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International Journal of Current Research
Vol. 5, Issue, 11, pp. 3278-3283, November, 2013

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

A HIGH RISK OF CONTAMINATION TO THE TOXIC HEAVY METALS (CADMIUM AND LEAD) AND TO FLUORINE DIET IN AN INSHORE INDUSTRIAL ZONE OF SOUTH OF TOGO

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ARTICLE INFO

Article History:
Received 15th September, 2013
Received in revised form
29th September, 2013
Accepted 16th October, 2013
Published online 19th November, 2013

Key words:
SNPT,
Heavy metals and fluorine,
Contaminated food,
Impacts on health.

ABSTRACT

The treatment of the phosphates in Togo constitutes an important source of pollution through the dismissal of the wastes after the treatment. The wastes are rejected in the sea and on soils. It entails the contamination of marine and farm products by cadmium, lead and fluorine contained in the wastes in the surrounding zones. Also, gases and dusts rejected in the atmosphere entail the contamination of water from the wells by these elements. A regular consumption of this contaminated food and a frequent use of the water from wells are sources of contamination of people by the heavy toxic metals and fluorine. The effects of these elements on the human health can then cause some concerns to the populations who live in the zone of treatment of the raw ore of the phosphates in Togo. The goal of this survey is to determine the frequency of consumption of food contaminated by the cadmium, lead and fluorine and the proportions of the individuals that suffer from the pathologies related to these xenobiotics in the surrounding zones of Société Nouvelle des Phosphates du Togo (SNPT) factory. The results show that food contaminated by the xenobiotics is frequently consumed in the households and the contaminated water from wells constitutes the first source of water supply for the daily needs of the households. This could be the reason why the prevalence of some illnesses is noticed in this zone. The decrease in number of the affected individuals as one move away from the factory and the sites of dismissal of the wastes indicates the function of this industrial activity in the appearance of these illnesses among the people. The method of management and treatment of the phosphates wastes by the SNPT in Togo presents harmful impacts on the health of the surrounding populations. It is therefore necessary to improve the management of these wastes in order to protect the people against the consequences of the pollutants in this zone.

INTRODUCTION

The industrial activities constitute one of the principal sources of introduction of xenobiotics in the organisms (Barbosa *et al*., 2005; Farombi *et al*., 2007; Mélila *et al*., 2012a, b). In Togo, "Société Nouvelle des Phosphates du Togo"(SNPT) industry installed at Kpémé (South of Togo) that treats the phosphates of Hahotoé - Kpogamè (South of Togo) dumps the solid waste and the mud in the sea (Gnandi and Tobschall, 1999; NSE/ONUDI, 2007). These wastes are also dumped in the neighbouring villages at Goumoukopé (Eastward) and Agbodrafo (Westward) and are drained towards Aného situated about 9 Km in the East of Kpémé. Unfortunately, these were containing fluorine and traces of heavy toxic metals such as cadmium (Cd) and lead (Pb) (Gnandi and Tobschall, 1999; Tchangbédji *et al*., 2000; Gnandi and Tobschall, 2002). The heavy metals and the fluorine contained in the wastes are bioaccumulated by marine fauna (Gnandi and al., 2006; Mélila *et al*., 2012a). Moreover, agricultural products and market garden produce cultivated near this industry bioaccumulated

