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Assessment of the Degree of Surface and Ground water pollution in the Landfill area of Ouèssè-Ouidah South of Benin

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Abstract

This work aims to assess the state of pollution of surface and groundwater in the middle of sanitary landfill of Ouèssè-Ouidah (South of Benin). To do this, physicochemical and microbiological parameters of surface water and ground water have been determined. The results obtained show that the oxygen chemical supply varies from 69.2 to 146 mg/L O_2 for surface water and from 35.7 to 44.3 mg/L O_2 for ground water. The contents of iron (> 300 µg/L) and total phosphorus (> 5 µg/L) reflect high levels in the several samples analyzed. Microbiological analysis shows that the samples of the lakes are contaminated with fecal bacteria especially by strains of Escherichia coli. This can be illustrated by the area 2 of the experimented lake which has a flora in Escherichia coli 100/mL. The well samples are the paucity of microbial amount, particularly well. But the samples of the other wells convey faecal flora as Klebsiella sp. Yet there is an abundant flora from one sample to another. It is the case of Lake (10800 cfu/mL), piezometer (9040 cfu/mL) and 13760 cfu/ml for the well. This abundant is due to food unsafety and lack of hygiene in the environment of these samples. The waters in the landfill mid-Ouèssè Ouidah should be protected from contamination that may impair their quality and thus limit their use.

Keywords: Pollution degree, landfill area, physicochemical, microbiological, parameters.

Introduction

Land filling constitutes formerly a waste disposal technique, easy to implement and relatively inexpensive[1].

One of the crucial problems associated with landfilling is the production of effluents containing organic and mineral matter. These effluents that are not often treated before discharge are a source of nuisance that increases the cost of health insecurity and pollution of the environment. The effluents can be driven off and reach surface waters or seep through the bottom layer of the landfill area and therefore contaminate the waters of the aquifer. Pollution of surface and ground water is one of the most disturbing aspects of the use of these waters for agricultural and food purposes is a danger to the safety of plant biomass and humans[2]. In the vicinity of the landfill (LES) of Ouèssè-Ouidah (southern Benin), surface water is used for agriculture and fisheries while ground water is used for human consumption. Considering how important these waters are to the life of the people of this region, we should appreciate, the state of pollution by assessing their physical, chemical and microbiological parameters.

This work aims to determine the state of degradation of surface and groundwater, in view of the evaluation of the extent of leachate's pollution from the landfill.

Study's area: The landfill of Ouèssè-Ouidah (southern Benin) is located along the road connecting with Savi a village near the national road of the coast and is about 700 m northwest of the intersection of Savi road and the track leading to the village of Ouèssè (town of Ouidah). The site is 5 km north of the paved road that connects it to Savi. The plan of the area shows that the site is relatively flat with a slight slope to the Lake Toho. The southern section of the site drains towards the southeast and the northeast section of the site to the north. The site of the landfill of Ouèssè-Ouidah (southern Benin) is located at the southern end of the plateau of Allada of the presence of Lake Toho marks the border with the coastal plain and the lagoon system of southern Benin. Waste is conveyed on this landfill, from two major cities of Benin (economic capital Cotonou and historical city of Ouidah)

Sampling Points: Water samples were carried from three piezometers (piezo), in six wells and from three locations of the lake located in the vicinities of the landfill site. Note that at each sampling point, five (5) samples were taken. The samples were defined based on their availability on the field.

Material and Methods

The temperature (T), pH, total dissolved solids (TDS), dissolved oxygen (O_2), redox potential (Eh) and conductivity / salinity

were measured in situ using a multi probe brand parameter WTW 340i (pH / Oximeter). The color and turbidity were also measured in situ by the colorimeter HACH DR / 890.

In water samples, total phosphorus and soluble phosphorus were measured by colorimetry (method molybdate / ascorbic acid) with a spectrophotometer U 800 Aqualytic brand.

The chemical oxygen demand (COD) in water samples is determined using the spectrophotometer U 800 Aqualytic mark (oxidation method to potassium dichromate in concentrated H_2SO_4 medium).

In water samples the ions F^-, Cl^-, PO_4^{3-}, SO_4^{2-}, NO_3^-, NO_2^- were determined by an ion chromatograph Metrohm brand and model 761 SD Compact IC. The eluent is a mixture of carbonate and sodium hydrogencarbonate. The separation column is anion type METROSEP SUPP4 A (L = 250 mm, D = 4.6 mm particle size 5 .mu.m).

