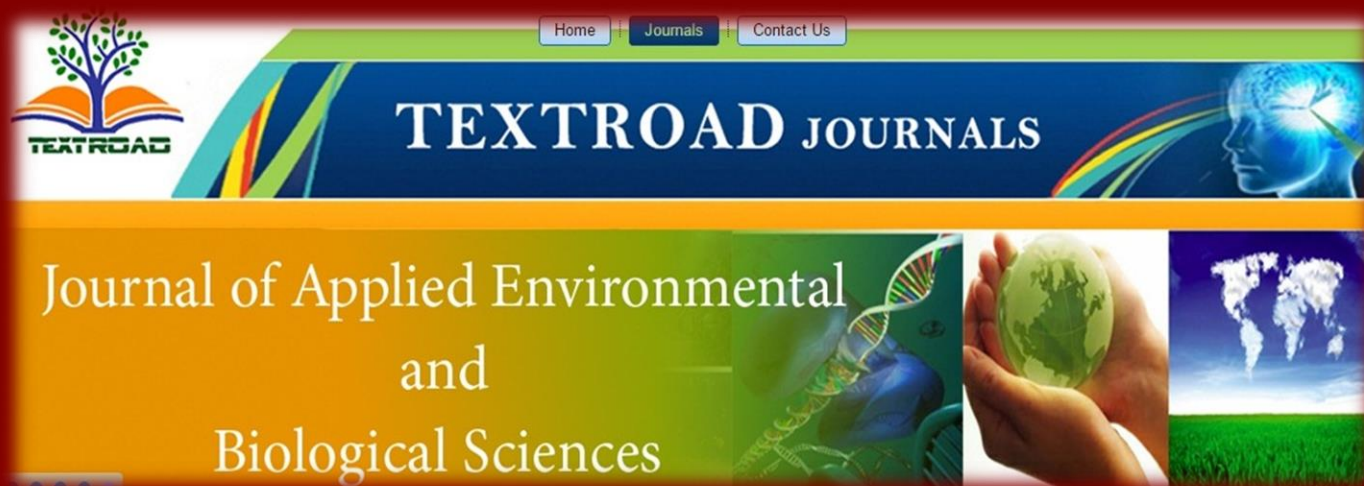


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Contamination of Vegetables Grown on Urban Waste Landfill and Health Risks : Case of Akouedo (Abidjan, Cote D'ivoire)

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ABSTRACT

The contamination of vegetables grown on the Akouedo landfill was studied and the health risks associated with their consumption was assessed. The concentrations of Cu, Zn, Ni, Pb and Cd in soil and vegetables were determined on the Abandoned and Operating sites. The concentrations of the bioavailability heavy metals in the soils showed that Zn and Pb have the highest levels at both sites. These concentrations are in the range of 426 mg / kg (Operating Site) and 432 mg / kg (Abandoned site) for Zn and 62.7 mg / kg (Abandoned site) and 66.4 mg / kg (Operating Site) for Pb. The heavy metals concentration in the fruits and leaves of the vegetables were higher for Zn (1.91-13.50 mg/kg dw) and Cu (0.50-8.50 mg/kg dw). However, the concentrations of Zn and Cu obtained in the different vegetables were very low compared to the sanitary standard. The Pb concentration recorded in the tomato fruits harvested on the abandoned site (0.36 mg / kg Pb dw) and those of okra taken from abandoned site (0.57 mg / kg Pb dw) and operating site (0.35 mg / kg Pb dw) were higher than the sanitary standard (0.3 mg / kg Pb dw). The consumption of those vegetables fruits contaminated with Pb could cause anemia and disorders of the nervous system. Moreover, the Bioconcentration Factor (BCF) values were higher for Cu on the abandoned site for okra (0.343) and operating site for eggplant (0.447). Generally, Pb presented the lowest BCF value for all vegetables on the two sites.

KEY WORDS: Heavy metals, Akouedo landfill, vegetables contamination, health risks.

INTRODUCTION

Soils have become increasingly polluted by heavy metals with increasing urbanization and industrialization and this threatens ecosystems, surface and ground waters, food safety, and human health [1-2-3-4]. Heavy metals concentrations in soils are influenced by anthropogenic activities such as agricultural practices, industrial activities and waste disposal methods [5-6]. The presence of heavy metals in the environment is of great ecological significance due to their toxicity at certain concentrations, translocation through food chains and nonbiodegradability which is responsible for their accumulation in the biosphere [7]. Studies have shown that soils at refuse dumpsites contain different kinds and concentration of heavy metals, depending on the age, contents and location [8-9]. In recent times, it has been reported that heavy metals from waste dumpsites can accumulate in soils at an environmentally hazardous levels [10-11]. Urban wastes contribution for heavy metals in soils to 28% for copper (Cu), 20 % for zinc (Zn), 38% for cadmium (Cd) and 19% for lead (Pb) [12]. Wastes dumpsites have been used extensively as fertile ground for cultivating varieties of vegetables. The consumption of those vegetables can constitute serious health concern to human and animal [13-14], because of the heavy metals transfer to the crops.

Moreover, industrial development combined with high population growth in the district of Abidjan (Côte d'Ivoire) generated large quantities of solid wastes of about 1.5 million tons per year. Approximately, 70% of that production are dumped at the Akouedo landfill, which was exploited since 1965 and classified as wild landfill. According to [15], Akouedo landfill generate heavy metals pollution with concentrations ranging from 10.3 to 1 500 ppm and 1 and 11.5 ppm, respectively for Pb and Cd. Akouedo landfill was used every seasons for cultivating vegetables such as okra, tomato, eggplant, and maize. This research is aimed to determine the heavy metals concentration in vegetables grown on Akouedo landfill and analyse health risks associated to their consumption.

MATERIALS AND METHODS

The characterization of the degree of contamination of the vegetables produced on the Akouédo landfill was carried out in order to apprehend their level of contamination and to evaluate the potential health risks related to their consumption. Vegetable and soil samples were collected from the abandoned site (AS) and the operating site (OS) of the Akouédo landfill. Five (5) plots of 100 m² were established on each site, four at the corners and

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one at the center. The plots site choice taking account the presence of the vegetables sampled and the representativeness of the whole site.

Vegetables sampling

Tomato *Lycopersicum esculentus* L. (Figure 1A), Okra *Hibiscus esculentus* L. (Figure 1B), Eggplant *Solanum melongena* L. (Figure 1C) and Spinach *Spinacia oleracea* L. (Figure 1D) were considered because they represented the most grown vegetables on the Akouedo landfill. These vegetables are sold on the markets and are part of the food chain. In addition, these three fruiting vegetables and spinach leaves are described as heavy metals accumulators [16-17-18-19-20]. Vegetables sampled included fruiting vegetables (tomato, eggplant and okra) and spinach leaves. At each plot level, the vegetables were randomly harvested and packaged in sealed food bags. All fruits and spinach leaves from the five (5) plots were assembled to form the composite sample for each vegetable at each site. One sample per site and per vegetable species was obtained.

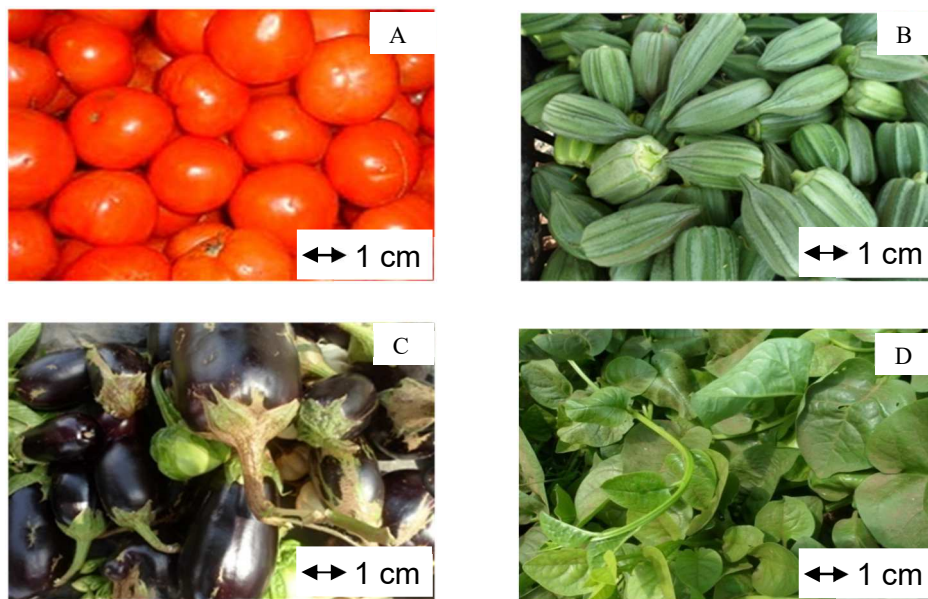


Figure 1: Fruits of tomato (*Lycopersicum esculentus* L.) (A); okra (*Hibiscus esculentus* L.) (B); eggplant (*Solanum melongena* L.) (C) and leaves of spinach (*Spinacia oleracea* L.) (D)

Soil sampling

Soil samples were collected using an auger at depth of 0-30 cm on the five (5) plots established on the abandoned and the operating site. On each plot, one (01) elementary sample of approximately 1.15 dm³ was taken at the center. A composite sample was prepared with five (5) elementary samples obtained on each site. Soil samples were collected in plastic bags, air-dried and ground to pass through a 2 mm sieve.