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xenobiotics trough dust and gas produced by the industry; also, by the wastes dumped on the soils (Gnandi and Tobschall, 2002; Gnandi *et al*., 2008). Furthermore, water from the wells is contaminated by dust and water tables (NSE/ONUDI, 2007). Toxicity of Cd, Pb and fluorine impact on the good functioning of the organisms through many pathologies especially cardiovascular illnesses, renal failure, mental disorder, autism, cancers, respiratory illnesses, neonatal malformations, induction of an oxidizing stress and dental fluoride (Kazantzis, 1990; Abadin *et al*., 1997; Maatouk *et al*., 1998; Chinni and Yallapragda, 2000; Barbosa *et al*., 2005; Goullé *et al*., 2005; Mélila *et al*., 2012b). The presence of Cd, Pb and fluorine in the marine products, agricultural products, market garden produce and in drinking water make people be vulnerable in case of frequent consumption of these foods (Thun, 1985; Sorahan, 1987; NSE/ONUDI, 2007; Mélila *et al*., 2012a, b). The intensity of fishing and market gardening activities in the Togolese phosphate treatment area can thus arouse a worry as far as eating consumption habits is concerned; It can be a source of contamination of xenobiotics people in that area. This study aims to determine the frequency of consumption of food contaminated by the xenobiotics (Pb, Cd and fluorine) in the surrounding area of SNPT industry This helped to show the intensity of the introduction of the pollutants in human organisms through trophic way and so to justify the high content of these chemical elements in human blood (Mélila *et al*., 2012b, 2013) as well as the frequency of some pathologies observed in that area.

MATERIALS AND METHODS

Localization of the study area

The study area is a whole situated in the south of the international road Lomé - Aného (Togo), from the village of Gbodjomé (in West) to Aného (in East), going through Kpémé with about 20 Km of distance. According to its geographic situation, this whole belongs to the prefecture of lacks in the marine region of Togo (Fig. 2). The essential characteristic of this geographic space is that it accommodates the industry of treatment of ore rough phosphate of Hahotoé - Kpogamé (South of Togo) which rejected gas in the atmosphere, as the wastes and the mud rejected in the sea (Fig. 1), contains Pb, Cd, and fluorine (Gnandi and Tobschall, 1999; Tchangbédji *et al*., 2000; Gnandi and Tobschall, 2002; NSE/ONUDI, 2007).

Fig. 1. Reject of phosphate mud in the sea at Goumoukopé(A) at Kpémé(B);of phosphate wastes in the sea at Agbodrafo(C) and factory chimney of the industry of Kpémé spreading gas (and/or dust) of phosphates in the surroundings.(D)

