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Abstract

Analytic Fingerprints of Se-Stimulated Cabbage Biofortification †

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Abstract: A selenium–vinasse plant biostimulant was foliar-sprayed on white cabbage cultivated in a drought area, and various analytic methods were applied on the control and treated cultivars in order to investigate particular analytic fingerprints relevant for cabbage cell wall development and plant biofortification. IR spectroscopy, X-ray diffraction, fiber content and thermogravimetry evidenced specific fingerprints regarding cabbage cell wall composition in pectin and Iα-cellulose, soluble and insoluble fibers, volatiles and mineral content, together with a faster molecular metabolism toward pectin and Iα-cellulose accumulation and increased biofortification with minerals.

Keywords: molecular fingerprints; selenium foliar biostimulant; vinasse; drought

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1. Introduction

Plants have been evolving since 3.7 billion years ago in a continuous optimization of biosynthesis mechanisms and adaptation to environmental conditions. Plant physiology studies developed exponentially in the last century, together with the global technologyaiming toward molecular and bionanotechnology usage for a better understanding of the green world [1]. This study aims to highlight and discuss particular aspects of the biostimulant effects of the selenium–betaine nanoformulation (Se-BNF) on cabbage growthunder drought conditions [2], concentrating on particular physical-chemical fingerprints of the plant cell wall response to foliar fertilization.

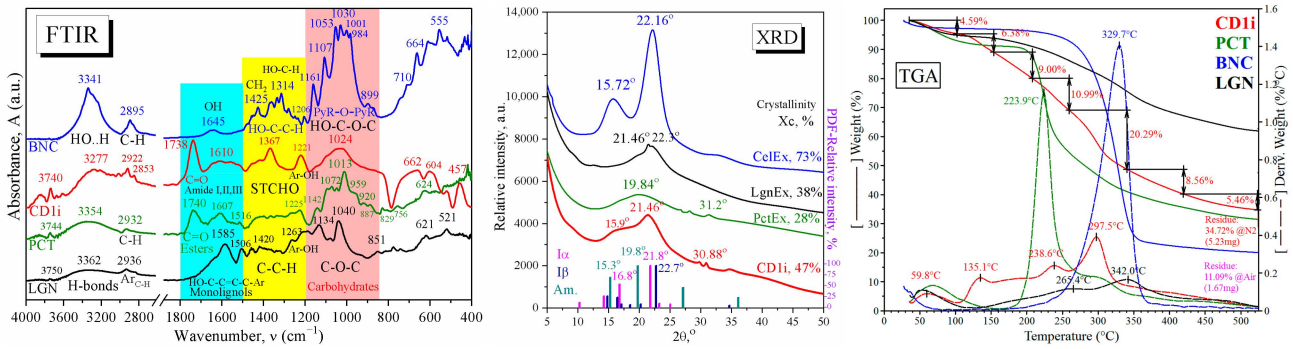
2. Materials and Methods

Infrared spectroscopy (FTIR), X-ray diffraction (XRD), thermogravimetry (TGA) and fiber content were used to compare the inner and outer leaves of the Se-biostimulant-treated cabbage cultivars, working with previously detailed methods [2].

3. Results and Discussions

FTIR analyses presented in Figure 1a evidenced the particular absorption bands of cellulose Iα, pectin and lignin thatwerefurther found to be convoluted in the cabbage spectrum. The free -OH bands around 3740 cm^{-1} were reduced in the cultivars treated with Se-BNF, while the bound -OH band around 3300 cm^{-1} increased, suggesting a tighter-packed, or biofortified, molecular structure via the chelation of Se, minerals, glycine-betaine and other biocompounds. Secondly, the intense C-H bands around 2918 and 2852 cm^{-1} for Se-BNF−treated cultivars may indicate the development of aliphatic (seleno)glucosinolates and lipids. A third FTIR fingerprint is linked to the pectin bands around 1738 cm^{-1}

and 1612 cm^{-1}, specific for esterified respectively unesterified carboxyl groups, the ratio inversion after Se-BNF treatments suggesting a stabilization of pectins in an unesterified form. The fourth FTIR fingerprint is the absorption region of carbohydrates around 1030 ± 100 cm^{-1}, which suggests the development of polysaccharides, especially cellulose Iα, as confirmed viaXRD in Figure 1b.



(**a**) (**b**) (**c**)

Figure 1. Analytic fingerprints: (**a**) FTIR spectra of cellulose Iα-rich bacterial nanocellulose (BNC), cabbage treated with dose D1i (CD1i), commercial pectin (PCT) and lignin (LGN); (**b**) XRD analyses of CD1i, extracted pectin (PctEx), cellulose (CelEx) and lignin (LgnEx); (**c**) TGA and DTG analyses of CD1i, PCT, BNC and LGN.

The TGA and derivative DTG curves presented in Figure 1c suggest splittingwithin the temperature range of 25–525 °C into seven specific thermo-regions with two additional regions for N_2 and air residues. The corresponding weight losses evidenced that the foliar Sebiostimulant induced an accelerated biomass accumulation in the pectin and cellulose thermo-regions, together with an increased mineral content in the ash.

4. Conclusions

The applied analytical methods evidenced the cellulose Iα-pectin structure of cabbage, together with lignin as a molecular and structural binder. FTIR evidenced more hydrogen bridges than free OH and a low esterification of pectins induced by the Sebiostimulant. All techniques suggested the accumulation of carbohydrates incell walls upon Se-BNF treatment.

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