



Détection de la présence de substances chimiques dans le sang humain



Analyse du contenu chimique d'échantillons sanguins
de trois ministres belges de l'Environnement



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GREENPEACE

Décembre 2004

Determination of chemicals in human blood

Report on chemical content in blood samples collected from three Belgian
environment ministers

Dr Fawaz Al Bitar – December 2004

Détection de la présence de substances chimiques dans le sang humain

Analyse du contenu chimique d'échantillons sanguins de trois ministres belges de l'Environnement

L'objectif de cette étude est d'effectuer une analyse du sang de 3 ministres belges de l'Environnement et d'un directeur de Greenpeace afin d'y quantifier les substances chimiques dangereuses préalablement détectées dans les poussières domestiques. Cette enquête s'inscrit dans le cadre d'une analyse plus large du sang de 91 individus néerlandais.

Contexte

De récentes analyses menées par Greenpeace dans différents pays européens ont révélé la présence d'une contamination chimique généralisée de la poussière domestique des habitations où nous passons 90% de notre temps. En Belgique, des échantillons de poussières ont été collectés dans 69 habitations différentes dont les logements ou lieux de travail de 11 politiciens belges et différents bureaux du Parlement européen à Bruxelles. Les résultats ont clairement montré que chaque foyer ou bureau analysés contenaient des substances chimiques bioaccumulables (accumulation dans les tissus vivants et la chaîne alimentaire), peu biodégradables (persistantes) et potentiellement toxiques. D'autres analyses scientifiques indiquent que ces mêmes substances dangereuses peuvent se retrouver dans une large gamme de biens de consommation comme des produits textiles, cosmétiques et appareils électroniques. Il est donc très vraisemblable que la contamination chimique de nos habitations trouve en partie son origine dans nos mobiliers et autres biens de consommation courante.

Les propriétés (bioaccumulable et peu biodégradable) des substances retrouvées dans les habitations et biens de consommation suggèrent qu'il est fortement possible qu'elles s'accumulent dans nos corps.

Participants à l'étude

- ◆ Mme **Evelyne Huytebroeck**: ministre bruxelloise de l'Environnement
- ◆ Mr **Kris Peeters**: ministre flamand de l'Environnement
- ◆ Mr **Benoit Lutgen**: ministre wallon de l'Environnement
- ◆ Mr **Wendel Trio**: directeur des campagnes de Greenpeace Belgique

Substances analysées

- **retardateurs de flamme bromés**: utilisés notamment dans le mobilier, les produits électriques et électroniques et dans les produits textiles.

Toxicité potentielle: interférence avec le système hormonal en provoquant des troubles du développement.

- **esters de phtalates** : utilisés notamment dans les plastiques souples, produits cosmétiques et peintures.

Toxicité potentielle: atteintes à la différenciation sexuelle, au développement du système reproductif, au développement et aux fonctions du foie, risques accrus d'asthmes infantiles.

- **composés organoétains**: utilisés notamment pour stabiliser le PVC et comme produits antifongiques dans les tapis et textiles.

Toxicité potentielle: perturbations du système immunitaire, du développement de l'embryon et des testicules, atteintes au système enzymatique et neurotoxicité.

- **alkylphénols** : utilisés notamment dans les détergents, produits cosmétiques, shampooings et autres produits de soin corporel.

Toxicité potentielle: perturbations du système hormonal, toxicité pour la reproduction et détérioration de l'ADN humain.

Analyse des résultats

Commentaires individuels

- ◆ **Mme Huytebroeck**: onze substances chimiques dangereuses ont été détectées dans le sang de Mme Huytebroeck. Elles appartiennent aux groupes chimiques suivants: retardateurs de flamme bromés, phtalates, composés organoétains et alkylphénols. A une exception près, toutes ces substances avaient été détectées, au cours d'une étude préalable, dans les poussières du cabinet que Mme Huytebroeck occupe depuis quelques mois. Les plus hautes concentrations mesurées dans son sang ont été enregistrées pour les phtalates DEHP et DBP, tous deux pouvant entraîner des perturbations du développement et classifiés en Europe comme "toxiques pour la reproduction". La concentration en DBP de son sang se situe parmi les plus hautes valeurs des analyses en DBP réalisées, suivant la même méthode, sur le sang de 91 volontaires aux Pays-Bas. Le sang de Mme Huytebroeck était le seul échantillon belge à contenir des concentrations détectables en l'organoétain DBT, qui peut provoquer des perturbations du développement des systèmes immunitaires et nerveux chez les mammifères. Des perturbateurs endocriniens potentiels, comme le nonylphénol et le bisphénol-A ont été mesurés dans son sang à une concentration se situant dans la fourchette supérieure des résultats émanant du panel hollandais.
- ◆ **Mr Peeters**: quatorze substances chimiques dangereuses ont été détectées dans le sang de Mr Peeters. Elles appartiennent aux groupes chimiques suivants: retardateurs de flamme bromés, phtalates, composés organoétains et alkylphénols. La plupart de ces substances avaient déjà été largement détectées dans les poussières des habitations belges, au cours d'une étude précédente. Les plus hautes concentrations mesurées dans son sang ont été enregistrées pour les phtalates DEHP, BBP et DBP, toxiques pour la reproduction. Les concentrations en DBP et BBP dans son sang se situent parmi les plus hautes valeurs des analyses en ces substances réalisées, suivant la même méthode, sur le sang de 91 volontaires aux Pays-Bas. Le phtalate DEP, qui peut perturber le développement du sperme humain, a également été détecté dans le sang de Mr Peeters. Son sang était le seul échantillon belge à contenir des concentrations détectables en organoétains MBT, MOT et

DOT. Des perturbateurs endocriniens potentiels, comme le nonylphénol et le bisphénol-A ont été mesurés dans le sang de Mr Peeters à une concentration se situant dans la fourchette supérieure des résultats émanant du panel hollandais.

- ◆ **Mr Lutgen:** sept substances chimiques dangereuses ont été détectées dans le sang de Mr Lutgen. Elles appartiennent aux groupes chimiques suivants: retardateurs de flamme bromés, phtalates et alkylphénols. A une exception près, toutes ces substances avaient été détectées dans les poussières de l'ensemble des habitations belges, au cours d'une étude précédente. Les plus hautes concentrations mesurées dans son sang ont été enregistrées pour les phtalates DEHP et DBP, à une concentration supérieure à la valeur médiane des analyses réalisées, suivant la même méthode, sur le sang de 91 volontaires aux Pays-Bas. D'autres phtalates reconnus pour leur dangerosité, comme le DEP, ont été détectés dans le sang de Mr Lutgen. Des perturbateurs endocriniens potentiels, comme le nonylphénol et le bisphénol-A ont été mesurés dans son sang à une concentration se situant dans la fourchette supérieure des résultats émanant du panel hollandais.
- ◆ **Mr Trio:** dix substances chimiques dangereuses ont été détectées dans le sang de Mr Trio. Elles appartiennent aux groupes chimiques suivants: retardateurs de flamme bromés, phtalates et alkylphénols. Toutes ces substances avaient déjà été détectées dans les poussières des habitations belges, au cours d'une étude précédente. La plus haute concentration mesurée dans son sang a été enregistrée pour le phtalate DEHP, toxique pour la reproduction. Le DEHP peut interférer avec le développement testiculaire chez les mammifères. D'autres perturbateurs du développement ont été détectés dans le sang de Mr Trio: les phtalates DBP et DEP. Le DEP est un perturbateur potentiel du sperme humain. La concentration en BDE-100, un retardateur de flamme bromé, se situe parmi les plus hautes valeurs des analyses en BDE-100 réalisées, suivant la même méthode, sur le sang de 91 volontaires aux Pays-Bas. Son sang était le seul échantillon belge à contenir de l'HBCD, un retardateur de flamme bromé génotoxique. Des perturbateurs endocriniens potentiels, comme le nonylphénol et le bisphénol-A ont été mesurés dans son sang à une concentration se situant dans la fourchette supérieure des résultats émanant du panel hollandais.

