THE AGROCHEMICAL EFFECT OF A PROTEIN HYDROLYZATED BIOSTIMULANT APPLIED IN VEGETABLE CROPS

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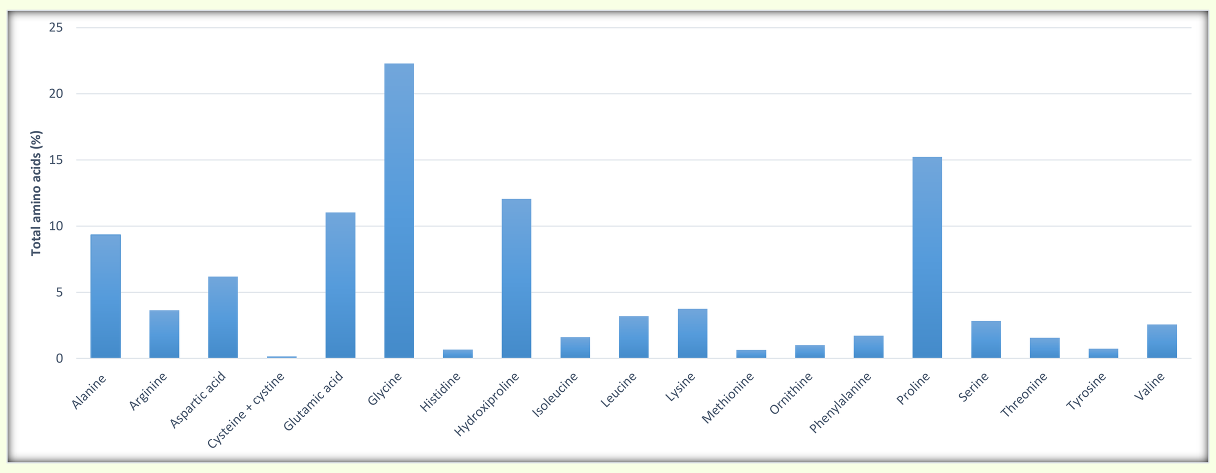
In alignment with the European Green Deal, which aspires to achieve climate neutrality and a sustainable framework by 2050, the imperative to establish a resilient and sustainable agricultural system is increasingly apparent. Such an initiative is vital for addressing critical challenges that impact economically viable agricultural production while adhering to ecological and sustainable principles.

According to European legislation, a "plant biostimulant" refers to a product that stimulates plant nutrition processes independently of the product's nutrient content, with the sole purpose of improving one or more of the following characteristics of the plant or its rhizosphere: (a) nutrient use efficiency; (b) tolerance to abiotic stress; (c) quality traits; (d) availability of limited nutrients in the soil or rhizosphere (Regulation (EU) 2019/1009).
Plant biostimulants are increasingly recognized as a sustainable and promising innovation in agriculture, applicable across various sectors such as horticulture, arboriculture, viticulture, cereal, and industrial crop production. These products offer substantial potential to enhance plant resilience against a range of abiotic stresses, including drought, salinity, and temperature extremes. Moreover, biostimulants contribute to improved nutrient use efficiency, allowing plants to optimize the uptake and utilization of available resources. By enhancing these physiological responses, plant biostimulants support the development of more resilient and resource-efficient agricultural ecosystems, thereby contributing to sustainable agricultural practices and long-term food security.

Protein hydrolysates (PHs), defined as "mixtures of polypeptides, oligopeptides, and amino acids obtained through the partial hydrolysis of proteins," are particularly valuable not only for their effectiveness as biostimulants but also due to their sustainable production from organic waste, fitting seamlessly into the concept of an eco-friendly circular economy

MATERIALS AND METHODS

A variant of a biostimulant fertilizing product with soy protein hydrolysate (HPF) was obtained, characterized physico-chemically, and tested agrochemically. The soy protein hydrolysate was obtained through enzymatic hydrolysis. The experimental variant of the biostimulant fertilizing product with soy protein hydrolysate (HPF) contains: total nitrogen 1.92-2.31%, potassium 0.76-0.92%, phosphorus 0.10-0.26%, organic matter 16.38-18.64% from the soy protein hydrolysate, iron (Fe) 0.03 – 0.05%, copper (Cu) 0.02 – 0.03%, zinc (Zn) 0.13 – 0.22%, manganese (Mn) 0.01 – 0.02%, boron (B) 0.04 – 0.09%, sulfur (S) 0.43 – 0.58%, molybdenum 0.004 – 0.01%, total amino acids 11.32 – 12.96%, free amino acids 2.97 – 3.41%, 0.5% solution pH 5.82 – 6.14, 0.5% solution conductivity 688 – 744 mS/cm. The raw materials used to produce these fertilizing products are permitted for use in organic farming in accordance with Regulation (EU) 848/. These products also comply with the requirements for fertilizing products set out in Regulation (EU) 2019/1009.



