Save the dates : *17 – 18 – 19 January 2023*

Summit of Organic and Organo-Mineral Fertilisers Industries in Europe

SOFIE2 - Brussels & hybrid, 17-18 January 2023

The 1st SOFIE in 2019, brought together, for the first time ever, the European carbon-based fertiliser sector, and attracted over 125 participants, from industry (two thirds of participants), as well as regulators, stakeholders and R&D, from 14 European countries and worldwide (summary in SCOPE Newsletter n°130).

Delayed by Covid, this 2nd SOFIE will centre on **how organic and organo-mineral fertiliser products and technologies deliver specific agronomic performance characteristics for farmers' needs**. The event is being co-organised by ESPP, ECOFI, Eurofema and Fertilizers Europe, with support of the International Fertiliser Society.

"Organic" here means containing organic carbon, as in the EU Fertilising Product Regulation definitions of PFC1A "Organic Fertiliser", PFC1B "Organo-Mineral Fertiliser" and PFC3A "Organic Soil Improver" (that is, not particularly fertilisers certified for Organic Production). Organic carbon input is increasingly recognised as valuable for soil carbon storage, water retention and nutrient availability in all types of farming.

SOFIE provides a unique opportunity to meet companies, technology suppliers, regulatory experts and other actors in this fast-developing sector. The new EU Fertilising Products Regulation includes organic and organo-mineral fertilisers, opening the European market, but there are challenges in adapting EU legislation to the specificities of organic fertilisers. The EU Fertilising Products Regulation also enables the inclusion of recycled organic nutrients in CE-marked products, subject to input material and fertiliser product quality criteria.

Call for presentations for SOFIE

SOFIE2 will showcase:

- industry innovation in organic and organo-mineral fertiliser formulation and performance, processing technologies, testing and monitoring, field application
- agronomic demonstration of organic fertiliser products
- update on EU Fertilising Product Regulation implementation and product conformity assessment

Proposals for presentations for SOFIE2 should be sent by 15th October to info@phosphorusplatform.eu: maximum one page (free format), outlining proposed presentation content, references or websites, speaker(s) names, organisation and emails.

*SOFIE2 - 2nd Summit of the Organic and organo-mineral Fertilisers Industries in Europe, **Brussels** Renaissance Marriott Hotel, 19 rue de Parnasse, **& hybrid, 17-18 January 2023** www.phosphorusplatform.eu/SOFIE2023*

First workshop on Nitrogen Recovery

ESPP event: Brussels & hybrid, 19 January 2023

ESPP is widening to include recovery for recycling of nitrogen*. A literature search and technology inventory is currently underway. A first meeting is organised, open to all technology providers and developers**:

- Literature search and technology inventory conclusions and overview, market perspectives vision
- Why recycle nitrogen? current price and import crises, global nitrogen cycle
- Perspectives from the fertilisers industry, water industry, biogas operators
- Technology sessions, including: ammonia recovery (from gas cleaning or "stripping" of liquids), potential NOx /N2O capture for N recycling, N recovery from liquid phase
- Final panel and discussion: What next? Working Group? Actions?

Save the date: 19th January 2023, Brussels (L42 Centre) & hybrid. Further information and registration will be online soon on ESPP's website www.phosphorusplatform.eu/NRecovery

To propose a presentation of your process or technology, or on N-recovery context and perspectives, contact Olivier Bastin, ESPP

This workshop will be open, for physical participation in Brussels, to invited participants only. This is necessary to limit numbers in order to enable exchange and discussion on how to engage actions to promote, develop and implement nitrogen recovery for recycling. Online access will not be limited. To participate in Brussels, you should send a request to Olivier Bastin, ESPP indicating what technology, market or regulatory expertise you can bring to this workshop.

** subject to approval of statutes change by ESPP members, to cover recovery of nitrogen and other elements, at the next ESPP General Assembly.*
*** please send any relevant information to Olivier Bastin* nitrogenrecovery@phosphorusplatform.eu

EU public consultations

EU public consultation on animal by-products (ABPs) in EU fertilising products (FPR)

The European Commission (DG SANTE) has published, for public comment to 24th October 2022, a proposed amendment of the EU ABP Regulation to allow use of certain ABPs as component materials under the EU FPR (Fertilising Products Regulation). This has been awaited by stakeholders since early 2016 when the Commission published the draft FPR regulatory proposal with an empty box for ABPs. Still today, no ABP nor ABP derived material whatsoever can be used in a CE-Mark fertiliser, unless and until this proposed amendment to the ABP Regulation is adopted and published and enters into force.

It is not clear to ESPP whether also amendments will be required to the annexes of the FPR: possibly not for some materials, where these are already specifically cited in a CMC (see below), but presumably amendment of the FPR Annex II will be required for other materials (to populate the currently empty box of CMC10).

