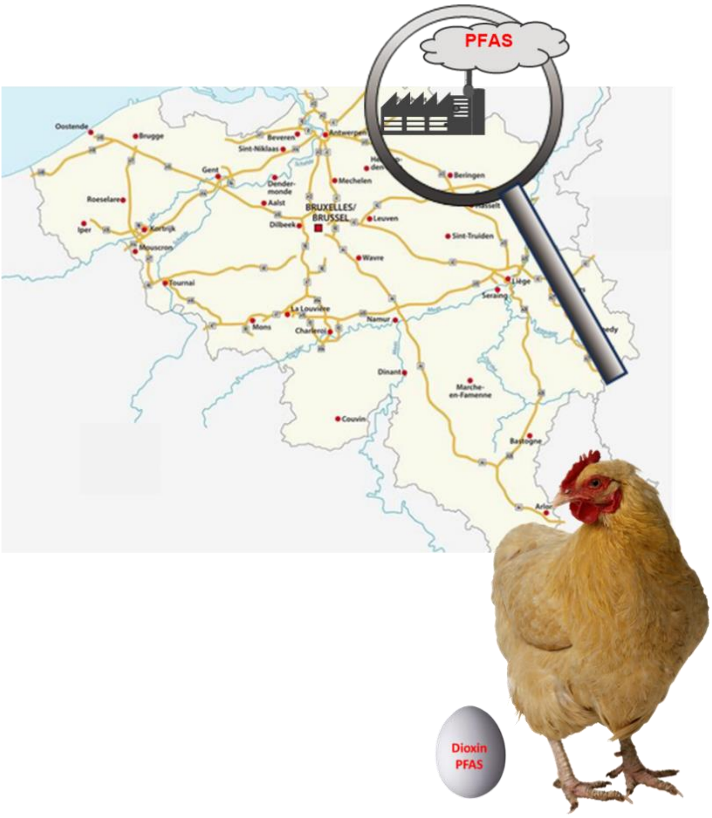
PFAS in eggs of backyard chicken
TW research Beringen, Belgium 2023



October 2023

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Thanks the local community group *Leefbaar Tervant* and participants of backyard chicken coop owners of Beringen.

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Client: Local community group *Leefbaar Tervant*

www.toxicowatch.org

List of abbreviations

Abbreviation	Description
AFFF	Aqueous Film Forming Foam (firefighting foam)
BEQ	Biological Equivalents
BMI	Body Mass Index
bw	Body weight
DR CALUX®	Dioxin Responsive Chemical-Activated LUciferase gene eXpression
ECHA	European Chemical Agency
EDI	Estimated Daily Intakes
EFSA	European Food and Safety Authority
EOF	Extractable Organic Fluorine
FITC-T4	Fluorescein IsoThioCyanate L-Thyroxine (T4)
FTOH	Fluorotelomers with an alcohol functional group
FOSE	Perfluorooctane sulfonamido ethanol
GC-MS	Gas Chromatography Mass Spectrometry GC-MS
GenX	Fluorochemicals related to hexafluoropropylene oxide dimer acid (HFPO-DA)
HDPE	High-density polyethylene
HFPO-DA	Hexafluoropropylene oxide-dimer acid (Gen-X)
LC-MS	Liquid Chromatography Mass Spectrometry GC-MS
LOD	Limit of Detection, detection limit
LOQ	Limit of Quantification
ng	Nanogram; 10^{-9} gram
PFAS	per- and polyfluoroalkyl substances
PFBA	perfluorobutanoic acid
PFBS	perfluorobutane sulfonic acid;
PFDoDA	Perfluorododecanoic acid is a dodecanoic acid (12-carbon chain). All the hydrogens attached to carbon atoms are replaced by fluorines.
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexane sulfonic acid
PFNA	perfluorononanoic acid
PFOA	Perfluorooctanoic acid
PFOS	PerFluoroOctane Sulfonates
pg	Picogram; 10^{-12} gram
PM	Particulate Matter (PM10), fine (PM2.5) and very fine (PM1.0)
POP	Persistent Organic Pollutants
RPF	Relative Potency Factors
T4	Thyroxine hormone 3,5,3′,5′-tetraiodo-L-thyronine
TDI	Tolerable Daily Intake
TOF	Total Organic Fluorine
TSH	Thyroid Stimulated Hormone
TTR	Thyroid transport protein (transthyretin)
TW	ToxicoWatch
TWI	Tolerable Weekly Intake
µg	Microgram 10^{-3} gram

Abstract

PFAS in eggs of backyard chicken

From 2019 to 2022, ToxicoWatch (TW) performed a multi-year biomonitoring study on dioxins (PCDD/F/dl-PCB) in eggs from hobby chickens in Beringen. Waste incineration as a possible source of PFAS contamination has not yet received much attention. PFAS is burned in large quantities in waste incinerators, as it is found in very many (household) products and packaging materials. PFAS cannot be eliminated in a WtE plant due to imperfect combustion temperatures and air filtration. However, PFAS emissions are not measured at waste incinerators. Studies in chicken eggs show a relationship between dioxins and PFAS. The more dioxins, the greater the PFAS contamination. TW, at the request of a local community group *Leefbaar Tervant* in Beringen, conducted an additional PFAS study at two sites, where most dioxins were found in eggs of backyard chicken in 2022.

Results

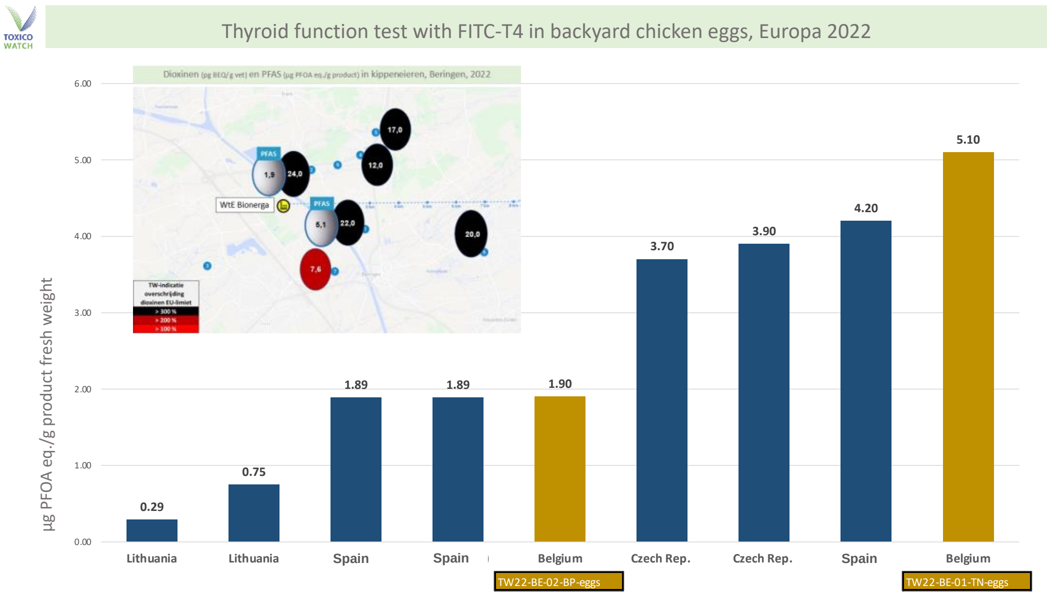
The results of PFAS in the eggs are 1.9 and 5.1 micrograms of PFOA equivalents per gram of product (µg PFOA eq./g product), analysed by FITC-T4 analysis method. The locations are direction NO and O-ZO from the incinerator in Beringen.