Observations générales

Seize types de substances chimiques dangereuses ont été détectés dans les échantillons de sang analysés dans cette étude. Chacun d'entre eux avait préalablement été détecté dans la poussière domestique des habitations belges et européennes, la plupart étaient même systématiquement présents dans chaque foyer analysé. De plus, ces 16 substances chimiques ont aussi été retrouvées dans une large gamme de biens de consommation: biberons, jouets, peintures, produits de soin corporel, cosmétiques, désodorisants, pyjamas, T-shirts, imperméables, chaussures de sports, matelas, GSM ou encore ordinateurs. Dès lors, les résultats de nos différentes analyses suggèrent que **la présence de substances chimiques dangereuses dans nos biens de consommation conduit à une contamination systématique de nos habitations et à une accumulation de ces substances potentiellement toxiques dans nos corps.**

Les concentrations détectées dans cette étude sont cohérentes avec les résultats émanant de l'analyse effectuée, suivant la même méthode, sur 91 volontaires aux Pays-Bas.

Les concentrations déterminées dans cette étude sont-elles inquiétantes?

Toutes les concentrations détectées sont inquiétantes, car il n'existe pas de niveau de concentration "acceptable" pour les substances analysées dans cette étude. Ces substances étant persistantes et bioaccumulables, il est fort possible que leur concentration augmente dans notre sang au cours des prochaines années. Diverses études scientifiques ont en effet établi que la concentration de certaines de ces substances avait déjà augmenté de manière exponentielle dans les tissus humains, ces dernières années. Ainsi, la présence, dans le sang des volontaires de cette étude, de substances potentiellement perturbatrices des systèmes immunitaires ou hormonaux ou encore dommageables pour le développement et la reproduction, est particulièrement préoccupante. Cette contamination du sang des ministres belges de l'Environnement est, très probablement, une des conséquences de la contamination chimique grandissante de notre environnement. Récemment, plusieurs scientifiques de renom, regroupés pour lancer ce que l'on appelle "l'Appel de Paris"¹, ont pointé du doigt cette contamination chimique, comme étant l'une des causes de l'augmentation du nombre de certaines maladies (comme le cancer) ces dernières années.

Nécessité d'une législation efficace

La présence de substances chimiques dangereuses dans les poussières de nos habitations et dans nos corps tend à prouver l'inefficacité du contrôle des substances chimiques. Une réforme de la législation chimique est donc capitale.

L'Union européenne élabore actuellement une nouvelle législation qui vise à appliquer aux substances chimiques produites et vendues en Europe un système de réglementation unique, baptisé REACH ("Registration, Evaluation, and Authorisation of Chemicals"). Les substances chimiques devraient d'abord être enregistrées et leurs risques évalués avant qu'elles ne reçoivent une autorisation de commercialisation.

Les pressions exercées par le lobby industriel ont réussi à considérablement affaiblir la portée de REACH. Pour être efficace, REACH devra absolument inclure le **principe de substitution**. C'est-à-dire que les substances chimiques dangereuses devront être systématiquement remplacées par des alternatives plus sûres.

REACH est actuellement discuté, pour amendements, au sein du Conseil européen et du Parlement européen, en vue d'une adoption en 2006. Il y a lieu d'espérer que la preuve d'une contamination chimique qui ne semble épargner personne responsabilise les ministres belges de l'Environnement et les amène à oeuvrer pour que le Conseil européen vote un système REACH renforcé, incluant, entre autres, le principe de substitution. Il est également capital que les membres du Parlement européen prennent en considération cette étude ainsi que celle (WWF) qui avait indiqué une contamination du sang de différents membres du Parlement européen, et se prononcent pour un renforcement de REACH. Ceci est essentiel pour que le niveau de substances chimiques dangereuses diminue dans le sang des citoyens européens afin d'éviter de graves problèmes en terme de santé publique.

¹ <http://www.artac.info/>

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1. Executive Summary

Blood samples from three Belgian environment ministers and the Campaign Director of Greenpeace Belgium were analysed and found to contain 16 of 33 hazardous chemicals that fall into four groups: brominated flame retardants, phthalates, organotins, and alkylphenols. These 16 chemicals have also been detected in a wide range of consumer goods - feeding bottles for infants, toys, paints, body care products, cosmetics, air fresheners, pyjamas, T-shirts, raincoats, sports shoes, mattresses, mobile phones, and computers – and in the dust of homes and offices in Belgium and other European countries. Consequently, the results of this study provide further evidence that the use of hazardous chemicals in consumer products contributes to the occurrence of these same chemicals as contaminants in the bodies of the population.

The chemical contaminants in the blood of the four people in this study were present in the same general ranges as those measured in the blood of 91 volunteers from the Netherlands. However, concentrations of some chemicals were higher than the median values determined in the Dutch study.

Since many of these are persistent, bioaccumulative chemicals that can damage the hormone, immune and development systems and can be toxic to reproduction, their presence at any concentration in human blood is of particular concern. Some have shown an exponential rise in concentrations in human tissue during the last 20 years. To reverse such trends and end human contamination, effective control of the production and use of chemicals must be enacted.

The results of this study further corroborate the failure of current chemicals legislation to protect the population against widespread exposure to hazardous chemicals. The European Union is preparing plans for the most comprehensive system of chemicals regulation yet seen. A potentially far more effective system of chemicals regulation -- Registration, Evaluation, and Authorisation of Chemicals (REACH) -- is currently being discussed by the European Parliament and Council and may become law by 2006.

2. Introduction

Innumerable scientific investigations have found hazardous chemicals in every environmental sector, including lake and marine sediments, remote polar regions and aquatic and terrestrial organisms, including humans.

Several recent studies revealed that house dust samples collected all around Europe are contaminated with a variety of hazardous chemicals (Santillo *et al.*, 2003a; Santillo *et al.*, 2003b; Al Bitar, 2004). In Belgium, house dust was collected in 69 locations, including homes or offices of 11 Belgian politicians and several offices in the European Parliament in Brussels. Results indicated that every Belgian dust sample contained numerous chemicals that are persistent (they break down very slowly), bioaccumulative (they build up in fatty tissues of humans and other organisms), and toxic (Al Bitar, 2004). While the origins of these contaminants are not well documented, these hazardous chemicals most probably enter the dust as a result of losses from goods and furnishings present in the homes and offices where the samples were collected. Indeed, different investigations indicated that the same chemicals can be detected in a wide range of every-day consumer goods including textiles, cosmetics, shampoos and electrical goods (Peters, 2003a; Peters, 2003b; Pedersen and Hartmann, 2004). As a consequence of this contamination and of the intrinsic properties of these chemicals, some of them can be expected to accumulate in the bodies of the human population.

