Report on

Communication with the food technology community

Deliverable 9.6

EFFoST, M54

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817683.

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1. Executive summary

Communication and dissemination play a vital role in the FOX – Food processing in a bOX – project. Based on the FOX Communication & Dissemination plan (D9.1), this deliverable 9.5 highlights all communication and dissemination activities aimed at reaching the food science and technology community.

The "D9.5 Report on Communication with the Food Technology Community" under the FOX project comprehensively outlines the project's efforts in disseminating information about its objectives and results to the specific target group mentioned above. The report elaborates on the targeted communication strategy, which has been implemented at various levels from European to local and tailored to effectively engage this group.

Initially, the project focused on raising general awareness about its innovative down-scaled fruit and vegetable processing technologies. As the project progressed, the communication shifted to more specific messages about the project's progress and achievements. This was achieved through various dissemination activities, including articles in "Taste of Science," press releases, participation in conferences, and dedicated sections on the EFFoST website and social media channels.

Moreover, the report highlights the creation of practice abstracts detailing significant scientific developments within the FOX project, such as new juice extraction methods, sustainable drying technologies, packaging solutions, and upcycling of food side streams. Participation in notable conferences like EFFoST annual conferences played a crucial role in disseminating results and engaging with the community. Workshops and presentations at these venues helped in sharing knowledge and insights about the project.

Additionally, the project team has contributed to scientific journals and conferences, ensuring the reach of their findings within the academic sphere. This not only aids in spreading the word about the FOX project but also contributes to the broader scientific discourse in the field.

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2. Purpose ("Why?")

The aim of the communication and dissemination activities of the FOX project is to ensure information about the project's objectives and results is effectively disseminated to relevant audiences.

The FOX project aims to go beyond mere dissemination of information. It seeks to establish a dynamic dialogue with stakeholders in the food technology sector, fostering a two-way exchange of knowledge and insights. This interaction is vital for understanding the needs and challenges faced by the industry, especially by SMEs, and for tailoring the project's outputs to meet these needs.

Furthermore, the purpose of the communication strategy is also to stimulate collaboration and innovation within the food technology community. By sharing advancements and developments in down-scaled fruit and vegetable processing technologies, the project aims to inspire new research initiatives, encourage the adoption of innovative practices, and facilitate the development of more sustainable and efficient food processing methods.

Another critical aspect of the project's purpose is to influence policymaking by providing policymakers with robust scientific data and evidence-based recommendations. This is crucial for shaping policies that support sustainable practices in the food industry, promote health and nutrition, and contribute to environmental conservation.

The project endeavors to raise public awareness and understanding of the importance of innovative food technologies in addressing global challenges such as food security, nutrition, and climate change. By engaging the general public, the FOX project aims to foster a more informed and supportive environment for the advancement of food technology innovations.

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3. Target audiences (“Who?”)

The FOX project addresses a wide range of stakeholders and audiences, each requiring appropriate tailored information channels. The dissemination and communication strategy identified four main audiences:

- SMEs, large industries along the food supply chain, and associations representing their interests.
- Food scientists and technologists.
- Policymakers, regulators, and authorities
- The general public including consumers.

To maximize the chance of reaching the audiences concerned, every outreach task is being carefully designed and translated into local languages where needed. Moreover, audience-specific messages are disseminated on 4 geographic levels: the European, national, regional level, and local level.

This Deliverable 9.5 Interim Report focuses on the **communication and dissemination to the food scientists and technologists** with the aim to inform on the tested possibilities of mild processing in a mobile container and to involve them in the European Interest Group.

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4. Message (“What?”)

In the early stages of the FOX project, dissemination activities focussed on general messages to raise awareness about the FOX project, mainly down-scaled fruit and vegetable processing technologies and related topics, such as short food supply chains, food and vegetable sector, seasonality, and sustainability. Since project results started to become available, specific messages on the project’s progress and achievements were produced for each outreach activity.

As the project advanced, the message evolved to showcase specific achievements and milestones. This included detailed updates on the progress in developing new processing methods, the results of pilot studies and trials, and the potential impact these technologies could have on improving efficiency, reducing waste, and enhancing the nutritional value of food products.

Further, the message incorporated the environmental and sustainability aspects of the project. It emphasized how the FOX project's technologies align with broader environmental goals, such as reducing carbon footprint, minimizing water usage, and promoting sustainable agricultural practices. This aspect of the message was particularly targeted towards stakeholders concerned with environmental sustainability, including policymakers and environmentally conscious consumers.

Additionally, the message included the potential societal impact of the project. This involved discussing how the technologies could contribute to better food security, improved nutrition, and the economic empowerment of smaller food producers and local communities. This aspect was crucial in highlighting the project's alignment with global health and social objectives.

The extended message of the FOX project not only covers the technological advancements and their direct benefits but also encompasses the broader environmental, societal, and economic impacts, thereby offering a comprehensive view of the project's significance in the food technology landscape.

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5. Dissemination activities & tools (“How?”)

5.1 Articles in Taste of Science

“Taste of Science” is a free online platform about innovation in the food industry. The platform keeps small and medium-sized food producers posted on trends, new scientific knowledge, and technological developments. Food production is challenged by a fast-growing world population and resource scarcity. On top of tasty and safe foods, consumers want food to tell a story, have natural ingredients, and be prepared in a transparent and sustainable way. Taste of Science (ToS) presents solutions that enable food producers to meet these demands.

The ToS platform provides insight, inspires, facilitates decision-making on innovation, and involves its readers in EU projects. It covers developments in for example technology, health, food safety, traceability, sustainability, and marketing. Also, changes in EU legislation, subsidies, regional protection, and interviews with inspiring entrepreneurs can be found in Taste of Science. In short, it highlights everything that can help food entrepreneurs to survive in the increasingly competitive European food market.

The easy-to-read articles provide insight, inspire, and facilitate decision-making on innovation. The online platform bridges the gap between theory and practice. In Taste of Science, researchers and food enterprises can really be on the same page. The platform has currently >8,000 subscribers.

Four articles have been published on ToS regarding the developments of FOX project is being developed to raise awareness of the FOX project.

The **first article is titled "Low oxygen juice extraction and mild preservation"**. It discusses a new method for juice extraction and preservation developed by the scientists of the FOX project. This method combines oxygen-reduced extraction with Pulsed Electric Field (PEF) preservation, aiming to retain the original taste, aroma, and nutrition of the juice. The technology is implemented in a small-scale, mobile, and flexible unit capable of producing 250 L/h of juice.

The **second article is titled "Sustainable drying technologies"**. It explores the use of drying as a preservation method for fruits, vegetables, and mushrooms. The FOX project has introduced a mobile drying unit that merges traditional methods with modern non-thermal techniques. This approach aims to overcome the limitations of traditional sun and air drying, such as slow processing times and the potential loss of original flavors.

