

Effects of leaf herbivory and autumn seasonality on plant secondary metabolites: a meta-analysis

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Abstract

Plant secondary metabolites (PSMs) are produced by plants to overcome environmental challenges, both biotic and abiotic. We were interested in characterizing how autumn seasonality in temperate and subtropical climates affects typical PSM production in comparison to herbivory. Herbivory is commonly measured from spring to summer when plants have high resource availability and are prioritizing growth and reproduction. However, autumn seasonality also challenges plants as they cope with limited resources and prepare survival for winter. This suggests a potential gap in knowledge on how autumn seasonality affects PSM production differently from herbivory. Using meta-analysis, we recorded production of 22 different PSM subgroups from 58 published papers to detect a typical response across all PSMs. We also compared production of five phenolic subgroups – hydroxybenzoic acids, flavan-3-ols, flavonols, hydrolysable tannins, and condensed tannins. We calculated effect sizes from herbivory studies (absence to presence) and temperate to subtropical seasonal studies (summer to autumn), while considering other variables (e.g., plant type, increase in time since herbivory, temperature, and precipitation). We did not detect a shared effect of herbivory or season on PSM production across all subgroups. However, we discovered herbivory having a positive effect on flavonol production and autumn seasonality having a positive effect on flavan-3-ol and condensed tannin production. We discuss how these responses might stem from three factors: 1. some PSMs are constitutively produced by plants in autumn whereas others are induced only following herbivory, 2. plants produce metabolites with higher costs only during seasons when other resources for growth and reproduction are less available, and 3. some PSM subgroups serve more than one function for plants and such functions can be season dependent. The outcome of our meta-analysis is that autumn seasonality changes PSM production differently from herbivory, and we see value in further investigating seasonality-herbivory interactions with plant chemical defense.

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