The objective of the present study is to investigate the occurrence in the blood of three Belgian environment ministers and a Greenpeace Director of chemicals detected in Belgian house dust in a previous study. This analysis is also part of a broader study involving 91 people in the Netherlands (Peters, 2004).

Some of the chemicals analysed have been demonstrated to damage the immune system, to have adverse effects on the reproductive system, and/or to cause a range of other health effects potentially associated with disruption of the endocrine system.

2.1 Chemicals targeted for investigation

The chemicals analysed in this study have been chosen according to the following criteria:

- their reported high volume use in common household furnishings and other products
- their presence in house dust
- their intrinsic hazardous properties (persistent, bioaccumulative and toxic)

Therefore, the presence and concentrations of four main compound groups has been assessed:

- **Brominated flame retardants** are used to prevent or retard the spread of fire and may be applied to textiles or incorporated into plastics, foams and components of electrical goods.
Suspected toxicity: interfere with hormone system and potentially affect growth and development
- **Phthalate esters** are used as softeners, heat-transfer fluids or solvents in PVC, wallpapers, furnishings, cables, cars, medical equipment, clothing, toys, ink, paint,

adhesives, perfumes and cosmetics. Phthalates are considered as the most widespread man-made chemicals.

Suspected toxicity: toxic to reproduction, impacts on the development and function of the liver, increased risk of asthma

- **Organotin compounds** are used as stabilisers, biocides, fungicides, antifouling compounds and/or catalysts in plastics (especially PVC), carpets and paints or applied to fruits and vegetables.

Suspected toxicity: toxic to the immune system and affect embryo and testes development

- **Alkylphenols** are used as non-ionic surfactants, emulsifiers, lubricants or anti-oxidants in the following kind of products: detergents, textiles, leather, paints, shampoos, cosmetics, some plastics and pesticides. Alkylphenols have recently been reported to be ubiquitous in German food.

Suspected toxicity: hormone-disrupter, toxic to reproductive organs and harmful to human DNA

2.2 Dutch blood analysis

In an earlier study, Greenpeace analysed blood samples from a representative group of Dutch people, for the presence of five groups of hazardous substances frequently used in consumer products. Ninety-one healthy volunteers participated, 48 males and 43 females. Their ages ranged from 19 to 78.

Thirty-six of the 46 chemicals analysed were found in participants' blood, demonstrating that some chemicals found in consumer products are also found in human bodies (Peters, 2004).

The brominated flame retardant BDE-153 was detected in 76 samples. The newer brominated compounds HBCD and TBBPA, which are increasingly widely used, were detected in 11 and 32 of the samples, respectively. The phthalates DEHP and DBP were detected in 84 and 68 samples, respectively. The limited occurrence and low levels of organotin compounds might be due to the restricted use of these chemicals in the Netherlands. Bisphenol-A was above detection limit in 36 of the samples.

No correlation between any of the levels and age, sex, occupation or area of residence was observed. Only BDE-153 showed higher levels in males.

The authors found man-made chemicals in all blood samples and concluded that the Dutch population is exposed to a variety of man-made chemicals (Meijer *et al.*, 2004). A wide range of levels was detected for some compounds. The most likely explanation is differences in exposure.

3. Materials and Method

3.1. Sample collection

Blood samples were collected by doctors for Greenpeace Belgium using standard type BD-Vacutainer tubes. Each sample consisted of 6 tubes containing a total of approximately 60ml of blood. The following people participated in the investigation:

- ◆ Evelyne Huytebroeck: Environment Ministers for Brussels
- ◆ Kris Peeters: Environment Minister for Flanders
- ◆ Benoit Lutgen: Environment Minister for Wallonia
- ◆ Wendel Trio: Campaign Director of Greenpeace Belgium

The samples were sent to the laboratory of TNO Environment, Energy and Process Innovation (TNO-MEP), Apeldoorn, the Netherlands, for analysis. The samples were kept cool during transport. The chemical parameters determined are listed below; including the abbreviations used in the text and accompanying tables and the method detection limits.

Compound	Abbreviation	Method detection limit
<i>Brominated flame retardants</i>		
2,2',4-tribromo diphenylether	BDE 17	1 pg/g serum
2,4,4'-tribromo diphenylether	BDE 28	1 pg/g serum
2,2',4,4'-tetrabromo diphenylether	BDE 47	1 pg/g serum
2,2',4,5'-tetrabromo diphenylether	BDE 49	1 pg/g serum
2,2',3,4,4'-pentabromo diphenylether	BDE 85	3 pg/g serum
2,2',4,4',5'-pentabromo diphenylether	BDE 99	3 pg/g serum
2,2',4,4',6'-pentabromo diphenylether	BDE 100	2 pg/g serum
2,2',4,4',5,5'-hexabromo diphenylether	BDE 153	1 pg/g serum
2,2',4,4',5,6'-hexabromo diphenylether	BDE 154	1 pg/g serum
2,2',3,4,4',5',6'-heptabromo diphenylether	BDE 183	2 pg/g serum
decabromo diphenylether	BDE 209	100 pg/g serum
hexabromo cyclododecane	HBCD	80 pg/g serum
tetrabromodisphenol-A	TBBPA	5 pg/g serum
<i>Phthalates</i>		
dimethyl phthalate	DMP	1 ng/g serum
diethyl phthalate	DEP	1 ng/g serum
d-iso-butyl phthalate	DIBP	2 ng/g serum
di-n-butyl phthalate	DBP	2 ng/g serum
butylbenzyl phthalate	BBP	1 ng/g serum
dicyclohexyl phthalate	DCHP	1 ng/g serum
di-(2-ethylhexyl)phthalate	DEHP	10 ng/g serum
di-n-octyl phthalate	DOP	1 ng/g serum
di-iso-nonyl phthalate	DINP	10 ng/g serum
di-iso-decyl phthalate	DIDP	10 ng/g serum
<i>Organotin compounds</i>		
Monobutyltin	MBT	0,1 ng/g blood
Dibutyltin	DBT	0,1 ng/g blood
Tributyltin	TBT	0,1 ng/g blood
Tetrabutyltin	TeBT	0,1 ng/g blood
Monoctyltin	MOT	0,2 ng/g blood
Diocyltin	DOT	0,2 ng/g blood
Triphenyltin	TPT	0,4 ng/g blood
<i>Phenols and alkylphenols</i>		
bisphenol-A	BPA	0,5 ng/g serum
nonylphenol	NP	0,5 ng/g serum
octylphenol	OP	0,5 ng/g serum

Table 1: Compound groups and specific compounds included in this study.

3.2. Sample pre-treatment

A sub-sample of the whole blood sample was collected for the organotin analysis. The remaining part of the whole blood sample was allowed to clot at room temperature for 20 min and centrifuged at 4,000 rpm for 15 min. The serum was transferred into PTFE-capped glass vials and stored at 4°C until further analysis.

