Phitohormons – effectives instruments in modifying the plant's metabolism – with the aim of obtaining products with superior nutritional qualities

Received for publication, February 15, 2007
Accepted, April 15, 2007

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Abstract

The aim of this project is to increase the nutritional quality for the tuberous roots of the batata (Ipomea batata) and for those of the sweet potato (Solanum tuberosum) by influencing the accumulation mechanisms of biocompounds throughout pithohormons. The resulting tuberous roots are recommended for use in different branches of the food industry. [1]

Amino acids represent the basic units in the structure of a protein 20 amino acids, all different, essential and with a well defined named lie at the foundation of the protein structure. The structure and properties of a protein are established according to the sequence of its component amino acids. [6]

The batata and the sweet potato are some of the most important food sources, their nutritional importance being based on the content of vitamins and proteins that lie in each of them. The concentration of different amino acids in proteins varies depending on several factors, the theme of this study being exactly this: influencing this concentration.

The discovery of substances with a regulating action regarding growth-phitohormones, growth stimulators, inhibitors-brought the specialists a sensitive, effective instrument in directing and controlling the development and growth process of a plant, for the vegetal production. [5]

The fact that growth phitohormones increase the efficiency of use with fertilizers determines some specialists to confirm the superiority in directing a harvest throughout bioregulators rather than throughout the use of chemical fertilizers, because of the fact that bioregulators are environmentally friendly.

In order to develop, plants need besides the external factors (water, nutritives, temperature, light) substances that are formed within their body-phitohormones. [4]

They influence the growing and morphogenesis process regulating the physiologic processes from different tissues and organs of the plant. They are synthesized by the cytoplasm of young cells and accumulate especially in the growing areas of the roots and stem, in seeds, pollen, buds, young tissues and other. [3]

Phitohormones determine the growth of the plant by intensifying the cellular partition and by enlarging the existent cells. The mechanism throughout which the plant grows depends on the nature of the phitohormones.

From the chemical point of view, phitohormones are micro molecular substances extremely heterogenic, resembling vitamins and animal hormones. They are formed by cycling rings (indolic, purinic, iononic, gibanic and others) they contain ethereal connections (bonds) and other functional groups. They are widely spread and can be found in different tissues and organs of superior plants, feculences, funguses and micro organisms, in independent state but also in associations with proteins.

Auxines represent the first class of growth stimulation substances discovered through out the most enlightening representative: acid3-indolilacetic (AIA). The determination (produced by Kogl-1932) goes along with the cellular growth stimulating action, provoked by these substances. [7]

The action mechanism of the auxin is not elucidated yet despite all the investigations. It is a clear fact that the presence of the auxin induces a cellular elongation, and the fact that in approximately 10 minutes from the moment that the treatment has been applied, an acceleration of the growth speed in extremely small concentrations can be observed. This amplification can be made either by acting upon an enzyme as an alosteric effecter, either by stimulating its biosynthesis. The elongation, as an auxinic effect may be caused instantly by the modification of the permeability of the cellular membrane.

The growth induce by the auxin depends on the biosynthesis of the structural substances, on the proteic biosynthesis. [1]

Keywords: sweet potato roots, potato roots, amino acids; auxin

Material and Methods

The experimental determinations required to establish the quality and quantity estimation for some specific amino acids that are contained by proteins, from the sweet potato roots and potato roots, while their biosynthesis was influenced by the presence of the 3-indolilacetic acid in the nutritive solution.

The biochemical analysis has been made on the tuberous roots of the sweet potato and of the batata, harvested from the experimental lot, the nests being treated with solutions that contained the 3-indolilacetic acid. There have been made medium tests, the experiment including samples from the harvests obtained through out 2 years of study. The nutritional solutions have been applied through out the entire development of the plants, as follows:

Table 1. The nutritional options used along the development of the plant

Nutritional option	**The amount of auxin in the nutritional solution** (acid indolilacetic – ppm)
Witness	-
1	20
2	30
3	40
4	50
5	60

The proteic extract obtained from the tuberous roots of the batata for all the options was treated with proteaza fungica with the aim of hydrolyzing the protein in the environment at the amino acids contained by them.

