PROTEIN HYDROLYSATES AND AMINO-ACIDS FERTILIZERS - PHYSICOCHEMICAL CHARACTERISTICS

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Abstract

The necessities of a sustainable agriculture require the use of fertilizing solutions and methods capable to respond to the needs of agricultural crops and to the requirements of the environment protection. In this regard, extra-radicular fertilizers and liquid fertilizers with application or incorporation into the soil respond to these priorities. In the past 20 years, the range of fertilizers has greatly diversified, currently being developed the compositions containing minerals together with natural or synthetic organic substances, with application to a wide range of crops. Organic substances added are intended to stimulate the activity of photosynthesis, absorption of nutrients, to provide a balanced nutrition, to combat nutritional deficiencies and reduce the effects of different stressors. The most frequently used organic substances are protein hydrolysates of plant or animal origin, and various amino-acids. Complex matrices resulted by including into NPK structures organic substances led to the development of new types of bio-fertilizers whose agrochemical effects were tested with positive effects on the nutrition of different crops in the conditions present in Romania. Through a careful selection of raw materials and technological processes, certain formulas of bio-fertilizers can be used in organic farming, where the imposed requirements are defined by European regulations and verified by certification bodies. In my own researches the concerns are directed towards producing these fertilizers and their testing in the vegetation/green house and in field. This paper shows the physical and chemical characteristics for some of the complex matrices with organic substances used in agriculture.

Key words: fertilizer, protein hydrolysate, ferric chlorosis

The analysis of the data existing in the specialized literature regarding the conventional fertilizers of extra-radicular type or those with substances having a stimulating effect of growth indicates the fact that the exclusive use of certain substances in the category of bio-stimulators for the treatment of agricultural crops often does not lease to obtaining significant effects (Cioroianu T.M. et al, 2011; Cioroianu T.M. et al, 2009; Cioroianu T.M. et al, 2011; Cioroianu T.M. et al, 2011). In such cases the "explosive" vegetative development of the plant is not supported by an additional contribution, fast, of macro and micro-elements necessary for the nutrition (Iovi A. et al, 2000). This phenomenon strongly occurs in case of a poor basic fertilization, on degraded soils, as well as in case of unbalanced macronutrient fertilization.

In practice, it is known a wide range of liquid fertilizers, complex solutions with extra-radicular application, having as nutrients nitrogen, phosphorus, potassium, meso and micro-elements that may also contain synthetic organic substances, humic substances, fulvic substances, plant extracts, peptides or protein hydrolysates of animal origin or glycoproteins of plant origin, naphthenates, introduced in order to stimulate the metabolization of nutrients, or to facilitate the absorption of ionic species or molecules.

It is well known that the use of microelements like iron, copper, zinc, calcium, magnesium and manganese chelated with natural organic substances are more easily absorbed by plants, and their presence may destroy or reduce bacteria, viruses, fungi or other pathogens when applied as fertilizing substances to plants.

In the field of agriculture it is recommended the use of extra-radicular fertilizers not only in treating certain nutrition diseases of plants, but also to prevent them, for increased yields, for increased quality of products and to reduce the negative impact on the environment of conventional fertilizers (Dorneanu A. et al., 2003). Also, the plants treated with fertilizers containing natural organic substances with chelating role are more resistant to frost, drought, to biotic and abiotic

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stress factors (Sîrbu C. et al, 2010; Sîrbu C. et al, 2007; Sîrbu C. et al, 2008; Sîrbu C. et al, 2009; Trandafir V. et al, 2007; Trandafir V. et al, 2003).

MATERIAL AND METHOD

The experiments conducted in the last 5 years by I.N.C.D.P.A.P.M – I.C.P.A. Bucharest (*National Research and Development Institute for Soil Science Agro-Chemistry and Environment)* to obtain fertilizers with organic substance having a stimulating role of growth have used a protein hydrolysate of animal origin, obtained through neutral hydrolysis, having in its composition proteins, protides and amino-acids free in structure: glycine 30 -38%, alanine 10 – 15%, proline 10 – 15%, glutamic acid – 10%, hydroxyproline 7 – 9%, aspartic acid 4 – 6%, arginine 4 – 6%, serine 3 – 5 %, threonine 1 – 3%, and as essential amino-acids in significant proportions: lysine 2 – 4%, valine 2 – 4% leucine 2 – 3%, phenylalanine 1.5 – 2%, isoleucine 1 – 1.5 %, histidine 0.7 – 1.5%, methionine 0.2 – 0.5%.

