COSA SONO GLI IDROLIZZATI PROTEICI E QUALI EFFETTI INDUCONO SULLE PIANTE

Andrea Ertani, Michela Schiavon, Ornella Francioso, Serenella Nardi

Risposte comuni indotte dai biostimolanti nelle piante → i meccanismi di induzione possono essere diversi e dipendono dalle caratteristiche chimiche e fisiche e dall'attività biologica delle singole formulazioni

Contents lists available at ScienceDirect

Plant Science

journal homepage: www.elsevier.com/locate/plantsci

Review article

An overview of plant-based natural biostimulants for sustainable horticulture with a particular focus on moringa leaf extracts

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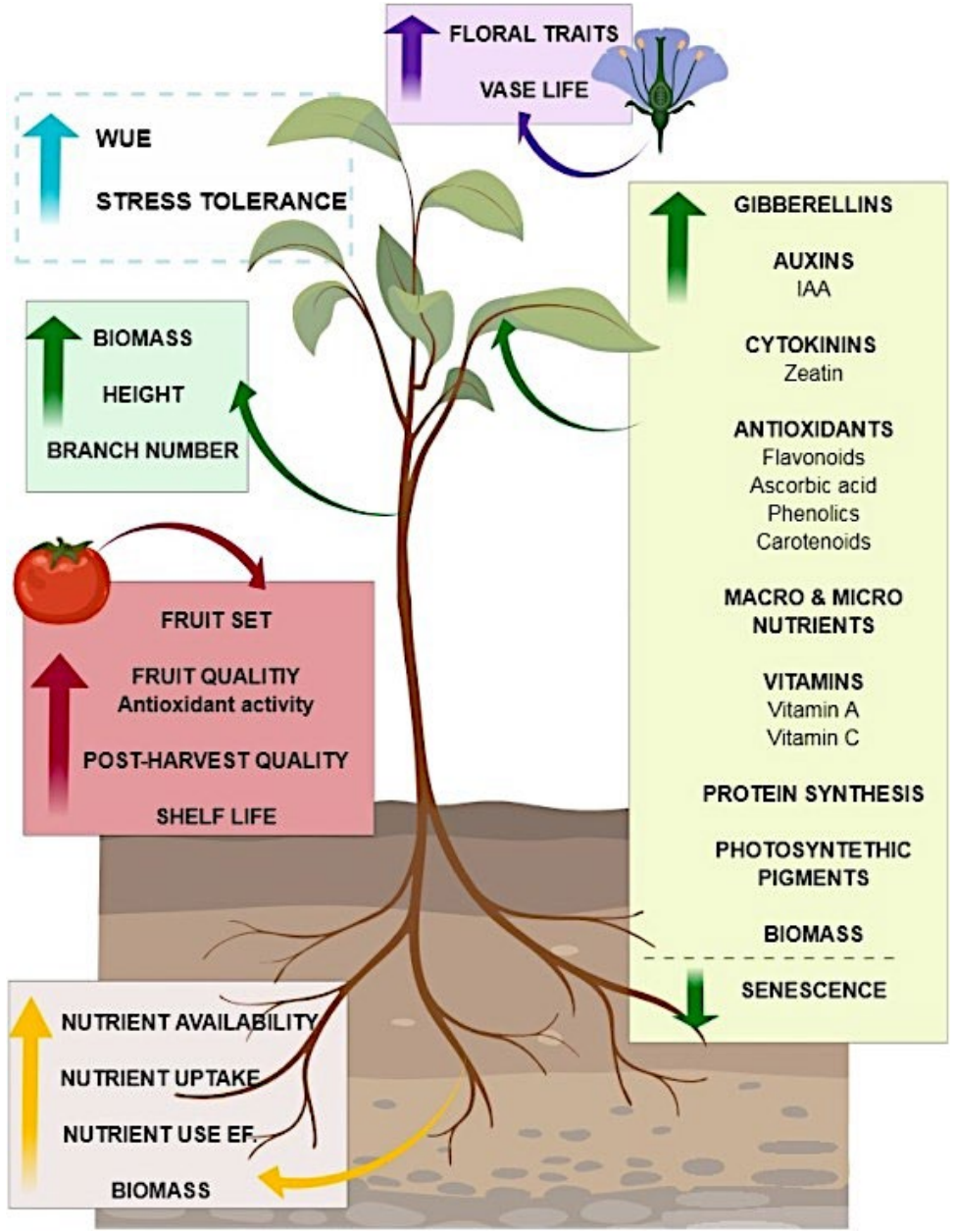
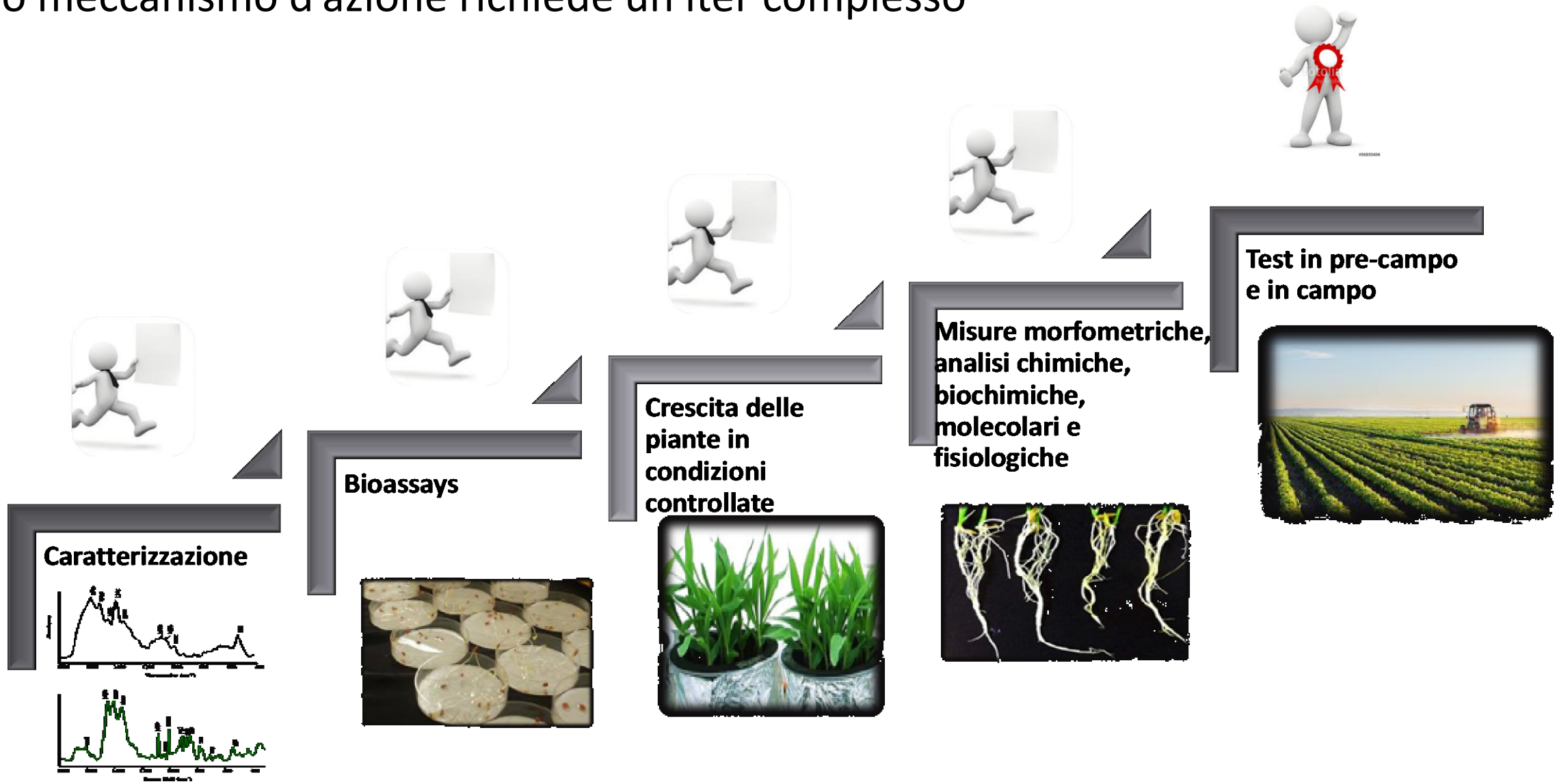


