RÉSEAU BIOFUELNET CANADA

HIGH HOPES FOR HIGH ENERGY PRODUCTION

Canola hull (left), oat hull (center) and Canola meal (right) are some examples of Canadian agricultural crop residues that can be converted to biofuels. Picture supplied by Dr. Ajay K. Dalai

Spinning straw into gold may be a *fairy tale...*

...but converting Canadian agricultural biomass into **high energy products** and **biochar** (charcoal produced from plant matter and stored in the soil as a means of removing carbon dioxide from the atmosphere) is an **attainable goal** for industry. This was the focus of the project "Biochar Production from Canadian Lignocellulosic Biomass and Application for Carbon Sequestration, Soil Improvement and Crop Productivity".

"In Canadian biodiesel industries, **canola** is a common feedstock for edible oil and biodiesel production, resulting in abundant quantities of the co-products canola meal and hull," said Dr. Ajay K. Dalai. Dr Dalai is Distinguished Professor of Chemical Engineering and Canada Research Chair in Bioenergy and Environmentally Friendly Chemical Processing, Department of Chemical and Biological Engineering, College of Engineering at the University of Saskatchewan. Once extracted from canola seeds, **the oil leaves behind over 60% biomass**, which requires sustainable technologies for utilization. The **annual availability** of biomass in Canada is up to **561 million dry tons**, of which agricultural crop residues account for about **18 million dry tons**. With this vast availability of agri-food residues in Canada, there is an immediate need for their **effective conversion** to address the issues related to domestic energy supply and a clean environment.

Generating Jobs

"The utilization of waste residues and by-products can enhance the Canadian economy and create employment opportunities in Saskatchewan and the rest of the country," said Dr. Dalai. "Our research group has expertise in **commercially viable** and **novel technologies** that can divert as much biomass as possible from the waste stream and create valuable and value-added products. This research is exploring an interesting application for agricultural residues which could help the agricultural sector and farmers through production of an effective carbon-based material to **increase crop productivity**."

For this project, the main product of interest is **biochar** and its vast array of applications for **soil fertility**, **crop productivity**, **soil contaminant absorption** and **carbon sequestration**. The study aims to support the Canadian agricultural sector, not only by developing methods for **efficient conversion** of agricultural residues into **biofuels**, but also by advancing the use of biochar as an **inexpensive source of carbon** and **nutrients** for improved plant growth, soil restoration and carbon capturing.

Thus far, Dr. Dalai's research team has developed a variety of biochars from **three different agricultural residues** including canola meal, canola hull and oat hull using pyrolysis process (a process of chemically decomposing organic materials at elevated temperatures in the absence of oxygen). The physico-chemical (physical and chemical) properties of agricultural residues and biochar are used to determine their suitability and potential in agricultural applications.

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"The data on physicochemical properties of these agri-crop residues can serve as a database of information for stakeholders, our industrial partner and co-principal investigators to utilize these waste feedstocks as **valuable commodities**. The canola meal biochar was found to contain **abundant amounts** of **metal oxides** because the precursor contains significant amounts of minerals, organic and inorganic compounds and heavy metals."

Overall, the biochar with the **highest surface area**, **greatest carbon content** (>70 %) and **lowest ash content** were obtained from pyrolysis of oat hull and canola hull. Compared with other inorganic elements in bio-char samples, large portions of alkaline elements showed the greatest potential for agricultural applications.

Promising for the province

For **Saskatchewan** in particular, the study results are promising to say the least.

"Saskatchewan is the **largest agricultural province** in Canada, producing a huge amount of **agricultural biomass** and **low-value bioproducts**. Research on the production of biochar from waste agricultural biomass and its utilization for environmental applications, soil improvement, and carbon sequestration has real importance to Saskatchewan." Specifically, the implementation of a commercially viable technology for the production of biochar using low value agricultural biomass will generate **substantial revenues** for the **partner company** and also create new employment opportunities in Saskatchewan. Moreover, the proposed route for biochar production will require a facility and feed-stocks that can be provided through the infrastructure at the University of Saskatchewan and by partner industries.

Perhaps most importantly, the benefits from this research extend to Canada **as a whole.**

"The major stakeholders of the advanced biofuels networks and industries are focused on helping Canada transform to a low carbon economy. The development of mobile pyrolysis units can transform pyrolysis from being a **carbon-neutral** to **carbon-negative** technology, with suggested on-site biomass conversion and biochar applications. The outcomes of the project address research and innovation for improving the economic growth, productivity and sustainable evolution of Canadian agriculture."

The project aims to **develop technology and markets for derived bioresources from agricultural wastes**. Of note is that the high carbon content and thermal stability of biochar results in carbon sequestration, which makes the process potentially eligible for **carbon credits** while supporting Canada's mandate for a **cleaner environment**. In addition, this material is being transformed into high quality activated carbon for the catalyst support of upgrading of bio-oil to transportation fuel. It's important to note that this project will also be highly beneficial to its industrial partner, **NULIFE Green Tech.** in Saskatoon.

"The proposed project will benefit the Canadian agricultural sector and biofuel industries by **reducing greenhouse gas emissions** and finding an **ecofriendly waste management technology** for agricultural wastes. This technology could serve as a **simple solution** that allows Canadian agriculture to process a wide variety of waste resources."

While spinning straw into gold remains a fantasy, it appears that converting Canadian agricultural biomass into high energy products and biochar is well within our grasp.

Given the ambitious goals of the project, Dr. Dalai felt it only right to recognize the **people**, the **funding agency** and **companies** that made it possible. This project is being executed by a diverse team of researchers including **Dr. Parmila Sangwan** (Post-Doctoral Fellow), **Dr. Venu Borugadda** (Post-Doctoral Fellow), **Mr. Thomas Conway** (Research Assistant), **Ms. Alivia Mukherjee** (Ph.D. student), **Ms. Shima Masoumi** (Ph.D. student), **Mr. Biswa Ranjan Patra** (M.Sc. student) and **Mr. Michael Qui** (Research Engineer). Dr. Dalai is grateful to **Biomass Canada Cluster, Agriculture and Agri-Food Canada,** and industry partner **(NULIFE Green Tech. Saskatoon)**. The total value of the Biomass Canada Cluster is **$8.3 million over 5 years** (2018-2023), with funds from both AAFC and industry partners ($4 million).

For more information on this project, please contact:

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