RÉSEAU BIOFUELNET CANADA

SCIENCE AIMS TO STOP WASTING WASTE

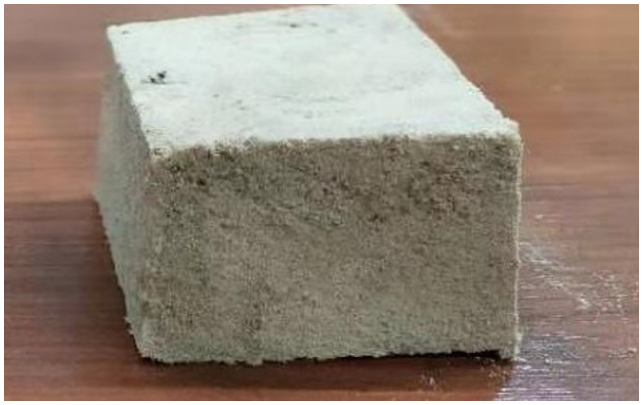
If you thought turning water into wine was a tall order, try converting greenhouse waste to recycled water and bioproducts.

This was the challenge for scientists as part of the project "Zero-Waste Process for Conversion of Wet Greenhouse Wastes and Agro-Forestry Residues into Recycled Water/Bioenergy/High-value Bioproducts". The goal is to put waste to work in a number of applications, and the **possibilities are intriguing**.

"This project is centered on the **sustainable supply** of **biomass and energy for greenhouses in Northern Canada**" said Dr. Charles Xu, professor, Department of Chemical and Biochemical Engineering at Western University. Dr. Xu is a co-principal investigator for the study along with Dr. Ze-Chun Yuan, research scientist for Agriculture and Agri-Food Canada (AAFC) at the London Research and Development Center. Making the most of waste products is **especially vital in northern communities**. These areas face multiple economic and development challenges due to their remote location, isolation, extremely short growing season, lack of sustainable and inexpensive energy and food supplies, and heavy reliance on fossil energy.

"We hope to **aid these communities** in addressing those obstacles and attaining **sustainable production of food**," said Dr. Xu. "As well, it is highly beneficial to the northern economy to utilize limited biomass resources for high-value bioproducts; for example, using bio-based polyurethane (BPU) foams as greenhouse growing media." To achieve their aims, researchers must navigate a complex process. They will use hydrothermal liquefaction (HTL) to co-liquefy wet greenhouse wastes (no de-watering or drying is needed) and agro-forestry residues or other wastes into bio-oils, biochar for bioenergy or soil conditioner, and recycled water for plants in greenhouses.

In addition, as an alternative technical approach, agricultural and forestry residues will be fractionated into **lignin** and **cellulose**. The obtained lignin and the HTL bio-oils will be used to create BPU foams. As well, the obtained bio-oils/lignin and cellulose will be used for the production of other high-value bioproducts such as bio-based wood adhesives and super absorbent polymer materials. The BPU foams will be tested by Dr.Yuan as low-cost hydroponic growing media for greenhouse planting, while the biodegradability of the foams will also be investigated.



Hydroponic foam derived from greenhuse wastes
Photo courtesy of Dr. Charles Xu.

Testing Time

While there is still much work to be done, scientists have almost completed lab scale research on two products: **bio-based foam** and **formaldehyde-free adhesive**. The bio-based foam can now produce a kilogram sample for testing, and the team is anxious to explore its potential application in greenhouse planting.

"We are collaborating with AAFC as they have a greenhouse facility," said Dr. Xu. "We want to produce the foam and have them incorporate it to grow tomatoes or other plants, as the foam can retain water and replace soil in the greenhouse. The first testing we will do is to **determine if the foam can be a good growing medium in that environment**."

Scientists have just submitted a patent on a novel **formaldehyde-free bio-based** wood adhesive derived from agricultural and forestry residues. They are hoping to perform kilogram scale testing shortly, followed by testing to evaluate the application of the product for manufacturers in the engineered wood products sector. From an industry standpoint, **cost savings represent the greatest benefit from this research**.