The fertilizers of extra-radicular type obtained consist in a matrix of NPK type to which micro and meso-elements are added: Fe, Cu, Zn, Mn, Mg, B, Mo, Co and protein hydrolyzate.

The main types of chemical reactions used in the process of obtaining extra-radicular fertilizers were:

- neutralization reaction;
- proton exchange reaction (ionization reaction, neutralization, ion displacement, hydrolysis);
- reactions forming chelates and metal complexes;

The technological process for obtaining fertilizers of extra-radicular type included the following steps:

- obtaining the solution of NPK macro-elements;
- obtaining the solution of chelated/complexed microelements;
- obtaining the solution of protein hydrolyzate;
- mixing, homogenization of the three solutions;

The general scheme of processes used to obtain most of the extra-radicular fertilizers having also in their composition protein hydolysates introduced as substances with a bio-stimulator role is shown in the *figure 1*.

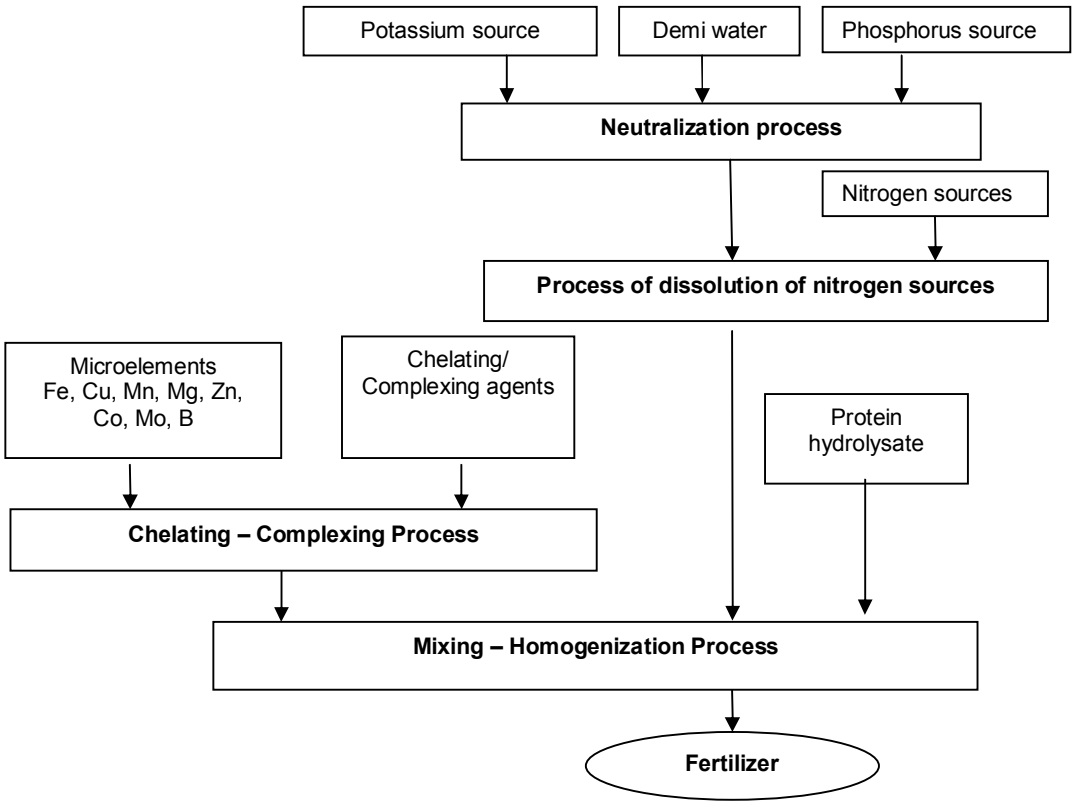

Figure 1 **Scheme of general processes used to obtain extra-radicular fertilizers with protein hydrolysates**

RESULTS AND DISCUSSIONS

Using the scheme of processes shown in the Figure 1, there were realized several versions of extra-radicular fertilizers, with the introduction into a matrix of macro, meso and microelements of the protein hydrolysate of animal origin.