The DG SANTE proposal published (5 pages) covers only 13 (groups of) materials for which processing is already defined in the ABP Regulations (1069/2009). That is, use of these materials is already allowed in "national" fertilisers, but subject to limitations which would not (under the proposal) be applicable to CE-Mark fertilisers (traceability, use limitations, e.g. not on grazing land). Of these 13 materials, it is proposed that 4 could be used "as such" (Cat.2-3 ash – but not Cat.1 ash, see article below, digestate, compost, processed manure - insect frass, in each case subject to meeting the relevant existing ABP Regulation processing specifications) whereas 9 would be subject to limitations to use: max 50 kg packaging, dilution by at least 50% with some other non-animal-feed material. These additional requirements are stated as intending to prevent inappropriate feeding of animal protein to other animals (citing EU Regulation 999/2001 on TSE transmissible spongiform encephalopathies). The dilution would have to not be with any material in the very long list of possible animal feeds in Regulation 68/2013. This list includes, amongst others, plant materials, plant micronutrients and several mineral feed chemicals, so this could severely limit use of these ABPs in fertilisers. ESPP does not understand why smaller packaging would prevent feeding to animals. As proposed the combination of small packaging and dilution (mixing) could be economically impracticable for agricultural fertilising products and generate considerable unnecessary transport, packaging and plastic waste.

For memory: DG SANTE has previously indicated that nitrogen salts recovered from off-gases from manure, manure processing, livestock stables (CMC15) are not concerned the Animal By-Product Regulation (ESPP eNews n°68).

DG SANTE's proposed amendment to the ABP Regulation (of 26/9/2022 published for ***consultation*** ***to 24/10/2022***) would allow **only** the following ABP-derived materials in FPR CE-Mark fertilisers:			*Specifications of processing required * (in Regulation 142/2011)*
Could be used directly, as such, as component materials of CE-Mark fertilisers (subject to respecting the specified existing processing conditions of the ABP regulations)			
Ash from Cat.2 and Cat.3 ABPs (not Cat. 1 ash – see article below on this question)	Already anticipated in FPR texts: ESPP understands no amendment to FPR annexes necessary. But subject to respecting relevant FPR CMC specifications:	CMC13	Annex III. I.e. incineration or co-incineration: ≥850 °C for ≥2 seconds or ≥1100 °C for ≥0.2 seconds (plus various operating and plant requirements).
Compost		CMC3	Annex V, chapters I, II & III
Digestate		CMC5	Annex V, chapters I, II & III
Processed manure and insect frass	Possibly CMC14 for biochars etc. if a relevant pyrolysis process is already specified in the ABP Regulations? Otherwise: CMC10		Annex XI, chapter I ($2 a, b & d): I.e. treatment at ≥70°C for ≥60 minutes and verification by sampling of specified pathogen levels.
Could only be used under conditions: small packaging, dilution with non-feed-list materials			
Glycerine and biofuel residues, Cat.2 and Cat.3	Require addition to CMC10: ESPP understands amendment of FPR Annex II will be necessary		Annex IV, chapter IV
Certain Cat.3 materials			Annex IV, chapter IV
PAP (Processed Animal Protein) Cat.3			Annex X, chapter II
Processed MBM (Meat and Bone Meal) Cat.2. Must also be marked with glyceroltriheptanoate (GTH)			Annex IV, chapter III A I.e. pressure sterilisation ≥133°C for ≥20 minutes and with steam at ≥3 bars
Blood products Cat.3			Annex X, chapter II, §2
Hydrolysed proteins			Annex X, chapter II, §5 D
Dicalcium phosphate and Tricalcium phosphate. *Concerns only DCP and TCP from certain Cat.3 ABPs, not from minerals*			Annex X, chapter II, §6 or §§7
Feathers and down.			Annex XIII, chapter VII C
Horns, hooves.			Annex XIII, chapter XII
** "Standard" (but not "Alternative") specifications of processing (parameters of minimum temperature, time, etc) for each material, as defined in ABPR Implementing Regulation 142/2011, consolidated version 17/4/2022 http://data.europa.eu/eli/reg/2011/142/oj*			

Public consultation on animal by-products (ABPs) in EU fertilising products (FPR) is open until 24th October 2022. *Input is in the form of a statement (4 000 characters max.) plus possibility to submit a document: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13478-Fertilisers-list-of-animal-by-products-to-be-used-without-further-official-controls-update-_en*

EU consultation on Critical Raw Materials

Public consultation open to 25th November 2022 towards a future EU Regulation on Critical Raw Materials (CRMs). At this stage, the consultation concerns an outline roadmap, with a general questionnaire on policies and priorities.

The Commission's proposed roadmap (dated 30th September 2022) refers to Critical Raw Materials as relevant to green and digital technologies, aerospace, defence and health industries, but does not mention agriculture or food security. It is, indicated that the consultation concerns not only materials currently on the EU CRM list (2020 list, here, which includes both "Phosphate Rock" and "Phosphorus" P_4), but also other strategic materials (e.g. Potash, currently under consideration in the CRM process SCRREEN2) but NOT energy materials nor agricultural raw materials (citing "wheat"). ESPP will underline that phosphorus and potassium fertilisers are critical for the EU's food supply, and so for security and resilience, but also nitrogen fertilisers, which are today heavily dependent on imported gas, resulting currently in major production and supply disruption.

