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ANALYZING THE EFFECT OF FLUORIDE ON THE BIOCHEMICAL PARAMETERS OF SELECTED VEGETABLES

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ABSTRACT

Certain inorganic components of water and soil affect how much fluoride plants take up from irrigation water. It was always thought that food did not provide a significant amount of fluoride for humans, however it is now known that certain foods contain very high fluoride levels. This investigation was conducted to measure the amount of fluoride that accumulates in vegetables from a possibly contaminated region of Rajasthan. Salicylic acid was used to cultivate watermelon seeds in vitro while studying the effects of sodium fluoride on germination and metabolic parameters. The percentage of germination, root and shoot length, and vigor index all improved after seven days of treatment with increasing doses of NaF, pigment content, chlorophyll stability index, and membrane stability index all reduced. Seed germination and other growth metrics were improved in SA- and SA+NaF-treated seedlings.

KEYWORDS Fluoride, Vegetables, Sugar, Biochemical Parameters

INTRODUCTION

The weathering of rocks and the leaching of fluoride-bearing minerals has led to elevated fluoride levels in groundwater. Because of its ability to concentrate fluoride in arid regions, evaporation is also significant. Use of groundwater for irrigation means that the veggies cultivated also contain fluoride. To accumulate in the leaves, where it might have harmful effects, fluoride must first be taken by the roots of the plant. Reduced plant growth, chlorosis, leaf tip burn, and leaf necrosis are only few of the documented physiological effects of fluoride. So, one of the first steps in preventing the development of fluorosis is to take stock of the fluoride content in drinking waters and the impact it has on plant physiology. The non-essential element fluorine may pose a concern to human health if it entered the food chain through plants' capacity to absorb and store it.

Fluoride does not exist in nature in its elemental form. Fluoride is found in a variety of foods and drinks, but the most common ways that people get it are via water, dental products. When fluoride is ionized in water, it quickly penetrates cell membranes after combining with Ca^{2+} to create calcium ionospheres, making it rapidly absorbable by the body via the intestinal mucosa. Ionospheres have far-reaching effects on many different systems. In little amounts, fluorides may help prevent dental cavities, but in large amounts they can destroy teeth and bone. Because of its high electronegativity, fluoride readily forms ionized fluorides with a wide variety of elements, some of which may accumulate in living tissue. Several studies have linked the clinical symptoms and tissue and organ damage seen in cases of fluoride poisoning to ionized fluorides.

LITERATURE REVIEW

Noel Makete et.al (2022) All forms of life are vulnerable to environmental fluoride (F) pollution, which is prevalent worldwide and mostly the result of natural geogenic processes but

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also, in certain situations, the result of human activity. Plants that take up F from polluted soil and water may experience a variety of abiotic stress symptoms, such as oxidative stress and disruption of critical physiology and biochemistry during germination, growth, and development. F-contaminated crops may play a significant role in contributing excessive F consumption in food chains, which might cause human and animal health problems, depending on the diet of the people living in the high F-polluted regions. It is hoped that reducing F bioaccumulation and associated harm on plants, as well as reducing F anthropogenic input in the soil, may achieve these goals, hence several strategies are now under study. However, the literature is still disorganized. Knowledge of the origins, mobility, and bioavailability of F in agricultural soils is provided in this study so that stakeholders may make educated judgements when choosing solutions for dealing with F impacts in agricultural systems. Unanswered questions and potential study topics have also been proposed.

Rakesh Kumar et,al (2021) Anthropogenic and geogenic activities, which impact billions of people throughout the globe, have led to widespread fluoride concentrations in the world's soil-water systems. Fluorosis of the skeleton and teeth, harm to the nervous system, and bone softening are only some of the chronic and acute adverse effects of fluoride consumption. Any quantity of fluoride in the soil will have a negative effect on plant growth and development. Bioaccumulation, biotransformation, and biosorption are all steps in the microbial bioremediation process. Biomass from microorganisms like bacteria, fungi, and algae may effectively clean up polluted areas while also being kind to the environment. It is yet to be researched whether or not industrial-scale treatment of fluoride-contaminated wastewater is possible. Most bioremediation methods are conducted on contaminated solutions in a laboratory setting. Consequently, the study suggests the viability and practicality of microbial bioremediation of fluoride in various settings.

