Research Article

Effect of (Strontium) Alkaline Earth Metal on the Morphological and Phytochemical Aspects of *Lycopersicon esculentum* Mill.

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ABSTRACT

An attempt has been made to study the accumulation of alkaline earth metal strontium in the plant *Lycopersicon esculentum* Mill., as bioaccumulation of this compound leads to various health risks. The study was conducted by treating the plant *Lycopersicon esculentum* Mill. with the chemical strontium chloride at four different concentrations (100µM, 500µM, 1mM and 5mM) and compared with the one kept as control. At the end of the study (80 days) strontium was observed in plant leaves and fruits.

Key words: Strontium chloride, *Lycopersicon esculentum* Mill.

INTRODUCTION

Strontium is a soft silver-white metallic element and in its elemental form it occurs naturally in many compartments of the environment, including rocks, soil, water, and air. Quite a large amount of waste substances and energy are introduced in to the environment through several sources [1-3].The soil contamination is primarily due to industrial waste disposal and secondarily by the water supplies within and underlying soil [4] It finally leads to various health risks. A part of the strontium that is disposed by Man reaches groundwater and remains in the soil for decades. Strontium concentrations in soil get increased by human activities, such as by the disposal of coal ash, incinerator ash, and industrial wastes.

The agricultural plants from industrial areas have higher probability of strontium uptake. Crops get saturated with heavy metals and chemicals which are harmful to man and other organisms [5]. For children exceeded strontium uptake may be a health risk, because it can cause problems with bone growth. When strontium uptake is extremely high, it can cause disruption of bone development. But this effect can only occur when strontium uptake is in thousands of ppm range. The present study aims at determining the effect of alkaline earth metal strontium chloride on morphological and phytochemical characters of *Lycopersicon esculentum* Mill. and also to observe the amount of strontium chloride accumulation on the leaves and fruits by using inductively coupled plasma atomic emission spectroscopy (ICP-AES).

MATERIALS AND METHODS

The pure and viable plant seeds were bought from Agricultural Technology Information Centre of Kerala Agricultural University, Mannuthy, Thrissur, Kerala. Surface sterilized seeds were soaked for 24 hours in various concentrations of strontium chloride (100µM, 500µM, 1mM and 5mM). For control, distilled water was used. Seeds were placed on filter paper in sterilized Petri dishes for germination and moistened with 15 ml of different concentrations of strontium chloride. 20 seeds were taken in triplicate at room temperature. After 4 days, the data on percentage of germination was documented and the length of radicle and hypocotyl was recorded.

For field studies, the seeds were allowed to grow in polythene bags which were filled with potting mixture at the ratio of soil: cow dung: sand as 3:1.5:1 respectively. The soil was analyzed in Soil Testing Laboratory Centre, Thrissur. The treated plants were irrigated thrice a week with different concentrations of strontium (100µM, 500µM, 1mM and 5mM). For control, distilled water was used for irrigation. Six replicates of each concentration were maintained. The different parameters like length of the shoot, length of the root, the number of secondary roots, number of leaves, width of shoot and the number of flowers were studied. These parameters are noted down at an interval of 20 days up to 80th day.

Foliar features like stomatal index, palisade ratio, vein islet ratio and vein termination number were studied using microscope. In phytochemical analysis, test for flavonoids, alkaloids, saponins, tannins and steroids were done. Estimation of carbohydrate was also carried out using anthrone method. The digested sample of each of the plant leaves and fruits were

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analyzed for strontium by atomic emission spectroscopy (ICP-AES).

After completion of growth, the plants were uprooted and dried in hot air oven at 100°C for 5 days, for recording the dry weight.

RESULTS AND DISCUSSIONS

The present study revealed that growth and development of strontium chloride treated plants was low as compared to those plants treated with control. Control shows highest value in radicle and hypocotyl length while 5mM concentration of chemical treated plant showed the lowest (Table 1).

Table 1: Effect of different concentration of strontium chloride on germination of *Lycopersicon esculentum* Mill.

Concentration of Strontium Chloride(M)	Length of Radicle (cm)	Length of hypocotyl (cm)	Germination percentage (%)
Control	3	2.5	100
100µM	3.8	3.5	90
500µM	0.4	1	60
1mM	0.4	0.4	45
5mM	0.3	0.2	45

From the data of germination percentage it is clear that the rate of germination was highest for control and the rate decreased with increase in strontium chloride concentration (Table 1). These observations are in agreement with those of [6,7]. For growth studies, the different parameters like shoot length, root length, number of secondary roots, width of the shoot, number of leaves and number of flowers were analyzed. For the above parameters the highest value was shown by control treated plants and lowest value was shown by plants treated with 5mM strontium chloride (Table 2 & 3).These observations are in agreement with [8].

The study on foliar features like stomatal index, palisade ratio, vein islet ratio and vein termination number revealed higher values for control plants and lowest value for plant treated with 5mM strontium chloride (Table 4). Polluted environment effects stomatal frequency. When the number of stomata decreases, gaseous exchange in plants get reduced. This has negative impact on photosynthesis and respiration which in turn affects productivity and growth [9]. A similar result was obtained for plant dry weight analysis (Table 3). These observations are in agreement with [10].

