CHANGES IN CHEMICAL COMPOSITION OF FRUITS OF SALINIZED DATURA STRAMONIUM

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SUMMARY: Changes in growth and chemical composition such as carbohydrate, protein, free amino acids, alkaloids, and minerals of fruits of salinized Datura stramonium were studied. Fresh and dry matter was mostly increased with the rise of salinization level. Generally, the insoluble and total carbohydrate, insoluble protein. Free amino acids other than proline and total alkaloid contents increased significantly with the rise of salinization level. However, the soluble carbohydrate, soluble and total protein, and proline contents decreased with the rise of salinization level. Mineral composition also exhibited significant changes, but the dominant feature was the progressively increase of sodium content with the rise of salinity level.

Key Words: Salinity, Datura stramonium.

INTRODUCTION

Adverse effects of salt stress on growth, dry matter production and economic yield of a number of cultivated plant species have been subjected to extensive investigations in recent year (2, 16, 22). However, the information regarding the effect of salt stress on the fruits is meager.

The adverse effects of salt stress on plant metabolism include accumulation of carbohydrates (9, 13), stimulates or reduction in the rates of synthesis of proteins (12, 21), accumulation of amino acids (1, 8, 29). Proline in particular was frequently recorded to be considerably accumulated more than any other free amino acids in water stress plants. However the plant ability to accumulate proline under stress conditions varies between species or even varieties (5, 26, 27, 33).

Furthermore salt stress may lead to an accumulation of ion including Na and Cl and to an deficiency in certain other including K in the vegetative parts of plants (15, 28).

As far as the literature available no regular studies were performed concerning the effect of salinity on the metabolic activities and alkaloid contents of fruits of medicinal plants. Only, Ahmed *et al.* (1) work on the effect of salinity on *Datura stramonium* and *Hyoscyamus muticus* found that the total alkaloid contents as well as the contents of various alkaloids fractions in both plants, increased mostly with the rise of salinization level, whatever the organs (leaves, stem and root) analyzed.

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Thus, the aim of the present work was to study the changes that might take place in fresh and dry matter and the chemical composition in fruits of *Datura stramonium* such as (carbohydrates, protein, amino acid, proline, alkaloids and mineral composition) after being subjected to some salinization treatments.

MATERIALS AND METHODS

Datura stramonium was used as test plant in this investigation. Seeds obtained from the University farm were sown in plastic pots, perforated at the bottom Each pots were irrigated with irrigation water till complete germination occurs. The seedlings were then thinned and ten plants per pot were left to grow for weeks at a soil water potential near the field capacity. Thereafter 1/10 Pfeffer's nutrient solution containing various salinization levels (0.0, 1000, 3000, 5000 and 7000 ppm) was used for irrigation. Salinization was performed by a mixture of NaCl and $CaCl_2$ (1:1 by weight). The nutrient solutions used was a 1/10 dilution of Pfeffer's nutrient solutions and was composed of (gm/1) 0.8 $Ca(NO_3)_2$, 0.2 KCL, 0.2 KH_2PO_4, 0.2 $MgSO_4$. Micronutrients were supplied to the nutrient solutions at concentrations similar to those used by Arnon and Hoaglend (4). The formula and weights of chemicals (mg/l) used were 2.86 H_3BO_3, 1.81 $MnCl_2.4H_2O$, 0.08 $CuSO_4.5H_2O$, 0.22 $ZnSO_4$, 0.09 $H_2MoO_4.H_2O$ and ($FeSO_4.7H_2O$ 0.5%. 0.6 ml/1: tartaric acid 0.4%. 0.6 ml/1). The PH value of this nutrient solution was 5.7±0.3. In order to prevent the accumulation of salts, the soil in each pot was leached every two weeks with excessive amount of water. Three replicates were considered for each treatments,

each replicate contained 10 fruits were collected. The plants were left to grow under these various salinization treatments for 60 days. Thereafter they harvested and processed for analysis the fruits.