Figures 1 shows the profile for total amino acids from the protein hydrolysate obtained through enzymatic hydrolysis of plant biomass (soy). The amino acids were determined using the High Performance Liquid Chromatography (HPLC) method.

Table 1. The influence of foliar fertilization with the HPF biostimulant on yield

No. Crt.	Vegetable culture	Production, Control (kg/ha)	Production, HPF (kg/ha)	Production increase (kg/ha)	Yield increases (%)
1	Tomatoes (*Precos*)	36369	49549	13180	136,2***
2	Bell peppers (*Bianca*)	22313	29957	7644	133,7***
3	Eggplants (*Belona*)	28511	36531	8020	128.1***
4	Cucumbers (*Cornistar*)	33127	46914	13787	141,6***

*Note: *** - indicates statistical significance at 0,1%; strong significance as compared to the control.*

Table 2. The influence of foliar fertilization with the HPF biostimulant on mineral nutrition

No. Crt.	Vegetable culture	Nutrient	Control	HPF	Increase (%)
1	Tomatoes (*Precos*)	Nitrogen (Nt %)	0,4736	0,6759	142,71***
		Phosphorus (P_2O_5 %)	0,2871	0,4033	140,48***
		Potasium (K_2O %)	0,2715	0,3906	143,88***
2	Bell peppers (*Bianca*)	Nitrogen (Nt %)	0,4827	0,6726	139,35***
		Phosphorus (P_2O_5 %)	0,2714	0,3754	138,32***
		Potasium (K_2O %)	0,3351	0,4701	140,29***
3	Eggplants (*Belona*)	Nitrogen (Nt %)	0,5842	0,7992	136,81***
		Phosphorus (P_2O_5 %)	0,3751	0,5092	135,76***
		Potasium (K_2O %)	0,4567	0,6273	137,36***
4	Cucumbers (*Cornistar*)	Nitrogen (Nt %)	0,4555	0,6830	149,96***
		Phosphorus (P_2O_5 %)	0,3016	0,4458	147,83***
		Potasium (K_2O %)	0,3356	0,4925	146,77***

*Note: *** - indicates statistical significance at 0,1%; strong significance as compared to the control.*

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RESULTS AND DISCUSSIONS

The agrochemical efficiency of the biostimulant fertilizing product was determined by applying it (0.5% solution) to four intensively cultivated vegetable crops in Romania, namely tomatoes (*Solanum lycopersicum*), eggplants (*Solanum melongena*), bell peppers (*Capsicum annuum*), and cucumbers (*Cucumis sativus*). The experiment was organized in a protected space and under drip irrigation conditions. The experiment consisted of three foliar treatments with a fine mist application over the entire leaf surface, as follows: the first treatment was applied after the flowering phase, while the second and third treatments were applied at 10-day intervals.
The agrochemical trials assessed the evolution of production yields, macronutrient content (N, P, K) in the leaves after fertilization, and photosynthetic assimilation processes.
Foliar fertilization with the HPF biostimulat during the periods of maximum nutrient demand for vegetables cultivated in protected spaces and under drip irrigation conditions had a significant influence not only on the photosynthetic activity and mineral nutrition of the plants but also on productivity indicators (table 1, 2).

It has been observed that organic components, particularly protein hydrolysates, play a crucial role as plant biostimulants by activating physiological and molecular processes that stimulate growth and boost productivity. These components work by enhancing nutrient uptake, improving water-use efficiency, and promoting hormonal balance within the plant. As a result, they increase resilience to environmental stresses such as drought and salinity, ultimately leading to healthier plants with higher yield and quality

CONCLUSIONS

Foliar fertilization with the HPF biostimulant had a significant impact on production increases for all tested crops. The highest production gains were observed in cucumbers, followed by tomatoes, bell peppers, and eggplants. Foliar application of the biostimulant product containing soy protein hydrolysate led to production increases ranging from 28.1% (in eggplants, Belona variety) to 41.6% (in cucumbers, Cornistar variety) compared to the control.
The three foliar treatments applied resulted in statistically significant increases in carotenoid content, chlorophyll pigments, and total assimilatory pigment content, with values ranging between 33.6% and 50.6%.
Moreover, by stimulating the biosynthesis of assimilatory pigments, it shortens the duration of the organogenesis stages. The content of essential nutrients (N, P, K) in plant leaves showed a significant increase.
Biofertilizers are a modern and indispensable component of environmentally friendly agricultural technologies, thus contributing to ensuring food safety and security. These products play an essential role in the development of a sustainable agricultural system, capable of addressing current challenges such as climate change and increasing food demand.

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