The metals (Al, Pb, Cu, Ni, Fe, Cd, Zn, Cr, As) were determined by ICP-AES with a brand spectrometer HORIBA Jobin Yvon JY model and 2000.

Ammonium levels in the water samples was determined using a spectrophotometer Aqualytic AL800 brand (indophenol blue method).

The total organic carbon, inorganic carbon and total carbon were measured by a meter brand Cot- Analytic Jena NC 2100S model by burning at 800°C and CO_2 dosage released by infrared.

The cations (Na^+, K^+, Mg^{2+}, Ca^{2+}) were measured in water samples by absorption spectrometry or atomic emission flame with a Thermo Scientific brand and model spectrometer ICE 3000 Series A Spectrometer.

Statistical analysis of the data obtained was performed with Microsoft Office Excel 2007. The software parameter variation is low during the study period we used the averages for the remainder of the study.

In terms of microbiological parameters, analyzes were conducted as follows:

The total flora was investigated by the seeding technique in Petri dishes 1mL of sample and 1mL of its successive dilutions (up to 10-3), to which is added sterile "Agar" standard for counting. Analytical standard is ISO 4831 of December 1997. The incubation was carried out at 37 ° C for 24h.

The colimétrie was performed according to ISO 4832 and ISO 7261 with the technique of the most probable number, using the lactose bile broth Brilliant Green (BLBVB) and Peptone Water Single (EPS) for the Mackenzie test. E. coli was alleged searched using the reagent Kovacks. Incubations were successively made 30°C ± 1°C for 24 to 48 hours and at 44°C ± 1°C for 24 hours. Other related identifications (among gram-negative bacilli.) were conducted using the API 20E galleries.

Statistical analysis of the data obtained was performed with Microsoft Office Excel 2007. The software parameter variation was low during the study period we used the averages for the remainder of the study.

Results and Discussion

The results show that for the waters of lakes, the temperature oscillates around 28.8°C. There was a slight rise in temperature for the samples of the lake. The standard set in the Republic of Benin is 25°C for surface water. For piezo water and wells, the temperature varies between 27.4 and 29.7°C; which slightly exceeds the Benin standard for drinking water. The analysis of this table shows that the pH of sampled water ranges from 6.53 to 7.33. Values between 6.5 and 8.5 are Benin standard for surface water and consumption. The values obtained for salinity show that, the water sampled from lake, piezo and wells show no content.

The total dissolved solids (TDS) of water samples vary from 49 to 76 mg/L, from 22 to 86 mg/L and from 30 to 108 mg/L for lakes, piezo and wells.

For surface water, electrical conductivity varies from 113.7 to 158 microSiemens/cm lower than those set by the Benin standard (1000 microSiemens/cm). As for water samples from wells and piezo, conductivity varies from 49.5 to 251 microSiemens/cm. These values are lower than the standard set by the European Union for water intended for consumption (250 microSiemens/cm). The electrical conductivity and TDS are characteristics of the natural minerals in the water in its banking[3].

Regarding the mean value of dissolved oxygen concentrations, it is found that the dissolved oxygen concentration of the water sampled from lakes, wells and piezo varies respectively from 1.19 to 1.86 mg/L; 2.06 to 2.70 mg/L and 2.89 to 3.29 mg/L. Examination of these results shows that the water of lakes, wells and piezo studied, has low dissolved oxygen concentration. Which fact would, probably, be due to biological degradation of organic materials in the releases[4]. It was also shown that dissolved oxygen is involved in aquatic organisms respiration, in the oxidation and degradation of pollutants and in the photosynthetic activity of plants and interaction with the atmosphere[5]. Studies have shown that reduced oxygen levels cause abnormal physiological and behavioral adverse effects in various organisms, particularly in fish[6]. From the results obtained for dissolved oxygen, we can say that the analyzed waters are polluted or are about to be pollute, confirming the results of Beaux stipulating that water is said to be polluted if it has a content dissolved oxygen of less than 3 mg/L[7].