Evaluation of the mass of heavy metals accumulated in vegetables

Evaluation of average crop production

To evaluate average crop yields (P), three plots of 10 × 10 m² were established for each crop. Depending on crop production cycles, different harvest intervals have been defined. Thus, for okra and tomato, the harvests were done every three days, ten times a month. As for the eggplant, the harvest was made every two weeks. The harvested vegetables were weighed to determine the fresh mass. :

The total areas of the different crops and the average yields were used to estimate the average production of the different crops according to the relation 1:

$$P = \left(\frac{\sum ri}{N} \right) * A \quad (1)$$

P = Average production (t) ;

ri = Plot yield (i) ;

N = Total of plots ;

A = Total area (ha).

Heavy metals mass estimating

Heavy metals accumulated mass in the vegetables produced on the Akouédo landfill was estimated from the average production of vegetables. The evaluation of the dry weight of vegetable-fruit consisted of washing the fresh vegetables harvested with tap water and rinsed with distilled water. Then these fruit vegetables were cut and then put in a mass crucible (m_1). The whole (crucible and vegetable) was weighed (m_2) and placed in an oven at 105 ° C for 24 hours [20-21]. After drying, the crucibles were removed and weighed again (m_3). The ratio (β) of the dry mass relative to the fresh mass of the vegetables was calculated according to relation 2:

$$\beta = \left(\frac{m_3 - m_1}{m_2 - m_1} \right) * 100 \quad (2)$$

$m_3 - m_1$ = dry mass of vegetable ;

$m_2 - m_1$ = fresh mass of vegetable.

The ratio value for each fruit vegetable was used to determine the dry mass of the average fruit vegetable production. Heavy metals accumulated mass in vegetables were calculated from the relation 3:

$$M = P * \beta * [HM] \quad (3)$$

M = Mass of heavy metal accumulated in vegetables (g) ;

P = Average production (kg) ;

β = The ratio of the dry mass relative to the fresh mass of vegetable ;

[HM] = Heavy metal concentration in vegetable (mg/kg dw).

Soil samples pretreatment and analysis

The soil samples were dried in the open air, then crushed and sieved using a 2 mm diameter AFNOR screen. Then, an intermediate sampling was carried out on the fraction sieved according to the technique of the quarterings so as to minimize the risks of error on the composition of the grounds related to their heterogeneity and to obtain the mass of residues necessary for the analyzes [22].

The bioavailable fraction of heavy metals was determined on the soil samples. The analyses were performed according the standard NFX 31-120 relating to the extraction with ammonium acetate (1.0 mol / l) and ethylene diaminetetraacetic acid (EDTA) (0.01 mol / l). Concentrations of Cd and Pb were determined using graphite furnace atomic absorption spectrophotometer (GFAAS) and Cu, Ni and Zn were determined using a flame atomic absorption spectrophotometer (FAAS) [23].

Vegetables samples pretreatment and analysis

The vegetables samples harvested were washed with tap water and rinsed with distilled water. The vegetables samples have been cut into homogeneous size and were dried at 105 ° C for 24 hours. Then, the dried samples were milled and then dried to constant weight.

The mineralization of the vegetables samples was done according to a method derived from the NFX 31-151 standard. The dry vegetable samples powder were digested with solution mixed with 100 ml of hydrochloric acid (37% HCl) and 100 ml of distilled water. Concentrations of Cd and Pb were determined using graphite furnace atomic absorption spectrophotometer (GFAAS) and Cu, Ni and Zn were determined using a flame atomic absorption spectrophotometer (FAAS) [23].

Bioconcentration Factor

The Bioconcentration Factor (BCF) was used to determine the quantity of metal trace elements that is absorbed by the plant from the soil. This is an index of the ability of a plant to accumulate a particular metal with respect to its concentration in the soil [24-25] and is calculated using the following formula 4:

$$BCF = [Metal]_{vegetable} / [Metal]_{soil} \quad (4)$$

RESULTS**Heavy metals concentration in the soil**

The concentrations of the bioavailability heavy metals in the soils show that Zn and Pb have the highest levels at both sites (Figure 2). These concentrations are in the range of 426 mg / kg (Operating site) and 432 mg / kg (Abandoned site) for Zn and 62.7 mg / kg (Abandoned site) and 66.4 mg / kg (Operating site) for the Pb. In contrast, Cu, Ni and Cd are weakly concentrated in the soils of the Akouédo landfill.

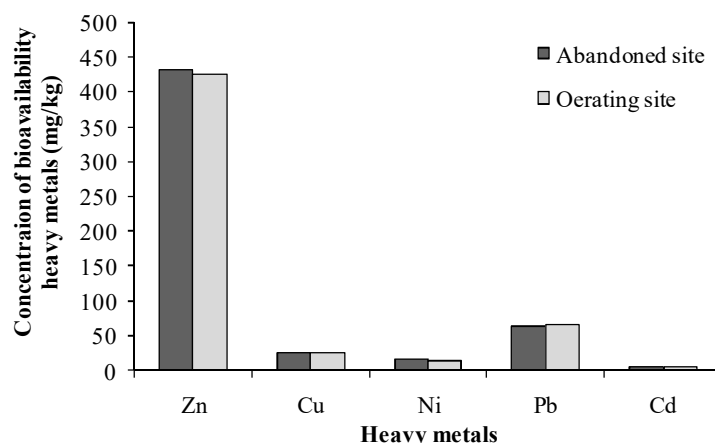


Figure 2. Concentration (mg/kg) of bioavailability heavy metals in the soils of Akouedo landfill

Heavy metals concentration in the vegetables

The heavy metals concentration in the fruits and leaves of the vegetables were higher for Zn (1.91-13.50 mg/kg dw) and Cu (0.50-8.50 mg/kg dw) (Table 1). However, the concentrations of Zn and Cu obtained in the different vegetables were very low compared to the sanitary standard.

The Pb concentration recorded in the tomato fruits harvested on the abandoned site (0.36 mg / kg Pb dw)) and those of okra taken from abandoned site (0.57 mg / kg Pb dw)) and operating site (0.35 mg / kg Pb dw)) were higher than the sanitary standard (0.3 mg / kg Pb dw).

The concentration of Ni and Cd were the lowest and ranged, respectively from 0.20 to 0.68 mg / kg Ni dw and from 0.01 to 0.13 mg / kg Cd dw. Those concentrations were very low compared to the sanitary standard.

Table 1. Heavy metals concentration (mg / kg Pb dw) in the vegetables crops

Heavy metals	Sampling sites	Vegetables				Standard FAO/ OMS (2011)
		Tomato (<i>Lycopersicum esculentus</i> L.)	Okra (<i>Hibiscus esculentus</i> L.)	Eggplant (<i>Solanum melongena</i> L.)	Spinach (<i>Spinacia oleracea</i> L.)	
Zn	Abandoned site	2.24	13.10	3.75	13.50	50
	Operating site	1.91	6.82	4.18	9.79	
Cu	Abandoned site	0.47	8.50	1.06	0.56	40
	Operating site	0.50	1.06	11.5	1.88	
Ni	Abandoned site	0.34	0.41	0.30	0.62	66.9
	Operating site	0.20	0.35	0.35	0.68	
Pb	Abandoned site	0.36	0.57	0.25	0.25	0.3
	Operating site	0.25	0.35	0.18	0.29	
Cd	Abandoned site	0.06	0.07	0.01	0.13	0.2
	Operating site	0.03	0.10	0.06	0.05	

Bioconcentration factor (BCF)

The Bioconcentration Factor (BCF) ranged from 0.001 (Cd) to 0.343 (Cu) and from 0.002 (Pb) to 0.447 (Cu), respectively on the abandoned and operating site (Figure 3). The BCF values were higher for Cu on the abandoned site for okra (0.343) and operating site for eggplant (0.447). Generally, Pb presented the lowest BCF value for all vegetables on the two sites.