Various qualitative and quantitative assays of active ingredients were conducted as part of phytochemical analysis. Plant secondary metabolites such as flavanoids, alkaloids, saponins, and tannins were present in all plants including control. The analysis showed the presence of steroid in control and plants treated with lower concentrations of strontium chloride, but was absent in plants treated with high concentrations of strontium chloride (Table 5). Estimation of carbohydrate revealed that the concentration of carbohydrate is high in control and gradually decreased as the concentration of strontium chloride increases and then gets remained stable as the concentration reached 500µM. Studies of [11,12] support these findings. The accumulation of strontium chloride in plant leaves and fruits were analyzed using ICP-AES. It was observed that accumulation was nil in control. Accumulation kept increasing up to 1mM but decreased at 5mM concentration (Table 6).

From the present study it is clear that strontium chloride gets accumulated at different concentrations in leaves and fruits of the plant- *Lycopersicon esculentum* Mill. Since this plant is used as a vegetable it is important to know the response of the plant to different concentrations of metal. Strontium chloride accumulation in leaves and fruits were found to be at toxic level which is harmful to human. Studies on effect of heavy metals Cadmium, Cobalt, Mercury and Lead in some members of Malvaceae [13], corn and soya beans support these findings [14,15]. So vegetables are not advised to cultivate in polluted areas.

CONCLUSION

Even if lower concentrations of Strontium are used for enhancing the growth of the plants, it is harmful to humans as well as animals. It is imperative to have proper understanding of plant response and pollutant concentration relationship with environmental conditions so as to preserve our nature and natural resources. In the present study, the Strontium accumulation in leaves and fruits were found to be at toxic level which is harmful to humans. Since *Lycopersicon esculentum* Mill. is used as a vegetable, it is important to know the response of the plant to the heavy metal at different concentrations.

Table 2: Effect of different concentration of strontium chloride on length of shoot, length of root, number of secondary roots and number of leaves *Lycopersicon esculentum* Mill.

Concentration of Strontium Chloride (M)	Length of Shoot (cm)				Length of Root (cm)				Number of Secondary Roots				Number of Leaves			
	20th day	40th day	60th day	80th day	20th day	40th day	60th day	80th day	20th day	40th day	60th day	80th day	20th day	40th day	60th day	80th day
Control	14	28.6	56.1	99.4	4.5	5.6	7.1	10.6	16	22	69	81	5	9	13	17
100µM	13.1	25.5	51.7	97.6	4.5	5	6.2	9	12	24	65	85	4	8	10	16
500µM	9	27	50.2	89.3	1.4	3.8	5	8.2	12	22	34	49	5	9	13	16

1mM	3.8	22.2	44.5	72	1.2	3	4.5	7	10	15	24	40	4	6	10	13
5mM	3.2	19.9	39.2	61.7	0.9	2.8	4	7	10	12	16	24	3	6	9	12

Table 3: Effect of different concentration of strontium chloride on width of shoot, number of flowers and dry weight of *Lycopersicon esculentum* Mill.

Concentration of Strontium Chloride (M)	Width of shoot (cm)			Number of flowers			Dry weight of plant after 80 days (g)
	40th day	60th day	80th day	40th day	60th day	80th day	
Control	0.9	1.8	2.7	5	40	71	13.74
100µM	0.8	1.1	2.2	2	33	68	7.08
500µM	0.7	0.9	1.8	8	25	56	8.06
1mM	0.2	0.8	1.1	5	18	25	7.22
5mM	0.2	0.5	0.9	2	8	15	2.55

Table 4: Effect of different concentration of strontium chloride on stomatal index, palisade ratio, vein islet number and vein termination number in the leaf of *Lycopersicon esculentum* Mill.

Concentration of Strontium Chloride(M)	Stomatal index	Palisade ratio	Vein islet ratio	vein termination number
Control	30.3	7.78	7-12	8-14
100µM	29.5	7	8-10	6-10
500µM	25	7	8-7	7-12
1mM	25	6.5	4-7	8-12
5mM	21.58	5	4-6	8-12

Table 5: Qualitative analysis of different concentration of strontium chloride on *Lycopersicon esculentum* Mill.

Concentration of Strontium Chloride(M)	Flavanoids	Alkaloids	Saponins	Tannins	Steroids
Control	+	+	+	+	+
100µM	+	+	+	+	+
500µM	+	+	+	+	+
1mM	+	+	+	+	+
5mM	+	+	+	+	-

Moderate precipitation: +, Absent: -

Table 6: Quantitative analysis of carbohydrate and ICP-AES result in different concentration of strontium chloride on *Lycopersicon esculentum* Mill.

Concentration of strontium Chloride(M)	Carbohydrate concentration (µg/ml)	Strontium chloride concentration in plant leaf (ppm)	Strontium chloride concentration in the fruit (ppm)
Control	0.52	0	0
100µM	0.35	30.64	41.23
500µM	0.32	235.75	276.19
1mM	0.32	253.18	291.02

5mM	0.32	103.56	124.78

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