3.3 Sample extraction

All glassware used in the analyses was heated in an oven for 16 hours at 280°C prior to use. All solvents were distilled prior to use to achieve low blank results. The latter is especially important for the determination of the phthalates.

The serum sample was weighed into a clean glass 60ml vial. Methanol, 0.1 M HCl and a set of internal standards (one or more for each group of chemicals) was added to the sample. The sample was extracted twice with a hexane-diethyl ether mixture and centrifuged after each extraction to separate the organic phase. The combined extracts were washed with a 1% KCl-solution and dried with anhydrous sodium sulphate. The extract was split into two equal parts, A and B.

3.4 Sample analysis

3.4.1 Bisphenol-A, alkylphenols and tetrabromo bisphenol-A

Part A of the extract was concentrated to a small volume without further purification. Methanol was added to the extract and the extract was concentrated further to remove all hexane-diethyl ether residues. The methanol extract was used for the determination of BPA, NP, OP and TBBPA. The final extracts were analysed with liquid chromatography coupled with mass spectrometry (LC/MS) in the selected ion monitoring mode (SIM).

3.4.2 Brominated flame retardants and phthalates

Part B of the extract was concentrated to a small volume. The extract was purified using a florisil clean-up procedure and separate fractions were collected containing the component groups. The purified extracts were concentrated to a small volume and an injection standard was added. The final extracts were analysed with gas chromatography coupled with mass spectrometry (GC/MS) in the selected ion monitoring mode (SIM).

3.4.3 Organotin compounds

The whole blood sample was weighed into a 60ml vial and internal standards were added. After the addition of a sodium dithiocarbamate solution in ethanol, the sample was sonicated, left overnight, and sonicated once more. The residue was removed and an acetate buffer and a sodium tetraethylborate solution in ethanol were added. The mixture was extracted twice with hexane and the concentrated extract was purified using a silica clean-up procedure. The purified extract was concentrated and an injection standard was added. The final extracts were analysed with gas chromatography coupled with mass spectrometry (GC/MS) in the selected ion monitoring mode (SIM).

3.5 Identification, quantification and expression of results

The identification of analytes was based on correct retention times and qualifier ion ratios, compared to an external standard. The quantification was based on an external standard analysed together with the samples. The recovery of the added internal standards was used to determine the performance of the analysis, but not to correct the results of the target compounds with the exception of the organotin compounds. In the latter case the results were corrected for the recovery of the internal standard.

The results in this report are expressed in pg/g serum (flame retardants) and ng/g serum (alkylphenols and phthalates).

When reading the tables of this report please note that while results are rounded to the correct decimal number, they are not always rounded to the correct number of significant units. In general, no more than two significant numbers apply.

In the tables, Belgian results are compared to Dutch blood analyses. Three percentiles (50th, 75th and 90th) are given to provide information about the shape of the distribution of these Dutch results. If the calculated percentile was smaller than the method detection limit, it was replaced by the method detection limit.

4 Results

4.1 General comments

The results of the Belgian samples are analysed in the following sections according to the chemical groups. In each table, the individual Belgian results are compared to the results from the Dutch analyses performed on 91 people, following the same methods as the present study (Peters, 2004). The Dutch mean value was not used for comparison as some abnormal values could disproportionately influence this mean. As some compounds were detected in only a few Dutch samples, the median value alone would not be appropriate for comparison since it would be below the detection limit. Thus, three percentiles including the 50th (median), 75th and 90th are given to provide information about the shape of the distribution of these Dutch results. The 50th, 75th and 90th percentiles are the concentration values that have, for the specified chemicals, 50%, 25% and 10% of higher concentrations, respectively.

4.2 Brominated flame retardants

Thirteen types of brominated flame retardants were determined. Four were present at levels above the detection limit in the blood of **Mr Trio**; three in the blood of **Mrs Huytebroeck** and **Mr Peeters**; and one in the blood of **Mr Lutgen** (Table 2). BDE-153 was found in all samples. This is consistent with the widespread presence of this compound in the Dutch population (84%) (Peters, 2004), and with an examination carried out by WWF that reported an omnipresence (100%) of BDE-153 in the blood of some European politicians (Thomas, 2004). The BDE-153 concentration found in the blood of **Mrs Huytebroeck** is higher than the Dutch median. This compound has also been detected in some Belgian dust samples (Al Bitar, 2004) and in computers (Peters, 2003b).

Both BDE-47 and BDE-100 that were also present in Belgian house dust were detected in the blood of **Mrs Huytebroeck**, **Mr Peeters** and **Mr Trio**. Their blood concentration in BDE-47 and BDE-100 were higher than the 75th percentile of the Dutch results, thus among the highest values measured in the Dutch population.

HBCD that was found in computers (Peters, 2003b) was detected in the blood of **Mr Trio** as well as in 12% of the Dutch samples (Peters, 2004).

Pg/g serum	E. Huytebroeck	K. Peeters	B. Lutgen	W. Trio	50 th percentile	75 th percentile	90 th percentile
BDE-17	<1	<1	<1	<1	<1	<1	<1
BDE-28	<1	<1	<1	<1	<1	<1	<1
BDE-47	9.7	5.1	<1	5.8	<2	4.4	9.4
BDE-49	<1	<1	<1	<1	<1	<1	<1
BDE-85	<3	<3	<3	<3	<3	<3	<3
BDE-99	<3	<3	<3	<3	<3	1.8	6.8
BDE-100	3	2.9	<2	37	<2	<2	5.8
BDE-153	8.3	3.6	3.1	3.1	7.5	9.9	22
BDE-154	<1	<1	<1	<1	<1	<1	3.1
BDE-183	<2	<2	<2	<2	<2	<2	2.2
BDE-209	<100	<100	<100	<100	<150	<150	174
HBCD	<80	<80	<80	112	<80	<80	114
TBBPA	<5	<5	<5	<5	<50	85	170

Table 2: Brominated flame retardant content in Belgian blood samples.

Individual results are compared to the 50th (median), 75th and 90th percentiles arising from blood analyses performed using the same method on 91 people in the Netherlands (Peters, 2004). The 50th, 75th and 90th percentiles are the concentration values that have 50%, 25% and 10% of higher concentrations, respectively.

Abbreviations: BDE-brominated diphenylethers (tribromo- to decabromo-), HBCD-hexabromo cyclododecane, TBBA-tetrabromobisphenol-A.

4.3 Phthalates

Six of the ten phthalates were detected in the blood of **Mr Peeters**; five in the blood of **Mrs Huytebroeck**; and four in the blood of **Mr Lutgen** and **Mr Trio** (Table 3). DEHP was present in all samples. The highest DEHP concentration, 206ng/g serum, was measured in the blood of **Mr Lutgen**, a concentration that is higher than the Dutch median. The pervasive presence of DEHP is consistent with the Dutch results (DEHP in 92% of the samples) and with the WWF studies (Peters, 2004; Thomas, 2004).

The DBP concentrations in the blood of **Mr Lutgen**, **Mrs Huytebroeck** and **Mr Peeters** ranged from 41 to 89ng/g serum. This range of values is higher than the Dutch 75th percentile. In **Mr Lutgen**'s blood, the DBP concentration is even among the top 10% of concentrations in the Dutch study.