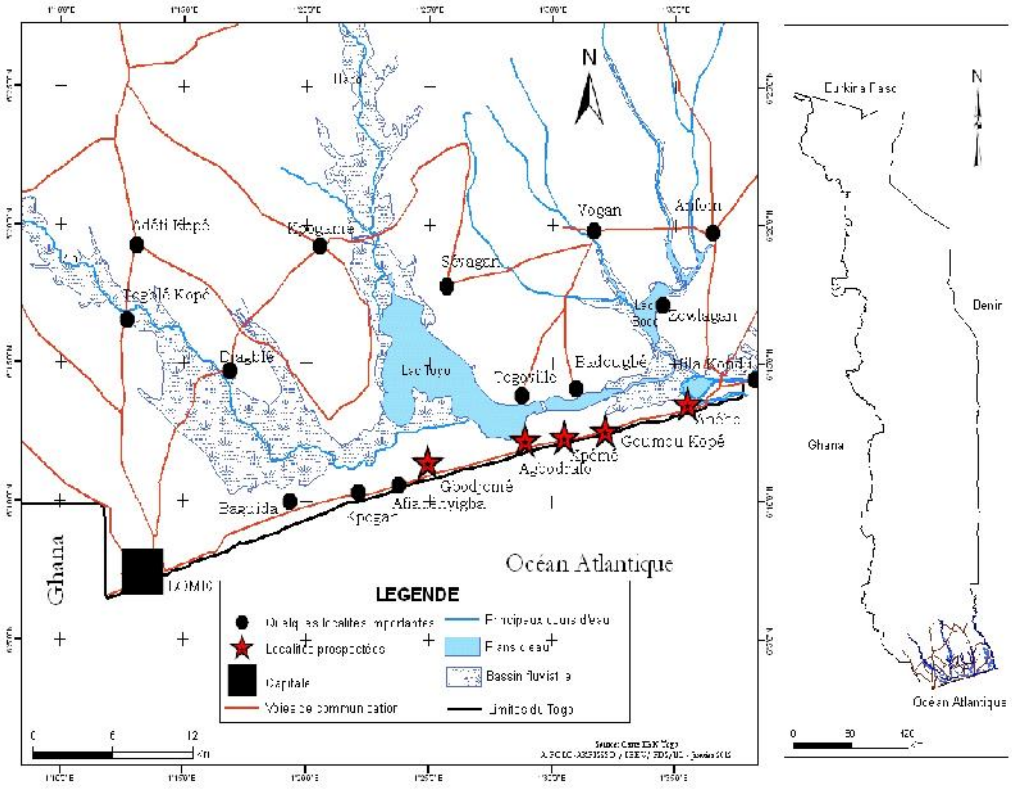

Fig. 2. Indication of study areas related to the dumping of phosphate wastes

Material

For this study, the coastal population of Gbodjomé, Agbodrafo, Kpémé, Goumoukopé and Aného participated in the survey. The material is essentially consisted of free and enlightened consent forms of subjects participating in the inquiry as required by the bioethics comity for such a study, food consumption inquiry forms, and inquiry forms on individual's health state. The protocol of study is certified by the Togolese bioethics comity for research in health under the number: 3287/ 2012/ MS /CAB/DGS/DPLET/CBRS.

METHODOLOGY

Food consumption inquiry

It is about an inquiry to determine the frequency of consumption of food contaminated by the xenobiotics in the households. The inquiry took place from the 27th June to November 2011 and was about 255 households in the whole chosen at random and divided up as followed: 47 at Gbodjomé, 58 at Agbodrafo, 54 at Kpémé, 53 at Goumoukopé and 43 at Aného. So, for each category of food consumed, weekly consumption frequency is determined. The list of food categories (marine products, agricultural products, source of water used) was pre-established according to the aim of the inquiry. For each category, the individual had the choice between five frequency of food consumption such as: every day's consumption, many times consumption a week (≥ two times), once a week, rarely and never.

Inquiry on individual's state of health

This inquiry is done simultaneously with the one based on the food consumption frequency. For this inquiry, an inquiry form had been achieved on which a list of some illnesses related to the presence of heavy toxic metals (Cd and Pb) and fluorine, but that could be completed during the inquiry. So, it was about to make an inventory of the illnesses from which patients were suffering; patients who went in consultation in the medical centers health record helped to take into account other pathologies from which the patients suffered. Some pathologies, notably, dental fluoride, autism, lower back pain, neonatal malformations were directly observable among the infected individuals by clinical analyses. In a broad way, 653 persons participated effectively in this inquiry, so be it a coefficient of 1/264 inhabitants of lacks prefecture with regard to the last counting in 2010 in Togo. The subject's age is between 04 and 60 years. The inquiries are divided up as follow: 118 at Aného, 117 at Goumoukopé, 121 at Kpémé, 186 at Agbodrafo and 111 at Gbodjomé.

Inclusion and exclusion criteria

The inclusion and exclusion criteria concerned essentially the life span in the locality, the sources of contamination to the heavy metals and to fluorine others that the industrial activities and the food habits. Thus, the consumers of tobacco (active tobacco addiction), the alcoholics (chronic alcoholism), the consumers of colas (active consumers), the newcomers (life span in the locality < 4 years), the irregular individuals in the locality, individuals presenting the infections of which the health state didn't permit to make clinical analyses, the pregnant women and HIV positive have been excluded. The others have been taken in account.

Statistic analysis

All the results are analysed with Microsoft Excel Software.

RESULTS

Sources of water and different forms of use

In the whole, we notice that water from well is more used in the villages of our study. Tap water is less used (Table 1).

Table 1. The different forms of water use according to localities

		Localitiés Gbodjomé (n = 47)		Agbodrafo (N= 58)		Kpémé (n = 54)		Goumoukopé (n = 53)		Aného (N = 43)	
		N	%	n	%	N	%	N	%	n	%
Water of well	Drinking water	31	65,96	47	81,04	09	15,67	45	84,91	11	25,58
	Food cooking	35	74,47	50	86,21	13	24,07	46	86,79	11	25,58
	Shower	41	87,23	55	94,83	37	68,52	51	96,23	33	76,74
Drilling water	Drinking water	11	23,40	08	13,79	17	31,48	08	15,09	12	27,91
	Food cooking	10	21,28	05	08,62	24	44,45	07	13,21	12	27,91
	Shower	06	12,77	03	05,17	15	27,78	02	03,77	07	16,28
Tap water	Drinking water	05	10,64	03	05,17	28	51,85	00	00	20	46,51
	Food cooking	02	04,25	03	05,17	17	31,48	00	00	20	46,51
	Shower	00	00	00	00	02	03,70	00	00	03	06,98

N = Number of households inquired; n = Number of households as far as water using is concerned.