Table-1
Physico-chemical parameters of water samples

Samples	pH	T°C	Salinity	Dissolved Oxygen mg/L	Conductivity (µs/cm)	TDS (mg/L)	Suspended matter (mg/L)	Turbidity (NTU)	Color (Pt Co)
Piézo 1	7,21	29,0	0	2,89	103,3	45	6	63	23
Piézo 2	7,20	28,7	0	3,04	195,5	86	4	47	3
Piézo 3	7,11	27,4	0	3,29	49,5	22	1	33	2
Lake 1	7,25	28,6	0	1,67	113,7	53	12	101	121
Lake 2	6,75	28,8	0	1,86	114,9	49	13	50	135
Lake 3	6,80	28,9	0	1,19	158	76	29	51	165
Well 1	7,25	27,9	0	2,26	136,1	59	3	48	37
Well 2	7,33	28	0	2,31	67,8	30	8	46	15
Well 3	6,81	28	0	2,40	85,7	37	6	70	28
Well 4	6,96	28,6	0	2,06	120,1	52	10	73	44
Well 5	7,31	28,3	0	2,70	251	108	17	50	35
Well 6	6,53	29,7	0	2,67	214	88	9	62	59

The results also show that the samples of analyzed water is turbid. The lake water has a turbidity ranging from 50 to 101 NTU; for wells, from 46 to 73 NTU and for piezo from 33 to 63 NTU. These values greatly exceed Benin standard of 5 NTU for water. This very high parameter in the samples indicates a pollution of the region's landfill. High turbidity is due to the presence of suspended solids in the samples. My contents vary from 12 to 29 m/L for the lake, from 3 to 17 mg/L for well water and 1 to 6 mg/L for water piezometers. We note that the color of the lake water is more intense (121 to 165 PtCo) than of well water (15 to 44 PtCo) and of piezo water (2 to 23 PtCo).

The results in table-2 show that the total organic carbon of the waters of piezo 1 (2.52 mg/L) is slightly higher than the French standard for drinking water. Remembering that this sampling point is very close to sanitary landfill site. For waters piezo 2 and 3, the values found are lower than the French standard. Regarding the well, only the total organic carbon of wells 5 and 6 are greater than the French standard (2 mg/L).

The levels of total phosphorus and soluble phosphorus are summarized in table-3. The examination of this table shows that the total phosphorus content of the water is higher than the European standard (5µg/L). The presence of phosphorus in surface water comes mainly from municipal effluent, leaching and runoff from fertilized agricultural lands and effluents of certain industries. Phosphorus, a toxic substance, is present in large amounts in all samples analyzed, which allows us to say that the waters around the LES are polluted.

Table-2
Content of Total Organic Carbon (TOC), Inorganic Carbon (IC) and Total Carbon (TC) of water samples

Samples	TOC mg/L	IC mg/L	TC mg/L
Piézo 1	2,52	6,68	9,20
Piézo 2	1,60	7,00	8,59
Piézo 3	1,81	4,88	6,69
Lake 1	11,23	5,47	16,70
Lake 2	9,48	4,72	14,20
Lake 3	32,82	25,68	58,50
Well 1	1,49	2,35	3,84
Well 2	1,12	2,56	3,68
Well 3	0,62	2,41	3,03
Well 4	0,91	2,65	3,55
Well 5	19,36	2,66	22,02
Well 6	11,89	2,76	14,65

Table-3
Total Phosphorus content and soluble phosphorus of different samples

Samples	Total Phosphorus mg/L P	Soluble Phosphorus mg/L P
Piézo 1	0,11	-
Piézo 2	0,66	0,25
Piézo 3	0,47	-
Lake 1	0,24	-
Lake 2	0,15	-
Lake 3	0,84	0,11
Well 1	<0,07	-
Well 2	<0,07	-
Well 3	<0,07	-
Well 4	0,07	-
Well 5	<0,07	-
Well 6	<0,07	-

Table-4 presents the results of the chemical oxygen demand. COD values obtained, for analyzed surface water, reveal that excepted Lake 3, where COD (146 mg/L) exceeds the set standard (80 mg/L) in Benin for surface water, the values obtained for the water of lake 1 and 2 are short of the standard. The high value obtained at Lake 3 could be due to leachate water discharge of SLE in this part of the lake. This form of pollution, does not affect the distribution of hygrophytes, but has a very negative effect on fish and by extension, on their consumers[9]. Regarding groundwater, which can be used for human consumption, the values of COD range from 35.7 mg/L to 51.5 mg/L. This range of concentrations obtained is greater than the Benin standard (25 mg/L). This leads us to say that the waters of the landfill mid-Ouèssè Ouidah are polluted.