The proposed roadmap underlines the need to improve resource efficiency and to support circularity, in particular by facilitating regulation and investment in recycling. ESPP will underline the need to accelerate authorisation of recycling of nutrients derived from wastes and animal by-products, whilst ensuring safety: in particular, use of Cat.1 ABP ash in fertilisers, clarification of legislation concerning recycling to animal feed, waste status of algae, End-of-Waste for materials recovered from waste waters.

ESPP will support the proposed actions on governance and monitoring of Critical Raw Materials, in particular by modifying trade customs codes to better identify relevant materials and by putting in place permanent (regularly updated) material flow data for the key plant nutrients (N, P, K), including data on quality of waste and by-product flows. Such flow data enables to identify loss hotspots and recycling opportunities, and to monitor effectiveness of policies (in coordination with monitoring already in place by the European Environment Agency and under EU policies such as the Water Framework Directive).

Concerning permitting, action should concern not only extraction of CRMs, but also facilitating permitting of industrial plants wishing to take in wastes for recycling to substitute virgin raw materials.

ESPP notes the reference to ensuring technical standards to support innovation, and reminds of the CEN SABE identification of standards needs to support phosphorus recycling from wastewater (2015), which should be extended to recycling of phosphorus and other nutrients from other secondary sources.

The Commission roadmap states that "recycling obligations" or "information on carbon footprint", applicable both within the EU and to imports, are necessary to ensure a level playing field, citing rare earths. ESPP will suggest that this should also be applicable to nutrients essential for food production.

The consultation, open to the general public and all companies or organisations, includes around 20 general questions about challenges and priorities for Critical Raw materials policies, covering monitoring and governance, permitting, financing and investment, resource efficiency, carbon footprint, circularity, international aspects and workforce skills,. The consultation also offers the possibility to make open comments and to submit position or reference documents.

EU "Critical Raw Materials" homepage. EU public consultation "European Critical Raw Materials act", open to 25th November 2022 HERE.

EU consultation on Soil Health

EU public consultation, to 24th October 2022, to support preparation of a future EU Soil Health Regulation.

EU consultation, open the general public, companies, organisations, to 24th October 2022 LINK.

ESPP new member

Department of Power Engineering (UCT Prague)

Department of Power Engineering
UCT PRAGUE

The Department of Power Engineering at the Faculty of Environmental Technology, UCT Prague, addresses the overall issue of thermochemical treatment of sewage sludge in the entire technological process, i.e., sludge drying, sludge pyrolysis, sludge incineration, pyrolysis gas and flue gas treatment, and the treatment of the resulting products such as sludge-char and ash. The department is fully equipped to determine the relevant fuel, functional, and environmental properties of sewage sludge and the products of pyrolysis, gasification and incineration processes. Senior and junior researchers, PhD students, as well as department students in process engineering and power engineering, ion exchange and membrane technologies, and corrosion are involved in the study of the above-mentioned issues. Currently, ongoing projects deal with: removal of PFASs during sewage sludge pyrolysis, physicochemical properties of sludge-chars and ashes after the sludge pyrolysis/incineration, application research on a commercial pyrolysis unit, and phosphorus and sewage sludge flows in the Czech Republic for applied research in phosphorus recovery or agricultural use of sludge-chars.

More information, list of current projects and publications: https://uen.vscht.cz/research/58693.

Policy

Austria notifies national obligation to recover P from sewage sludge by 2030

The Austria government has notified to the EU a national Ordinance on waste incineration introducing the requirement to incinerate sewage sludge from most wwtps ≥ 20 000 p.e. and to recover 60% - 80% of phosphorus. The Ordinance covers BAT and new substitute fuels in incineration plants. The section on "Sewage sludge incineration and phosphorus recovery" (chapter 4, page 16) specifies that sewage from wastewater treatment plants of ≥ 20 000 p.e. must be incinerated by 1st January 2030. Three P-recovery options are authorised:

- at least 80% of the P in the sewage sludge is recovered from the incineration ash.
- all the incineration ash itself is used for production of a fertiliser respecting national fertiliser regulation specifications (Düngemittelgesetz 2021, BGBl. I 103/2021).
- 60% of the P in the wwtp inflow is recovered by "thermal, chemical or physico-chemical" processes at or nearby the wwtp (if this third option is chosen, then the sewage sludge does not have to be incinerated)

In all cases, operators must produce an annual report indicating the quantity of P in ash / wwtp inflow, the type of P-recovery and the quantity of P recovered, with the first report by 30th April 2031.

Austria "Abfallverbrennungsverordnung 2022 – AVV 2022" (Waste incineration Ordinance), 4 "Klärschlammbehandlung. Klärschlammverbrennung und Phosphorrückgewinnung" (Sewage sludge treatment. Sewage Sludge Incineration and Phosphorus Recovery), notified (26/9/2022) to and published by the European Commission, Notification Number: 2022/645/A (search in EU TRIS with year = 2022, number = 645)

INCOPA supports more stringent wastewater phosphorus discharge consents

INCOPA (Cefic sector group, ESPP member) has taken position for lower thresholds for phosphorus emissions in urban wastewater, pointing to LCA data showing the low carbon emissions of iron and aluminium coagulants. INCOPA says that chemical P removal using Fe or Al salts is cost-effective and can achieve very low P discharge consents to protect surface waters from eutrophication, suggesting that P limits should be lowered in the current review of the EU Urban Wastewater Treatment Directive 91/271/EEC. INCOPA state that phosphorus should also be recovered and recycling and that coagulants can be compatible with P-recovery. A 2020 LCA study by IVL for INCOPA concludes that chemical P-removal (ferric or aluminium) gives lower greenhouse emissions and higher biogas methane production than biological P-removal.

