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# Assessment of toxicity of LOKPODJI, AGBOKOU and ACCRON TOKPA sediments then cytogenotoxicity of the fishes Parachana Africana

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**Abstract** The chemical pollution of our rivers (lakes and lagoons) by domestic and industrial waste creates everyday significant damage on the environment. This environmental pollution has harmful consequences on the quality of our life. The analyses of toxicity made on the sediments of the sites of LOKPODJI, AGBOKOU and ACCRON TOKPA showed that the average contents of heavy metals like zinc, copper, cadmium, and lead varied within site. These chemical pollutants pollute the watery environment and dangerously destroy the watery life by contaminating the species halieutics like shrimps, fish, crabs and the other species watery. The analyses of cytogenotoxicity made on the fish fished in our lagoons showed that heavy metals quoted previously are found according to variable concentrations in the various parts of these fishes. The indices mitotic and the percentages of aberrations obtained showed that these fishes had their genetic systems contaminated by the chemical pollutants present in our rivers. This cytogenotoxic pollution of the rivers can have very serious consequences on public health consuming these products halieutics.

**Keywords** Toxicity, sediments, *Parachana Africana*, cytogenotoxicity, river

## Introduction

The aquatic environments of several African countries are polluted more and more by pollutants being in domestic and industrial waste [1]. These chemical pollutants accumulate gradually to reach toxic thresholds which cause harmful consequences on health [1]. The contamination by heavy metals caused by the discharge of the industrial waste in the lakes and lagoons bring about a chemical pollution of these rivers like that obtained following accidents due to a pollution by mercury and cadmium in Sweden and to Japan [2-6].

The African continent had cognized for several years an industrialization which makes that the several countries are confronted with the problems of environmental pollution. Dejoux realized in 1988 a study on the various ecological problems in a monograph devoted to the African interior water pollution [7] and Philips in 1991 a study of the tropical marine ecosystems [8].
Several researchers undertook work on the contribution to the physicochemical study of the lake ecosystem Dayet to Morocco [9] and on the food one of fish with azolla on the agropiscicole ecosystem in Rwanda [10].
In Benin, some researchers investigated on the pollution of the rivers like (Mama and al, 2009) on the evaluation of the incidence of the activities of dyeing on water and the organics with the accesses of the lagoon of Cotonou [11] then on the methodology and the results of the diagnosis of the eutrophication of the lake Nokoué [12]. Dèdjiho realized in 2011 a study on the trophic chain of a marine surface protected in relation with her physicochemistry: Case of Gbézoumè in the distric of Ouidah [13]. Chouti in 2011, studied the chemical pollution of a tropical lagoon of Porto-Novo [14]. The tests of cytotoxicity were carried out in 2012 by Cakpo on waters of sites of the lagoon of Porto-Novo had shown precursory signs of a probable genotoxicity [15].

## Materials and Methods

### Test of toxicity of the sediments

The contents of the metal elements traces such as lead, zinc, copper and cadmium were determined by a colorimetric proportioning with the spectrophotometer of atomic absorption. The method used is the same one as that of the proportioning of the metal elements traces in fish.

### Test of toxicity of fish

The metal elements traces such as lead, zinc, copper and cadmium were determined by a colorimetric proportioning with the spectrophotometer of atomic absorption. This method allowed the determination of the content of metal elements traces in the flesh of fresh fish, the fishbone, the head and the liver of the fish. It is carried out in five stages with knowing: mineralization, preparation of the standards, the adjustment of the spectrophotometer, preparation of the samples and handling.
The mineralization of the flesh, the fishbones, the head and the liver of fished fresh fish were made according to protocol HACH.
The proportioning of lead, zinc, copper and of cadmium in the samples of the fresh fish flesh, the fishbones, the head and the liver mineral-bearing was made by a spectrophotometer of atomic absorption to flame Spectr AA 110.