Table-5 shows the results of anions determined in water samples. Examination of this table shows that the levels in mg/L of ions such as fluorides, nitrites and phosphates are less than the device's detection limit for all samples. As for nitrate and sulfate ions, they are absent in the samples of water from the Lake, piezo but present only in some well water samples (well 5: 30.49 mg/L for nitrates and 67.53 mg/L for sulphates) and (well 6: 5,74 mg/L for nitrates and 15.73 mg/L for sulphates). These values are lower than the standard set by the European Union (50mg/L for nitrates and 250 mg/L for sulphates). With regard to chloride ions, they are present in all water samples. There was a slight rise in the concentration of chloride ions in the lake 3 (60.38 mg/L); in water of the piezo 1 (28.73 mg/L) and in the water of well 4 (11.28 mg/L) and 5 (11.11 mg/L). However, all these concentrations are below the standard set by the European Union for surface water and ground water (200mg/L).

Table-4
Chemical Oxygen Demand (COD) of water samples

Samples	COD mg/L O_2
Piézo 1	35,7
Piézo 2	35,8
Piézo 3	36,3
Lake 1	69,2
Lake 2	73,6
Lake 3	146
Well 1	40,6
Well 2	44,3
Well 3	41,0
Well 4	41,7
Well 5	45,3
Well 6	51,5

Table-6 shows the results of assays of the metal elements. The aluminum, arsenic, cadmium, chromium, copper, iron, nickel, lead and zinc were determined in water samples. Except the iron that is present in all samples, concentrations of metals are lower than the unit's detection limit which was used for assay. The iron concentration in most samples of water that can be used for human consumption exceeds the standard established in Benin (300 mg/L). The high iron concentration obtained in the samples would be at the origin of high values of turbidity. The high concentration of iron in the waters of wells 2, 3, 4, 6 and piezo 1 could be due to the fact that the reducing medium is certain lakes and some reservoirs. The high presence of iron in natural water supply sources is due to the decomposition of rocks and minerals, to acid mine drainage waters, to the landfill leachate, or to effluents sewers[10-12]. Iron is essential to life because it captures and fixes the oxygen of the inspired air by the lungs and transports them to the cells which need it. Iron deficiency in the body leads to anemia. When abundant, it can cause damage such as permanent damage of the liver, heart, pancreas, endocrine glands and joints. Thalassemia, another disease of iron overload, is widespread in Asia, Africa and around the Mediterranean, in areas where malaria is prevalent because it confers resistance to disease.

Table-5
Concentration of anions in different samples

Samples	Fluoride mg/L	Chloride mg/L	Nitrite mg/L	Nitrate mg/L	Phosphate mg/L	Sulphate mg/L
Piézo 1	-	28,73	-	-	-	-
Piézo 2	-	5,45	-	-	-	-
Piézo 3	-	-	-	-	-	-
Lake 1	-	7,28	-	-	-	-
Lake 2	-	7,52	-	-	-	-
Lake 3	-	60,38	-	-	-	-
Well 1	-	14,45	-	-	-	3,23
Well 2	-	1,47	-	-	-	-
Well 3	-	3,23	-	0,24	-	-
Well 4	-	11,28	-	-	-	-
Well 5	-	11,11	-	30,49	-	67,53
Well 6	-	7,13	-	5,74	-	15,73

Table-6
Metal content of the different samples

Samples	Al	As	Cd	Cr	Cu	Fe	Ni	Pb	Zn
Piézo 1	-	-	-	-	-	351,20 ±3,95	-	-	-
Piézo 2	-	-	-	-	-	73,28 ±1,69	-	-	-
Piézo 3	-	-	-	-	-	-	-	-	-
Lake 1	-	-	-	-	-	1026,85 ±5,38	-	-	-
Lake 2	-	-	-	-	-	973,79 ±8,21	-	-	-
Lake 3	-	-	-	-	-	1016,54 ±5,54	-	-	-
Well 1	-	-	-	-	-	27,06 ±1,05	-	-	-
Well 2	-	-	-	-	-	303,50 ±0,38	-	-	-
Well 3	-	-	-	-	-	564,84 ±5,79	-	-	-
Well 4	-	-	-	-	-	369,27 ±3,64	-	-	-
Well 5	55,79 ±0,90	-	-	-	-	45,06 ±1,02	-	-	-
Well 6	-	-	-	-	-	471,76 ±6,28	-	-	-

