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Assessment Of The Health Safety Of The Fish From The Congo River In Democratic Republic Of Congo

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Summary
The objective of this study is to evaluate the health safety of fish from the Congo River in its section located in Lualaba Province, in Democratic Republic of Congo. In fact, for several decades, the Congo River has been receiving water polluted with mining waste from the Luilu river, into which the Luilu hydrometallurgical plant discharges its wastes, both solid and liquid. Solid releases contain 3% Cu and 0, 8 % Co while liquid releases contain 1, 5 g/L Cu and 1,0 g/L Co. It also receives, through the Butungu river, water polluted by untreated mine waste from UCK factory of Kolwezi town. The waters of the Butungu river contain Co and Se. All these tailings found in Katanga contain trace metal elements.
The Congo River, as well as the Panda and Kasungwe rivers, in the south-east of the Democratic Republic of Congo, constituted our research environment. The Congo River in its section located in the Lualaba Province provided the samples of the fish to be studied and checked (n=14), while the reference fish samples, all from Haut-Katanga Province, came from the Panda, Kasungwe and Congo rivers in the sections located near their sources and non- polluted by mining wastes (n=11). Ten metal trace elements (MTE) were assayed at the laboratory of the Congolese Control Office (OCC) of Lubumbashi and at the laboratory of the Catholic University of Leuven in Belgium using ICP-OES and ICP-MS.
To assess and evaluate the health safety of fish from the Congo River, the concentrations of fish samples from the Luapula river were compared with the concentrations of the reference fish samples from the Panda and Kasungwe rivers as well as from the Congo River by the Wilcoxon test. These concentrations were also compared with the maximum acceptable concentration of Metal Trace Element in fish of WHO, FAO, EU, and other regulatory bodies. The results of this study showed that fish in the Congo River are contaminated in Co, Cu, Mn, Ni, Pb and Se and, so, are not fit for human consumption. The results obtained will be brought to attention of the decision-makers, so that measures can be taken to ban metallurgical factories to drump their mining wastes into waterways.

Keywords: *Fish health safety, Congo River, Metal Trace Elements, Lualaba Province, South-east of Democratic Republic of Congo*

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I. Introduction

The south-east of the Democratic Republic of Congo is a region currently characterized by a proliferation of several ore processing plants of all sizes: artisanal, semi- industrial and industrial (Kalenga et al., 2006). Unfortunately, it has been found that almost all mineral processing plants discharge their mining wastes into the environment without any treatment and discharge their liquid effluents directly into a watercourse (SNC-Lavalin, 2003 ; Kalenga et al. 2006). This is the case of the Congo River. Indee, for several decades, the Congo River has been receiving water polluted with mining waste from the Luilu river, into which the Luiilu hydrometallurgical plant discharges its wastes, both solid and liquid. Solid releases contain 3% Cu and 0, 8 % Co, while liquid releases contain 1, 5 g/L Cu and 1,0 g/L Co (SNC- Lavalin, 2003). It also receives, through the Butungu river, water polluted by untreated mine wastes from UCK factory of the city of Kolwezi. The water of the Butungu River contain Co and Se (Koya, 2017). In addition, chemical analysis has shown that many of these wastes contain Metal Trace Elements such as Cu, Co, Cd, Ge, Zn, Pb and As (SNC-Lavalin, 2003).

And yet, the Congo river is very rich in fish. It provides fish to the local population and to that of the Kolwezi region. We can therefore say that the fish of the Congo River bathe in an aquatic environment polluted with mining wastes, themselves loaded with multiple pollutants, including Metal Trace Elements (SNC-Lavalin, 2003; Kalenga, et al., 2006;), This is why monitoring the quality of fish and its aquatic environment , in accordance with Decree N° 038/2003 (2003) of March 26, 2003 relating to Mining Regulationon in its article 462, is of great importance for the protection and preservation of the health of the entire population of the

Lualaba Province in general and that of the city of Kolwezi in particular who regulary consumes fish from the Congo River. In addition, with a view to protecting the environment, The Decree N°18/024 (2018) of june 8, 2018 amending and supplementing Decree Decree N° 038/2003 of March 26, 2003 relating to Mining Regulationon in its article 55 of Annex VIII and the Law N° 11/009 on the protection of the environment (2011) in its article 49 prohibits the discharge of wastewater, mine discharges, or any other contaminant into surface water.