The **third article is titled "Innovative quality analyses and sustainable packaging for fresh fruit and vegetable snacks".** It highlights the unique “breathing” needs of fresh-cut produce snacks, especially when different items are mixed together. The FOX project has developed sustainable and adaptable packaging solutions to address

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these challenges. The new packaging uses recyclable and compostable materials, ensuring both the quality of the snacks and environmental friendliness.

The **fourth article titled "Upcycling of plant-based food side streams using mild processing"** discusses the challenge of quickly degrading side streams in the food industry due to factors such as improper handling, storage mishaps, or microbial contamination. It highlights the industry's turn towards upcycling as a method to repurpose these side streams before they become non-food grade. The focus is on transforming these side streams into useful products to enhance sustainability and reduce waste while ensuring that the end products are of good quality. The Processtimator developed within the FOX project is cutting-edge software designed to accurately estimate and optimize processing parameters in food production. Its application in our project has been instrumental in efficiently analyzing the upcycling processes of plant-based food side streams.

5.2 Press releases

Dedicated press releases were released on scientific developments of the project. These were prepared with input from the model region leaders and published in the FOX model region languages.

Press releases in period M1-M54.

- „Lokale Lebensmittelkreisläufe im Trend“ published on Die Milchwirtschaft with input from FRAUNHOFER
- „Les technologies douces à l'étude pour valoriser les fruits et legumes“ published in Process Alimentaire with input from partner CTCPA

https://www.processalimentaire.com/procedes/les-technologies-douces-a-l-etude-pour-valoriser-les-fruits-et-legumes

- „DIL gewinnt neues EU-Großprojekt – mehr als eine Million Euro gehen nach Quakenbrück“ published on DIL website

https://www.dil-ev.de/news/detailansicht/news/dil-gewinnt-neues-eu-grossprojekt.html

- „Soucasti mezinarodniho projektu - Article on FOX in Změdělec“ (trans. Farmer - the biggest weekly newspaper in Czech republic) – print version. Published with the input from partner SMA CZ
- “Which trends will influence Europe's food sector until 2035?“ published on Fraunhofer website.

https://www.isi.fraunhofer.de/en/presse/2019/presseinfo-26-FOX.html

- “Which trends will influence the food sector until 2035?” published on Yumda Food & Drink business.
- “Was kommt auf die Lebensmittelbranche bis 2035 zu?” published in ingenieur.de with input from Fraunhofer

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https://www.ingenieur.de/technik/fachbereiche/produktion/was-kommt-auf-die-lebensmittelbranche-bis-2035-zu/

- „Welche Trends prägen die europäische Lebensmittel-Branche bis 2035?“ published on PresseBox.

https://www.pressebox.com/inactive/fraunhofer-institut-fuer-system-und-innovationsforschung-isi/Welche-Trends-praegen-die-europaeische-Lebensmittel-Branche-bis-2035/boxid/981153

- „MARKT/196: Welche Trends prägen die europäische Lebensmittel-Branche bis 2035?“ (idw) published on Schattenblick.

http://www.schattenblick.de/infopool/europool/ernaehr/euema196.html

- Welche Trends prägen die europäische Lebensmittel-Branche bis 2035? published in Industrielle Automation

https://www.industrielle-automation.net/

- „Welche Trends prägen die europäische Lebensmittel-Branche bis 2035?“ published on Vegconomist

https://vegconomist.de/studien-und-zahlen/welche-trends-praegen-die-europaeische-lebensmittel-branche-bis-2035/

- “Nahrungsmittel als Klimakiller” published on Taz with input from partner Fraunhofer

https://taz.de/Ernaehrung-in-der-Zukunft/!5642182/

- Kleinschalige maar hoogwaardige voedselverwerking met FOX Newletter (email and online) of Topsector Agri&Food, Netherlands with input from partner Wageningen Research

https://topsectoragrifood.nl/nieuws/kleinschalige-maar-hoogwaardige-voedselverwerking-met-fox/

- „Wie der Weg vom Apfel zum Saft kurz bleibt“ published with input from DIL on Regional Newspaper - Oldenburger Münsterland – print version
- „DIL aus Quakenbrück gewinnt neues EU-Großprojekt“ published with input from DIL on NBank
- “Slovenija: Nutris vabi na delavnico Najboljše prakse inovacij z evropskimi kmeti” published on In Store with the input from KU Leuven
- “Who drives the European food sector towards more sustainability? Three scenarios for 2035” published on Fraunhofer website

https://www.isi.fraunhofer.de/en/presse/2020/presseinfo-19-FOX-Szenarien-fuer-Lebensmittelsektor-2035.html

- PRZETWARZANIE ŻYWNOŚCI PRZY WYKORZYSTANIU TECHNOLOGII PEF (Food processing using PEF) published on Food Fakty with the input from WULS-SGGW.

https://foodfakty.pl/przetwarzanie-zywnosci-przy-wykorzystaniu-technologii-pef

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- Was essen wir morgen? published on Badische Neueste Nachrichten with the input from Fraunhofer
- Appelpulp, wortelschillen of oesterzwamvoetjes over? Bied jouw reststromen aan in de FOX voedselverwerking app! Published on Innovatie huis de peel

https://innovatiehuisdepeel.nl/nieuws/appelpulp-wortelschillen-of-oesterzwamvoetjes-over-bied-jouw-reststromen-aan-in-de-fox-voedselverwerking-app/

- Restjes prei of appel na de oogst? Via app uit Helmond wordt dit niet weggegooid maar verwerkt tot voedsel published on AD Netherlands

https://www.ad.nl/helmond/restjes-prei-of-appel-na-de-oogst-via-app-uit-helmond-wordt-dit-niet-weggegooid-maar-verwerkt-tot-voedsel~aeaccbbf/?referrer=https%3A%2F%2Fapp.meltwater.com%2F

- Restjes prei of appel na de oogst? Via app uit Helmond wordt dit niet weggegooid maar verwerkt tot voedsel published in Brabantsdagblad en Eindhovensdagblad (print version)
- Diseñan un contenedor móvil para que agricultores procesen frutas y hortalizas de forma sostenible. Published ob Valencia Plaza

https://valenciaplaza.com/disenan-contenedor-movil-agricultores-procesen-frutas-hortalizas-forma-sostenible

- AINIA diseña un contenedor movil para procesar frutas y hortalizas de manera local y sostenible. Published on Poscosecha
- Diseñan un contenedor móvil para que agricultores locales puedan procesar frutas y hortalizas. Published on Agrodiario Huelva

https://agrodiariohuelva.es/disenan-un-contenedor-movil-para-que-agricultores-locales-puedan-procesar-frutas-y-hortalizas/

- Diseñan un contenedor móvil para que agricultores locales procesen frutas y hortalizas de manera sostenibles. Published on Gente Digital

http://www.gentedigital.es/valencia/noticia/3260807/disenan-un-contenedor-movil-para-que-agricultores-locales-procesen-frutas-y-hortalizas-de-manera-sostenibles/

- AINIA diseña un contenedor móvil para procesar f&h de manera local y sostenible. Published on Fruittoday Magazine.

https://fruittoday.com/ainia-disena-contenedor-movil-para-procesar-fh-de-manera-local-y-sostenible/

- Diseñan contenedores móviles para que agricultores locales puedan procesar sus frutas y hortlizas de forma sostenible. Published on Fresh Plaza.

https://www.freshplaza.es/article/9374185/disenan-contenedores-moviles-para-que-agricultores-locales-puedan-procesar-sus-frutas-y-hortalizas-de-forma-sostenible/

- AINIA diseña un contenedor para que agricultores locales puedan procesar sus frutas y hortalizas de forma sostenible. Published on Financial Food.

