New development enables biofuel production from organic waste

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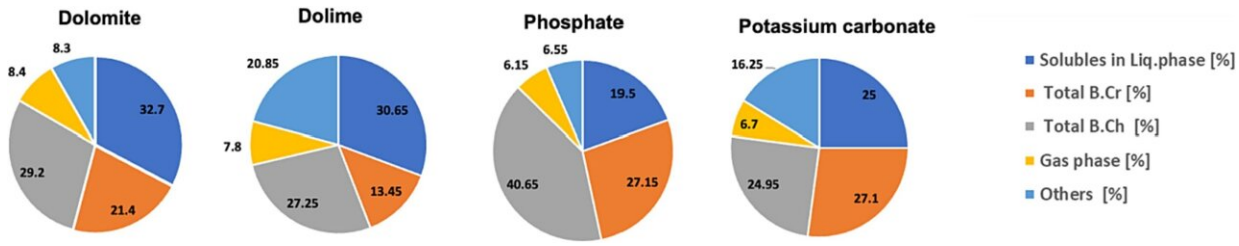

Food waste catalytic HTL product distribution. Credit: *Energy Conversion and Management: X* (2023). DOI: 10.1016/j.ecmx.2023.100475

An innovative development by a team of Tel Aviv University researchers allows for the conversion of the wet raw waste that we throw in the trash into liquid and solid biofuels, without the need to dry the waste. The researchers assess that at the national level, fuels produced from organic waste can, among other things, meet about a third of Israel's marine fuel consumption.

The study was led by Prof. Alexander Golberg of Tel Aviv University's Porter School of Environment and Earth Sciences and was published in the journal Energy Conversion and Management: X. The research was conducted by Ph.D. candidate Maya Mosseri in collaboration with engineer Michael Epstein, Prof. Michael Gozin of the Raymond and Beverly Sackler School of Chemistry, and Prof. Avraham Kribus of the

Fleischman Faculty of Engineering.

Israel's waste problem is escalating. In 2019, the country generated approximately 5.8 million tons of municipal waste, averaging about 1.76 kg of waste per person per day—about 30% more than the European average. This figure increases every year by about 2.6%. Currently, about 80% of household waste in Israel ends up in landfills. Organic waste presents a significant challenge, harming the environment through greenhouse gas emissions, leachate formation, and the pollution of air, water, and soil, often accompanied by unpleasant odors.

"Organic waste emits methane, which is a greenhouse gas, and also contaminates groundwater," explains Prof. Golberg. "The treatment of waste is a critical issue. Landfill sites in Israel are reaching capacity, and despite the desire to reduce landfill to a minimum, we are forced to open new sites, because there is no other solution. The major advantage of our proposal is that we will reduce the need for so many landfill sites. Municipalities invest considerable funds on waste transportation and treatment, and this solution has the potential to significantly cut those expenses."

In order to assess the potential of municipal waste in Israel, the researchers analyzed the results of a groundbreaking 2018 survey conducted by E. Elimelech et al. from the University of Haifa. The survey examined the composition of the garbage produced by 190 households in the city of Haifa over the course of a week.

The findings revealed that measurable organic waste constitutes about 36.4% of food waste and about 16.4% of total household waste. The category of measured organic waste was further analyzed, showing that it comprised 67% fruits and vegetables, 14% breads, pastas and cereals, 8% eggs and dairy products, 5% by-products such as peels and skins, 3% meat, fish and poultry, 2% sweets and cookies, and 1percent soft drinks.

In general, this organic waste contains around 80% water.

"The results of this survey formed the basis for the waste model in our study," says Prof. Golberg. "We built a continuous reactor—which will eventually be adaptable for solar energy usage—to heat the waste to 280 degrees Celsius, and we were able to significantly reduce the amount of water and oxygen in the biofuel.

"We found cost-effective catalysts that make it possible to control the ratio between the liquid and solid fuel products. Solid fuel can be used as biochar, effectively sequestering carbon dioxide for extended periods. The biochar can be burned in power plants like regular coal, and liquid biofuels, after upgrading, can power planes, trucks, and ships."

Using the representative model of the measured organic waste, the TAU researchers successfully produced liquid biofuel with a yield of up to 29.3% by weight and solid fuel with a yield of up to 40.7% based on dry raw material. This process is versatile and suitable for treating any wet organic waste or residue, for example, organic waste from food factories, institutional kitchens, and hospitals.

The researchers conclude, "The production of biofuels from organic waste components can significantly reduce the volume of municipal waste sent to landfills, thereby decreasing environmental pollution of soil, water, and air. Moreover, reducing landfilling will lower greenhouse gas emissions and decrease reliance on oil and coal. Converting waste into energy also offers a local solution for Israel's energy independence and security."

More information: Maya Brilovich Mosseri et al, Hydrothermal liquefaction of representative to Israel food waste model, *Energy Conversion and Management: X* (2023). DOI: 10.1016/j.ecmx.2023.100475

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