Conclusion

TW has conducted PFAS analyses on eggs of backyard chickens in Europe countries. All chicken eggs (10 eggs/location) were sampled at 500-3500 m from waste incinerators in Lithuania, Spain, the Czech Republic, and Belgium. The highest PFAS result was found in Beringen at a site 2900 m (O-SE) from the newly built waste incinerator Bionerga in Belgium. This result is significantly higher than what was measured in chicken eggs 1000 m away from one of the largest and oldest waste incinerators in Europe, i.e. Valdemingómez in Madrid, Spain.

Recommendation

More research is needed to determine whether waste incineration is the cause of this PFAS contamination. A follow-up study on PFAS in vegetation and chicken eggs at several locations in Beringen is recommended. The PFAS values found in eggs can be tested against the current EFSA (European Food and Safety Authority) safety standard, although it is based on only 4 PFAS substances. According to the latest findings, there are thought to be more than 7 million PFAS compounds. PFAS is related to thyroid problems, infertility, cardiovascular diseases, and even neurodegenerative disorders such as Alzheimer's disease. Newborns are at greater risk of exposure to PFAS due to the placenta, breast milk and even household dust.



Applying the analysis method of FITC-T4 contributes to a faster determination of the toxicity of the vast amount of PFAS compounds. These toxicities will otherwise remain out of the scope if only the focus is on the EFSA-4 PFAS and the limited chemical analysis for PFAS to rely on.

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Introduction

Incineration of (household) waste by waste incinerators is considered a sustainable and circular economy, in part due to energy generation which is usually supplied to adjacent businesses, industries or households. The guidelines and control of emissions of persistent organic pollutants (POPs), such as dioxins (PDCC/F/dl-PCB) from waste incineration, are laid down in the Basel, Rotterdam, and Stockholm Convention commitment documents (BRS COPs), as part of the United Nations Environment Programme (UNEP), and the European Industrial Emissions Directives (IED). In these still valid EU regulations, measuring only 2 x 6 hours (0.1% per year) is all that is required to preserve the license to operate production. Measurements are announced in advance and performed under the most ideal conditions. For new waste incinerators built after 2019, there is a requirement for semi-continuous measurement of dioxin emissions (PCDD/F/dl-PCB) of the flue gasses in the stack. This involves sampling with a probe/tube of at least 6 millimetres in a chimney of about 2.5 metres on average. The mandatory publication of emission data from these EU-required measurements are summaries and do not reflect the actual production process. The so-called raw minute data show the production process including technical failures in the air purification control and the entire combustion process. It is recommended to have these original, raw minute measurement data analysed and published by an independent expert organisation as a standard to achieve an objective assessment of whether the waste incinerator meets environmental requirements.

TW has performed research at two waste incinerators, namely: REC in Harlingen, the Netherlands and Ivry-Paris XIII in Paris, France. Both studies are based on provided minute data of more than 20,000 hours for the REC/NL (2015-2017) and 35,000 hours for IPXIII/Paris (2020-2021). In these two technical research by ToxicoWatch, concerning the semi-continuous measurements of these waste incinerators, it is found that frequent failures in the combustion process, Other Than Normal Operating Conditions (OTNOC), occurred. The technical measuring and sampling equipment appears to fail for various reasons, missing essential data on emissions data, as the technical data in these periods shows. The TW study of emissions REC/NL (2017) reveals that these events of malfunctions and failure of the measurement equipment appear to be precisely the moments when emissions of dioxins and POPs might have been released into the environment. In the Netherlands, REC, dioxins were measured in a few hours during a start-up, comparable with the annual load of dioxins under normal undisturbed waste incineration. If a waste incinerator is not functioning properly, this leads to emissions of Substances of Very High Concern (SVHC). In a relatively short period, large amounts of toxic substances such as PFAS and dioxins can be emitted in the event of incomplete combustion and shutdown of one or more filter components, also mentioned as OTNOC. This report takes a closer look at PFAS emissions through analysis of backyard chicken eggs in Beringen, Belgium.

1. PFAS sources

TW biomonitoring study 2019-2022 of dioxins in backyard chicken eggs in and around Beringen show analysis results of dioxins (PCDD/F/dl-PCB) in high concentrations by as well bioassay DR CALUX as the chemical analyses GC-MS. Incineration of household waste under normal conditions not only emits chlorinated dioxins but also other substances of very high concern (SVHC). Figure 1.