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https://financialfood.es/ainia-disena-un-contenedor-para-que-agricultores-locales-puedan-procesar-sus-frutas-y-hortalizas-de-forma-sostenible/

- AINIA diseña un contenedor movil para que agricultores locales puedan procesar sus frutas y hortalizas de manera sostenible. Published on Agronews CV.

https://www.agronewscomunitatvalenciana.com/index.php/ainia-disena-un-contenedor-movil-para-que-agricultores-locales-puedan-procesar-sus-frutas-y

- AINIA diseña un contenedor móvil para que agricultores locales puedan procesar sus frutas y hortalizas de manera sostenible. Published on Cuaderno Agrario.

https://cuadernoagrario.com/?p=33594

- Diseñan un contenedor móvil para que agricultores locales procesen frutas y hortalizas de manera sostenibles. Published on NoticiasDe

https://www.noticiasde.es/comunidad-valenciana/disenan-un-contenedor-movil-para-que-agricultores-locales-procesen-frutas-y-hortalizas-de-manera-sostenibles/

- Diseñan un contenedor móvil para que agricultores procesen frutas y hortalizas de forma sostenible. Published on Castellon Castilla.

https://castellonplaza.com/diseanuncontenedormovilparaqueagricultoresprocesenfrutasyhortalizasdeformasostenible

- Diseñan un contenedor móvil para que agricultores procesen frutas y hortalizas de forma sostenible

https://alicanteplaza.es/disenan-un-contenedor-movil-para-que-agricultores-procesen-frutas-y-hortalizas-de-forma-sostenible1

- Diseñan un contenedor móvil para que agricultores locales procesen frutas y hortalizas de forma sostenible. Published on Europa Press.

https://www.europapress.es/comunitat-valenciana/innova-00214/noticia-disenan-contenedor-movil-agricultores-locales-procesen-frutas-hortalizas-manera-sostenibles-20211116113203.html

- Diseñan un contenedor móvil para que agricultores locales procesen frutas y hortalizas de forma sostenible. Published on 20 Minutos.

https://www.20minutos.es/noticia/4892569/0/disenan-un-contenedor-movil-para-que-agricultores-locales-procesen-frutas-y-hortalizas-de-manera-sostenibles/

- AINIA diseña un contenedor móvil para que los agricultores locales procesen frutas y hortalizas de forma sostenible. Published on Agrodiario.

https://www.agrodiario.com/texto-diario/mostrar/3307983/ainia-disena-contenedor-movil-agricultores-locales-procesen-frutas-hortalizas-forma-sostenible

- AINIA diseña un contenedor movil sostenible para los agricultores. Published on Frutas y hortalizas.

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https://fyh.es/ainia-disena-un-contenedor-movil-para-los-agricultores-sostenible/

- Envasado y pelado a pie de campo. Published on Newspaper Levante – El mercantil Valenciano

https://www.levante-emv.com/el-mercantil-valenciano/2021/11/21/envasado-pelado-pie-campo-59758386.html

- Diseñan un contenedor móvil para procesar sus frutas y hortalizas de manera sostenible

https://www.foodnewslatam.com/paises/4964-europa/11775-dise%C3%B1an-un-contenedor-m%C3%B3vil-para-procesar-sus-frutas-y-hortalizas-de-manera-sostenible.html

- Téléchargez l'appli FOX ! Published on La gazette (Agroparc Avignon).

5.3 Section on www.effost.org

A specific section about the project has been created on www.effost.org, EFFOST´s website and this section redirects to the FOX project website:

https://www.effost.org/about+effost/projects/1591182.aspx?t=FOX-Food-In-A-Box

Mutual links have been established with project partners' websites and other organizations working or with interest in this area.

https://www.effost.org/insights/News/1944338.aspx?t=The-four-FOX-Food-Circles-

https://www.effost.org/insights/News/2522085.aspx?t=FOX-final-conference--Small-Scale-Big-Impact-Innovative-Approaches-for-Local-Food-Processing

5.4 EFFoST's social media channels

EFFOST´s social media department supports partner EUFIC as part of the communication and outreach programme towards the food science and technology community. This comprises Twitter activities (2771 followers), Facebook (2400 followers), and LinkedIn (11346 followers). Tailored messages are disseminated via these channels in order to reach food science and technology target audiences and wider dissemination through multiplying effects.

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5.5 Practice abstracts

Practice abstracts for each of the four FOX model regions were prepared based on major scientific developments in the FOX project. These practice abstracts summarized the results of the modular/mobile unit approach and highlighted the project's contribution to practitioner challenges as well as its potential for extension and replication in other regions.

The practice abstracts will be published on the FOX website (Leaflet FOX results, PressKit/Resources).

Practice abstract 1 - Low oxygen juice extraction and mild preservation

Problem

Juice preservation typically involves application of heat treatment, which can lead to quality decline and undesirable changes in nutrition, taste, and structure. An alternative method called Pulsed Electric Field (PEF) offers a less heat-intensive approach. However, the application of PEF technology is currently limited to preserving high-quality juices and smoothies, with only a few machines commercially available. Traditional methods for juice extraction still prevail, sometimes incorporating aroma recovery during deaeration.

Solution

Designing a small-scale, mobile, and flexible unit for fruit processing involves integrating downscaled technologies to ensure ease of use across various locations, raw materials, and final product requirements. The FOX mobile unit is designed for extracting fruit juices and purees in an oxygen-reduced environment. This innovative extraction system is coupled to a gentle preservation - Pulsed Electric Field (PEF), ensuring improved quality, while offering maximum flexibility for various applications.

Benefits

- The production line is automated and has a maximum capacity of 250 L/h, with the potential to be extended to 500 L/h.
- The processing line can process stone fruits like apples, pears, and quince, as well as berries such as strawberries, blackberries, raspberries etc.
- The unit is highly flexible and capable of producing juice ranging from slightly turbid to sauce and/or puree consistency.
- The yield of the unit varies depending on the desired consistency, with approximately 80% for almost clear apple juice.
- The juice is 100% directly pressed from fruit, with no additives, and has a fresh appearance, taste, and aroma, while keeping its nutritional quality.

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Practical recommendations

The concept of the FOX mobile juice unit is shown in Figure 1.