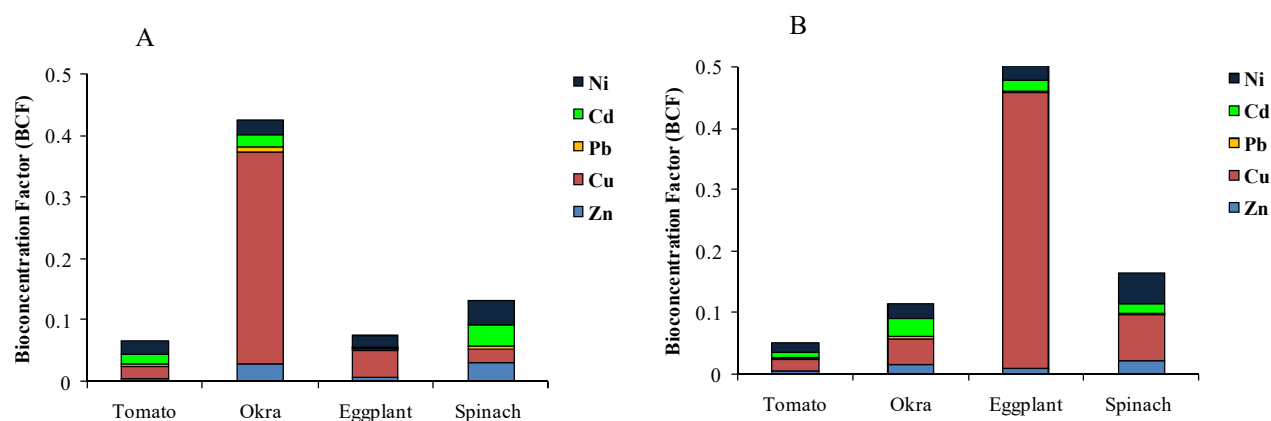


Figure 3: Bioconcentration Factor (BCF) values (A: Abandoned site; B: Operating site)

Heavy metals mass accumulated in vegetables produced

The average quantity of vegetables produced per farming season was high on the abandoned site. On that site, Tomato was most produced (3.36 ± 0.53 ton per farming season).

Table 2. Quantity of vegetables produced per farming season

Sampling sites	Vegetables production (ton per farming season)		
	Tomato (<i>Lycopersicum esculentus</i> L.)	Okra (<i>Hibiscus esculentus</i> L.)	Eggplant (<i>Solanum melongena</i> L.)
Abandoned site	3.36 ± 0.53	1.34 ± 0.12	0.22 ± 0.06
Operating site	2.53 ± 0.37	0.96 ± 0.21	0.09 ± 0.01

The mass of Pb accumulated in the vegetables production showed that the value obtained on the abandoned site was the highest for all the vegetable (Table 3).

Table 3. Mass (g) of Pb accumulated in the fruit vegetables produced on the Akouédo landfill

Sampling sites	Tomato (<i>Lycopersicum esculentus</i> L.)	Okra (<i>Hibiscus esculentus</i> L.)	Eggplant (<i>Solanum melongena</i> L.)
Abandoned site	0,32	0,35	0,01
Operating site	0,20	0,15	< 0,009

DISCUSSION

The vegetables produced on the Akouédo landfill soil concentrated heavy metals. The cultivation site is a wild landfill, exploited for more than five decades. Many types of solids waste, included industrial, household and hospitals of the district of Abidjan are dumped. The decomposition of these different solids wastes would cause the heavy metals transfer into the cultivated soils. The Akouédo landfill heavy metals contaminated soils were reported by [15-26-27]. Another source of vegetables contamination on the landfill could be the atmospheric depositing. That source could be due to the emissions of the vehicles flow and the waste incineration. According to [28], the car traffic and air humidity contributed significantly to the emission of heavy metals into the environment and consequently to their accumulation by vegetables located in the surrounding zone.

Moreover, the heavy metals concentration obtained in the vegetables harvested on the landfill depend on the types of vegetables and the level of pollution of the growing site. Concentrations of Zn and Cu, although lower than the sanitary standard, remain the highest in vegetables. These concentrations of Zn and Cu would be attributed to their nutrient character. In return, the heavy metals concentration obtained for the vegetables were similar to those recorded by [29] for tomato and okra in India, [30] and [31] for eggplant, respectively in India and Nigeria.

The high levels of Pb, recorded in tomato and okra fruits, could be due to their ability to accumulate that heavy metal. According to [32], tomato had a high degree of tolerance for Pb, Zn and Cu. Others authors such as [31] and [16], obtained for Pb 81.8 mg / kg dw in tomato and 9.4 mg / kg dw in okra, respectively.

Among the heavy metals analyzed, Pb presented concentrations above the sanitary standard reported by [33]. In addition, spinach leaves recorded Pb concentrations relatively equal to the sanitary standard. The concentrations of Cd were higher than those obtained by [20] on the vegetables cultivated on the market gardening in Abidjan. The high concentration of Pb and Cd recorded in the spinach leaves from Akouédo landfill would likely be related to the nature of that site. In addition, the consumption of those heavy metals contaminated vegetables, including tomato and okra, could pose a threat to the health of populations. Indeed, the consumption

of those vegetables contaminated with Pb could exposes consumers to several diseases such as anemia, cancer, gastrointestinal disorders, disorders of the nervous system and kidneys [12-34-35].

CONCLUSION

The study showed high contamination of heavy metals in the soil and the vegetables grown on the Akouedo landfill. The heavy metals concentration in the fruits and leaves of the vegetables were higher for Zn and Cu. However, the concentrations of Zn and Cu obtained in the different vegetables were very low compared to the sanitary standard. The Pb concentration recorded in the tomato and okra fruits were higher than the sanitary standard. The consumption of those vegetables presented public health concerns.

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The Effect of Gender on Pedagogical Efficacy in Classroom Management of Educators in District Toba Tek Singh

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ABSTRACT

This study was designed to analyze and compare the Pedagogical Efficacy of male and female educators in classroom management in District Toba Tek Singh (T.T.S.). It was a quantitative descriptive study in which survey technique was applied to serve the objectives of the study. The target population included all SSE (Secondary School Educators) in District Toba Tek Singh (T.T.S.). The total number of SSE is equal to 540. The sample was 270 SSE's including 135 males and 135 females. The sample was selected by simple random sampling technique. The data collecting tool was a self-developed questionnaire framed on three-point Likert Scale. The data were displayed in the form of contingency table. Descriptive data were analyzed by computing frequency distribution and Chi-Square test of independence. Findings of the study shows that gender affect pedagogical efficacy in 4 out of 10 parameters of classroom management studied. It was also found that male educators were more efficacious in controlling problem behavior and enhancement of student's efficacy. Female educators were found better in providing alternating explanations and developing interactions between the students. This study has also found six parameter of classroom management efficacy in which gender has no influence on efficacy.

KEYWORDS: Pedagogy, efficacy, classroom management, educators, parameters of classroom management

INTRODUCTION

Education is a long-lasting process. [18]; [19] The knowledge is a fundamental and crucial variable that affect the humans. [20]; [21] Education is a long-lasting procedure claiming the learning and ability increased through training. The education is a critical component of the strategy for accomplishing and supporting national success, eminence and moral up lift. [20]; [21] Teachers are one of the major sources of moral inspiration [1] The attributes of the teachers are highly correlated with successful educational outcomes of an education system. [2] Owing to the prime importance of education and teachers the government of the Punjab Province has recruited educators designated as SSE (Secondary School Educators). They all have master's degree qualification in their relevant fields. This study was designed to investigate the pedagogical efficacy in classroom management of educators with the purpose of the study to analyze and find effect of gender on classroom management efficacy.

