Potentiation of neuritogenic activity of medicinal mushrooms in rat pheochromocytoma cells

Syntyche Ling-Sing Seow1,2, Murali Naidu1,2*, Pamela David1,3, Kah-Hui Wong1,3 and Vikineswary Sabaratnam1,2

Abstract

Background: Senescence of the neurons is believed to be a focal factor in the development of age-related neurodegenerative diseases such as Alzheimer's disease. Diminutions in the levels of nerve growth factor (NGF) lead to major declines in brain cell performance. Functional foods, believed to mitigate this deficiency, will be reaching a plateau in the near future market of alternative and preventive medicine. In the search for neuroactive compounds that mimic the NGF activity for the prevention of neurodegenerative diseases, the potential medicinal values of culinary and medicinal mushrooms attract intense interest.

Methods: Cytotoxic effects of aqueous extracts of three medicinal mushrooms basidiocarps, Ganoderma lucidum, Ganoderma neo-japonicum and Grifola frondosa towards rat pheochromocytoma (PC-12) cells were determined by 3-(4,5-diethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay. The potentiation of neuritogenic activity was assessed by neurite outgrowth stimulation assay. Involvement of cellular signaling pathways, mitogen-activated protein kinase kinase/extracellular signal-regulated kinase (MEK/ERK1/2) and phosphoinoside-3-kinase/protein kinase B (PI3K/Akt) in mushrooms-stimulated neuritogenesis were examined by using specific pharmacological inhibitors. Alteration of neuronal morphology by inhibitors was visualized by immunofluorescence staining of the neurofilament.

Results: All the aqueous extracts tested caused a marked stimulation of neuritogenesis with no detectable cytotoxic effects towards PC-12 cells. The aqueous extract of G. neo-japonicum triggered maximal stimulation of neurite outgrowth at a lower concentration (50 μg/ml) with 14.22 ± 0.43% of neurite-bearing cells, compared to G. lucidum and G. frondosa that act at a higher concentration (75 μg/ml), with 12.61 ± 0.11% and 12.07 ± 0.46% of neurite-bearing cells, respectively. The activation of MEK/ERK1/2 and PI3K/Akt signaling pathways were necessary for the NGF and aqueous extracts to promote neuritogenesis.

Conclusions: Ganoderma lucidum, G. neo-japonicum and G. frondosa may contain NGF-like bioactive compound(s) for maintaining and regenerating the neuronal communications network. The present study reports the first evidence of the neuritogenic effects of aqueous extracts of basidiocarps of G. neo-japonicum in vitro and showed the involvement of MEK/ERK1/2 and PI3K/Akt signaling pathways for neuritogenesis in PC-12 cells.

Keywords: Ganoderma lucidum, Ganoderma neo-japonicum, Grifola frondosa, Neuritogenesis, Neurodegenerative disease, Nerve growth factor, MEK/ERK signaling pathway, PI3K/Akt signaling pathway

*Correspondence: murali_naidu@um.edu.my
1Mushroom Research Centre, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia
2Department of Anatomy, Faculty of Medicine, University of Malaya, 50603 Kuala Lumpur, Malaysia
Full list of author information is available at the end of the article

© 2013 Ling-Sing Seow et al. licensee BioMed Central Ltd. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.