- The processing line is designed for operation by a minimum of two people. One person should be responsible for operating the entire processing line from a control panel (1).
- Fruits and vegetables (or mixtures) are manually fed into the elevator (3).
- The elevator washes and transports the produce directly to the funnel of a multi-crush unit (4). In the multi-crush unit, fruits and vegetables are crushed in the presence of nitrogen to reduce contact with oxygen.
- The resulting mash is then transported to the vacuum spiral filter press (6).
- The juice is pulled out by the vacuum through the sieve surrounding the spiral filter press. The extracted juice is transported to a product buffer tank (7). When the tank is filled with over 50 L of juice, it is pumped from the tank into the LHS.
- The juice is pre-heated in the LHS (10) to the desired temperature (typically not higher than 40 °C) before being pumped into the PEF system (9).
- After the PEF preservation step, the juice is immediately cooled down to the desired temperature. Cooling the juice helps reduce thermal load and prevent loss of thermally sensitive compounds (usually below 20 °C).
- The cooled juice is collected in a second tank (12), referred to as the product tank.
- From the product tank, the juice can be pumped to the filling unit (13). The filling unit supports two options: (1) 5-L BAGinBOX or (2) diverse size glass bottles.

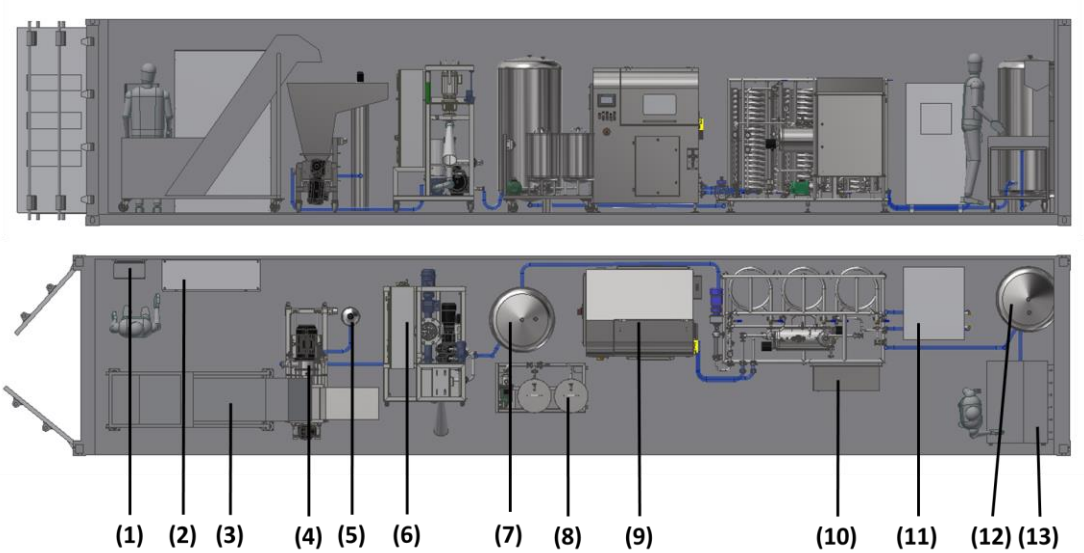

***Figure 1**. The concept of FOX mobile juice unit: (1) Control Panel, (2) Electric Cabinet, (3) Elevator, (4) Multi-crush unit, (5) Nitrogen bottle, (6) Vacuum spiral filter press, (7) Juice buffer tank, (8) Mobile CIP unit, (9) Pulsed electric field (PEF) unit, (10) Liquid handling system (LHS), (11) Cooling unit, (12) Juice storage tank, (13) Filling unit.*

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Environmental impact

The environmental impact of the FOX mobile juice unit has been compared to conventional systems using traditional pressing and thermal pasteurization technologies. Both systems were operated at their optimal production capacity level. The main environmental impacts were linked to apple cultivation and energy usage for juice processing. The conventional system produced more waste (pomace) and had a lower juice yield compared to the FOX mobile juice unit. FOX mobile juice unit was 20% more environmentally friendly than a similar small-scale stationary processing line. Changes in transportation and operation scenarios had minimal effects on environmental performance but reducing the distance of fruit transportation proved advantageous. Although the type of apple juice produced was the same, variations in extraction and preservation technologies resulted in differing quality.

Further information

Videos

https://www.youtube.com/watch?v=_dnPNjSzA0k

https://www.youtube.com/watch?v=RN-j8xpGwrk

https://www.youtube.com/watch?v=kNOO6xRi6A8

Further readings

Zdravkovic M., Snoeck E.R., Zicari A., Vranken L., Heinz V., Smetana S., Aganovic K. (2021). Sustainability assessment of mobile juice processing unit: Farmers perspective. *Future Foods*. 4, 1-8.

Weblinks

https://foxlink.app/

About this practice abstract

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Practice abstract 2

Sustainable, low-temperature drying technologies for soft fruits, vegetables, mushrooms, and their derivatives

Problem

Non-thermal technologies (PEF, HHP, and US) impact air drying kinetics, but limited knowledge exists about physicochemical characteristics of air-dried fruits, vegetables, and mushrooms. Little research explores non-thermal pre-treatment combined with

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unconventional drying methods (microwave, infrared, or vacuum drying) and its effects on kinetics and product quality. Dehumidified air drying preceded by non-thermal technologies lacks data on process kinetics and product quality. Scaling up non-thermal processing as a pre-treatment prior to drying remains unexplored beyond lab -scale.

Solution

Developing a mobile and flexible drying unit that integrates non-thermal pre-treatment techniques with conventional and unconventional drying systems. This innovation enhances process kinetics and improves the quality of dried plant material, enabling the utilization of unstable plant-origin materials. The drying unit enables pilot-scale production and can operate both with and without the application of PEF pre-treatment. This versatility allows for flexible utilization, depending on the user's specific requirements and capabilities.

Benefits

- The drying unit can efficiently accommodate different production needs by handling a wide range of batch sizes (25-200 kg).
- Both infrared (IR) and convective drying (CD) options enable the drying of diverse products, including those with different moisture levels or heat sensitivities.
- The rotating sieve improves product quality, consistency, and throughput by evenly distributing products while drying, reducing variations, and shortening drying times.

Practical recommendation An infrared-assisted air-drying unit was designed and put into the final conception model (Figure 1). The final conception of the designed drying unit has a total area available for drying of 19.2 m^2 that fits into the container size chosen.

- Consider the effectiveness of industrial dryers: industrial dryers typically have an effectiveness of 80%.
- Calculate power requirement by determining the amount of water that needs to be evaporated to reduce moisture to 15% (d.w.). In this case, the calculated power requirement is 35.4 kW.
- To optimize drying, use the temperature regulation and airflow regulation fan. The machine operates between 0-280 ºC with a maximum power supply of 55 kW. For optimal efficiency, it is recommended to use approximately 30 kW.
- Use the rotating platform in the dryer to enhance the drying process. It rotates the trolley with screens, leading to better processing uniformity.
- Implement PEF as an optimal pre-drying treatment in the process line to reduce energy consumption and enhance the quality and taste of the final product. The PEF unit was designed to be compact, easy to operate, clean, and flexible.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817683.

