Evaluation of fluoride uptake and accumulation by *Portulaca grandiflora* Hook. and *Brassica oleracea* Linn. from water

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***Abstract*—Phytoremediation plays an important role to clear up metal polluted soils and water reservoirs. Fluoride is a one of the common environmental pollutant in soil and water. In present investigation, the possible role of *P. grandiflora* and *B. oleracea* plants to uptake and accumulate fluoride from water was studied. These plants were grown in minus fluoride culture medium as a control and 10mg/l concentration of fluoride as Test group. Results revealed that, the fluoride uptake by test group *P. grandiflora* (90.46%) and *B. oleracea* (87.43%) were observed maximum over the control. The accumulation of fluoride was comparatively more in root than that of leaf parts in both studied plants. However, the exponential decrease in protein and total sugar content were observed due to uptake and accumulation of fluoride. Thus, present study is important to describe phytoremediation potential of *P. grandiflora* and *B. oleracea* plants.**

Index Terms*— Phytoremediation, fluoride, *P. grandiflora, B. oleracea

I. INTRODUCTION

From recent past decades, the natural resources are highly contaminated due to heavy metals. Pollution of natural resources by heavy metals may be due to industrial effluents, weathering of rocks, volcanic eruption and unregulated human activities. In India states like Andra Pradesh, Bihar, Chattishgarh, Haryana, Maharashtra, Karnataka, Orissa, Punjab, Utter Pradesh, and West Bengal are mainly affected by fluoride. Recently, Patil *et al.,* [1] reported that fluoride content in drinking water of some villages of Shirala Taluka, (MS) India exceeds the WHO specifications. They stated that, water quality was found to be unsatisfactory for drinking purpose without any prior treatment.

Phytoremediation is the direct use of plants to remove metals from soil and water. Asada *et al.,* [2] state that, phytoremediation process involve use of green plants and their associated microorganisms to stabilize or absorb contaminants from soils, sludge, sediments, surface water and ground water.

Fluoride is one of the heavy metal and it may be considered as potent environmental pollutant. Fluoride is the ionic forms of fluorine. It is widely distributed in our earth. Soils and rocks are the main sink of fluoride. According to Sinha *et al.,* [3] fluoride has been considered as both an essential element and pollutant at high concentrations that causing number of disorders among the consumers. Santos-Diaz *et al.,* [4] studied the uptake of fluoride by using seventeen different plant species under hydroponic culture. According to him, these plants species are tolerant to Hydrogen fluoride (HF).

No any strong evidences available to remediate fluoride from water sample by using *B. oleracea* and *P. grandiflora*. Hence this investigation will be design to focus on fluoride uptake and accumulation by using these test plants.

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II. MATERIAL AND METHODS

The seedlings of *Portulaca grandiflora* and *Brassica oleracea* were collected from Sajeev nursery, Kolhapur, India. The SPADNS method was used to determine the fluoride content in water sample. The standardization of fluoride solution (10 mg/l) was done and used for further study

Standardization of fluoride-

In the present study, standardization of fluoride (10 mg/l) was done with the help of SPADNS method.

Screening of plants-

At the initial, a number of common garden plants were screened for fluoride uptake. From which, *P. grandiflora* and *B. oleracea* plants were selected. The roots of these plants were washed off under tap water and finally with distilled water. The whole fluoride uptake and accumulation experiment was performed in 100 cm^3 Erlenmeyer flasks containing 50 ml of 10 mg/l fluoride solution with one uprooted plant as test group while, only 50 ml of distilled water taken as control. The fluoride contents were measured on 0^{th}, 7^{th}, 14^{th}, and 21^{st} days.

Estimation of fluoride by plants-

The fluoride uptake by *P. grandiflora* and *B. oleracea* plants was estimated by taking solution from test as well as control group by SPADNS method.

Determination of fluoride removal percentage-

The fluoride removal percentage by *P. grandiflora* and *B. oleracea* plants measuring the concentration of fluoride by SPADNS method at 0^{th} day (Initial) and 21^{st} day (final).

Estimation of fluoride accumulation in plants-

The roots and leaves extract of control and test plants were used to estimation of fluoride accumulation in plants.

Effect of fluoride accumulation on protein and total sugar-

The fresh roots and leaves extract of control and test plants were used to analyze effect of fluoride accumulation on protein and total sugar. The protein content and total sugar were estimated by the methods of Lowry *et al.,* [5] and Anthrone method.

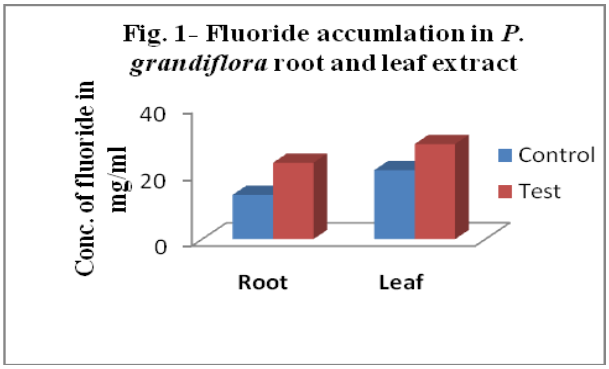
III. RESULT AND DISCUSSION

The both plant species showed variable results against fluoride uptake and accumulation. The plants were found to be absorbed and accumulate different amount of fluoride from remaining solution of fluoride. The result revealed that, the test group *P. grandiflora* showed 90.46% fluoride absorbs potential while *B. oleracea* absorb about 87.43% of fluoride in 21^{st} days of incubation (Table-1).

