9èmes journées du GDR 3544 « Sciences du bois » - Grenoble, 18-20 novembre 2020
Poster B03

Prolonging the storage of agricultural wastes by mixing with waste MDF

IRLE Mark[1], BELLONCLE Christophe[1], BONNIN Estelle[2] and LAHAYE Marc[2]

[1] Ecole Supérieure du Bois, LIMBHA, Nantes, France
[2] INRAE, Paroi Végétale et Polysaccharides Pariétaux, Nantes, France
mark.irle@esb-campus.fr

Keywords: MDF; waste; storage; biorefinery

Introduction

Both Ecole Supérieure du Bois and INRAE are partners in a Horizon 2020 project called FLEXIBI[1], which is financed by the ERANET named FACCE SURPLUS. The overall aim of FLEXIBI is investigate "*the use of agriculture, landscaping, agro-food industries and post-consumption plant biomass waste from periurban areas as feedstocks for Small scale Flexi-feed Biorefineries (SBF)*". The idea is to use SBF to extract valuable compounds from these wastes.

A major challenge for any biorefinery, even a small-scale one, is that it must operate all year round, but, agricultural residues are generated seasonally and then tend to biodegrade very rapidly. Certainly, the tomato and cucumber wastes studied in this project show significant changes, caused by biodegradation, within a few days. Biodegradation can be slowed, or even stopped, if the residues are dried. Drying, however, is energy intensive and, therefore, cost prohibitive.

The volume of MDF waste generated around the world is increasing exponentially due to the rapid expansion of installed manufacturing capacity and the relative short lifespans of products made with MDF (Irle, et al., 2018). Rather worryingly, there is, currently, no commercially viable method of recycling MDF. As a consequence, much of it is burnt for energy. Data collected on the moisture content of waste wood supplied to an incinerator over a 9 year period indicates a moisture content of around 23% (Edo *et al.,* 2016). MDF is principally used for in-door products (EPF, 2020) and, consequently, it is reasonable to assume that waste MDF would have a similar or lower moisture content. In addition, it is available all year round.

This short paper presents some results on the mixing of cucumber wastes with waste MDF.

Materials and methods

Waste MDF was obtained directly from the FINSA factory based in Morcenx, France. A range of panels with thicknesses varying from 15-22 mm were used. The panels were cut into strips 7 mm wide, then passed through a garden waste chipper, followed by a laboratory grinder (Resch) without a screen (see Fig. 1). The distribution of particles was found to be 18.2% retained on an 8 mm sieve, 74.7% on a 4 mm sieve and 7.1% in the bottom pan.

[1] Information about the project can be found at: https://cit.kuleuven.be/biotec/flexibi-home/

Fig. 1 : The range of particle sizes after passing 7 mm strips of MDF through a garden chipper and then a laboratory grinder (right: 8 mm sieve, middle: 4 mm sieve, left: bottom pan)

The cucumber waste was collected directly from Olivier S.C.A., Nantes. The waste was pressed to reduce its water content to approximately 84%, see Fig. 2. Then the pressed waste was mixed with the appropriate weight of MDF chips to give the desired water content of the mixture of 15%, 20%, 25% or 33%. The mix was formed into a mattress and pressed at approximately 8 MPa. Finally, the pressed cake was then placed in a plastic box for long-term storage. Although the boxes are not completely sealed the water content was found to fall by only 16% over an 11 month period, i.e. the 33% water content mixture still had a water content of 27.7%. A type K thermocouple was placed in the centre to allow temperature measurement of the mixture.

Fig. 2: The main steps of making a "cake" of MDF chips and cucumber waste.

From time to time, 35-40 g samples were taken from the box in order to measure the water content of the MDF, the cucumber and the mix as whole. Some of the sample was separated by hand to obtain a sub-samples of MDF and cucumber waste; the remaining sample was also dried at 103 °C for 4-9 hours.

Results

Fig. 3 shows how the water content of the cucumber and MDF wastes changed when mixed together and stored in plastic boxes. For clarity, only the two extremes are shown, i.e. 15% and 33% water contents. There is quite a lot of variability in the data caused by the difficulty in separating sufficient quantities of cucumber waste from the MDF. Consequently, the trend of water content change is highlighted by lines of best fit based on proportional decrease/growth of the form:

$$wc = wc_i - \frac{k_1}{k_2}(1 - e^{-k_2 t})$$

where: wc = water content, wc_i = initial water content, k_1 and k_2 are constants, a t = time in days.