At the end of the experiment the fresh and dry matter of fruits of each treatment were taken to determine per fruits.

For the determination of carbohydrates, the anthrons sulphuric acid method which was carried out applied by Schlegel (24). Proteins were estimated by the method of Lowry *et al.* (19). For the determination of free proline, the method recommended by Bates *et al.* (6) was used. For the determination of total alkaloids, the Vitali color reaction method given by Fish (10) was used. The alkaloid content was calculated as mg atropine gm^{-1} dry matter. The flame emission is a sensitive method for the determination of cations such as sodium, potassium and calcium, flame photometer method (30) was used.

RESULTS AND DISCUSSION

The fresh and dry matter of fruits of *Datura stramonium* was mostly enhanced with the rise of salinization level (Table 1). Such a stimulation in growth was also recorded in the vegetative parts of flowering plants in the halophytes and succulent plants after being subjected to salinity treatments (11, 32).

Salinity stress was found to induce profound changes in the components of carbohydrates. Salinity is capable of inducing a general increase in insoluble and total carbohydrate contents while the soluble carbohydrate contents decreased with the rise of salinization level 1 as shown in Table 1. Such accumulation or reduction was recorded by many investigators (9, 13).

The data in Table 1 clearly show that the soluble and the total protein in the fruits of salinized *Datura stramonium* were sharply reduced with the rise of salinization level, while the insoluble fraction of protein highly significant increase with the rise of salinization level. The stimulation or reduction of protein are in accordance with those obtained by some other suthors (12, 17, 21).

Changes in proline and other free amino acids in the fruits of *Datura stramonium* after the plant being subjected to various salinization treatment was shown in Table 1. The contents of proline decreased progressively with the rise of salinization level. However, the contents of free amino acids highly significant increased with the rise of salinization level, which of considerably higher values compared to those of proline. These results are in accordance with those obtained by some other authors working on vegetable parts of some economic plants (1, 8, 23, 29).

The total alkaloid contents in fruits of *Datura stramonium* exhibited highly significant amount under salinization level up to level 3000 ppm. There above these contents tended to decreased again with the rise of salinization level.

Generally, it can be seen that the increase of total alkaloid content in salinized *Datura stramonium* fruits

Table 1: Changes in growth and chemical composition of fruits of salinized *Datura stramonium*.

	Plant anteriols		Carbohydrates content mg gm^{-1} dry motter			Protein content mg gm^{-1} dry motter			Proline mg gm^{-1} dry motter	Total free amino acid mg gm^{-1} dry motter	Total alkaids mg gm^{-1} dry motter	Mineral composition mg gm^{-1} dry motter		
Salinization level (ppm)	Frech weight gm $fruit^{-1}$	Dry weight gm $fruit^{-1}$	Soluble	Insoluble	Total	Soluble	Insoluble	Total				Na	K	Ca
0.0	1.94	0.93	31.40	48.62	80.02	46.18	12.80	58.98	8.22	49.70	4.83	1.16	24.01	0.05
	‘		‘’	‘’	‘’	‘’	‘’	‘’			‘’	‘’	‘	
1000	2.37	1.01	22.60	72.60	95.20	35.29	18.24	53.53	7.93	102.13	9.26	1.43	24.75	0.05
		‘	‘’	‘’	‘’	‘’	‘’	‘’	‘’	‘’	‘’	‘’		
3000	2.41	1.12	22.30	81.70	104.00	32.35	17.94	50.29	5.48	99.70	10.57	1.43	24.49	0.05
			‘’	‘’	‘’	‘’	‘’	‘’	‘’	‘’	‘’	‘’		
5000	2.23	0.99	22.00	97.00	119.00	31.76	17.06	48.82	5.48	98.48	5.73	1.96	24.44	0.05
			‘’	‘’	‘’	‘’	‘’	‘’	‘’	‘’				
7000	2.17	0.97	20.80	93.70	94.50	30.36	16.03	46.33	5.30	24.21	4.31	1.34	24.40	0.05
L.S.D. at 5%	0.42	0.19	1.40	3.19	3.43	2.45	2.23	2.67	1.30	4.31	2.52	0.22	0.73	0.07
L.S.D. at h%	0.63	0.29	2.11	4.82	5.19	3.71	3.38	4.04	1.97	6.53	3.82	0.37	1.11	0.11