Gitika Devi et.al (2020) Vegetables, in addition to ground water, are another major source of fluoride in the human diet. The top five most consumed veggies are tomatoes, brinjal, cabbage, potatoes, and French beans. Six samples were collected, two each from two different growing zones, to represent each vegetable kind. Fluoride concentrations in tomatoes, brinjals, cabbage, potatoes, and French beans ranged from 4.6 to 6.19 to 3.29 to 12.43 to 1.44 milligrammes per kilogramme, on average. Vegetable buildup of fluoride is mostly attributable to fluoride levels in soil and irrigation water. How much fluoride a plant takes in depends on how well it takes to the element. Using a formula, researchers were able to determine that the average BCF for the five different vegetables was 2.49, 2.72, 1.9, 3.64, and 1.41. All of the samples with BCF values greater than 1 show a marked propensity for fluoride buildup. But, other elements, such as soil composition and plant conditions, can have a role. Vegetables, Irrigation, Soil, Groundwater, and Bromide-Chlorofluoromethane (BCF) are some of the most important terms in this context.

A. Banerjee et.al (2019) A xenobiotic in the environment, fluorine is one of the most common elements on Earth. The amount of F in the atmosphere, water, and soil has grown dramatically due to unchecked human activity. Crops and vegetables that are irrigated with F-contaminated groundwater or grown using agricultural techniques on F-contaminated soils suffer from altered physiological and biochemical characteristics, which in turn reduces their growth and productivity. Toxic ions may be transported from the roots to the shoots of some plants, where they can accumulate in the fruit or vegetable. The results of F bioaccumulation are risky because F concentrations in edible portions might exceed the acceptable range. To aid phytoremediation, screening for F hyperaccumulators and F-tolerant plants has been carried out. There are plant bioindicators that may be used to measure how much F pollution is in the air. Agricultural soil quality with respect to hazardous F concentration may be enhanced by the cumulative usage of these organisms through well-crafted scientific planning schemes. Strengthening the efficacy of these phytoremediation techniques via rigorous field experiments should be a primary focus of future study. In order to introduce F-tolerance into otherwise susceptible agricultural cultivars, high throughput genetic analysis should be used to identify quantitative trait loci.

Lejalem Abeble Dagnaw et.al (2017) The alkali fusion - ISE method was used to assess the fluoride content of leafy vegetables grown on six farms, and the results showed that the range (mg/kg dry weight) for lettuce, Swiss chard, cabbage, and Abyssinian cabbage was as follows: 2.95-5.76; 2.75-5.40; 2.12.2-2.70; and 2.08-2.59. Fluoride concentrations in irrigation water sources in the study region ranged from 0.43 to 7.66 mg/L. Soluble fluoride levels in the examined farmed soil ranged from 4.30-23.4 mg/kg, with total fluoride levels ranging from 133-802 mg/kg. Vegetables grown in Rift Valley farms have much higher fluoride levels than those grown in non-Rift Valley fields. The Rift Valley's irrigation water and agricultural soil also have higher fluoride concentrations. Using analysis of variance, we determined that the mean fluoride levels of the vegetables were significantly different at the p 0.05 level. Both the soil and the water used for irrigation had varying degrees of fluoride in them, and the strength of the link between the two was shown using the Pearson test. In general, Consistent consumers of greens were shown to have much higher fluoride intakes than those who did not.

METHODS

Fluoride toxicity was assessed by testing grocery samples from three study regions. Veggies in the research region were watered with fluoridated ground water because of the lack of rain. The levels of fluoride discovered there are dangerously high.

Analysis of Fluoride in Vegetable Samples

Samples of produce were collected from fields, stored in plastic or paper bags, and sent to a testing facility as soon as feasible after harvest. The following procedure was used to determine the fluoride contents of various vegetables and leafy greens. Crushed into a powder thin enough to pass through a 40-mesh filter, We washed and dried at 105°C freshly collected vegetables/leaves from both the contaminated and control zones, then ground them up. One half gramme of each sample was weighed and then put in a nickel crucible containing 150 millilitres of de-ionized water. The filtered solution was then diluted with distilled water to the appropriate level in a 100 mL plastic volumetric flask before being stored in the refrigerator. Similar methods and an ion selective electrode (Orion type) were employed to analyze a 25 ml sample of vegetable for fluoride. There were three sets of measurements obtained.

