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Comparison of Heavy Metals Contents for Some Cigarettes Brands

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ABSTRACT

According certain studies, smoking could be associated with an increase of health risk link to heavy metals and these risks would be more important in developed countries. So, this study attempted to verify these informations throuth the comparison of the levels of lead (Pb), cadmium (Cd) nickel (Ni) and arsenic (As) in some cigarettes sold in Benin and France. Composite samples of cigarette brands purchased in Benin (developing country) and France have been taken in the same periods from the two countries. Samples were analyzed for cadmium (Cd), lead (Pb), nickel (Ni) and arsenic (As) by atomic absorption spectrophotometer. The amounts (average ± SD) have been compared by the statistical Student p test ($T>t$) = 0.05. The results showed that all the cigarettes tobacco is differently contaminated with Cd, Pb, Ni and As. The amounts reveal that for all metals the regulatory limits are over passed but the level of contamination varies from one brand to another one. However, it could not be obvious to conclude that the cigarettes in developed countries are more concentrated in heavy metals than those of developing countries. This affirmation has been discussed. Indeed, it appeared that the level of lead and arsenic obtained in some cigarette brands purchased in Benin were significantly higher than ($p<0.05$) those sold in France. Otherwise, all the France cigarette brands contain about two or three times more cadmium that Beninese cigarettes. However, excepted these particularities, there was no significant differences ($p<0.05$) between heavy metals contents in cigarette brands sold in Benin and France. Overall, findings from this study suggest that, Beninese cigarettes did not differ in heavy metals contents from cigarettes sold in France markets. The high levels of toxic metals recorded in some cigarette tobacco from each country are probably the result of soil conditions where tobacco is grown. But, the presence of high levels of heavy metals may constitute a global health concern. The adoption of reasonable behavior are needed to preserve the public health.

Keywords: Cigarette Brands, Developed Country, Developping Country, Toxic Metals, Health Risk

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1. INTRODUCTION

Under the label of progress, globalization and civilization, the cigarette from the West (Connolly *et al*., 1986; Galanti *et al*., 1997), was introduced and widespread in Africa (Kaplan *et al*., 1990; Peltzer, 2003) and even in Benin, despite the legislative, regulatory, ethical and health barriers (Sasco *et al*., 2004). Tobacco is a fast-growing plant (Saad *et al*., 2006) and, like all the natural plants, it uptake toxic metals from the soil (Pietel *et al*., 2000). Some of these contaminants can be naturally found in soils where tobacco plants are grown (Xian, 1989), others were brought in soils through fertilizer and various pesticides during the cultivation of tobacco crops (Deluisa *et al*., 1996; Bourrelier and Berthelin, 1998). Besides, smoking is associated with an increase in heavy metals in human tissues (Friberg, 1974; Kjellstrom, 1979; Scherer and Barkemeyer, 1983; Mussalo-Rauhamaa *et al*., 1986) and these health risks are more importants in developed countries (Watanabe *et al*., 1987). In order to confront these informations, this study attempted to determine and compare the concentrations of toxic metals (lead, cadmium, nickel and arsenic) in some cigarette brands purchased in Benin, developping country and in France.

2. MATERIALS AND METHODS

2.1. Processing and Analysis

6 brands of cigarette had been taken from some locations in Benin between march and april 2009 and 3 brands of cigarettes were purchased in France. There are:

- From Benin:
  - Yes, Green Concorde and Red Concorde that were manufactured by BATCo Company in Benin
  - Rothmans King Size, Craven A and Marlboro that were imported but smoked in Benin
- From France:
  - Rothmans King Size, Craven A and Marlboro

All the samples have undergone the necessary treatment before heavy metals analysis by electrothermal atomic absorption spectrophotometer according to the method described in (Anane *et al*., 1995; Vaidya and Rantala, 1996). For each sample, there were 3 replicates and the average values and standard deviation were calculated.

2.2. Statistical Tests

Results are presented in tables as average ± standard deviation and analyzed using SPSS 16.0 software. All statistical treatments performed in this study show many comparisons. This procedure involves comparing pair-wise all or part of the results using Student p test (T> t) = 0.05.

3. RESULTS

The results are summarized in **Table 1-3**.

- **Table 1:** Concentration (µg/g) of heavy metals in imported cigarettes and cigarettes made and sold in Benin
- **Table 2:** Concentration (µg/g) of heavy metals in cigarettes made and sold in France
- **Table 3:** Comparison of concentrations (µg/g) of heavy metals in cigarettes sold in Benin and France

4. DISCUSSION

The results show that all the cigarette samples taken from the two countries are contaminated with lead (Pb), Cadmium (Cd), Nickel (Ni) and Arsenic (As). As depicted in **Table 1-3**, the levels of metals of health varied considerably among brands. The amounts reveal that, for all metals, the regulatory limits (1 µg g^{-1}) are over passed but the level of contamination varies from one cigarette brand to another one.