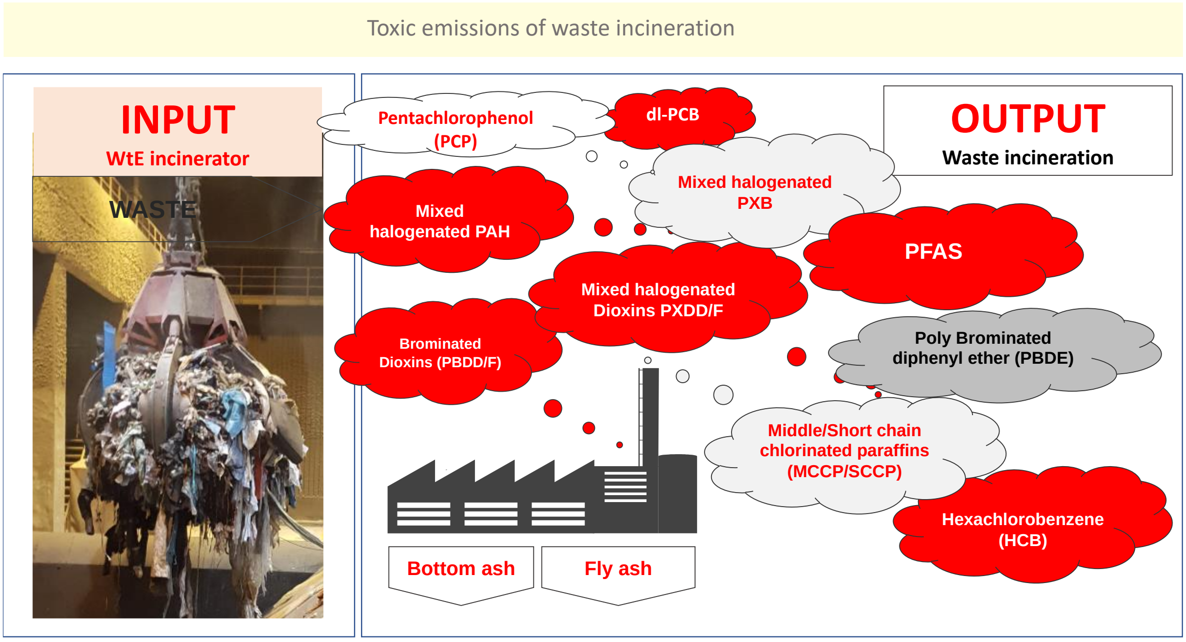

Figure 1: Toxic emissions and residual waste of waste incinerators

Industrial emission sources of PFAS are more and more in the headlines as this contamination is observed in soil and water, such as Chemours in Dordrecht (NL) and the 3M industry in Zwijndrecht (Belgium). The role of Waste-to-Energy (WtE) waste incineration residues as a secondary source of PFAS emissions has hardly come to the attention yet and needs further research. An investigation by the Environment and Transport Inspectorate (ILT) Netherlands (12-10-2023) alerts about the inability of waste incinerators to process PFAS effectively and the lack of monitoring of PFAS-containing waste.[1] TW research in 2018 showed PFOA and PFOS in waste incinerator emissions.[2] PFAS is also found in high concentrations in residues such as fly ash and bottom ash.[3] PFAS emissions related to waste incineration have now, anno 2023, also been confirmed by Björklund.[4] TW has pointed out in its presentations and reports the incomplete combustion of POPs due to inadequate waste gas air purification techniques.[5,6] Structural control of these emissions, especially PFAS, should be included in Basel and Stockholm Regulation of toxic emissions from such thermal installations as waste incinerators and biomass without delay.

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[1] https://www.ilent.nl/documenten/leefomgeving-en-wonen/afval/afvaltransport-evoa/signaalrapportages/meer-grip-op-pfas-in-afval-nodig

[2] *Arkenbout, A. (2018). Long-term sampling emission of PFOS and PFOA of a Waste-to-Energy incinerator. ToxicoWatch. 3p. http://dx.doi.org/10.13140/RG.2.2.14281.19046*

[3] *Liu, S.et al. (2021. Perfluoroalkyl substances (PFAS) in leachate, fly ash, and bottom ash from waste incineration plants: implications for the environmental release of PFAS. Sci. Total Environ. 2021, 795, No. 148468*

[4] *Björklund S. et al (2021). Emission of Per- and Polyfluoroalkyl Substances from a Waste-to- Energy Plant. Occurrence in Ashes, Treated Process Water, and First Observation in Flue Gas, Environ. Sci. Technol. 2023, 57, 10089−10095*

[5] *Arkenbout, A, Bouman KJAM, 2018. Emissions of dl-PCB, PBB, PBDD/F, PBDE, PFOS, PFOA, and PAH from a waste incinerator, poster Dioxin2018, https://www.toxicowatch.org/_files/ugd/8b2c54_cbc72aef99e549049030d4309097ebab.pdf*

[6] https://dioxin20xx.org/wp-content/uploads/pdfs/2019/1069.pdf

A Dutch study at 64 sites of eggs from backyard chicken eggs found a linear relationship between dioxins and PFAS (Zafeiraki).[7] The more dioxins, the greater the PFAS contamination. The TW biomonitoring results (2019-2022) in several European countries demonstrate, that research on waste incineration as a source of PFAS contamination should receive much more attention and research. However, to get a complete picture of current PFAS contamination, one must consider the limited chemical analysis capabilities. There is an urgent need to introduce analytical methodologies that measure the total toxicity that mankind now faces. And these are available in the form of bioassays. EU food and environment laws and regulations, on the advice of the European Food and Safety Authority (EFSA), are based on only four (4) PFAS compounds. Gen-X, for example, is not included in this EU PFAS limit, even though this toxic compound is frequently found in the environment. This substance was presented by the industry at the time, as a substitute for the toxic PFOS. However, Gen-X also turns out to be (even more) toxic, making it yet another example of a '*regrettable substitute*'. Applying the bioassay FITC-T4 analysis method as initial screening can help to detect contaminations more quickly, which will otherwise remain out of scope for too long if only chemical analysis is relied on.

PFAS is primarily analysed chemically by liquid chromatography (LC/LCMS). According to the most recent calculation, humanity is now faced with more than 7 million PFAS compounds.[8] Most laboratories offer a package for analyses of 24 (exceptions up to 100+) fluorine compounds. EFSA has recommended a PFAS standard for the EU based on 4 PFAS compounds (EFSA-4), namely: PFOA, PFOS, PFHxS and PFNA, Figure 2.

Other PFAS analysis methods are:

a. Total Oxidisable Precursor (TOP) test
b. Extractable Organic Fluorine (EOF)
c. Bioassays PFAS CALUX and FITC-T4.

