Research Summary Sheet

Deliverable n°: 6.2 (Task 7.1)

"Demonstration trial of integrated technology chain"

Context and Challenges

This Deliverable D6.2 is to report activities done in Task 6.2 in the frame of WP6 "Up-scaling/demonstration". WP6 aims to demonstrate the applicability of NoAW holistic/integrated approach for agro-wastes conversion in conditions close to real ones, and the availability of a new cascading conversion chain of agro-wastes (defined agrowastes, area, season, technologies and targeted markets) ready to be demonstrated in full scale and real conditions with NoAW stakeholders.

In this frame, Task 6.2 is about "Up scaling and demonstration of one agro-wastes cascading conversion technology issued from WP3 and WP4". Task 6.2 aims to demonstrate that it is possible and feasible to upgrade the conventional and "existing" anaerobic digestion towards obtaining more valuable products, which are additional to typical AD products, i.e. biogas and anaerobic digestate. In other words, the minimal target is to obtain at least one bio-based advanced material plus bioenergy and biofertilizers, from the AD-based technology chain.

Results and Applications

Based on preliminary analysis of several alternatives to be possibly scaled up, the following routes have been scaled up in task 6.2

- PHA production (performed at the WP3 pilot scale platform by INNOVEN / UNIROMA)

- Solvent based extraction of polyphenols out of wine pomaces (scaled up and performed by FRAUNHOFER)

- Production of active packaging materials using polyphenols received after solvent based extraction (performed by FRAUNHOFER)

- Utilization of wine pomace extraction residues for production of bio-composites with PHA (performed by FRAUNHOFER)

- Utilization of wine shoots for production of bio-composites with PHA (performed by INRA)

The project leading to this application has funding from European Union's Horizon 2020 research and innovation programme under grant agreement No 688338.

Breakthroughs, benefits and added value

A **big-size pilot-plant for PHA production** was deeply revamped to improve the technical feasibility of several steps. To the present this new plant has been operated for VFA production from organic feedstock with good results in terms of conversion yield and final VFA concentration. On the other hand, the difficulties in VFA purification were not completely solved and prevented the use of VFA mixture for following step of PHA accumulation. Preliminary batch experiments were also done by performing a further filtration of VFA liquid stream at pore size 0.2 um and clean effluent was obtained. Although the capacity of the available machine was too low to be used for routinary continuous cleaning of VFA mixture in the pilot plant, this result anyway indicates the way for further development of the process. As a contingency measure, PHA accumulation was realized by using a synthetic mixture of VFAs (acetic and propionic acid).

- While plant revamping was still pending, as an additional contingency measure, three grades of PHA (namely PHBV) were made available by NoAW partners by using other pilot plants which basically uses the same technology based on microbial mixed cultures. These PHBV grades were deeply characterized and films were prepared. It resulted that the purification of the PHBV powders is a key step to allow the processing of PHBV-based materials. Indeed, the presence of impurities, depending on their nature, even in low amounts, can induce the thermal degradation of materials (production of brown films) and/or the occurrence of macroscopic defects within the films. Although we estimate a good improvement potential in this direction, present materials were considered to not be suitable for following applications, but for IBET grade which showed satisfactory performance by thermopressing filming; however, the amount of IBET grade was too little and, as a contingency measure, commercial PHA was used for development of PHA-based materials.

- The **recovery of bioactive molecules (namely polyphenols)** from red and white grape pomace, by means of solvent based extractions, was successfully scaled up to pilot size (starting from lab-scale results in WP4). Generally, the results of the upscaling trials were rather similar to the results of the lab experiments in WP4, where the yields in lab-scale were 10-25 % higher than during up-scale. Regarding the solvents, it was concluded that acetone is a bigger challenge than ethanol (more safety issues, higher resistance of plant components) which has to be noted for industrial implementation.

- **Polyphenols received after solvent based extraction** were coated on films produced with commercial PHA, by lacquering or spray coating. With spray coated films a high antibacterial effect was obtained. On the other hand, in full media, the dried polyphenol extract dissolved upon exposure to the inoculation suspension, so

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that an application for food packaging seems hardly feasible under the present conditions. Further optimization of active coatings is therefore required, also to transfer the technique from flat films to thermoformed trays.

- As for **biocomposites, vine shoots fillers** were successfully produced at industrial scale by dry fractionation. Then compounding of a commercial grade of PHBV (PHI003) with vine shoots fillers was successfully performed using melt extrusion, using a filler content of 20 wt% (batches of 10 kg). Finally, PHBV-based trays were successfully produced by injection molding. This work demonstrated the up-scaling of the production of PHBV/vine shoots biocomposites, and confirmed the high technical, environmental and economic interests for such materials. These good results need to be confirmed by using PHBV coming from organic feedstock and experiments with IBET grade of PHA are planned.

Further information on NoAW project: *http://noaw2020.eu*

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