Despite the fact that the congolease population of the South-East of the Democratic Republic of Congo consumes fish from rivers polluted whith mining wastes, which are otherwise untreated, studies on the quality control of the fish are rare and almost non-existent. A part from our work on the quality of fish in the Lake Tshangalele in 2012 and 2017, Katemo (2010) , studied the impact of mining effluents on the Shituru hydrometallurgical complex on the Lufira basin.

The results showed that the gills of Oreocromis macrochir were contaminated in Pb (0,95 mg/kg), Co (93,17 mg/kg) and Cu (55,8mg/kg) and those of Tilapia rendalli in Pb (0,60mg/kg), Co (48,3mg/kg), et Cu (32,2 mg/kg).

Thus, we can clearly see that the fish of the Congo River bathe in an aquatic environment polluted with mining waste, themselves loaded with multiple pollutants, including Metal Trace Elements Consequently, we think that the fish from the Cong River cannot be suitable for human consumption. Thus, the objective of this study is to verify the health safety of the fish from Congo River at the at its section located in the Lualaba Province, in Democratic Republic ofCongo.

II. Materials And Methods

The Congo River as well as the Panda and Kasungwe rivers, in the south-east of the Democratic Republic of Congo, constituted our research environment. From September to October 215, samples of fish from the Congo River were taken downstream of mining activities at the Lualaba Bridge 25 km from Kolwezi and at the locality of Nzilo (n=12) . Samples of reference fish were taken upstream of all mining, at sections located near the sources of the Panda and Kasangwe rivers as well as the Congo River (n=11).

The fishes studied belong to different families including *Anabantidae (Ctenopoma multispinis Peters*), *Cyclidae (Chromidotilapia sp, Haplochromis sp, Coptodon rendalli), Cyprinidae (Barbus neefi; Enteromius neefi,), Cyprinodontidae (Apocheilicthys katangae;), Mochokidae* (*Synondontis sp. and Orthygospiza locustella;) Claridae* (*Clarias buthupogon and Clarias dumerlii;), Poecillidae (Lacustricola katangae). Some fish have not been well identified.*

Fish were cought by net at the Pont Lualaba and Nzilo sites. After capture the fish samples were placed in small packing bags 28 cm x 17 cm and transported in insulated boxes to the freezer for conservation. The preparation consisted of stripping the samples of their viscera and scales using a knife. After cleaning with distilled water, put in a bucket, the samples were dried in Binder and Thermosi SR2000 brand ovens at 70 °C for 48 hours. After drying, the samples were crushed and powdered using porcelain mortars and pestles. The samples were then sent to the laboratory. Ten metal trace elements namely Al, As, Cd, Co, Cu, Mn, Ni, Pb, Se, and Zn were selected and assayed using ICP-MS at the laboratory of the Catholic University of Leuven in Belgium and ICP-OES at the laboratory of the Congolese Control Office (OCC) in Lubumbashi, in Democratique Republic of Congo.

To assess and evaluate the health safety of fish from the Congo River, the concentrations of fish samples from the Congo River were, by the Wilcoxon test as described by Ancelle (2002), compared with the concentrations of the reference fish samples from the Panda and Kasungwe rivers as well as from the Congo River at the level of their sections not polluted with mining wastes. The concentrations of fish samples from the Congo River were also compared with the maximum acceptable metal trace element concentrations established by the FAO, WHO, EU (European Union) and other regulatory bodies as reported by Akoto et al. (2014).