Groups		**Concentration of fluoride in mg/ml**			
		0^{th} day	**7^{th} day**	**14^{th} day**	**21^{st} day**
P. grandiflora	Control	2	1.5	-	-
	Test	16.84	14.08	7.91	1.617
B. oleracea	Control	2.17	2	-	-
	Test	16.78	14.76	8.47	2.12

Values are a mean of three experiments

The roots of test group plants accumulate higher amount of fluoride than that of control group. The fluoride accumulation in roots of test group *P. grandiflora* was 22.96 mg/ml while in control it's about 13.30 mg/ml. Similarly, test group *B. oleracea* accumulate more fluoride in root which was about 12.91 mg/ml as compared to control, 11 mg/ml. (fig.1-2). Contradictory results observed by, Arjun Khandare and G. Shankar Rao [6] According to them, cabbage accumulate less fluoride than other vegetables crops.



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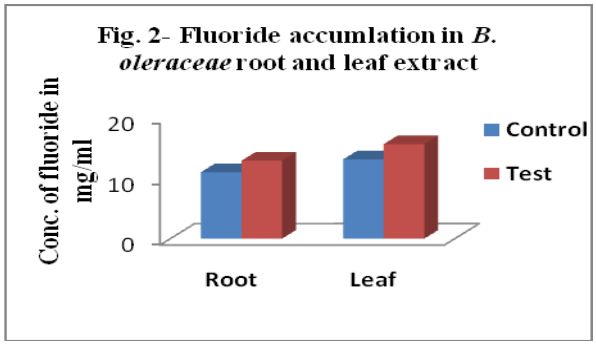
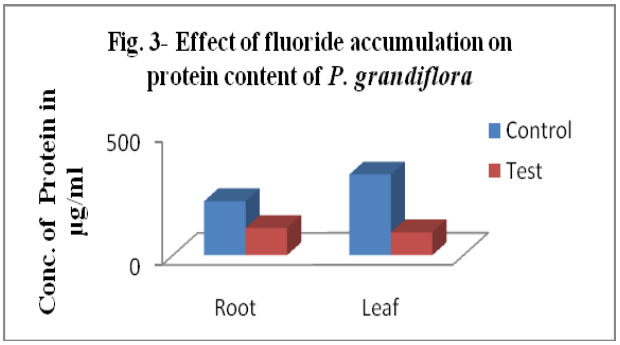
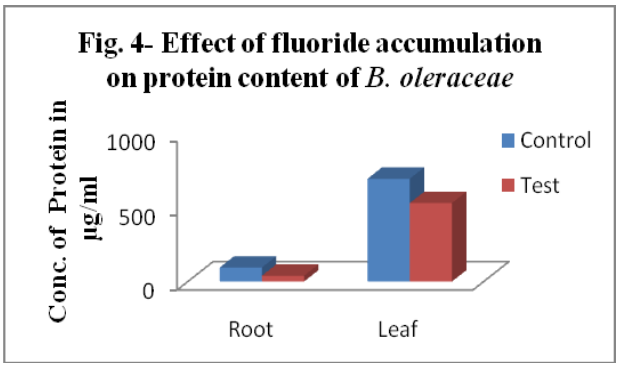


The similar results were observed by Mamta Baunthiyal and Vinay Sharma [7]. According to them, *A. tortilis*, *P. juliflora*, and *C. fistula* were accumulating maximum fluoride in their roots. The fluoride accumulation in leaf extract of test group *P. grandiflora* was considerably more than that of control sample, which was about 28.58 mg/ml and 20.71 mg/ml respectively. Whereas, the fluoride content in the leaf of test group *B. oleracea* was 15.66 mg/ml, which was slightly higher to that of control, 13.12mg/ml.

The effect of fluoride accumulation on protein content in root and leaf extract is shown in Fig.3-4.





The result obtained in present study showed exponentially decreases in protein content were observed in the both plant species. In control, *P. grandiflora* the protein content in root showed 220µg/ml and in roots extract which was reduced to 111µg/ml. In case of *B. oleracea* the root extract showed 329µg/ml proteins in control which was reduced to about 93.45µg/ml in test *B. oleracea*. While, the leaf protein content in control *P. grandiflora* showed 329µg/ml which was exponentially decrease in test *P. grandiflora* about 93.45µg/ml. similarly, results was observed by *B. oleracea*. The leaf protein content in test *B. oleracea* drastically reduced over control plant. The total sugar content in test *P. grandiflora* exponentially decreases from 666µg/ml to 495µg/ml due to effect of fluoride accumulation. While, there was very less decrease in total sugar observed from 115µg/ml to 103µg/ml in *B. oleracea* (Table-2).

Groups		Concentration of Total Sugar content in µg/ml
P. grandiflora	Control	666
	Test	495
B. oleracea	Control	115
	Test	103

Values are a mean of three experiments

IV. Conclusion

Phytoremediation is a promising technology for the treatments of polluted soil and water resources. The present study revealed that, *P. grandiflora* and *B. oleracea* can clean fluoride contaminated water considerably. Thus, the use of these plants would be cost effective and eco friendly for *in situ* treatment of soil and water samples.

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