The experimental fertilizers were characterized physically and chemically in the Laboratory for Testing and Control of Fertilizers Quality, accredited by the Romanian Accreditation Association (RENAR), belonging to ICPA

Bucharest and agro-chemically tested in the National Network for the authorization of fertilizers to be used in agriculture.

The chemical composition of the fertilizers of foliar type experimentally obtained and agro-chemically tested in order to be authorized is presented in the *tables 1, 4* and *8 (Regulation (EC) N°. 2003/2003 the European Parliament and of the Council of 13 October 2003 on fertilizers, Regulation (EC) N°. 834/2007 of the Council of 28 June 2007 on organic production and labeling of organic products, and for repealing the Regulation (EEC) N°. 2092/91)*

The results of the agro-chemical tests for the experimental fertilizers are shown in the *tables 2, 3, 5 – 7*.

Table 1

Chemical composition of fertilizers AMINO-FERT N, NK and NPK

Chemical composition	AMINO-FERT NK	AMINO-FERT N	AMINO-FERT NPK
	(g/l)	(g/l)	(g/l)
total nitrogen (N)	17,0	18,0	125,0
Phosphorus (P_2O_5)	0,01	0,01	70,0
Potassium (K_2O)	8,5	0,01	60,0
Copper (Cu)	1,0	1,0	0,22
Zinc (Zn)	1,0	1,0	0,18
Iron (Fe)	3,0	2,75	0,45
Manganese (Mn)	0,6	0,55	0,3
Boron (B)	0,5	0,5	0,3
Magnesium (MgO)	3,5	2,5	0,55
Molybdenum (Mo)	-	-	0,01
Cobalt (Co)	-	-	0,01
Sulfur (SO_3)	28,0	19,0	3,5
Organic substances, of which	95,0	97,0	26,0
Protein substances	95,0	97,0	10,0

Table 2

The effectiveness of *AMINOFERT* products, applied to sunflower, cultivated on cambic chernozem
Unit: TELEORMAN Agricultural Research and Development Station
Basic soil fertilization with N-80, P_2O_5, - 80 Kg/ha

Version N°.	Treatment	Number of treatments	Soil concentration %	Quantity of fertilizers used liters/ha		Production of seeds (kg/ha)	Increase		
				For a treatment	For all the treatment		kg/ha	%	kg/liter fertilizer used
1	Non-fertilized	-	-	-	-	2742	-	100,0	-
2	AMINOFERT N	2	0,5	5,0	10,0	3082	340***	112,3	34,0
3	AMINOFERT NK	2	0,5	5,0	10,0	3193	451***	116,4	45,1
4	AMINOFERT NPK	2	0,5	5,0	10,0	3216	474***	117,3	47,4

Table 3

The effectiveness of *AMINO-FERT* products, applied to grape vine, variety Chasselas Doré, cultivated on cambic chernozem. Unit: Institute of Biological Research, Iasi, Experimental Field of the University of Agricultural Sciences and Veterinary Medicine, Iaşi Without basic fertilization in soil

Version N°.	Treatment	Number of treatments	Soil concentration %	Quantity of fertilizers used liters/ha		Production of grapes (kg/ha)	Increase		
				For a treatment	For all the treatment		kg/ha	%	kg/liter fertilizer used
1	Non-fertilized	-	-	-	-	11213	-	100.0	-
2	AMINOFERT N	3	0.5	5.0	15.0	15357	4144***	136.9	276.3
3	AMINOFERT NK	3	0.5	5.0	15.0	15545	4332***	138.6	288.8
4	AMINOFERT NPK	3	0.5	5.0	15.0	15607	4394***	139.2	292.9

Table 4

Chemical composition of the fertilizer AMINO-FERT 1H

N°.	Composition (minimum values)	AMINO-FERT 1H (g/l)
1	Total nitrogen (N), of which:	130
	- Nitric nitrogen	5
	- Ammonium nitrogen	5
	- Amide nitrogen	120
2	Phosphorus (P_2O_5)	50
3	Potassium (K_2O)	45
4	Copper (Cu)	0.07
5	Zinc (Zn)	0.05
6	Iron (Fe)	0.25
7	Manganese (Mn)	0.1
8	Boron (B)	0.1
9	Magnesium (MgO)	0.1
10	Sulfur (SO_3)	0.5
11	Organic substances, of which:	12.0
	- Protein substances, hydrolysate	7.5

