Valorization of collagen and keratin by-products from leather industry to increase the quality of production from orchard

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Introduction

The natural leather processing industry, through the specificity of the processes, is an important source of protein by-products, collagen and keratin, which can be exploited for agricultural use due to the high nitrogen content and the wide spectrum of amino acids with potential of protection against abiotic stress and stimulation of plant growth .

Figure: 1 Protein by-products from leather processing industry

In the present research gelatin, collagen hydrolysates and keratin hydrolysate were extracted for protein combinations dedicated to association with plant extracts with fungicidal effects, in order to develop and validate a multifunctional bio-pesticide for orchard protection and to increase production.

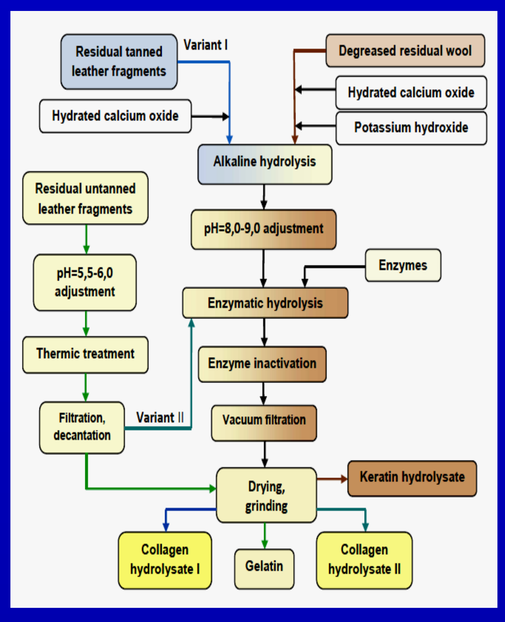
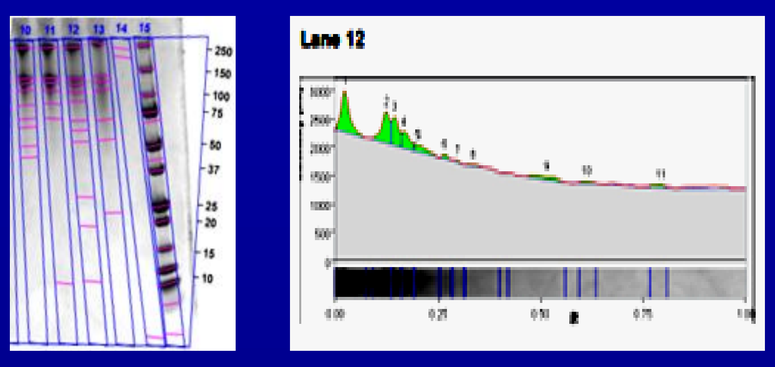


Figure 2: Protein extraction processes

Gelatin and hydrolysates were prepared by thermal, alkaline and enzymatic hydrolysis. The protein extracts were analyzed physico-chemically to evaluate the most significant characteristics, for applications in the agricultural field. The combined protein extracts, as part of a biopesticide prototype, in two experimental variants were tested in the orchard on fruit of the cherry species, compared to an untreated control and a standard treatment.

Results & Discussion

The average molecular mass of gelatin was determined by SDS Page electrophoresis with processing of the migration gel on the viewing camera. Figure 3 shows the migration gel, with the gelatin sample on line 12, the buffer on line 14 and the marker on line 15, detected automatically, as well as the details recorded by the viewing camera for the gelatin sample on line 12.



(a) (b)

Figure 3: SDS Page electrophoresis of gelatin: (a) the gel after decolorization, (b) the molecular mass profile of the peptides, shown by the viewing camera

The recorded data lead to an average molecular weight of gelatin of 127 kDa was obtained, in accordance with the amino nitrogen content (< 0.2% of total nitrogen).

The amino acid profile and content in protein extracts determined by HPLC is shown in the Figure 4.