III. Results

Table I: Metal trace element concentrations of reference fish samples coming from near the sources of the Kasungwe, Panda and Congo River (mg/kg).

N°	Codification	Nom scientifique	Al	As	Cd	Co	Cu	Mn	Ni	Pb	Se	U	Zn
1	LUAS P22	*Enteromius neefi*	98,90	0,06	0,20	0,22	2,98	34,40	0,57	0,29	0,78	0,0	691,30
2	LUAS P23	Not identified	292,70	0,14	0,43	0,62	5,40	24,72	0,43	0,59	0,85	0,02	205,80
3	LUAS P24	Not identified	350,20	0,14	0,43	1,01	4,64	30,20	0,62	0,15	0,79	0,02	196,0
4	LUAS P25	Not identified	307,70	0,11	0,24	0,45	3,84	22,41	0,62	0,17	0,82	0,02	184,50
		Average	262,37	0,11	0,32	0,57	4,22	27,93	0,56	0,30	0,81	0,01	319,4
		Standard deviation	111,7	0,0	0,1	0,3	1,0	5,4	0,1	0,2	0,0	0,0	248,1
5	KAS P27	*Clarias dumerlii*	166,8	0,17	0,02	0,11	1,91	8,42	0,30	0,14	2,1	0,01	29,2
6	KAS P28	*Clarias dumerlii*	130,8	0,205	0,02	0,11	1,53	8,88	0,20	0,22	2,04	0,0	26,9
		Average	148,8	0,2	0,02	0,11	1,72	8,65	0,25	0,18	2,07	0,0	28,05
		Standard deviation	2	0,0	0,0	0,0	0,3	0,3	0,1	0,1	0,0	0,0	1,6

7	PAS P29	*Clarias dumerlii*	27,5	0,25	0,06	0,17	2,86	14,8	0,29	0,41	2,76	0,01	47,5
8	PAS P30	*Ctenopoma multispinis*	36,4	0,08	0,13	0,29	1,92	14,23	0,15	0,03	2,19	0,0	44
9	PAS P33	*Synodontis sp*	28,3	0,07	0,3	0,34	1,72	16,15	0,11	0,05	1,83	0,0	58,1
10	PAS P34	*Synodontis sp*	31,2	0,04	0,26	1,09	1,58	13	0,14	0,07	2,06	0,0	41,9
11	PAS P36	*Lacustricola katangae*	73,1	0,0 3	0,1	0,07	1,87	17,41	0,18	0,05	1,53	0,01	126,7
Average			39,3	0,11	0,17	0,39	1,99	15,12	0,17	0,12	2,07	0,0	63,64
Standard deviation			19,2	0,1	0,1	0,4	0,5	1,7	0,1	0,2	0,5	0,0	35,8
General average			162,8	0,2	0,18	0,41	2,75	18,6	0,33	0,2	1,6	0,01	150,2
General standard deviation			122,5	0,1	0,1	0,4	1,3	8,4	0,2	0,2	0,7	0,1	192,8

The above table shows that the concentrations are quite low. Indeed, no concentration was found to be higher than the thresholdsestablished by the WHO (30mg/kg for Cu and 2mg/kg for Cd and Pb).

Table II: Concentrations of trace metal elements in fish samples collected from the Congo River at the "Pont Lualaba" site, 25kilometres from Kolwezi (mg/kg)

