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Evaluating the effect of Calcium on Fluoride as water pollutant in Fenugreek plant growth

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Abstract

The aim of the study is to determine the effect of calcium on fluoride consumption in fenugreek. Fenugreek is one of the oldest medicinal plant used as simulant, as skin care, for hair care, for weight management, etc. Fluoride is an accumulative poison in plant foliage. It strongly inhibits the process of photosynthesis. Many studies shows that calcium interferes with absorption of fluoride and diminishes its effect. For these, two sets of experiment were done in which fluoride was taken as water pollutant. In first set of experiment different concentration of fluoride was taken. In second set of experiment same concentration as first of experiment was taken but with fluoride calcium was also mixed with it. As a control condition dist. Water and tap water is used. Then seeds were sown in field and manuring and watering was done normally. At the interval of every 14 days growth data were taken up to yield.

Key words : Sodium fluoride, calcium chloride, toxicity, removal, growth data, water pollutant.

Fenugreek is one of the oldest medicinal plants originating in India and North Africa[6]. Trigonella foenum graecum, an annual plant in the Leguminosae family, is the source of fenugreek. It is the well-known seasoning used in human meals. Fenugreek seeds and green leaves are used both as food and as medicine, according to a long-standing custom in human history. One of the many chemical components of fenugreek is steroid sapogenins[16]. The stem has 28% mucilage, a volatile oil, two alkaloids like trigonelline and choline, 5% of a more potent-smelling fixed oil with a bitter taste, 22% proteins, and a yellow colouring substance[8]. According to the US Department of Agriculture[14], fenugreek has 23-26% protein, 6% to 7% fat, and 58% carbs, of which 25% is dietary fibre.

Both Greek and Latin pharmacopoeia as well as Ayurveda scriptures discuss the therapeutic benefits of fenugreek seeds. Although this plant is praised in Ayurveda scriptures for its potency as an aphrodisiac,

current vaidyas appear to use it more for digestive and respiratory issues brought on by an excess of kaph (phlegm) and vat (wind)[16].

Rich in vitamins and minerals and strong in protein due to its status as a seed and a legume. In addition, they are a significant source of diosgenin (Food Reference, 2004). In Turkey, where it is produced on 700 hectares with an annual production of 670 tonnes and a yield of 957 kg/ha, fenugreek has been a common crop for a very long time (Anonymous, 2000). While the leaves are being used as green leafy vegetables, the seeds are utilised as spices all over the world. Fenugreek seeds have a bitter flavour and have long been valued for their therapeutic effects. The 6-8% of fenugreek oil which can be extracted has a foetid smell, a bitter flavour, and strong drying characteristics. Dietary fibres, indigestible complex carbohydrates that are included non-plant foods, are a core part of a nutritious diet. While others generate insoluble roughage, some are soluble and produce a gel. Dietary fibre from fenugreek is very stable, with a long shelf life. The bitterness, gastrointestinal stimulation, increased acidity, and increased hunger of fenugreek are caused by its 4 to 8% saponins and 1% alkaloids[15].

The element fluorine, a gas that never appears in nature in a free state, is the source of the fluoride ion. Fluoride is widely present in the environment and only appears as fluoride compounds, which are parts of the minerals in rocks and soil. Consequently, fluoride is frequently linked to volcanic activity.

Groundwater fluoride contamination levels can range from 1.0 to 48 mg/l. One of today's most urgent problems is the fluoride contamination of groundwater, which has a detrimental effect on every continent in the world. The research sites' groundwater samples had fluoride concentrations ranging from 0.20 to 1.10 ppm[17].

Fluoride has a significant propensity to pick up a negative charge and produce fluoride ions in solution because it is extremely electronegative. Up to 40% of ingested fluoride is absorbed from the stomach as HF when fluoride is present in aqueous Solutions in acidic environments like those of the stomach. Fluorosis has been shown to be endemic in 20 Indian states. In India, endemic fluorosis poses a risk to around 62 million people, including 6 million children[9]. As calcium uptake is frequently shown to be hindered by F, the complexion of F with Ca has been suggested as a mechanism explaining F toxicity in plants[2]. Investigating the effects of pH and Ca in solution or soil on the absorption of F by tea plants was the goal of this investigation.

Material : Glass, petridish, NaF, $Cacl_2$, dist. Water, fenugreek seed, vermicompost, weighing scale.