- The drying system includes stainless-steel tables for preparation, slicers for cutting, a sealer for packaging, and electric curtains instead of heavy side doors to avoid potential harm.

Environmental impact

The production of FOX dried apples has several environmental impacts. Air contamination contributes to climate change (28.99%), while water contamination causes eutrophication (23.87%), acidification (8.97%), and ecotoxicity (6.96%). Water contamination accounts for 39.8% of the total environmental score. The use of fossil resources contributes 15.56% to the endpoint score. The processing stage, mainly due to electricity use, is the primary contributor to all impact categories, accounting for 97% of the overall impact. Agricultural production, other production, consumption, and distribution have negligible effects. The application of low temperature drying in France, utilizing nuclear, hydro, and wind power, appears to be the most promising solution. The Czech Republic and Poland have similar results, while Spain, the Netherlands, and Germany have lower impacts.

Figure 2. *The drying unit including the PEF pre-treatment unit inside the container and all auxiliary devices.*

Further information

Videos

https://www.youtube.com/watch?v=dHb1OgEN1QQ&t=1s

Further readings

Matys A., Dadan M., Witrowa-Rajchert D., Parniakov O., Wiktor A. (2022). Response Surface Methodology as a Tool for Optimization of Pulsed Electric Field Pretreatment and Microwave-Convective Drying of Apple. *Applied Sciences*, 12, 3392.

Weblinks

https://www.fox-foodprocessinginabox.eu/foxlink-app/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817683.

About this practice abstract

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Practice abstract 3

Innovative quality analyses and sustainable packaging for fresh fruit and vegetable snacks

Problem

Variability in breathing characteristics of fresh-cut products affects their shelf life without adjustable conditioning. Adapting conditioning methods, like adjusting headspace composition and micro perforation density, is crucial but challenging for optimal preservation. Research on characterizing and conditioning under industrial conditions, especially for complex ripening mechanisms in product mixtures, is lacking. Simple, flexible, and mobile systems are needed for characterization and conditioning. Furthermore, establishing the relationship between individual fruit and vegetable characteristics and packaging material gas permeability is a preservation challenge for product mixtures.

Solution

Development of a sustainable packaging system for fresh fruits and vegetables snacks. The system adapts to the quality of raw materials, using minimal processing and small-scale packaging units. The secondary packaging is made of a new biocomposite with recycled cork. The quality of fresh fruits and vegetables and new sustainable packaging systems (primary and secondary) for the preservation and distribution of fresh fruit and vegetable snacks that are produced are analyzed and packed in small-scale and mobile units.

Benefits

Benefits of primary packaging:

- Designed to be compostable by using PLA.
- Incorporating rPET from post-consumer trays (50%).
- Optimizing the quantity of material used for producing the trays.
- Using a recyclable material for the tray (PET) and the lid (PO).

Benefits of secondary packaging:

- Incorporating recycled post-consumer cork.
- Designing for being reusable.
- Designing for being recyclable or compostable (at the end of the life product).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817683.

- Designing using materials from renewable sources.

Practical recommendations

Prioritize thoughtful fruit and vegetable selection based on regional varieties, seasonality, and consumer preferences to cater to your target market's specific tastes.

Pay attention to the quality of raw materials, making sure that they are not damaged and have the appropriate level of maturity.

Primary packaging

In the case of bags, the use of coatings derived from natural extracts demonstrates good compatibility with PLA, which is commonly utilized in bag manufacturing. Moreover, it is crucial to establish the ideal theoretical microperforation level for various product combinations in order to guarantee optimal performance and the preservation of the bag's contents.

In the case of trays and bowls, four designs were defined, and a significant breakthrough was achieved by producing a preseries for each design using a rPET sheet containing 50% post-consumer recycled content derived from pots, tubs, and trays. This accomplishment marks a significant milestone in sustainability. Additionally, the necessary microperforation for the lids was determined for each product combination. Lastly, a commercial coating was selected to ensure reclosability for these packaging solutions.

Secondary packaging

The extrusion compounding process will also serve to validate the material's processability initially. The PHBV and granulated postconsumer cork in pellet form is introduced through the primary hopper, while the powder additive is incorporated through the secondary hopper. Within the secondary hopper, the polymer is melted. The resulting compound is obtained in pellet form, making it suitable for various processes such as injection molding. Twin-screw extruders, known for their superior mixing capabilities, enable efficient blending at lower melt temperatures.

The cork (alveolar part) was successfully incorporated into the PHBV material, showing no signs of adhesion problems. The pellets exhibited a uniform appearance, indicating successful incorporation. Analysis of SEM images further confirmed the robust adhesion between PHBV and cork, with minimal occurrence of cavities or holes that could impede the processing phase.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817683.

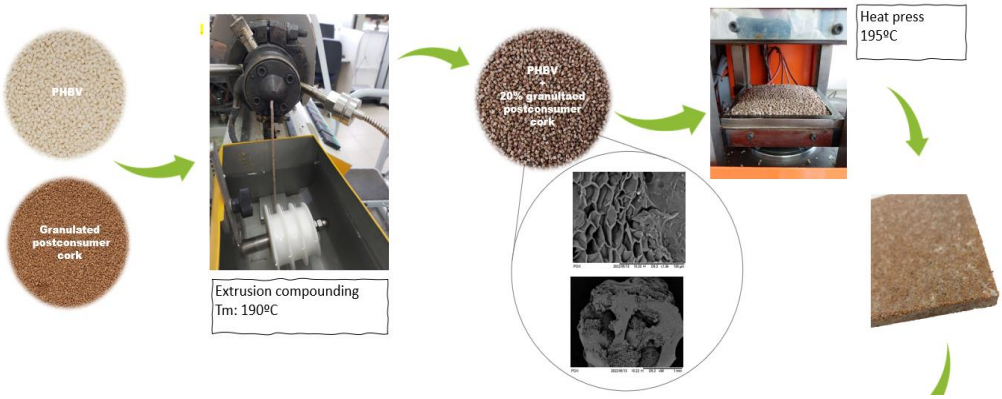

Figure 3. *Secondary packaging – material for reusable transport boxes*

Further information

Videos

https://www.youtube.com/watch?v=DmgCApXSpHk&t=59s

Weblinks

https://www.fox-foodprocessinginabox.eu/foxlink-app/

About this practice abstract

Authors: Leonor Pascual[1], Lucian Miron[2]

[1] AINIA

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Practice abstract 4

Upcycling of plant-based food side streams using mild processing

Problem

Food side streams have the potential for use in food products but can quickly become non-food grade due to handling, storage, quality deterioration, and microbial spoilage. Upcycling these side streams enhances the sustainability of the food chain. One way to prevent this transition is by processing them directly into sustainable applications like ingredients, food products, or feed. However, the feasibility and economic viability of this approach are not always guaranteed. A major obstacle is the limited stability of fruit and vegetable side streams, in such cases, using stabilizing pre-processing techniques can be a practical alternative.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817683.