"INCOPA is ready to support the implementation of more stringent phosphorus emission limits in urban wastewater, with low carbon footprint inorganic coagulants" www.incopa.org 23rd June 2022 HERE. "LCA analysis of different WWTP processes", IVL for INCOPA, 2020 HERE.

ESPP input submitted on EU Fertilising Products Regulation

The EU survey on material inputs for CE-Mark fertilisers and other proposals for amendments remains open. ESPP submitted a table of 22 secondary materials currently excluded from CMC criteria. 188 different companies and organisations submitted detailed information concerning their own product or process. After the first cut-off date of 16th September 2022, this EU survey remains open for further input. For this first cut-off date, and after wide consultation of member companies and stakeholders, ESPP listed and provided summary information on the following secondary materials as potentially relevant for the nutrient circular economy, currently excluded from use in CE-Mark fertiliser production, which could be considered for development of criteria, to define criteria to enable safe recycling: Derivates of secondary mineral acids; Potassium, calcium and other salts recovered from (non CMC13) ashes; Ammonium salts from ABC powder fire extinguisher refurbishment; Nitrogen recovery from liquid phase of wastewaters; Biomass grown in sewage and in other waste waters; Natural biomass collected as waste; Fish excreta; Fish and seafood processing residues; Insect frass; Separately recovered human urine and derivates; Processed solids from dry toilets; Vivianite from sewage; Humus from tree bark; Pulp & paper industry limes; Pulp & paper fibrous sludges; Digestate from biorefineries processing biomass; Macro- and micronutrients recovered from battery recycling; Plasma treatment of digestates; P leached from sludge or biochars; Pre-processed input materials for CMC 13 and CMC14; Pyrolysis and gasification materials from sewage sludge; Multi-stage thermal oxidation processes.

EU survey on materials for CE-mark fertilisers "EU survey on possible future development of the FPR". Survey remains open to all companies and organisations with relevant information to input:
ESP submitted input table www.phosphorusplatform.eu/regulatory
All contributions submitted to this survey can be consulted here (answers to the questionnaire only, the submitted attachments are – it seems – not accessible)

Proposed revisions of EU BAT and pollutants Directives

European Commission legislative proposals would improve industrial material efficiency requirements and bring 185 000 cattle, pig and poultry farms (up from 20 000 today) under Industrial Emissions Directive (BAT) obligations. The Commission has now published various documents summarising the proposals for revision of the Industrial Emissions Directive (IED, defining BAT) and of the Regulation of the E-PRTR Regulation (now Industrial Emissions Portal). Key objectives presented in the Fact Sheet and Q&A include reducing livestock ammonia and methane emissions, fostering industrial materials efficiency, non-toxic or less toxic chemicals use and integrating depollution and decarbonisation. All livestock production of 150 or more LSU (livestock units) is concerned, and will have 3 ½ years to comply with BAT (Best Available Technology).

European Commission "Revision of the Industrial Emissions Directive (IED)" web page

Animal by-product (ABP) ash in EU fertilisers

Legal Opinion on Cat.1 ABP ash

ESPP has obtained an expert Legal Opinion on the possible use of Category 1 ABP ash in production of EU fertilising Products. This questions DG SANTE's position that this is somehow "not allowed" under EU ABP Regulations. Cat.2 and Cat.3 ABP ash are underway to being authorised in CMC13 (see article on EU consultation above), but this consultation excludes Cat.1 ash. ESPP underlines that, if such use of Cat.1 ash is in fact legally admissible (as this Opinion suggests), then we nonetheless fully recognise that safety needs to be ensured, and support the request for an EFSA (European Food Safety Agency) Opinion engaged by DG SANTE (letter of 31/5/22 to ESPP here). The Legal Opinion, commissioned by ESPP from Barry Love, accredited specialist in environmental law, Environmental Law Chambers, Scotland, concludes that the Waste Framework Directive is intended to take over the regulation of ABPs once they are destined for incineration. The Opinion concludes that it is incorrect to consider (as DG SANTE seems to do) that art. 32 of the ABP Regulation excludes use of Cat1 ash or materials derived from such ash cannot be used in fertilisers. The Opinion also suggests that appropriate incineration of Cat1 ABP material could be regarded as a "recovery operation" leading to End-of-Waste status if the resulting ash is used as a fertiliser or in fertiliser production, and that also that the ABP Regulations do not necessarily exclude the use of such fertilisers on fields grazed by animals. It is noted that the EU Fertilising Products Regulation (FPR) could bestow such EU End-of-Waste status (after modification of clauses in Annex II CMCs which currently exclude Cat1 derived materials, and subject to appropriate REACH registration), but such FPR End-of-Waste status would only apply to the final conformity-assessed fertilising product (not to intermediates, such as phosphoric acid, which could however obtain End-of-Waste status by some other route). In particular FPR CMC13 (Thermal Oxidation Materials and Derivates) currently excludes Cat1 ash and Cat1 ash was not discussed by Member States and experts during the JRC STRUBIAS process preparatory to this CMC (because it was excluded by DG SANTE). ESPP suggests that the proposed EFSA Opinion on Cat1 ash could redress this. The Legal Opinion notes that specific use limitations (e.g. grazing land) could be included in FPR Annex III (Labelling requirements) if considered appropriate by EFSA.

