*International Research Journal of Environmental Sciences*_____ ISSN 2319–1414
Vol. **13(4),** 11-17, October **(2024)** *Int. Res. J. Environmental Sci.*

Cytotoxicity study of the hospital liquid effluents and their chemical depollution by clays of the Benin: Case of CNHU-HKM of Cotonou, Benin

Arthur Romuald CAKPO*, SEIDOU O. Cowiyou and SAGBO Etienne
Laboratoire de Chimie Physique-Matériaux et Modélisation Moléculaire (LCP3M), Unité de recherche de Chimie Inorganique, Ingénierie des Matériaux et Environnement (URCIIME), Faculté des Sciences et Techniques (FAST), Université d'Abomey, Calavi (UAC). République du Bénin
arthurac22@gmail.com

Available online at: www.isca.in, www.isca.me
Received 17th July 2024, revised 18th September 2024, accepted 15th October 2024

Abstract

The chemical substances used in the hospitals for various activities are often found in the hospital liquid effluents. The rejection of these effluents in the natural environment is a health risk human, and can cause a true environmental problem with harmful and sometimes irreversible consequences on the watery ecosystem. The objective of this research is to evaluate the chemical pollution of the liquid effluents of the Hospital National Center and Academic Hubert KOUTOUKOU MAGA (CNHU-HKM) of Cotonou by the test of cytotoxicity based on the inhibition of the growth of the onions roots put in culture. The test of cytotoxicity carried out on the samples of hospital effluents of CNHU- HKM not cleansed showed that the Effective Concentration for which the chemical effects are observed for 50% of the individuals tested (EC50) is 22%. This result obtained reveals that the effluents of CNHU-HKM are chemically polluted, therefore is not in conformity with the standards as the vigor with the Benin one. These effluents were the subject of a depollution with three types of clays of Benin which are those of ETIGBO III, Gbedji-kotovi and MASSI. When clays are not purified, depollution is not effective. On the other hand when they are purified, depollution is effective especially in the case of the clay of ETIGBO III whose EC50 passed from 50% to 80%. This study shows the urgency and the interest of a control and a regular follow-up of these effluents at the exit of the station of purification of the hospital before being rejected into the urban networks of cleansing.

Keywords: Hospital liquid effluents, pollution, medical risk, standards, cytotoxicity, purification, treatment, clays.

Introduction

Any human activity generates solid, liquid and gas waste which is the principal sources of pollution, contamination and harmful effect. The liquid waste generated by the hospital complexes contains micropolluants. This waste thus represents a potential danger if they are rejected into nature without treatment. Taking into account the toxicity of this waste (medical residues, chemical reagents, detergents…), the problems of the rejections of hospital effluents become increasingly significant. To this end, stations of purification are built in the hospital complexes to collect then to purify the water used before their rejections in nature. In the Hospital National Center and Academic Hubert KOUTOUKOU MAGA (CNHU-HKM) of Cotonou, there exists a Station of Purification (SE). It receives all worn water which comes from the activities of care, washing of the equipment except water coming from the mortuary and certain operating theatre suites for which specific treatments are planned[1] Several studies on the characterization of the hospital effluents were carried out[2-6]. These studies seldom carry any time on a physicochemical characterization and a thorough cytotoxicity of the effluents. This research is at the heart of the problems of the rejections of hospital liquid effluents and has as an ambition to evaluate their toxicity and then to cleanse them with clays in order to improve knowledge on quality of the rejections of hospital liquid effluents. Since always, the tests of toxicities were carried out on animals but they was very expensive and required a long period of realization[7]. Thus various other alternatives of determination of toxicity were implemented among which one can quote the test of toxicity based on the roots of the plants often used in the biological tests[8]. The cytotoxicity and environmental pollution can be evaluated by the test in vivo on the cells of the ends of the roots of onions[9]. The studies undertaken by these various researchers revealed that the test of onions is used for the detection of the cytotoxicity in water[10-12]. The test of onions was used in this study to evaluate the cytotoxicity of the liquid effluents of CNHU-HKM of Cotonou and their chemical depollution by clays of the Benin one.

Materials and Methods

The onions used for the test of toxicity of the effluents of CNHU-HKM are bought in Porto-Novo at the Ouando market. The first dry layers of onions were removed like all the roots. The weight of onions varies between 50g and 83,3g and their diameters vary between 5,5 cm and 6,1 cm. The effluents are taken downstream from the station of purification in plastic cans. Some physicochemical parameters are carried out directly on the ground with an apparatus multi-parameter.

The temperature: 27, 10°C; pH: 6, 8; conductivity: 1440µs/cm and the TDS: 755ppm. The cans are then stopped hermetically and placed in a large refrigerator with ice at a temperature of 4°C to preserve the integrity of the effluents. There is not recommendation of absolute conservation[13]. The cans are then transported to Laboratory of Physical Chemistry, Materials and Molecular Modeling (LCP3M) of the University of Abomey-Calavi (UAC) for the analyses. Once at the laboratory, the sample is preserved at the same temperature with the refrigerator.