These findings are not surprising since DEHP and DBP were also found in all the Belgian house dust samples (Al Bitar, 2004) and have been detected in consumer products such as body care products, cosmetics, pyjamas, air-fresheners, mobile phones, sports shoes, toys, mattresses or vinyl flooring (Peters, 2003a; Peters, 2003b; Pedersen and Hartmann, 2004).

DEP and DIBP were also found in all Belgian blood samples. The blood of **Mr Peeters** also contained 2 other phthalates that were widely found in Belgian house dust (Al Bitar, 2004): DOP and BBP, which was found at a considerably higher concentration (42ng/g serum) than the 90th Dutch percentile. BBP was also detected in textiles, mobile phones, sports shoes, mattresses and vinyl flooring (Peters, 2003a; Peters, 2003b; Pedersen and Hartmann, 2004).

Ng/g serum	E. Huytebroeck	K. Peeters	B. Lutgen	W. Trio	50 th percentile	75 th percentile	90 th percentile
DMP	<1	<1	<1	<1	<1	1.1	2.6
DEP	1	2.5	3.9	2.7	<2	<2	6.6
DIBP	9.7	19	16	7.7	<2	<2	52
DBP	59	41	89	6.8	8.1	19	63
BBP	1	42	<1	<1	<1	1.5	2.2
DCHP	<1	<1	<1	<1	<1	<1	<1
DEHP	148	64	206	11	151	550	1680
DOP	<1	1	<1	<1	<1	<1	<1
DINP	<10	<10	<10	<10	<10	<10	<10
DIDP	<10	<10	<10	<10	<10	<10	<10

Table 3: Phthalate content in Belgian blood samples.

Individual results are compared to the 50th (median), 75th and 90th percentiles arising from blood analyses performed, following the same method, on 91 people in the Netherlands (Peters, 2004). The 50th, 75th and 90th percentiles are the concentration values that have 50%, 25% and 10% of higher concentrations, respectively.

Abbreviations: DMP- dimethyl phthalate, DEP- diethyl phthalate, DIBP- di-iso-butyl phthalate, DBP- di-n-butyl phthalate, BBP- butylbenzyl phthalate, DCHP- dicyclohexyl phthalate, DEHP- di-(2-ethylhexyl) phthalate, DOP- di-n-octyl phthalate, DINP- di-iso-nonyl phthalate, DIDP- di-iso-decyl phthalate

4.4 Organotins

Seven organotin compounds were tested. Three were detected in the blood of **Mr Peeters** and one in the blood of **Mrs Huytebroeck** (Table 4). The measured concentrations are roughly in the range of those found in the Dutch blood with DOT and MOT concentrations in the blood of **Mr Peeters** that are higher than the Dutch 90th percentile (Peters, 2004). The MBT, MOT and DOT found in the blood of **Mr Peeters** and the DBT found in the blood of **Mrs Huytebroeck** were also detected in each Belgian house dust sample (Al Bitar, 2004). These chemicals have been found in sports shoes, mattresses, T-shirt, pyjamas or raincoats (Peters, 2003a; Peters, 2003b; Pedersen and Hartmann, 2004).

ng/g blood	E. Huytebroeck	K. Peeters	B. Lutgen	W. Trio	50 th percentile	75 th percentile	90 th percentile
MBT	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DBT	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TBT	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TeBT	<0.1	<0.1	<0.1	<0.1	/	/	/
MOT	<0.2	0.2	<0.2	<0.2	<0.1	<0.1	0.1
DOT	<0.2	1	<0.2	<0.2	<0.1	<0.1	0.4
TPT	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4

Table 4: Organotin content in Belgian blood samples.

Individual results are compared to the 50th (median), 75th and 90th percentiles arising from blood analyses performed, following the same method, on 91 people in the Netherlands (Peters, 2004). The 50th, 75th and 90th percentiles are the concentration values that have 50%, 25% and 10% of higher concentrations, respectively.

Abbreviations: MBT-monobutyltin, DBT-dibutyltin, TBT-tributyltin, TeBT-tetrabutyltin, MOT-monooctyltin, DOT-dioctyltin, TPT-triphenyltin

4.5 Alkylphenols and Bisphenol-A

Three phenol compounds were investigated. Two were detected in the blood of **Mrs Huytebroeck**, **Mr Peeters**, **Mr Lutgen** and **Mr Trio**: BPA and NP (Table 5). The Belgian values were similar to the highest Dutch concentrations. Each BPA and NP concentration was higher than the Dutch 75th percentile. Both BPA and NP were found in all Belgian house dust samples (Al Bitar, 2004). BPA was detected in feeding bottles while NP was found in toys, pyjamas, sports shoes, mattresses, paints and vinyl flooring (Peters, 2003a; Peters, 2003b).

ng/g serum	E. Huytebroeck	K. Peeters	B. Lutgen	W. Trio	50 th percentile	75 th percentile	90 th percentile
BPA	1.3	1.4	1.8	1.4	<0.5	1.1	2.5
OP	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
NP	1.1	2.3	1.3	3	<0.5	<0.5	1.2

Table 5: Alkylphenol and Bisphenol-A content in Belgian blood samples.

Individual results are compared to the 50th (median), 75th and 90th percentiles arising from blood tests performed, using the same method, on 91 people in the Netherlands (Peters, 2004). The 50th, 75th and 90th percentiles are the concentration values that have 50%, 25% and 10% of higher concentrations, respectively.

Abbreviations: BPA-bisphenol-A, OP-octylphenol, NP-nonylphenol

5 Conclusions

5.1 Individual results

- ◆ **Mrs Huytebroeck** carried eleven hazardous chemicals belonging to the following chemical groups in her blood: brominated flame retardants, phthalates, organotins and alkylphenols (Figure 1). All these chemicals but one had also been detected in the dust of her ministry in a previous investigation (Al Bitar, 2004). The highest concentrations in her blood were found for the phthalates DEHP and DBP, which are known developmental toxins, classified in Europe as “toxic to reproduction”. When compared to the Dutch blood investigation performed on 91 people, her DBP concentration was considerably higher than the 75th percentile, and so fell near the highest Dutch values. Mrs Huytebroeck was the only participant who carried detectable concentrations of the organotin DBT, in her blood. DBT is toxic to the developing immune and nervous system in mammals (Kergosien and Rice, 1998). Her blood also contained recognised and suspected endocrine disruptors such as nonylphenol and bisphenol-A at concentrations similar to the highest Dutch values.
- ◆ **Mr Peeters** carried fourteen hazardous chemicals belonging to the following chemical groups in his blood: brominated flame retardants, phthalates, organotins and alkylphenols (Figure 2). Most of these chemicals were widely detected in the Belgian house dust samples (Al Bitar, 2004). The highest concentrations in his blood were found for the phthalates DEHP, BBP and DBP, which are toxic to reproduction. Concentrations of DBP and BBP in his blood were considerably higher than the 75th percentile of the Dutch study and so were similar to the highest Dutch values. Another phthalate, DEP, which can affect the development of human sperm, was also present in Mr Peeters’ blood. His blood was the only Belgian sample to contain the organotins MBT, MOT and DOT. Recognised and suspected endocrine disruptors such as the nonylphenol and the bisphenol-A were also found in the blood of Mr Peeters, at concentrations higher than the Dutch 75th percentile.
- ◆ **Mr Lutgen** was found to carry seven hazardous chemicals belonging to the following chemical groups in his blood: brominated flame retardants, phthalates and alkylphenols (Figure 3). All but one of these chemicals were detected in all the Belgian house dust samples (Al Bitar, 2004). The chemicals present in the highest levels in his blood were the phthalates DEHP and DBP, which occurred at concentrations higher than the median concentrations in the Dutch study. Other hazardous phthalates such as DEP were also present in Mr Lutgen’s blood. Recognised and suspected endocrine disruptors such as nonylphenol and the bisphenol-A were also found in his blood, at concentrations higher than the Dutch 75th percentile.
- ◆ **Mr Trio** carried ten hazardous chemicals belonging to the following chemical groups in his blood: brominated flame retardants, phthalates and alkylphenols (Figure 4). All these chemicals have been found in Belgian house dust samples (Al Bitar, 2004). The highest concentration in his blood was found for the phthalate DEHP, which is toxic to reproduction. DEHP can interfere with testes development in mammals (Park *et al.*, 2002). Other developmental toxins found in Mr Trio’s blood include the phthalates DBP and DEP. DEP can affect the human sperm development. The concentration in the brominated flame retardant BDE-100 in his