Frequency of food consumption

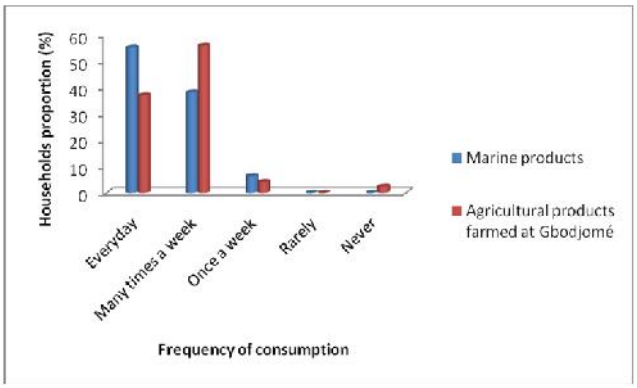

Fig. 3. Frequency of marine and agricultural products consumption at Gbodjomé

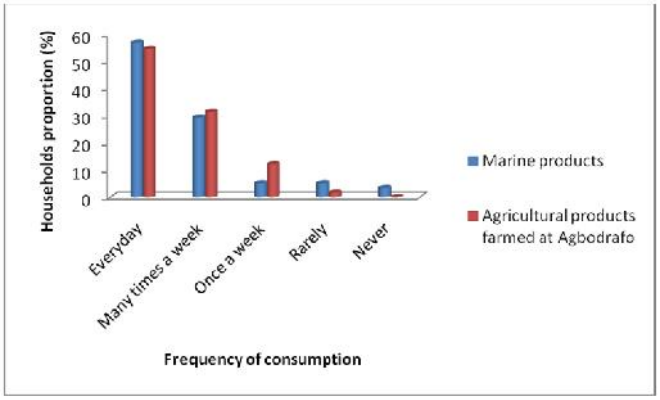

Fig. 4. Frequency of marine and agricultural products consumption at Agbodrafo

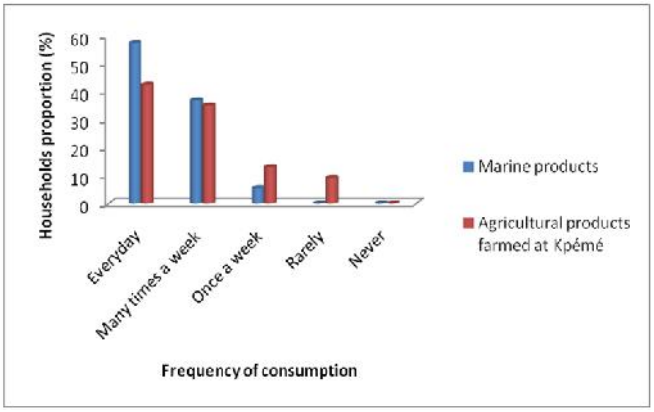

Fig. 5. Frequency of marine and agricultural products consumption at Kpémé

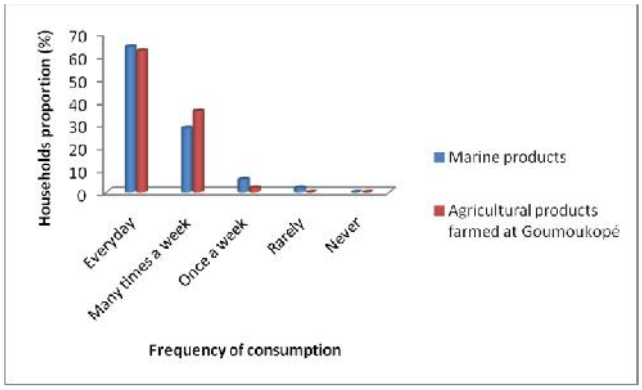

Fig. 6. Frequency of marine and agricultural products consumption at Goumoukopé

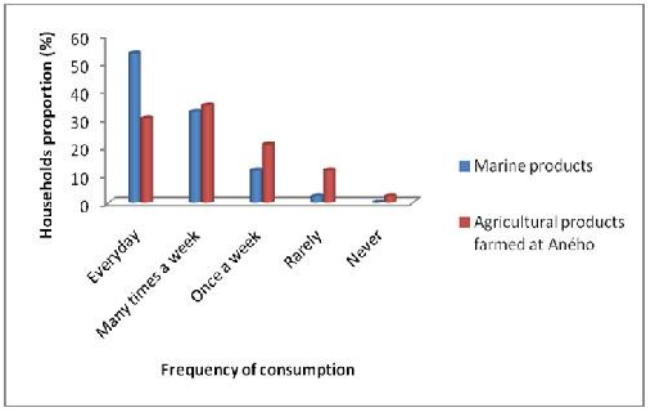

Fig. 7. Frequency of marine and agricultural products consumption at Aného

Inquiry on health state

We notice that dental and bones fluorosis, heart disease and lower back pain remain in the whole the frequent pathologies. However, other pathologies such as high blood pressure, diabetes, obesity, asthma and autism constitute public health problem in the phosphates treatment area in Togo too (Fig. 8).

DISCUSSION

The results of the inquiry on the food consumption at the surrounding areas of the SNPT factory reveal that a large majority of the population frequently consume marine products and market garden produce (Fig. 3; 4; 5; 6 and 7). This situation is explained by the fact that the study area is costal with an important fishing activity, principal source of animal protein for the population. Furthermore, another very important activity in this area is market gardening, source of vegetables for households. So the contamination of these foods by xenobiotics makes the consumers vulnerable (Gnandi *et al*., 2006; Farombi *et al*., 2007; Gnandi *et al*., 2008; Yildirim *et al.*, 2011; Mélila *et al*., 2012a; Mélila, 2013). We notice that the population frequently use these contaminated foods and water from the wells (Fig. 1; 3; 4; 5; 6 and 7; Table 1) in the polluted areas. That would lead to a bioaccumulation of Cd, Pb and fluorine by individuals through food consumption (Abadin *et al*., 1997; NSE/ONUDI, 2007; Mélila *et al*., 2012b, 2013). Such a nutrition is dangerous for