Table-7 shows the results of the concentrations of sodium, potassium, magnesium and calcium in the different samples. An analysis of this table shows that the concentrations of sodium, magnesium and calcium in water samples from wells, piezo and lakes, are below that established by European standards (150 mg/L sodium, 50 mg/L magnesium ions) for waters that can be used for drinking or agriculture. As for potassium ions, except the waters of the well 5 (18.02 mg/L) and the Lake 3 (60.81 mg/L), for which the contents exceed the standard set by the European Union (12mg/L), all water samples analyzed, have less amount. Generally water of the landfill of Ouèssè-Ouidah, are partly polluted by mineral substances.

In table-8, are fixed the results of ammonium ion concentrations in the samples. The study of these results allow us to say that, apart from the lake 3, which ammonium ions average is 16,00 mg/L, all other water samples taken have met the European standard (0.5 mg/L) for surface water and groundwater. This result could be explained by the fact that the Lake 3 located in the descent of the drainage water. The ions Cl^- and NH_4^+ translate induced mineralization. They are indicators of the mineralization[13].

Fecal coliforms are generally less or equal to total coliforms. From table-9, despite the absence of coliforms in some samples, we find that the total flora is present in all samples.

Samples of piezometers don't convey Escherichia coli. The flora in piezometer 1 is reduced to strains of Klebsiella pneumoniae, a fact inherent in the environmental health of that piezometer, unlike the other two whose samples exhibit virtually absence of fecal flora. Samples taken from lakes are contaminated with *fecal bacteria*, in particular *Escherichia coli*. This can be illustrated by the lake 2 whose water sample has a flora in *Escherichia coli* of 100/mL. The wells samples are paucity of microbial, particularly well 1. But other wells convey some strains of *Klebsiella sp*. There are no *faecal flora* in the well 4. Notwithstanding a disparity of presence of the fecal flora in the different samples, there is nevertheless abundant total flora from one sample to another: it is the case of Lake 1 (10800 cfu/mL), piezometer 1 (9040 cfu/mL) and (13760 cfu/ml) well 5. The presence of different total flora is due to safety and hygiene in the environment of these samples. Note that these *bacteria sought* in samples, express recent faecal contamination, and the analyzes for the detection of *Clostridium spores* of sulphite-reducing, and *fecal streptococci* of old fecal contamination have not been made[14].

Table-7
Cation content of different water samples

Samples Paramètres Echantillons	**Na^+ (mg/L)**	**K^+ (mg/L)**	**Mg^{2+} (mg/L)**	**Ca^{2+} (mg/L)**
Piézo 1	32,12	0,66	2,67	4,62
Piézo 2	141,11	0,29	0,95	2,59
Piézo 3	6,75	0,23	0,50	1,20
Lake 1	18,29	1,19	1,81	3,09
Lake 2	18,23	1,11	1,61	2,74
Lake 3	65,82	60,81	4,37	5,18
Well 1	23,48	0,63	0,82	1,59
Well 2	11,52	0,22	0,40	0,82
Well 3	15,90	0,17	0,21	0,51
Well 4	21,00	2,30	0,44	1,17
Well 5	21,00	18,09	5,58	8,75
Well 6	18,11	0,72	0,80	1,76

Table-8
Ammonium ion content in the various water samples

Samples	Ammonium en mg/L N
Piézo 1	0,06
Piézo 2	1,05
Piézo 3	0,03
Lake 1	0,25
Lake 2	0,29
Lake 3	16,00
Well 1	0,05
Well 2	0,04
Well 3	0,04
Well 4	0,03
Well 5	0,10
Well 6	0,11

Table-9
Bacteriological parameters of water samples

Samples	Total coliform /ml	Fecal Coliform /mL	Total Flora /mL	Escherichia Coli /mL
Piézo 1	500	240	9040	-
Piézo 2	-	-	190	-
Piézo 3	-	-	170	-
Lake 1	400	400	10800	-
Lake 2	200	200	2200	100
Lake 3	200	200	2900	-
Well 1	-	-	40	-
Well 2	20	20	1580	-
Well 3	220	120	940	-
Well 4	-	-	900	-
Well 5	400	380	13760	-

Conclusion

Overall, the waters of the landfill mid-Ouèssè Ouidah report no pollution from metallic elements. Always the wells 1; 5; 6 and Lake 3 are of anthropogenic pollution, resulting in high values of iron, total phosphorus and organic matter (COD), but very low levels of dissolved oxygen.

