Bacterial Power

Luis Wilfrido Atienza
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lw.atienza@gmail.com

One of the country's current most pressing concerns is finding new reliable ways to generate electricity. Concerns about the sustainability of traditional ways of generating energy like coal and natural gas are pushing power generators and researchers to look at alternative ways to power the Philippines. Renewable energy sources like wind and solar energy are becoming more and more common, as well as other alternative power sources like microbial fuel cells (MFCs).

MFCs are devices that make use of certain species of bacteria to turn the chemical energy found in organic materials to electrical energy. Certain species of bacteria, called electrochemically active bacteria, break down organic substances. This reaction results in the movement of the electrons found in the organic material. The movement of these electrons can be harnessed by a microbial fuel cell and used to generate electricity.

One of the main advantages of MFCs is that they can make use of waste many common waste materials to create power. These organic waste materials, or substrates, can take many forms, from sewage water to the byproducts of harvested plants. Developing MFCs will allow us to make use of a more sustainable power source than fossil fuels, as well as giving these materials—which would normally be thrown away or treated—a second use.

Mark Dondi Arboleda from the University of the Philippines Los Baños is working on local applications of MFC technology. He recently published a paper in Journal of Environmental Science and Management, looking to discover effective substrate materials that are common and locally available in the Philippines. This experiment looked at domestic sewage, rice paddy water, seawater, sediment from the pens of milkfish, and corn stover (the leftover parts of the corn plant after harvest), in particular.

The study also looked to test the potential uses of bacteria from the genus *Enterobacter* to create power, by adding *Enterobacter* samples to MFCs containing corn stover.

To perform this research, Arboleda constructed simple MFCs out of food jars and PVC pipes. The substrate materials were added to these jars, along with agar which would promote the growth of bacteria. Graphite electrodes made from pencil leads were connected with copper wire to complete the MFC circuits.

The study involved several sets of these MFCs. Different sets tested the power-generating potential of each substrate. Several sets also tested different concentrations of sediment from the fishpens, as well as the sediment with the addition of fish feed, and the sediment with the addition of ammonium sulfate to promote the growth of bacteria. Different concentrations of corn stover were also tested—on their own, as well as with the addition of *Enterobacter* samples, and with ammonium sulfate. All these MFCs were observed for 25 days.

Arboleda constructed several of these makeshift MFCs using simple materials to test the power generation potential of several substrates

The power generated by each MFC was measured in terms of voltage, amperage, and power density; all common electricity measurements. In general, the MFCs using the fishpen sediment were the most successful ones, with different concentrations of sediment proving to be the best substrates across each category. The MFCs using 40% fishpen sediment as a substrate produced the highest recorded voltage, at 766 mV, and the MFCs with 30% sediment substrates showed consistently high voltages as well. These MFCs were also able to continue producing power up to 25 days after the test began. MFCs with fishpen sediment also consistently showed the highest amperages.

The addition of *Enterobacter* also proved to be effective. MFCs with corn stover substrates combined with samples of *Enterobacter* bacteria produced higher voltages than MFCs with corn stover substrates alone. The addition of ammonium sulfate increased the voltage of the MFCs even further. The same effect was seen in the amperage tests, with MFCs with corn stover, *Enterobacter,* and ammonium sulfate producing nine times the current output of corn stover alone.

Circuits connected in series will usually result in an increase in the power generated by those circuits. The study also tested this principle in MFCs. Four MFCs with 30% fishpen sediment were connected in series and observed as well. The series of MFCs was able to produce a voltage of up to 2.4 volts, compared to the 0.75 volts that were produced by the most effective single MFC.

This study is one of many efforts looking in to alternative ways of producing energy in the country. The data from this research can be used to further explore MFC technology locally, serving as a basis for refining the design of MFCs and MFC components, or allowing us to explore and modify potential substrates, treatments, and interactions with microorganisms. Simple, effective, innovative science like this will have an important part to play in creating a more sustainable future for Philippine power.

REFERENCE

Arboleda MDM. Utilization of putative *Enterobacter* isolate and substrates for microbial fuel cells. Journal of Environmental Science and Management. 2017;20(2):88–94.

Luis Wilfrido Atienza graduated from the Ateneo de Manila University, with a BS in Biology, and a minor in poetry. He currently works as a copywriter for a sustainable agency, and spends some of his free time writing about science.