The 1st International Joint Seminar on Agricultural Science and Biotechnology: Frontiers in Natural Product Chemistry and Biomass Science

Wednesday, November 9th, 2022
1:00 p.m. – 2:30 p.m. (Japan Time)

Speakers and Lecture Titles

Prof. Rakhi Chaturvedi (Indian Institute of Technology Guwahati, INDIA)

"Sustainable Production of Plant Secondary Metabolites by the Application of Plant Tissue Culture Techniques"

Prof. Wasrin Syafii (IPB University, INDONESISA)

"Biological Activities of Extractives From Tropical Woods"

Assoc. Prof. Hikaru Kobori (Shizuoka University, JAPAN)

"Effective Utilization of Wood Biomass and Its Evaluation by Vis-NIR Spectroscopy"

Convener

Assoc. Prof. Shiro Suzuki (Gifu University, JAPAN)

Organized by

International Consortium of Universities in South and Southeast Asia for the Doctoral Education in Agricultural Science and Biotechnology (IC-GU12)

Lecture 1

Sustainable Production of Plant Secondary Metabolites by the Application of Plant Tissue Culture Techniques

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ABSTRACT

For consistent metabolite production, the unique capacity of plant cells, which have many other applications in plant improvement, propagation and conservation other than basic and applied plant sciences, can be utilized. Conservation of improved germplasm and sustainable production of bio-active metabolites are major breakthrough discoveries of plant tissue culture research. The enhanced rate of plant multiplication can considerably reduce the period between the selection of superior plants and raising enough planting material for metabolite extraction. The technique can further be used to scale-up the production of bioactive metabolites. The most important advantage of in vitro grown plants is that it is independent of geographical variations, seasonal variations and also environmental factors. It offers a defined production system, continuous supply of desired products with uniform quality and yield. Novel compounds which are not generally found in the parent plants can be produced in the in vitro grown plants through plant tissue culture. In addition, stereo- and region-specific biotransformation of the plant cells can be performed for the production of bioactive compounds from economical precursors. The callus, a mass of undifferentiated cells, can be induced on semi-solid medium from any part of the plant under the correct nutritional conditions. These callus cultures, which are friable in texture, are utilized to raise cell suspension cultures in shake flasks. This plant cell suspension cultures can serve as inoculum for scale-up of cell biomass and product development in bioreactors. Cell suspensions in bioreactors favor high cell growth rate and consistent metabolite production though with associated challenges, which can be resolved by nutrient and process optimization. The metabolite production can further be enhanced by the use of elicitors and precursors selectively. However, large scale biomass and secondary metabolite production in bioreactor is more complex than shake flask cultures. It requires standardization of parameters, like aeration, agitation speed, pH, temperature, minerals, carbohydrates, growth regulators and cell density, primarily due to large size of culture volume combined with shear sensitive nature of plant cells. Efficient downstream recovery of products and rapidity of production are its added advantages.

Keywords: biotransformation, callus, cell suspension, conservation**,** secondary metabolites, tissue culture

Lecture 2

Biological Activities of Extractives from Tropical Woods

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ABSTRACT

"Whole tree utilization" is a concept to utilize all parts of the tree effectively and efficiently with the aim of minimizing waste. This concept is applied through three aspects, namely, utilizing all species of wood, utilizing all parts of wood, and utilizing all wood components. Extractives are very diverse and unique components in each wood species. This diversity also shows the very wide potential of utilization as a source of active ingredients. The high biodiversity of Indonesia supports a higher diversity of extractive components to be explored. In particular, extractives from several tropical wood species from Indonesia have shown biological activities related to human health (antioxidant, antidiabetic, antibacterial, and antimalarial) and effectiveness as biopesticides (anti-fungal and anti-termite). *Acacia crassicarpa* heartwood showed good antioxidant capacity among four others. Flavonoid compounds are thought to be responsible for the antioxidant activity and are dominated in *crassicarpa* heartwood extract. *Baccaurea motleyana* extractives inhibited three different bacteria, *Staphylococcus aureus*, *Staphylococcus epidermidis*, and *Pseudomonas aeruginosa*. *Strychnos ligustrina* extracts are potent anti-malarials when used alone or in combination with artemisinin. The alkaloid compounds, brucine and strychnine, were predicted to be anti-malarial active compounds. *Raru* woods inhibited the alpha-glucosidase enzyme and was potent as an antidiabetic. A phenolic compound was isolated from raru wood as an active anti-diabetic compound. *Melia azedarach* was effective as a natural anti-termite biopesticide against subterranean termites, acting through both toxic and repellent mechanisms. Moreover, two neoflavonoids from *Dalbergia latifolia* showed significant potential as antitermites against subterranean termites. Two white-rot fungi (*Schizophyllum commune* Fries and *Pleurotus ostreatus*) were inhibited by *Shorea laevis* and *Palaquium* sp. As active antifungal compounds, two fatty acid-active compounds have been isolated from *Shorea laevis* and *Palaqium* sp. The antifungal activity of neolignans as active compounds from *Eusideroxylon zwageri* against white-rot fungi (*Coriolus versicolor*) and brown-rot fungi (*Tyromeces polutris*) was also demonstrated. The diverse range of biological activity in tropical wood extractives suggests significant potential. As a result, extractives, must be employed effectively and efficiently.

Keywords: tropical woods, extractives, antioxidant, antimalarial, antidiabetic, antibacterial, antifungal, anti-termite

Lecture 3

Effective Utilization of Wood Biomass and Its Evaluation by Vis-NIR Spectroscopy

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ABSTRACT

Appropriate use of wood biomass is one of the important issues to promote a recycling-oriented society. Direct usage of unused biomass such as forest residue, sawdust or any other byproducts is not easy due to the instability of quality and supply amount of them, therefore, some mechanical processing and compounding with other materials are required. Particle boards are produced by particles from wood bark bonded together by hot pressing without any adhesive or additives. Mechanical properties of bark-based particle boards vary with species, however in some species, addition of small amounts of ball-milled bark improves the bending property. Wood plastic composite (WPC), composed of wood flour mixed with thermoplastic resin, is another application of wood biomass such as sawdust and demolition woods. WPC has been widely used for kitchen, and exterior since it has higher water resistance than solid wood. Though the amount of wood flour is the most influencing factor for the mechanical properties of WPC, wood species, chemical composition and morphological characteristics also influence. For example, there are the optimal particle size and combination of particle size distribution; excessive amounts of small wood flour causes the aggregation, which results in the reduction of bending properties. Measuring several parameters of wood flour is effective to predict the mechanical properties of final products, however several different measurements are required. Near Infrared (NIR) spectra contain the information regarding the overtone and combination of vibration of functional groups. Furthermore, morphological characteristics such as particle size, surface roughness or bulk density affect the light scattering, which results in the variation of baseline of NIR spectra. Therefore NIR diffuse reflectance spectra of wood flour contains both chemical and morphological information. Measurement of NIR spectra could be an alternative method to evaluate the mechanical properties of the final product from wood flour. NIR spectra also can identify the types of resin and wood flour content of final products. This could contribute to the proper recycling of WPC products.

Keywords: wood biomass, bark, WPC, NIR spectroscopy, recycling