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姓　　名：普天磊　20141058

学　　校：云南中医学院

院（系）：研究生部

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基于SNP和InDel标记的余甘子群体遗传分析

普天磊,金 杰,何 璐,瞿文林,廖承飞,袁建民,罗会英,赵琼玲*

(云南省农业科学院热区生态农业研究所•元谋干热河谷植物园,云南元谋 651300)

摘 要:【目的】采用高通量测序技术解析余甘子种质资源的群体遗传结构和遗传多样性,为余甘子系统分类、遗传资源创新利用提供理论基础。**【方法】**利用ddRADseq技术对112份余甘子种质资源进行高通量简化基因组测序,利用Cutadapt和Trimmomatic软件对原始数据进行过滤,筛选得到高质量测序数据;使用MUNEAK软件进行多态性标记发掘,基于获得的SNP和InDel标记,进行群体结构分析、主成分分析、系统发育分析及遗传多样性分析。**【结果】**余甘子测序样品共获得8934个SNP和InDel标记,群体结构分析将余甘子种质分为2个类群,类群划分与种质来源地相关,该结果与主成分分析和系统发育分析相一致。余甘子各种质间遗传距离为0.027~0.459,平均遗传距离为0.248;云南地区的余甘子种质的期望杂合度、观测杂合度及多态性信息含量值最高,依次为0.267、0.184及0.218;余甘子群体间的Fst在0.080~0.266之间,群体遗传分化程度中等偏高。**【结论】**该测序技术可有效地解析余甘子种质的群体结构和遗传多样性,为余甘子种质资源的鉴定评价、系统分类及遗传多样性研究提供参考。

关键词:余甘子;SNP;InDel;群体结构;遗传多样性

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Population and genetic analysis of *Phyllanthus emblica* by SNP and InDel markers

PU Tianlei, JIN Jie, HE Lu, QU Wenlin, LIAO Chengfei, YUAN Jianmin, LUO Huiying, ZHAO Qiongling*

(Institute of Tropical Eco-agriculture Yunnan Academy of Agricultural Sciences/Yuanmou Dry-Hot Valley Botanical Garden, Yuanmou 651300, Yunnan, China)

Abstract:【Objective】Based on SNP and InDel molecular markers, the high-throughput sequencing technology-ddRADseq was used to analyze the genetic background of 112 wild *Phyllanthus emblica* germplasms collected from different origins. The population genetic structure and genetic diversity of *P. emblica* germplasm resources were analyzed in order to provide a theoretical basis for the systematic classification and innovative utilization of genetic resources of *P. emblica*.【Methods】The leaves of 112 *P. emblica* germplasms from different origins were collected and preserved for future use. Among them, 3 accessions were introduced from Fujian, 9 accessions from Guangxi, 11 accessions from Yunnan. The genomic DNA of *P. emblica* leaves was extracted by the improved CTAB method. The purity and concentration of the genomic DNA were tested. The ddRADseq technology was used to perform high-throughput simplified genome sequencing on 112 *P. emblica* germplasm resources. The original data were filtered by Cutadapt software and Trimmomatic software to obtain high-quality sequencing data. The MUNEAK software was used to develop polymorphic markers. Based on the obtained SNP and InDel markers, the STRUCTURE software was used to analyze the population structure and calculate the value of ΔK. The most reasonable number of group number and the attribution of each sample were

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作者简介:普天磊,女,研究实习员,硕士,研究方向:功能植物资源与利用。Tel:0878-8225680,E-mail:1041661300@qq.com

*通信作者 Author for correspondence. Tel:0878-8225680,E-mail:qionglingzhao@163.com

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辣木抗逆相关研究现状及应用

普天磊 韩学琴 廖承飞 邓红山 罗会英 金杰
（云南省农业科学院热区生态农业研究所 元谋干热河谷植物园，元谋 651300）

摘 要： 辣木（*Moringa oleifera* Lam）属于热带、亚热带速生树种，具有耐高温、耐贫瘠、耐旱等优良抗性，营养成分和功能性成分含量丰富，可应用于食品、保健品、饲料等多种领域。全球环境变化和人类活动使非生物胁迫加剧，辣木的非生物胁迫抗性越来越受关注，包括干旱胁迫、低温胁迫和盐胁迫抗性。同时，辣木提取物可作为安全有效的生长调节剂，缓解非生物胁迫对植物的损伤，促进植物生长，提高抗逆性，改善产量和品质。无论是辣木的抗逆性研究还是辣木生长调节剂的应用研究，主要通过植物的形态、产量/品质、渗透调节系统、酶保护系统、光合系统、分子水平等相关参数的变化来评价辣木植株或品种的抗性及对逆境损伤植物的改善程度。综述了近年来辣木抗逆研究现状及其提取物在植物抗逆上的应用进展，对其中存在的问题进行讨论，并提出展望，以期为辣木抗逆育种研究、抗逆机制研究及诱导植物抗逆性的应用研究提供参考。

关键词： 辣木；辣木提取物；抗逆；生长调节剂
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Research Status on the Stress Resistance of *Moringa oleifera* and Its Application

PU Tian-lei HAN Xue-qin LIAO Cheng-fei DEN Hong-shan LUO Hui-ying JIN Jie
(*Institute of Tropical Eco-agriculture Yunnan Academy of Agricultural Sciences/Yuanmou Dry-hot Valley Botanical Garden*, *Yuanmou* 651300)

Abstract: *Moringa oleifera* Lam is tropical and subtropical fast-growing tree species. It has excellent resistance to high temperature, barrens, and drought. It is rich in nutrient and functional ingredients, and thus it can be used in various fields such as food, health product, and fodder. The changes of global environmental and human activities have aggravated abiotic stress. The resistances of *M. oleifera* to abiotic stress, including drought, low temperature, and salt, have been attracted growing attentions. At the same time, the extract from *M. oleifera* can be used as a safe and effective biostimulant for alleviating the damage caused by abiotic stress, promoting plant growth, increasing stress resistance, and improving the yield and quality of plants. In either the study of abiotic stress resistance of *M. oleifera* or the study of *M. oleifera* growth regulators, the resistances of *M. oleifera* plant and species as well as the improvements to the plant damages by the stress were evaluated by the changes of relevant parameters, such as morphology, yield and quality, osmoregulatory systems, protective enzyme systems, photosynthetic systems, molecular levels, etc. This review summarizes the research status in last few years on the stress resistance of *M. oleifera* and the application progress of its extract in the stress resistance of plants, discusses the existing issues, and proposes the research prospects, aiming to provide references for studying the stress-resistant breeding, the mechanism of stress-resistance, as well as the application research of inducing plant stress resistance.

Key words: *Moringa oleifera*; extract from *Moringa oleifera*; stress resistance; plant growth regulator

辣木为十字花目辣木科辣木属多年生落叶乔木，其为单属科，现有 13 个种[1]，也有报道称 14 个种[2]，目前，常见的品种为印度传统辣木、印度培育的改良品种和非洲辣木[3]，主要在我国的云南、海南、

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作者简介：普天磊，女，硕士，研究方向：药用植物资源开发与利用；E-mail：1041661300@qq.com
通讯作者：金杰，男，研究员，研究方向：作物资源与利用；E-mail：276361917@qq.com