### Test of cytogenotoxicity of fish *Parachana Africana*

The fish used for the test of genotoxicity were fished on the three sites.
The fish fished on each site were replaced in the water of the site on which they were fished with various concentrations (0%, 25%, 50%, 75%, 100%) during 72h. Then, the blades were dried then gone up under the microscope. Parameters such as the number of cells and the deformed cells were counted on the level of each sample.

## Results

### Cytogenotoxicity of fish *Parachana Africana*

The parameters of cytogenotoxicity such as the index mitotic and the percentages of chromosomal aberrations of fish fished on each site and raised in water where they were fished are represented on figures 1 and 2.

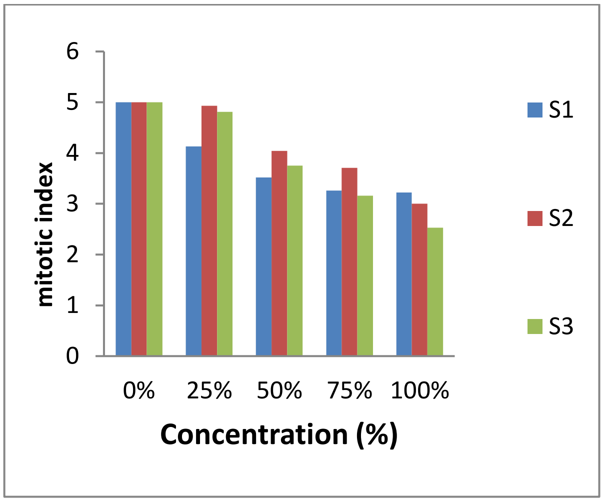


*Figure 1: Indices mitotic of fish of the three sites*

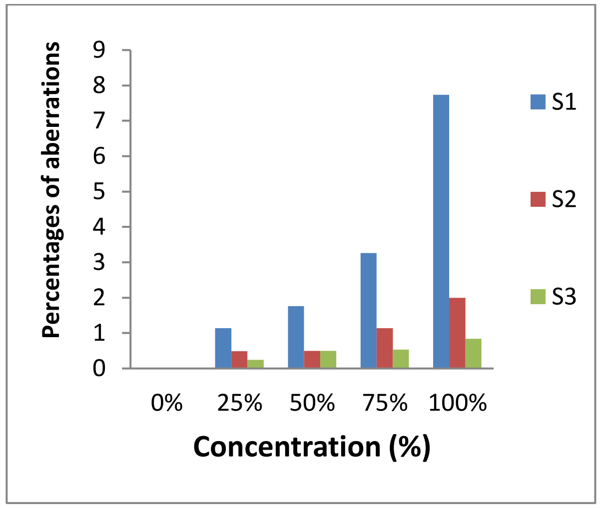


*Figure 2: Percentages of aberrations of fish of the three sites*

The microscopic treatment carried out on fish of site 1 made it possible to note that the mitotic index decreases from 5 to 3.22 whereas the percentage of aberrations grows from 0 to 7.74 when the concentration of water tested grows from 0% to 100%. For fish of site 2, when the concentration grows from 0% to 100%, the mitotic index decreases from 5 to 3 while the percentage of aberrations grows from 0 to 2. With regard to fish of site 3, one noted that the mitotic index decreases from 5 to 2.53 while the percentage of aberrations grows from 0 to 0.87.

The average mitotic index and average percentages of aberrations of the three sites are assembled in Table 1.

The classification of cytogenotoxic parameters decreasing according to the three sites (Table 2).

**Table 1:** Parameters cytogenotoxic (average index mitotic and average percentages of aberrations) of the three sites determined starting from the test on fish

| Site | Site 1 | Site 2 | Site 3 |
|---|---|---|---|
| average mitotic index | 3.53 | 3.92 | 3.56 |
| average percentage of aberration | 3.47 | 1.03 | 0.53 |

**Table 2:** Classification decreasing of the three sites according to the parameters cytogenotoxic (mitotic index and percentages of aberrations) starting from the test on fish

| Classification decreasing of the sites according to the mitotic index of fish | Classification decreasing of the sites according to the percentages of aberrations of fish |
|---|---|
| Site 2 | Site 1 |
| Site 3 | Site 2 |
| Site 1 | Site 3 |

**Toxicity of the sediments and fish**

**Toxicity of the sediments**

**Contents of heavy metals in the sediments**

The contents zinc, copper, lead and cadmium in the three grounds corresponding on the ground of the three sites were determined and their evolutions on the level of the ground of each site were represented on figure 3.