La conferma dell’efficacia di un prodotto biostimolante e la comprensione del suo meccanismo d’azione richiede un iter complesso



Idrolizzati proteici (PH)

- ✓ Prodotti di origine diversa
- ✓ **Generati attraverso idrolisi termica, chimica o enzimatica**

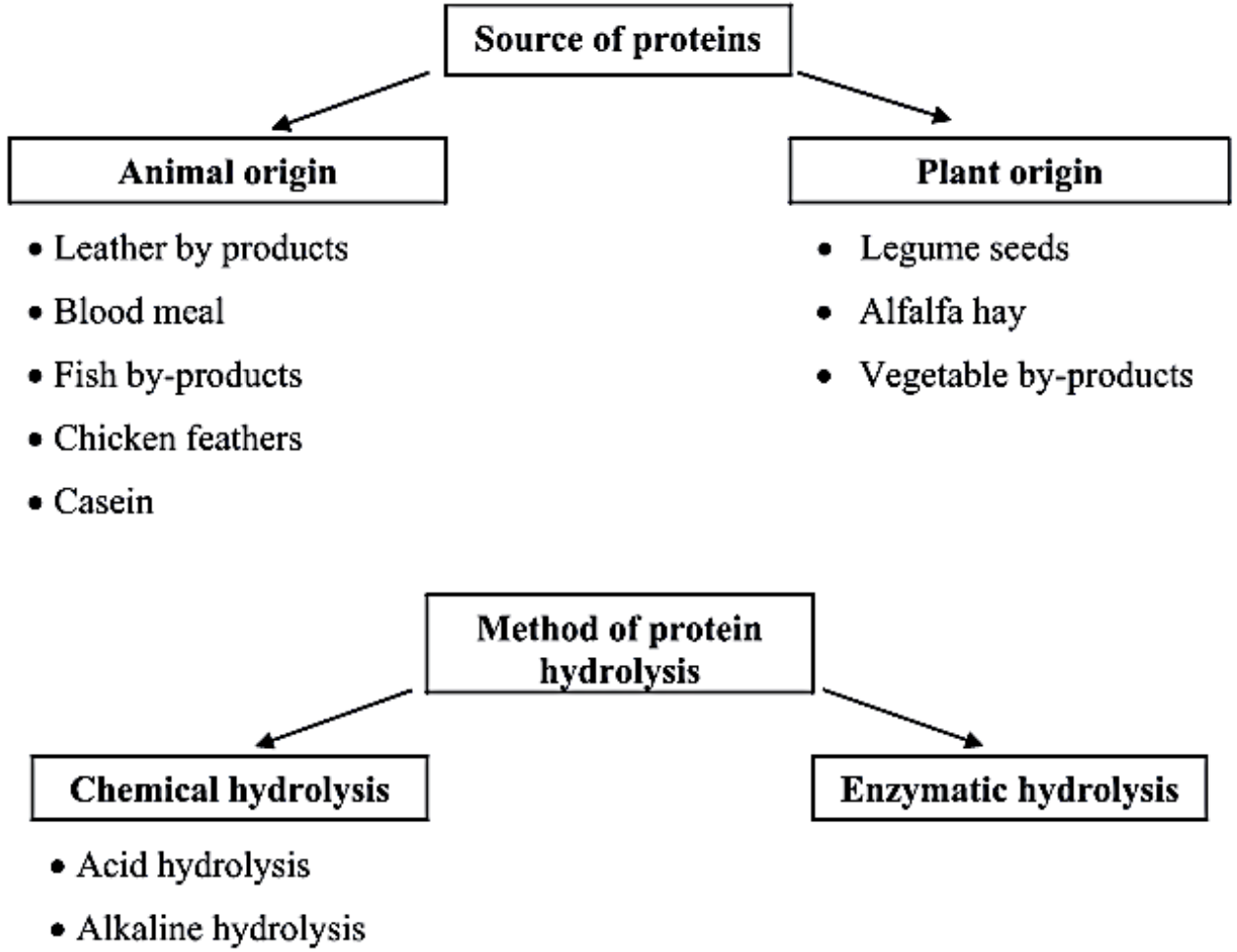


Fig. 1. Classification criteria of protein hydrolysates on the basis of protein source and the method of protein hydrolysis used in the production process.