Table 5

The effectiveness of the product AMINOFERT 1 H applied to H-Olt corn, cultivated on psamosol (sandy soil) Research and Development Center for Agricultural Plants on Sands – DABULENI, Without basic fertilization

Version N°.	Treatment	Number of treatments	Soil concentration %	Quantity of fertilizers used liters/ha		Production of grains (kg/ha)	Increase		
				For a treatment	For all the treatment		kg/ha	%	kg/liter foliar fertilizer
1	Control	-	-	-	-	1644	-	100.0	-
2	AMINOFERT 1H	2.0	1.0	5.0	10.0	4522	2878***	275.0	287.8

Table 6

The effectiveness of the product AMINOFERT 1 H applied to grape vine, variety Sauvignon, cultivated on faeziom argic. Unit: Institute of Biological Research, Iasi, Experimental Field of the University of Agricultural Sciences and Veterinary Medicine, Iaşi. Basic fertilization with: Nt-100, P_2O_5 – 100, K_2O – 100 kg/ha

Version N°.	Treatment	Number of treatments	Soil concentration %	Quantity of fertilizers used liters/ha		Production of grapes (kg/ha)	Increase		
				For a treatment	For all the treatment		kg/ha	%	kg/liter foliar fertilizer
1	Control	-	-	-	-	5580	-	100.0	-
2	AMINOFERT 1H	3	1.0	10.0	30.0	8030	2450***	144.0	81.7

Table 7

The effectiveness of the product AMINOFERT 1 H applied to sunflower, variety Favorit, cultivated on cambic chernozem. Unit: TELEORMAN Agricultural Research and Development Station Basic fertilization with N-80, P_2O_5, - 80 Kg/ha

Version N°.	Treatment	Number of treatments	Soil concentration %	Quantity of fertilizers used liters/ha		Production of seeds (kg/ha)	Increase		
				For a treatment	For all the treatment		kg/ha	%	kg/liter fertilizer
1	Control	-	-	-	-	2118	-	100.0	-
2	AMINOFERT 1H	2.0	1.0	5.0	10.0	3134	1016***	147.9	101.6

Table 8

Chemical composition of the fertilizer FERT - IRON

Chemical composition	FERT – IRON (g/l)
Nitrogen (Nt)	60
Phosphorus (P_2O_5)	23
Potassium (K_2O)	27
Copper (Cu)	0.1
Zinc (Zn)	0.5
Iron (Fe)	27
Manganese (Mn)	0.1
Magnesium (Mg)	2.5
Boron (B)	0.5
Sulfur (S)	20
Protein hydrolysate	10

Means were compared by using Student test at the level of significance a = 0.05.

According to the data in Tables 2,3,5,6,7, it can be seen that there are significant differences for the two fertilizers compared to control and they are statistically insured.

The performances achieved after the extra-radicular application on the soil Chardonnay grafted on rootstock Berlandiaeri x Riparia SO4-4 (1% solution, three treatments) of the fertilizer FERT - IRON can be summarized as follows:

- it has brought a very significant production increase of 50.7%, compared to the untreated control;
- it has brought an increase in grain dry matter content, statistically highly significant of 9.9% compared to the untreated control;
- it has brought an increase in sugar content from must (of grapes) / unfermented wine, very significant from 254 g/l (untreated control) to 272.0 g/l.
- it has prevented and treated ferric chlorosis of grapevine.

CONCLUSIONS

It has been developed a technology for obtaining extra-radicular fertilizers of the type NPK with macro, meso, micronutrients and protein hydrolysates. There were obtained and characterized physically and chemically five fertilizers with extra-radicular application, agro-chemically tested in the National Network for fertilizers authorization. An increased production obtained by applying extra-radicular fertilizers, compared to the foliar unfertilized control, was significant and ranged between 12% for the sunflower and 50% for the grapevine. There have been formulated and obtained two fertilizers AMINO-FERT N and NK, tested and certified, compatible for application in organic farming. There has been formulated and obtained a fertilizer for the prevention and treatment of ferric chlorosis of grapevine. Fertilizing compositions have been authorized for use in agriculture.

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