Test of toxicity of the effluents: The test on the inhibition of growth of root lengths of cultivated onions to various concentrations of hospital effluents was done. The onions are laid out in transparent disposable glasses of 160 ml containing the various concentrations of the taken samples. The concentrations carried out for this study are: 0%; 10%; 50% and 100%. They are obtained by diluting the effluents with distilled water. Each concentration is repeated four times; one thus has sixteen (16) culture media. The onions are cultivated during three (3) days in the darkness to prevent the roots from collecting the light. The culture media to various concentrations are changed every 24 hours thus twice into three (3) days. After the third day of culture, one cuts the roots of onions of the weakest concentration to the highest. These roots are laid out according to each concentration and one measures their lengths in centimeter (cm) by means of a suitable rule.

Test of toxicity of the hospital effluents cleansed with not purified clay: We used three clays of Benin to cleanse the hospital effluents. It is about the clay of ETIGBO III, Gbedji-kotovi and MASSI. The experimental protocol is carried out for each cleansing (clay). The concentrations carried out for this study are: 0%; 10%; 50%; 100%. They are obtained by diluting the effluents cleansed with distilled water. Each concentration is repeated four times; one thus has sixteen (16) culture media for each clay is forty eight (48) culture media for three clays. The culture media to various concentrations are changed every 24 hours thus twice into three (3) days.

Test of toxicity of the hospital effluents cleansed by purified clay: This time three clays are purified initially before being used to cleanse the hospital effluents.

Objective of the purification: It aims at eliminating the impurities from clay to increase its specific surface in order to increase its capacity of adsorption.

The concentrations carried out for this study are 0%; 10% and 100% for three treated clays: clay of ETIGBO III, Gbedji-kotovi and MASSI. These concentrations are obtained by dilution of the effluents cleansed with distilled water. Each concentration is repeated four times; one thus has thirty six (36) culture media for three treated clays. The culture media to various concentrations are changed every 24 hours thus twice into three (3) days.

Results and Discussion

The results obtained starting from the test of cytotoxicity carried out on the onions roots show that there exists on the level effluents of CNHU-HKM an inhibition of the growth of the roots. This inhibition appears by the fact that the onions roots put in culture do not push well compared to onions put in culture at 0%. One thus deduces from it that the effluents of CNHU-HKM are chemically polluted.

These effluents were the subject of a depollution by clays in order to increase the length of the onions roots put in culture. It results from it that, when clays are not purified, the roots of onions pushed well. On the other hand when clays are purified before being used, the roots of onions pushed more. The clay purified most effective for depollution is the clay of ETIGBO III (CE50 = 80%). Figure-1 shows the average lengths of the roots of onions put in culture in the effluents of CNHU-HKM.

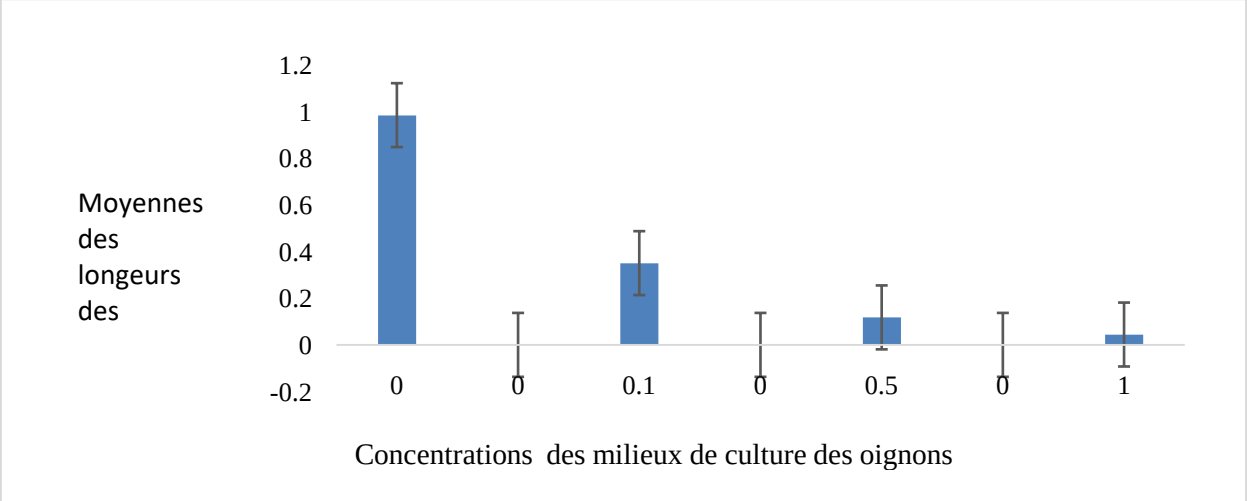

Figure-1: Average lengths of the onions roots put in culture in the effluents of CNHU-HKM.