The Legal Opinion suggests that "*if all that is currently standing in the way of*" moving towards authorisation of Cat1 ash and derivates in EU fertilisers (in parallel to definition through the announced EFSA Opinion of conditions necessary to guarantee safety) "*is that the Commission believes Cat.1-derived ash is a legal impossibility under the ABPR, then they must be prevailed upon to substantiate that position".*

The Legal Opinion concludes that DG SANTES's position that Cat.1 ash cannot legally be used in fertilisers *"is an unsupportable conclusion which fails to (i) acknowledge the lack of any express prohibition to that effect, (ii) address the interface between WFD and ABPR, and (iii) achieve the purposive result envisaged by the Circular Economy principles*."

Please see the full text of this Legal Opinion for detail: the above short summary is necessarily incomplete and imprecise.
"At the request of European Sustainable Phosphorus Platform LEGAL OPINION on 'End of Waste' and use of Cat 1 ABP incineration ash as fertiliser", 13th September 2022, Barry Love, LL.B (Hons), LL.M (Environmental Law), Dip.L.P, Solicitor, Accredited by the Law Society of Scotland as a specialist in Environmental Law (2006-present), online at www.phosphorusplatform.eu/regulatory

Fertiliser information

IFS FerTech Inform

The International Fertiliser Society (IFS, the fertiliser science organisation) has launched a knowledge base and information exchange forum on fertiliser production technologies. The knowledge centre provides introductory information on processes, chemistry, materials and equipment and a data base of in depth materials, including links to IFS Proceedings. The data base is supported by an interactive forum and a panel of experts. FerTechInform targets fertiliser industry technicians, managers and partners. Enrolment is 1 500 € per level and the training is validated by examination.

FerTechInform has been developed with input from the IFDC Fertilizer Manual 'Green Book', with other content provided by the European Fertilizer Blenders Association, Fertilizers Europe, European Sustainable Phosphorus Platform (ESPP), Ammonia Energy Association, EasyMining, OCI Nitrogen, Prayon and Yara. https://fertechinform.org/

IFA Sustainable Fertilizer Academy

The International Fertiliser Association (IFA, the fertiliser global industry federation) has launched a virtual training curriculum on fertiliser industry sustainability. Two training levels are open: Introductory, Intermediate. Themes covered include application of sustainability to fertilisers, sustainable business and finance, circularity and nutrient recovery and recycling, fertiliser production, mining, green ammonia, waste management, emissions, plant nutrition, biodiversity and fertiliser use, food supply chains.

IFA 'Sustainable Fertilizer Academy'. https://ifa-sfa.org/
Founding partners: University Mohammed VI Polytechnic (UM6P), Anglo American, CF Industries, GPIC, ICL, Ma'aden, Mosaic, OCI, OCP, QAFCO, Yara.

Phosphate in diet and health

Trends in US dietary P intake

Analysis of data 1988 – 2016 suggests that US average adult phosphorus intake rose by around 8% to c. 1.4 gP/person/day whereas intake of food additive phosphorus fell. The study uses US official survey estimates of intakes of different types of food and tables of P-content for each food type (both from NHANES US National Health and Nutrition Survey and WWEIA What We Eat in America, sampling around 5 000 persons annually), combined with industry-sourced information on levels of food additive P commercially used in each food type and market survey (Innova Market Insights) data on the % of each food type sold containing or not food P additives. Estimated mean P intake increased from 1.29 gP/person/day o, 1988-1994 to 1.43 in 2011-2012, then fell again to 1.4 g/person/day in 2015-2016, that is +8% from 1998 to 2016. Food additive P consumption peaked in 2011-2012 and fell to its lowest level of the period in 2015-2016, at c. 9% lower than in 1988-1994. When compared to mean body weight, which has increased in the US over the period, total P intake again peaked in 2011-2012 but was slightly lower in 2015-2016 than in 1988-1994. This is relevant in that dietary recommendations for P intake are generally expressed per kg body mass. The highest sources of dietary P are identified as cheese, pizza, chicken meat, milk and eggs, but in total these make up <20% of total P intake, however the paper eludes the point raised by other authors that food additive P is generally highly soluble and so is taken into the body, whereas only c. 60% of natural diet P is adsorbed (Noori 2010, Cupisi 2018). Food additive P was <12% of total dietary P intake in 2015-2016. The authors underline that the NHANES assessment of intakes of different food types (by questionnaire) can be unreliable, that the food table indicators of P content for different food types may also be unreliable, and that better data is needed on natural and food additive P in different foods.