N°	Codification	Nom scientifique	Al	As	Cd	Co	Cu	Mn	Ni	Pb	Se	Zn
1	LUAPO P52	*Coptodon rendalli*	141,50		0,2	3,44	38,04	25,75	21,17	2,06	7,71	134,3
2	LUAPO P53	*Coptodon rendalli*	213,30	<0,002	0,12	5,62	24,24	56,17	21,03	126,60	6,97	189,2
3	LUAPO P54	*Coptodon rendalli*	111,10	<0,002	0,37	3,61	37,07	28,41	17,02	0,37	6,93	128,4
4	LUAPO P55	*Coptodon rendalli*	70,49	<0,002	0,13	4,19	32,37	38,58	17,27	<1,001	8,23	170,0
5	LUAPO P56	*Coptodon rendalli*	54,12	<0,002	0,11	2,96	14,83	36,83	7,47	42,65	10,25	146,2
6	LUAPO P57	*Coptodon rendalli*	171,9	2,49	0,12	4,84	36,30	35,32	13,12	1,34	5,19	157,2
7	LUAPO P58	*Chromidotilapia sp*	25,16	<0,002	<0,1	2,29	13,18	9,79	10,67	61,10	3,51	89,55
8	LUAPO P59	*Chromidotilapia sp*	16,29	<0,002	0,08	1,69	12,81	11,30	7,50	35,71	8,84	81,48
9	LUAPO P60	*Lacustricola katangae*	12,65	<0,002	0,05	1,32	11,36	21,26	9,03	57,95	6,12	97,05
10	LUAPO P61	*Lacustricola katangae*	18,39	<0,002	0,09	1,75	22,05	19,79	0,58	<1,001	9,61	120,6
11	LUAPO P62	*Lacustricola katangae*	56,58	<0,002	0,47	2,69	22,80	23,20	8,31	3,12	8,66	128,8
12	LUAPO P63	*Lacustricola katangae*	24,62	0,573	0,01	2,10	15,86	20,37	13,91	75,15	6,78	135,6
13	LUAPO P64	*Lacustricola katangae*	56,15	1,711	0,12	2,24	17,37	21,69	13,17	83,34	9,35	166,3
14	LUAPO P65	*Lacustricola katangae*	32,34	<0,002	0,07	1,99	13,59	21,10	10,02	50,49	10,08	139,4
15	LUAPO P66	*Clarias buthupogon*	71,12	<0,002	0,17	2,19	23,02	29,76	8,05	0,35	7,12	77,0
16	LUAPO P67	*Clarias buthupogon*	21,78	<0,002	0,15	2,02	17,44	30,66	6,78	<1,001	5,82	58,6
17	LUAPO P68	*Haplochromis sp*	101,6	<0,002	0,82	5,21	43,28	84,64	17,64	<1,001	7,34	81,37
18	LUAPO P69	*Haplochromis sp*	36,73	<0,002	0,01	24,83	24,83	64,76	115,0	<1,001	5,08	115,0
19	LUAPO P70	*Haplochromis sp*	59,23	<0,002	0,18	6,03	23,67	219,0	6,55	<1,001	4,94	112,5
20	LUAPO P 71	*Haplochromis sp*	33,25	<0,002	0,02	2,86	29,12	81,58	8,68	<1,001	5,46	117,6
21	LUAPO P72	*Haplochromis sp*	42,55	<0,002	0,01	2,96	21,97	42,06	13,59	<1,001	3,06	103,6
22	LUAPO P73	*Haplochromis sp*	28,83	<0,002	0,13	2,65	25,26	49,14	10,44	<1,001	8,86	109,3
	Average		63,6	1,6	0,2	4,1	23,6	44,14	16,2	41,5	7,1	120,8
Standard deviation			53,5	0,8	0,2	4,8	9,1	44,1	22,6	39,7	2,0	33,1

In accordance with the WHO thresholds, Cu has five samples out of twenty-two and Pb has eleven with concentrations abovethese thresholds of 30mg/kg for Cu and 2mg/kg for Cd.

Tableau III : Concentrations of trace metal elements in fish samples taken from the Congo River at the Nzilo site (mg/Kg).

