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Aegerolysins: lipid-binding proteins with versatile functions

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Abstract
Proteins of the aegerolysin family span many kingdoms of life. They are relatively widely distributed in bacteria and fungi, but also appear in plants, protozoa and insects.
Despite being produced in abundance in cells at specific developmental stages and present in secretomes, only a few aegerolysins have been studied in detail. In particular, their organism-specific physiological roles are intriguing. Here, we review published findings to date on the distribution, molecular interactions and biological activities of this family of structurally and functionally versatile proteins, the aegerolysins.
Keywords: aegerolysin; pore-forming protein; lipid binding; lipid rafts; sphingolipid imaging

1 Introduction

Pore-forming proteins are a large group of proteins found in all kingdoms of life. While bacterial and animal pore-forming proteins are well characterized and are predominantly involved in either defense or attack mechanisms, very little is known about their roles in fungi. Importantly, a number of different pore forming protein families are represented in the fungal kingdom such as the Membrane Attack Complex Perforin/Cholesterol-Dependent Cytolysins (MACPF/CDCs), aerolysins, flammutoxins, delta-endotoxins (e.g. volvatoxins), phallolysins and aegerolysins. These have suspected roles in protecting against nematode and/or insect predators, defense from bacteria and in development [1–8].
One important family of pore forming proteins in fungi is the aegerolysin family which can either play a direct role in pore formation or facilitate other pore forming proteins to assemble. The aegerolysin protein family includes about 132 non-redundant, ~13 kDa to 20 kDa, β-structured, single-domain proteins, from 77 different species across viruses, bacteria, protozoa, fungi, plants and one insect species [6,8,9]. Historically, Asp-hemolysin from *Aspergillus fumigatus* [10] and pleurotolysin (Ply) from the mushroom *Pleurotus ostreatus* [11] were the first aegerolysins detected and isolated as hemolytic proteins. Later, the cDNAs were found to encode Asp-hemolysin [12], non-cytolytic aegerolysins Cbm 17.1 and Cbm 17.2 from *Clostridium bifermentans* subsp. *malaysia* [13,14], and the Aa-Pri1 protein from the mushroom *Agrocybe aegerita* [15]. Partial amino-acid sequencing of the native proteins Asp-hemolysin [12], aegerolysin Aa-Pri1, and ostreolysin (Oly) from *P. ostreatus* [16] have further confirmed the existence of related proteins in fungi. These proteins share sequential identity and were