The separation and identification of the amino acids have been established by using the chromatographic method, being used, in parallel, a series of standardized amino acids, the revealing (the color reaction) being made with ninhidrine. The type of chromatographic analysis was bidimensional, on paper, the standard solutions of the amino acids having a concentration of 0.01 %. The amino acids from the samples have been identified by comparison with the standardized solutions, according to the color and the Rf. Following the determination of the amino acids, their samples colored by ninhidrine were cut from the paper were dissolved with methanol solvent.

A curve of standardization was drown by using the spectrophotometrical method with the help of a leucine standard solution of 0.01%, using the same the coloring reactive the ninhidrine. The quantity determination of the amino acids was based on standardized graphic. (Figure 1).

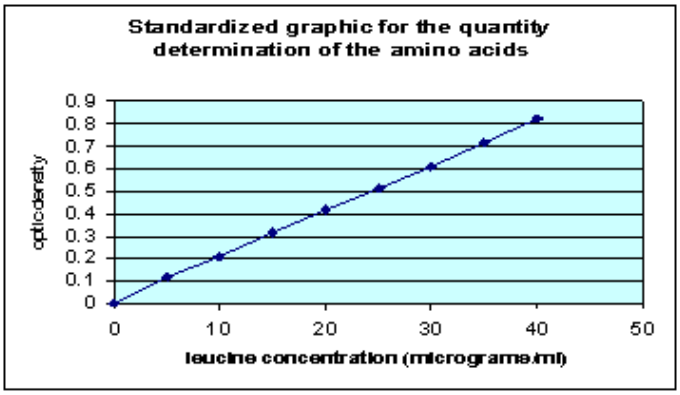


Figure 1.

The quality and quantity determination (based on the standardized graphic) for the amino acids contained in the batata protein can be found in Table 2 and for the sweet potato protein in Table 3.

Table 2. The amount of amino acids (mg/100 g batata) (medium amounts for the 2 years of study) for *Ipomea batata*

	Nr. crt.	Amino acids	Rf	Wit-ness	Treatment: 3- indolil acetic acid **20 ppm**	Treatment: 3- indolil acetic acid **30 ppm**	Treatment: 3- indolil acetic acid **40 ppm**	Treatment: 3- indolil acetic acid **50 ppm**	Treatment: 3- indolil acetic acid **60 ppm**
				1	**2**	**3**	**4**	**5**	**6**
	1	cystine	0,08	8	8,64	9,23	9,71	9,76	9,73
	2	arginine	0,20	31	32,41	32,96	33,04	33,12	33,10
	3	aspartic acid	0,57	365	376	387	389	387	388
	4	alanine	0,38	95	98,76	99,42	99,50	99,48	99,53
	5	valine	0,60	72	76,58	78,45	78,67	78,32	78,65
	6	leucine	0,73	85	87,56	89,46	90,23	90,31	90,29
	7	cysteine	0,07	4	5,11	5,62	5,67	5,86	5,79
	8	lysine	0,14	96	102,34	103,81	103,86	103,84	103,85
	9	glycine	0,26	38	41,23	43,56	43,67	43,32	43,69

	10	glutamic acid	0,30	127	132,47	134,62	134,56	134,84	134,77
	11	proline	0,43	41	45,67	46,87	46,72	46,84	46,85
	12	methionine	0,55	39	42,35	44,31	44,84	44,53	44,67
	13	histidine	0,22	24	26,79	27,42	27,53	27,54	27,52
	14	serine	0,27	62	68,46	68,62	68,44	68,78	68,69
	15	threonine	0,35	68	71,23	73,46	73,78	73,72	73,88
	16	hidroxiproline	0,31	28,5	30,11	31,24	31,67	31,73	31,87
	17	tyrozine	0,45	27,5	29,34	29,67	29,48	29,77	29,71
	18	phenilalanine	0,68	41	43,46	44,53	44,64	44,87	44,81
	19	glutamine	0,38	15,5	17,21	17,96	18,05	18,09	18,06
	20	**tryptophan**	**0,50**	**0**	**3,45**	**4,11**	**4,23**	**4,26**	**4,24**

A significant accumulation of the triptofan amino acids compared with that of the witness sample can be observed, especially a contribution of 3-indolilacetic acid of 20ppm and 30ppm. After the 30ppm amount no considerably accumulations are noted.