First, sterilized the glass and Petridishes. Two set of experiments were prepared. In first set of experiment, different concentration solution of NaF were made e.g., 175 ppm(P3), 350 ppm(P4), 525 ppm(P5), 700 ppm(P6) and 825 ppm(P7). In second set of experiment $Cacl_2$ was First, sterilize the glass and petridishes. Two set of experiments were prepared. In first set of experiment, different concentration solution of NaF were made e.g., 175 ppm(P3),

350 ppm(P4), 525 ppm(P5), 700 ppm(P6) and 825 ppm(P7). In second set of experiment $Cacl_2$ was mixed with NaF and same as set first different concentration solution were made175 ppm (P8), 350 ppm (P9), 525 ppm (P10), 700 ppm (P11) and 825 ppm (P12). 50 dry fenugreek seeds were taken and dipped in this solution for overnight. As a control condition 50 seeds of fenugreek were dipped in dist. Water (P1) and other 50 seeds were dipped in tap water (P2) for overnight. Then these pretreated seeds were transferred to field plot. Vermicompost was used as manure and watering was done normally. After every 14 days, growth data were measured up to life cycle.

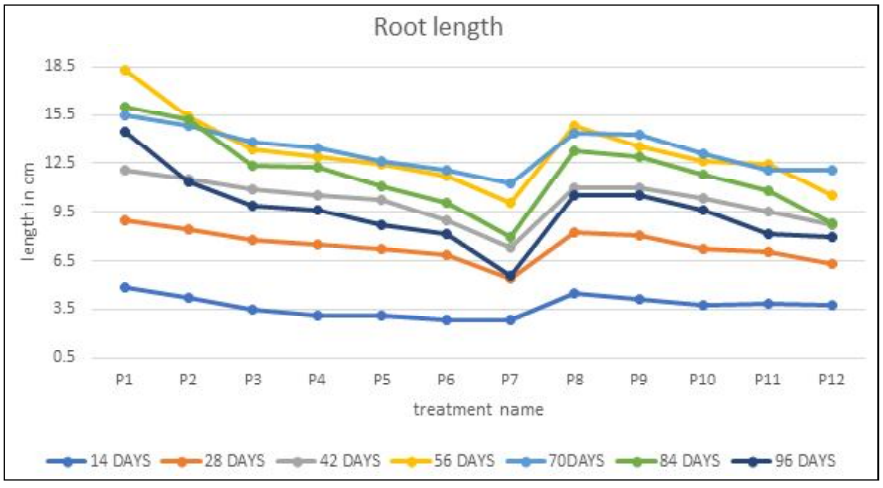
Vegetative growth :

Root length :

As seen in graph 1 the root length, which were treated with only fluoride shows stunt growth as the concentration of NaF increases. Lower concentration of NaF (175 ppm NaF) has the maximum root length in that series while the higher concentration has the lowest root length in that series. This root length gets decreasing as the NaF concentration increases. While in the second set, which was treated with NaF + $Cacl_2$, the lowest concentration has the maximum root length which was also higher value than only fluoride treated (first set of experiment, 175 ppm NaF) plants. Higher Concentration of NaF + $Cacl_2$ shows higher growth than only fluoride treated higher concentration (825 ppm NaF) but lower than 175 ppm to 700 ppm NaF + $Cacl_2$ treatment. While the control condition which was dist. Water has the highest root length followed by tap water.

Stem length :

From the graph 2, it is clear that the control condition (Dist. Water (P1) and tap water (P2)) has the highest stem length in this experiment. In the first set of experiment which was treated with only fluoride same as seen in root, lower concentration (175 ppm NaF(P3)) has higher stem length followed by 375ppm(P4), 525 ppm(P5), 700 ppm NaF(P6).