L’idrolisi è l’azione di scissione dei legami di un composto organico o inorganico in ambiente acquoso, con produzione di composti semplici.

Journal of Plant Nutrition and Soil Science

Regular Article | Full Access

Biostimulant activity of two protein hydrolyzates in the growth and nitrogen metabolism of maize seedlings

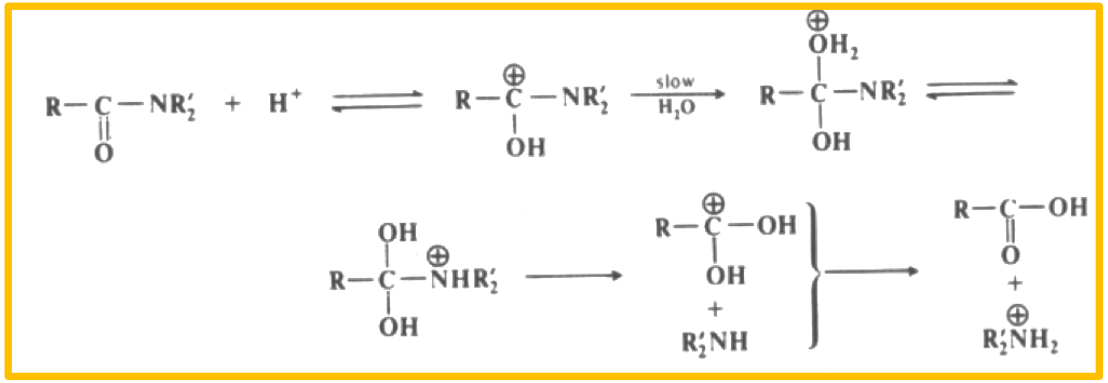
Andrea Ertani, Luciano Cavani, Diego Pizzeghello, Elena Brandellero, Adriano Altissimo, Claudio Ciavatta, Serenella Nardi

First published: 02 April 2009 | https://doi.org/10.1002/jpln.200800174 | Citations: 176

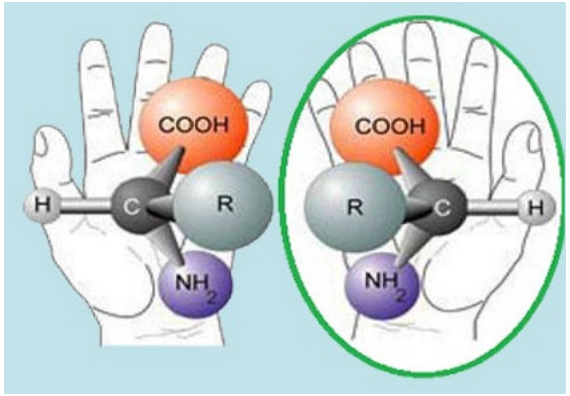
L’idrolisi può avvenire utilizzando:

- Acqua;
- Temperatura;
- Sostanze chimiche (idrolisi chimica);
- Enzimi (idrolisi enzimatica).

Idrolisi chimica: è un processo di idrolisi tramite **acido** solforico, idrossido di sodio, ecc. e quindi a **pH acido o basico** ed in genere, ad **alta temperatura** (> 100 °C). È un processo aggressivo che punta ad ottenere un prodotto con una maggior quantità di **amminoacidi totali**, ma che porta con sé molti svantaggi, tra i quali amminoacidi non assimilabili in forma **destrogira**, alta salinità ecc...



In natura, ed anche con l'idrolisi enzimatica, gli amminoacidi si trovano sotto forma levogira.