This study was funded by the food additive industry (IFAC International Food Additive Council). The authors are with a food product marketing company.
"Trends in Total, Added, and Natural Phosphorus Intake in Adult Americans, NHANES 1988–1994 to NHANES 2015–2016", K. Fulgoni & V. Fulgoni, Nutrition Impact LLC, Nutrients, 2021, 13, 2249. https://doi.org/10.3390/nu13072249

Diet phosphorus and certain health indicators

Total dietary phosphorus intakes show some weak correlations with blood phosphorus, weak correlations to reduced risk of cardiovascular disease (CVD), improved bone density, lower cholesterol, lower blood pressure. No correlations were found to mortality This is the second of two papers funded by the food additive industry (IFAC), with main authors from a food product marketing company, see above. This paper again analyses data from the US NHANES survey and estimates of food additive P and natural P in diet (see above). In this case, the estimated mean P intakes are compared to various health outcomes for which NHANES collects data. Total dietary P was significantly correlated to slightly increased blood phosphorus levels. Total dietary P was correlated to slight improvements in several health parameters, but with varying differences when considering food additive P or natural dietary P. Total and natural P were correlated to reduced total cholesterol and reduced LDL cholesterol ("bad") but increased HDL cholesterol ("good"), whereas food additive P correlated to decreased HDL. Both forms of P intake correlated to reduced blood pressure (diastolic and systolic) and to improved bone density (femur BMC, femur BMD). Total dietary P and natural P correlated to slightly reduced risk of cardiovascular disease (CVD) whereas food additive P correlated to a slight increase in CVD risk. It is noted that a number of previous studies show correlation of blood phosphorus levels (serum P) to CVD risk, probably resulting from artery hardening due to calcium phosphate precipitation and impacts of phosphorus concentrations on artery wall cells. No clear correlations between P intakes and mortality were shown, with some correlation appearing only after correction for certain covariates. The authors underline that in most cases the predicted health impacts of changes in dietary P intake are very small.

This study was funded by the food additive industry (IFAC International Food Additive Council). The first two authors are with a food product marketing company. T. Wallace presents himself as "America's favorite food scientis".
"Association of Total, Added, and Natural Phosphorus Intakes with Biomarkers of Health Status and Mortality in Healthy Adults in the United States", K. Fulgoni, V. Fulgoni, T. Wallace, Nutrients 2022, 14, 1738. https://doi.org/10.3390/nu14091738

Blood phosphorus, alcohol metabolism, pancreatitis

Higher levels of blood phosphorus correspond to lower peak blood alcohol concentrations after alcohol intake. **Low diet P in mice resulted in alcohol intake causing pancreatitis risk**.

In Bramness et al. 2022, Twenty young male volunteers, after overnight fasting followed were given alcohol (vodka, 38%) 30 minutes after by a light breakfast, calculated (according to body weight) to reach blook alcohol concentration of 1.2%. Baseline (after fasting) blood serum P concentration was negatively correlated (albeit with scattering) to peak blood alcohol concentration (in this case, the first blood alcohol measurement one hour after intake) but not to alcohol elimination rate These results differ from a recent study using mice which found no correlation between serum P and peak blood alcohol concentration (Farooq 2021).

The Farooq study shows a different effect, in mice, which is that hypophosphatemia (low serum P), resulting from a low P diet, caused alcohol intake to lead to pancreatitis, with this effect being prevented by phosphorus intake along with the alcohol. 4 week old mice were given either a normal P-level diet (0.33% P in feed) or low P diet (0.02% P) for two weeks, then fed either alcohol, water, or alcohol plus P (Na_2HPO_4) for five days, with alcohol at 2.86 g ethanol / kg body weight (equivalent to human binge drinking). After five days, the mice showed serum P c. 1/3 lower for the low P diet. After the five days, pancreas cells in the low P diet mice showed significant increases in edema, serum analyse and lipase and pancreatic MPO (myeloperoxidase), indicators suggesting increased susceptibility to pancreatitis. In vitro tests showed that the low P diet mice pancreatic cells showed cytotoxicity to acinar cell function, with further tests suggesting that this is related to phosphorus regulation of intracellular calcium levels.

"Blood alcohol levels after standardized intake of alcohol are related to measured blood phosphate levels", J. Bramness et al., Clinical Biochemistry in press 2022 DOI.
"The Role of Phosphate in Alcohol-Induced Experimental Pancreatitis", A. Farooq et al., Gastroenterology 2021;161:982–995 DOI.

Research

Manure additive to reduce manure nitrogen and methane emissions

The EU has agreed to provide nearly 2.5 M€ funding to the "GasAbate N+" project, led by GlasPort Bio (Ireland), reducing GHG emissions during manure storage and increased anaerobic digestion renewable energy potential. Two chemicals are dosed (no capital investment is required) which inhibit certain specific microbial activity in the manure during storage, without affecting other microbes in the slurry. The chemicals are GRAS (generally regarded as safe) and have been extensively studied with their safety proven for humans, animals and the environment, with no environmental concerns over residues remaining in the slurry. The result is to inhibit release of methane and of other gases including ammonia and hydrogen sulphide. The project states that this can result in a 30% saving in N losses (so reducing farmers' need to purchase mineral N fertiliser), a 98% reduction in greenhouse gas emissions (methane and nitrogen gas compounds) and a 40% increase in biogas production if manure then goes to anaerobic digestion (carbon is retained in the manure, not lost as methane, so is available for methane production in the digester). These numbers are based on treatment of manure during 14 weeks storage.