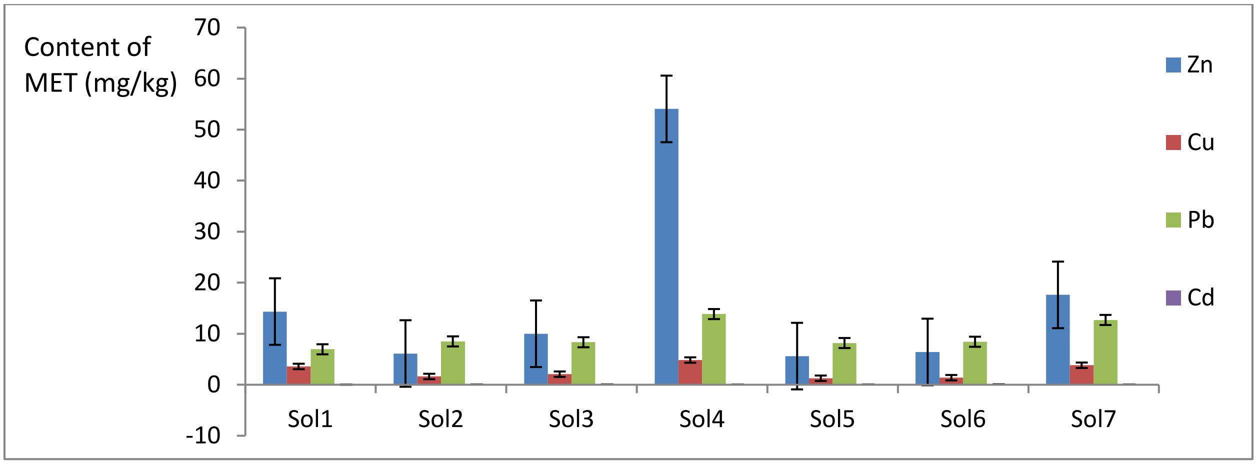


*Figure 3: Evolution of the contents zinc, copper, lead and cadmium in the grounds of the three sites*

The maximum contents of zinc and of copper are obtained in ground 1. Lead has a maximum content in ground 2 while its minimal content is of 6.945 mg/kg and was recorded in ground 1. With regard to cadmium, its minimal content was recorded in ground 1 and is equal to 0.025 mg/kg.

**Numerical classification of the sites of sampling following the parameters of toxicity of the sediments**

The average contents of the Metal Elements Traces (MET) in the three grounds made it possible to classify these grounds according to their decreasing toxicity (Table 3). In table 4 there are the average contents of each Metal Elements Traces in the sediments of the whole of the three studied sites.

**Table 3:** Average contents of the metal elements traces in the grounds of the three sites

| Grounds of the three sites | Average Contents of the MET (mg/kg) |
|---|---|
| Sol 1 | 6.2225 |
| Sol 3 | 5.1115 |
| Sol 2 | 4.070 |

**Table 4:** Average contents of each Metal Elements Traces

| Heavy metals | Average contents of the ETM (mg/kg) |
|---|---|
| Zinc | 16.30771 |
| Lead | 9.557429 |
| Copper | 2.651286 |
| Cadmium | 0.047714 |

**Toxicity of fish**

**Determination of the Metal Elements Traces (Pb, Zn, Cu, Cd)**

The content of the Metal Elements Traces (MET) such as lead, zinc, copper and cadmium were given in the flesh, the head, the liver and the fishbones of the fish. The results obtained made it possible to represent the graphs of figure 4.