Figure-1 represents the average lengths of the onions roots put in culture in the samples of taken hospital effluents. On the whole, sixteen (16) onions are put in culture and three hundred and twenty seven (327) roots of onions are measured. The smallest length of the measured roots is 0.2 cm and largest east 5.5 cm. The figure obtained shows that the roots of onions did not push same manner. In the witness (distilled water 100%), the roots of onions pushed at 100%. In the culture medium concentrated to 10% of hospital effluents, the average lengths of the roots is 35%. One notes a reduction up to 10% when the effluents are concentrated to 50%. For 100% of effluents of CNHU-HKM, the average lengths of the roots of onions put in culture decreases up to 3%.

It is noted that the average lengths of the roots decreases as the concentration in effluent increases in the culture medium. What shows that the effluents tested prevent the roots from pushing. One deduces from it that they are chemically toxic.

Parameters based on inhibitions of the growth of the roots of onions: These parameters are based on the effective concentration. Effective concentration EC50 is the concentration for which the chemical effects are observed for 50% of the individuals tested (Figures-2 to 8). The results obtained are indicated in the Table-1.

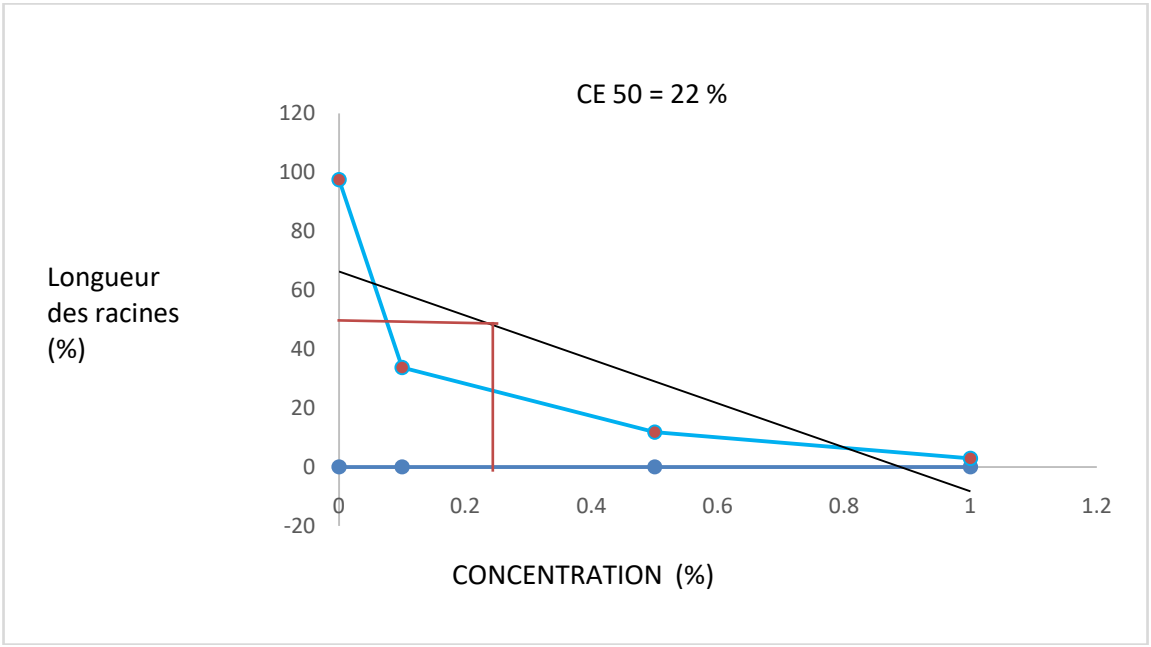

Figure-2: EC50 of the effluents of CNHU-HKM.