The GasAbate technology is different from manure acidification, which is widely developed and is recognised as EU BAT (see ESPP-DPP-NNP Nutrient Recovery Technology Catalogue) in that the solution of GasAbate N+ is intended for use during slurry storage, increasing its utility as an organic fertiliser and as a feedstock for anaerobic digestion, whereas slurry acidification is intended for application during storage and/or during field application of slurry or digestate.

Preparatory tests using dairy slurry in 25 litre storage drums are reported in Thorn et al 2022. The GasAbate project is now at its mid-point. Trials have been carried out at dairy farms in Ireland where c. 80% reduction in methane emissions from stored slurry from a 200 head herd was achieved (publication pending). Further trials are planned in Europe and in the US and on pig slurry in Ireland.

"GasAbate N+: Additive Technology to Prevent Greenhouse Gas Emissions and to Enhance the Fertiliser and Bioeconomy Feedstock Value of Animal Manures and Slurries", Horizon 2020 CORDIS and YouTube video. Contact email.

Eutrophication control measures reduce aquatic methane emissions

Freshwater eutrophic mesocosm studies showed lower methane emissions after soluble P removal using lanthanum or after dredging. 1.15 m diameter, 0.75 m depth, mesocosms (number not specified) were set up in July and filled with sediment and water from eutrophic Lake Wylerbergmeer, Netherlands, then monitored for 18 months. For phosphorus removal, LMB (lanthanum modified bentonite = 'Phoslock') was added in a 1:1 La:$P_{\text{-available}}$ molecular ratio. Dredging removed the top 5 cm of sediment. Both diffusive and ebullitive (bubbles) emissions of methane were captured and measured. Physiochemical, plant and microbial community variables were measured. Diffusive accounted for most methane emissions in all cases. Dredging significantly reduced emissions, both in the first and in the second summers, whereas lanthanum dosing slightly increased methane emissions for the first summer, but then reduced emissions more than did dredging in the second summer. Methanogenic bacteria were related to surface water ammonia and oxygen and sediment porewater phosphorus levels. Total methane emissions were extremely different in the first and second summers, increasing from c. 5 in the first summer to around 150 mg-methane/m^2/day in the second summer, so remained ten times higher in the second summer even after lanthanum treatment or dredging.

"Phosphorus control and dredging decrease methane emissions from shallow lakes", T. Nijman et al., Science of the Total Environment 847 (2022) 157584 DOI.

Phosphorus recovery from sewage sludge ash by thermochemical processes

Thermochemical treatment of sewage sludge ash (SSA) by microwaves (MW) promotes the formation of bioavailable $CaNaPO_4$, with limited reaction times and lower energy consumption. A MW absorber is added to the samples, while the chamber is composed of a secondary MW absorbent (susceptor) and a MW transparent material to benefit thermal insulation for the heat generated in the sample by the susceptor. SSAs (60% of sample mass) were added with sodium bicarbonate (25%), used as a sodium ion source to partially replace calcium ions in the phosphates, therefore increasing their solubility, and anthracite (15%), used as MW absorber. Samples (0.4 g) were placed in the dedicated chamber and inserted into the oven, and treated at 1000 W for 15 minutes. The thermochemical treatment increased P availability with respect to the corresponding raw samples, supporting the possibility of direct reuse of the obtained products as fertilisers. XRD analysis highlighted the formation of $CaNaPO_4$ in several samples, together with the formation of other P-containing crystalline phases (e.g., $AlPO_4$). In addition, the water solubility of Pb, Zn, and Cr was decreased after the treatment. Given that microwave energy requirements are not proportional to scale-up, the authors suggest that MW technology involves low energy consumption and CO_2 emission.

"A new breakthrough in the P recovery from sewage sludge ash by thermochemical processes", L. Fiameni et al., Green Chem. Advance Article (2022) DOI

Overview of sewage sludge contaminants, thermal treatment and P-recovery

Based on over 200 references, contaminants in sewage sludge are discussed (heavy metals, nanoparticles, microplastics, pharmaceuticals …), thermal treatment routes and routes for P-recovery from ash are summarised. The authors note that sewage sludge can be a suitable fertiliser for agriculture, improving soil quality and preventing soil erosion, but raise concerns about possible impacts on soil, soil organisms, plants and the food chain, of contaminants present in sludge. Field evidence of impacts of organic contaminants is generally limited, but these have been shown to have effects in lab trials with soil and sewage sludge. For example silver nanoparticles can impact snails and silver can be taken up by plants (Courtois 2021). Microplastics can affect earthworms. PET microplastics can be broken down by snails and have negative effects on them (Song 2019). PFAS can accumulate in plants. ESPP notes that new EU Chemical Strategy announces restrictions on both PFAS and nanoparticles which should address these pollutants at source. The authors consider that the revision of the EU Sewage Sludge Directive should take into account research on organic pollutants in sewage sludge. Thermal treatment routes for sewage sludge are discussed: mono-incineration, co-incineration, pyrolysis and gasification (allothermal, autothermal). The authors' previous paper (Moško 2021, ESPP eNews n°52) is cited concluding that pyrolysis above 600°C eliminates nearly 100% of most organic pollutants. The authors conclude that mono-incineration is a known and stable route for sewage sludge treatment and that several processes for phosphate recovery from the ash are today operational.