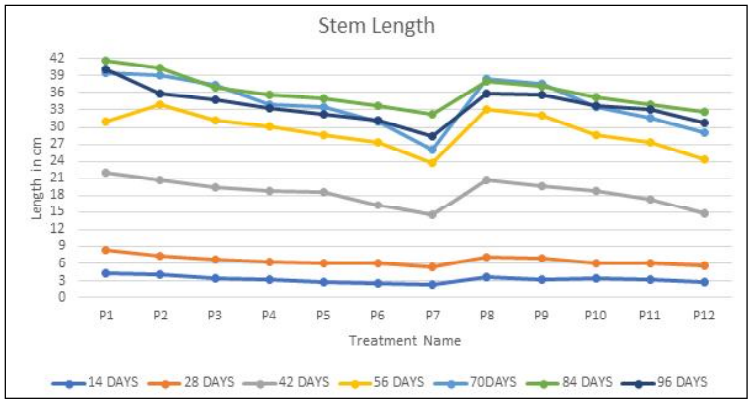


Graph 1. Effect of NaF and NaF + $CaCl_2$ on Root length of fenugreek

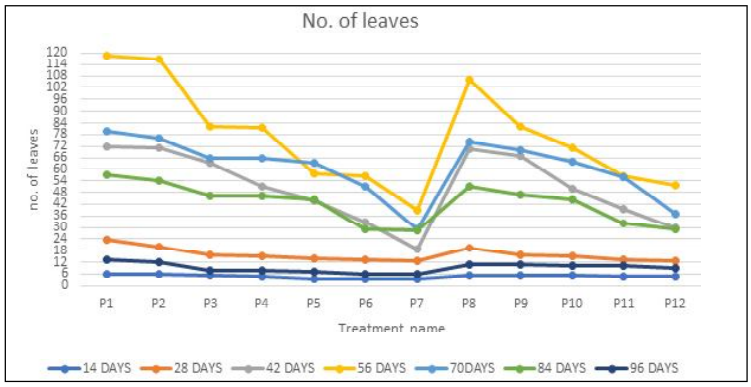
Higher concentration 825 ppm NaF(P7) has the lowest stem length in the whole experiment, while in the second set of experiment lower concentration 175 ppm NaF+$Cacl_2$ (P8) has the third highest stem length followed by 350 ppm(P9), 525 ppm(P10), 700 ppm(P11) and 825 ppm NaF + $Cacl_2$ (P12). From the graph it can be see that 350 ppm and 525 ppm NaF + $Cacl_2$ has not much difference in length.

Leaves no :

Looking at the graph 3, the plants treated with only NaF shows reduction in no. of leaves. In which the higher concentration 825 ppm NaF has the lowest no. of leaves among the whole experiment, while the higher concentration 825 ppm NaF + $Cacl_2$ has also the lowest no. of leaves in second set of experiment but it was higher than 825 ppm NaF, Lower concentration of only fluoride 175 ppm NaF has more no. of leaves in the first set of experiment followed by 350 ppm, 525 ppm, 700 ppm and 825 ppm NaF. Where there is an increase in 200 ppm, NaF + $Cacl_2$ over 175 ppm NaF has more no. of leaves which was followed by 350 ppm, 525 ppm, 700ppm and 825 ppm NaF. Where there is an increase in 2ppm NaF + $Cacl_2$ over 175ppm NaF in no. of leaves which was followed by tap water treated plants. Damage of fluoride in broadleaf plants causes necrosis leaf tip and margins.



Graph 2. Effect of NaF and NaF + $CaCl_2$ on Stem length of fenugreek



Graph 3. Effect of NaF and NaF + $CaCl_2$ on no. of leaves of fenugree

From these three graphs, it can be said that Dist. Water and tap water has the highest vegetative growth followed by second set of experiment (NaF + $Cacl_2$). Only fluoride treated plants shows stunt growth in all the three parameters. So, fluoride induce the vegetative growth very affectively. As the concentration of fluoride increases the growth shows more stunt. Where adding calcium can remove the effect of fluoride on vegetative growth. As root length gradually increased with increasing concentrations of fluoride as high as 95 mg NaF per kg of soil, shoot length gradually decreased with the increase. Fluoride has a significant influence on the length of roots and shoots.

