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## EXPO SPOTLIGHT: EUBIS

EUBIS and CNR Milan joined forces to create a public workshop at EXPO that highlighted the importance of food waste valorisation, a vast range of practices that add value to and reduce the environmental impact of food waste, all along the supply chain from farm to fork, and beyond.



COST (European Cooperation in Science and Technology) is a pan-European intergovernmental framework. Its mission is to enable break-through scientific and technological developments leading to new concepts and products and thereby contribute to strengthening Europe's research and innovation capacities. [www.cost.eu](http://www.cost.eu)

To compliment the scientific research within the EUBIS COST Action TD1203, it is necessary to disseminate the work and spread the food waste (FW) valorisation story outside of the usual academic circles. EXPO 2015, Milan, presented the network with an opportunity to do just that - especially with such a well-fitting theme as 'Feeding the planet, energy for life'. Over 100 people attended the half-day meeting on Wednesday 5th August 2015, including enzymatic chemists, polymer chemists, agri-food professionals, journalists and even a captain of the Army - many of whom had no previous attachment to the Action but had booked their attendance purely out of intellectual interest. CNR Director of National Chemical Science & Materials Technology Department, Luigi Ambrosio, gave the introduction to the half-day meeting, highlighting the importance of food in all aspects of human life, and the irrational use of FWs in the present compared to the rational uses prevalent in the past. He was hopeful that events like this would help to enhance the sustainable use of wastes and encouraged recognition of the added value that FWs along the management chain can supply. Dr Nicoletta Ravasio then introduced Prof James Clark, as both the chair of the COST Action on FW valorisation and a founding figure in the Green Chemistry movement.

### James Clark - Food waste as a source of renewable chemicals and materials

Prof Clark's presentation firstly introduced to the mixed audience the importance of FWs and their place in the emerging circular economy, which had led to the set-up of two networks - Biowaste Industrial Symbiosis (BIS) and the expanded EUBIS, taking the national network to a European and global scale. Both of these networks use the philosophy that wastes from one industry should go to benefit another, thus changing the inherent

concept of waste. In order to impress upon businesses and policy makers the impact FW utilisation could have, there was a need to assess volumes of available FWs - to compete with stable and well-developed oil refining, stakeholders need to know how much waste is available and where it is. He then explained the FW mapping work that had been done at York, and introduced EUBIS's FW mapping portal to the public for the first time.

Until this point, the mapping had been behind a members-only wall, but this was released as a resource for public audiences at this event. After introducing the interactive database and the ways in which it can be a useful tool for proving the potential of waste valorisation in Europe, Prof Clark then went on to explore some of the global figures that are available regarding food supply chain waste, including 9.4 Mtonnes of citrus processing wastes each year in Brazil, and the illegal burning of 175 Mtonnes of rice straw occurring annually in China. He then introduced the next steps for the FW mapping project - mapping their chemical potential. With 1.3 bn tonnes produced worldwide, the carbon potential of FW is enough to displace all oil-derived chemicals in the market, and almost any chemicals can be made from these wastes - it is now just a case of making these methods environmentally sustainable and economically viable.

The talk was concluded with a brief overview of the Green Chemistry Centre of Excellence's FW research, including the Orange Peel Exploitation Company project.

### Nadia Plata - From food waste to products

The founder of EPTES, Switzerland, introduced her company's work on improving the commercial viability of FW valorisation and shared key lessons for consideration when commercialising such innovations. After a promising process leaves the laboratory, EPTES helps to optimise it at a larger scale, aiding a company in their transformations from waste to useful product, specialising in logistics and patenting. Challenges are identified along the commercialisation pathway, with one major hurdle the local market and waste behaviours - in Switzerland, the main FW management procedure is incineration and bio-oil is the only FW-derived product that is currently tradable.

EPTES focuses on producing food ingredients, nutraceuticals, fragrances and colourants from FW. Production options of these high added value products (HAVPs) can be via chemical or biological means, and as well as

the production technology, there are a vast range of considerations that need to be addressed when putting the techniques into practice. Transportation is a large factor in determining viability of large-scale production. Generally, FWs cost around € 0.2-0.5 per kg to transport, and time limitations add extra complexity. For example, winery waste is only produced around October-November, so forward planning is required to ensure transportation and extraction occurs during this time. Storage time for FW is typically short as it is prone to rotting - infrastructure for freezing/drying is necessary to prolong lifetimes. Odour can be a barrier to commercialisation - health authorities may shut down a large-scale FW processing facility if its construction in a residential area leads to complaints, therefore it is vital to carefully plan the site and foresee potential impacts. Once production is up and running, the product needs to fulfil product quality standards such as stability, and must match the market's standard product as closely as possible (a notoriously tricky feat for bio-derived products). It is vital that the consumer accepts the product - communication is essential for maximising acceptance, making a potentially negative-sounding idea acceptable, or even desirable.