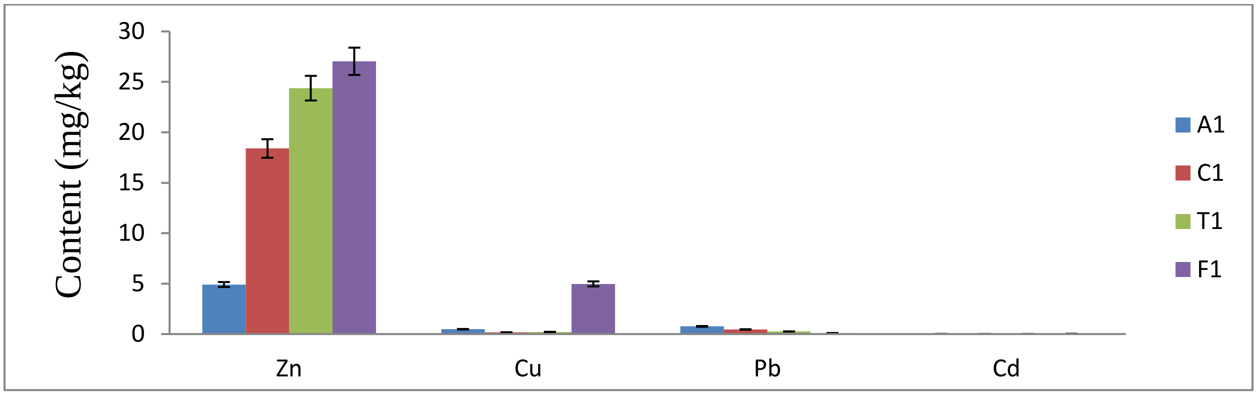


*Figure 4: Evolution of the content of heavy metals in the various parts of the fish*

In the fish, zinc is concentrated more in the flesh than in the fishbones A1. While the zinc content in the flesh F1 is exceeds of 13.48 mg/kg that which found in the fishbones A1. The zinc contents are maximum in the liver F1 of the fish. They exceed respectively of 2.66 mg/kg those found in the head T1. Copper concentrated preferentially in the liver of the fish studied with a maximum content of 4.974 mg/kg in the liver F1 of the fish. The contents of copper are weak in the other parts of fish. Lead is slightly concentrated in all the parts of fish. It has a maximum content of 0.76 mg/kg in the fishbones A1 of the fish. The cadmium contents are extremely weak in all the parts of fish.

**Comparative study of the content of heavy metals in the various parts of fish**

The contents lead, zinc, copper and cadmium in the flesh, the head, the liver and the fishbones of the fish made it possible to represent the graphs of figures 5, 6, 7, 8 and 9.

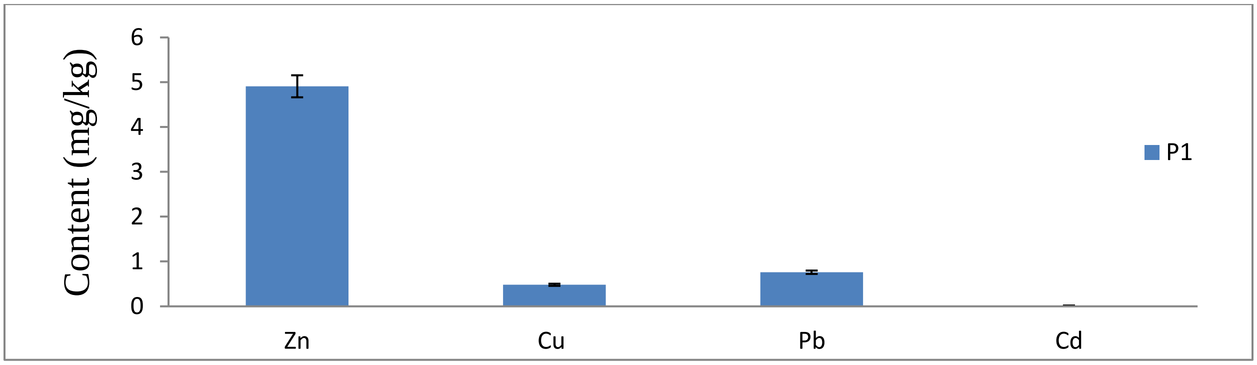


*Figure 5: Evolution of the content of heavy metals in the fishbones of the fish*