Fresh weight of root, stem and leaves :

The root of distilled water treatment (graph no04) has higher fresh weight than tap water has higher fresh weight of root. Only fluoride treated plants (first set of experiment)

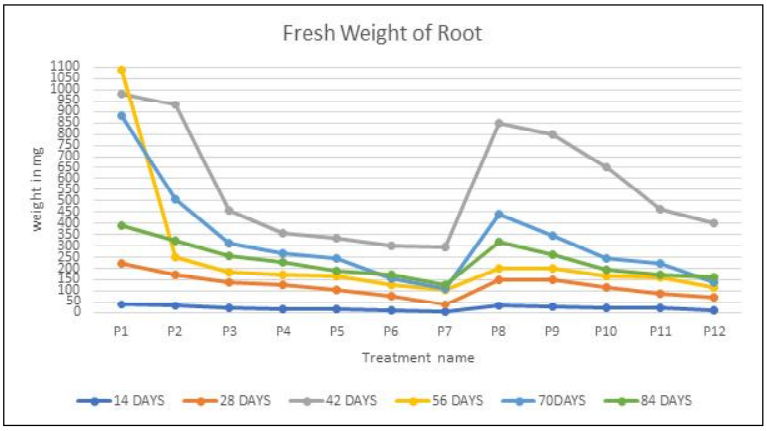
Shows continue reduction as the concentration increases. Same as first set, second set shows continue reduction as the concentration increases but it was higher than only fluoride treated plants and lower than tap water and dist. Water.

Fresh weight of stem :

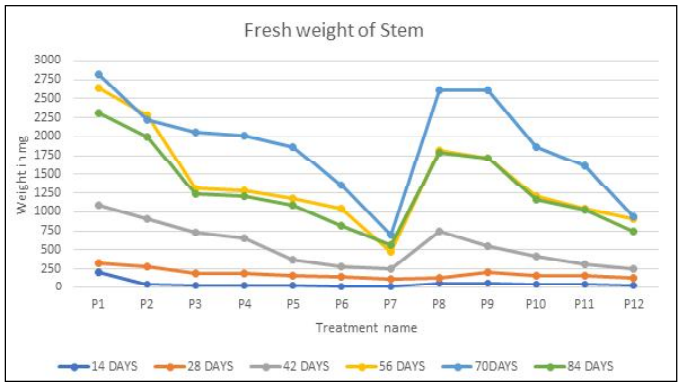
Same as root, dist. Water has the highest fresh weight followed by tap water. Only fluoride treated plants shows retarted fresh weight. Plants treated with Calcium mixed with fluoride also shows retarted fresh weight but higher than that of only fluoride treated plants. In this both set of experiment, as the concentration increases fresh weight deceases. Dist. water and tap water have the highest fresh weight. (Graph 5).

Fresh weight of leaves :

Looking at the graph 6, same as fresh weight of root and stem, leaves show the same result. Dist. Water has the highest fresh weight followed by tap water. Only fluoride treated plants shows continue reduction in weight but calcium can reduce the effect of fluoride in second set because fresh weight in second set is higher than first set of experiment. Upon absorption of high levels of fluoride, the plant's metabolism becomes impaired, and necrosis, needle senility, and tip burn disease are caused[10].



Graph 4. Effect of NaF and NaF + $CaCl_2$ on Fresh weight of Root of Fenugreek



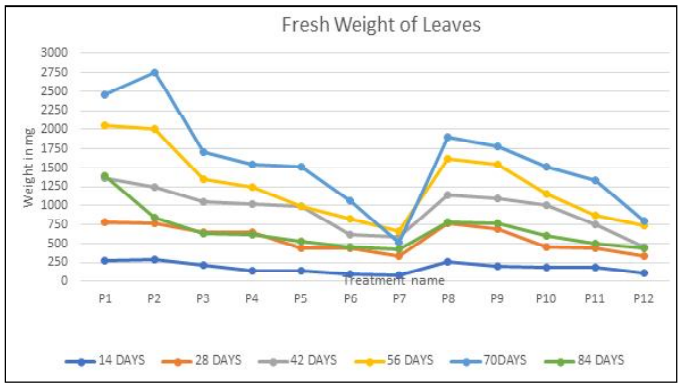
Graph 5. Effect of NaF and NaF + $CaCl_2$ on Fresh weight of stem on Fenugreek.

