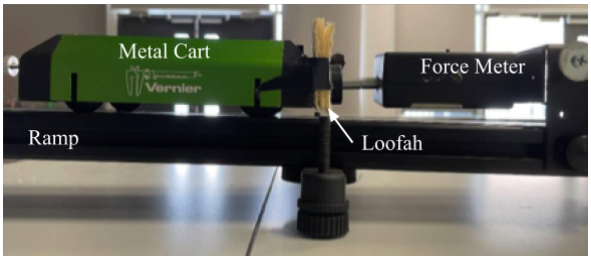

Figure 2. Metal Cart colliding against the loofah

For each trial, a number of layers of loofah were placed against the force probe located at the end of the rail so the cart would impact flatly. For every trial, the metal cart was pulled back to the end of the rail and released to collide against the layers of loofah, and the corresponding maximum force and deceleration were recorded using Logger Pro. Tests were conducted for up to eight layers of loofah. The same was done for bubble wrap, with a maximum of seven layers tested. Five trials were tested for each condition.

For both materials, the force and deceleration data were compared and found to be consistent with each other, within uncertainties, and were then averaged together to find average deceleration.

III. RESULTS AND DISCUSSION

The average maximum deceleration during the collision exhibits an inverse relationship with the layers of loofah, as shown in Figure 3. Adding more layers decreases the maximum deceleration during collision, however as the number of layers increases, the corresponding reduction in deceleration is decreased. This demonstrates the suitability of using loofah as a cushioning material in packaging. Further research is recommended to develop loofah into a commercially viable sustainable packaging material to replace bubble wrap.

It is likely that increasing the cushioning above a certain level would have negligible effects on the level of protection for the item. The ideal number of loofahs needed would depend on the fragility of the item and how roughly is it handled. In order to use loofah as a packing material, more testing must be done and guidance developed for the number of layers to use for different purposes.

Looking at the data for the bubble wrap, shown in Figure 4, surprisingly there was not a significant change in deceleration from one to seven layers, with only a small increase in cushioning effect with increasing layers. This could be due to the fact that here bubble wrap layers were laid flat on the front of the cart, while in real packaging, layers of bubble wrap are wrapped around the item more loosely, potentially increasing the cushioning effect. Further research is suggested testing the cushioning effects of large sheets of loofah and bubble wrap wrapped loosely around a package, simulating real-world usage.

Data for zero layers of loofah was not shown as it yielded the same average maximum deceleration values to the minimum number of layers of loofah and bubble wrap tested. It is likely that the collision time with no layers of loofah or bubble wrap may have been too short for the accelerometer and force meter to accurately measure.

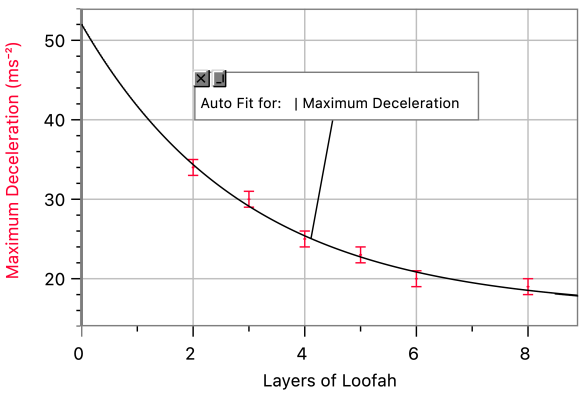

Figure 3. Layers of loofah and average maximum deceleration during the collision.

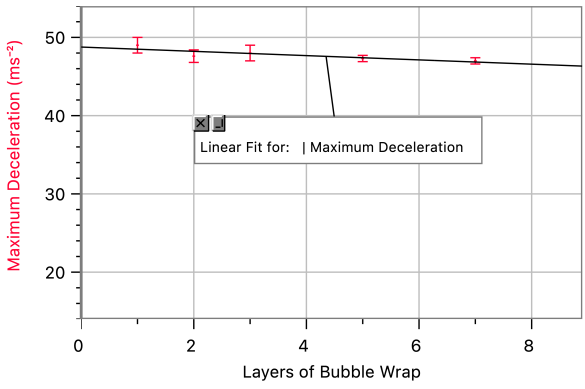

Figure 4. Layers of bubble wrap and average maximum deceleration during the collision.

IV. CONCLUSION

As the number of layers of loofah increase, there is an increase in cushioning effect, indicating that loofah is potentially suitable for use as a packaging material in modern shipping.

Bubble wrap did not demonstrate a significant cushioning effect in the conditions tested here, with only a 4% increase in average maximum deceleration between one and seven layers. Overall, loofah showed a much higher cushioning effect compared to bubble wrap. However, these are preliminary findings, and more research and development must be conducted before loofah can be considered a viable sustainable substitute for bubble wrap.

V. REFERENCES

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