The main obstacles that EPTES's clients face are infrastructure costs, cultural and consumer acceptance, FW composition changes (change year-to-year), lack of knowledge (which is where EPTES's R&D and demo plants come in), political resistance and communication strategies. The importance of setting up a centralised national recycling network for FW is stressed - in Switzerland, all other recycling (card, glass etc) is managed in this way, and a similar system for FW could have a major positive impact. The closing remarks highlighted top tips for encouraging development in the FW valorisation field. Firstly, ensure that your process and products are actually more environmentally friendly than the alternative, through calculation of environmental impact. Creating strong partnerships with producers (of both the FWs and the HAVPs) is important to cement collaboration and minimise complications with transportation and storage - this is also aided by finding companies a way to test processes before investing in expensive new technology. Sound planning is essential to create a viable economic model - firstly ensuring you take developments step-wise and don't immediately commit to high FW volumes, and also planning ahead to make the endeavour run smoothly. Effective communication with consumers is the final key ingredient to ensuring a marketable product is produced.

### **Lucinda Tolhurst - From "supply chain" to "supply cycle": the transformation of dairy processing**

Lucid Insight is a consultancy focusing on turning the supply chain into the supply cycle by diverting wastes back into businesses. The talk's focus was the worldwide dairy industry. UK dairy processing since the 1900s has been dominated by a small number of large companies, whose waste volumes are too large to be distributed to traditional waste management methods (eg, ricotta production, land treatment). Therefore they had to invest heavily in developing effective wastewater treatment methods, and now have to re-invest to upgrade to valorisation.

The USA was a pioneer in dairy waste management - nowadays fractionation of this waste to whey proteins, lactose and phospholipids generates the industry more profit than cheese production. Arla (UK) are a leader in dairy valorisation, producing over a hundred products from their whey - specific isolated proteins and lactoses for nutraceuticals, plus biogas. However, there are still issues surrounding their delactosed whey permeate - this material is very salty and lacks sufficient levels of sugar for



fermentation. Also, the large volumes of water used in washing and milk processing are another source of waste that Arla have yet to address fully. Next, some emerging commercial success stories in this area were showcased. Cellulac, a company in Cambridge (UK) are creating lactic acid from whey for sale on the bulk chemicals market - a similar process is being commercialised in Italy (Egg-plant). Elsewhere, sorbitol and dulcitol from whey are being transformed into bioplastics. The potential of the aforementioned delactosed liquid fraction is being explored in Dublin, where its use as a preservative for foods like tomatoes and strawberries has improved shelf life and maintained nutritional value. In Denmark, NuRe-Sys are transforming dairy wastewaters into fertiliser, and in Wageningen, peptides from wastewaters are being exploited for nutraceuticals.

One way to improve environmental credentials of these new processes is to integrate them with an operational dairy processing plant. Recycling on-site saves money and energy whilst reducing waste - an Israeli company are recovering 80% of their cleaning chemicals from wastewaters, using the clean water for irrigation and putting the chemicals back into cleaning. In Mexico, Nestle's new milk powder plant saves 1.6m litres of water per day compared to previous technologies through in-house water recycling, meaning they no longer need to exploit precious groundwater.

Finally, an idealised circular model for the dairy industry was presented - it was highlighted that to improve environmental credentials even more, we must be careful about the energy inputs (renewable over fossil fuels) and ensure that outputs don't have negative impacts further along the line.

### **Salvatore Raccula - Edible films from shrimp and citrus wastes**

Prior to exploring his prepared presentation, Dr Raccula shared some perspectives on the nature of waste in the food industry, stating that if a system is working properly it is not producing any waste at all. He also shared examples where the original 'wastes' are now in line to be more profitable than the original products, such as a vaccine developed from citrus peels that is being picked up by pharmaceutical companies, and cancer and tumour treatments derived from artichoke and pomegranate that are being licensed by the medical industry. In the case of citrus, juicing companies are re-ordering their processes to ensure maximum extraction of this valuable compound.

The focus of the talk was the work they have been doing on pectin and chitosan. As the relatively easy extraction of chitosan from seafood waste is already quite mature in Italy, especially Sicily, the market has become saturated. So the team combined Sicilian strengths and utilised chitosan as a preservative for prickly pear, local produce that has yet to find a market further afield. The reason for the small geographical scale of the prickly



pear market is that the thick, spiny skin needs to be removed before sale and so the very sugary fruit quickly degrades once exposed to air. Therefore the time from packaging to eating needs to remain quite small. By applying a coating of chitosan solution to the peeled prickly pears, drying and then packaging in a protective atmosphere, the lifetime of the pears is lengthened and thus the scope of transportation and potential market size is expanded. The feasibility of transportation and market expansion was tested with trials to shops outside of the usual market area (Hamburg instead of Milan). A similar practice was attempted with artichoke hearts - another Italian foodstuff with potential to expand geographical market size by enhancing shelf life. By coating them in pectin from FWs, the artichokes could be refrigerated for 24 days - the pectin served as a barrier to acids and oxygen. Questions following the talk included whether the coatings affected taste, to which the answer was no - they had undergone taste tests and difference was not noted. Secondly it was asked if the trials had shown promise of being profitable. This answer was less optimistic - they would not be able to sell the treated pears at a higher price (it wouldn't be accepted by the consumer) so the role of the film was to maximise the amount sold by expanding the market and minimising wastage.