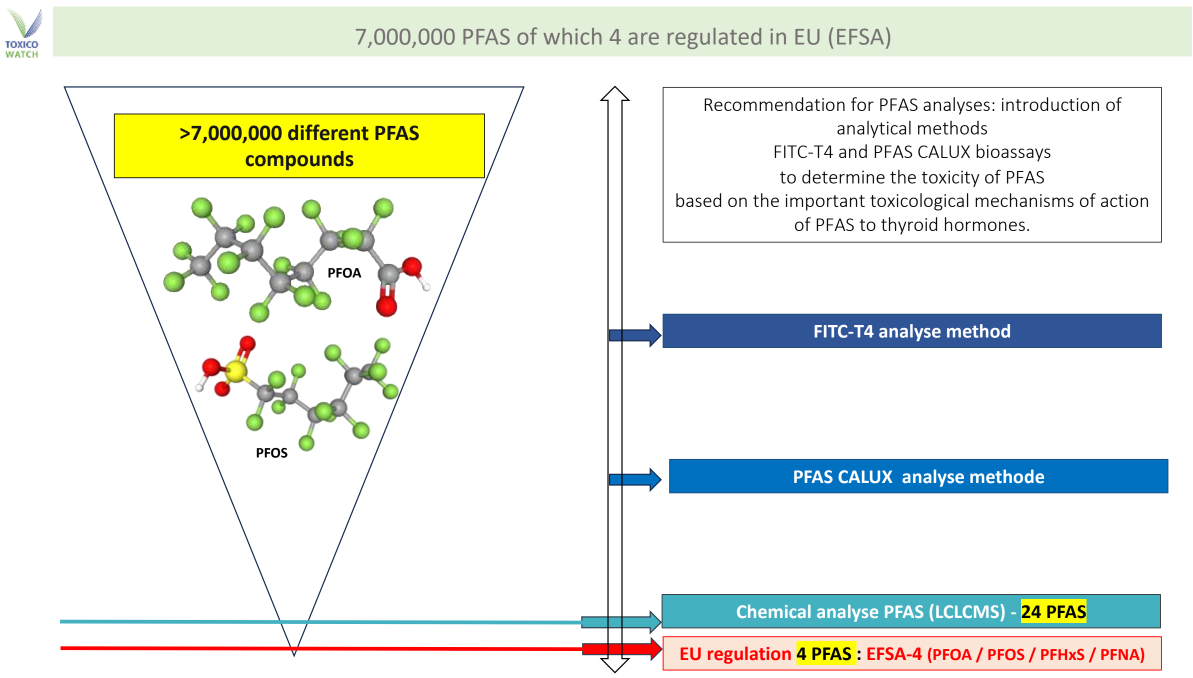


Figure 2: Schematic representation of a large amount of PFAS compounds and the limitations of the chemical analyse method.

[7] *Zafeiraki E, et al. (2016). Perfluoroalkylated substances (PFASs) in home and commercially produced chicken eggs from the Netherlands and Greece. Chemosphere. 2016 Feb; 144:2106-12*

[8] *Schymanski EL. (2023). Per- and polyfluoroalkyl substances (PFAS) in PubChem: 7 million and growing. https://doi.org/10.26434/chemrxiv-2023-j823z*

2. Research method

The eggs of backyard chickens are important biomarkers of POPs in studies of industrial emissions, such as those from waste incinerators. Backyard chickens consume small invertebrates, natural vegetation, seeds, soil, and water and breathe ambient air. Chickens with such optimal contact with the environment reveal environmental contamination through examination of the eggs laid, Figure 3.

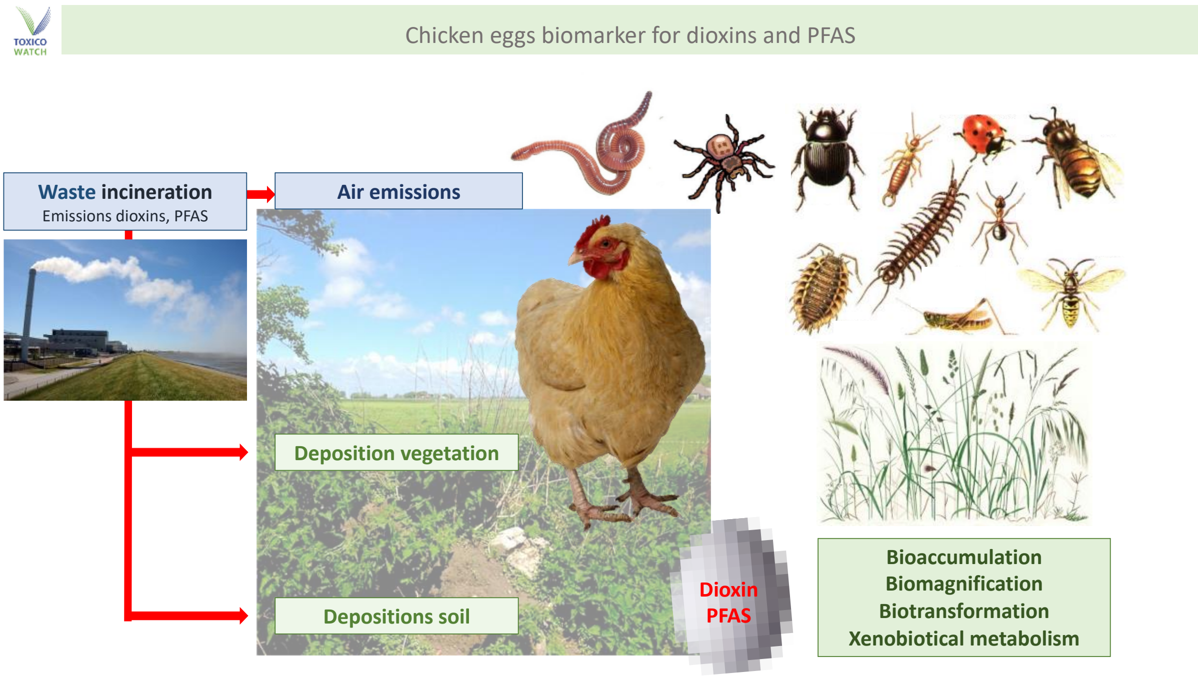


Figure 3: Chicken eggs as a biomarker for dioxins and PFAS.

In this research two (2) sites, at 1790 m, (Location A, wind direction NO) and 2900 m, (Location B, wind direction O-SE) distance from the Bionerga waste incinerator in Beringen, eggs were sampled and analysed on PFAS by using the bioassay analysis method FITC-T4. From both locations, A and B, 10 fresh egg samples were taken on 17-18 October 2022. Ten (10) eggs per site were mixed into one homogeneous liquid egg sample (yolk + egg white), divided into two equal amounts, as a laboratory sample and a reserve lab sample and stored/frozen in HDPE containers. The backup egg samples from two locations A and B were analysed for PFAS by BioDetection Systems, in Amsterdam, the Netherlands.