N°	Codification	Nom scientifique	Al	As	Cd	Co	Cu	Mn	Ni	Pb	Se	Zn
1	LUANZIP73	*Coptodon rendalli*	21,9	<0,002	0,431	16,48	36,76	43,27	20,15	<0,001	6,893	179,4
2	LUANZIP74	*Coptodon rendalli*	82, 38	0,123	0,429	6,737	23,19	21,71	7,53	<0,001	6,517	138,4
3	LUANZIP75	*Coptodon rendalli*	50,02	<0,002	0,481	5,172	26,4	14,86	6,57	<0,001	6,849	151,4
4	LUANZIP76	*Coptodon rendalli*	51,18	<0,002	0,332	7,019	32,54	21,52	11,39	<0,001	6,844	106,4
5	LUANZIP77	*Coptodon rendalli*	22,72	<0,002	0,214	15,54	20,67	40,05	9,44	<0,001	4,354	110,6
6	LUANZI P78	*Coptodon rendalli*	68,42	<0,002	0,413	7,37	15,03	17,22	24,98	<0,001	10,090	142,5
7	LUANZI P79	*Coptodon rendalli*	30,05	<0,002	0,315	21,9	22,35	55,94	11,95	<0,001	4,345	99,52

8	LUANZIP80	*Coptodon rendalli*	63,68	<0,002	0,717	10,46	42,62	25,55	16,71	<0,001	6,365	201,10
9	LUANZIP81	*Coptodon rendalli*	40,88	0,029	0,261	31,66	35,55	65,63	13,26	<0,001	3,844	153,50
10	LUANZIP82	*Coptodon rendalli*	42,73	0,916	0,136	24,16	17,29	58,4	7,73	<0,001	4,24	144,00
11	LUANZIP83	*Coptodon rendalli*	71,97	0,944	0,122	22,91	13,22	50,56	6,31	<0,001	5,47	140,20
	Average		49,1	0,5	0,35	15,4	25,9	37,7	12,4	-	5,9	142,4
	Standard deviation		18,1	0,5	0,2	8,8	9,7	18,3	6,0	-	1,8	30,3

Compared to the WHO thresholds, only Cu presents four out of eleven samples with concentrations above the WHO threshold of 30mg/kg.

Table IV: Results of comparison, by Wilcoxon test, of the Metal Trace Elements concentrations of fish samples from Congo River to themetal trace elements concentrations of reference fish samples from Panda, Kasungwe and Congo Rivers

	Congo River sample concentrations (mg/kg)				Reference fish samples Concentrations (mg/kg)		Wilcoxon test z value	
	Pont Lualaba		Nzilo site		Range	Avarage	Pont Lualaba site	Nzilo site
	Range	Avarage	Range	Avarage				
Al	12,6-213,3	63,6	21,9--82,38	49,1	27,5—362,7	162,8	2,37>1,96	2,26>1,96
As	<0,002-2,49	1,6	<0,002--0,94	0,5	0,03—0,25	0,2	2,94>1,96	2,06>1,96
Cd	<0,1--0,82	0,2	0,12--0,71	0,35	0,02—0,43	0,18	0,8<1,96	0,11<1,96
Pb	<0,001--126,6	41,5	<0,001	--	0,03—0,56	0,2	1,18<1,96	-
Zn	58,6--189,2	120,8	99,52--201,1	142,4	26,9—691,3	150,2	1,0<1,96	1,0<1,96
Co	1,32--24,83	4,1	5,17--31,6	15,4	0,11—1,09	0,41	4,62> 96	3,97>1,96
Cu	11,36--43,28	23,6	11,36-43,28	20,9	1,53—5,4	2,75	4,62>1,96	3,97>1,96
Mn	9,79--84,64	44,14A	14,86---65,6	37,7	8,65---34,4	18,6	2,78>1,9	2,59>1,96
Ni	0,58---115,0	16,2	6,31---4,9	12,4	0,11---0,62	0,3	4,54>1,9	3,97>1,96
Se	3,06--10,25	7,1	3,84--10,09	5,9	0,78---2,76	1,6	4,62>1,9	3,97>1,96

