Brassinosteroid overproduction improves poplar biomass quantity and quality to maximize bioethanol yield under green-like process

Abstract:

Cellulosic ethanol has been evaluated as perfect additive to gasoline with less net carbon release, and woody plants are leading biomass feedstock for biofuels. It becomes important to reduce lignocellulose recalcitrance using genetic engineering approaches and advanced biomass process in woody plants. Here, we cloned and characterized *PtoDET2*, a brassinosteroid biosynthesis gene. Overexpression of *PtoDET2* in poplar promoted plant growth rate and biomass yield, increased xylem development and cell wall polymer deposition. Meanwhile, the *PtoDET2*-OE poplar showed significantly improved lignocellulose features such as reduced cellulose CrI, DP values, hemicellulose Xyl/Ara ratio, and increased biomass porosity and accessibility, leading to remarkably enhanced biomass enzymatic saccharification and bioethanol yield. In contrast, the CRISPR/Cas9-generated mutation of *PtoDET2* showed the opposite results. Additionally, the optimal green-like pretreatment for high bioethanol yield was established. Taken together, this study has hence demonstrated a powerful strategy to enhance bioethanol production by regulating brassinosteroid biosynthesis, and provided green-like biomass process for woody plants.

Key words:

brassinosteroid, bioethanol, saccharification, lignocellulose modification, green-like pretreatments.

Brief Biography

Brief CV

Name: Chunfen Fan

Title: Postdoctoral
Institution: Southwest Universit
Address: School of Life Sciences, Southwest University,
Chongqing 400715, China.
Email: luckyfcf@swu.edu.cn

Education and Professional Career:

Huazhong Agricultural University

Bachelor of Agronomy, College of Plant Science & Technology 2005/09-2009/06
PhD. Crop Biotechnology, College of Plant Science & Technology 2009/09-2017/06

Southwest University

Pos-Doc., Biology, School of Life Sciences 2017/10-

Research Interests:

Plant cell wall biosynthesis, hormones, bioethanol

Selected publications

(1) **Fan CF**, Li Y, Hu Z, Hu HZ, Wang YT, Li A, et al. Ectopic expression of a novel *OsExtensin*-like gene consistently enhances plant lodging resistance by regulating cell elongation and cell wall thickening in rice. *Plant Biotechnology Journal*, 2018, 16(1), 254-263.
(2) **Fan CF**, Feng SQ, Huang JF, Wang YT, Wu LM, Li XK, et al. AtCesA8-driven OsSUS3 expression leads to largely enhanced biomass saccharifcation and lodging resistance by distinctively altering lignocellulose features in rice. *Biotechnology for Biofuels*, 2017, 10(1): 221.
(3) Wang YT[#], **Fan CF**[#], Hu HZ, Li Y, Sun D, Wang YM, et al. Genetic modification of plant cell walls to enhance biomass yield and biofuel production in bioenergy crops. *Biotechnology Advances*, 2016, 34(5): 997-1017.
(4) **Fan CF**, Wang YT, Peng LC, Feng SQ. Plant extensins function and their potential genetic manipulation in crops. *Plant Physiology Journal*, 2018, 54(8):1279-1287.
(5) Hu HZ, Zhang R, Feng SQ, Wang YM, Wang YT, **Fan CF**, et al. Three AtCesA6-like members enhance biomass production by distinctively promoting cell growth in Arabidopsis. *Plant Biotechnology Journal*, 2018, 16(5), 976-988.
(6) Hu HZ, Zhang R, Dong SC, Li Y, **Fan CF**, Wang YT, et al. AtCSLD3 and GhCSLD3 mediate root growth and cell elongation downstream of the ethylene response pathway in Arabidopsis. *Journal of Experimental Botany*, 2017, 69(5), 1065-1080.
(7) Li XK, Liao HF, **Fan CF**, Hu HZ, Li Y, Li J, et al. Distinct geographical distribution of the Miscanthus accessions with varied biomass enzymatic saccharification. *PLOS ONE*, 2016, 11(8), e0160026.
(8) Si SL[#], Chen Y[#], **Fan CF**, Hu HZ, Li Y, Huang JF, et al. Lignin extraction distinctively enhances biomass enzymatic saccharification in hemicelluloses-rich Miscanthus species under various alkali and acid pretreatments. *Bioresource Technology*, 2015, 183: 248-254.
(9) Wu LM, Li M, Huang JF, Hu SW, Li Y, **Fan CF**, et al. A near infrared spectroscopic assay for stalk soluble sugars, bagasse enzymatic saccharification and wall polymers in sweet sorghum. *Bioresource Technology*, 2015, 177: 118-124.
(10) Sun HY, Guo K, Feng SQ, Zou WH, Li Y, **Fan CF**, et al. Positive selection drives adaptive diversification of the 4-coumarate: CoA ligase (4CL) gene in angiosperms. *Ecology and Evolution*, 2015, 5(16): 3413-3420.
(11) Li M[#], Feng SQ[#], Wu LM, Li Y, **Fan CF**, Zhang R, et al. Sugar-rich sweet sorghum is distinctively affected by wall polymer features for biomass digestibility and ethanol fermentation in bagasse. *Bioresource Technology*, 2014, 167: 14-23.
(12) Sun HY, Li Y, Feng SQ, Zou WH, Guo K, **Fan CF**, et al. Analysis of five rice 4-coumarate: coenzyme a ligase enzyme activity and stress response for potential roles in lignin and flavonoid biosynthesis in rice. *Biochemical and Biophysical Research Communications*, 2013, 430(3):1151-1156.