Solution

The use of mild processing technologies for further processing can result in ingredients with good quality and functionality. Mild processing methods and research on upcycling plant-based side streams aim to preserve natural ingredients, produce high-quality products, and reduce food waste. Understanding upcycling is essential for companies making decisions about food loss and waste. This includes estimating costs, examining material properties, and considering the impact of processing choices, material variations, and uncertainties. The *Processtimator* software tool assists in designing and analyzing upcycling pathways, considering various factors influencing costs and material properties.

Benefits

- Determine and design potential process routes for converting a side stream into valuable ingredients.
- Perform mass balance calculations to determine the composition of the end products and estimate their value as feed.
- Estimate the necessary process resources, costs, and carbon dioxide equivalent footprint.
- Conduct variation analysis to facilitate optimization and comparison of different scenarios.
- Provide feasibility analyses and propose process solutions in a report.

Practical recommendation Improving resource use efficiency by upcycling food side streams may improve the sustainability of food chains. The Processtimator aids in selecting the upcycling options that are economic of interest and result in a net positive contribution to sustainability. Furthermore, it provides insight into the factors which influence the potential of upcycling the most. These results and insights are essential to encourage side-stream owners and potential users to stimulate resource use efficiency by total use of valuable food materials. The tool can be employed by food processing specialists in short-term advice studies with specific food chain stakeholders, as well as in longer-term research looking into the potential of total use from a broader perspective.

The *Processtimator* is implemented with careful consideration of the necessary factors for sustainable and reliable process knowledge and data sourcing, as shown in Figure 3.

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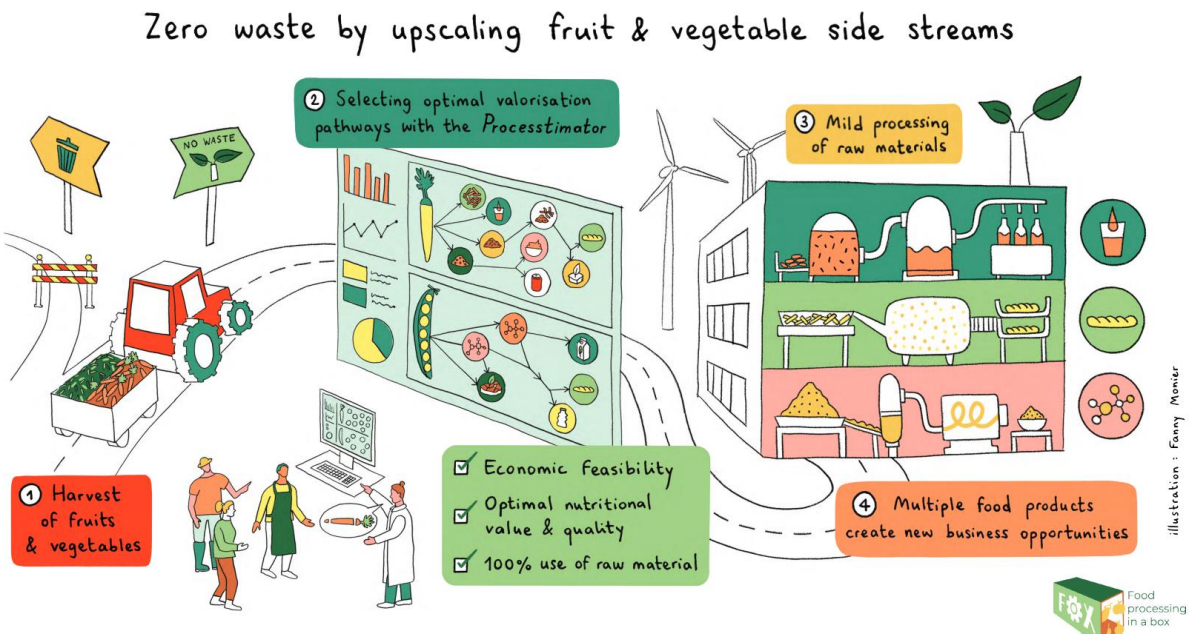

Figure 3. *Key aspects that are part of the implementation of the Processtimator*

The key components of the *Processtimator* are:

- Upcycling of side streams: The tool considers further processing or assigning a use to fractions of materials that are not intended to be the final product, taking into account associated costs and benefits.
- Modular process design: Each process step has inputs and outputs, allowing for interchangeability and automatic generation of outputs.
- Process selection advice: The tool incorporates knowledge of suitable processes for food materials, providing advice based on material characteristics.
- Emphasis on mild processing: The tool includes a range of processing technologies, with a focus on milder methods such as dry separation and use of pulsed electrical fields.
- Integration with databases: Relevant information on food side stream composition, economic value, and processing costs is obtained from external databases.
- Multiple outputs: The tool provides information on production costs, energy and water use, auxiliary materials, fraction quality, and CO_2-equivalent footprint.
- Scenario analyses: Different types of scenario analyses can be conducted, exploring the effects of input volumes, starting material composition, and process yields.
- Expert tool: The *Processtimator* is designed for food technologists with sufficient knowledge in food processing, allowing them to modify process settings and override default values.

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Environment impact

A key aspect to consider in upcycling side streams is the environmental impact. The process pathways obtained with the *Processtimator* are therefore analysed on environmental impact expressed in a kilogram of CO_2 equivalents. This impact is compared with the impact of the current use of the side streams, such as composting, anaerobic digestions, and use as feedstock to be able to determine if the upcycling results in a net positive contribution to the important aspect of sustainability.

Further Information

Further readings

Home - FOX (fox-foodprocessinginabox.eu)

Link to VMT article (Dutch): https://www.vmt.nl/59588/zijstromen-hergebruiken-intelligente-tool-schat-de-processingkosten?giftCode=G4mOtcNYupdLvDLVdTkqgrTFT9dS8EPasMveniRlaSdUtAbpHEWBepMO5LlCa-Nn&social=copy

Weblinks

https://foxlink.app/

About this practice abstract

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[1] Wageningen University

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5.6 Participation to conferences

EFFOST annual conferences and related events such as ISEKI were used to both disseminate FOX results and support partners in presenting specific outcomes (e.g., poster presentations etc.). Where possible and appropriate, FOX-related workshops were organized to tap into the expertise and experience of the audience of these events. Such workshops were designed to disseminate ongoing findings from the FOX approach but also to encourage feedback, input, and comments from the food science and technology audience.