The Biochemical Oxygen Demand (BOD) incubator maintained a temperature of 28.1°C for the petri dishes. On day three after planting the seeds, the germination rate was calculated. Root length, shoot length, and vigor index15 were evaluated after seven days of treatment, and the total soluble sugars19, phenolics content20, and photosynthetic pigments content21 were estimated using entire seedlings.

Statistical Analysis: Mean and standard deviation were used to summarize the data. With the help of SPSS statistical version 16.0, a correlation analysis was carried out between the fluoride concentration in the water and the other indices of water quality.

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DATA ANALYSIS

There is a wide range in fluoride concentrations across various types of vegetables, just as there is among these other minerals. Results of examinations of the raw vegetable's fluoride accumulation, protein content, and carbohydrate content are shown in tables 1, 2, and 3 below. In contrast to roots and fruits, leafy greens including cilantro, fenugreek, spinach, and cabbage accumulated more fluoride. The highest concentration of fluoride in vegetables was identified in onions (5.1040.305mg/kg) in the Nagore district, while the lowest concentration was reported in potatoes (0.1720.018mg/kg) in the Udaipur region. Based on the findings, it seems that other biochemical parameters (carbohydrate and protein levels) tend to decline as fluoride concentration increases.

Table 1: Carbohydrate, %Protein and Fluoride content in selected vegetables of Kota district (± Std. Dev.).

KOTA				
Sr.N.	VEGETABLE	CARBOHYDRATE (mg/gm)	% PROTIEN	FLUORIDE (mg/kg)
1	Lady finger	70.14±0.464	8.875±0.921	0.716±0.015
2	Cluster bean	68.39±0.392	9.634±0.734	1.029±0.132
3	Brinjal	71.07±0.273	8.235±0.657	0.837±0.018
4	Cauliflower	72.24±0.218	7.169±0.729	0.914±0.214
5	Broccoli	69.51±0.457	9.729±0.527	1.126±0.402
6	Cucumber	70.10±0.412	9.541±0.614	0.821±0.091
7	Peas	67.32±0.374	8.081±0.431	0.726±0.104
8	Potato	69.29±0.197	7.152±0.525	0.904±0.121
9	Tomato	72.51±0.316	7.261±0.631	0.621±0.074
10	Zucchini	70.37±0.213	7.521±0.814	0.734±0.018
11	Pumpkin	71.26±0.429	9.325±0.701	1.168±0.062
12	Beet root	70.63±0.137	8.167±0.634	0.274±0.110
13	Radish	69.37±0.326	9.231±0.610	0.716±0.059

Table 2: Carbohydrate, %Protien and Fluoride content in selected vegetables of Nagore district (± Std. Dev.).

NAGORE				
Sr.N.	VEGETABLE	CARBOHYDRATE (mg/gm)	% PROTIEN	FLUORIDE (mg/kg)
1	Spring onion	49.01±0.734	4.132±0.239	3.129±0.147
2	Ginger	55.37±0.897	5.269±0.137	4.647±0.204
3	Garlic	45.29±1.018	5.325±0.059	3.371±0.169
4	Turnip	41.15±0.912	4.134±0.231	3.176±0.236
5	Onion	39.05±0.721	4.051±0.171	5.104±0.305
6	Sweet potato	58.19±0.836	3.967±0.084	3.273±0.178
7	Spinach	37.71±0.629	3.852±0.174	2.229±0.214
8	Potato	56.18±0.614	4.441±0.098	4.147±0.194
9	Cabbage	38.09±0.729	2.152±0.121	4.039±0.231
10	Carrot	42.44±0.814	3.347±0.096	3.714±0.294
11	Fenugreek leaf	38.29±0.529	4.269±0.128	4.461±0.136

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Table 3: Carbohydrate, % Protien and Fluoride content in selected vegetables of Udaipur district (± Std. Dev.).