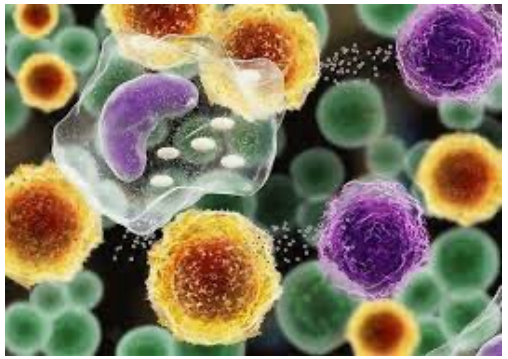


(la luce polarizzata avrà un orientamento a sinistra, mentre gli amminoacidi destrogiri si formano a causa dell'aggressività del processo di idrolisi chimica che modifica la forma naturale dell'amminoacido, per il quale, visto al microscopio, la luce polarizzata avrà un orientamento a destra).

Gli amminoacidi in forma **destrogira non vengono mai assimilati** dalla pianta. Inoltre, le alte temperature determinano una denaturazione delle molecole organiche presenti nella matrice madre (vitamine, flavonidi, ecc).

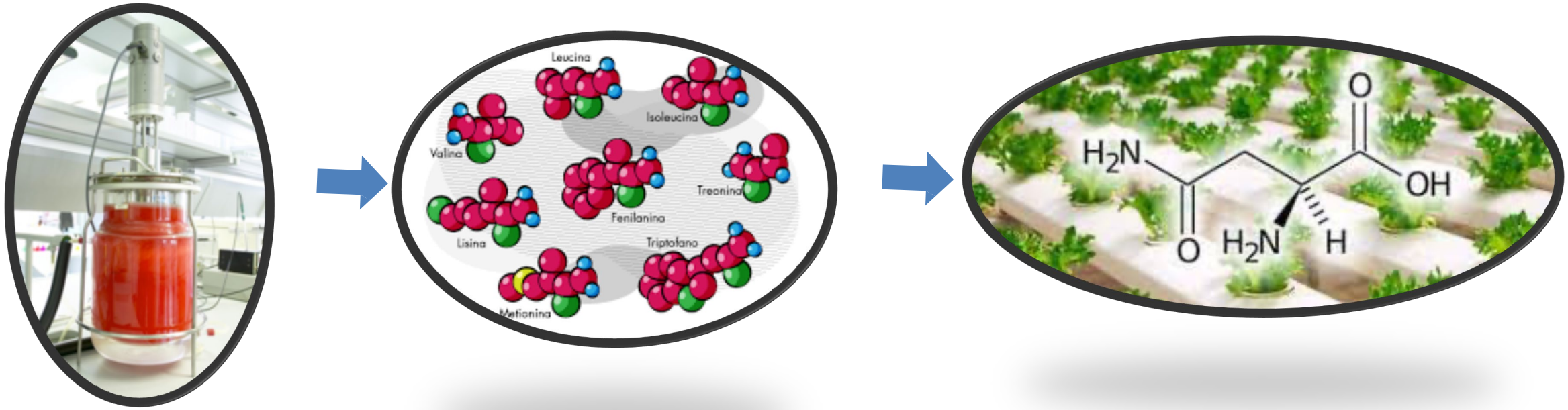
Idrolisi enzimatica: è un processo di idrolisi delle proteine animali o vegetali che avviene ad opera di **enzimi specifici** e selettivi in grado di scindere la catena di amminoacidi in punti specifici. Tale processo avviene all'interno di bioreattori controllati, a **bassa temperatura** (40-50 °C) e **pH vicino alla neutralità**. Condizioni ottimali che consentono agli enzimi di idrolizzare il substrato proteico e di conservare gli amminoacidi nella loro forma **naturale (levogira).**

Il prodotto finale di questo processo è caratterizzato da una buona stabilità, da una bassa salinità e da una buona miscibilità con tutti i prodotti presenti in commercio.



Un parametro per valutare la qualità di un idrolizzato proteico è il **grado di racemizzazione**, che tiene conto della **quantità e della disponibilità degli amminoacidi**.

