A comparative UHPLC-Q/TOF–MS-based eco-metabolomics approach reveals temperature adaptation of four *Nepenthes* species

ABSTRACT

Nepenthes, as the largest family of carnivorous plants, is found with an extensive geographical distribution throughout the Malay Archipelago, specifically in Borneo, Philippines, and Sumatra. Highland species are able to tolerate cold stress and lowland species heat stress. Our current understanding on the adaptation or survival mechanisms acquired by the different *Nepenthes* species to their climatic conditions at the phytochemical level is, however, limited. In this study, we applied an eco-metabolomics approach to identify temperature stressed individual metabolic fingerprints of four *Nepenthes* species: the lowlanders *N*. *ampullaria*, *N*. *rafflesiana* and *N*. *northiana*, and the highlander *N*. *minima*. We hypothesized that distinct metabolite regulation patterns exist between the *Nepenthes* species due to their adaptation towards different geographical and altitudinal distribution. Our results revealed not only distinct temperature stress induced metabolite fingerprints for each *Nepenthes* species, but also shared metabolic response and adaptation strategies. The interspecific responses and adaptation of *N*. *rafflesiana* and *N*. *northiana* likely reflected their natural habitat niches. Moreover, our study also indicates the potential of lowlanders, especially *N*. *ampullaria* and *N*. *rafflesiana*, to produce metabolites needed to deal with increased temperatures, offering hope for the plant genus and future adaption in times of changing climate.