Upcycling Wood Into Nutritional, Sustainable Protein Source for People & the Planet

By: Lisette Tenlep, PhD, CTO & SVP, R&D, Arbiom

July 1, 2020

How to make do with limited resources in a world of seemingly limitless growth? That's the question gripping feed producers today as the global population continues to expand rapidly and socio-demographics evolve. The stakes are high and time is short.

According to projections from the Food and Agriculture Organization of the UN (FAO), the world's population will expand to almost 10 billion (current population is ~7.5 billion) by 2050.1 That's more than two billion more people on this planet. Anticipating moderate economic growth during this time, the report suggests that agricultural demands will likely increase by some 50 percent compared to 2013.

Researchers have looked far and wide in the search to find answers for the exponential growth in future food, demand, and there are many promising innovations in development to solve the challenges we face. One of the innovative solutions has emerged from a natural resource that's right outside the front door: wood. Renewable and readily available, wood is one of the most natural and organic carbon sources in the world. Thanks to the advancements of technology and bioconversion processes, it's now possible to extract the nutritional elements of wood to enable the production of protein.

Though the functionality of wood continues to expand across industries, we still have a long way to go before it is used to its full potential. In this paper, we'll explore more on the promising potential of wood as a food source that expands global production to safely and sustainably feed future generations.

Why Wood?

While wood has not historically been a part of the food supply chain, it contains several chemical compounds that ultimately can provide nutritional benefits for animals and humans. Wood is a complex of chemical components made out of biopolymers. Its primary components are polysaccharides, such as cellulose (35 – 55%), hemicellulose (20 – 35%) and polyphenolic fractions, such as lignin (15 – 36%). Its secondary components are organic and inorganic substances such as extractives and ashes that affect its color, odor and resistance.

These compounds have functional properties that food and feed producers desire for their products. In fact, advancement is occurring in wood-derived protein as a reliable feed ingredient with significant benefits. Scientists and engineers at Arbiom have developed a process that optimizes protein production by extracting its fermentable components from woody biomass. As development progresses, the objective is to produce a quality wood-derived protein in commercially relevant volumes for food solutions that can help providers fulfill increasing feed demands.

In addition to protein, there are other wood-based components that can provide beneficial supplemental ingredients in food and feed products. The functional polysaccharide mannans, for example, enable several prebiotic health benefits in foods – playing a role in body weight control, constipation alleviation and the prevention of diarrhea. Mannans can also help reduce inflammation due to gut related diseases, assist in the management of diverticular disease management, balance intestinal microbiota, modulate the immune system and reduce the risk of colorectal cancer.2

Additionally, another key wood component is lignin, which comprises 10-25 percent on average of lignocellulosic biomass.3 Lignin has shown to have antioxidant properties that can play a protective role against the development of different diseases as a dietary ingredient by reducing the harmful impact of free radicals.4

Research-Backed Promise

In addition to delivering nutrition and health benefits, recent research points to other functional properties in of wood that can serve as a basis to improve the sensory characteristics of food.5 Components – including xylan, cellulose, and lignin – can be used to boost the quality and texture content of food products.

Studies have revealed that, in comparison with conventional manufacturing techniques, xylan and cellulose improve the smoothness of yogurt. Tests have showed that the texture was more stable with no separation of water from the yogurt gel observed. Additionally, lignin was tested in the manufacturing of muffins, proving itself to be an efficient substitute for whole eggs and egg yolks. Lignin also functioned as emulsifier in mayonnaise and reinforced juiciness when used in a meat product.

Ongoing research and commercial developments are focusing on expanding the wood-to-food value chain. In addition to commercializing a technology to maximize wood-based protein production, Arbiom's team of scientists and engineers are partnering with leading companies in the industry to advance other wood-based food properties. Currently in the midst of a three-year multidisciplinary project, researchers are aiming to develop new techniques to scale up the conversion of wood byproducts into lignocellulosic sugars and lignin for food and feed producers.

Opportunity to Upcycle By-Products

Wood processing byproducts serve as a particularly promising means of exploration and development of food formulation considering their prevalence in wood production. Typically, wood processing byproducts come in the form of tree bark, woodchips and sawdust from a variety of wood-processing mills.