blood was considerably higher than the 90th percentile arising from blood analyses performed on 91 people in the Netherlands and so was similar to the highest Dutch values. Mr Trio was the only participant whose blood contained the genotoxic brominated flame retardant HBCD. Recognised and suspected endocrine disruptors such as nonylphenol and bisphenol-A were also found in his blood at concentrations higher than the Dutch 75th percentile.

5.2 General Findings

Sixteen hazardous chemicals were found in the blood of the four participants in this study. All of these chemicals were detected in the dust of Belgian and European houses and offices, with most of them occurring in every dust sample (Santillo *et al.*, 2003a; Santillo *et al.*, 2003b; Al Bitar, 2004). Moreover, these 16 chemicals have also been detected in a wide range of consumer goods: feeding bottles, toys, paints, body care products, cosmetics, air fresheners, pyjamas, T-shirts, raincoats, sports shoes, mattresses, mobile phones and computers (Peters, 2003a; Peters, 2003b; Pedersen and Hartmann, 2004). Consequently, the results presented here provide strong evidence that the ongoing use of hazardous chemicals in consumer products is associated with the occurrence of some of these chemicals in the bodies of the general population. Although further study is needed regarding the ways in which people are exposed to these compounds, it is very likely that exposure occurs through inhalation, ingestion or direct skin contact with contaminated dust and consumer products.

The chemical concentrations found in this study are in the general range of those found in the blood of 91 volunteers from the Netherlands (Peters, 2004). These two studies have been performed according to the same protocol. All the detected concentrations are of concern given the intrinsic properties of the chemicals analysed, some of which have shown an exponential rise in concentrations in the tissues of the general population over the last 20 years (Meironyte *et al.*, 1999). As these chemicals can damage the hormone, immune or development systems or are toxic to reproduction, their presence in human blood is, at any concentration, of particular concern. This was also recently stressed by scientists and Nobel prize-winners, who recognised that the development of numerous current diseases can be a result of this chemical contamination, and that the health of adults, children and future generations is under serious threat (The “Paris Appeal”).

5.3 Regulation needed

The only way to end human contamination to hazardous chemicals is to adopt strong legislation that regulates the production and use of chemicals. The fact that the hazardous chemicals tested in this study are occurring in dust of ordinary homes and offices as well as in human bodies is a clear indication that current legislation to control such chemicals has failed. The European Union is preparing plans for the most comprehensive system of chemicals regulation yet seen. Known as Registration, Evaluation, and Authorisation of Chemicals (REACH), the regulation is currently being discussed by the European Parliament and Council and may become law by 2006.

Chemical industry representatives succeeded in getting the text for REACH dramatically watered down before the Commission launched its proposal, with the result that it currently largely ignores the substitution principle. This states that if there is a safer substitute for a hazardous chemical currently used in the manufacture of a product and if that substitute is available at reasonable cost, then the hazardous substance will no longer be permitted for that use and will be replaced by the safer alternative. This principle is essential to the effectiveness of the REACH system.

The present study has shown that Belgian environment ministers have hazardous chemicals in their blood. It is to be hoped that they will take into consideration their own test results, as well as the chemical contamination of the general population, and exercise their responsibility in leading the European Council to adopt an effective REACH legislation. It is also to be hoped that this study, together with the WWF study showing the levels of hazardous chemicals in the blood of various Members of the European Parliament (Thomas, 2004), will convince the European Parliament of the urgency to incorporate the substitution principle into REACH. This is the only way to ensure that European citizens of the future will not have to live with blood contaminated by hazardous chemicals.

6.QA/QC statement

TNO-MEP operates in compliance with the quality standard ISO 9001, certificate number 07246-2003-AQ-ROT-RvA. This examination was performed in accordance with that ISO-9001 accreditation.

7. Acknowledgements

Greenpeace Belgium is especially very grateful to Dr Hercot, Dr Brasseur and Dr Cazes for the blood collection.

Greenpeace Belgium also thanks Dr Pat Costner for her detailed review of this report and her fruitful comments and Dr David Santillo and Katharine Mill for their critical review.