Dry weight of root, stem and leaves :

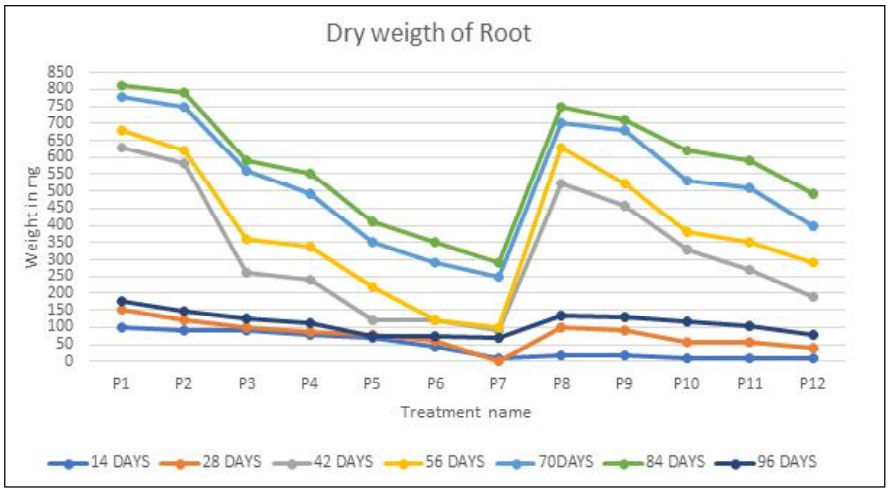
As seen from graph no (7), (8) and (03) dry weight of root, stem and leaves in higher concentration of first set of experiment (825 ppm NaF) shows stunt growth and lowest dry weight among the whole experiment where lower concentration (175 ppm NaF) shows more dry weight than higher concentration. While in the second set in which calcium was mixed with fluoride, higher concentration (825 NaF + $Cacl_2$) shows stunt growth but lower concentration (175 ppm NaF + $Cacl_2$) shows much good dry weight than higher concentration. Dist. Water highest dry weight followed by tap water. Dry weight of leave and root, 175 ppm, 350 ppm and 525 ppm has not much difference.

Reproductive growth :

After 32 days of seed sown, first pod appears in and maximum no. of pods are from dist. Water treated plants. This was followed by tap water. The no. of pods is not much less than dist. Water. The first set of experiment (only NaF treated plants) in which lower concentration (175 ppm NaF) has maximum no. of pods and higher concentration (825 ppm NaF) has the lowest no. o pods. Then in second



Graph 6. Effect of NaF and NaF + $CaCl_2$ on fresh weight of leaves on fenugreek



Graph 7. Effect of NaF and NaF + $CaCl_2$ on dry weight of root on Fenugreek

set (calcium mixed with fluoride) pods has lowest no. of pods than $Cacl_2$ + NaF. But in both the experiments as the concentration increases no. of pods decreases. An interactive effect of fluoride and calcium on tomato pollen germination and growth were confirmed by sulzbach and pack. Similar results were also obtained using Pant *et al*. as gram of Bengal, wheat, mustard and Tomato[12]. (Graph 10).