FITC-T4 is the acronym for Fluorescein IsoThioCyanate (FITC) and T4 refers to the thyroid hormone Thyroxine, which contains 4 iodine elements (T4). The PFAS bind to the thyroid transporter protein transthyretin (TTR), preventing the natural hormone thyroxine (T4) from binding to TTR. This free unbound hormone thyroxine (T4) is a measure of the amount of PFAS. Analysis results with the FITC-T4 are expressed in **micrograms of PFOA equivalents per gram of product (µg PFOA eq./gr product)**. FITC-T4 is applied for screening for PFAS, but also for other toxic substances, such as tetrabromobisphenol-A (TBBPA), phthalates and Polybrominated diphenyl ethers (PBDEs). These also have disruptive effects on the thyroid gland in humans. Another bioassay is the PFAS-CALUX, this more sensitive test, which is estimated to be 10% non-PFAS-related substances.[9]

[9] *Besselink H. (2019). Testing the PFC CALUX® bioassay for monitoring the effects of PFAS, report no bds-php18240-rap3-final-hb.*

3. Results PFAS in eggs of backyard chicken

PFAS results of backyard chicken eggs at the two (2) locations in Beringen with the bioassay FITC-T4 are for Location A (TW22-BE-02-BP-eggs:) **1.9 µg PFOA eq./gr product** and for Location B (TW22-BE-01-TN-eggs): **5.1 µg PFOA eq./gr product.** Toxicity is expressed in terms of relative toxicity to PFOA, the most common and investigated PFAS substance. Below is an explanation of how to interpret these two (2) results.

Figure 4 is an overview of PFAS biomonitoring results on backyard chicken eggs performed with the FITC-T4 by TW in different European countries in 2022. All chicken eggs (10 eggs/location, processed into an analytical sample as described under research method on page 9) were sampled at 500-3500 m around waste incinerators in Lithuania, Spain, Spanish Basque Country, Czech Republic, and Belgium. The highest PFAS result was found in Beringen at chicken egg Location B at 2900 m (O-SE) from the newly built waste incinerator Bionerga in Belgium. This result is significantly higher than measured in chicken eggs 1000 m away from one of the largest and oldest waste incinerators in Europe, i.e. Valdemingómez in Madrid, Spain. At Locations A and B, the highest values of dioxins (PCDD/F/dl-PCB) were found in the TW biomonitoring study, Beringen 2019-2022, both with the bioassay DR CALUX analysis and the chemical analysis (GC-MS). Therefore, the reason this additional study on PFAS in backyard chicken eggs in Beringen was undertaken at these two locations.

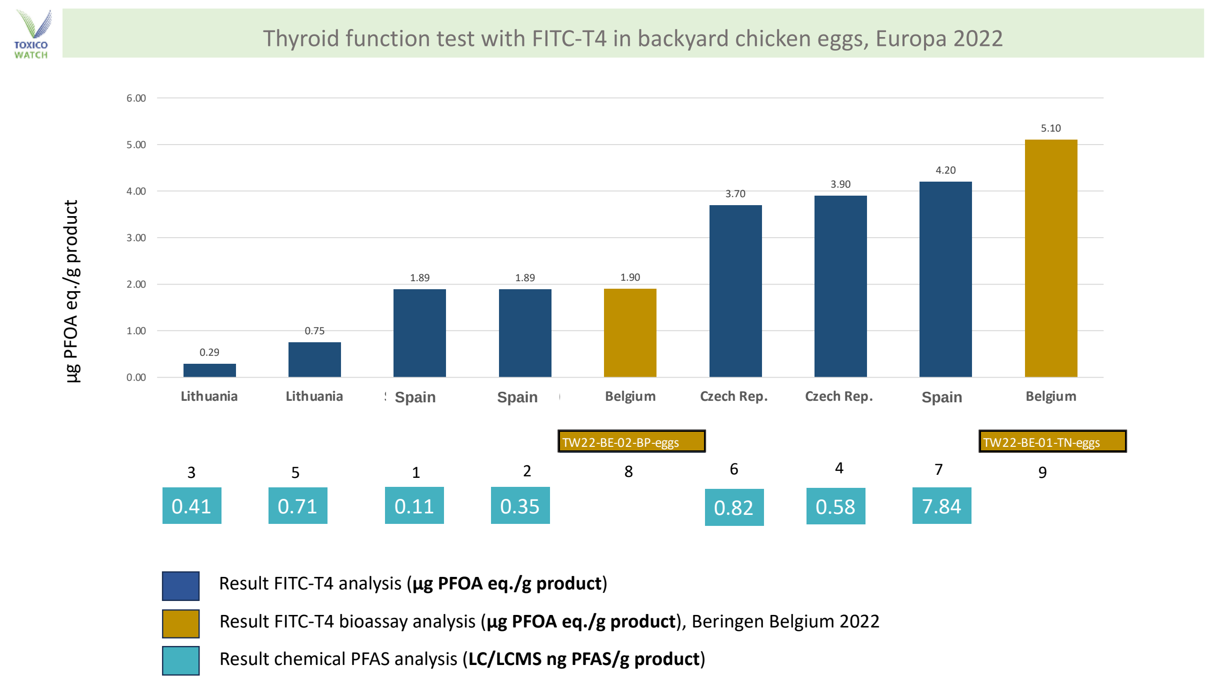


Figure 4: Thyroid disruption measured with bioassay FITC-T4 in eggs from hobby hens, Europe 2022

3.1 EFSA food safety standard for PFAS

The EFSA food safety standard for PFAS, known as EFSA-4, has been set at 4 PFAS compounds (PFOA, PFOS, PFHxS, PFNA) by 2023. This standard is set by EFSA at 4.4 ng PFAS/kg bw/week, or **4.4 nanograms PFAS per kilogram of body weight (body weight/bw) per week**. The development of PFAS/PFOA regulation by the European Food & Safety Authority, EFSA is moving fast. In a time of 12 years, it has been adjusted downwards by a factor of 2386. See Figure 5.