The first event under this activity was planned at the **35th EFFoST International Conference**, 1-4 November 2021, Lausanne, Switzerland. A joint workshop with the EU project Shealthy took place at this conference. The 35th EFFoST International Conference explored the theme: Healthy Individuals, Resilient Communities, and Global Food Security. This is further examined in the below-mentioned sub-themes that highlight the expertise of our conference hosts.

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Advancing Science for Shifting Consumer Trends

- Food product design in times of uncertainties: technologies for affordable, shelf-stable products
- Food & nutrition to enhance the resilience of individuals and societies.

Shaping Robust and Flexible Supply Chains & Manufacturing Setups

- Technologies for decentralized and modular food processing
- Safety, Authenticity, Sanitation in Innovative Food Processing
- Towards Food Industry 4.0

Engineering Affordable and Sustainable Nutrition Solutions

- Food technology for low cost & high nutritional value
- Biodiversity for healthier diets: alternative proteins, ancient ingredients, minimum processing
- Plant-based vs. animal-based protein: ingredients, processing, nutrition, and liking.

The second event under this activity was organised at the **37th EFFoST International Conference**, 6-8 November 2023, Valencia, Spain, name of the special session was "FOX: Small-Scale, Big Impact – Innovative Approaches for Local Food Processing". The session was co-chaired by Ariete Matser from Wageningen University & Research and Jeroen Knol from EFFoST. The special session included the following 5 presentations and panel discussions:

1: FOX: Food Processing in a BOX. Innovative mild technologies for short food supply chains

Ariette Matser

Wageningen University & Research, Wageningen, The Netherlands.

2: Low oxygen juice extraction and mild preservation with PEF in a mobile container

Kemal Aganovic[1,2]

[1]DIL German Institute of Food Technologies e.V. Quakenbrück, Germany

[2]Institute of Food Quality and Food Safety, University of Veterinary Medicine Hannover, Hannover, Germany

3: Low-temperature drying combining PEF pretreatment with mild drying in a mobile container

Malgorzata Nowacka, Aleksandra Matys

Warsaw University of Life Sciences, Institute of Food Sciences, Department of Food Engineering and Process Management, Warsaw, Poland

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817683.

4: Innovative quality analyses and sustainable packaging of fresh fruit and vegetables in a mobile container

Leonor Pascual and Mª Paz Villalba

Ainia, Spain

5: Upcycling plant side streams using mild processing: advise of the FOX *Processtimator* tool on the feasibility of an additional washing step for industrial carrot and ginger juice extraction

Martijntje Vollebregt and Joanne Siccama

Wageningen Food & Biobased Research, Wageningen, The Netherlands

Panel discussion with panel members and the public - Impact of the FOX approaches: sustainability, business opportunities, consumer engagement.

Erika de Keyser[1], Ewa Doenitz[2], Ekaterina Salnikova[3], Ariette Matser[4]

[1]KU Leuven, Leuven, Belgium

[2] Fraunhofer Institute for Systems and Innovation Research ISI, Karlsruhe, Germany,

[3]Aarhus University, MAPP Centre, Aarhus, Denmark,

[4]Wageningen University & Research, Wageningen, Netherlands.

Next to the above-mentioned scientific conferences, partners have participated in **other conferences to promote the FOX project**:

- EFFoST Conference 2019, Rotterdam, Netherlands
- 5th PEF School, Cesena, Bologna
- Pulsed Electric Fields Advantage Demo Days, Quakenbrück, Germany
- Food Tech - Food Science Sweden conference, Lund and Alnarp, Sweden
- Fruchtwelt fair in Friedrichshafen, Bodensee (Lake Constance), Friedrichshafen, Germany
- 12 International Conference on Life Cycle Assessment of Food October 13, 2020 - October 16, 2020
- 3rd F&V Processing conference
- SHE Symposium 2021, online
- Ogólnopolska Konferencja Młodych Naukowców - VIII EDYCJA, Warsaw, Poland, 2021, online
- III Konferencja Doktorantów pt. „Cztery Żywioły - współczesne problemy w naukach o życiu”, Lublin and Warsaw, Poland, 2021, online
- Ultrasonic 2021, online
- Scientific session of the Young Scientific Staff Section of PTTZ and VIII International Session of Young Scientific Staff 2021, 20-21 of May 2021

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- XLV Sesja Naukowa Komitetu Nauk o Żywności i Żywieniu Polskiej Akademii Nauk, 2021, Gdansk, Poland
- XIV Konferencja Naukowa z cyklu „Żywność XXI wieku”, 2021, Cracow, Poland
- The 10th International Symposium „Euro-Aliment 2021”, 2021, Galati, Romania, online
- III Seminario de sensibilización por un sistema alimentario sostenible para una alimentación saludable "Frutas y verduras, todo por ganar y nada que perder, 2021.
- ELLS Scientific Student Conference 2021, Warsaw, Poland, online
- IV Konferencja Doktorantów pt. „Cztery Żywioły - współczesne problemy w naukach o życiu”, Lublin, Poland, online
- Fruchtwelt Bodensee 2022, online
- Wydział Technologii Żywności SGGW / Instytut Nauk o Żywności SGGW w Warszawie, 2022
- IFMRS - International Food Marketing Research Symposium, 2022
- VII Sympozjum Inżynierii Żywności, Warsaw, Poland, 2022
- Global Food Summit, Munich, 2022
- 15th Baltic Conference on Food Science and Technology „FOODBALT-2022”, Kaunas, Lithuania
- 36th EFFoST International Conference 2022, Dublin, Ireland
- Food Symposium 3.0, Baton Rouge, Louisiana, USA, online
- 14th International Conference on Agrophysics, Lublin, Poland

Extract of oral /poster presentations given; full list of conference proceedings is after project end available on: https://cordis.europa.eu/project/id/817683/results.

5.7 Articles in specialized magazines and journals

Whenever possible major scientific developments were disseminated by partners through articles in specialized magazines and journals for relevant audiences (e.g., New Food and Trends in Food Science & Technology which is associated with EFFOST) but also in non-scientific and non-peer-reviewed publications (popularised publications).

Articles published in M1-M54:

- The research in the Institute of Food Sciences, Agricola, Magazine published by WULS-SGGW.
- La innovación como herramienta fundamental para el desarrollo de envases más sostenibles, Technical magazine "Valor ecológico" nº 80, AINIA, https://www.ecovalia.org/index.php/comunicacion/publicaciones-2

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- Thinking outside the box on sustainability published on Eurofruit's magazine. https://www.fox-foodprocessinginabox.eu/wp-content/uploads/2022/02/p.36-37.pdf
- Innovación y tendencias en envases y embalajes para frutas y hortalizas published in Revista Mercados. https://revistamercados.com/innovacion-y-tendencias-en-envases-y-embalajes-para-frutas-y-hortalizas/
- FOOD PROCESSING IN A BOX - šance pro malé zpracovatele published in Journal Selska revue. https://www.fox-foodprocessinginabox.eu/wp-content/uploads/2021/12/Selska-revue-journal.pdf
- Trends im europäischen Lebensmittelsektor für das Jahr 2035. Der Lebensmittelbrief (2020, 31. Jahrgang, p.35). https://www.fox-foodprocessinginabox.eu/wp-content/uploads/2020/06/FOX-article-Levensmittelbrief-03-2020.pdf

5.8 Scientific publications

Opportunities for participants to publish FOX research in leading scientific journals and present at scientific conferences were identified and monitored by WR with support from the other partners, in order to maintain a database of publications from the project. All publications were published in open-access (gold or green). Project partners were further encouraged to share their research via the ResearchGate community (e.g., more than 80,000 European food scientists currently have a profile there) to disseminate their findings further, make them accessible to the scientific community, and engage the food science network. A session at each annual project meeting was focused on identifying research findings suitable for publication during the following year (and appropriate journals), together with potential conference opportunities for disseminating research to academics.