‘ Significant differences as compared with the control

‘’ Highly significant differences as compared with the control

goes parallel to the accumulation of free amino acids other than proline. This could be due to the fact that ornithine, the precursor of tropane alkaloids (3) and proline have the same precursor namely glutamic acid. Therefore it can be said that salinity could inhibit the transamination reactions and hence the glutamic acid is accumulated and transformed to other nitrogenous compounds such as ornithine. Proline not accumulated and ornithine was further transformed to tropane alkaloid. Devitt *et al.* (7) reported that free proline decreased with increasing salinity in wheat grain.

The data in Table 1 clearly show that highly significant accumulation of sodium with increase salinization level. Higher accumulation of sodium after salinization has been recorded in various crop species Lessani and Marschner (18). Potassium content was not influenced by the high accumulation of sodium, and remained more or less constant under the various salinization levels used. The content of calcium was not influenced with the rise of salinization level. Similar results was also obtained by Shimose (25); Wilson *et al.* (31); and Heikal (14).

Finally, it can be concluded that as far as the constituents followed, there are some metabolic discorders in the fruits of *Datura stramonium* plant under salinization conditions. Fortunately these discorders include the accumulation of alkaloids for which this medicinal plant is generally considered.

REFERENCES

1. Ahmed AM, Heikal MM, Ali RM : Changes in amino acids and alkaloid contents in Hyoscyamus maticus and Datura stramonium in response to salinization. Phyton, 29:137-147, 1989.

2. Ahmed AM, Heikal MM, Zidan MA : Effect of salinization treatments on growth and some leguminous plants. Cand J Plant Sci, 29:713-720, 1980.

3. Ahmed A, Leete E : Biosynthesis of tropine moiety of hyoscyamine from-N methylorinithine. Photochemistry, 9:2345-2347, 1970.

4. Arnon DI, Hoagland DR : Crop production in artificial solution and ion soils with special reference to factors influencing vields and absorption of inorganic nutrients. Soil Sci, 50:463-485, 1940.

5. Bar-Nun N, Poljakoff-Mayber A : Salinity stress and the content of proline in root of Pisum sativum and Tamorix tetragyna. Ann Bot, 41:173-179, 1977.

6. Bates LS, Waldren RP, Teare ID : Rapid determination of free proline for water stress studies. Short Communication. Plant and Soil, 39:205-207, 1973.

7. Devitt DA, Stolzy LH, Labanauskas CK : Impact of potassium, sodium, and salinity on the protein - and free amino acid content of wheat grain. Plant and Soil, 103:101-109, 1987.

8. Dhingra HB, Varghese TM : Effect of salt stress on viability, germination and endogenous levels of some metabolites and ions in maize (Zea mays L) Pollen. Ann Bot, 55:415-420, 1985.

9. Downton WJS : Photosynthesis in salt stressed grapevines. Austr Plant Physiol, 4:183-192, 1977.

10. Fish F: Effect of gibberellic acid on growth and alkaloidal content of Datura stramonium L. J Pharm Pharmacol, 12:428-436, 1960.

11. Gale J, Poljakoff - Mayber A : Interrelations between growth and photosynthesis of saltbush (A triplex halimus L) grown in saline media. Austr J Biol Sci, 23:937- 945, 1970.

12. Hall JL, Flowers TJ : The effect of salt on protein synthesis in the halophyte Suaeda maritima. Planta, 110:361-368, 1973.

13. Hawker JS : Invertase from the leaves of Phaseolus vulgaris plants grown in nutrient solutions containing NaCl. Am J Botany, 51:748-752, 1980.