Teachers self-efficacy is now intensively researched educational knowledge area in the field of educational research. [22] The studies which has addressed this issue include [3] where they have examined the self-efficacy beliefs of science math pre-school teachers in Turkey aimed to find efficacy of teachers with respect to working experience. This study has found experienced teachers are more efficacious. [4] and co-authors have investigated the effect of technology on Self-efficacy beliefs of teachers and concluded effectiveness of technology in enhancing the self-efficacy of teachers. He [5] and co-authors have analyzed the teaching methods of the highly efficacious teachers and concluded that highly efficacious mostly use inquiry method in their classwork. They [6] have compared the efficacy of novice and experienced female secondary school teachers. They have compared the female teachers by experience and impact of experience on the sub-factors of efficacy such as Efficacy for Instructional Strategies, Efficacy for Classroom Management and Efficacy for Student Engagement. They have concluded that novice teachers are less efficacious than experienced ones. They [7] have done a wonderful study in which they studied the self-efficacy of teachers as a dependent variable and two independent variables of gender and qualification. It has concluded that gender has no influence on efficacy, but qualification has had effect simultaneously. They [8] have generated the data which revealed that female English teachers had more sense of efficacy as compared

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to male teachers on the distribution of teachers' sense of efficacy scale (TSES), Moreover female students performed better on students' academic achievement test as compared to male students.

These studies mentioned above have addressed the self-efficacy of teachers, but they are deficient and limited for instance the study addressing effect of working experience on efficacy has not equalize the qualification of the participants thus the concluded effect may be because of difference of qualification. Some of these studies has investigated the effect of training on efficacy. Training is always effective but here the nature of training is not explained fully which less than enough to replicate the studies. Some studies have compared the efficacy of male and female teachers in general that are not focused on classroom management efficacy. This study was conducted to fulfil the gap left by previous studies as it is focused on classroom management pedagogical efficacy of male and female teachers of same working experience and almost same academic and professional qualifications. The efficacy of teachers is contextual because of different nature of educational systems of different counties and different provinces of same country. Thus, the researcher was convinced that the analysis of efficacy conducted in other counties are not valid for the teachers of Punjab. This study is a significant effort to describe the pedagogical efficacy of educators of District Toba Tek Singh with special focused on classroom management. This study has included research-based consensus parameters of classroom management in questionnaires.

Statement of problem

The government of the Punjab has recruited thousands of educators in different categories in last few years. Teaching is an art and the pedagogical efficacy is one of the most effective component of the art of teaching. [3] This study was designed to address the problem that what is the actual situation of the pedagogical efficacy of educators in classroom management in district Toba Tek Singh. And what is the influence of gender of educators on their efficacy to manage their classrooms.

Objectives of the Study

Specific objectives of the study were:

1. To find pedagogical efficacy of educators to manage the classroom activities.
2. To compare the pedagogical efficacy of male and female SSE.

Hypotheses of the study

The null hypotheses of the study were:

H₀= the efficacy level of male and female educators is same in controlling the disruptive behavior in the classroom.

H₀ the efficacy level of male and female educators is same in preventing problem behavior on the school grounds.

H₀ the efficacy level of male and female educators is same in increasing collaboration between teachers and administration.

H₀ the efficacy level of male and female educators is same in using a variety of assessment strategies.

H₀ the efficacy level of male and female educators is same in providing an alternative explanation for example when students are confused.

H₀ the efficacy level of male and female educators is same in turning classroom atmosphere in which feel free to interact.

H₀ the efficacy level of male and female educators is same in doing to get students to believe they can do well in classwork.

H₀ the efficacy level of male and female educators is same in reducing school absenteeism.

H₀ the efficacy level of male and female educators is same in getting students to trust teachers.

H₀ the efficacy level of male and female educators is same in creating cultural harmony in classroom.

Significance of the Study

The teacher is a key factor in educational systems in all over the world. [23] The performance of the teachers has a direct link with the success or failure of the student. The performance of teacher is affected by his sense of efficacy. [8] There are numerous studies that aimed at the explanations of different aspect of teacher's act of teaching. It is significant to investigate the self-efficacy beliefs of educators of district Toba Tek Singh about classroom management.

Limitations of the study

The results of this study cannot be generalized to whole Pakistan or to the globe because of sample size was small and weak sampling technique, instruments used was not a standard instrument and role of researcher's biases.

Delimitations of the study

Due to lack of time and resources this study was delimited to teachers of district Toba Tek Singh, educators of secondary level in district T.T. Singh, teachers of only Government sector only and the study addresses only pedagogical efficacy the educators about classroom management.

METHODOLOGY

The research design of this study was descriptive and quantitative. The study was completed by applying survey methodology to achieve the set objectives of the study. The target population of the study was all SSE educators appointed in District Toba Tek Singh the number of SSE educators in District TTS is 540. Sample for this study was selected by simple random technique. It comprised of 270 randomly selected SSE educators from the District TTS. This sample included 135 male SSE and 135 Female SSE

Data collection tool of the study was a questionnaire. It was constructed on three point Likert Scale. It was a self-developed tool and it was developed by consulting He [9] guides for development of Self-efficacy scales. It was validated by the opinion of experts by sending them developed scale and the objectives of the study. The reliability of the scale was established by conducting pilot study and Cronbach's alpha was computed by SPSS. For this purpose, draft questionnaire was pilot tested from 100 teachers that were not included in the sample of the study the value of alpha 0.6 was the criterion for reliability of the scale. The calculated value of alpha was 0.9. this shows that the questionnaire is highly reliable. High value of alpha is because this questionnaire was adopted from standard self-efficacy scale of Albert Bandura.

The researcher has approached CEO education TTS office for obtaining the list of SSEs appointed during 2009-2014. Then 270 SSE were selected randomly as required sample. The questionnaire was sent to the subjects by three means i.e. by post and by email and personal visit where ever possible. Filled in questionnaires were personally collected to achieve maximum response rate.

RESULTS

Data were collected by three-point attitude scale developed by consulting Bandura [9] and Government of Guyana Ministry of Education [10]. It included ten parameters of pedagogical efficacy about classroom management. The result presented in table below showed the frequency distribution of all response types of the attitude of the participants to describe the efficacy level of the educators. The values of χ^2 and p were presented to test the null hypotheses.

Table 1: Analysis of the Attitude of the Participants towards Pedagogical Efficacy

S.N	Statements	Gender	Attitude Preferences			χ^2
			Favor	Undecided	Against	
1	I can control disruptive behavior in the classroom.	Male	124	5	6	1.896 P=.388
		Female	117	8	10	
2	I can prevent problem behavior on the school grounds.	Male	108	21	6	22.78 P=.001
		Female	90	12	33	
3	I can increase collaboration between teachers and administration	Male	100	20	15	4.88 P=.086
		Female	114	14	7	
4	I can use a variety of assessment strategies	Male	108	18	9	0.175 P=.9
		Female	109	16	10	
5	I can provide an alternative explanation for example when students are confused	Male	70	20	45	36.24 P=.00001
		Female	112	15	8	
6	I can turn classroom atmosphere in which feel free to interact.	Male	80	21	34	25.37 P=.0001
		Female	100	30	5	
7	How much can you do to get students to believe they can do well in classwork?	Male	102	10	23	22.78 P=.000011
		Female	65	30	40	
8	How much can you do to reduce school absenteeism?	Male	123	7	5	5.30 P=.070
		Female	110	15	10	
9	How much can you do to get students to trust teachers?	Male	107	12	16	57.82 P=.0001
		Female				
10	How much can you create cultural harmony in classroom?	Male	55	5	75	39.73 P=.001
		Female	100	5	25	

From table 1 row 1 showed the results of the analysis of the attitude of educators towards the pedagogical efficacy in controlling disruptive behavior in students in the classroom. Majority of male (124) and female (117) educators were found to be in favor of the statement showing that they believed that they were efficacious in this parameter. Chi-Square test of independence was applied to test the null hypothesis that male and female educators have same level of efficacy in classroom management. The result of Chi-square $\chi^2(2, N=270) = 1.896$, $p > 0.05$ failed to reject the null hypothesis.