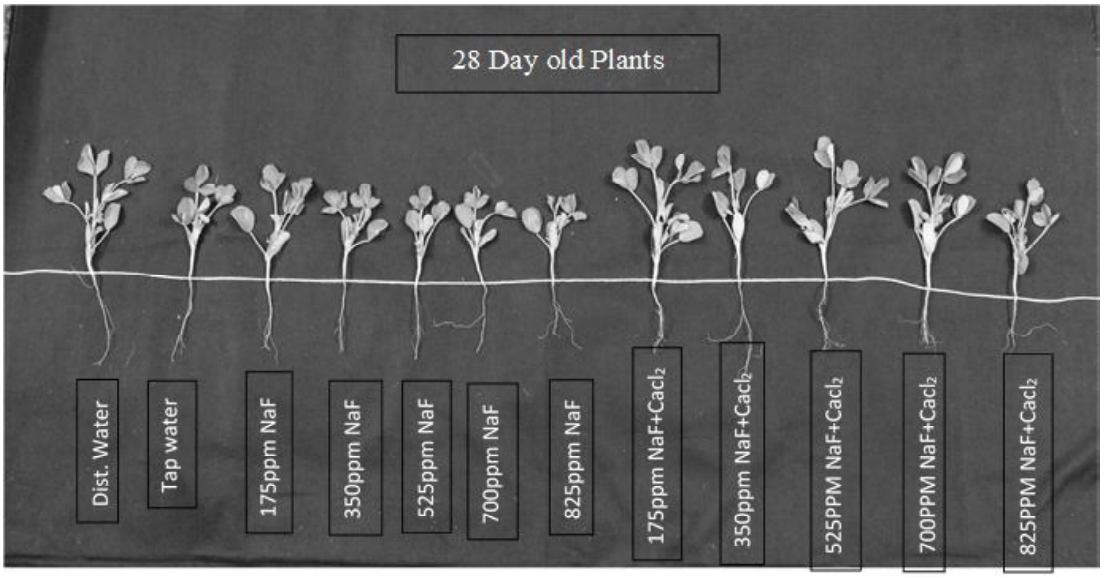
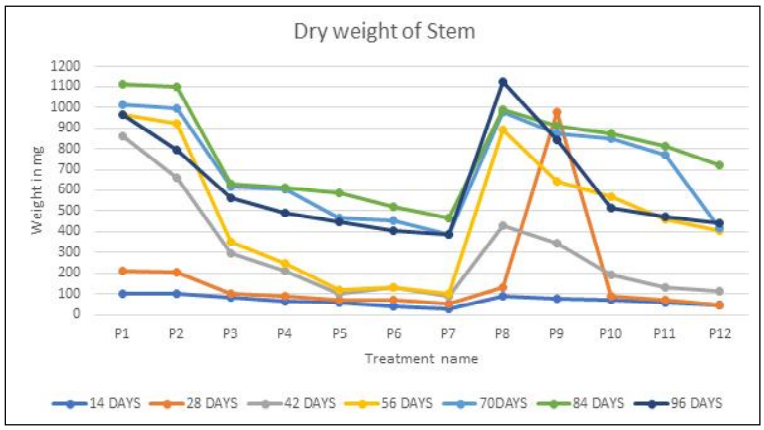
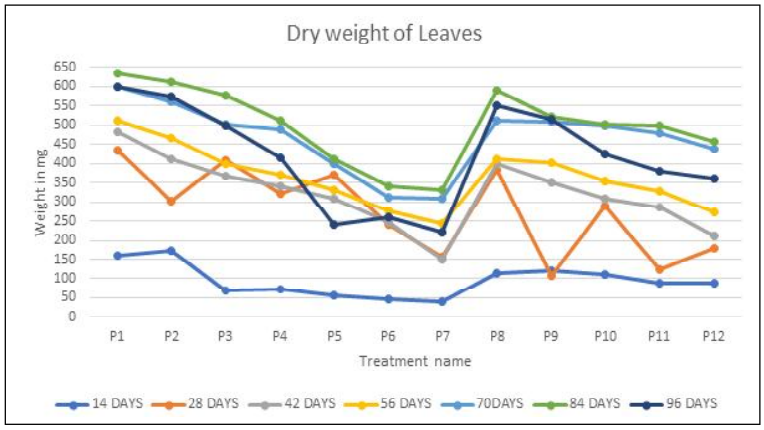


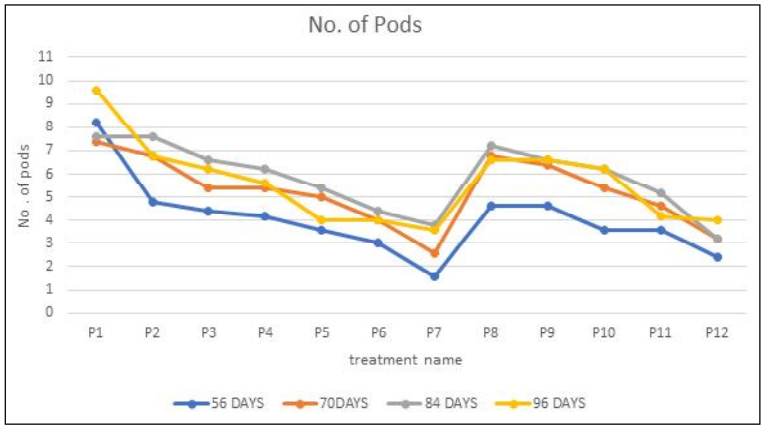
Figure 1. Effect of NaF and NaF + $CaCl_2$ on Fenugreek plant (28 days old plants)