The tryptophan acid, absent in the witness sample, under the influence of the 3-indolilacetic acid nutrition accumulates in significant amounts in the tuberous roots of the batata. This shows that the auxines are directly involved in the synthesis of this amino acid particularly.

Table 3. The amount of amino acids (mg/100 g potato) (medium amounts for the 2 years of study) for *Solanum Tuberosum*

	Nr. crt.	Amino acids	Rf	Wit-ness	Treatment: 3- indolil acetic acid **20 ppm**	Treatment: 3- indolil acetic acid **30 ppm**	Treatment: 3- indolil acetic acid **40 ppm**	Treatment: 3- indolil acetic acid **50 ppm**	Treatment: 3- indolil acetic acid **60 ppm**
				1	**2**	**3**	**4**	**5**	**6**
	1	cystine	0,08	7,31	7,62	7,91	8,11	8,09	8,12
	2	arginine	0,20	31,41	32,31	32,69	33,14	33,16	33,12
	3	aspartic acid	0,57	312	334	339	341	341,61	340,96
	4	alanine	0,38	90,36	92,76	92,92	93,50	93,48	93,53
	5	valine	0,60	67	68,58	68,45	68,67	68,32	68,65
	6	leucine	0,73	80,13	80,56	81,46	81,23	81,31	81,29
	7	cysteine	0,07	2,9	3,11	3,62	3,67	3,86	3,79
	8	lysine	0,14	84,12	92,36	93,64	93,67	93,83	93,89
	9	glycine	0,26	27,78	31,29	33,52	33,23	33,39	33,42
	10	glutamic acid	0,30	104,2	109,77	110,72	110,76	110,74	110,77
	11	proline	0,43	32	35,60	36,57	36,74	36,35	36,68
	12	methionine	0,55	33,47	34,65	34,94	40,04	40,23	40,17
	13	histidine	0,22	19,46	21,69	22,12	22,53	22,57	22,61
	14	serine	0,27	51,15	58,86	58,92	58,96	58,78	58,89
	15	threonine	0,35	61,12	61,73	63,49	63,88	63,77	63,84
	16	hidroxiproline	0,31	22,51	23,61	23,94	32,97	23,95	23,97
	17	tyrozine	0,45	20,54	24,84	24,64	24,78	24,67	24,73
	18	phenilalanine	0,68	33,56	34,42	34,53	34,67	34,81	34,80
	19	glutamine	0,38	11,35	14,61	15,16	15,15	15,09	15,14
	20	**tryptophan**	**0,50**	**2,34**	**6,45**	**7,11**	**7,13**	**7,16**	**7,14**

According to the determinations, the treatment with the active physiological substances for both the *Ipomoea batata and Solanum tuberosum* has an important role in accelerating the biosynthesis of amino acids from proteic structures, and thus obtaining a higher nutritional quality of these products.

The biosynthesis of the tryptophan it is highly accelerated by means of the auxines treatment. So, if for the batata the amount is zero in the witness sample for this amino acid, following treatment, at the concentration level of 30 ppm

3-indolilacetic acid, the amount rises at 4.11mg/100g vegetal material.

In case of similar treatment at the same level of concentration also with 3-indolilacetic acid, but for the sweet potato, the amount of the tryptophan acid rises from 2.34mg/100g vegetal material to 7.11mg/100g vegetal material in the treated product, concluding the fact that the amount of this amino acid almost triples. In figure 2, we present tryptophan concentration in potato roots and sweet potato roots.