#### Thierry Talou - Fruits and vegetables wastes: the Veggies&Fruit waste valorisation wheel

Dr Talou began by highlighting the importance of treating FW as a source of multiple products, not just one. Single use valorisation is common and relatively unsustainable, with examples such as extraction of benzaldehyde from apricot stones - a useful product from a waste, but ultimately only exploiting a tiny amount of the waste's potential. The Agro-refinery approach that he promotes is different to traditional biorefinery approaches because it aims to incorporate a wide range of bioprocesses as well as more traditional chemical processing.

Examples of projects based on the flavours and fragrances potential of wastes include the Flavoil project, where flavoured vegetal oils are created from vegetable wastes by one-pot extractions of oils and aromatics; the complete use of plum kernels to create benzaldehyde, virgin vegetal oil and agromaterials (trials for furniture applications); and the use of a range of fruit seeds for aromatic vegetal oils, flavoured flours and agromaterials production. An example of a fragrance that can be extracted from seeds is propionaldehyde, green apple smell from apple seeds, which are available in large quantities when making cider. Another interesting waste explored at INPT is fennel, whose extracted oil is very high in petroselenic acid, which makes it very interesting for cosmetics.

Dr Talou then gave an overview of the Veggies&Fruits Waste Valorisation Wheel he has created in collaboration with EUBIS. He approached the net-

work with his idea to create an interactive display where fruits and vegetables were connected to their wastes and the products that can be produced through valorisation. In total, 12 labs from 8 countries contributed resources and information for 7 fruits, 9 vegetables and 1 mushroom. He went on to describe some of the examples of the processes and products displayed on the wheel. From the network and their external contacts, the wheel showcases tomato wastes and their transformation into vegetal flour, lycopene for pharmaceutical uses and plastics for use in cars (a joint project between Heinz and Ford); and grape seed waste for oils, skin extracts for cosmetics and nutraceuticals and prunings for materials.

#### Igles Corelli - Veggie peels, wastes and Cucina Circolare

Nicoletta introduced the meeting's celebrity guest by highlighting that the main source of FW in developed countries is not produced during farming and processing, but is produced post-consumer. This means that there needs to be an emphasis on encouraging consumers to make full use of the foods they buy and to be aware of all the different ingredients one food can provide.

Igles Corelli is a famous Italian chef whose TV programme focuses on Cucina Circolare - Circular Cooking. His ethos is to encourage full use of produce without the need for complex cooking methods like ultrasound, vacuum cooking and water baths, which are unfeasible at home. He uses different parts of the food to create different aspects within the same dish or across a range of dishes. Whole foods are complex entities, which are processed into a range of simpler items for use in other complex entities (meals) - this is his definition of cucina circolare.

In order to demonstrate some examples, he had put together a video made in his restaurant's kitchen. The video highlighted three detailed examples - celery, king red prawns and anchovies. The celery was first split out into all of its constituent parts - outer stalks, leaves, parts close to the root, heart and inner stalks. The inner stalks were peeled, then pureed for the basis of a soufflé and celery cream, with the peels dehydrated to a wafer. The outer stalks were transformed into a broth and a jelly. The heart was chopped up to create a salad. The leaves were dried to create a powder that was then a basis for foams and dried foams. All of these parts were then used in three different celery-based dishes - a sorbet, a salad and a soup, all with a variety of celery elements. This showed that a vegetable that can often be seen as a basic, boring ingredient can be transformed into a range of exciting dishes without wasting a single part.

Igles intends to share his exciting approach to cooking by creating training materials for schools, communicating the message that if you respect produce then you can reduce costs and create exciting, healthy meals with no waste.

After the talk had concluded, Prof Clark asked if there was potential for translating some of these practices into the food processing industry, which deals with huge volumes of FW. Igles noted that in south Italy, a company making prawn carpaccio had approached him about making better use of their wastes, so he showed them how to use prawn heads to make a broth. However, although the company was interested, it was hard to finance and so has not been taken up at this stage.

Nicoletta rounded up the meeting and invited all those attending to have a closer look at the Veggies and Wastes Wheel at the front of the room, and also for those interested in learning more to join us the following day at CNR for the societal impacts workshop and exhibition.