Transforming farm residues into biofuels and more

August 14 2015, by Jan Overney

Credit: EPFL – Estelle Antille

To cut the cost of biofuels, their production-process can be enhanced to include additional valuable biochemical compounds. A recent experimental study focuses on one source of biomass: residues from Brazilian palm oil production.

Biofuels still have a long way to go to become sustainable substitutes for fossil fuels. A number of social and environmental hurdles have to be overcome, and crucially, their price has to come down to make them competitive. One way to make the overall process economically viable would be to process the biomass in biorefineries and transform it into additional high value chemicals for the chemical industry. Publishing in the journal *Industrial Crops and Products*, researchers from EPFL

present how one such source of biomass, agricultural residues from Brazilian oil palm plantations, can be used to produce bioethanol and two additional end products: furfural, a much-used industrial compound, and lignin, a solid fuel that can be used in the biorefinery.

Oil palm dates grow in bunches, which are harvested and pressed to extract oil, which is currently used for cooking, cosmetics, and the production of biodiesel, among others. The left over fibrous residues are typically discarded as waste. But as Edgard Gnansounou and Jegannathan Kenthorai Raman from EPFL's Bioenergy and Energy Planning Research Group (BPE) explain, the empty fruit bunches are far from worthless. "You can make at least 30 valuable biochemical compounds using residues from palm oil production," they say.

So are empty palm oil fruit bunches a sustainable source of biomass? And if so, what types of compounds should they be transformed into? These are the kinds of questions that Gnansounou and Kenthorai seek to address in their research. For this particular study, they characterized the composition of the empty fruit bunches and optimized the chemical processes for their transformation. These data will feed into an assessment of the environmental impact and economic cost that such a biorefinery would have.

From oil refineries to biorefineries

"If all you do with the empty fruit bunches is produce bioethanol, it will be too expensive to compete with fossil fuels," they say. "But adopt a biorefinery approach to produce additional compounds that you can sell for a profit, such as furfural, which has many applications in the chemical industry, such as fungicides, special adhesives, flavor compounds and solvents, and you can lower the price of biofuel." But even this, they warn, may not be enough to compete economically with today's cheap fossil fuels.

For now, biorefineries exist as blueprints and computer models. Once mature, they will be capable of process and add value to most forms of agricultural wastes – rice husks, corn stalks and leaves, wheat straw, and green wastes, such as forest and garden residues. Because they all share the same basic make-up, long and shorter chain sugar polymers (cellulose and hemicellulose), and tough, hard to digest lignin, they can all be processed similarly.

Toward sustainable biofuels

Biofuel production has not been free of controversy, as the feedstock can potentially come into direct competition with food crops. But, say the researchers, second generation biofuels can avoid the first issue by only using biomass from non-arable crops or agricultural residues that are commonly incinerated or left on the field. And while in many countries palm oil production has been associated to deforestation and the destruction of natural habitats, policy in place in Brazil specifically promotes the use of degraded land for oil palm plantations.

"There is huge potential for commercial scale biorefineries in the future," the researchers say, citing the European Union's target of having at least 10% transportation fuels from renewable energy sources by 2020 and increased support for bio-based chemicals as positive developments. Scaling up production will involve developing sustainable solutions to round up biomass from farms, plantations, and agricultural processing sites, and improving the efficiency of the biotechnological processes used in the biorefineries.

"As the son of a farmer myself, I am excited about this work, as it adds economic value to something that farmers have a lot of: plant residues," says Kenthorai. The development of biorefineries, he says, has the potential to stimulate the economy of rural societies, creating jobs in the collection, transportation, and processing of agricultural residues, and

these new opportunities could potentially counteract rural exodus in certain communities.

More information: "Furfural production from empty fruit bunch – A biorefinery approach," *Industrial Crops and Products*, Volume 69, July 2015, Pages 371-377, ISSN 0926-6690, dx.doi.org/10.1016/j.indcrop.2015.02.063

Provided by Ecole Polytechnique Federale de Lausanne