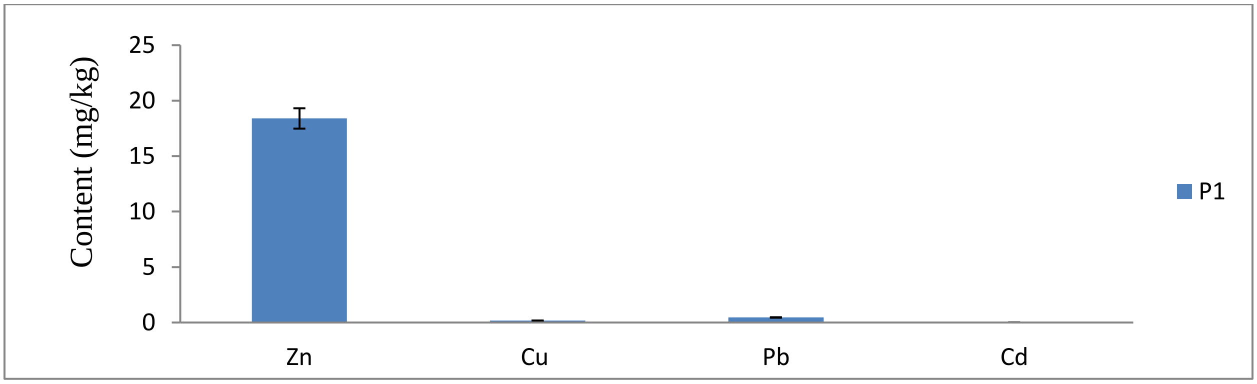


*Figure 6: Evolution of the content of heavy metals in the flesh of the fish*

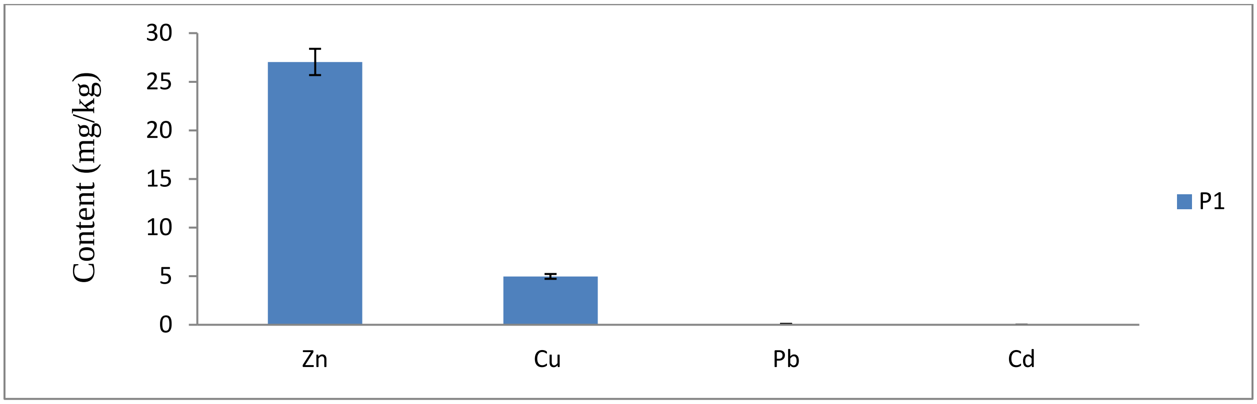


*Figure 7: Evolution of the content of heavy metals in the liver of the fish*

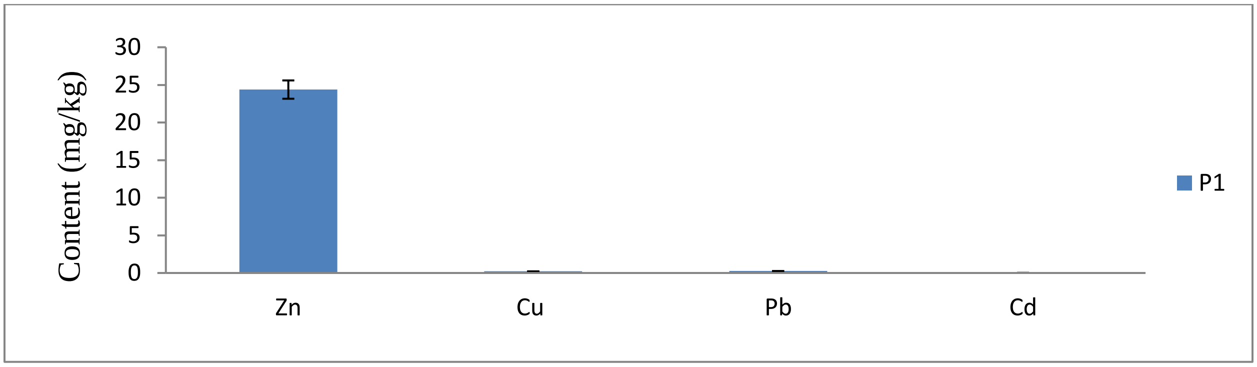


*Figure 8: Evolution of the content of heavy metals in the head of the fish*