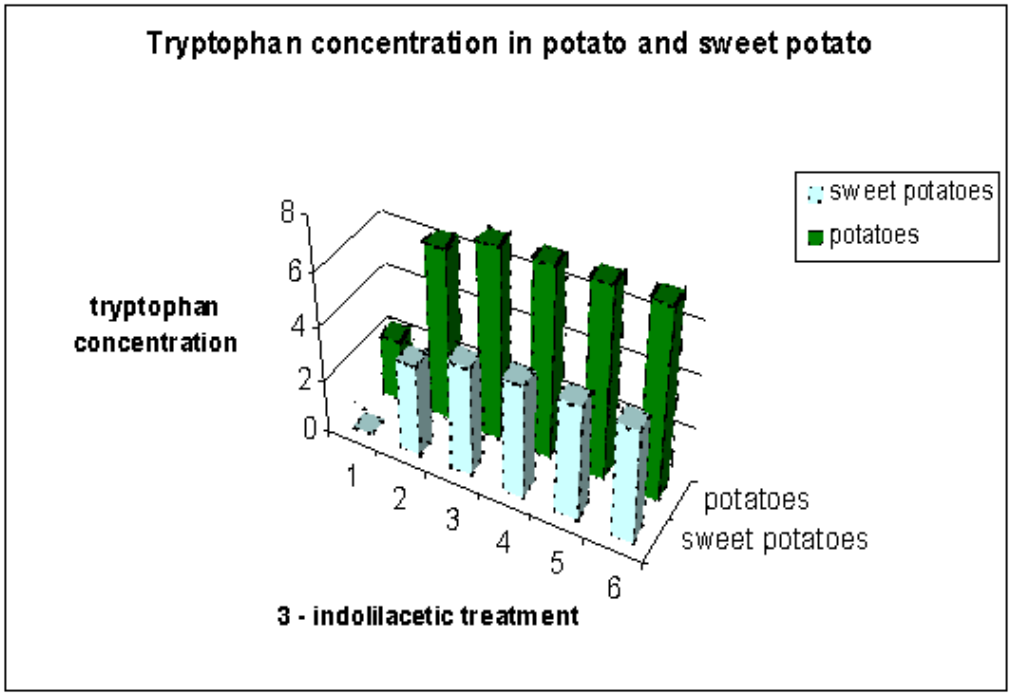


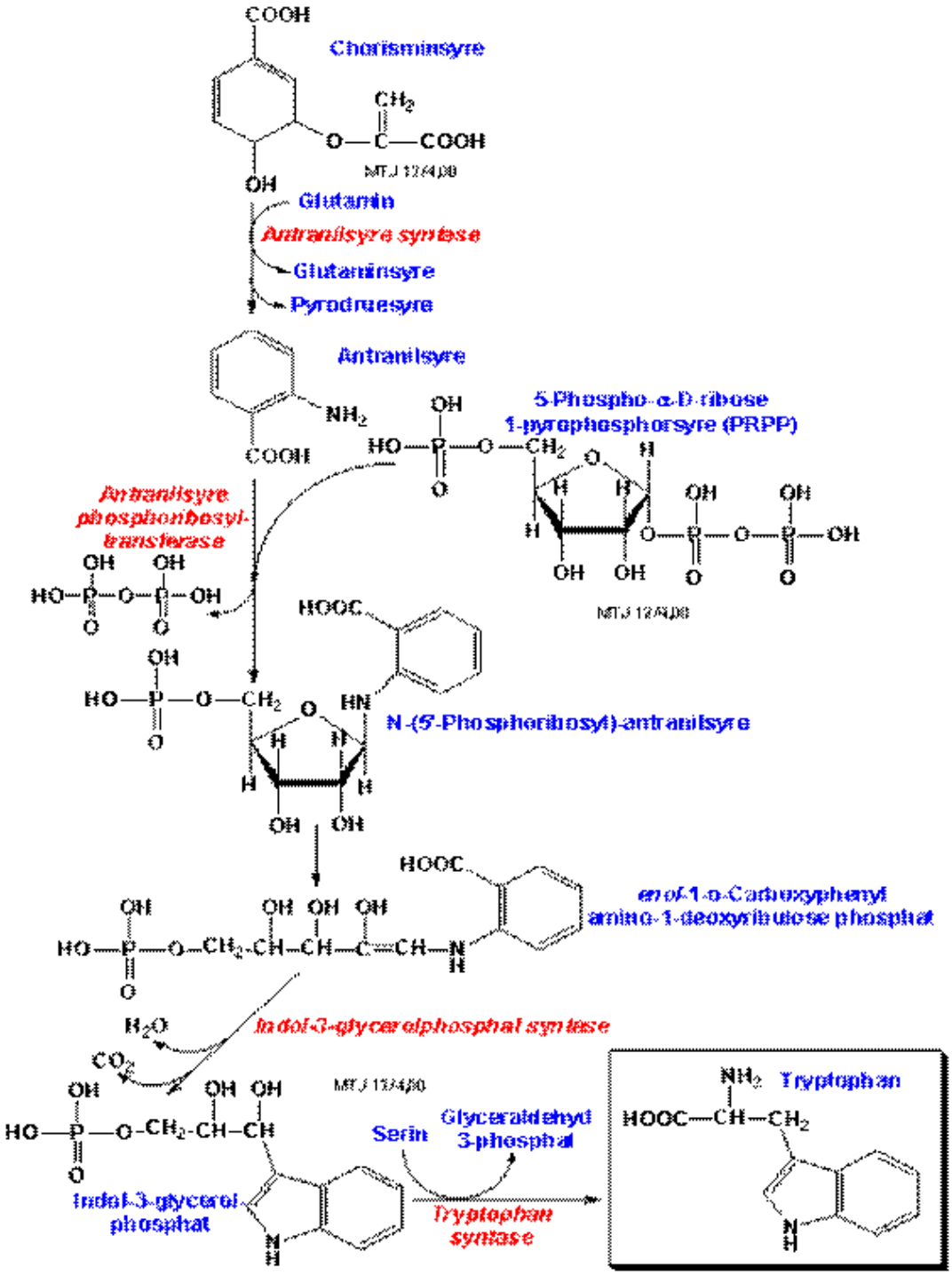
Figure 2.