In fact, wood processing byproducts account for up to 50 percent of the initial material and are often used as a renewable energy resource in the closed-loop wood production cycle.6 Companies in the wood and paper industry use wood waste to produce steam and electricity, which can save them money by reducing the costs associated with purchasing other fuel sources.7

Though wood byproducts are often used for renewable energy generation, they are still not being leveraged to their full potential. Industrial mills, for example, do not typically operate at their full capacity – or use all the wood byproducts they have available. While solid waste generation is directly related to the conversion efficiency of roundwood to sawn lumber, conversion efficiencies are often below 40 percent in the industry.8

The wood-to-food model currently being pursued by Arbiom offers an opportunity for mills to produce a higher-value end-product from wood and wood wastes – leveraging the forest products industry's strong supply chains and asset base dedicated to sourcing and processing wood. It also allows for higher volumes of byproduct material, residues and wastes that lumber and paper mills tend to produce. Arbiom is forging partnerships with developers in the bioconversion space, which will allow mills and wood companies the establishment of a more profitable platform for the utilization of their wood wastes and develop new manufacturing opportunities.

Looking Forward

The projected growth in the global population and the increasingly finite natural resource on the planet

require that we improve the way we use and consume resources. Arbiom's wood-to-food bioconversion technology platform represents a promising resource-efficient solution to address global food supply challenges in a way that is sustainable, traceable and scalable.

Those that see this challenge as an opportunity stand to help pioneer a new landscape and forge new partnerships in the process. Leading companies and organizations in the food, agricultural and livestock industries recognize that efficiency is key to safely and sustainably feeding the world in the near future. Arbiom wood-to-food technology represents one innovation that will make it possible to provide more using less. It is the time to invest in those that want to be positioned at the forefront of this industrial evolution, helping to shape the future of food production.

To learn more, visit www.arbiom.com.

References:

1) United Nations Food and Agriculture Organization (FAO). "The future of food and agriculture - Trends and challenges." Rome. 2017.
2) Singh, Saumya, et al. "Mannans: An Overview of Properties and Application in Food Products." International Journal of Biological Macromolecules, vol. 119, 2018, pp. 79–95., doi:10.1016/j.ijbiomac.2018.07.130.
3) Vinardell MP, Mitjans M. "Lignins and Their Derivatives with Beneficial Effects on Human Health." International Journal of Molecular Sciences, vol. 18, no. 6, July 2017, p. 1219., doi:10.3390/ijms18061219.
4) Dereca Watkins, Md., et al. "Extraction and Characterization of Lignin from Different Biomass Resources." Journal of Materials Research and Technology, Elsevier, 28 Nov. 2014.
5) Technical Research Centre of Finland (VTT). "Wood components to boost quality of food products." Science Daily. ScienceDaily, 1 June 2016.
6) Ramage, M.H., Burridge, H., Busse-Wicher, M. et al. "The wood from the trees: The use of timber in construction." Renewable and Sustainable Energy Reviews, 68 (1), 2017, pp. 333-359. ISSN 1364-0321.
7) "Wood and Wood Waste." Wood and Wood Waste - Energy Explained, Your Guide To Understanding Energy - Energy InformationAdministration,www.eia.gov/energyexplained/index.php?page=biomass_wood
8) Environmental, Health, and Safety Guidelines. "SAWMILLING AND MANUFACTURED WOOD PRODUCTS," The World Bank Group, April 2007.
9) Ramage et al. The wood from the trees: The use of timber in construction, Renewable and Sustainable Energy Reviews, Volume 68, Part 1, 2017.

July 1, 2020

About the author

Lisette Tenlep-Akers, PhD, CTO & VP of R&D, Arbiom

Lisette has over 10 years of experience in the biotechnology and renewable energy sectors, with her expertise in biomass conversion and bioprocessing technologies. In her role at Arbiom, Lisette oversees the development, implementation and validation of Arbiom's Wood-to-Food technology platform. Prior to Arbiom, Lisette was with Blue Sugars (formerly KL Energy), where she contributed to the successful scale-up of the company's biomass conversion technology, from lab to demonstration scale, and played a key role in entering a joint venture agreement with a Petrobras. Additionally, she developed Blue Sugars' enzyme applications and methods for bioethanol production from bagasse and other lignocellulosic feedstocks, includng dilute acid pretreatment technologies, working with a range of biomass materials with several strategic partners. She developed and implemented Blue Sugars' biomass physicochemical analyses. Lisette holds a Ph.D. in Chemistry from South Dakota State University, an MBA from Duke University, and a B.Sc. & a M.Sc. in Chemistry from the University of Siegen, in Germany.