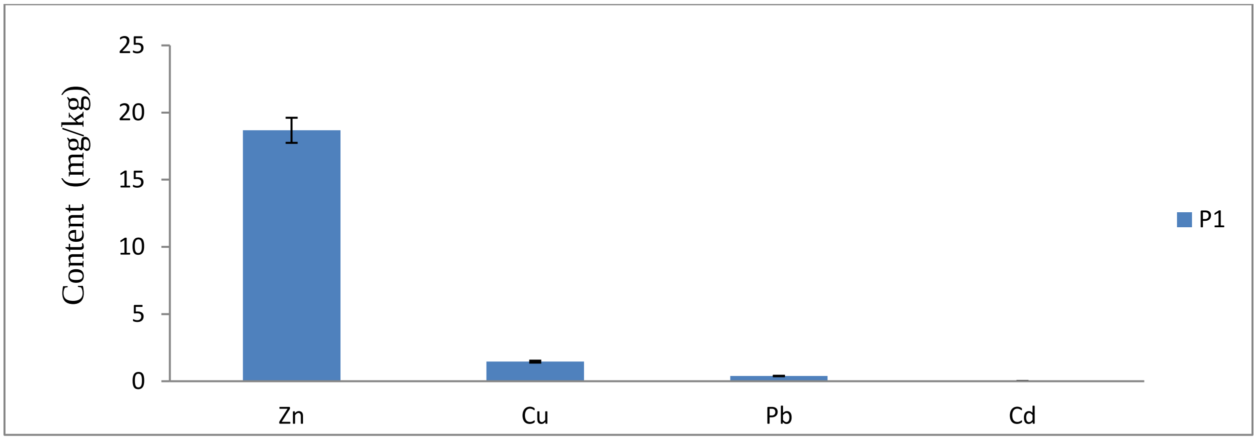


*Figure 9: Evolution of the average content of heavy metals in the fish*

The minimal zinc content was found in the fishbones. It is equal to 4.91 mg/kg. As for lead, its content maximum is equal to 0.76 mg/kg. It is concentrated in the fishbones. The cadmium contents are very weak in all the parts of fish. It is about 0.01 mg/kg (Figure 5).