UDAIPUR				
Sr.N.	VEGETABLE	CARBOHYDRATE (mg/gm)	% PROTIEN	FLUORIDE (mg/kg)
1	Potato	74.27±0.984	5.231±0.327	0.172±0.018
2	Tomato	67.36±1.034	4.167±0.521	1.217±0.132
3	Bitter gourd	58.15±0.785	4.259±0.278	0.984±0.094
4	Bottle gourd	61.09±0.837	3.324±0.436	1.102±0.051
5	Spinach	53.21±0.972	5.679±0.372	1.030±0.126
6	Taro	59.27±0.736	6.531±0.391	2.011±0.084
7	Onion	54.19±1.027	4.134±0.514	1.237±0.037
8	Turnip	53.15±1.139	4.467±0.602	1.184±0.128
9	Coriander	47.20±0.839	5.337±0.510	0.976±0.027
10	Brinjal	56.22±0.914	5.021±0.481	0.855±0.154
11	Pumpkin	58.32±0.829	4.305±0.316	1.207±0.390
12	Cucumber	46.14±1.074	6.169±0.291	0.784±0.097
13	Cauliflower	52.27±0.725	5.142±0.370	0.654±0.134
14	Broccoli	55,62±0.821	6.554±0.429	1.029±0.096

Carbohydrate

Plants' sugar concentrations are inversely proportional to the severity of the stresses they're experiencing. The leaf and vegetable lowering sugar levels of the fluoride-affected region were much lower than those of the control area. Under fluoride stress, photosynthesis slows down, and less photo assimilate accumulates in the leaves and fruits of the plant. This reduces the susceptibility of the plant to the contaminant. Leaves of plants exposed to F have been shown to have lower quantities of reducing sugars like glucose, fructose, and mannose, suggesting that these sugars are being converted to non-reducing sugars like sucrose and raffinose or sugar alcohols. Plants may respond to these circumstances by increasing non-reducing sugars in tissues, which may mitigate the harmful effects of F.

Protein

According to Chang, the deleterious effects of fluoride on protein synthesis extend to a reduction in the number of ribosomes and the destruction of the structure of ribosomal proteins. We are able to reach the same conclusion based on our investigation. The lowered rate of amino acid synthesis caused by fluoride stress resulted in significantly lower protein content in the leaves and vegetables of several species grown in the fluoride-stressed region compared to the control area.

When the NaF concentration was raised, the average root and shoot length decreased, as shown in Table 4. The seedlings' shoot growth was significantly impacted although the roots were only mildly affected. It's likely that the F-caused reduction in root and shoot length is due to an

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insufficiency in nitrogen intake by the seedlings. Root and shoot lengths were both considerably improved by SA treatment compared to their respective control groups. Our results show that SA enhances shoot and root growth in a variety of plant species, perhaps through regulating cell division and elongation and restricting auxin oxidation.

Table 4. Effect of sodium fluoride (NaF) on seed germination, root and shoot length, and vigor index in C. lanatus seedlings under salicylic acid (SA) treatment.

Group	Seed Germination (%)	Root Length (cm)	Shoot Length (cm)	Vigor Index
Control	90.81±1.28	7.46±0.002	5.36±0.050	1065.04±25.16
NaF 1 mM	78.30±1.02*	5.83±0.18*	3.66±0.031*	743.81±11.21*
NaF 10 mM	70.40±1.13	4.16±0.009*	2.96±0.021*	502.53±30.55*
SA 0.25 mM	97.83±1.11*	8.66±0.003*	6.63±0.052	1496.87±10.00
NaF 1 mM + SA 0.25mM	90.59±1.19	6.83±0.012	4.66±0.011*	1042.00±13.09
NaF 10 mM + SA 0.25mM	85.65±1.02*	5.33±0.011	4.20±0.019	816.66±6.89
CD at 5% level†	0.0276	0.021	0.011	1.102.00

The research found that increasing the concentration of NaF had a detrimental impact on the vigour index, a measure of seed vigour based on the rates of germination and development of the young plants. The seed vigor index was highest for seedlings given either SA alone or SA with NaF, compared to the corresponding controls.

CONCLUSION

Plants' sugar content is proportional to their amount of exposure to various stresses. Fluoride afflicted areas have significantly lower reducing sugar in their leaves and vegetables compared to unaffected areas. This may be because, under fluoride stress, photosynthesis slows down, resulting in less photo assimilate being accumulated in leaves and fruits. Our results show that farmers might benefit from using SA to pretreat seeds to lessen the damaging impact of F on young seedlings.

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