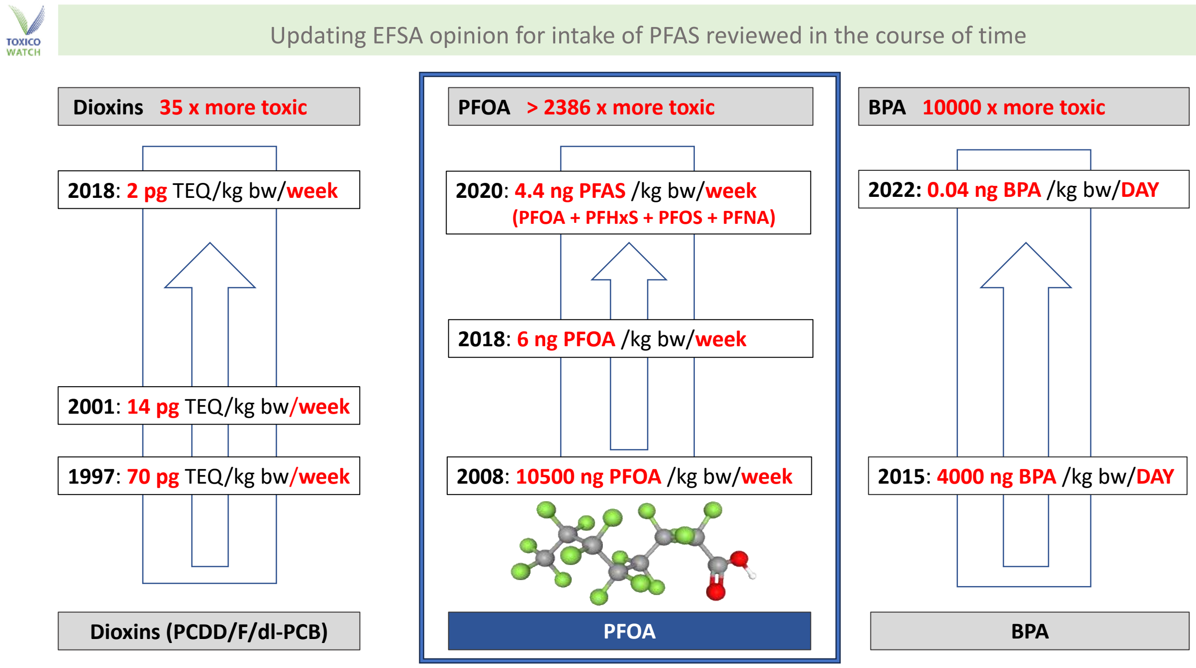


Figure 5: Updating EFSA opinion for PFAS intake reviewed over time.

Regulation is currently based on the extremely limited capabilities of chemical analyses with liquid chromatography (LC/LCMS) comparing to the many (>7 million) estimated PFAS compounds. In the Netherlands, water quality is analysed with a full set of bioassays, such as FITC-T4 and PFAS CALUX. It is a strong recommendation, to deploy bioassays, which measure total toxicity of PFAS, to be applied for environmental contamination and food safety determination. Several studies indicate the importance of the disruptive influences of PFAS on thyroid hormone.[10] Bioassay testing combined with performing chromatographic fractionation and then chemical analysis on active fractions is known as effect-directed analysis (EDA). It is ideally an approach used to reduce the complexity of environmental samples and to identify chemicals responsible for these bioassay effects. [11,12]

[10] *Ouyang X. et al (2017). Miniaturization of a transthyretin binding assay using a fluorescent probe for high throughput screening of thyroid hormone disruption in environmental samples, Chemosphere, Volume 171, 2017, Pages 722-728*
[11] *Schepper de, J. K. H. et al. (2023). The contribution of PFAS to thyroid hormone-displacing activity in Dutch waters: A comparison between two in vitro bioassays with chemical analysis. Environment International, 181, 1-11. Article 108256*
[12] *Jonkers, T.J.H., et al. (2022). High-performance data processing workflow incorporating effect-directed analysis for feature prioritization in suspect and nontarget screening. Environ. Sci. Technol. 56, 1639–1651.*

3.2. PFAS in vegetation and backyard chicken eggs

Figure 6 sets out the results of TW biomonitoring research in Europe (2019-2022) with the FITC-T4 analyse method. Noteworthy are the higher values of PFAS found in vegetation (pine needles, tree leaves, and mosses) compared to the results found in eggs of backyard chicken. These backyard chickens are often supplemented with chicken laying pellet feed as well with grains, grain mix, and daily food residues, according to the returned TW questionnaires from participants, which may also influence analytical results in the eggs. In a Danish study, PFAS contamination in eggs is attributed to chicken feed.[13] In the multi-year TW biomonitoring research in several countries in Europe in 2019-2022, both eggs from hobby chickens and vegetation (pine needles, moss) were sampled at the same sample locations. The analysis results of both biomarkers, backyard chicken eggs and nearby vegetation on the same location are often synchronous. From this, it can be concluded for those locations, that the chicken feed cannot be the source of contamination during those sampling periods. The TW results of PFAS on vegetation in the vicinity of waste incinerators clearly show that there is more going on than a regional PFAS contamination from, for example, fishmeal in chicken feed, according to analyses of dioxins (PCDD/F/dl-PCB), PAHs and PFAS in TW biomonitoring studies on vegetation and backyard chicken eggs from the same site.