The greatest zinc content was found in the flesh C1. It is equal to 18.39 mg/kg. The contents of copper and lead are very weak in all the parts of the fish. The minimal content coppers and the maximum content lead which are respectively equal to 0.16 mg/kg and 0.45 mg/kg were found in the flesh C1. The cadmium contents are extremely weak. They are about 0.01 mg/kg in all the parts of the fish (Figure 6).

The maximum content zinc in the liver is equal to 27.04 mg/kg and the greatest content of copper was found in the liver. The lead contents are very weak in all the parts of the fish. They are about 0.1 mg/kg. The strongest concentration of cadmium was found in the liver of the fish. It is equal to 0.02 mg/kg (Figure 7).

Zinc is strongly concentrated in the heads. The maximum content zinc is of 24.37 mg/kg in the fish. The cadmium contents are extremely weak in the heads of fish. They are equal to 0.01 mg/kg (Figure 8).

The average contents of heavy metals in studied fish were represented on Figure 9.

The maximum average zinc content is of 18.68 mg/kg. The average copper content in fish is practically 1.5 mg/kg. As for lead, it is concentrated in the fish. Its average content is equal to 0.4 mg/kg. The average cadmium content in the fish are extremely weak. It is equal to 0.01 mg/kg.

**Discussion**

The contents of zinc and copper dropped in ground 2 compared to the ground 1, contrary to the lead whose content increased in ground 2 compared to ground 1. Let us note that the cadmium content in the three grounds is very weak and that the average contents of studied heavy metals are lower than the standards set by Directive 76/464/CEE into 2000 which are respectively of 95 mg/kg; 19 mg/kg; 33 mg/kg; 0.11 mg/kg for zinc, lead, copper and cadmium [16] [17]. The average contents of copper, zinc and cadmium are lower than those found in the lake Ahémé - Gbèzoumè. On the other hand, the average lead content of the studied sites is higher than that of this complex lagunaire [17]. The average contents of copper and zinc of the seven studied sites are largely higher than those found into 2011 in the lagoon of Porto-Novo [18]. These contents increased because worn water then domestic, agricultural and industrial waste continues to be poured in the lagoon.

The results obtained show that the fishbones and the flesh of the fish P1 (*Parachana Africana*) have a lead content, higher than the standard set by ministerial decree number 425/MAEP/D-CAB/SGM/DA/DP/CSRH/SA of April 7 2003 which is of 0.2 mg/kg of fresh weight. The high percentage of lead in the flesh and the fishbones of the fish is certainly due to the fact that it lives in contact with the sediments and nourishes digger organizations such as the worms and the larvae which accumulate the pollutants stored in the sediments. These various pollutants stored in the sediments of our lakes and lagoons are suspended by a significant maregraphic dynamics and adhere to surface organizations and the gills of the fish [19]. The same phenomenon was observed at *Tilapia guineensis* which has an omnivorous mode and nourish organic refuses, phytoplanktons, shrimps, bivalves and larvae [20]; what could increase their content of metals heavy [21] [22]. The lead contents obtained in the various parts of studied fish are largely lower than the content found in the *sarotherodon melanotheron* at the time of the study than we made on this species into 2012. This difference in lead toxicity could be explained by the fact why the two studied fish are less accumulating lead than the *sarotherodon melanotheron* or although there exists in studied fish a phenomenon of detoxication which enables them to reduce their content of heavy metals considerably. In a general way, the presence of xenobiotic in the cells leads to the activation of the biochemical systems of detoxication. Two phases can be distinguished in this process which aims at expelling the contaminants out of the cells. The phase of fonctionnalization which consists in oxidizing the substrate, often by the means of the cytochrome P450 and the phase of conjugation which binds a very polar endogenous molecule to the substrate oxidized in order to facilitate its expulsion [23]. Indeed, the activation of these mechanisms of defence modifies the allowances of energy of the exposed organizations. This can induce the times of growth and to assign the individuals in their interactions will intra and interspecific, and consequently to have harmful impacts on higher biological scales [24]. These systems of detoxication have as a role to suppress the contamination [25-26]. Some modifications of the activity of detoxication according to the nature of the contaminant and the temperature were noted [27]. For these authors, the bio-accumulation depends on a synergistic effect between the contaminant and the temperature of water on the mechanisms of detoxication of fish [27].