From table 1 row 2 showed the results of the analysis of the attitude of educators towards the pedagogical efficacy in preventing problem behavior in the school. Majority of male (108) and female (90) educators were found to be in favor of the statement showing that they believed that they were efficacious in this parameter. Chi-Square test of independence was applied to test the null hypothesis that male and female educators have same level of efficacy in classroom management. The result of Chi-square $\chi^2(2, N=270) = 22.78$, $p < 0.05$ supported to reject the null hypothesis. Thus, alternative hypothesis, that male and female educators different level of efficacy, was accepted.

From table 1 row 3 showed the results of the analysis of the attitude of educators towards the pedagogical efficacy in increasing collaborations. Majority of male (100) and female (114) educators were found to be in favor of the statement showing that they believed that they were efficacious in this parameter. Chi-Square test of independence was applied to test the null hypothesis that male and female educators have same level of efficacy in classroom management. The result of Chi-square $\chi^2(2, N=270) = 4.88$, $p > 0.05$ failed to reject the null hypothesis. Thus, alternative hypothesis, that male and female educators different level of efficacy, was accepted.

From table 1 row 4 showed the results of the analysis of the attitude of educators towards the pedagogical efficacy in applying variety of assessment techniques. Majority of male (108) and female (109) educators were found to be in favor of the statement showing that they believed that they were efficacious in this parameter. Chi-Square test of independence was applied to test the null hypothesis that male and female educators have same level of efficacy in classroom management. The result of Chi-square $\chi^2(2, N=270) = 0.175$, $p > 0.05$ failed to reject the null hypothesis. Thus, alternative hypothesis, that male and female educators different level of efficacy, was accepted.

From table 1 row 5 showed the results of the analysis of the attitude of educators towards the pedagogical efficacy in providing alternative explanations when students were confused. Majority of male (70) and female (112) educators were found to be in favor of the statement showing that they believed that they were efficacious in this parameter. Chi-Square test of independence was applied to test the null hypothesis that male and female educators have same level of efficacy in classroom management. The result of Chi-square $\chi^2(2, N=270) = 36.24$, $p < 0.05$ supported to reject the null hypothesis. Thus, alternative hypothesis, that male and female educators different level of efficacy, was accepted.

From table 1 row 6 showed the results of the analysis of the attitude of educators towards the pedagogical efficacy in turning classroom atmosphere favorable for free interactions. Majority of male (80) and female (100) educators were found to be in favor of the statement showing that they believed that they were efficacious in this parameter. Chi-Square test of independence was applied to test the null hypothesis that male and female educators have same level of efficacy in classroom management. The result of Chi-square $\chi^2(2, N=270) = 25.37$, $p < 0.05$ supported to reject the null hypothesis. Thus, alternative hypothesis, that male and female educators different level of efficacy, was accepted.

From table 1 row 7 showed the results of the analysis of the attitude of educators towards the pedagogical efficacy in getting students to believe in themselves that they can do. Majority of male (102) and minority of female (65) educators were found to be in favor of the statement showing that they believed that they were efficacious in this parameter. The female educators were not efficacious Chi-Square test of independence was applied to test the null hypothesis that male and female educators have same level of efficacy in classroom management. The result of Chi-square $\chi^2(2, N=270) = 22.78$, $p < 0.05$ supported to reject the null hypothesis. Thus, alternative hypothesis, that male and female educators different level of efficacy, was accepted.

From table 1 row 8 showed the results of the analysis of the attitude of educators towards the pedagogical efficacy in reducing absenteeism. Majority of male (123) and female (110) educators were found to be in favor of the statement showing that they believed that they were efficacious in this parameter. Chi-Square test of independence was applied to test the null hypothesis that male and female educators have same level of efficacy in classroom management. The result of Chi-square $\chi^2(2, N=270) = 5.30$, $p > 0.05$ failed to reject the null hypothesis.

From table 1 row 9 showed the results of the analysis of the attitude of educators towards the pedagogical efficacy in developing trust in teachers. Majority of males (107) and minority of females (55) educators were found to be in favor of the statement showing that they believed that they were efficacious in this parameter. Female educators were not efficacious in this parameter. Chi-Square test of independence was applied to test the null hypothesis that male and female educators have same level of efficacy in classroom

management. The result of Chi-square $\chi^2(2, N=270) = 57.82$, $p < 0.05$ supported to reject the null hypothesis. Thus, alternative hypothesis, that male and female educators different level of efficacy, was accepted.

From table 1 row 10 showed the results of the analysis of the attitude of educators towards the pedagogical efficacy in creating cultural harmony. Minority of male (55) and majority of female (100) educators were found to be in favor of the statement showing that they believed that they were efficacious in this parameter. Majority of males were less efficacious in this parameter. Chi-Square test of independence was applied to test the null hypothesis that male and female educators have same level of efficacy in classroom management. The result of Chi-square $\chi^2(2, N=270) = 39.73$, $p < 0.05$ supported to reject the null hypothesis. Thus, alternative hypothesis, that male and female educators different level of efficacy, was accepted.

DISCUSSION

This study was designed to research out the self-efficacy beliefs of male and female educators appointed in government schools in district Toba Tek Singh of Province of Punjab. The objectives of this research paper were to find the efficacy level of male female educators and to compare their beliefs of self-Efficacy. These teachers have almost same qualification because basic required academic qualification was sixteen-years schooling in relevant areas of specification and bachelor's degree in professional qualification. [11] The objectives of the study also included to analyze and compare the pedagogical efficacy in classroom management of educators. Analysis of the data has led the researcher to compile two major findings. First, male and female teachers were found similar in level of pedagogical efficacy in four out of ten parameters of classroom efficacy. These parameters are control of disruptive behavior, collaboration, application of various assessment strategies in the classroom. These findings are in line with the studies of [12], [6] Second major finding showed that male and female educators have different level of self-efficacy in managing the classroom activities. The difference in efficacy exist in six out ten parameters of pedagogical efficacy about classroom management. These parameters are prevention of problem behavior in students, exercise of alternative explanation to remove student's confusion in the comprehension of some concepts, make classroom environment suitable for student interactions, instill student motivations to do well in classwork, develop trust in teachers and create cultural harmony. This finding is in line with the studies of [13], [14], [15] It was found that male teachers were more efficacious than female teachers in prevention of problem behavior, student motivations and development of trust in teachers but female teachers were more efficacious than male teachers in application of alternative strategies to solve student confusions, making classroom atmosphere friendly for interaction and generating cultural harmony in the class. This finding is in line with studies of [16], [17]

CONCLUSION

In the light of results, findings and discussion it is concluded that male and female teachers based on difference in teaching styles and difference in personality traits show different level of self-efficacy. Depending on nature of the components of classroom management efficacy male and female teachers have same level of self-efficacy in certain components like control of disruptive behavior, collaboration, assessment strategies and reduction of absenteeism. In case of general analysis of pedagogical efficacy in classroom management the educators are efficacious in performance of classroom activities except two parameters of classroom management i.e. female educators believed that they are not efficacious to motivate students in developing self-confidence to do well in classwork, male educators believed that they are not efficacious in developing cultural harmony in the classroom.

RECOMMENDATIONS

This study is based on data collected in the self-reported attitude of teachers about their own beliefs of efficacy. So, there may be exaggeration in the narration of plus points of their personality and concealment of facts in narration of negative points of their personality. It is therefore, recommended that this study should be replicated by using other techniques of data collection such as participant observations or non-participant observations.

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Fish Contamination on Artisanal Gold Mining Area and Health Risks in Hiré, Côte D'Ivoire

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ABSTRACT

The present study aim at assessing the contamination of fish from rivers where chemicals used in gold extraction by artisanal miners are discharged. The study was conducted on in the town of Hiré in the south of Côte d'Ivoire. This town is dominated by the artisanal gold mining activities. Furthermore, the health risks associated with this contamination were also be assessed. The samples of two fishes (*Tilapia zillii* and *Oreochromis niloticus*) were collected along three rivers course (Agbalé, Tchebi and Akississo). These fishes are the most consumed by the population. Samples were persevered and taken to the laboratory for analysis. Muscles and gills were used for analysis. The sample fish tissues were analyzed by inductively coupled plasma mass spectrometry (copper and zinc); by cold vapor atomic fluorescence spectrometry (mercury) and by ultraviolet digestion (total cyanide). The results obtained showed in the organs of the fish, a strong accumulation of pollutants (copper, zinc, total cyanide), preferentially in the gills, on all sites. The content of these pollutants generally exceeds the threshold value tolerated for fish but also for humans. This is a limiting factor in the protein of the population of Hiré. Long-term consumption risks expose the population to contamination and therefore to the effects of these pollutants.