"Sewage sludge treatment methods and P-recovery possibilities: Current state-of-the-art", M. Husek, J. Mosko, M. Pohorely, J. Environmental Management 315 (2022) 115090 DOI.

Testing bio-based coagulants for P-removal

The LIFE-NEWEST project tested two different bio-based chemicals for P-removal from wastewater, including a total of 45 months full-scale testing in four sewage works in Spain. First, a new chemically synthesised tannin-based polymer (see US patents US4558080 and US6955826) was tested. This however showed significant traces of formaldehyde, from the synthesis process, so was then replaced by a blend of bio-sourced organic polymers, presumably again based on tannin. This also had the advantage that these polymers were already REACH registered. ECOTAN T3 was used in four municipal sewage treatment works (Lloc nou d´en Fenollet, Beniganim, Ontinyent and Canalsat, near Valencia, Spain, managed by subsidiaries of Global Omnium) at the same dosage (mg/l) as ferric chloride for a total of 45 months operation, achieved somewhat poorer P-removal results, but respected the discharge consents in all cases (2 or 1 mg P_{-total}/l). Ferric achieved 0.5 mgP/l in one works but the bio-sourced coagulant did not (at the same dosage). The bio-sourced coagulants (at the same dosage as ferric) resulted in better sludge dewatering with lower flocculant polymer consumption, and higher biogas production, with no deterioration in sewage works organics removal (COD discharge). Testing of composted sewage sludge as fertiliser for orange and almond trees showed in most cases no difference between use of sludge with bio-sourced coagulant and use of mineral fertiliser.

LIFE-NEWEST LIFE16 ENV/ES/000156, "New urban wastewater treatment based on natural coagulants to avoid phosphorus pollution allowing mud's agrivalorization", Final Report 30/11/2021 project reports here.

Climate change: nutrient addition and warming affect soil P in grasslands

Nitrogen addition may promote P mineralisation and transformation of refractory soil inorganic P, while warming regulates plant acquisition and enzyme activity accelerating the P cycle. A meta-analysis of 68 publications (up to mid-2021) on changes in soil P in global grasslands under warming and N/P addition to fields showed that N addition reduced microbial biomass P (− 11 %) but increased litter P concentration (+ 16 %) and available P (+ 14 %), due to a promotion of plant growth leading to enhanced P mineralisation and conversion of refractory forms of soil inorganic P. Experimental warming regulates plant acquisition and enzyme activity, leading to a reduced microbial biomass P (− 11 %) and available P (− 7 %), but increased litter P concentration (+ 46 %). However, soil total P was not affected, as warming accelerated phosphatase and microbial activity, litter decomposition and returned P to the soil to maintain the balance of soil total P. P addition accelerated the immobilisation of microbial biomass P (+ 98%) and the solubilisation of inorganic P, leading to an increased available P (+ 222 %). Variations of available P due to nutrient addition and experimental warming were more sensitive in temperate grasslands than in alpine grasslands, and the responses of soil total and available P to nutrient addition depended on environmental conditions such as air temperature, precipitations and soil pH. The study provides evidence of how climate change may impact soil phosphorus.

"Nutrient addition and warming alter the soil phosphorus cycle in grasslands: A global meta-analysis", W. Hu et al., Journal of Soils and Sediments 22 (2022) 2608–2619 DOI

Annual and periodic P fertilisation in Chinese Inceptisols

18-year maize field trial suggests that periodic (rather than annual) P fertilisation results in improved soil fertility and prevents P loss from soil in the long term. Six treatments were applied, i.e., no N and P fertilisers; annual input of 0 kg P/ha, 25 kg P/ha, or 75 kg P/ha; periodic input of 150 kg P/ha or 450 kg P/ha every 6 years for three times (triple superphosphate, 45% P_2O_5 and 15% Ca). Both the annual and the periodic P fertilisation regimes provided sufficient P to meet the threshold of Olsen-P for maize (12 mg/kg Olsen P) in the tested soil. However, the periodic fertilisation resulted in a lower degree of P saturation and concentration of soil Olsen- and water extractable-P, but a greater P sorption capacity than those of the annual P fertilisation at the end of each 6-year period. ^{31}P-NMR analyses highlighted an accumulation of organic P monoesters rather than immediately available orthophosphate when P was applied every 6 years. These organic P forms could be preserved in soil when mineral P addition is sufficient to sustain crop P uptake, and be mineralised in case of P shortage. Even though these results suggest that periodic fertilisation regime could improve soil P fertility and prevent P loss from soils in the long term, rainfall events subsequent to P application must be taken into consideration as they may increase the risk of incidental P losses.

"Periodic phosphorus fertilization is beneficial to lowering potential risk of phosphorus loss from Inceptisols", Y. Wang et al., Journal of Soils and Sediments (2022) DOI

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