individuals' health, for toxicity of Cd, Pb and fluorine and the same as that of the other revealed elements by other studies notably copper, zinc and nickel has an effect on organisms through dangerous effects (Dietrich, 1998; Chinni and Yallapragda, 2000; Patriarca *et al*., 2000; Sharma and Pervez, 2005; Goullé *et al*., 2005; Barbosa *et al*., 2005). Gas and dust production by the SNPT factory would be an additional source of contamination of human being by xenobiotics in the phosphates treatment area in Togo through skin way (NSE/ONUDI, 2007). This atmospheric pollution is also a source of contamination of water from the wells that is generally used by the population. This leads to the introduction of metals and fluorine in human organisms through water (NSE/ONUDI, 2007). The results of our inquiries with regard to the use of water of the wells show that a large proportion of the population uses water from the wells for shower, for drinks and to cook foods (Table1). This is justified by the availability of that source of water. This availability of water from the wells and its frequent use by the families would accentuate the introduction of xenobiotics in human organisms. Moreover, respiratory way of contamination is also to be taken into account in the bioaccumulation of xenobiotics by organisms, because the presence of gas and dust in the atmosphere in the phosphate treatment area exposes the subjects to the pollutants through breathing (NSE/ONUDI, 2007). So, the contaminated ways of xenobiotics in human organisms are diversified and the contamination through trophic way remains the most important in the surrounding villages of SNPT factory. This situation leads to a bioaccumulation of these xenobiotics which would justify the observed pathologies among subjects who live in those villages (Mélila *et al*., 2012b). In fact, the results on the health state of the subjects reveal that much pathology related to heavy toxics metals and fluorine notably dental and bony fluorosis, cardiovascular diseases, asthma, autism, lower back

