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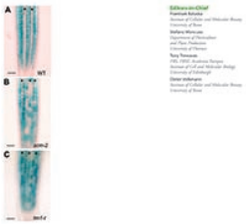

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Roles of H_2S in adaptation of alpine plants *Lamiophlomis rotata* to altitude gradients

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Hydrogen sulfide (H_2S) is an important gaseous transmitter in organisims. It widespreads in the organs and tissues of animals and participates in the biological process of cardiovascular relaxation, cell apoptosis and protection, inflammation and neuromodulation. H_2S also can be synthesized in plants system and is involved in stress responses and the biological process of growth and development. This review describes the synthesis and biological function of H_2S in plants. Based on our research for the adaptation of *Lamiophlomis rotata* to different altitude gradients, we firstly proposed H_2S plays an important role in the adaptation of *Lamiophlomis rotata* to alpine environment.

H_2S as the third gasotransmitters after nitric oxide (NO) and carbon monoxide (CO) were found, they can start defense responses when plants are exposed to stress. H_2S is endogenously synthesized by enzymes catalysis in plants and it can freely cross the cell membrane. It has specific target cells and physiological functions.[1,2] The endogenous H_2S is synthesized through the substrate D/L-cysteine catalyzed by pyridoxal-phosphate (PLP)-dependent D/L-cysteine desulfhydrases(D/L-CDs). Another enzyme, b-Cyanoalanine synthase (CAS), converts cysteine and cyanide to H_2S and b-cyanoalanine[3-5] and OAS-TL is critical for the formation of cysteine.[6]

Up to date, there has been many reports about the physiological function study of H_2S in plants. It participates in the biological process of response to abiotic stress, development and growth. When plants are exposed to heat stress, it will start the salic acid (SA) signaling pathway which induces the formation of H_2S to promote the expression of stress resistance genes and enhance the heat resistance.[7] There will accumulate reactive oxygen species when plants are exposed to heavy metal, then the Ca^{2+}, NO and H_2S signaling pathway start, and they have cross-talks to induce the expression of antioxidant enzymes and stress resistance genes. The upstream signal NO can induce the formation of H_2S, and parts of H_2S can also be induced by Ca^{2+}.[8,9] H_2S plays an important role in the drought resistance process and it causes swelling of guard cells through modulating the K^+ channel. In the process of drought resistance, the accumulation of H_2S induces formation of NO which starts ABA signaling pathway to cause the closure of stomatal. H_2S also induces the expression of microRNA to enhance the capacity of drought resistance.[10-12] The signaling pathway of H_2S-IAA-NO induces occurrence of adventitious roots, but high concentration of H_2S inhibits auxin transport and change root system formation.[13,14] H_2S mediates the seed germination and flowering time transition.[15,16]

In our study, we utilized the proteomics method to explore the molecule mechanism for adaptation of *Lamiophlomis rotata* at different altitudes. The environment becomes harsh at high mountain altitude, plants are exposed to stress. The proteomics result showed that antioxidant enzymes and proteins related to synthesis of H_2S gradually increased with increasing altitude. Accordingly, we made a measurement of biochemical substance. The content of enzymes related to the synthesis of H_2S such as CAS, OAS-TL, L-CD and D-LD all increased with increasing altitude. The antioxidant enzymes CAT, APX, SOD, GSH and GSNOR showed an increasing trend. When we treat *Lamiophlomis rotata* with different concentration of NaHS which was H_2S donor, the content of antioxidant enzymes increased with increasing NaHS. In contrast, when different concentration of H_2S synthase inhibitor PAG or H_2S scavenger HT was sprayed on leaves of *Lamiophlomis rotata*, the content of antioxidant enzymes decreased. The results showed the signal molecule of H_2S promoted the expression of antioxidant enzymes to enhance the response of *Lamiophlomis rotata* to stress.

With increasing altitude, the harsh environment of *Lamiophlomis rotata* exposed was more seriously and increasing gas transmitter H_2S promoted the expression of antioxidant enzymes to remove the oxidative damage. We firstly put forward H_2S played an important role on the adaptaion of *Lamiophlomis rotata* to huge enviorment change at different altitude gradients.

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Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

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