"The effect of Vetiver (*Chrysopogon zizanioides* L.) in the removal of fluoride and other contaminants from water for human consumption in the village of Guarataro, Yaracuy State, Venezuela"

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SUMMARY

Key words: Chrysopogon zizanioides L. / Vetiver / treatment of waters / fluorine / phytoremediation / Vetiveria

An essay was performed with vetiver grass of the hydroponic treatment of water contaminated with fluoride in the community of Guarataro, in Yaracuy state, Venezuela. This community has shown serious problems, especially damage to public health, due to the consumption of untreated water contaminated with fluoride. The high concentrations of this element in the drinking water coming from underground springs surpass the limits set by international norms. In conjunction with other factors, this has caused dental fluorosis in the population; this condition is characterized by dental lesions consisting of enamel alterations, as well as gingival and alveolar lesions in some cases. In this community, 93% of the population presents damage by dental fluorosis, especially children in school age. The main objective of this work was to develop a water treatment system for the removal of fluoride from water through the use of vetiver. The installed physical model consisted of five plastic containers of 200L each one, connected in series for treatment with vetiver like and for the treatment without vetiver (control). Five culms of vetiver approximately one year old were placed in the containers through a simple flotation system using plastic vessels. The plants, which were approximately 30 cm long, were allowed to grow in contaminated water. Samples to evaluate the behavior of the model were taken to the entrance and so much exit of the system vetiver like in the system without vetiver. An initial analysis was conducted 2 months after the installation of the treatment system. This analysis showed a slight reduction in the fluoride levels of the water, from $2,72 \text{ mg/l}^{-1}$ a $2,22 \text{ mg/l}^{-1}$ in the vetiver system. Further analyses were performed over several months, and the results showed that there was no reduction of the contaminant in the water of either system. Nutrient analyses (for nitrogen and phosphorus) were also performed; the results showed an important reduction of over 90% in the nitrate levels of the vetiver system. This system also showed an initial increase in phosphorus, but the level of this element later decreased to minimal levels. There was an increase in the electrical conductivity of the vetiver system with respect to the non-vetiver, and other parameters like temperature, pH and suspended solids were also measured. As for the chemical analysis performed on the plant tissue, there was evidence of fluoride accumulation in both the foliage and roots of vetiver.

INTRODUCTION

In some areas the problematics of the presence of chemical elements in the waters of consumption has caused pollution of the same ones, specially in the underground waters, these chemical elements in high concentrations believe potential risks to the public health. Inside the chemical elements one finds the fluorine, has caused serious problems to plants, animal and to the health of the persons in many parts of the world (Alarcón et al., 2001). In Venezuela, there exists a community that has come presented serious problems of water pollution with fluorine, specially causing damages to the public health due to the consumption of these waters without previous treatment. It is for this reason that in this project there was studied the possible removal of the fluorine and other pollutants with vetiver. With it, one tries to possess an alternative of treatment to reduce the levels of fluorine of the water of supply to the population, and to limit the exhibition and risk for this route to the above mentioned element, allowing so the inhabitants of this community have a better quality of life. The Technology of the Pasture Vetiver (TPV) has been developed by investigators in programs of application about the world in the last 15 years. This system being used this one in more than 70 countries (Chomchalow, 2006). The TPV is of low cost, is an ecological alternative and a tool of fitorremediación for the control and the extenuation of the pollution (Truong, 2001).

MATERIALS AND METHODS

There took raw water of the source of water supply of the population, these are waters from wells, to which they no previous treatment is realized for your consumption. A system of treatment was established hidropónico, there were in use five plastic containers of 200 liters each one, in them a plant was placed of vetiver, clumps of approximately a year of age. The plants were established in every container by a simple system of flotamiento by plastic bottles and held themselves with plastic tape.

Realized measurements: The parameters used to determine the behavior of the process were: concentration of Fluorine, Nitrates, Phosphorus and Solid suspended, besides electrical Conductivity, Temperature and pH. The water samplings were realized from March, 2005 until January, 2006. The water sampling was realized in the entry and in the exit of the system to be able to determine by means of the parameters to evaluate the efficiency of the system vetiver. To Vetiver's plants chemical analysis of the fabric was realized. Also it measured up, height of plant and length of roots.

RESULTS AND DISCUSSION

Fluorine: in the figure 1, can observe that in the system with vetiver there was a slight reduction of the

levels of fluorine in the water of 2,72 mgL-1 to 2,22 mgL-1. These results demonstrate that the plant vetiver exercised a small response to the levels of fluoride in the water that was treating itself. These results cannot be compared with other studies, because this experiment is the first one that is realized in Venezuela and worldwide in relation to the treatment of waters contaminated with fluorine and with the plant.



Figura 1. Valores de Flúor del Agua Cruda y el Sistema con Vetiver

Then later analyses were done in the system of water treatment, so much in the system with vetiver as in the treatment without vetiver, from June, 2005 until January, 2006. The obtained results do not show a clear and definite trend of the system of water treatment used. These results probably should to that the water level was not kept in the system of treatment and the evaporation caused by the plant concentrated the level of pollutant in the same one, the water volume in the system with vetiver tends to decrease for the consumption of the plant, for what it increases the relative concentration of you go out. In addition there realized pruning neither to the foliage nor to the roots of the plants(floors), which could contribute that the plant was coming to levels thresholds of tolerance (Truong, 2006. Personal communication).

Removal of Nitrates and Phosphorus:

There has been demonstrated across numerous studies that the vetiver reduces considerably the levels of nitrate and phosphorus in the water, and accumulates it in his(her,your) fabrics (Hart et to., 2003 and Scavo, 2004). The following figure, it shows a reduction of nitrates in more than 95 % for May and November, 2006.



Figura 2.Valores de nitrato del agua cruda y del sistema con vetiver.

In the figure 3, is observed that the levels of phosphorus found in the system with vetiver for May, 2005, they increase considerably in relation to the values found in the raw water, these values are inexplicable, since obviously the phosphorus increased inside the system. A possible reason could have been the presence of aquatic animals favored in his growth for this micro-ecosystem, which they

could have caused this imbalance in the analyses. Nevertheless for the second sampling in November, the levels of phosphorus diminished considerably 4,9 mgL-1, up to coming up to not detectable levels for January, 2006.



Figura 4. Valores de fósforo del agua cruda y en el sistema con vetiver para diferentes meses.

CONCLUSIONS

The opposing results demonstrate that initially of the experiment, the vetiver, exercised a positive effect in the reduction of the fluorine in the water. Nevertheless in the later analyses that were realized, the obtained results do not reflect with clarity the effect of the vetiver in diminishing the levels of fluoride in the water. Nevertheless for January 2006, the obtained values show a reduction of the level of the pollutant. As for the nitrates and the phosphorus, it was confirmed that the vetiver exercises an important function in the reduction of these pollutants, in more than 90 %, which demonstrates the efficiency of the system in the removal of nutrients.

The chemical analyses realized to the fabric of the plant, they showed a considerable absorption of fluoride, which demonstrates for effects of this investigation that the plant vetiver accumulated this element in his tissues, nevertheless this is not significant to system level of water treatment for removal of fluoride.

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