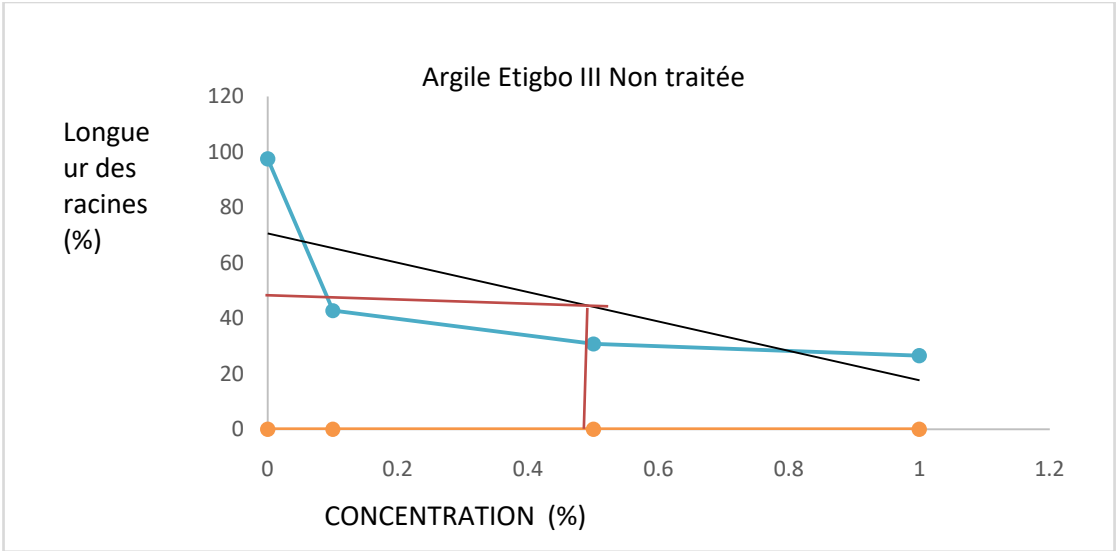

Figure-3: EC50 of untreated ETIGBO III.

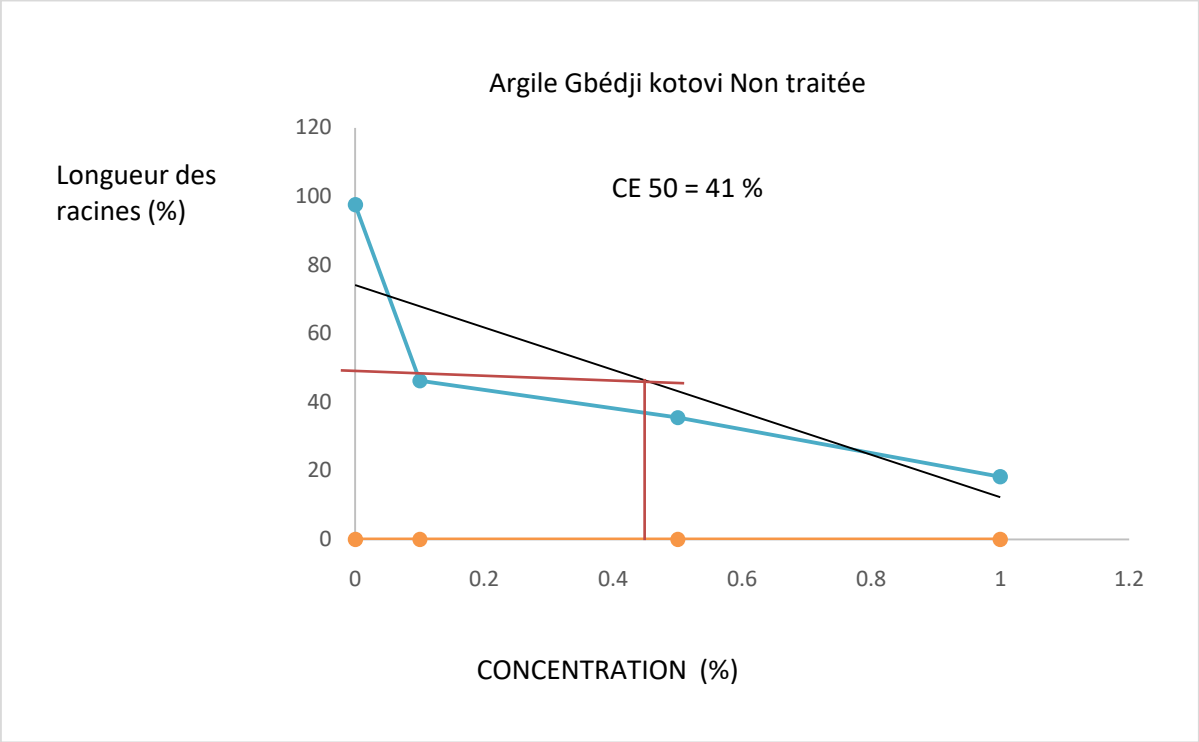

Figure-4: EC50 of Gbedji-kotovi untreated.