Scientific articles in peer-reviewed journals

- Selected Quality Parameters of Air-Dried Apples Pretreated by High Pressure, Ultrasounds and Pulsed Electric Field—A Comparison Study. Artur Wiktor, Aleš Landfeld, Aleksandra Matys, Pavla Novotná, Magdalena Dadan, Eliška Kováříková, Malgorzata Nowacka, Martin Mulenko, Dorota Witrowa-Rajchert, Jan Strohalm and Milan Houška. Foods (2021). https://www.mdpi.com/2304-8158/10/8/1943
- Influence of Ultrasound and the Conditions of Convective Drying with Dehumidified Air on the Course of the Process and Selected Properties of Apple Tissue. A Matys, A Wiktor, M Dadan, D Witrowa-Rajchert. Foods (2021). https://www.mdpi.com/2304-8158/10/8/1840
- Measures to Increase Local Food Supply in the Context of European Framework Scenarios for the Agri-Food Sector. Voglhuber-Slavinsky, A., Derler, H., Moller,

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B., Dönitz, E., Bahrs, E., & Berner, S. Sustainability (2021). https://www.mdpi.com/2071-1050/13/18/10019

- Sustainability assessment of mobile juice processing unit: Farmers perspective. Zdravkovic, M.;, Snoeck, E.R.; Zicari, A.; Vranken, L.; Heinz, V.; Smetana, S.; Aganovic, K. Future Foods (2021). https://www.sciencedirect.com/science/article/pii/S266683352100054X?via%3Dihub
- Response Surface Methodology as a Tool for Optimization of Pulsed Electric Field Pretreatment and Microwave-Convective Drying of Apple. A Matys, M Dadan, D Witrowa-Rajchert, O Parniakov, A Wiktor. Applied Sciences (2022). https://www.mdpi.com/2076-3417/12/7/3392
- Application of pulsed electric field prior to vacuum drying: Effect on drying time and quality of apple tissue. A Matys, D Witrowa-Rajchert, O Parniakov, A Wiktor. Research in Agricultural Engineering (2022). https://www.agriculturejournals.cz/pdfs/rae/2022/02/04.pdf
- Setting life cycle assessment (LCA) in a future-oriented context: the combination of qualitative scenarios and LCA in the agri-food sector. A. Voglhuber-Slavinsky; A. Zicari; S. Smetana; B. Moller; E. Dönitz; L. Vranken; M. Zdravkovic; K. Aganovic; E. Bahrs. European Journal of Futures Research (2022). https://eujournalfuturesresearch.springeropen.com/articles/10.1186/s40309-022-00203-9
- Impact of Pulsed Electric Field Treatment on the Process Kinetics and Selected Properties of Air and Dehumidified Air-Dried Mushrooms. Dadan, M.; Baranska, A.; Matys, A.; Rybak, K.; Witrowa-Rajchert, D.; Wiktor, A.; Nowacka, M. Processes (2023). https://www.mdpi.com/2227-9717/11/7/2101
- Assessment of the effect of air humidity and temperature on convective drying of apple with pulsed electric field pretreatment. A Matys, D Witrowa-Rajchert, O Parniakov, A Wiktor. LWT (2023). https://www.sciencedirect.com/science/article/pii/S0023643823010344?via%3Dihub
- Suitability of different electrode materials for Pulsed Electric Field (PEF) application. Zdravkovic, M.; Juadjur, A.; Pasch, K.; Heinz, V.; Bindrich, U.; Wiktor, A.; Aganovic, A.; Innovation Food Science and Emerging Technologies (in progress).

Other scientific publications

Next to scientific presentations (oral , poster) on conferences as reported under 5.6, further non peer-reviewed scientific publications were done:

- Brochure: 50 trends influencing Europe's food sector by 2035 (2019). Björn Moller, Ariane Voglhuber-Slavinsky, Ewa Dönitz, Aaron Rosa. Fraunhofer Institute

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for Systems and Innovation Research ISI. https://www.isi.fraunhofer.de/content/dam/isi/dokumente/ccv/2020/Fox_Scenario_Brochure.pdf

- Three scenarios for Europe's food sector in 2035 (2020). Authors Björn Moller, Ariane Voglhuber-Slavinsky, Ewa Dönitz. Fraunhofer Institute for Systems and Innovation Research ISI. https://www.fox-foodprocessinginabox.eu/wp-content/uploads/2019/11/50-trends-influencing-Europes-food-sector.pdf
- LOCAL FOOD SYSTEMS - Recipes for future proof business models (2023): Björn Moller, Lorenzo Giacomella, Anna Kirstgen. Fraunhofer Institute for Systems and Innovation Research ISI.

https://www.isi.fraunhofer.de/content/dam/isi/dokumente/ccv/2022/FOX_Local-Food-Systems.pdf

- A local, healthy, and sustainable food factory on wheels (2021): Inge de Bresser. The Project Repository Journal.

https://www.europeandissemination.eu/article/a-local-healthy-and-sustainable-food-factory-on-wheels/17719

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817683.

6. Conclusions

The report on communication with the food technology community under the FOX project has demonstrated significant achievements. The project successfully introduced innovative down-scaled food processing technologies and effectively disseminated these advancements through varied channels like "Taste of Science" articles, social media, conference participation, and scientific publications. This multifaceted communication strategy has had a profound impact on different stakeholders, including SMEs, large industries, food scientists, technologists, policymakers, and the general public, fostering innovation and sustainable practices in the food technology sector.

The project's experiences have yielded valuable lessons, highlighting both successful strategies and challenges faced in engaging diverse stakeholders. These insights are crucial for shaping future communication and research endeavours in the field. Recommendations for ongoing and future initiatives focus on enhancing communication approaches and furthering technological advancements in sustainable food processing.

Overall, the FOX project stands as a pivotal contribution to the evolving landscape of food technology, emphasizing the importance of innovative, sustainable methods in this sector. Its legacy is not only in its technological advancements but also in setting a benchmark for future projects in terms of effective communication and community engagement in the realm of food science and technology.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817683.