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Adding value to the co-products of the Hauts-de-France Region (Chicory/Endive) in compostable biosourced packaging formulations.

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Agricultural by-products represent a significant loss of biomass, so their use would seem to be the ideal solution for designing new biosourced plastic packaging that does not compete with food production. The Hauts-de-France region has a strong production of endive, forming a traditional production fabric that is helping to promote those crops as local products. However, inflation, energy crisis and restrictions on phytosanitary inputs are having a negative impact on these sectors. Producing bio-based packaging from the co-products of these crops would therefore help to improve the sustainability of this sector.

Figure 1: Photograph of endive roots produced at the APEF (Associations des Producteurs d'Endives de France) experimental station (A) before forcing eliminated after grading; (B) before forcing graded; (C) after forcing before chicory/root separation.

Regarding endive, 48.5 tons/ha of co-products (roots removed after grading, roots after forcing, leaves and downgraded products, radicles) that could be recycled each year [1]. This represents 360,000 tons of waste to be valorized annually in northern France. We are currently assessing the recovery potential of two endive co-products for the production of biosourced packaging: roots before forcing (removed after sizing) and roots after forcing (after separation from the chicory) (Figure 1).

With the aim of using these two co-products in a zero-waste way, we wanted to produce bioactive films using casting methodology, adding as few products as possible to the formulation and processing the raw material without polymers extraction in order to limit the environmental impact of the process. First, bioactive films were produced from the raw material alone. Each co-product was freeze-dried, finely ground and then sieved to ensure that the pieces obtained were uniform (Figure 2). Casted bioactive films obtained from chicory roots before forcing biomass present a yellow color and show flexibility and elasticity. Scanning electron microscopy (SEM) reveals an irregular but smooth surface, a homogeneous thickness and an edge made up of a dense, well-agglomerated network. In contrast, the films obtained from endive roots after forcing are beige/brown, non-homogeneous and have a 'paper' texture. Although they remain flexible, they have every limited elasticity. These results are corroborated by SEM observations which show granular films on the surface, with a less dense network whose fibrous layer distribution is visible suggesting a lack of agglomeration which would explain the lack of elasticity. The difference in behavior in terms of film-forming properties between these two types of biomasses could be explained by the difference in the degree of polymerization of the fructans of which they are composed. In fact, the average degree of fructans polymerization is greater in the roots before forcing than after forcing [2].

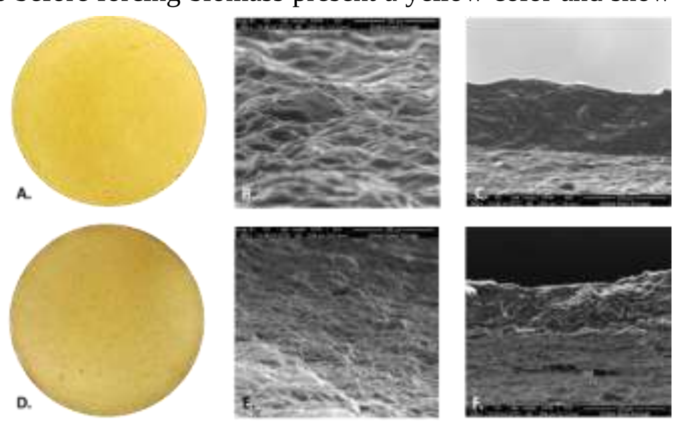

Figure 2: photograph (A-D) and scanning electron microscopy of the surface (B-E) and edge (C-F) of bioactive films obtained from endive roots before forcing (A, B, C) and after forcing (D, E, F).

[1] Marle, Cassan, Sanvicente (2020). L'endive, CTFIL; [2] Van den ende, W. et al. (1996). New Phytologist, 132: 555-563.