Phytochemical Extraction to Improve the Economic Benefits of Biomass Processing

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Phytochemicals are non-nutritive plant components having bioactive activities. Compared with synthetic chemicals, phytochemicals have numerous advantages, and they are now widely used in health foods, cosmetics, and pharmaceuticals. Phytochemicals also provide a rich natural resource pool for new health food and medicine development. Because of their wide uses, phytochemicals have high economic value for their development and utilization. Phytochemicals are present in a vast number of plants, and their production has a wide range of feedstock sources. In traditional biomass processing, phytochemicals are often considered as wastes and are not recovered. In order to improve the economic benefits, the extraction of phytochemicals has now become an attractive sub-process during the biomass processing. However, the low content of phytochemicals in plants makes their extraction challenging. Efforts are needed to increase the phytochemical content in plants and develop more efficient extraction and separation processes. This editorial briefly discusses phytochemicals and their extraction to improve the economic benefits of biomass processing.

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Phytochemicals: An Important Class of Plant Bioactive Chemicals with Great Market and Economic Value

Phytochemicals are a powerful group of chemicals that are derived from natural resources, namely plants. They are non-nutrient bioactive components that often give plants their color, flavor, scent, and texture. Phytochemicals are secondary metabolites and not essential in plant growth, but they play important biological functions in their growth and development (Jan and Abbas 2018; Sa *et al.* 2021). For example, they protect plants from harmful agents such as insects and microbes as well as stressful events such as ultraviolet irradiation and extreme temperatures. They also attract beneficial birds and insects that promote pollination, germination, and seed dispersal. Phytochemicals exist in a vast assortment of plants, and thousands of phytochemicals have already been found. The most common phytochemicals include flavonoids, glucosinolates, organosulfur compounds, saponins, monoterpenes, sesquiterpenes, capsaicinoids, and capsinoids (Jan and Abbas 2018; Sa *et al.* 2021). Some of these phytochemicals have multiple pharmacological and biological activities such as antioxidant, anti-inflammatory, anticancer, antidiabetic, antihypertension, hypolipidemic, cardioprotective, hepatoprotective, nephroprotective, neuroprotective, antiglycation, skin regeneration, melanogenesis inhibitory, and wound healing. To date, a great many phytochemicals have

been used in health foods, cosmetics, and pharmaceuticals (Jan and Abbas 2018; Sa *et al.* 2021). Most of the best-selling health foods and cosmetics contain phytochemical ingredients, and some phytochemicals are used as medicines to prevent or treat diseases. For example, the flavonoids from kudzu are used in health foods due to their anti-inflammatory and anticancer ability, in cosmetics to increase their antiglycation and skin regeneration ability, and as medicines to treat such diseases as fever, drunkenness, hypertension, and heart disease (Zhang *et al.* 2024a). With the rapid development of modern phytochemistry, more and more phytochemicals with special biological abilities will be discovered, and they will provide a rich natural resource pool for new health foods, cosmetics, and medicine development. Moreover, phytochemicals have numerous advantages compared with the synthetic compounds. They can be completely metabolized by the natural enzymes and leave no residues in nature. Their production processes are ecologically friendly, and they don't pollute. People often think that these phytochemicals are safe as food, cosmetics, and medicine because they are pure natural products. In general, the phytochemicals have much higher price and market acceptance than the synthetic chemicals. All these factors are causing phytochemicals to become an important class of plant bioactive compounds with great market and economic value.

Phytochemical Extraction: An Indispensable Sub-process in Biomass Processing to Increase Its Economic Benefits

Plants are the most abundant class of biomass in the world. They are used in the production of energy, materials, and chemicals *via* biomass processing, which is an effective way to reduce the consumption of fossil resources and improve the environment and ecology around us (Lee *et al.* 2022; Zhang *et al.* 2023). In traditional biomass processing, phytochemicals are often considered as wastes and are not recovered. As discussed above, these phytochemicals have great market and economic value if they can be effectively recovered. Therefore, the extraction of these phytochemicals may become an indispensable sub-process in biomass processing to increase its economic benefits (Zhang *et al.* 2024b). However, in most cases, the content of phytochemicals in plants is rather low, which makes their extraction, separation, and purification challenging. Efforts are urgently needed to address these challenges. Firstly, studies are needed to increase the content of phytochemicals in plants through conventional breeding and genetic modification technology, which helps provide high quality raw material for their extraction, separation, and purification during biomass processing. Secondly, studies are needed dealing with the efficient extraction, separation, and purification technologies for phytochemical extraction in biomass processing. At present, large scale industrial phytochemical extraction technologies with low cost are scarce. More studies should be carried out to broaden the application of phytochemicals and develop more healthy food, cosmetics, and new medicines. After these efforts, phytochemical extraction, as an indispensable sub-process in biomass processing has potential to improve the economic benefits of biomass processing and makes it a profitable industry.

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