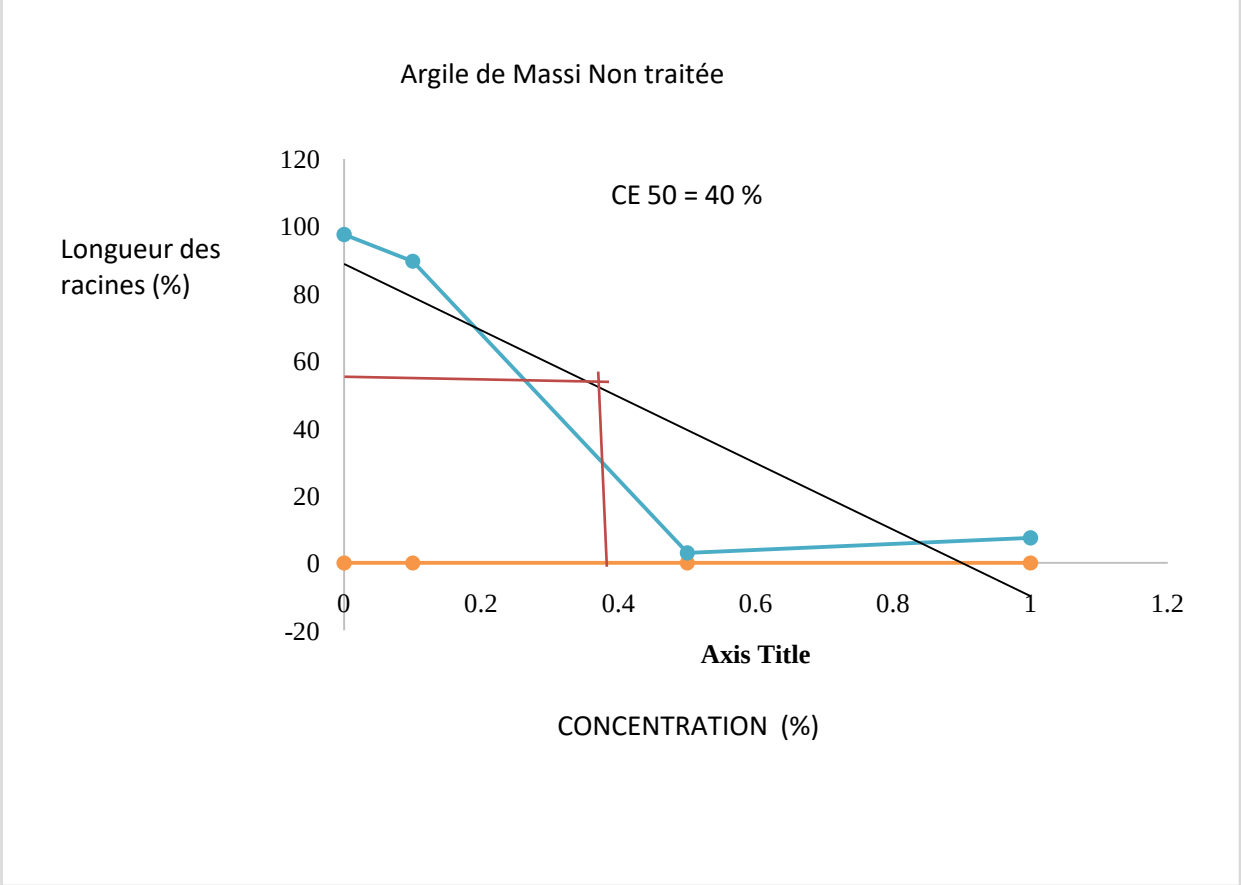

Figure-5: EC50 of untreated MASSI.