IV. Discussion

Al

The Wilcoxon comparison of the Al concentrations of the Congo River fish samples from Lualaba Province to the Al concentrations of the reference fish samples showed that for the samples from the “Pont Lualaba” site, z=2,37 for Al, and for samples from the Nzilo site, z=2,26 for Al. All values of z are greater than 1,96 (p<0,05). However, we could see that the Al concentrations of the reference fish samples (27,5mg/kg--362,7mg/kg), with an avarage of 162,8mg/kg), are higher than the Al concentrations of the Congo River fish samples (12,6mg/kg--213,3mg/kg), with an avarage of 63,6mg/kg, for Pont Lualaba site, and (21,9mg/kg--82,38mg/kg), with an avarage of 49,1mg/kg, for Nzilo site (Table IV);

It can be concluded that, on average, the concentrations of Al in the reference fish samples are higher than the concentrations of Al in the fish samples from the Congo River ,. As a result, this suggests that there is no contamination of Al in the fish of the Congo River

No physiological role of aluminum is known in a human or animal organism (Miquel, 2001). Hight exposure to Al results in pulmonary, gastrointestinal, cardiovascular, hematological neurological, hepatopacreantic, musculosquelettic toxic effets. (Boudjella and al., 2022). Squadrone et al. (2016) obtained Al concentration values for the Lufira river at the Kapolowe-Gare site (135,4 mg/kg) and Koni site (226 mg/kg) that were much higher than those obtained in the present study (63,6mg/kg) at Pont Lualaba site and 49,1 mg/kg at Nzilo site. But, in Egypt, El Nabawi et al. (1987) obtained for lakes Mariout and Edku an As concentration value of 0,03mg/kg, lower than those obtained in this study : 1,6mg/kg for fish samples from Pont Lualaba site and 0,5mg/kg for fish samples from Nzilo site.

As.

The Wilcoxon comparison of the As concentrations of the Congo River fish samples from Lualaba Province to the As concentrations of the reference fish samples showed that for the samples from the “Pont Lualaba” site, z=2,94, and for samples from the Nzilo site, z=2,06 . All values of z are greater than 1,96 (p<0,05). However, we could see that the As concentrations of the Congo River fish samples for the Pont Lualaba site (<0,002mg/kg- 2,5mg/kg) with an avarage of 1,6mg/kg (Table IV) are higher than the As concentrations of the reference fish samples (0,03mg/kg - 0,25mg/kg, with an avarage of 0,2 mg/kg (Table IV). We can then consider the fish from the Congo river as contaminated in As at the Pont Lualaba site. But, at the Nzilo site, the As concentrations of the fish samples from the Congo (<0,002mg/kg

- 0,94mg/kg) with an avarage of 0,5mg/kg (Tables IV), are of the same order as the As concentrations of the reference fish samples (0,03mg/kg - 0,25mg/kg, with an avarage of 0,2 mg/kg (Table IV). For this reason, it can be considered that there was no contamination in As of the fish from the Congo River.

Cd, Pb and Zn

The Wilcoxon comparison of the Cd, Pb and Zn concentrations of the Congo River fish samples from Lualaba Province to the Cd, Pb and Zn concentrations of the reference fish samples showed that for the samples from the Pont Lualaba site, z=0,8 for Cd, z= 1,18 for Pb and z=1,0 for Zn; and for samples from the Nzilo site, z=0,11 for Cd, no z value for Pb, and z=1,0 for Zn. All z values are less than 1,96 ($p<0,05$). It is concluded that, on average, the concentrations of Cd, Pb and Zn values in the reference fish samples are higher than the concentrations of Cd, Pb and Zn values in the fish samples from the Congo River.