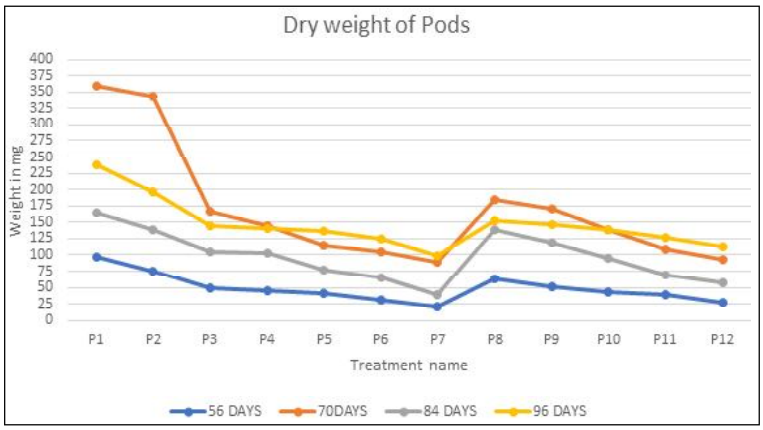
Graph 8. Effect of NaF and NaF + $CaCl_2$ on Dry weight of stem of fenugreek



Graph 9. Effect of NaF and NaF + $CaCl_2$ on Dry weight of leaves of Fenugreek



Graph 10. Effect of NaF and NaF + $CaCl_2$ on No. of pods of Fenugreek



Graph 11. Effect of NaF and NaF + $CaCl_2$ on No. of pods of Fenugreek

Dry weight of pods :

As seen in graph (11) dry weight of distilled water has the higher f dry weight followed by tap water. Looking at the graph set-1 experiment (only fluoride treated plants) contain lower dry weight, which was in continue reduction as the concentration increases. Higher concentration has the lowest weight. In second set of experiment (calcium mixed with fluoride) has lower dry weight as the concentration increases but higher than the first set of experiment but it was seen lower than dist. Water and tap water. In addition, they said that Florida's treatment, particularly at higher concentrations, is detrimental to wheat development and production. Water is the major source of fluoride, however bioaccumulation of fluoride in wheat grains generates secondary sources of fluoride for the human population, leading to food-borne fluorosis.

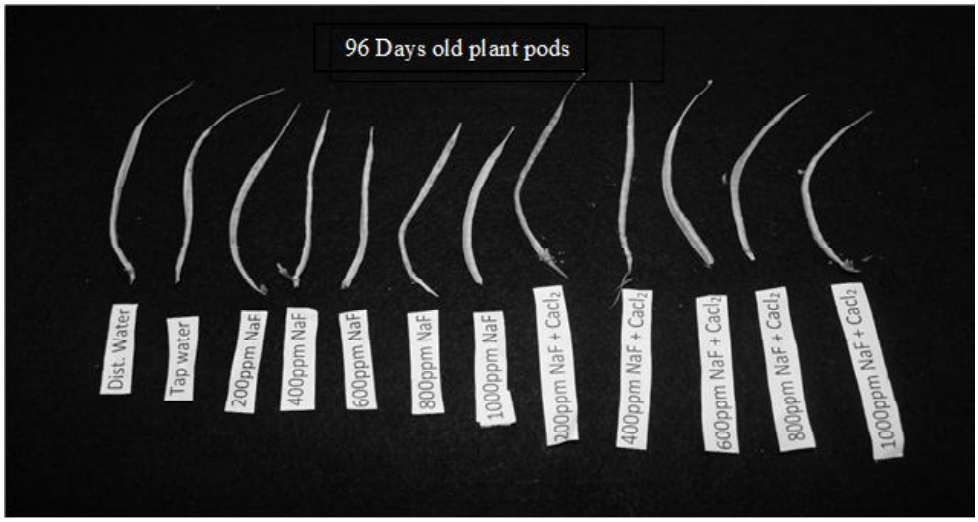


Figure 2. Effect of NaF and NaF + $CaCl_2$ on pods of Fenugreek (96 days)

Figure 3. Effect of NaF and NaF + $CaCl_2$ on Fenugreek plant on 42nd day (control condition plant)

According to the findings of the current study, fenugreek has a significant capacity to absorb fluoride. Aerial sections had more fluoride than subsurface parts. The length, fresh weight, and dry weight of the root, stem, and leaves are all significantly reduced by fluoride. Chlorosis and leaf necrosis are possible outcomes. In contrast to plants that have simply been treated with fluoride, the effects of fluoride when combined with calcium seem to be less detrimental. Growth in both the vegetative and reproductive organs was impacted. With only fluoride-treated plants, the number of pods and dry weight of pods were also significantly impacted, but when calcium and fluoride were combined, the number of pods and dry weight of pods increased. Which unmistakably shows that calcium can somewhat mitigate the effects of fluoride.

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