KEY WORDS: artisanal gold mining, fish contamination, health risks, heavy metals

INTRODUCTION

Development of economics activities of Côte d'Ivoire to the mining sector has led to the increased of artisanal gold mining. These activities are frequently accompanied by extensive environmental degradation and deplorable socio-economic conditions, both during operations and well after mining activities have ceased [1]. Indeed, artisanal miners employ rudimentary techniques for mineral extraction and often operate under hazardous, labour intensive, highly disorganized and illegal conditions. Human health impacts resulting from chemicals (mercury, cyanide, zinc, copper, etc.) use to extract gold. These chemicals polluted water and soils around sites and subsequently the food chain [2]. These pollutants are thus found in the tissues of plants and aquatic organisms. These fish, when ingested by man, contaminate it and expose it to the effects of the said pollutants. Trace elements (copper and zinc) play a biological role at low concentrations but become toxic at high levels. Others (cyanide and mercury) are considered to be trace pollutants of the environment and have deleterious biological effects even at low concentrations on human health [1-3].

In Côte d'Ivoire, few studies have been carried out concerning the characterization of environmental pollution and the health impacts of artisanal and small-scale gold mining activities. The present study aim at assessing the contamination of fish from rivers where chemicals (copper, mercury, zinc and total cyanide) used in gold-washing are discharged. Furthermore, the health risks associated with this contamination will also be assessed. In order to achieve these objectives, the town of Hiré was chosen because of the intensity of artisanal and small-scale gold mining activities in this zone compared to the other mining zones [4]. Specifically, measurements of copper, mercury, zinc and total cyanide concentrations in the gills and muscle tissues of *Tilapia zillii* and *Oreochromis niloticus*, which were the most consumed fishes, and analysis of the risks associated with their consumption.

MATERIALS AND METHODS

Study area

The study was carried in the town of Hiré (06°15'08.6 and 06°10'00.0 N and 05°23'44.8 to 05°16'32.1 W) [5]. The sampling stations are the streams bordering gold mining sites of Tchebi, Agbalé and Akississo (Figure 1).

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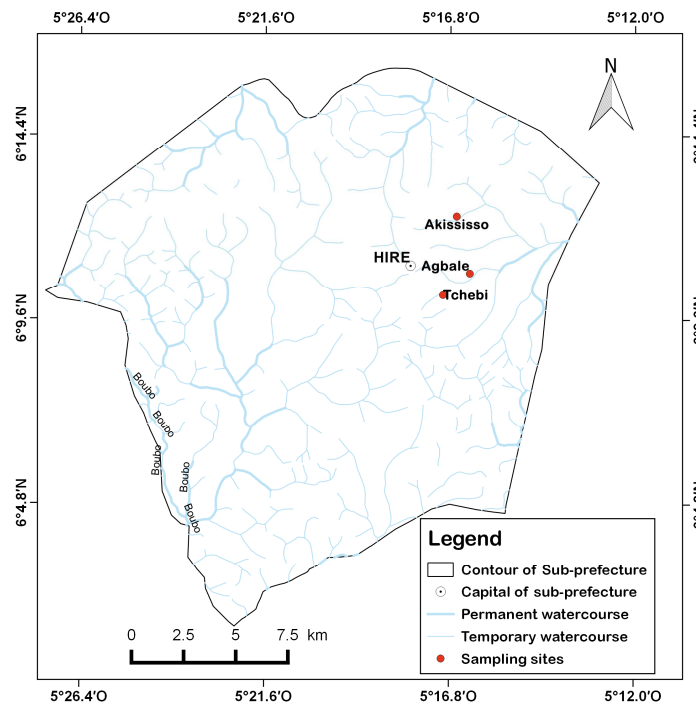


Figure 1. Sampling sites

Collection and preparation of fish samples

Three specimens of *Tilapia zillii* and *Oreochromis niloticus* were fishing from each sampling stations. They were considered as representative of fish species commonly consumed in the area under study. Fish were then identified according to the identification keys of [6-7] and were preserved in an ice box and transferred to the laboratory, where the samples were frozen. At laboratory, each specimen was weighed and measured by total length.

Chemical parameters concentration in fish tissues analyses

Preparation of samples and analysis were made according to FAO technical paper [8]. For metal analysis, frozen fish were partially thawed, and each fish was dissected using stainless steel instruments. Muscles and gills were taken out; composite samples of 25 to 100 g, respectively for small-size and large-size individuals, were used for analysis. The sample fish tissues were analyzed by inductively coupled plasma mass spectrometry (copper (Cu) and zinc (Zn)); by cold vapor atomic fluorescence spectrometry (mercury (Hg) and by ultraviolet digestion (total cyanide (CNT)).

Statistical analysis

The normality of the data was verified using the Shapiro-Wilk test (software R) and homogeneity was verified by Levene's test (STATISTICA 7.1). The variation of the chemicals parameters measured between organs fishes was compared using ANOVA of Kruskal-Wallis. The Mann Whitney test was employed to indicate significant differences between both organs fishes. The statistical program used for both tests was R software 3.1.1. The significance level was $p < 0.05$.

Method for assessing the health risks

The evaluation of the health risk to local people in the area of study posed by the consumption of fishes was based on the data from the muscle samples. The contents of the pollutants contained in the muscular tissues have been used for risks assessment.

Health risks of exposure of the population

Daily Dose of Exposure (DDE)

The daily dose of exposure (DDE) to chemical pollutants following consumption of fresh fish per individual was determined according to the equation 1 [9-10].

$$\text{DDE} = \frac{\text{CP}}{\text{BW}} = \frac{\text{CCP} * \text{R}}{\text{BW}} \quad (1)$$

Where

DDE (mg/kg/d): daily dose of an individual's exposure to chemical pollutants from fish consumption ;

CP (mg/kg/d): chemical pollutant intake per day after the consumption of fish by an individual ;

BW (kg): body weight of the fish consumer (60 kg) over the entire lifetime also estimated at 60 years [11] ;

CCP (mg/kg): concentration of chemical parameter in fish ;

R: yearly fish consumption per person, which is 14.45 kg for Côte d'Ivoire [12].

Hazard quotient (HQ)

The methodology of estimating hazard quotient (HQ) provides indications of the human health risk level due to exposure to pollutants [10]. HQ is the ratio between daily dose of an individual's exposure to chemical pollutants from fish consumption and tolerable daily dose. If the HQ > 1, there is a potential risk related to the studied metal [13]. The following equation was used to estimate risk:

$$\text{HQ} = \frac{\text{DDE}}{\text{TDD}} \quad (2)$$

Where

HQ: Hazard quotient

DDE (mg/kg/d): daily dose of an individual's exposure to chemical pollutants from fish consumption;

TDD (mg/kg/d): tolerable daily dose

Quantity of fish (QF) to be consumed for exposure to chemical pollutants

QF is the maximum quantity of fish can be eating to attack tolerable dose [14]. The equation (3) was used to estimate QF.

$$\text{QF} = \frac{\text{TDD} * \text{BW} * \text{FBM}}{\text{CCP} * \text{R}} \quad (3)$$

Where

QF (kg): Maximum quantity of fish can be eating by day without risk;

TDD (mg/kg/d): tolerable daily dose;

BW (kg): body weight of the fish consumer (60 kg) over the entire lifetime also estimated at 60 years [11] ;

FBM: Fish body mass (kg);

CCP (mg/kg): concentration of chemical parameter in fish;

R: yearly fish consumption per person, which is 14.45 kg for Côte d'Ivoire [12].

RESULTS

Concentration of mercury, copper, zinc and total cyanide in fish organs

The concentrations of mercury, copper, zinc and total cyanide in the gills and muscular tissues of the species *Tilapia zillii* and *Oreochromis niloticus* caught in the Agbalé, Tchebi and Akississo rivers are illustrated in Table 1.

Whatever the organ, fish and sampling site, mercury concentrations are well below the recommended threshold (0.5 mg/kg) for any organ, fish and sampling site. In fact, mercury concentrations are between $1.1 * 10^{-5}$ and $6 * 10^{-5}$ mg/kg. For *Tilapia zillii* from Akississo and Agbalé, and *Oreochromis niloticus* from Agbalé, the results indicate that Hg accumulates preferentially in the gills comparatively to *Tilapia zillii* and *Oreochromis niloticus* from Tchebi. The Kruskal-Wallis test showed no difference ($p > 0.05$) between the concentrations of mercury obtained in the gills and in muscle.