La **racemizzazione** è un fenomeno naturale che determina una mutazione degli amminoacidi **da una forma levogira ad una forma destrogira**.



- Aumentano la crescita della pianta e la produzione di clorofilla
- Stimolano l'assimilazione dell'N (a livello di espressione genica ed attività enzimatica
- Promuovono la sintesi si composti antiossidanti (es. composti fenolici) e l'accumulo di zuccheri riducenti

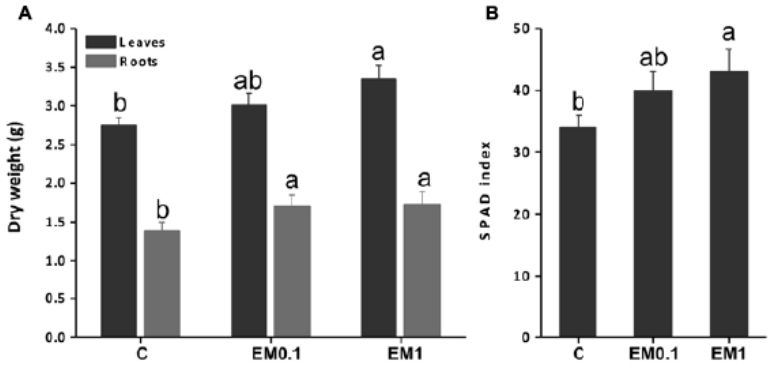
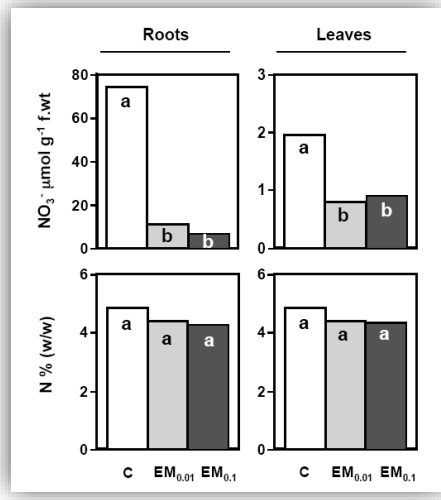
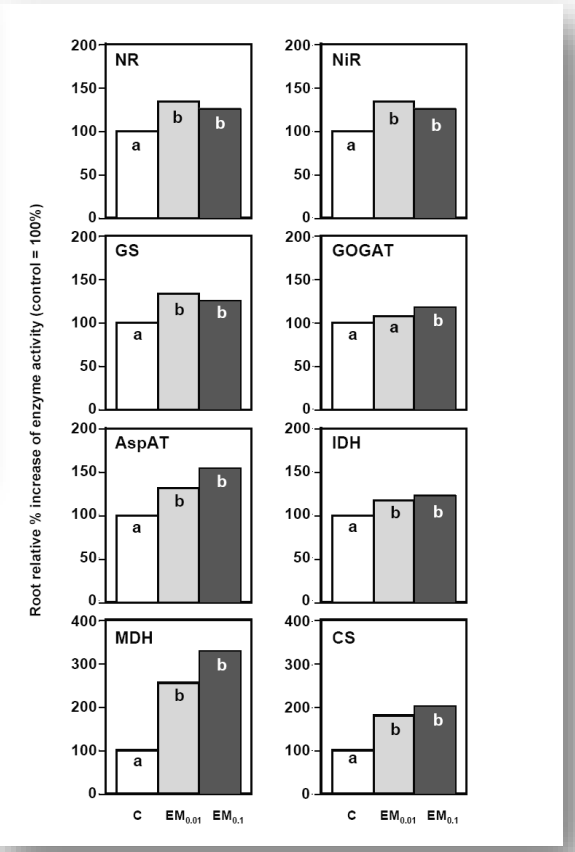
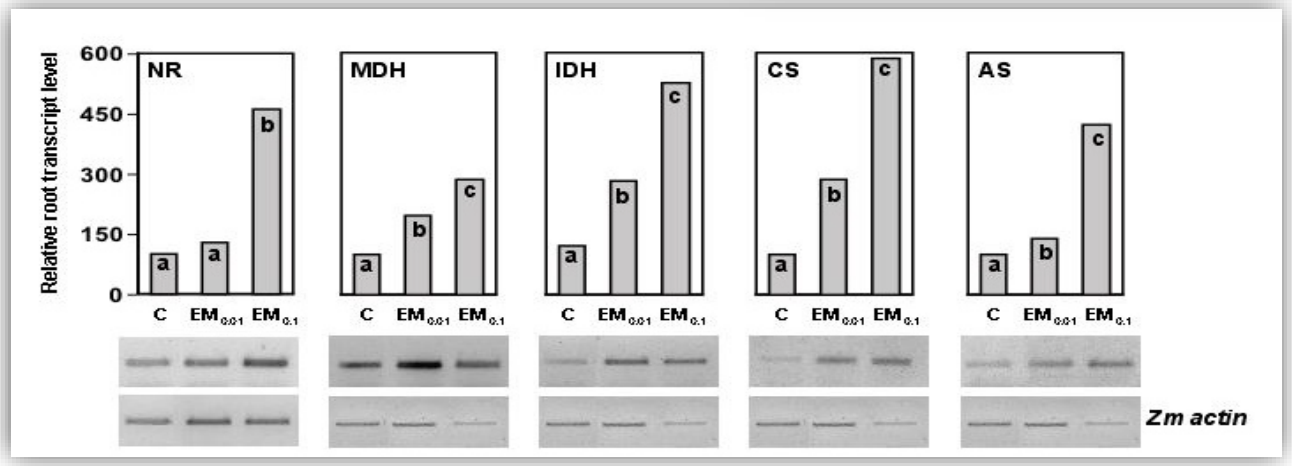