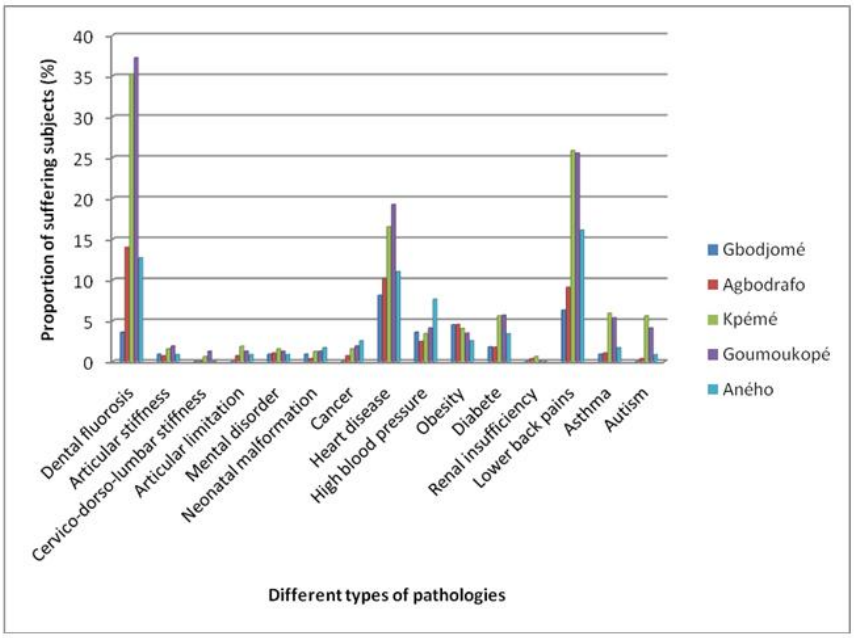

Fig. 8. Proportion of different pathologies according to localities

pain, cancer are relatively frequent among population of the prospected villages. This situation is more observable at Goumoukopé and at Kpémé, principal sites of wastes dumping, followed by Agbodrafo, neighbouring village of Kpémé towards East where are also dumped the wastes and Aného towards West at 9 Km from Kpémé where are drained the wastes dumped upstream. Pathologies are less observed at Gbodjomé, village situated about 11 km from Kpémé towards the upstream in West and which is not directly concerned by the phosphates wastes dumping. So, marine and agricultural products consumed and water of wells used by the subjects at Gbodjomé are less contaminated by xenobiotics (Gnandi *et al*., 2006; Mélila *et al*., 2012a). It is this low contamination of food consumed at Gbodjomé that explains the low prevalence of illnesses related to pollutants at that locality. Furthermore, the pathologies prevalence decreasing recorded bit by bit when one moves away from the phosphates wastes dumping sites confirms that these pathologies are caused by the pollution induced by industrial activities. The previous works on those pollution that indicated that the intensity of the impacts on the environment and human health decrease when we move away from the phosphates treatment area are in agreement with the results of the present study (Gnandi *et al*., 2006 ; Mélila *et al*., 2012a, b, 2013).

Conclusion

The present study indicates clearly that the surrounding populations of SNPT factory would be contaminated by xenobiotics through trophic way. In fact, high frequencies of consumption of contaminated foods and the use of contaminated water from wells would be important sources of Cd, Pb and fluorine introduction in human organisms. The impact of these xenobiotics on health would explain the frequency of some pathologies notably dental fluorosis, cardiovascular diseases, renal diseases, autism, asthma and cancers in this industrial area of Togo. It is therefore necessary that the authorities take into account the problem of pollution that arises in the phosphates treatment zone. The responsible for this factory would have to integrate new methods of management of the garbage generated during the treatment of the phosphate ore to avoid the population's contamination by the pollutants as early as possible.

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