

蔗糖通过能量和信号双重作用促进黑果枸杞枝刺发生*

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摘要: 黑果枸杞是重要的生态经济型多枝刺灌木。在移栽相同条件下, 同一无性系的黑果枸杞植株呈现出“少叶无刺”和“多叶带刺”两种类型。鉴于两种材料第一茎节刺原基的明显差异, 并且生理和基因表达差异通常早于形态差异, 应选择无刺和有刺枝条的顶芽 (Thless 和 Thorny) 作为进一步研究的材料。RNA-Seq 分析显示, 淀粉和蔗糖代谢 KEGG 通路以及该通路上的差异基因 *SUT13*、*SUS*、*TPP* 和 *TPS* 在有刺材料中显著上调。有刺和无刺材料之间差异基因注释最多的 COG 功能类群为碳水化合物转运和代谢。生理测定发现, 有刺顶芽中蔗糖含量显著高于无刺顶芽, 而海藻糖-6-磷酸 (T6P) 含量则恰好与之相反。剪叶处理降低了蔗糖含量, 抑制了枝刺的发生/发育; 施加 16 g/L 外源蔗糖对枝刺的发生和发育的促进作用显著高于非代谢性蔗糖类似物的处理。这些结果表明, 蔗糖可能在枝刺的发生过程中起着能量和信号的双重作用。多叶导致的顶芽高蔗糖供应 (由低 T6P 介导) 有促进黑果枸杞可见枝刺发生的作用; 少叶导致的顶芽低蔗糖供应 (由高 T6P 介导) 能够抑制其可见枝刺发生; *SUT13*、*SUS*、*TPP* 和 *TPS* 基因在该过程中可能发挥了重要作用。本研究建立了叶片数量/蔗糖供应控制黑果枸杞可见枝刺发生的分子假说模型, 为培育无刺黑果枸杞及其他木本植株的无刺类型奠定基础。

关键词: 黑果枸杞; 枝刺; 蔗糖; 海藻糖-6-磷酸; 糖信号

Sucrose promotes branch-thorn occurrence of *Lycium ruthenicum* through dual effects of energy and signal

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Lycium ruthenicum is an important eco-economic thorny shrub. In this study, *L. ruthenicum* plants of a clone showed two types of ‘less leaves without thorn’ and ‘more leaves with thorns’ under the same condition after transplanting. Morphological differences of organisms usually lag behind the related gene expression and physiological differences. Thus, to excavate the key genes involved in the occurrence of visible thorns of *L. ruthenicum*, the materials before the first thorn primordium should be selected for comparison. RNA-Seq analysis showed that KEGG pathway of *Starch and sucrose metabolism* and DEGs of *SUT13*, *SUS*, *TPP* and *TPS* were significantly up-regulated in the Thorny. The COG Function Class with the largest number of DEGs between the Thless and Thorny was *Carbohydrate transport and metabol*

ism. The content of sucrose in the Thorny was significantly higher than that in the Thless, but the content of trehalose-6-phosphate was opposite. Leaf-clipping treatments reduced sucrose content and inhibited the occurrence/development of branch-thorns; exogenous sucrose of 16g/L significantly promoted the occurrence and growth of branch-thorns and the promotion effects were significantly higher than those treated with non-metabolizable sucrose analogs. These findings suggested that sucrose might play a dual role of energy and signal in the occurrence of branch-thorns. Higher sucrose supply in apical buds from more leaves promoted the occurrence of branch-thorns via lower content of trehalose-6-phosphate and higher expression levels of *SUS*, *TPP* and *TPS*, whereas less leaves inhibited the occurrence. Molecular hypothesis model of leaf number/sucrose supply regulating the occurrence of branch-thorns in *L. ruthenicum* was established in the study, which provides foundation for breeding both thornless *L. ruthenicum* and thornless types of other species.

Key words: black wolfberry; branch thorn; sucrose; trehalose-6-phosphate; sugar signal