However, when compairing the values of Pb concentrations at the Pont Lualaba site (<1,001-126,6) to the thresholds of the WHO (2,0mg/kg) and European Union (0,3 mg/kg), we see that 9 Pb concentrations (3,1 – 126,6mg/kg) out of 22 (Table IV) have higher values than the thresholds of the WHO (2,0 mg/kg) and 13 Pb concentrations (0,35mg/kg – 126,6 mg/kg) out of 22 (Table IV) have higher values than the thresholds of the European Union (0,3mg/kg). This observation leads us to consider the fish of the Congo River in its section located in the Lualaba Province, as problematic and of doubtful health safety. Thus, we prefer considerer the fish from the Congo River as contaminated in Pb. But, it can be said that there is no contamination of the Congo River fish in Cd and Zn.

At hight levels, lead poisonning is manifest by effectcs of the central nervous system, with stupor, coma and convulsions. (Wright and Melbourn, 2002). In addition, Pb blocks several enzymes necessary for the synthesis of hemoglobin. These effects dampen a decrease in the number of red blood cells and anemia (Miquel, 2001). The mean Pb concentration of fish samples from the Congo River (1,7 mg/kg) is far higher than the values obtained by Koya (2012) for Lake Tshangalele at the Kapolowe-Mission locality site (0,35mg/kg) and theKibangu locality site (0,64 mg/kg).

Cd, just like the Pb, is classified among the most toxic metal which have no known biochemical benefits to human or to animal (Miquel, 2001) Prolonged exposure to cadmium in humans can lead to kidney damage, bone fragility, harmful effects on the respiratory system, reproductive disorders and an increased risk of cancer and especially inthe occurrence of prostate and lung cancers (Lauwerys, 1999).

Zinc is essential for normal growth, reproduction, and life expectancy in animals (Lauwerys). In chronic exposure to Zn, bone marrow and neurological effects may occurs. Chronic igesstion of Zn and resulting Cu deficiency result in sideroblastic anemia, granulocytopenia and myelodysplasmic syndrome. (Angnew and Slesinger, 2022). The mean Zn concentration of fish samples taken from the Congo River at the Pont Lualaba site (120,8 mg/kg) is significantly higher than the mean values of Zn concentrations obtained by El Nabawi et al. (1987) for Lake Idku (7,4 mg/kg) in Egypt and by Kakulu et al. (1987) for the Niger Delta (4,8 mg/kg) in Nigeria.

Co, Cu, Mn, Ni and Se

The Wilcoxon comparison of the Co, Cu, Mn, Ni and Se concentrations of the Congo River fish samples, in the section located in Lualaba Province, to the Co, Cu, Mn, Ni and Se concentrations of the reference fish samples showed that for the samples from the "Pont Lualaba" site, z=4,62 for Co, z=4,62 for Cu, z=2,78 for Mn, z=4,54 for Ni, and z=4,62 for Se and for samples from the Nzilo site, z=3,97 for Co, z=3,97 for Cu, z=2,59 for Mn, z=3,97 for Ni and z=3,97. All values of z are greater than 1,96 ($p<0,05$). All these values being greater than 1,96 ($p<0.05$) , It is concluded that, on average, the concentrations of Co, Cu, Mn, Ni and Se in the fish samples from the Congo River, in its section located in the Lualaba Province, are higher than the concentrations of Co, Cu, Mn, Ni and Se in the reference fish samples (Table IV). This means that the difference between the concentrations of Co, Cu, Mn, Ni and Se in the Congo River samples and the concentrations of CO, Cu, Mn, Ni and Se in the reference fish samples is significant. This suggests that since the Congo River has received water polluted with mining waste, the fish in this river are indeed contaminated with Co, Cu, Mn, Ni and Se.

CO is a constituent of vitamin B12 which is essential for the normal formation of red blood cells . However, when you breathe too high concentrations of Co in the air, you can get lung problems such as asthma or pneumonia Cobalt, 2024). In excess, Co can cause poisoning: in particular irritation of the respiratory tract, nervous and digestive disorders (Lauwerys, 1999). Koya (2017) obtained a Co average value of 1,5 mg/kg for the Lufira river, in Democratic Republic of Congo, at the Koni site lower than that obtained in the present study on an averageof 15,4mg/kg at the Nzilo site.

