BIOCONVERSION OF AGRO-INDUSTRIAL BY-PRODUCTS INTO HIGH VALUE-ADDED LIPIDS THROUGH ZYGOMYCETES CULTIVATION

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ABSTRACT

The value-added metabolites obtained through microbial cultivation in organic agro-industrial residues, as a remedy for the diminishing natural resources on our planet, align with the principles of sustainable development and circular economy. Mushroom stalks (MS) and roots (R) derived from hydroponically cultivated plants are some of the main solid wastes in the processes of mushroom and vegetable production. Polyunsaturated fatty acids (PUFA), particularly gamma-linolenic acid (GLA), exhibit significant therapeutic properties, serving as anti-cancer agents and combating conditions such as rheumatoid arthritis and atherosclerosis. Thus, there is considerable pharmaceutical and nutritional interest in the notable GLA content found in lipids of Zygomycetes fungi.

In the current study, the fungus *Cunninghamella elegans* NRRL 1392 was evaluated for its ability to grow in extracts derived from dried and ground agricultural residues and produce PUFA- and GLA-rich lipids. Initially, the compositions of MS and R were analyzed, and the fungus was batch-flask cultivated in 5 different commercial semi-defined substrates containing glucose, galactose, mannose, xylose, or arabinose, as the main sugars contained in MS and R. Subsequently, *C. elegans* was cultivated in a tailor-made semi-defined commercial substrate, which could be potentially resemble the hydrolysate derived from the total (enzymatic) hydrolysis of carbohydrates found in mushroom stalks, under both nitrogen-excess and nitrogen-limited conditions. In parallel, it was cultivated in a tailor-made semi-defined commercial substrate resembling hydrolysate of roots under nitrogen-excess conditions. Finally, the fungus was cultivated in a broth derived from water-extraction applied to mushroom stalks, enriched with organic nitrogen sources to evaluate its ability to grow and produce lipids. Based on the results, this *C. elegans* strain was capable to assimilate all 5 sugars, but at a lower rate in case of arabinose. Under nitrogen-excess conditions, higher production values for biomass, PUFA, and GLA were observed (20.3 g/L, 1538 mg/L, 298 mg/L) accompanied with high productivity values due to short cultivation periods, while under nitrogen limitation high lipid accumulation (48%, w/w), especially rich in oleic acid was presented. The fungus was successfully grown in the water-extract derived from mushroom stalks, resulting in dry biomass of 14.5 g/L, lipids of 1.8 g/L, containing 15% (w/w) GLA.

KEYWORDS: Zygomycetes, agro-industrial residues, polyunsaturated fatty acids, gamma-linolenic acid, circular economy

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