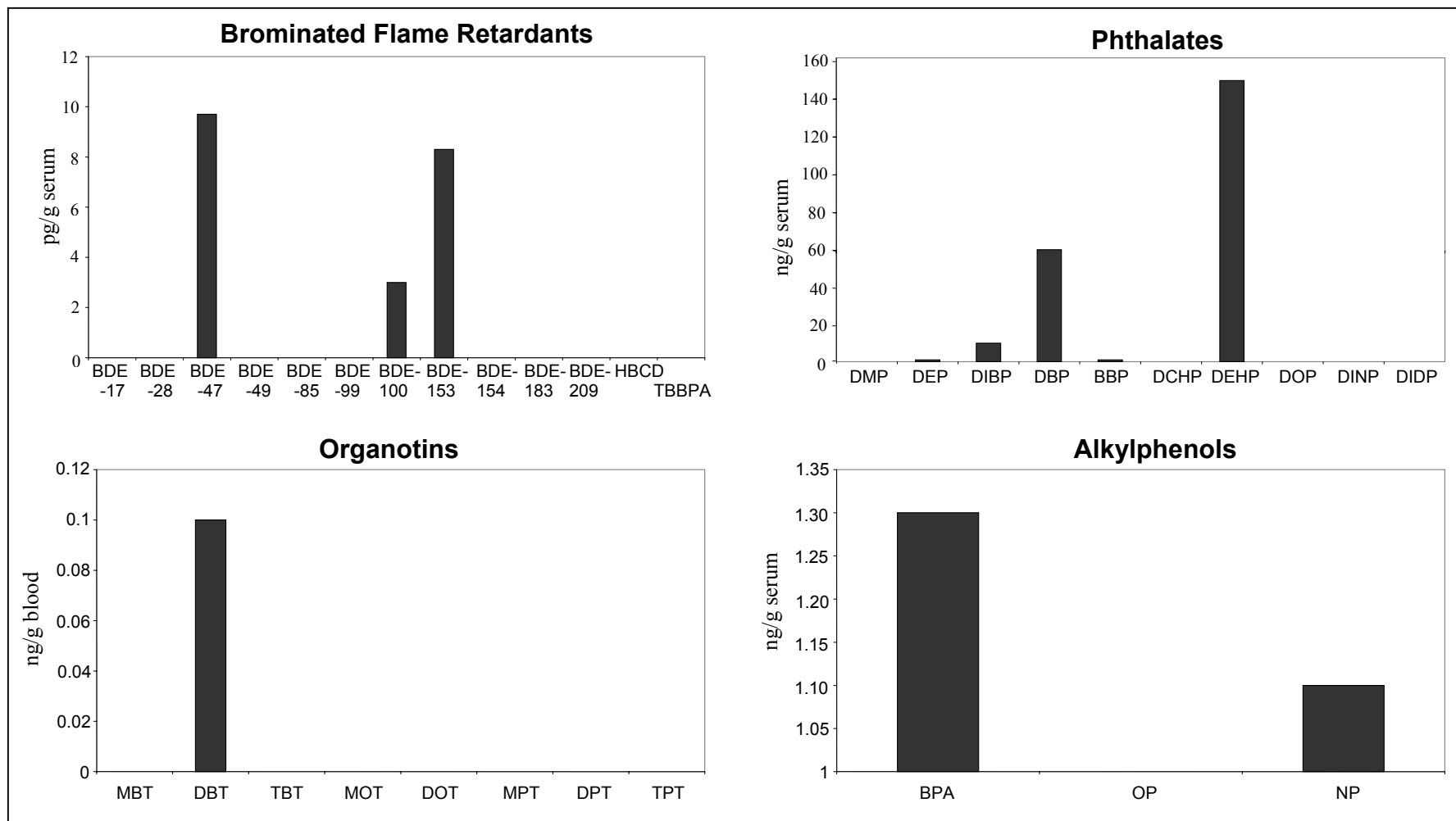


Figure 1: Chemical content in the blood of Mrs Huytebroeck, Environment Minister for Brussels.

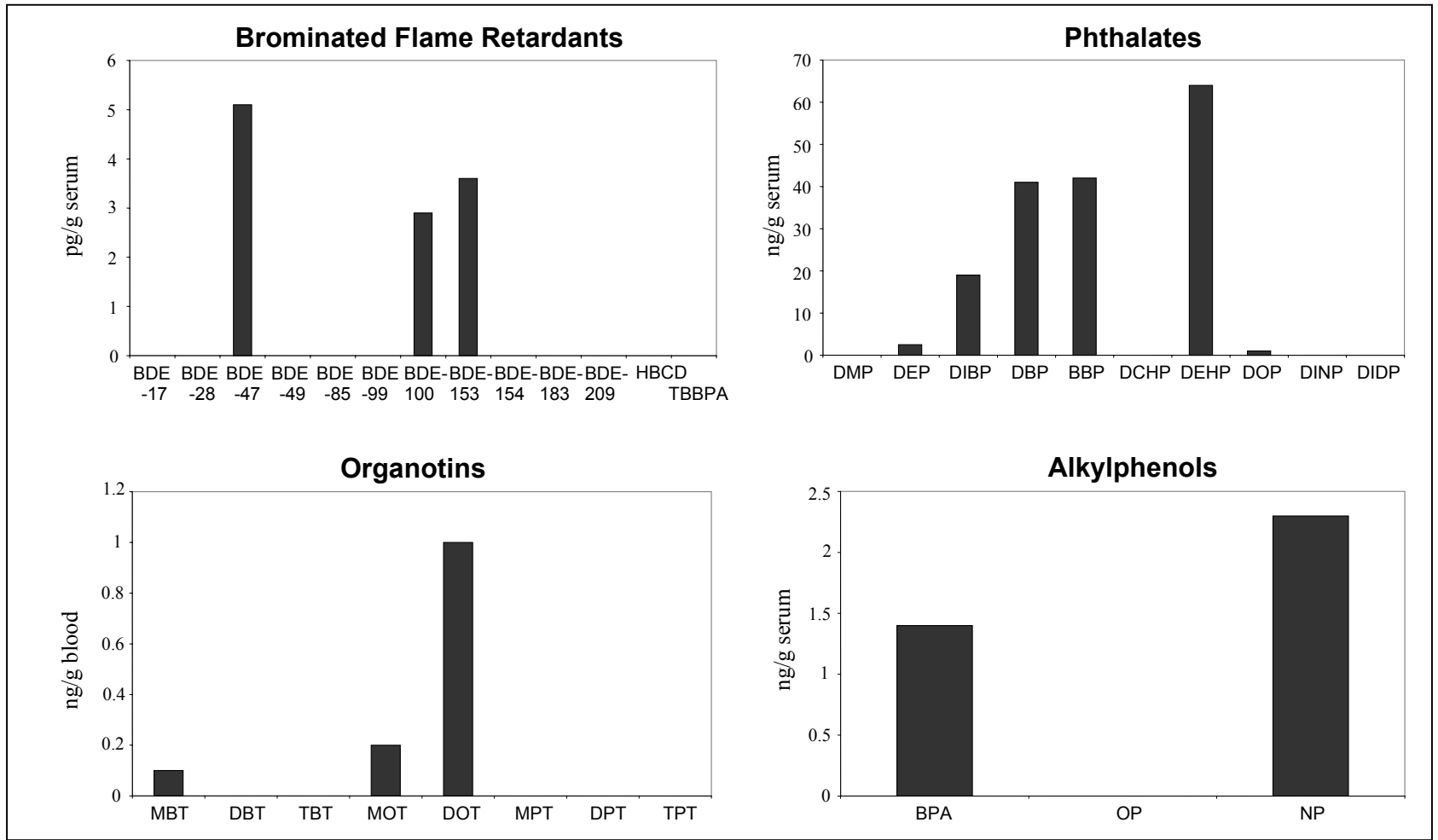


Figure 2: Chemical content in the blood of Mr Peeters, Environment Minister for Flanders.