The concentrations of copper are above the threshold value (0.3 mg/kg) at any site. These concentrations recorded in the gills are higher to those of the muscle excepted *Oreochromis niloticus* from Akississo. In the gills, the minimum concentrations (0.53 mg/kg) of copper are recorded at Agbalé in *Oreochromis niloticus*, while the maximum concentrations (12.27 mg/kg) of copper in the same organ are recorded in *Tilapia zillii* from Tchebi. At the muscle, the low concentrations (0.36 mg/kg) of copper in both fish species are recorded at Agbalé. Unlike in the Tchebi *Tilapia zillii* muscles, where the highest concentrations (0.82

mg/kg) of copper are noted. The Kruskal Wallis test shows a difference ($p < 0.05$) between copper concentrations in gills and muscle.

The Zn concentrations in the two organs of the different fish exceeded FAO and WHO limit (0.5 mg/kg). It is also noted that the zinc concentrations recorded in the gills are significantly higher than those of the muscle tissues for all sites (Mann-Withney: $p < 0.05$). In the gills, the maximum Zn concentration observed was 40.99 mg/kg at Akississo in *Tilapia zillii* and the minimum of 7.93 mg/kg for *Oreochromis niloticus* collected at Akississo. At the muscle, the concentration of zinc is lowest (6.75 mg/kg) of *Tilapia zillii* from Tchebi, but, highest (9.40 mg/kg) of *Tilapia zillii* at Agbalé.

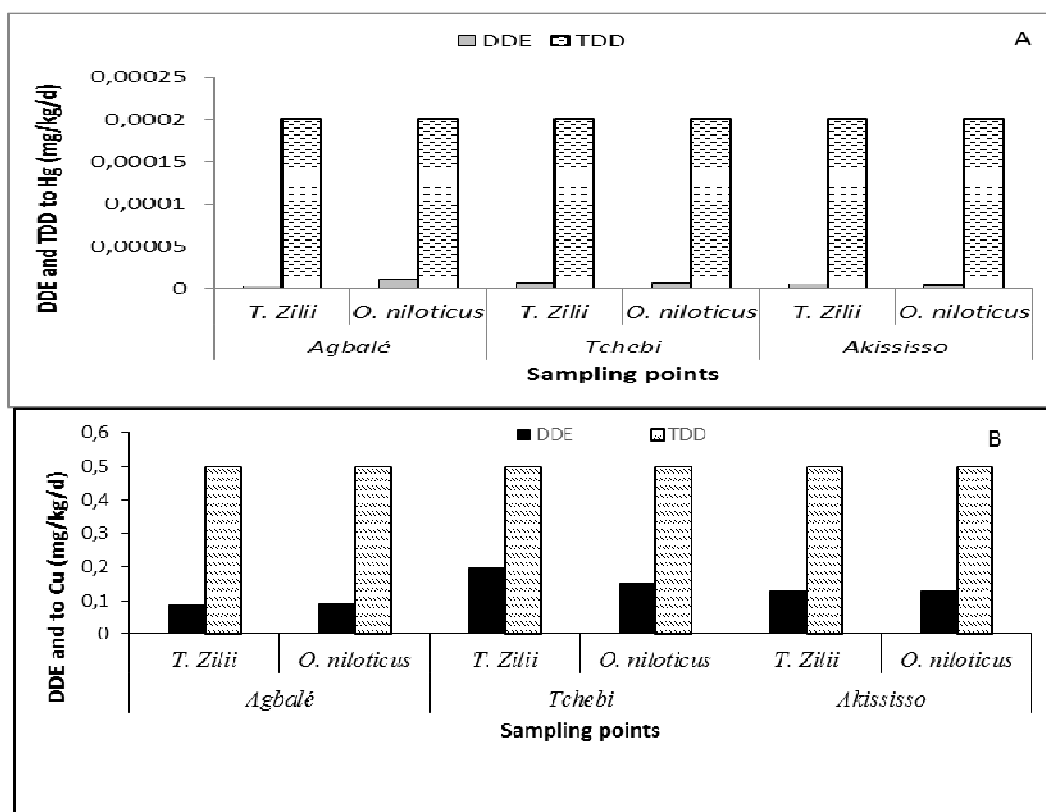
The total cyanide concentrations at the two organs of the different fish are above the threshold value (0.05 mg/kg). The total cyanide concentration accumulates preferentially in the gills than muscle. The low concentrations of total cyanide (0.72 mg/kg) are recorded at the muscle of *Tilapia zillii* from Agbalé, and the highest CNT concentrations content of *Oreochromis niloticus* from Tchebi was (4.81 mg/kg). The Kruskal Wallis test showed no difference ($p > 0.05$) between the total cyanide concentrations obtained in the gill and muscle.

Table 1. Heavy metals concentration in fish organs

Fish species	Sampling sites	Fish organs	Hg (mg/kg)	Cu (mg/kg)	Zn (mg/kg)	CNT (mg/kg)
<i>Tilapia zillii</i>	Akississo	Muscle	2,2*10 ⁻⁵	0.54	7.39	1.71
		Gill	6*10 ⁻⁵	3.03	40.99	3.22
	Tchebi	Muscle	2,9*10 ⁻⁵	0.82	6.75	2
		Gill	2,3*10 ⁻⁵	12.27	30.73	4.79
	Agbale	Muscle	1,6*10 ⁻⁵	0.36	9.40	0.72
		Gill	5,8*10 ⁻⁵	2.49	24.45	3.56
<i>Oreochromis niloticus</i>	Akississo	Muscle	1,9*10 ⁻⁵	0.53	7.93	2.16
		Gill	1,9*10 ⁻⁵	0.53	7.93	2.16
	Tchebi	Muscle	2,9*10 ⁻⁵	0.64	7.58	1.98
		Gill	1,1*10 ⁻⁵	6.28	15.38	4.81
	Agbale	Muscle	4,4*10 ⁻⁵	0.37	6.88	1.07
		Gill	5,8*10 ⁻⁵	2.49	24.45	3.56
Norm FAO/WHO			0.5	0.3	0.5	0.05

Daily dose exposure (DDE) to chemical pollutants

The DDE to Hg (Figure 2A), Cu (Figure 2B) are well below tolerable daily dose 0.0002 mg/kg/d, 0.5 mg/kg/d respectively. But the DDE to CNT (Figure 2C) were higher than tolerable daily dose (0.056 mg/kg/d).



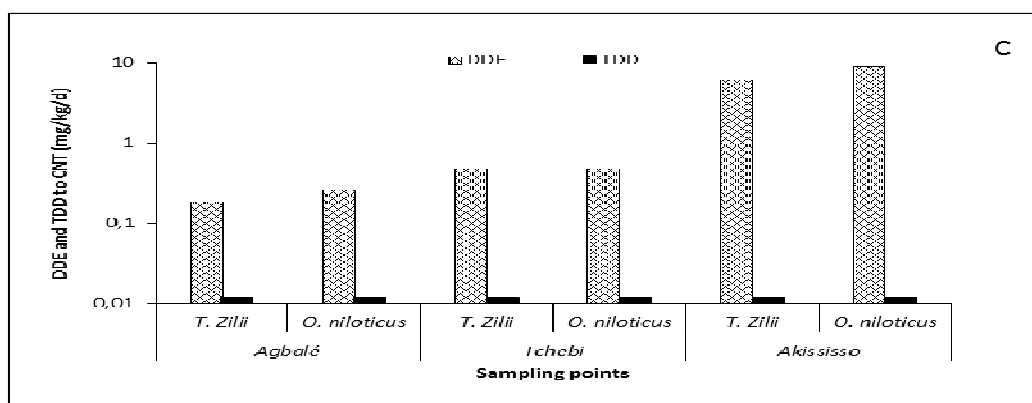


Figure 2. Daily dose of exposure (DDE) and tolerable daily dose to Hg (A), Cu (B) and CNT (C)

Hazard quotient (HQ)

In the present study, the results of HQ calculated for each of the heavy metals (Hg, Cu and CNT) in two fish species (*Tilapia zillii* and *Oreochromis niloticus*) are given in Table 2. The HQ to fish consumption is generally below 1 for Hg and Cu in all fish at sampling points. Unlike HQ values for CNT in Akississo fish's exceeds 1.