14. Heikal MMD : Physiological studies on salinity changes in the water content and mineral composition of some plants over a range of salinity stresses. Plant and Soil, 48:223-233, 1977.

15. Imamul-Huq SM, Larher F : Osmoregulation in higher plants. Effect of NaCl salinity on non-nodulated Phaseolus oureus L, II Changes in organic solutes. New Phytologist, 93:209-216, 1983.

16. Jeschke WO, Wolf O : Effect of NaCl salinity on growth development ion distribution and ion translocation in castor bean (Ricinus communis L). J Plant Physiol, 132:45-53, 1988.

17. Kleinkopf GE, Wallace A, Hortsoch TL : Salt tolerant, drought-tolerant potential source of leaf protein. Plant Sci Lett, 7:313-320, 1976.

18. Lessani H, Marschner H : Relation between salt tolerance and long-distance transport of sodium and chloride in various crop species. Aust J Plant Physiol, 5:27-37, 1978.

19. Lowry OH, Rosenbrough NJ, Farr AJ, Randall RJ : Protein measurement with the folin phenol reagent. J Biol Chem, 193:265-275, 1951.

20. Moore S, Stein W : Photometric ninhydrin method for use in the chromatography of amino acids - from the laboratories of Rockefeller Institute for Medical Research, New York, 1948.

21. Patil PK, Patil VK, Ghonsikar CP : Effect of soil salinity on growth and nutritional status of guava (Psidium guajava). Int J Trop Agric, 2:237-334, 1984.

22. Radi AF, Heikal MM, Abdel-Rahman AM, El Deep BAA : Interactive effect of salinity and phytohormones of growth and plant water relationship parameters in maize and safflower plants. Revue Roumanie De Biologiec Serie De Biologie, 33:27-37, 1988.

23. Reddy MP, Vora AB : Effect of salinity on protein metabolism in bajara (Pennisetum typhoides) Leaves. Indian J Plant Physiol, 28:190-198, 1985.

24. Schlegel HG : Die verwertung organischer sauren durch chlorella in licht. Planta, 47:510, 1956.

25. Shimose N : Physiology of salt injury in crops. Three-salt tolerance of matrush plants. J Sci Soil Tokyo, 34:147-149, 1963.

26. Singh TN, Paleg LG, et al : Stress metabolism I. Nitrogen metabolism and growth in the barley plant during water stress. Aust J Biol Sci, 26:45-46, 1973.

27. Stewart GR, Larher F : Accumulation of amino acids and related compounds in relation to environmental stress. In the Biochemistry of Plants. A comprehensive Treatise 5:609- 695. Academic Press, New York, 1980.

28. Tal M, Rosenta I, Apromovitg R, Forti M : Salt tolerance in Simmondisa chinensis (jojoba) water balance and accumulation of Cl, Na, proline under low and higher salinity. Ann Bot, 43:701-709, 1979.

29. Vyas SP, Kathju S, Garg BK, Lahiri AW : Performance and metabolic alterations in Sesamum indicum L under different intensities of water stress. Ann Bot, 56:323-331, 1985.

30. Williams and Twine : Flame photometric method for sodium, potassium and calcium in modern methods of plant analysis by K Peach and MV Tracey, Vol V, Springer, Verlag, Berlin, 1960.

31. Wilson JR, Haydock KP, Robins MF : Response to salinity in Glycine. 5-Changes in the chemical composition of there Australian species of species of G. Welghtii (G. Javanica) Over a range of salinity stresses. Aust J Exp Agric Anim Hush, 10:156-165, 1970.

32. Winter K : Effect of sodium chloride salinity on growth and photosynthesis in the halophyte Mesembryanthenum nodiflorum L and Suaedo maritima L. Dum Oecologia, 17:317-327, 1974.

33. Wyn-Jones RG, Gorham J : Osmoregulation. In Encyclopedia of Plant Physiology. Ed by OL Lange, PS Nobel, CB Osmond and H Zeigier, 12:35-54, Springer, Verlag, Berlin-Heidelberg-New York, 1983.

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