4.1. Metals Concentration in Beninese Cigarettes

The average concentrations of heavy metals in cigarettes sold in Benin are presented in **Table 1**. The tested Beninese brands averaged 1.96±1, 01 µg g^{-1} Pb (range 1.15-3.85), 47.23±21.64 µg g^{-1} Cd (range 26.03-84.79), 5.25±0.24 µg g^{-1} Ni (range 4.97-5.66.) and 37.14±42.96 µg g^{-1} As (range 1.01-95.25). According this table, there was no significant difference ($p<0.05$) in cadmium concentrations of cigarette brands. The lowest concentration was recorded in Green Concorde brand whereas the highest in Yes brand. Similarly, no significant difference ($p<0.05$) was observed in nickel concentrations among the 6 cigarette brands used in Benin. The lowest concentration was recorded in Graven brand whereas the highest in Yes brand. Concerning lead contents, there was no significant difference ($p<0.05$) between Marlboro, Graven A and Yes.

Table 1. Concentration (µg/g) of heavy metals in imported cigarettes and cigarettes made and sold in Benin

	Cd	Pb	Ni	As
Marlboro	2.34±0.76	37.08±1.19	5.18±0.98	81.83±5.61**
Rothmans	1.48±0.40	55.53±1.44*	5.40±2.52	1.01±1
Craven A	1.31±1.11	29.86±2.43	4.97±0.73	95.25±9.97***
Red Concorde	1.67±1.93	50.13±4.14*	5.09±1.33	1.77±6.53
Green Concorde	1.15±1.13	84.79±3.11**	5.21±1.01	1.38±3.46
Yes	3.85±2.39	26.03±2.36	5.66±2.39	41.60±9.18*
Average ± SD	1,96±1,01	47,23±21,64	5,25±0,24	37,14±42,96

The signe *; Represented the statistically significantly difference among mean values at 5% level of Probability in each column metal

Table 2. Concentration (µg/g) of heavy metals in cigarettes made and sold in France

	Cd	Pb	Ni	As
Marlboro	4.33±1.43	46.16±2.14*	4.70±1.76	89.55±5.26*
Rothmans	4.54±1.52	13.31±1.38	5.65±0.50	2±1.59
Craven A	4.28±1.41	63.51±2.63**	4.11±1.13	1.01±1
Average ± SD	4,38±0,11	40,99±20,81	4,82±0,63	30,85±41,50

The signe *; represented the statistically significantly difference among mean values at 5% level of Probability in each column metal.

Table 3. Comparison of concentrations (µg/g) of heavy metals in cigarettes sold in Benin and France

	Cd		Pb		Ni		As	
	Benin	France	Benin	France	Benin	France	Benin	France
Marlboro	2.34±0.76	4.33±1.43	37.08±1.19	46.16±2.14	5.18±0.98	4.70±1.76	81.83±5.61	89.55±5.26
Rothmans	1.48±0.40	4.54±1.52	55.53±1.44*	13.31±1.38	5.70±2.52	5.65±0.50	1.01±3.89	2±1.59
Craven A	1.31±1.11	4.28±1.41	50.13±4.14	63.51±2.63	4.97±0.73	4.11±1.13	95.25±9.97*	1.01±1
Aver. ± SD	1,77± 0,55	4,38±0,11	40,82± 13,23	40,99±20,81	5,18 ± 0,21	4,82±0,63	59,36± 50,97	30,85±41,50

The signe *; Represented the statistically significantly difference among mean values at 5% level of Probability in each ligne cigarette brand for each metal

But there was significant difference ($p<0.05$) in lead concentrations in Red Concorde and Rothmans brands brand compared to the other ones, excepted for Green Concorde brand which lead level was substantially higher (84.79 µg g^{-1}). For arsenic contents, there was no significant difference ($p<0.05$) between Rothmans (1.01 µg g^{-1}), Green (1.77 µg g^{-1}) and Red Concorde (1.38 µg g^{-1}). On the other hand, there was significant difference ($p<0.05$) between them and the other brands. But, by increasing order, the levels of as were substantially higher for yes (41.60 µg g^{-1}), Marlboro (81.83 µg g^{-1}) and Graven A (95.25 µg g^{-1}). So, the highest arsenic concentration was recorded in Craven A brand while the lowest was recorded in Rothmans brand. What means that, the levels of As in Marlboro and Graven A were substantially higher (2-90 fold) compared to the other brands.