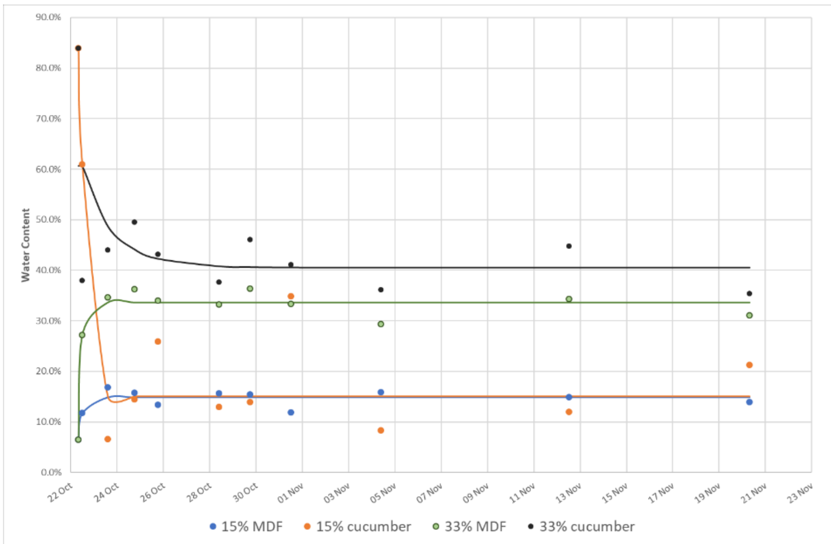

Fig. 3: The changes in water content of the cucumber and MDF wastes as a function of time for the mixtures having initial water contents of 15% and 33%.

The trend lines clearly show that the greatest change in water contents occurred as a result of the pressing step. Certainly, this is so for the 15% water content mix as both the decrease in water content of the cucumber and the increase in water content of the MDF reached stable levels within 2 days of storage. Even for the 33% water content mixture, over 80% of the changes occurred within the first 2 days.

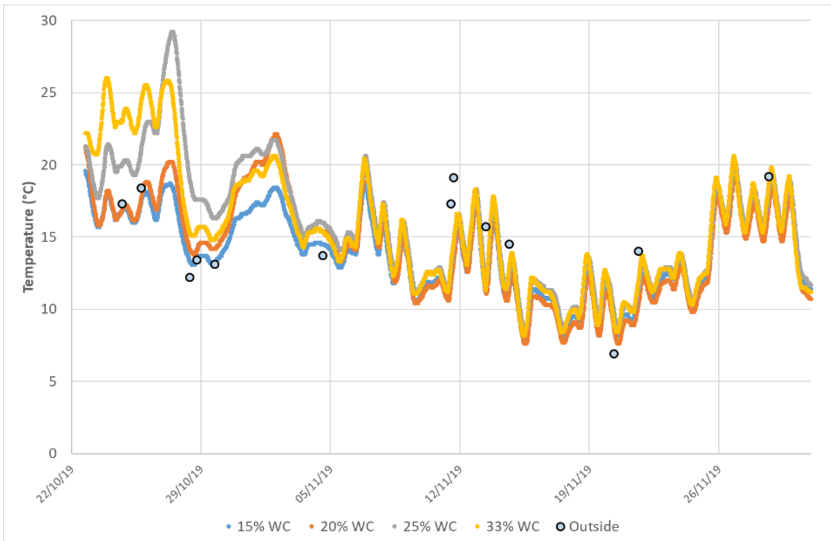

Fig. 4 : The temperatures recorded in the middle of the samples. The “Outside” data points indicate the outdoor temperature recorded at the time of sampling.

Fig. 4 shows the temperature within the mixtures during storage. Although temperatures were recorded over almost 6 months only the first 6 weeks are shown in the graph. It would appear that the 25% and 33% mixes were warmer than the others and the ambient temperature. This could be caused by the continued metabolic processes within the cucumber and/or from metabolic processes of microbes attacking the agricultural waste. All the mixtures exhibited the same temperatures after 2 weeks of storage. This implies that no further, significant biological changes within the mixes after this.

Visual assessment of the cucumber waste after nearly 1 year of storage indicates that the cucumber is in good condition, see Fig. 5. The water content at the end of this storage period was 28%, which is sufficient to support biological attack. One possible explanation is that the concentration of formaldehyde in the air within the box prevents decay.

Fig. 5 : The condition of the 33% water content mixture after nearly 1 year.

Conclusion

The long-term storage of high-water content agricultural residues is possible if they are mixed with low-water content waste MDF and pressed to at least 8 MPa in order to help transfer liquids between the two components.

Acknowledgments

The authors are grateful for the financial support from the "Région Pays de la Loire" council, ADEME via the ERA-NET FACCE SURPLUS that finances the FLEXIBI project (ANR-17-FASU-0002).

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