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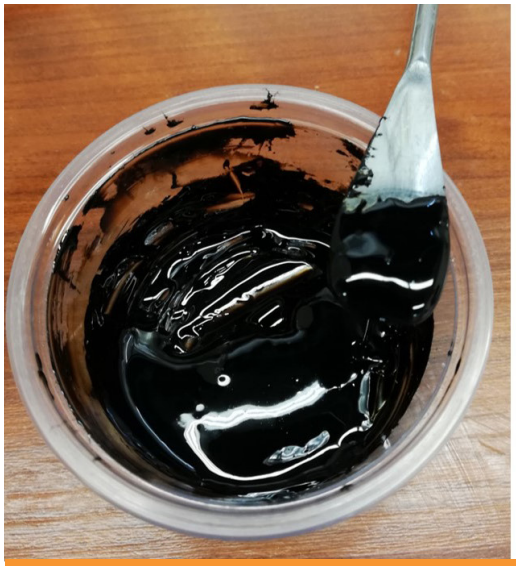

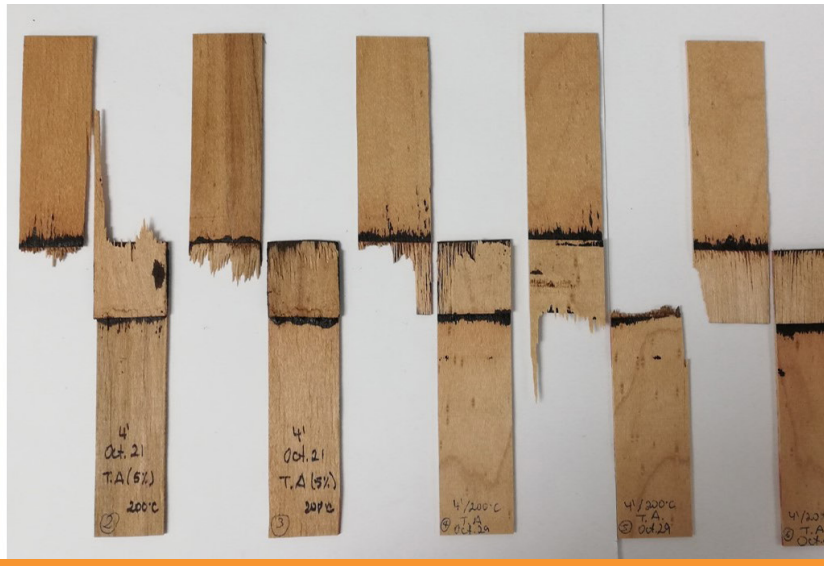

Formaldehyde-free wood adhesives derived from crop residues | Photo courtesy of Dr. Charles Xu.

"Our substitution with bio-based material, especially with the waste coming from greenhouses and crop or forest residue, makes the process cost effective and green. **Keeping costs low** while **supporting sustainability** will let us be competitive with petroleum-based products in the long run."

Coming full circle

For his part, Dr. Xu is pleased by the "closed loop" nature of the project, where waste from greenhouses is put back into the agriculture sector as part of a circular process. He is also grateful for the widespread support for this project Biomass Canada Cluster, Agriculture and Agri-Food Canada, Western Maple Bio Resources Inc (industry partner both in significant cash and in-kind contributions), as well as the provision of equipment and facilities by Western University and the Institute for Chemicals and Fuels from Alternative Resources (ICFAR).

Super Absorbent Polymer derived from agricultural biomass
Photo courtesy of Dr. Charles Xu.

"It is very exciting to be working with an industry partner that is keen to push the products from this study to market as soon as possible. They are now raising funds to do the upscaling of this process, and we're anxious to see it commercialized in the near future."

That may not happen as quickly as water turning into wine, but if the benefits are there, it will be well worth the wait.

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