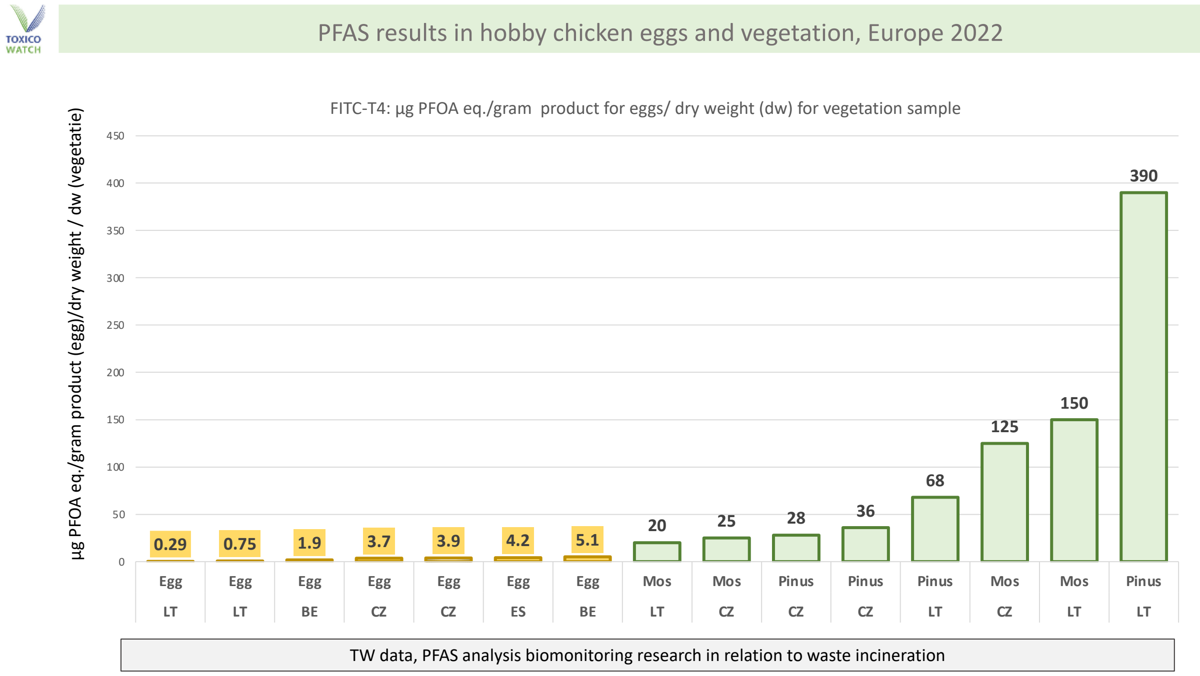


Figure 6: PFAS-resultaten in eieren van hobbykippen en vegetatie, Europa 2022

In the Netherlands, residents of a large area around the Chemours PFAS industry are recommended not to eat fruit and vegetables from their vegetable garden.[14,15] Important to mention that the results of this study cannot be addressed as just "An egg problem", as TW highlighted in other similar biomonitoring studies. The backyard chicken eggs are an indicator of environmental health. TW recommends a continuation of the biomonitoring study on backyard chicken eggs in Beringen, sampling not only vegetation (pine needles, moss) but also local kitchen garden vegetables and agricultural products grown in and around Beringen.

[13] *https://www.food.dtu.dk/english/newsarchive/2023/01/pfas-found-in-organic-eggs-in-denmark*
[14] *https://www.rivm.nl/publicaties/herziening-risicobeoordeling-genx-en-pfoa-in-moestuingewassen-in-dordrecht-papendrecht-en-sliedrecht*
[15] *Boon PE. (2022). Risicobeoordeling van PFAS in moestuingewassen uit moestuinen in de gemeenten Dordrecht, Papendrecht, Sliedrecht en Molenlanden, RIVM-briefrapport 2022-0010*

4. Health risks PFAS

The European Food and Safety Authority (EFSA) concluded in 2018 that a large proportion of the European population exceeds the tolerable weekly intake (TWI) of PFAS.[16] This conclusion is based on only 4 PFAS compounds, EFSA-4: (PFOA, PFOS, PFHxS and PFNA), which, as pointed out here in this report, are only a minuscule part of the total PFAS burden of many millions of fluorine compounds that we all face today through use of products, packaging materials, food, water and soil (see Figure 7). Like dioxins, PFAS represent persistent organic compounds, Persistent Organic Pollutants, (POPs), which are hardly degradable and reside in the human body for a long time. Toxic phenomena often only appear later measured.

For a long time, PFAS has been very evidently associated with worldwide thyroid problems, obesity, diabetes, and insulin resistance. [17] There is a relationship between immunotoxicity [18] and the declining efficacy of vaccines according to EU reporting.[19] An increase in cardiovascular disease has also been found to be linked to PFAS exposure. Several studies point to changes in lipid and glucose metabolism and increased blood pressure as possible links to cardiovascular thromboembolic events.[20] Children are at greater risk of exposure because PFAS are transmitted through the placenta and postnatal sources of breast milk and house dust.[21] Even neurodegenerative diseases like Alzheimer have a relationship with PFAS exposures.[22] PFAS causes male infertility by reducing sperm quality, testicular volume, and even penile length.[23] Neonatal mortality is also associated with PFAS contamination as well as deficiency of development in new-born babies.[24] The list of damage caused by PFAS seems to get longer every day, numerous studies show.

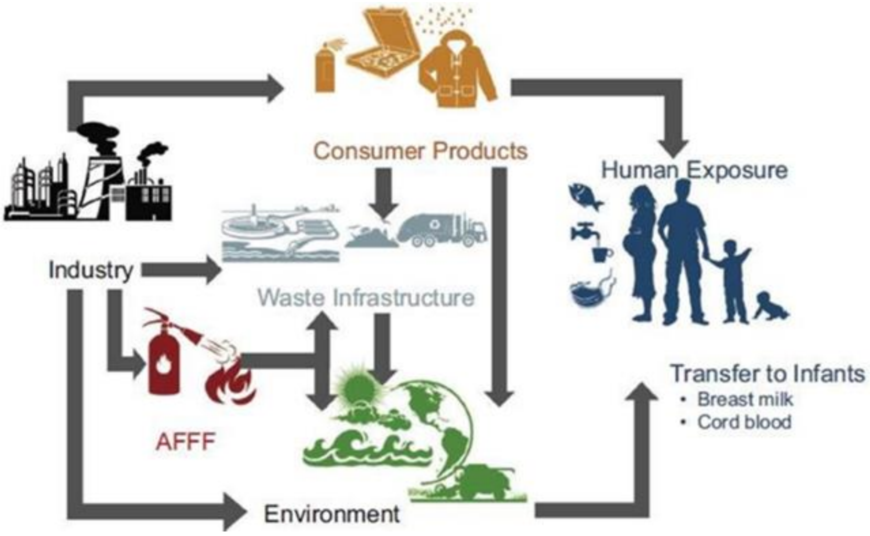


Figure 7: PFAS exposure pathways to the human population and the environment (Sunderland et al. 2019

[16] https://ec.europa.eu/environment/pdf/chemicals/2020/10/SWD_PFAS.pdf
[17] *Young, A.S. et al. (2021). Env. Health Perspect. 129 (4), 047010-1 to 047010-13.*
[18] *Corsini, E., et al., Perfluorinated compounds: Emerging POPs with potential immunotoxicity. Toxicol. Lett. (2014)*
[19] *Grandjean P, Andersen E, Budtz-Jørgensen E, et al. Serum vaccine antibody concentrations in children exposed to perfluorinated compounds. JAMA. 2012; 307:391–7.*
[20] *Meneguzzi A, et al. (2021) Exposure to Perfluoroalkyl Chemicals and Cardiovascular Disease: Experimental and Epidemiological Evidence. Front. Endocrinol. 12:706352.*
[21] *Wang et al (2019). Inactivation of common airborne antigens by perfluoroalkyl chemicals modulates early life allergic asthma. PNAS 2021 Vol. 118 No. 24 e20119571*
[22] *Zhang, Qian et al. "Developmental perfluorooctane sulfonate exposure results in tau hyperphosphorylation and β-amyloid aggregation in adult rats: Incidence for link to Alzheimer's disease."* Toxicology *347-349 (2016): 40-6*
[23] *Di Nisio A. et al. (2018). Endocrine disruption of androgenic activity by perfluoroalkyl substances: clinical and experimental evidence, The Journal of Clinical Endocrinology & Metabolism; Copyright 2018 DOI: 10.1210/jc.2018-01855*
[24] *DeWitt, Jamie. (2015). Toxicological Effects of Perfluoroalkyl and Polyfluoroalkyl Substances. 10.1007/978-3-319-15518-0.*