Furthermore, the location of the landfill of Ouèssè-Ouidah, at the edges of a river (Lake Toho) is an advanced pollution danger to the population that uses water contaminated by leachate of this discharge. A short or long-term consequence of this drainage of landfill leachate will have an impact on the surrounding water and eventually reach humans. To prevent or remedy this situation, we have to take protective measures very quickly by setting up a process for the treatment of leachate water or implement the regulations on the management of waste water which exposes aquatic and terrestrial environments to any form of pollution. The surrounrinding population should be educated vis-a-vis the dangers that they face, due to the use of these water resources for agricultural purposes or for consumption.

References

1. Saadi Sanae, SBAA Mohamed, Mohamed EL Kharmouz leachate physicochemical Characterization of the landfill site in the city of Oujda (Morocco Oriental) *Science Lib Editions Mersenne*, **5,** 2111-4706 **(2013)**

2. Laferriere JJ, Minville J. and Lavoie P., Payment, The pork industry and lesrisques related to human health, *Bull. Environm Health Information, Quebec*, **7(2)** 1-4. (**1996)**

3. Parfait Hounsinou, Daouda Mama, Flavien Dovonou, Achille Dedjiho and Dominique Sohounhloue, Organic Pollution Indication as Tracer for the pollution of Well Water: The example of the District of Abomey-Calavi (Benin), *Res. J. chem. sci.,* **5(1),** 49-54 **(2015)**

4. Mompoint M., Evaluation of environmental hazards generated by urban liquid effluents on the ecosystem of the Bay of Port-au-Prince: First methodological approach. End of studies thesis for obtaining the degree in Civil Engineering, Faculty of Science, Engineering and Architecture, University Quisqueya (Dominican Republic), 61 pp + Appendices **(2004)**

5. Lamizana-Diallo MB, Kenfach Millogo S. and Rasolodimby J., Physico-chemical quality of water Evaluation of a temporary stream of Burkina Faso: The case of Massili in Kadiogo, *South Sci. Techno*., **16**, 23-28 **(2008)**

6. Houémènou H., Anthropogenic waste assessment and their potential impacts on the lake Nokoué, *Memory to obtain the master's degree in environmental engineering to EPAC / UAC, Benin*, 92, **(2012)**

7. Kumar A and Kumar V, Fluoride Contamination in Drinking Water and its Impact on Human Health of Kishanganj, Bihar, India, *Res. J. chem. sci.,* **5(2),** 76-84 **(2015)**

8. Moctar L. BAWA, Gbandi DJANEYE-BOUNDJOU and Yaya BOUKARI, Characterization of two industrial effluents in Togo of environmental impact study, *Science Africa*, **2(1)** 57-68 **(2006)**

9. Lamizana-Diallo MB, Effect of system of inland natural flood on hygrophytes. Case of a reach of Burkina Fasso-Massili. DEA, Laboratory of Biology and Plant Ecology, *UFR-SVT, University of Uoagadougou*. 77 **(2005)**

10. Singh V.B., Piplode S., Thakur V. and Agrawal R., Comparative Physico-Chemical Analysis of Narmada River Water at Barwani and Khalghat, MP, India, *Res. J. of Chem. Sci*., **5(3),** 6-8 **(2015)**

11. Chinna R.P. and Gundala P.H., Analysis of Water Quality Parameters of Lakshmipuram tank, Anantapuramu (d), Andhra Pradesh, India*, J. of Chem. Sci*., **5(4**), 26-32 **(2015)**

12. Piplode S. and Singh V.B., Physico-chemical Evaluation of Narmada River Water at Khalghat MP, India, *Res. J. of Chem. Sci.,* **5(5),** 24-26 **(2015)**

13. Hani A Djarbri, The Mania J. Study of the physicochemical characteristics of the massif of crystallophyllian Seraidi (northeastern Algeria), Hard Rock Hydrosystems (Proceedings of Rabat Symposium S2, *IAHS Publ.*, **241,** 41-59 **(1997)**

14. Guiraud J. and Galzy P., Microbiology in food processing plants, *doin edition* (**1990**)