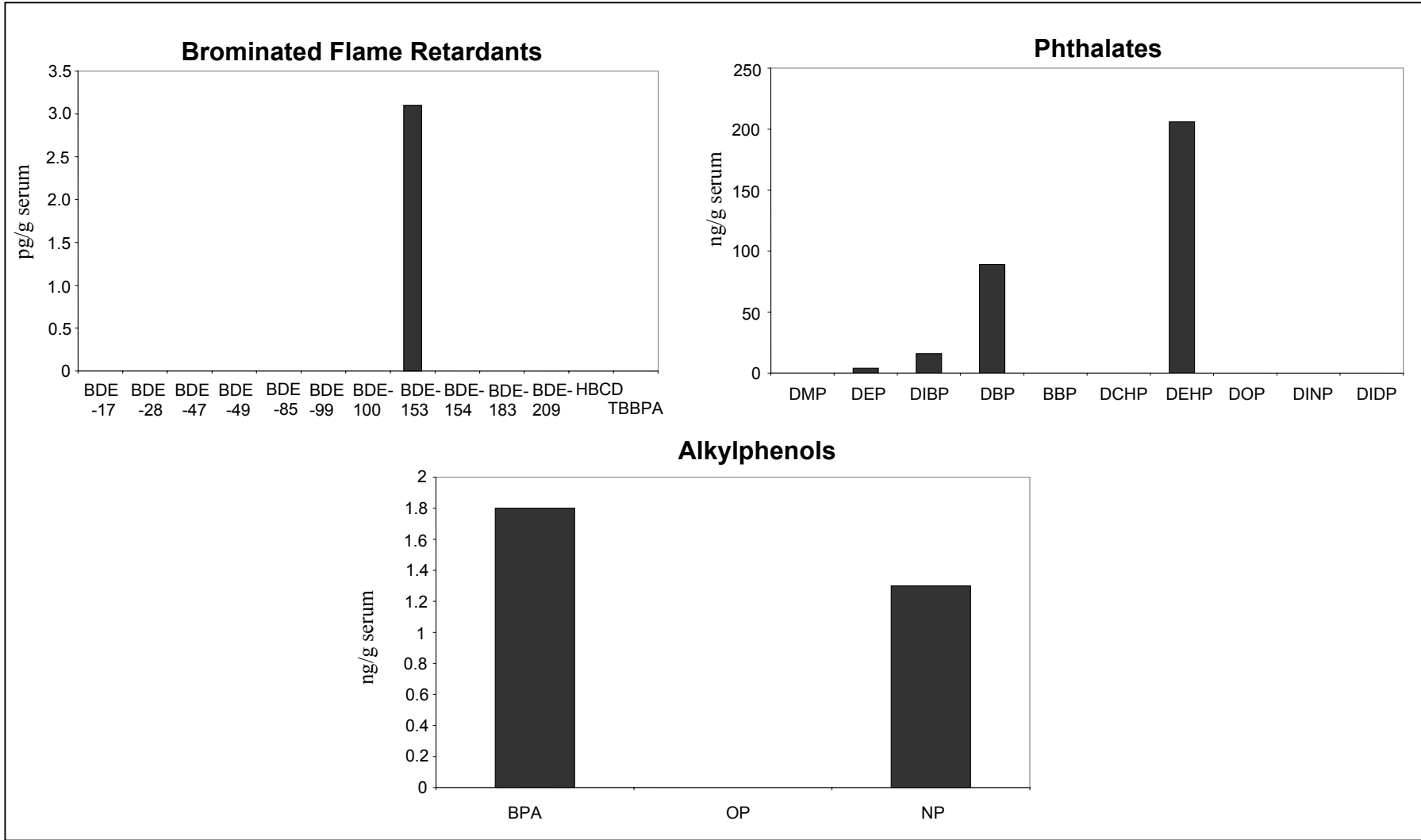


Figure 3: Chemical content in the blood of Mr Lutgen, Environment Minister for Wallonia.

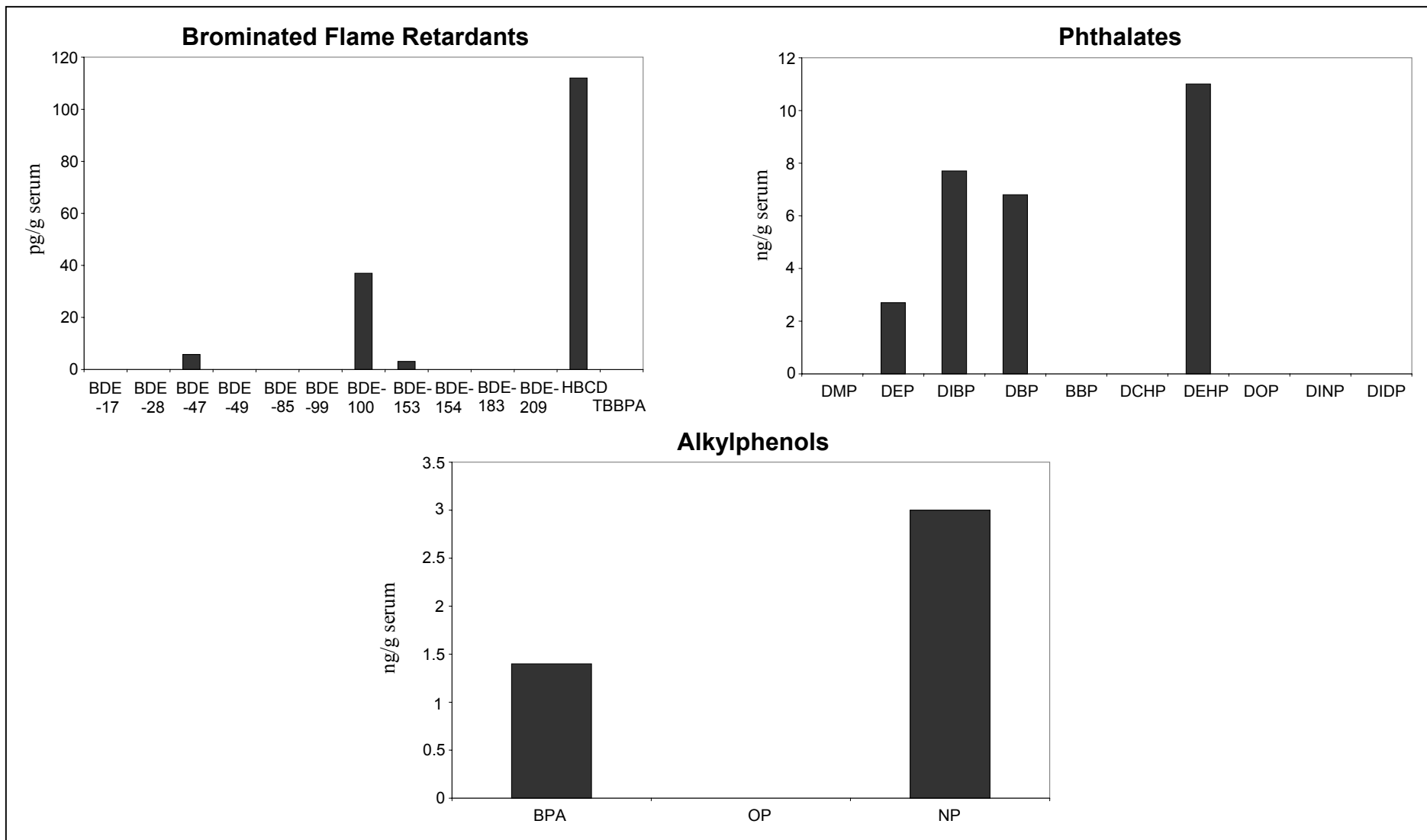


Figure 4: Chemical content in the blood of Mr Trio, Campaign Director of Greenpeace Belgium.

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Une publication de Greenpeace Belgique
Chaussée de Haecht 159 1030 Bruxelles
Téléphone: 02/274.02.00.
<http://www.greenpeace.be>