In very low doses, Cu is a well-known trace element. It is essential for the synthesis of hemoglobin, normal bone formation, and maintenance of myelin in the nervous system (Wright & Welbourn, 2002). However, chronic exposure can cause irritation of the affected areas, including the mucous membranes, nasal cavities, eyes. It causes headaches, stomach aches, dizziness, digestive disorders such as vomiting and diarrhea (ASEF, 2017)**.** El Nabawi et al. (1987) obtained, for fish from Lake Idku and Mariout in Egypt Cu concentration value (1,77 mg/kg) lower than that obtained in this study (23,6 mg/kg) at the Pont Lualaba site. .

Mn is a constituent or activator of important enzymes such as arginase, enalase, ATPase, and carboxylases. It is involved in the normal structure of bone, reproduction, and the normal functioning of the central nervous system (Wright and Welbourn, 2002). But, in poisoning, we observe burning of the respiratory and digestive tracts with bloody vomiting. In chronic intoxication there is neurological damage. (Lauwerys,1999). The mean Mn concentration of fish samples from Congon River at the Pont Lualaba site (44,14 mg/kg) and Nzilo site (37,7mg/Kg) is higher than the value obtained by Koya (2012) for Lufira river at Misisi site(5,4mg/kg) in DR Congo.

In small quantities, nickel is essential but if the absorption is too great, it can pose a health risk. Chronic inhalation Ni poisoning results in changes in the nasopharynx and respiratory tract epithelium. Chronic changes may include rhinitis, polyps, asthma or pulmonary fibrosis. In addition, an increased incidence of lung cancers has been observed (Gates and al., 2023) Squadrone et al. (2016) obtained lower avarage values of Ni concentration for lake Tshangalele at the Kapolowe-Mission (0,9 mg/kg) and Mwadingusha (0,21 mg/kg) sites than that obtained in the present study (12,4 mg/kg) at the Nzilo site..

Se can contribute to the proper functioning of the body, including immune system metabolismnd thyroid function. However, consumption of high doses of Se can be toxic or even deadly. Signs of toxicity include of the behaves hair loss, dizziness, nausea, vomiting, tremors, muscle aches (Show, 2023). The Se concentration values obtained in this study (5,9 mg/kg) at the Nzilo site and 7,1mg/kg at the Pont Lualaba site are much higher than the Se concentration values obtained by Koya (2012) for the Lufira river at the Kapolowe-Gare (0,4 mg/kg), Misisi(0,97 mg/kg) and Kapolowe-Mission (0,7 mg/kg) sites..

V. Conclusion

Throuh this study, we wanted to verify the health safety of the fish from tne Congo River , given that this river has been receiving for several years untreated mining wastes from metallurgical factories. The results of the chemical analysis as well as the comparison of the concentrations of metal trace elements in the samples of fish from the Congo river to the concentrations of Metal Trace Elements of the reference samples by the Wilcoxon test and to the thresholds recommended by the WHO, FAO, EU and other regulatory bodies have shown that the Congo River, in its section located in Lualaba Province, is contaminated in As, Co, Cu, Mn, Ni, Pb and Se. In doing so, we wanted to give almost for each metal trace element treated in this study some exemples of the pathologies that it can cause in order to show how dangerous it is to consume fish coming from an aquatic ecosystem polluted with mining wastes contening metal trace element themselves. The consumption of fish from the Congo river presents a fairly serious risk to the health of the consumer. All this makes the fish of the Congo River unsuitableand unfit for human consumption.

The results obtained will be brought to attention of the decision-makers, and in particular of those of the Province of Lualaba, so that measures can be taken to ban metallurgical factories to drump their mining wastes into waterways and in particular those that supply fish to the local population. Further more based on our results, we raise awareness among the political-administrative Authorities, and also the population, from the Province of Lualaba, of the risk to health of eating fish from Congo River since contaminated with trace metal elements.

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