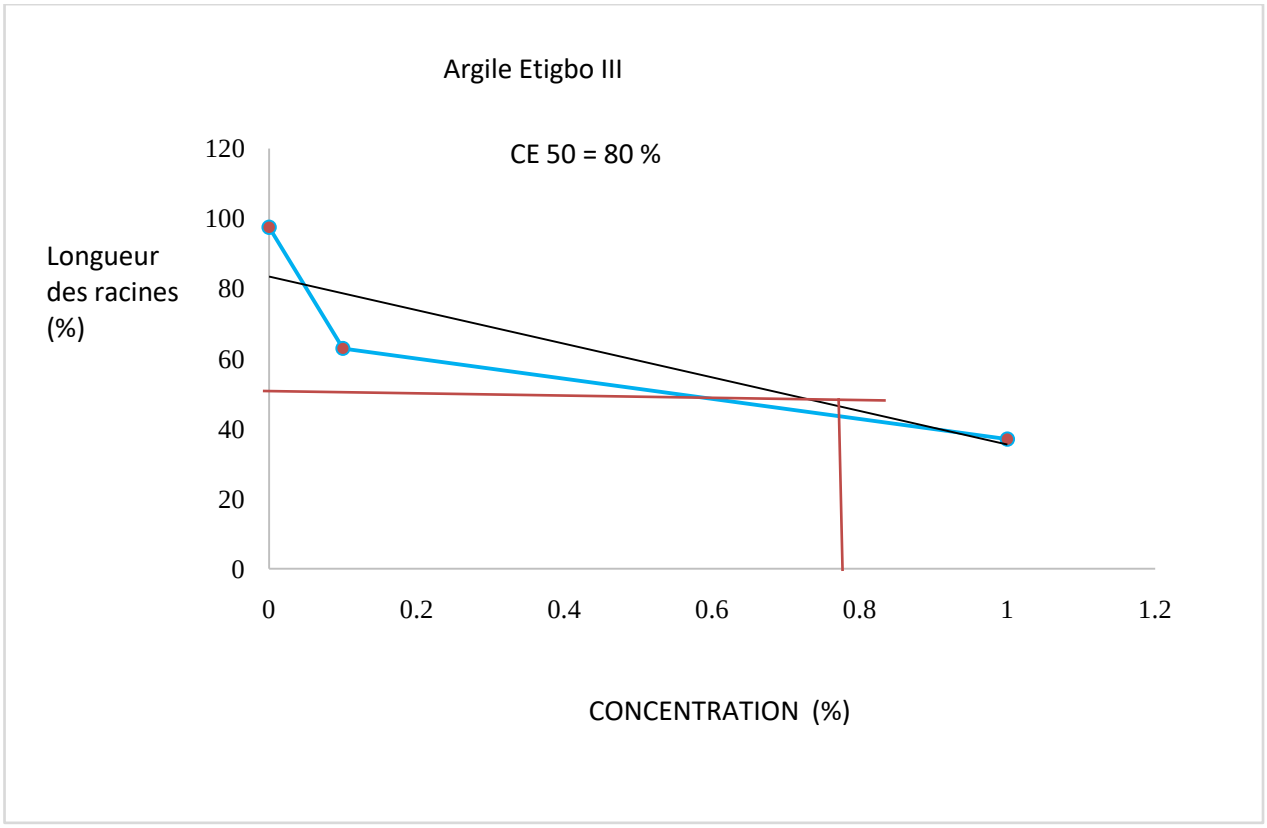

Figure-6: EC50 of treated ETIGBO III.

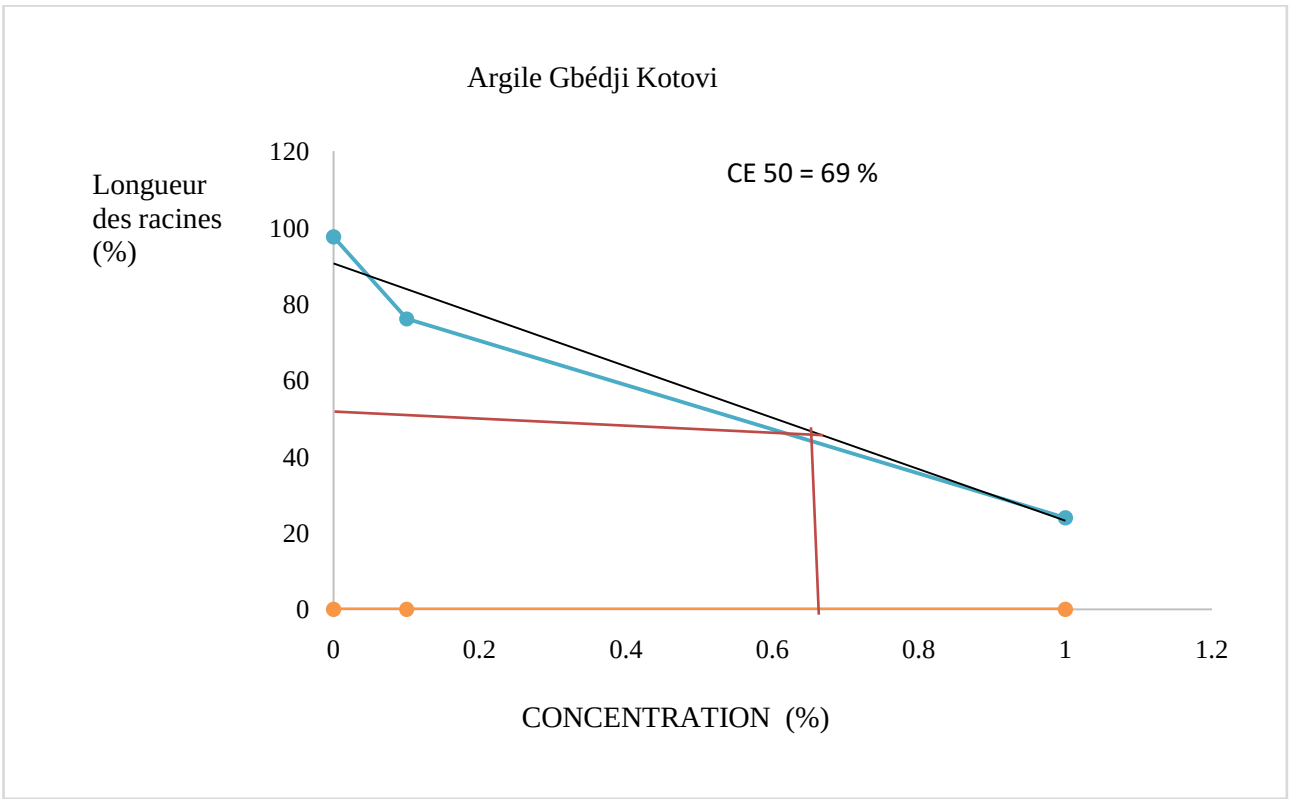

Figure-7: EC50 of treated Gbedji-kotovi.