TABLE 3 | Content of soluble sugars (glucose and fructose) and total phenols (TP), and total antioxidant capacity (TAC).

	Glucose	Fructose	TP	TAC
	mg g^{-1} FW		mg GA eq kg^{-1} FW	mg Fe^2 kg^{-1} FW
Leaves				
Control	1.96 ± 0.18b	2.45 ± 0.32c	0.36 ± 0.02b	4.63 ± 0.22b
EM 0.1	2.09 ± 0.33b	1.76 ± 0.47b	0.43 ± 0.03a	6.40 ± 0.31a
EM 1	5.61 ± 0.29a	6.41 ± 0.58a	0.41 ± 0.02a	5.15 ± 0.19a
Roots				
Control	0.51 ± 0.12	0.32 ± 0.10	0.18 ± 0.02a	1.35 ± 0.12a
EM 0.1	1.22 ± 0.21	1.24 ± 0.15	0.23 ± 0.03a	2.13 ± 0.14b
EM 1	1.11 ± 0.19	0.88 ± 0.17	0.19 ± 0.03a	1.82 ± 0.30b







Target principali

- ✓ Meccanismi di difesa delle piante contro stress biotici e abiotici (es. stress salino in mais)
- ✓ Trasportatori di nutrienti, aminoacidi e peptidi
- ✓ Metabolismo dell'N e del C (respirazione cellulare e fotosintesi)
- ✓ Metabolismo degli zuccheri e dei lipidi
- ✓ Stimolazione della crescita attraverso una regolazione di geni coinvolti nel trasporto e nelle vie di segnalazione dell'auxina

Effetti degli idrolizzati proteici evidenziati in diverse specie vegetali

Table 2
Effects of protein hydrolysates (PHs) on horticultural crops.