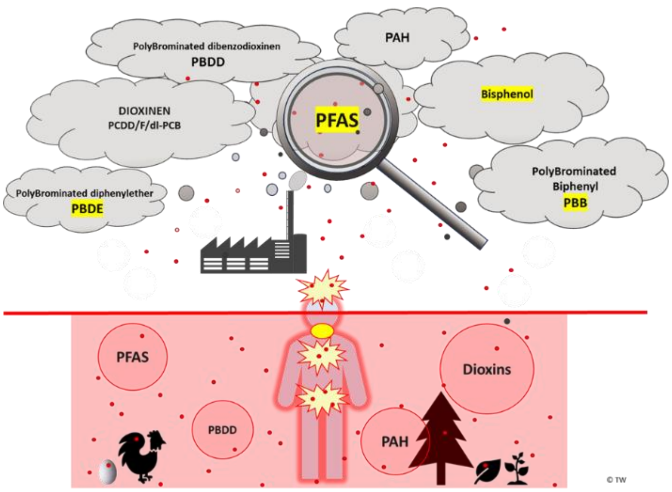
5. Conclusion

This report places the PFAS results in eggs from backyard chickens in Beringen in context with previously published TW biomonitoring studies about emissions of waste incineration. At two locations of these biomonitoring studies in Beringen, a local community group *Leefbaar Tervant* commissioned an additional PFAS study was conducted on the chicken eggs, sampled in October 2022.

The dioxins detected in the eggs of backyard chickens and at various other locations have been increasing in an upward trend since the Bionerga waste incinerator went into production in 2020. Locations A and B of this PFAS research were also the locations of the highest dioxin (PCDD/F/dl-PCB) results of TW biomonitoring research, in 2022 in Beringen. Therefore, these two sample locations are chosen for this additional TW-PFAS study 2023. The two (2) PFAS analyses on backyard chicken eggs of these locations indicate that Beringen has a PFAS problem in addition to a dioxin problem.

It is advisable to verify the values found, by chemical (LC/LCMS) PFAS analyses, and check them against the current EFSA food safety standard. Note the EFSA safe standard is based on only 4 PFAS substances (PFOA, PFOS, PFHxS, PFNA), which is only 0.00005% of all possible PFAS compounds. This indicates the technical backlog on the analysis of the many millions of substances as PFAS.
It is highly recommended to implement screening tools like FITC-T4 or PFAS-CALUX in standard analyses of food, environmental and industrial samples. In addition, industry should be more open about their specific chemical product specifications, toxicity studies and emissions to air, water, and soil. The waste incinerator Bionerga should provide access to uncorrected raw minute data, meaning not calculated or average data from semi-continuous measurements of the flue gases in the chimney. These data should be independently verified to investigate whether the waste incinerator meets the requirements of the Best Available Techniques (BAT) to reduce emissions of Persistent Organic Pollutants (POPs) to the utmost.

Waste incinerators are a potential source of PFAS contamination. Like other POPs such as dioxins and PAH, these 'forever' chemicals pose a threat to human and environmental health. This is also evident from TW studies (2015-2017), which measured PFAS (PFOA and PFOS) in the flue gases of the newest 'State-of-the-art' waste incinerator in the Netherlands (2017). The newly built Waste-to-Energy (WtE) waste incinerators, like Bionerga, are not suitable to fully incinerate the persistent substances containing PFAS waste, given the much higher required combustion temperatures than 850° C to do so. Unfortunately, PFAS is so integrated into our everyday lives that PFAS will always be burnt in our (household) waste. The results of PFAS in the eggs of backyard chickens in Beringen, Belgium cannot be addressed as just an 'egg problem'. This biomarker, as a health indicator of the environment, should ring the bells for the action of more transparent research.



List of Figures

Annex Laboratory analysis

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Analysis report

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Date report (dd-mm-yyyy):
09-12-2022

Responsible person BDS:
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Information about report
The results of examination refer exclusively to the checked samples.
Results are given in table 1.
Sample characteristics are given in table 2.
Accredation ISO 17025 (RvA L401) is not applicable for activities described in this report
Date of the performance of the test: 08-12-2022

Table 1 sample analysis results

No.	Client code	Method	Parameter	Result	Conclusion	Cut off	Unit
1	TW22-CZ-E05	FITC-T4	Thyroid disruption	3.7	---	n.a.	ug PFOA eq./gram fresh weight
2	TW22-CZ-E06	FITC-T4	Thyroid disruption	3.9	---	n.a.	ug PFOA eq./gram fresh weight
3	TW-MD22-Egg01	FITC-T4	Thyroid disruption	4.2	---	n.a.	ug PFOA eq./gram fresh weight
4	TW22-BE-01-TN-eggs	FITC-T4	Thyroid disruption	5.1	---	n.a.	ug PFOA eq./gram fresh weight
5	TW22-BE-02-BP-eggs	FITC-T4	Thyroid disruption	1.9	---	n.a.	ug PFOA eq./gram fresh weight
6	TW-LT22-Egg-05	FITC-T4	Thyroid disruption	0.75	---	n.a.	ug PFOA eq./gram fresh weight
7	TW-LT22-Egg-06	FITC-T4	Thyroid disruption	0.29	---	n.a.	ug PFOA eq./gram fresh weight

n.a.= no cut off according to EU guideline in BEQ established, maximal levels applicable if available

Table 2 sample characteristics

No.	Client code	BDS code	Matrix	ISO17025 (RvAL401)	Date arrival	Sealed
1	TW22-CZ-E05	44301	Food, egg(product)	no	15-11-2022	
2	TW22-CZ-E06	44302	Food, egg(product)	no	15-11-2022	
3	TW-MD22-Egg01	44303	Food, egg(product)	no	15-11-2022	
4	TW22-BE-01-TN-eggs	44304	Food, egg(product)	no	15-11-2022	
5	TW22-BE-02-BP-eggs	44305	Food, egg(product)	no	15-11-2022	
6	TW-LT22-Egg-05	44306	Food, egg(product)	no	15-11-2022	
7	TW-LT22-Egg-06	44307	Food, egg(product)	no	15-11-2022	