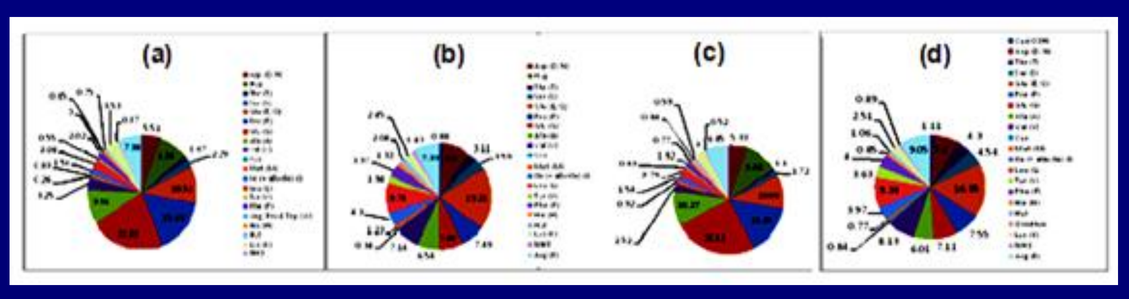


Figure 4: Amino acid profile in protein extracts: (a) gelatin, (b) collagen hydrolysate extracted from tanned leather, (c) collagen hydrolysate extracted from untanned leather, (d) keratin hydrolysate

A very wide profile of amino acids, including essential ones, capable of penetrating cell membranes is observed.

Two combinations of protein extracts, made for the biopesticide prototype, were analyzed by DLS confirming the content of nanometric particles, associated with the presence of amino acids and oligopeptides recognized for the effects of biostimulation, nutrition and systemic protection of plants.

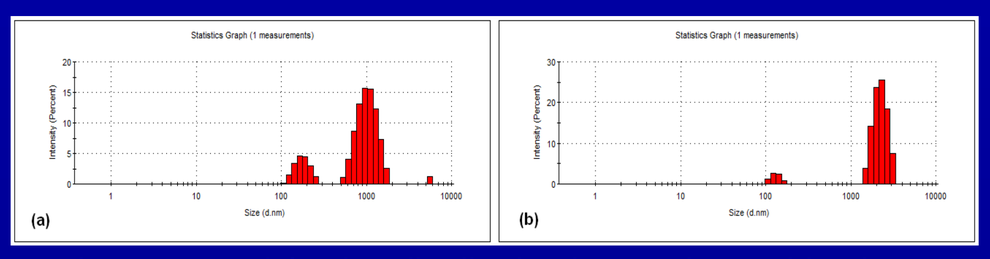


Figure 5: Particle size distribution in protein combinations:
(a) gelatin and collagen hydrolysate;
(b) gelatin, collagen hydrolysate and keratin hydrolysate

The reflected light intensity measurements indicate the existence of both small and medium particle populations (100-1000 nm), as well as particle populations larger than 1000 nm. In the protein combination (a) we find a population of 14% particles of 100-200 nm, a population of 85% particles of 500-1500 nm and 1% particles of 5560 nm, which differentiates it from protein combination (b) which we find a population of 7% particles of 100-200 nm and a population of 93% particles of 1500-3000 nm.

In figure 6, the fruit production of the cherry species, the Skeena variety, is presented for the tested treatment variants:

1. the untreated control;
2. treatment with the biopesticide prototype containing gelatin and collagen hydrolysate extracted from untanned leather;
3. treatment with the biopesticide prototype containing gelatin extracted from untanned leather, collagen hydrolysate extracted from tanned leather and keratin hydrolysate;
4. treatment with a standard product (Serenade® ASO).

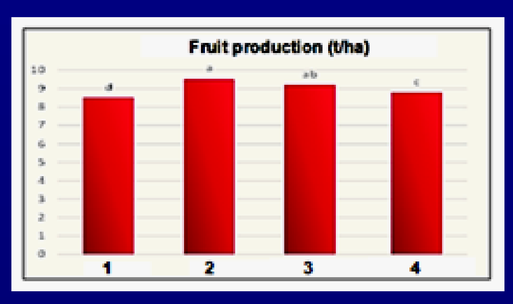


Figure 6: The influence of treatments with biopesticide variants containing protein combinations, on fruit production

The treatments containing protein combinations was shown to increase fruit production compared to both the standard treatment and the untreated control.

Conclusions

- The composites based on protein hydrolysates and gelatins have amino acids and polypeptides suitable for the immediate and delayed release of organic nitrogen necessary for plant stimulation and nutrition.
- The use of collagen and keratin from the by-products of the leather industry for agricultural applications is a viable alternative to synthetic products.

Acknowledgement: The present work was supported by the Romanian Ministry of Research, Innovation and Digitalization, UEFISCDI, project PN-III-P3-3.5-EUK-2019-0250, BIO_PLANT-Protect, Contract no. 262/2021.