4.2. Metals Concentration in France Cigarettes

Average concentrations of lead, cadmium, nickel and arsenic in cigarettes made and sold in France is presented in **Table 2**. The tested France brands averaged 4.38±0, 11 µg g^{-1} Pb (range 4.28-4.54), 40.99±20, 81 µg g^{-1} Cd (range 13.31-63.51), 4.82±0, 63 µg g^{-1} Ni (range 4.11-5.65) and 30.85±41, 50 µg g^{-1} As (range 1.01-89.55). As depicted in this table, the levels of toxic metals varied considerably among brands. For cadmium and nickel concentrations, no significant differences ($p<0.05$) were observed. Concerning lead contents, by increasing order, the levels were substantially higher ($p<0.05$) for Marlboro (46.16 µg g^{-1}) and Graven A (63.51 µg g^{-1}) compared to Rothmans brand samples (13.31 µg g^{-1}). For arsenic concentrations, there was no significant difference ($p<0.05$) between Rothmans and Graven A. But, the level of As in Marlboro was substantially ($p<0.05$) higher (40-80 fold) compared to the other brands.

4.3. Comparison of Beninese and France Cigarettes

The comparison of heavy metals contents in cigarettes sold in Benin and France are presented in **Table 3**. Excepted the significantly differences ($p<0.05$) recorded for Pb (55.53±1.44 in Beninese Rothmans versus 13.31±1.38 in France one) and for As (95.25±9.97 in Beninese Graven A versus 1.01±1 in France one), there was no significant differences for

heavy metals contents in cigarette brands sold in Benin and France. So, Rothmans cigarette brands of Benin contain about four times more lead that France Rothmans. Also, Graven A cigarette brands of Benin contain about ninety times more arsenic that Graven A sold in France. Otherwise, the average cadmium contents in France cigarettes brands is slightly higher than the average recorded in cigarettes smoked in Benin. Indeed, all the France cigarette brands contain about two or three times more cadmium that Beninese cigarettes. On the other hand, the average arsenic contents in Beninese cigarettes brands is slightly higher than the average recorded in cigarettes smoked in France. However, there was no significant difference ($p<0.05$) between the averages metals contents for the three compared cigarette brands taken from the two countries. These results revealed that cadmium, lead, nickel and arsenic levels in Beninese cigarettes were comparable to those sold in France. The substantially differences between heavy metals contents were recorded essentially, not among the two countries, but from one cigarette brand to another one, inside each country. The results of this study are consistent with existing literature on presence of heavy metals in cigarettes (Watanabe *et al*., 1987; O'Connor *et al*., 2010). Metal content in tobacco leaf primarily is driven by the metal content of the soil in which it is grown, rather than resulting from processing (Golia *et al*., 2009). About the cadmium contents that are important in such studies, we did not find particularly high levels of cadmium in Benin like O'Connor *et al*. (2010) who recorded such results in Chine, developping country in cigarette tobacco. On the contrary, it was rather in all France cigarette brands that the cadmium levels were higher, which is probably the result of soil conditions where tobacco is grown in France. But, this debate is not important because the amounts reveal that, for all metals, the regulatory limits are over passed. Indeed, the presence of high levels of heavy metals may constitute a global health concern. Mussalo-Rauhamaa *et al*. (1986) found that 22-50% of the Cd was in the ash and stumps of the smoked cigarettes, which indicated that this element passed in large amounts to sidestream smoke. Recent work also suggests that cadmium and lead levels are higher in lung tissues of current and former smoking lung cancer patients relative to non-smokers (Palma *et al*., 2008). Did the tobacco industry have not the opportunity to test his crop in order to remove the most contaminated? Did such proposal can dent its huge profits? We thought, it's like gasoline with lead: heavy metals would be burn retardants. They would increase the amount of nicotine available when the cigarette consumme. This would be why they are still found in tobacco when they could not be there. Otherwise, smokers usually smoke 20 cigarettes or more per day and these heavy metals added a cocktail of tobacco toxic substances. While the relative health burden of metal exposure from tobacco is still unclear, Fowles and Dybing (2003) suggest that they might be at least as important in carcinogenesis as Polycyclic Aromatic Hydrocarbons (PAHs) and N-nitrosamines.

5. CONCLUSION

This study found that Beninese and France cigarettes contain potentially dangerous quantities of heavy metals (cadmium, lead, nickel and arsenic). Overall, these findings suggest that Beninese cigarettes did not differ in heavy metals contents from cigarettes sold in France markets, though they follow similar patterns in determining cadmium, lead, nickel and arsenic yields under standard testing conditions. But the presence of high levels of some heavy metals both in some Beninese and France cigarettes may constitute a potential global public health problem as manufactures and exports continue to increase. Regulators should require disclosure of the source and growing conditions of tobacco used in all products and should consider product standards based on heavy metal content.

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