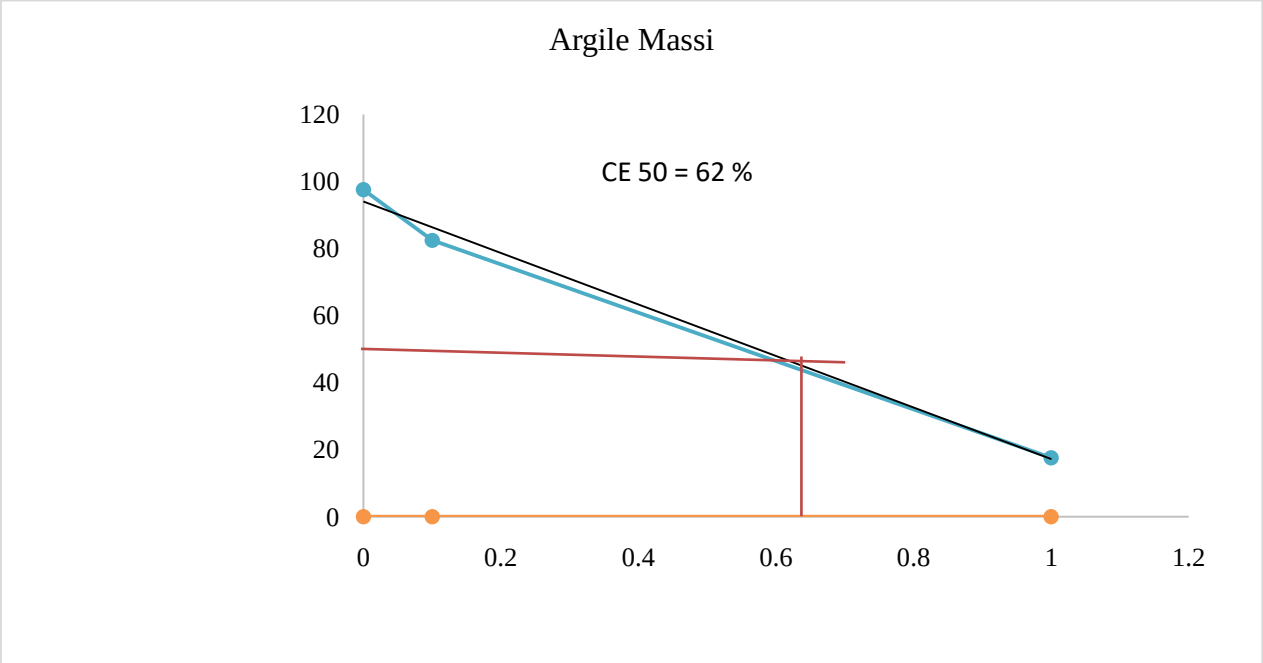

Figure-8: EC50 of treated MASSI.

Table-1: Effective concentrations EC50 of the hospital effluents and the various tests of cytotoxicity carried out.

	Sample of CNHU-HKM effluents	Clay not purified of ETIGBO III	Clay not purified of GBEDJI-KOTOVI	Clay not purified of MASSI	Clay purified of ETIGBO III	Clay purified of GBEDJI-KOTOVI	Clay purified of MASSI
EC50 (%)	22	50	41	40	80	69	62

Discussion: The values of effective concentrations EC50 obtained starting from the analysis of the toxicity based on the inhibition of the growth of the roots of onions made it possible to evaluate the toxicity of the effluents tested. Effective concentration EC50 of the effluents of CNHU-HKM is 22% (Figure-2). This value increased when the effluents are cleansed with clays. We used two types of clays: not purified clays and purified clays. These clays are those of ETIGBO III, Gbedji-kotovi and MASSI. Effective concentration the highest EC50 obtained when not purified clays were used is equal to 50% which is that of clay of ETIGBO III (Figure-3). Weakest is 40% corresponding to the clay of MASSI (Figure-5). When clays are purified, effective concentration the EC50 highest was obtained with the clay of ETIGBO III which is equal to 80% (Figure-6) while weakest is 62% (Figure-8).

It was recorded with the clay of MASSI. When we consider all the effective concentrations obtained, we note that the effective concentration highest is equal to 80%. It results from it that when clays are purified, depollution is much more effective. The clay which effectively cleansed the effluents tested is that of purified ETIGBO III. We note that the EC50 of three purified clays have values higher than those obtained when they do not undergo purification.