Table 2. Hazard quotients (HQ) for individual metals caused by the consumption of fish

Parameter	Havy metals	Sampling points						Threshold value
		Agbalé		Tchebi		Akississo		
		<i>T. zillii</i>	<i>O. niloticus</i>	<i>T. zillii</i>	<i>O. niloticus</i>	<i>T. zillii</i>	<i>O. niloticus</i>	
HQ	Hg	0.05	0.05	0.03	0.03	0.02	0.02	1
	Cu	0.17	0.18	0.40	0.28	0.26	0.26	
	CNT	0.32	0.46	0.86	0.86	11	15.96	

Quantity of fish (QF) to be consumed for exposure to chemical pollutants

The QF recorded from Agbalé site ranged from 0.59 for CNT to 539.31 (kg/day) for Hg with *T. zillii* (0.0085 kg), and from 0.35 for CNT to 162.22 (kg/day) for Hg with *O. niloticus* (0.0075 kg). The two fish species from Tchebi site presented high QF (803.02 kg/day) for Hg with *T. zillii* (0.0152 kg) and low QF (0.34 kg/day) for CNT with *O. niloticus* (0.00135 kg). *T. zillii* (0.00306 kg) and *O. niloticus* (0.00278 kg) showed higher QF (41.4 and 50.09 kg/day for Hg) and lower QF value (0.639 and 1.02 kg/day for CNT) on Akississo site.

Table 3. Maximum quantity of fish to be consumed by day without risk (QF)

Parameters	Heavy metals	Agbalé		Tchebi		Akississo	
		<i>T. zillii</i>	<i>O. niloticus</i>	<i>T. zillii</i>	<i>O. niloticus</i>	<i>T. zillii</i>	<i>O. niloticus</i>
FBM (kg)	Hg	0.0085	0.0075	0.0152	0.00135	0.00306	0.00278
QF (kg/day)	Hg	539.31	162.22	803.02	32.82	41.4	50.09
FBM (kg)	Cu	0.0085	0.0075	0.00152	0.00135	0.00306	0.00278
QF (kg/day)	Cu	2.44	2.097	1.764	2.217	5.972	5.426
FBM (kg)	CNT	0.0085	0.0075	0.0152	0.135	0.306	0.278
QF (kg/day)	CNT	0.59	0.35	0.38	0.34	1.02	0.639

DISCUSSION

Concerning the level of contamination of fish *Tilapia zillii* and *Oreochromis niloticus*, analyzes of pollutants in the organs (muscular tissues and gills) showed strong accumulations of copper, zinc and total cyanide in these organs. What would mean that the fish would have accumulated these pollutants follows a contamination. Fish gills accumulated more pollutants than muscle tissue. These same observations were noted by [15-16]. These authors showed that an accumulation of chemical pollutants in fish organs, especially at the

gill, was indicative of the high presence of these pollutants in their living environment or in their diet. However, the concentrations of Hg, Cu, Zn and CNT in fish organs differ markedly from site to site and from species to species. The difference between sites is due to the frequency of use of chemicals to extract gold [17].

Concerning the degree of accumulation of pollutants in fish species, *Tilapia Zillii* accumulated more pollutants than *Oreochromis niloticus*, irrespective of the sampling site and the analyzed organ. This could be explained by the fact that these fish not the same feeding mode. The fish studied belong to trophic levels in a food chain. According to [18], this chain includes primary consumers who directly harvest food from primary producers (vegetation, etc.) and secondary consumers who feed on primary consumers (invertebrates and small crabs, etc.). Indeed according to a study conducted by [19], *Oreochromis niloticus* feeds mainly on phytoplankton. He filters these seedlings into the water column. As for *Tilapia zillii*, it has a larger diet in that it feeds on insects, molluscs, zooplankton, fish, macrophytes [20]. As a result, the variety of the diet of *Tilapia zillii* is one of the factors contributing to a strong accumulation of chemical pollutants by this fish. Furthermore, [21-22] showed that the accumulation of chemical pollutants in fish organs also depended on factors such as the level of water and sediment contamination, diet, size, sex, Behavior, eating habits and the reproductive cycle. Moreover, according to [23-24], benthic species accumulated more pollutants because they live in the sediments that are the reservoirs of many chemical pollutants.

The results indicate that the risk of danger from fish consumption is less than 1 for Hg and Cu, but is very critical regarding total cyanide. Contamination of the consumer by polluted fish should be taken seriously. According to [25], fish remains an important source of protein for populations. It should be recalled that feeding populations is the source of their exposure to chemical pollutants [26]. For [27], due to their resistance to biodegradation, their persistence and toxicity, chemical pollutants can be concentrated in the muscular tissues of living organisms and cause considerable ecological and public health damage.

The quantities of *O. niloticus* from Tchebi and the two fish species caught in Akississo have the lowest amount in relation to the estimated quantity of fish to be consumed per day per individual regarding to mercury. Those small amounts are related to the fact that those fishes have accumulated high concentrations of mercury. As for contamination by copper, all fishes caught in Tchebi and Agbalé have the lowest quantities of fish to be consumed. This would mean that the fish in these sites were more impacted by copper, so an uncontrolled feeding of fish from these sites would expose the consumer more. For total cyanide contamination, fishes from the Tchebi and Agbalé streams have the lowest amounts of fish to be consumed. That quantity might be due to the accumulation of total cyanide in the fish muscles. For [3], these small amounts of fish to consume reflect the high toxicity of these pollutants to which consumers are exposed. There is then a relationship between the exposure of the populations and the heavy metals concentration in the flesh of the fish to be consumed [28]. Moreover, those maximum quantities of fish are higher than the total national average daily consumption in Côte d'Ivoire. These quantities of fish that should not be exceeded in consumption are a limiting factor to the consumption of the Hiré population, even if the probability of consuming such a quantity of fish per day is low.

CONCLUSION

Chemical pollutants preferentially concentrate in the gills than the muscle. In addition, *Tilapia zillii* concentrated more pollutants of *Oreochromis niloticus*. The hazards quotient determined clearly shows that the daily consumption of fish exposes consumers to high health risks because the levels of these metals are above standards. The risk of accumulation of these pollutants in the body is real and the adverse effects to be feared. In view of all the above, we recommend that the Hiré population not consume *Tilapia zillii* and *Oreochromis niloticus* fish from Tchebi and Akississo, to the competent authorities in this area, to regulate gold-washing activities in order to preserve the water and the fishing resources of the pollution of the chemicals used in this activity.

Acknowledgements

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1. Hadjibabaie, M., N. Rastkari, A.Rezaie and M. Abdollahi, 2005. The Adverse Drug Reaction in the Gastrointestinal Tract: An Overview. Intl. J. Pharmacol., 1 (1): 1-8.

Books:

1. Daniel A. Potter, 2002. Destructive turfgrass insects: Biology, diagnosis and control. Wiley Canada Publishers, pp: 24-67.

Chapters in Book:

1. Bray R.A., 1994. The leucaena psyllid. In: Forage Tree Legumes in Tropical Agriculture (eds R.C. Gutteridge and H.M. Shelton) pp. 283–291. CAB International, Oxford.

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A Report:

1. Makarewicz, J.C., T. Lewis and P. Bertram, 1995. Epilimnetic phytoplankton and zooplankton biomass and species composition in Lake Michigan, 1983-1992. U.S. EPA Great Lakes National Program, Chicago, IL. EPA 905-R-95-009.

Conference Proceedings:

1. Stock, A., 2004. Signal Transduction in Bacteria. In the Proceedings of the 2004 Markey Scholars Conference, pp: 80-89.

A Thesis:

1. Strunk, J.L., 1991. The extraction of mercury from sediment and the geochemical partitioning of mercury in sediments from Lake Superior, M. S. thesis, Michigan State Univ., East Lansing, MI.

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Tables and equations should not be submitted in a format exceeding the A4 page size (in portrait form). **All tables should be embedded within the manuscript, and must be captioned and numbered sequentially.** Each table should be on a separate page, numbered consecutively in Arabic numerals and supplied with a heading and a legend. Tables should be self-explanatory without reference to the text.

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