Knowing that the tryptophan acid is indispensable for the development of animal organisms (thus being an essential amino acid) the growth of the amount of this amino acid in vegetal materials is highly benefic.

Tryptophan is an amino acid and essential in human nutrition. It is one of the 20 amino acids in the genetic code (codon *UGG*). Only the L-stereoisomer appears in mammalian protein. Tryptophan is an amino acid that occurs in proteins; is essential for growth and normal metabolism; a precursor of niacin.

In diagram 1, we present the metabolic method of biosynthesis of the tryptophan acid. [2]

Diagram 1. Biosynthesis of the tryptophan



Conclusion

- The growth of the plant induce by the auxin depends on the biosynthesis of structural substances, especially on the proteic biosynthesis. The action mechanism of the auxin is not completely elucidated despite all the investigation carried with respect to it.
- It is a clear fact that the presence of the auxin induces a cellular elongation, an acceleration of the growth speed in extremely small concentrations can be observed. This amplification can be made either by acting upon an enzyme as an alosteric effecter, either by stimulating its biosynthesis. The elongation, as an auxinic effect may be caused instantly by the modification of the permeability of the cellular membrane.
- The tryptophan acid, absent in the sample witness, under the influence of the 3-indolilacetic acid nutrition accumulates in significant amounts in the tuberous roots of the batata. This shows that the auxines are directly involved in the synthesis of this amino acid particularly

- It is a remarkable fact that the tryptophan acid is biosynthesized in the tuberous roots of the sweet potato and in those of the batata, only in the presence of phitohormonal solutions, normally without stimulation this amino acid does not exist, or it is in an extremely small quantity.
- Because of the given fact that animal organisms must consume the tryptophan acid, the growth of the amount of acid in plants, by influencing the accumulating mechanism with the help of phitohormones, is a modern, effective way to obtain vegetal products of a superior nutritional value.

Bibliography

1. ORY, R.; RITTING, F., - *Bioregulators – Chemistry and Uses* – American Chemical Society, Washington, 1984.
2. PASELK, R. – *Biochemical Pathway Diagrams* – Humboldt State University, International Student Edition, 1997.
3. PURCHIT, S. EDITOR, - *Hormonal Regulation of plant Growth and Development* - London, 1985.
4. TING, I.P. – *Plant Physiology* – Addison Wesley Publishing Company, 1982.
5. TOLBERT, N.; - *The Biochemistry of Plant* – Academic Press, New York, London, Toronto, Sydney, San Francisco, 1980
6. L. STRYER – *Biochemistry* – International Student Edition – Third edition, New York, 1988
7. *** - *Encyclopedie permanente d` agricultura biologique*, Editions Debard, Paris, 2000.