That is due to the fact that the purification of clays increased their specific surfaces what makes it possible to increase the capacity of adsorption of these clays. Purified clays cleanse more than those which were not purified. The clay of ETIGBO III is the best of the three clays used for the chemical depollution of the effluents of CNHU-HKM.

Conclusion

The chemical pollution of the liquid effluents of Hospital National Center and Academic Hubert KOUTOUKOU MAGA (CNHU-HKM) of Cotonou was evaluated by the test of cytotoxicity based on the inhibition of onion root growth put in culture at concentrations of 0%; 10%; 50%; 100%.

In this study, the length of the roots of onions was used to determine the effective concentration (72h, EC50) and the inhibition of root growth. According to the results obtained, the effluents of CNHU-HKM are chemically polluted (EC50 = 22%). These effluents were the subject of a depollution with three types of clays of Benin which are those of ETIGBO III, Gbedji-kotovi and MASSI. When clays are not purified, depollution is not effective.

On the other hand when they are purified, depollution is effective especially in the case of the clay of ETIGBO III whose EC50 is 50% when clay is not purified and of 80% when clay is purified (it is the highest EC50).

The study of the cytotoxicity of the liquid effluents of CNHU-HKM based on the inhibition of onion root growth reveals that the effluents tested prevented the roots of onions from pushing. This inhibition was observed completely in the concentration 100%. It comes out from this work that the liquid effluents of CNHU-HKM are toxic and are not likely to support a good development of the species in the mediums where they are poured. On the other hand these effluents can be cleansed with clay in occurrence purified clay. This study shows the urgency and the interest of a control and a regular follow-up of these effluents at the exit of the station of purification of the hospital before being rejected into the network of urban cleansing.

References

1. Fagnibo, H. (2012). Gestion des effluents domestiques en milieu hospitalier: cas du Centre National Universitaire et Hospitalier HKM de Cotonou, 62 pages. Mémoire de Master.

2. Deloffre-Bonnamour, N. (1995). Les rejets des établissements de santé: des effluents liquides aux déchets solides. *Mémoire de maîtrise - IUP Génie de l'Environnement-Ecodéveloppement-Université Claude Bernard-Lyon*, 1, 75.

3. LEPRAT, P. (1999). Les effluents liquides: Caractéristiques et impacts des rejets liquides hospitaliers. *Techniques hospitalières*, 54(634), 56-57.

4. Emmanuel, E. (2004). Évaluation des risques sanitaires et écotoxicologiques liés aux effluents hospitaliers (Doctoral dissertation, Insa Lyon).

5. Hartemann, P., Hautemaniere, A., & Joyeux, M. (2005). La problématique des effluents liquides hospitaliers. *Hygiènes (Lyon)*, 13(5), 369-374.

6. Zounkova, R., and Houloubek, I. (2006). Evaluation de l'écotoxicité et de la génotoxicité dans les centres hospitaliers. Europe, pages 7-11.

7. Cakpo, A. (2022). Etude de la toxicité des eaux d'une lagune tropicale et contamination du poisson par le plomb : Cas du tilapia (Sarotherodon melanotheron) de la lagune de Porto-Novo (Sud Bénin), mémoire DEA, FAST, Université d'Abomey-Calavi. 54 pages.

8. Samuel, O. B., Osuala, F. I., & Odeigah, P. G. (2010). Cytogenotoxicity evaluation of two industrial effluents using Allium cepa assay. *African Journal of Environmental Science and Technology*, 4(1).

9. El-Shahaby, O. A., Migid, H. A., Soliman, M. I., & Mashaly, I. A. (2002). Genotoxicity screening of industrial wastewater using the Allium cepa chromosome aberration assay. *Pakistan Journal of Biological Sciences*, 6(1), 23-28.

10. Rank, J., & Nielsen, M. H. (1998). Genotoxicity testing of wastewater sludge using the Allium cepa anaphase-telophase chromosome aberration assay. *Mutation Research/Genetic Toxicology and Environmental Mutagenesis*, 418(2-3), 113-119.

11. Cotelle, S., Masfaraud, J. F., & Férard, J. F. (1999). Assessment of the genotoxicity of contaminated soil with the Allium/Vicia-micronucleus and the Tradescantia-micronucleus assays. *Mutation Research/Fundamental and Molecular Mechanisms of Mutagenesis*, 426(2), 167-171.

12. Serra de Lima Moraes, D., & Jordão, B. Q. (2001). Evaluation of the genotoxic potential of municipal waste water discharged into the Paraguay river during periods of flood and drought. *Environmental Toxicology: An International Journal*, 16(2), 113-116.

13. Kosmala, A. (1998). Evaluation écotoxicologique de l'impact des effluents de stations d'épuration sur les cours d'eau: intérêt d'une approche intégrée (Doctoral dissertation, Doctorat Toxicologie de l'environnement, Université de Metz).