The high lead content can be also caused by the anthropic activities which enrich the aquatic environments out of heavy metals [28]. This is justified because all the sediments of the three sites of the lagoon studied have a lead content higher than 6.94 mg/kg.

None fish has a cadmium content higher than the standard set at Benin which is of 0.05 mg/kg of fresh weight; this is certainly due to the average content of cadmium (0.047 mg/kg) in the sediments of the three sites. All the studied fish have average contents lower than the standards set by FAO of 2001 which are respectively 3 ppm and 1000 ppm for copper and zinc [16] [17].

The lead content of the fishbones of the fish P1 is higher than those found in *Tilapia guinéensis* and *Sarotherodon melanotheron* [20] [29]. But lower than the lead contents in the two species according to the studies made by Youssao and al into 2011 [30]. The lead content found in the flesh of the fish P1 is higher than that found in *Sarotherodon melanotheron* [20] but lower than that found in the same species [29] [30]. On the other hand, it is higher than the lead contents found in *Tilapia guinéensis* [20] [29] but lower than that found in same species [30]. Heavy metals that we proportioned on the level of the various parts of fish and in the sediments of the studied sites could involve in molluscs of the mutagen properties [31]. They constitute for the man of the carcinogens potential [32] [33] [34]. The contamination of the rivers is due to the accumulation of the toxic substances in the various watery compartments.

These toxics as heavy metals have contents which vary according to the species of fish studied and according to the analyzed human organ [35].

For the test of cytogenotoxicity, the similar results were obtained by Samuel and al in 2010 [36] when they carried out the test of cytogenotoxicity based on onions on the effluent of the textile factory (Nichemtex) of Lagos in Nigeria and by Odeigah and al in 1997 for the work completed on the lixiviats of industrial solid waste with the roots of onions [37] and on worn water of the oil reservoirs [38] then finally by Rencuzogullari and al in 2001 for their work on the cytogenetic effects of sodium metabisulfite [39]. The inhibition of the mitotic activities is often used for the tracing of the cytotoxic substances [36]. This study showed that water of the three sites caused chromosomal aberrations such as the wandering chromosomes and in bridge; sticking or viscous chromosomes and others in fragments. Several of these chromosomal deformations were frequently observed. All these deformations indicate the presence of the cytogenotoxic substances in water of the three studied sites

## Conclusion

All of the three sites contain zinc, copper, lead and cadmium in varied proportions. Cadmium is in very small proportion in the sediments of all the sites studied with an average content of 0.05 mg/kg and that the average content of lead exceeds at least 6.9 mg/kg that of copper.

With regard to the toxicity of fish, the maximum contents zinc, lead and cadmium were given in the head of the fish. One notes as same heavy metals such as zinc, lead and cadmium accumulate as well in the flesh as in the head of the fish. Consequently, one can deduce that there is a synergy of these three pollutants which are bioaccumulated more quickly and more easily when they are associated in the flesh and the head of the fish.

The accumulation of heavy metals in the fishbones, the flesh, the head and the liver varies according to differents parts of studied fish. A strong accumulation of zinc in the fish P1 was noted.

The parameters of genotoxicity such as the index mitotic and the percentage of chromosomal aberrations made it possible to show that the three sites are genotoxic. The percentages of chromosomal aberrations obtained on the three studied sites come to confirm the character genotoxic of water as of the these sites because they all are higher than those of the witness; what means that water tested involves chromosomal deformations on the level of the cells. The average values of the indices mitotic and the percentages of aberrations made it possible to classify the three sites according to these two parameters of genotoxicity.

These results enable us to conclude that the site1 is the site more polluted respectively according to the index mitotic and the percentage of aberrations.

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