Crop	Type of PH	PH application mode	Experimental conditions	Effects	References
Banana	Chicken feather derived PH	Root and foliar	Field trial	Early flowering; increased nutrient, chlorophyll content, and proline in leaves; reduced sugars, proteins, amino acids, phenolics and flavonoids in fruits	Gurav and Jadhav (2013)
Corn	PHs from meat flour or alfalfa	Root	Hydroponic system under growth chamber	Increased root and leaf growth, and nitrate reductase and glutamine synthetase activities	Ertani et al. (2009)
Corn	Alfalfa derived PH	Root	Hydroponic system under growth chamber	Increased crop salinity tolerance, nitrogen assimilation and activity of antioxidant systems	Ertani et al. (2013)
Grapevine	PH of distiller's dried grains and carob germ flour	Root	Field trial	Increased total phenolics, and anthocyanin content in grape juice	Parrado et al. (2007)
Grapevine	PHs from soybean or casein	Foliar	Field trial	Up-regulated defense genes encoding pathogenesis-related proteins and the stilbene synthase enzyme; increased resistance to *Plasmopara viticola*	Lachhab et al. (2014)
Grapevine	Plant derived PH	Foliar	Field trial	Increased tolerance to drought, soluble solids, total phenols and anthocyanins in fruits	Boselli et al. (2015)
Kiwifruit	Animal derived PHs with different molecular weights	Foliar	Pot trial	Shoot and root biomass were increased by PH fractions with the lowest molecular weight especially at low rates	Quartieri et al. (2002)
Lettuce	Plant derived PH (Trainer)	Root and foliar	Pot culture under greenhouse using saline and non-saline solution	Increased crop tolerance to salinity, chlorophyll fluorescence, nitrogen and phosphorus content of leaves	Lucini et al. (2015)
Lettuce	Plant derived PH (Trainer)	Root	Hydroponic system with two concentration of nutrient solution	Increased yield, SPAD index, and nitrogen content of leaves	Colla et al. (2013)
Lettuce	Plant derived PH (Aminol 16)	Root and foliar	Greenhouse crop during winter season; foliar and soil application of PH	Increased crop uniformity, and antioxidant activity; reduced nitrates in leaves	Tsouvaltzis et al. (2014)
Lettuce	Animal derived PH (Terra-Sorb Foliar)	Foliar	Pot culture in growth chamber under cold stress conditions	Increased plant fresh weight and stomatal conductance	Botta (2013)
Lily	Animal derived PH and alfalfa derived PH	Foliar	Pot culture under greenhouse conditions	Reduced the length of crop cycle; increased leaf area, diameter of flower buds, and stem and bulb dry weight	De Lucia and Vecchietti (2012)
Olive	Animal derived-PH (Siapton)	Foliar	In vivo and in vitro trials	Increased pollen tube elongation	Viti et al. (1990)
Papaya	Animal derived-PH (Siapton)	Foliar	Field trial	Increased yield	Morales-Pajan and Stall (2003)
Passionfruit	Animal derived PH	Foliar	Nursery	Increased seedling growth	Morales-Pajan and Stall (2004)
Pepper	Alfalfa derived PH	Foliar	Pot culture under greenhouse conditions	Increased fresh weight and number of fruits, and secondary metabolites in fruits	Ertani et al. (2014)
Pepper	Animal derived PH plus micronutrients (Fosfonutren)	Foliar	Pot culture under greenhouse conditions during fall-winter season	Decreased growth, yield and efficiency and utilization of nitrates	Ruiz et al. (2000)
Persimmon	Animal derived PH containing Ca (Stressal)	Root	Field trial under saline conditions	Decreased Cl uptake, leaf necrosis, and leaf water potential	Visconti et al. (2015)
Spinach	Animal derived PH (Siapton)	Foliar	Field trials in spring and autumn seasons using two cultivars	No effect on yield; positive or no effect on dry matter and nitrate content of leaves	Kunicki et al. (2010)
Strawberry	Animal derived PH (Aminoflor)	Foliar	Bag culture under greenhouse conditions	Decreased weight of daughter plants	Lisiecka et al. (2011)
Tomato	Carob germ derived PH	Root	Pot culture under greenhouse condition	Increased plant height, number of flowers, and number of fruits	Parrado et al. (2008)
Tomato	Animal and plant derived PHs	Root and foliar	Hydroponic system with plants grown in Fe-sufficient nutrient solution or in lime-induced Fe deficiency	Growth depression with animal derived PH while plant derived PH enhanced root Fe(III)-chelate reductase activity, chlorophyll concentration, and leaf Fe concentration under lime conditions	Cerdán et al. (2013)
Tomato	Plant derived PH (Trainer)	Root	Soilless culture in growth chamber	Increased rooting and shoot growth	Colla et al. (2014)